Tektronix®

8560

MULTI-USER SOFTWARE DEVELOPMENT UNIT

SERVICE

INSTRUCTION MANUAL

Tektronix®
COMMITTED TO EXCELLENCE

WARNING

THE FOLLOWING SERVICING INSTRUCTIONS ARE FOR USE BY QUALIFIED PERSONNEL ONLY. TO AVOID PERSONAL INJURY, DO NOT PERFORM ANY SERVICING OTHER THAN THAT CONTAINED IN OPERATING INSTRUCTIONS UNLESS YOU ARE QUALIFIED TO DO SO.

PRELIMINARY

PLEASE CHECK FOR CHANGE INFORMATION AT THE REAR OF THIS MANUAL.

8560
MULTI-USER SOFTWARE DEVELOPMENT UNIT
SERVICE

Tektronix, Inc.
P.O. Box 500
Beaverton, Oregon 97077

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Product Group 61

Serial Number ______________

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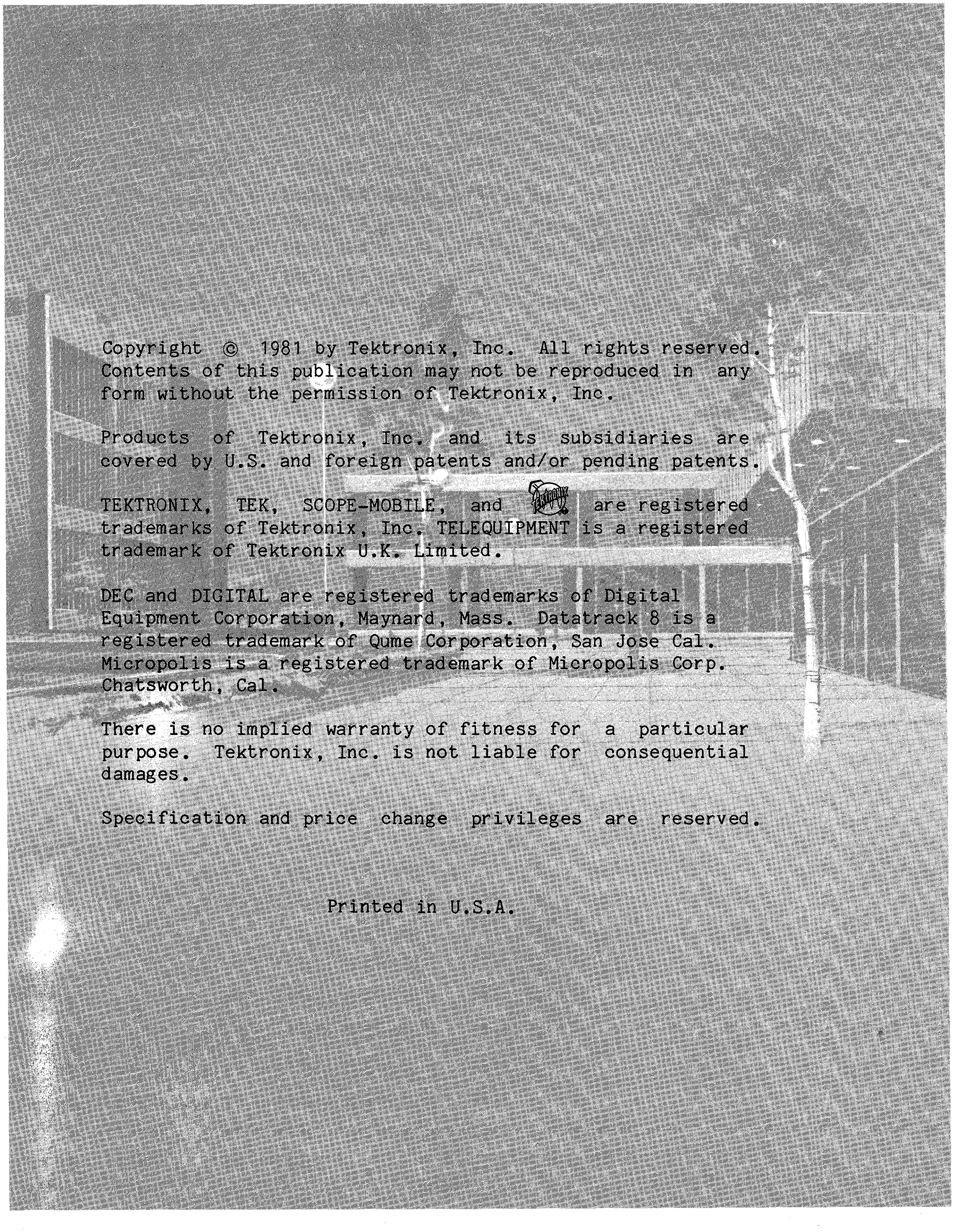


Printed in U.S.A.

PREFACE

RELATIONSHIP TO OTHER EQUIPMENT

The 8560 Multi-User Software Development Unit (MUSDU) is used primarily in conjunction with the 8540 Integration Unit. Together, the two units comprise a complete microcomputer development lab. Uses of this lab are described in separate user manuals.

MANUAL APPLICATION

This service manual describes the 8560 Multi-User Software Development Unit (MUSDU) in sufficient detail to permit service technicians to perform on-site board-level repairs.

ABOUT THIS MANUAL

This manual introduces you to the 8560 MUSDU Multi-user Software Development Unit (MUSDU). The manual also describes hardware operations within the 8560 at a block diagram level.

This Manual is organized into 22 sections. A brief description of each section follows:

Section 1	This section contains general information and an introduction to the 8560 MUSDU.
Section 2	This section contains the 8560 specifications.
Section 3	This section contains a brief description of front and rear panel controls, connectors, and indicators. It also contains board configuration drawings and tables, showing the default strap and jumper positions for each board.
Section 4	This section describes the LSI-11/23 Processor.
Section 5	This section describes the Utility board.
Section 6	This section describes the System Memory (RAM) board.
Section 7	This section describes the I/O Processor board.

SAFETY PRECAUTIONS

Grounding the Product

The 8560 is grounded through the grounding conductor of the power cord. To avoid electrical shock, plug the power cord into a properly wired receptacle before connecting to the equipment's power input terminals. A protective ground connection by way of the grounding conductor in the power cord is essential for safe operation.

Use the Proper Power Cord

Use only the power cord and connector specified for your product.

Use only a power cord that is in good condition.

Refer cord and connector changes to qualified service personnel.

Use the Proper Fuse

To avoid fire hazard, use only the fuse specified in the parts list for your product. Be sure the fuse is identical in type, voltage rating, and current rating.

Refer fuse replacement to qualified service personnel.

Do Not Operate in Explosive Atmospheres

To avoid explosion, do not operate the 8560 in an atmosphere of explosive gases.

Do Not Remove Covers or Panels

To avoid personal injury, do not remove covers or panels from the 8560. Do not operate the 8560 without the covers and panels properly installed.

SERVICING SAFETY SUMMARY

FOR QUALIFIED SERVICE PERSONNEL ONLY

(Refer also to the preceding Operators Safety Summary)

DO NOT SERVICE ALONE

Do not perform internal service or adjustment on the 8560 unless another person capable of rendering first aid and resuscitation is present.

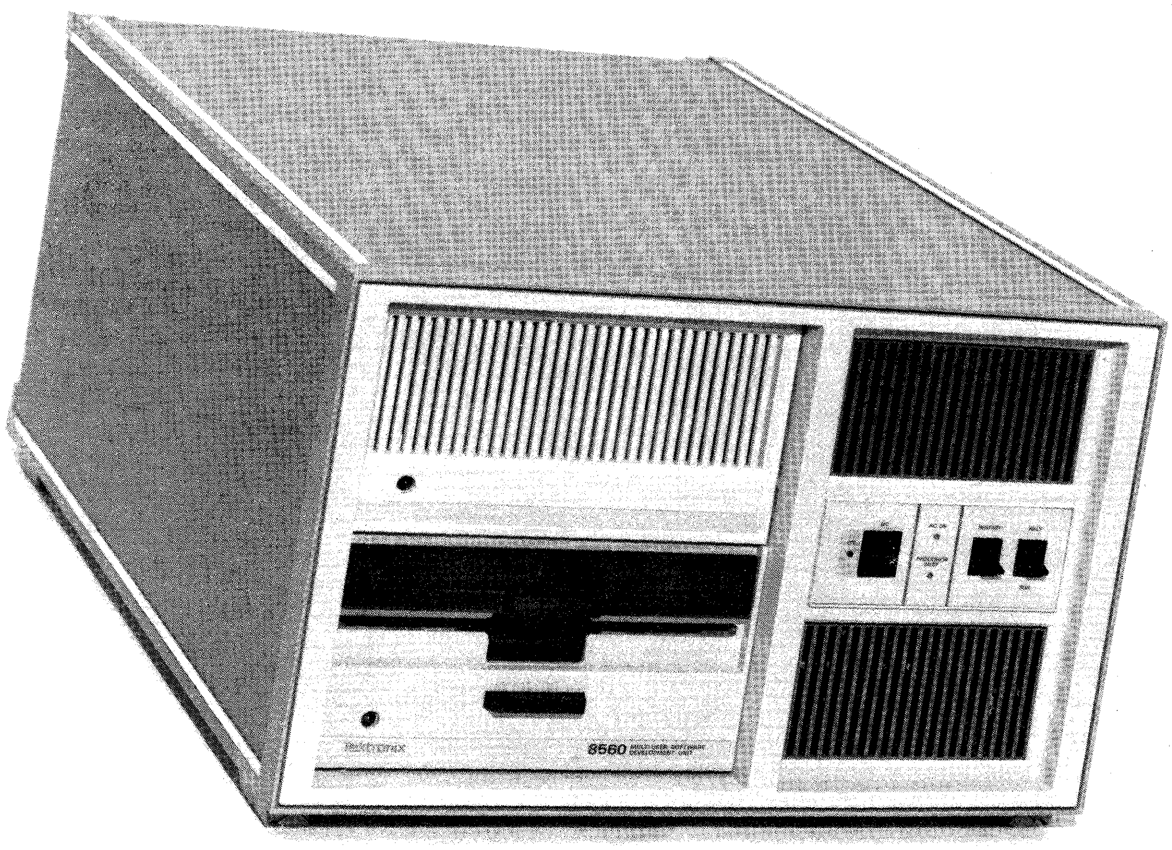
USE CARE WHEN SERVICING WITH POWER ON

Dangerous voltages exist at several points in the 8560. To avoid personal injury, do not touch exposed connections and components while power is on.

Disconnect power before removing protective panels, soldering, or replacing components.

POWER SOURCE

The 8560 is designed to operate from a power source that will not apply more than 250 volts rms between the supply conductors or between either supply conductor and ground. A protective ground connection by way of the grounding conductor in the power cord is essential for safe operation.



8560 Multi-User Software Development Unit

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Section 8 This section describes the I/O Adapter and I/O Connector boards.

Section 9 This section describes the PMS Controller board.

Section 10 This section describes the Micropolis M1220 Interface board

Section 11 This section provides a general description of the hard disc and flexible disc drive units.

Section 12 This section describes the 8560 power supply. It also contains procedures for bringing up and adjusting the supply.

Section 13 This section describes the 8560 power-up diagnostics.

Section 14 This section contains an adjustment procedure for the power supply +5V reference.

Section 15 This section describes all Power-Up Diagnostic Tests. It also describes how the tests can be used to isolate problems if any diagnostic test fails to execute properly.

Section 16 This section describes all disc-resident diagnostic tests.

Section 17 This section lists the 8560 MUSDU options.

Section 18 Installation information is provided in this section.

Section 19 This section contains reference material such as bus signal mnemonic descriptions, and Main Interconnect board connector pin assignments.

Section 20 This section contains the 8560 Replaceable Electrical Parts list.

Section 21 This section contains the 8560 Schematic Diagrams.

Section 22 This section contains the Replaceable Mechanical Parts list.

MANUAL CONVENTIONS

SIGNAL LINE CONVENTIONS

The schematic drawings in this manual use a high/low convention to describe the asserted state of all signal lines. The asserted (true) state of each signal line is shown as (L) for low or (H) for high, immediately following the signal line name as follows:

- SLVOPREQ(L)
- CMEM(H)
- M(L)/IO(H)

SLASHED ZEROS

Throughout the text in this manual, zeros are not slashed.

HEXADECIMAL NOTATION

All address references in this manual are represented by hexadecimal numbers. The contents of 8-bit registers and data busses are also represented by hexadecimal numbers. Exceptions are made in some instances when binary values are noted.

CHANGE INFORMATION

Change notices are issued by Tektronix, Inc. to document changes in the manual after it has been published. Change information is located in the back of this manual, following the yellow tab marked "CHANGE INFORMATION & TEST EQUIPMENT". When you receive this manual, enter any change information into the body of the manual, as indicated on the change notice.

REVISION HISTORY

As this manual is revised and reprinted, revision history information is included in the text and diagrams. Original manual pages are indicated by the "@" symbol at the bottom inside corner of the page. Existing pages of manuals that have been revised are indicated by a revision code and date (REV OCT 1981) in place of the "@" symbol. New pages added to an existing section (whether they contain old, new, or revised information) contain the "@" symbol alongside the revision date (@ OCT 1981).

OPERATIONAL AND INSTALLATION INFORMATION

A minimum of operational and installation information is presented in this manual. Refer to the 8560 MUSDU System Users Guide for information regarding operating procedures. Refer to the 8560 MUSDU Installation Guide for information regarding system installation and initial start-up procedures.

OPTIONS

8560 options are documented by individual manuals. See the Tektronix Products catalog or contact your local Tektronix Field Office or representative for a list of available options.

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ACCESSORIES

CHANGE INFORMATION

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OPERATORS SAFETY SUMMARY

The general safety information in this part of the summary is for both operating and servicing personnel. Specific warnings and cautions will be found throughout the manual where they apply, but may not appear in this summary.

TERMS

In This Manual

CAUTION statements identify conditions or practices that could result in damage to the equipment or other property.

WARNING statements identify conditions or practices that could result in personal injury or loss of life.

As Marked on Equipment

CAUTION indicates a personal injury hazard not immediately accessible as one reads the marking, or a hazard to property including the equipment itself.

DANGER indicates a personal injury hazard immediately accessible as one reads the marking.

SYMBOLS

As Marked on Equipment

⚡ DANGER high voltage.

⏚ Protective ground (earth) terminal.

⚠ ATTENTION - Refer to manual.

Section 1

GENERAL INFORMATION

ILLUSTRATIONS

Section 1

GENERAL INFORMATION

INTRODUCTION

Section 1 introduces the 8560 Multi-User Software Development Unit. It introduces individual hardware system building blocks, and discusses their relationship to each other. This section also introduces the system's operating software and the diagnostic firmware/software.

THE 8560 MUSDU

The 8560 Multi-User Software Development Unit (MUSDU) is a 16-bit bus-oriented computer with mass storage. The 8560 MUSDU allows up to eight users to simultaneously develop programs for their 8540 Integration Unit workstation. The 8560 consists of these major components:

- system hardware,
- operating firmware
- diagnostic firmware
- diagnostic software, and
- operating software.

The 8560 MUSDU's main purpose is to serve as a program development tool and provide file management for the 8540. Data storage is on two disc drives. A Winchester-technology hard disc drive unit stores up to 35 M-bytes of data. A second disc drive-unit provides 1 M-byte of storage on double-sided, double-density flexible discs.

This manual describes system hardware, diagnostic firmware, and diagnostic software. Furthermore, this manual introduces operating firmware for two micro-processor-controlled boards.

8560 System Software, the TNIX Operating System and its components, are described in a separate 8560 Users Manual.

HARDWARE CONFIGURATION

The 8560 MUSDU is a single-enclosure mainframe. It contains power supplies, disc drives and all control circuits in a bus-oriented system architecture.

The 8560 main controller is a Digital Equipment Corp LSI-11/23 processor. Two additional processor controlled boards work in conjunction with the LSI-11/23. Figure 1-1 shows a simplified 8560 block diagram.

The 8560 MUSDU employs the back-plane concept. In that concept, a horizontally located board serves as the mother board into which the major system boards plug into. In the 8560 MUSDU, this board is called the Main Interconnect board. It provides the vehicle for the 100-line wide 8560 bus.

The Main Interconnect board provides direct system bus-access for the following boards:

- the LSI-11/23 Processor,
- the PMS Controller,
- two System Memory boards
- two I/O Processor boards
- the Utility board

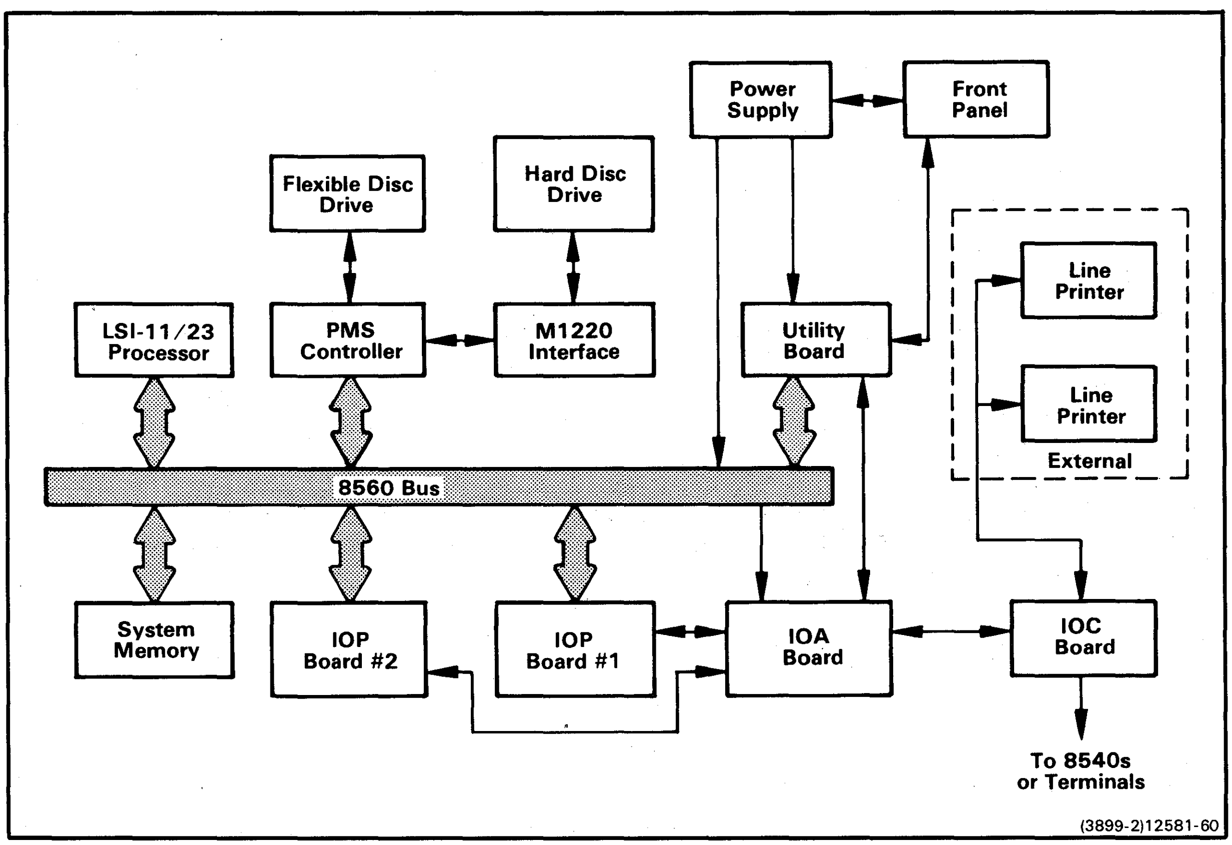


Fig. 1-1. 8560 system block diagram.

THE 8560 BUS

The 8560 bus is the main system bus. The 100-line wide bus is based on the DEC "Q-bus" but with increased flexibility. The DEC interrupt structure is retained, as is most of the DEC signal protocol. Each 8560 circuit board interfaces directly with the 8560 bus. The 8560 bus provides 22 data lines. (For more 8560 bus information see Section 19 in this manual.)

THE MAIN INTERCONNECT BOARD

The Main Interconnect board is a horizontally mounted circuit board located near the cabinet bottom adjacent to the drive units. The Main Interconnect board provides a vehicle for the 100 line-wide 8560 system bus. 72 of those lines serve the LSI-11/23. The remaining 28 lines provide specific board functions for the previously listed boards.

The Main Interconnect board contains one 72-pin connectors and eight 100-pin connectors. The 72-pin connector connects to the LSI-11/23. All other 8560 system boards, except the power supply and two I/O boards, plug into the Main Interconnect board's 100 pin connectors. Because of the 8560 bus structure, each circuit board is assigned a specific connector. Figure 1-2 shows the system bus and a typical system configuration.

The Main Interconnect board also contains seven bus grant jumpers that pass the system bus grant to the next installed board when a connector is empty. Section 20 of this manual provides connector wiring charts, and Section 3 identifies the bus grant jumpers.

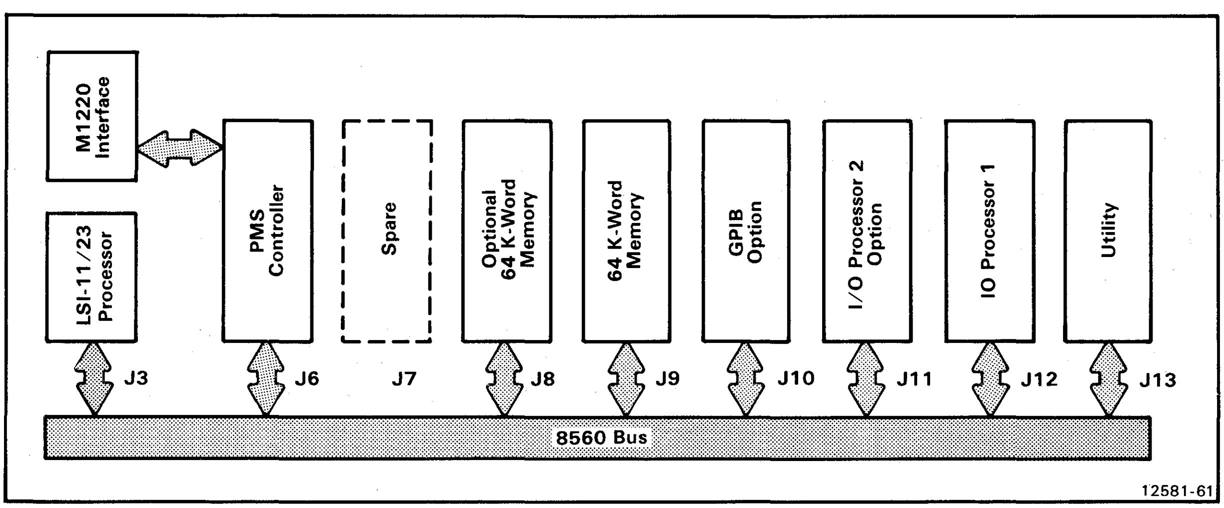


Fig. 1-2. Typical 8560 Configuration.

THE LSI-11/23 PROCESSOR

The 8560 MUSDU uses the Digital Equipment Corporation LSI-11/23 16-bit microcomputer as its main control unit. The heart of the LSI-11/23 microcomputer is the LSI-11/23 chip set. The LSI-11/23 chip set consists of three LSI devices: a data control unit, a memory management unit, and an optional floating point arithmetic unit.

THE UTILITY BOARD

The Utility board contains miscellaneous logic for a number of 8560 functions. The Utility board has the following features:

- Two RS-232-C Interfaces
- Line-Time Clock Control circuit (LTC)
- System bootstrap firmware
- RAM board service routine firmware
- Power-up diagnostics firmware

The Utility board plugs into connector J13 of the Main Interconnect board.

THE SYSTEM MEMORY BOARD

The 8560 system memory consists of 64 K-words of RAM located on one circuit board. Another 64 K-word RAM board may be added to increase 8560 memory to 128 K-words. The two boards plug in Main Interconnect board connectors J8 and J9.

THE I/O PROCESSOR (IOP) BOARD

The I/O Processor board is an 8088-controlled communications board. The IOP controls data flow to and from external 8560 peripherals. The IOP relieves the LSI-11/23 of most I/O processing chores that are associated with external 8560 peripheral communications.

One IOP board plugs into Main Interconnect board connector J12, and processes data for four HSI channels. A second optional IOP board plugs into connector J11 and increases the number of available HSI ports to eight.

THE I/O ADAPTER (IOA) BOARD

The I/O Adapter (IOA) board is a small circuit board mounted to the side rail near the rear of the 8560 cabinet. The IOA board services eight high speed interface (HSI) ports and two RS-232-C-compatible printer ports.

HSI ports 0-7 operate under either High Speed Interface protocol (electrically compatible with RS-422) or RS-232-C protocol. The PRINTER ports operate only under RS-232-C protocol.

THE I/O CONNECTOR (IOC) BOARD

The I/O Connector (IOC) board is a small circuit board without active devices that contains up to ten 25-pin D-type connectors. The board is mounted on the rear panel with the connectors protruding through the rear panel. The connectors are accessible from the cabinet outside; and serve printer ports LP1 and LP2, and HSI ports 0 - 7.

THE PERIPHERAL MASS STORAGE (PMS) CONTROLLER

The Peripheral Mass Storage (PMS) Controller controls all interfacing between the flexible and hard disc drives and the 8560 system. The PMS controller consists of two circuit boards: the PMS Controller board; and the attached Micropolis M220 Interface board.

The PMS Controller Board

The PMS Controller board provides control and interface functions for the flexible disc, and control functions for the hard disc drive. The PMS Controller board is Z80-based, and can assume 8560 bus mastership whenever required. This board plugs into Main Interconnect board connector J6.

The Micropolis M1220 Interface

The M1220 Interface provides interfacing logic for the Micropolis M1223-1 hard disc drive. The M1220 Interface is attached in piggy-back fashion to the PMS Controller board, and interfaces with it, and the Micropolis M1223 Winchester-technology hard disc drive, henceforth called the hard disc. The Miccropolis Interface is controlled by the PMS Controller board and its Z80 processor. Thus, the two boards operate in a master/slave fashion.

THE POWER SUPPLY

The 8560 power supply provides four DC voltages and one AC voltage. It generates DC voltages in four steps from the AC line voltage.

MECHANICAL PACKAGE

INTRODUCTION

The 8560 mechanical package consists of mounting hardware, a Qume flexible disc drive, and Micropolis Winchester-technology hard disc drive, all in a covered enclosure. The power supply is in an enclosed assembly that occupies the left rear corner. Attached to the rear of the 8560 is a fan enclosure. The fan provides cooling for the disc drives, power supply assembly, and circuit boards. Section 11 provides additional information on the two disc drives.

THE FLEXIBLE DISC DRIVE

The 8560 flexible disc drive is a Qume Corporation DataTrack 8. This unit utilizes standard removable eight-inch flexible IBM discs. The flexible disc drive can store data on double-sided single-density discs (0.6M-bytes of storage), or on double-sided double-density discs (1.2M-bytes of storage).

THE WINCHESTER-TECHNOLOGY HARD DISC DRIVE

The 8560 hard disc drive-unit is the winchester-technology 35 M-byte Micropolis Model M1223-1. This hard disc drive unit contains a control/interface board on top that is hinged to provide access to both board sides.

The discs themselves are located in the sealed chamber that comprises the lower part of the drive unit. To service the discs the whole drive unit must be completely removed. and returned to your Tektronix Service Center. For more service information and instructions to remove the hard disc drive see Section 15, Maintenance.

THE FRONT CONTROL PANEL

The front control panel contains the front panel board, DC, HALT/RUN, RESTART switches and three LED status indicators.

Front Panel Board

The front panel board is located to the right of the two disc drives, directly behind the front panel. The RESTART, DC, and RUN/HALT switches are mounted on the front panel board, and extend through the Front Control Panel. The DC ON power switch, however, is mounted directly on the front control panel.

THE REAR PANEL

The 8560 rear panel contains up to eight High-Speed Interface (HSI) ports, two auxiliary RS-232 compatible ports, a primary power switch, line fuse, primary line-voltage indicator, and the power-supply fan assembly.

OPERATING FIRMWARE

The 8560 operating firmware provides instructions for the micro-processor controlled system boards. Operating firmware is located in the Utility, PMS Controller, I/O Processor and M1220 Interface boards 8560 operating firmware falls into two categories:

- System boot-up firmware;
- firmware containing instructions for the PMS Controller and the I/O Processor.

BOOT-UP FIRMWARE

The 8560 boot-up firmware is the first firmware executed when the 8560 is turned on or restarted. The boot-up firmware is located on the Utility board. The boot-up firmware performs system initialization, and then turns control over to the power-up diagnostics. Once the power-up diagnostics has checked system operation, it returns control to boot-up firmware, which moves the 8560 operating system from disc into memory. At that point, system control is turned over to the operating system. The boot-up and power-up diagnostics are executed by the 8560's LSI-11/23 processor.

CONTROLLER FIRMWARE

As previously stated, the PMS Controller and I/O Processor are both micro-processor controlled. The IOP board contains 24 K-bytes of controller firmware in ROM. The PMS Controller and Interface boards together contain 16 K-bytes of controller firmware in ROM.

DIAGNOSTIC FIRMWARE

8560 diagnostic firmware informs you of the overall system conditions; and provides you with specific system status information. 8560 Diagnostic firmware provides power-up tests for the user and the service technician, and service routines for the technician.

8560 diagnostic firmware consists of power-up diagnostic tests including disc drive service routines service routines for the system Memory boards.

The power-up tests together with the system memory board firmware are located on the Utility board. They share 2 k-bytes of ROM with the Boot-up routines. Power-up tests are described in Section 13.

Another, not previously mentioned firmware package, is the ODT (Octal Debugging Technique) firmware. ODT is located in unchangeable microcode and is part of the LSI-11/23 chip-set. Section 13 describes ODT usage. ODT allows you to look at memory and I/O port locations, and check the status of the LSI-11/23.

POWER-UP DIAGNOSTICS FIRMWARE

8560 Power-up diagnostics perform a general system check, verifying that all standard circuit boards are installed, and are in working condition. If a failure is detected, the power-up diagnostics identify the failure with a message on the system terminal. Power-up diagnostics are further described in Section 13 of this manual.

DIAGNOSTIC SOFTWARE

The 8560 provides you with another service tool -- Disc-based Diagnostics. 8560 Disc-based Diagnostics provide individual board test programs that you call from a terminal. These programs locate problem areas to the block diagram level. The disc-based diagnostics are stored on a separate flexible disc. Section 16 provides detailed descriptions of the tests and their functions.

OPERATING SOFTWARE

The 8560 operating software is an enhanced version of the popular UNIX* operating system called TNIX. The TNIX operating system is stored on the Micropolis Model M1223-1 Winchester-technology hard disc. The TNIX operating system is described in a separate systems users manual.

*UNIX is a registered trademark of Bell Laboratories

Section 2

SPECIFICATIONS

TABLES

Section 2

SPECIFICATIONS

INTRODUCTION

This section contains the 8560 system specifications. Table 2-1 lists the electrical specifications, Table 2-2 lists the environmental specifications, and Table 2-3 lists the physical specifications. Power supply internal specifications are given with the supply description in section 12. Section 14 of this manual provides power supply calibration information.

Table 2-1
Electrical Characteristics

Characteristic	Performance Requirements
Primary Power Input Voltages	90 to 132 Vac
	180 to 250 Vac
Frequency	48 to 66 Hz
Line Fuses 115 Vac	3AG, 8 Amps, 250 Volt, medium-blow (5 sec.)
230 Vac	3AG, 4 Amps, 250 Volt, medium-blow (5 sec.)
Power Consumption (maximum)	460 Watts
Power Supply	110 VAC for disc drive motor
	+5.0 Vdc +4%, -2%, 31A
	+12.0 Vdc +/- 3%, 1.7A
	-12.0 Vdc +/- 5%, 1.3A
	+24 VDC +/- 5% 4.0A.

Table 2-1 Electrical Characteristics (Cont.)

Characteristic	Performance Requirement
Static Discharge	
Operating	15 kV and below with no effect on operation of unit
	20 kV and below will not cause component failure

Table 2-2
Environmental Characteristics

Characteristic	Description
Temperature	
Operating	0 C to +40 C (+32 F to +104 F)
Storage	-55 C to +75 C (-67 F to +167 F)
Humidity	
Operating	To 90% relative non-condensing
Altitude	
Operating	To 2 500 m (8,000 feet)
Storage	To 12 200 m (40,000 feet)

Table 2-3
Physical Characteristics

Characteristic	Description
Net Weight	33 kg (72.5 lb.)
Overall Dimensions	
Height	267 mm (10.5 in.)
Width	432 mm (17 in.)
Length	646 mm (25.4 in.)

Section 3

OPERATING INFORMATION

ILLUSTRATIONS

TABLES

Section 3

OPERATING INFORMATION

INTRODUCTION

This section briefly describes all 8560 controls, connectors, and indicators. In addition, Section 3 gives the location of all circuit board straps and jumpers, and describes their functions.

Detailed 8560 operating information can be found in the 8560 System Users Manual. Refer to it for explanations of all software related questions.

CONTROLS, CONNECTORS, AND INDICATORS

The following paragraphs discuss the 8560 controls, connectors, and indicators. In addition, the pin configurations for all rear panel connectors are also included.

THE FRONT PANEL

Switches

The 8560 front panel has three switches: DC ON/OFF, RESTART, and RUN/HALT. They are described in the following text. Figure 3-1 shows the 8560 front panel layout.

DC ON/OFF

This switch supplies DC voltage to the system. When this switch is in the OFF position, the system is in the standby mode, and the AC ON indicator is lit. In this mode, the DC voltages are available on the power supply, but are not supplied to the individual circuits.

RESTART

Toggling this momentary-contact switch, resets the entire system to its initial state; and executes the power-up tests.

RUN/HALT

Toggling the RUN/HALT switch, halts the processor regardless what task it performs at the time.

Indicators

The front panel has three indicator lights. They are DC ON, PROCESSOR BUSY, and AC ON. Their description follows.

DC ON

This indicator is lit when the DC switch is in the ON position and DC power is applied to the system.

AC ON

This indicator is lit whenever the rear panel AC switch is on.

PROCESSOR BUSY

This indicator is lit when the LSI-11/23 is performing a task.

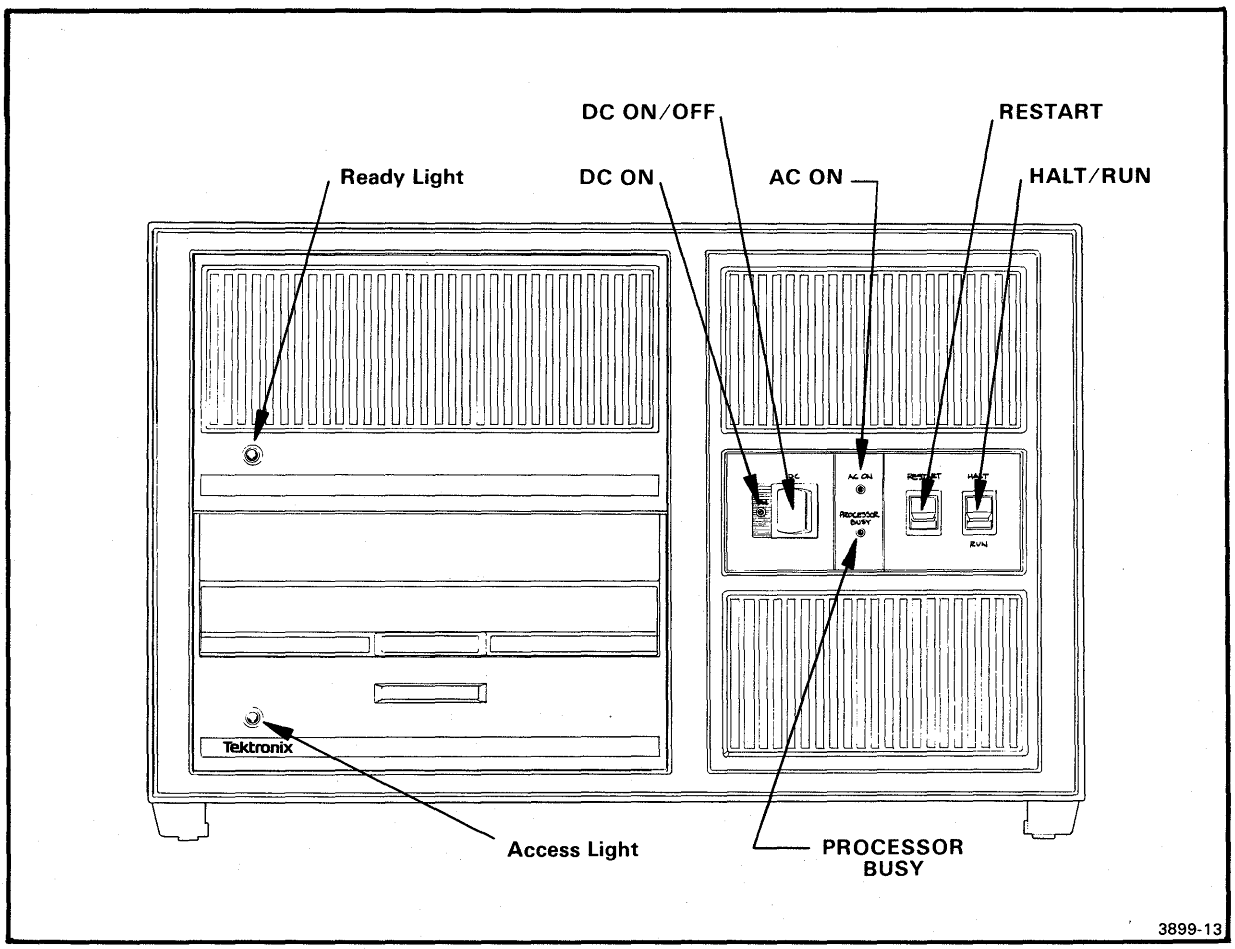


Fig. 3-1. 8560 Front panel controls and indicators.

THE REAR PANEL

Controls

POWER ON/OFF

This switch is the main system power switch, providing line voltage to the power supply. When this switch is ON, the front panel AC ON indicator is lit. Figure 3-2 shows the 8560 rear panel layout.

LINE FUSE

This is the line fuse for the 8560. If the instrument is configured for 115 Vac, use a 3AG, 8 Amp, 250 Volt, medium-blow (5 sec.) fuse. If the instrument is configured for 230 Vac, use a 3AG, 4 Amp, 250 Volt, medium-blow (5 sec.) fuse.

PRIMARY POWER PLUG

This is the primary power supply plug for the 8560. Only the line voltage indicated by the source voltage cover plate should be connected.

PRIMARY VOLTAGE SOURCE

The primary voltage source for an 8560 is selected at the factory. A cover plate on the instrument rear panel indicates which of two possible voltage sources is selected. To change the voltage source, remove this cover plate, change the two-position switch, replace the cover plate to indicate the new setting.

If you change the voltage source, be certain that your instrument has the proper fuse for the new configuration.

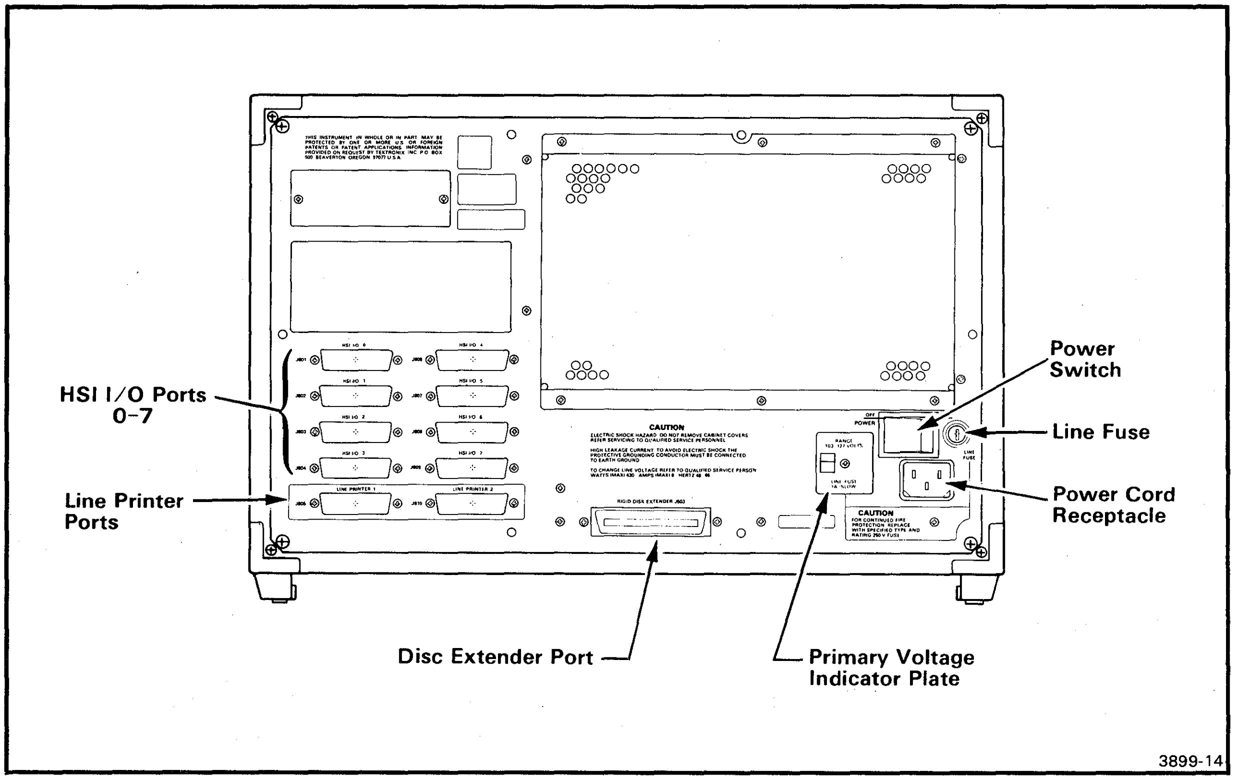


Fig. 3-2. 8560 Rear panel control and connectors.

Connectors

HSI PORTS 0 - 7

J801 through J804 and J806 through J809 are the High-Speed Serial Interface (HSI) Ports. In a standard configuration, only sockets J804 through 806 are available. The HSI Ports are modified RS-422-compatible serial ports designed to communicate with a workstation such as the TEKTRONIX 8540 Integration Unit..

The HSI ports transmit and receive at 153.6 K-baud. Any HSI port, however, can be reconfigured to operate under RS-232-C protocol by moving the appropriate jumper block on the IOA board. this allows you to connect a system terminal directly to the 8560. Instructions to configure an HSI port and an RS-232 port are located in Section 8 of this manual. Table 3-1 show HSI port pin assignments.

Table 3-1
HSI Port Configurations

Pin	Function
1	Shield
7	Signal Ground
2	R DATA -- Receive Data
11	R DATA'
3	T DATA -- Transmit Data
12	T DATA'
20	DTR -- Data Terminal Ready
13	DTR'
5	CTS -- Clear To Send
25	CTS'
6	DSR -- Data Set Ready
18	DSR'
8	CAR DET -- Carrier Detect
9	CAR DET'

Notes: (1) The DSR and CAR DET signals are always transmitted on.
(2) During RS-232-C operation, only the positive (+) side

PRINTER PORTS 1 and 2

J8051 and J8101 are the ports that provide communications with auxiliary equipment, such as line printers and terminals. These ports are RS-232-C compatible and have switch-selectable baud rates. Table 3-2 gives pin configurations for the PRINTER PORTS.

Table 3-2
Line Printer Port Configuration

Pin	Function
1	Shield
7	Signal Ground
2	R DATA - Receive Data
3	T DATA - Transmitted Data
20	DTR - Data Terminal Ready
5	CTS - Clear to Send
6	DSR - Data Set Ready
8	CAR DET - Carrier Detect
15	T CLK
17	R CLK - External Clock
4	RTS - Request to Send

Notes: 1. The DSR and CAR DET signals are always asserted.
2. The external clock input (T CLK and R CLK) is routed directly to the Utility Board.

COMMUNICATIONS

INTRODUCTION

This subsection describes how peripherals connect to the 8560 MUSDU. Recall that in its standard configuration, the 8560 supports four HSI ports and two printer ports. HSI ports typically operate under modified RS-422 protocol and communicate with the 8540 Integration Unit. You can, however, reconfigure them for use as terminal ports operating under RS-232 protocol.

By adding another I/O Processor board and exchanging the I/O connector board with one having eight connectors, four additional HSI ports are available as an 8560 Option.

As shown later in this manual, each I/O Processor (IOP) board controls up to four HSI ports. Figure 3-3 shows how the signals connect from HSI ports to the I/O Processor via the I/O Adapter (IOA) board to the I/O Connector (IOC) board.

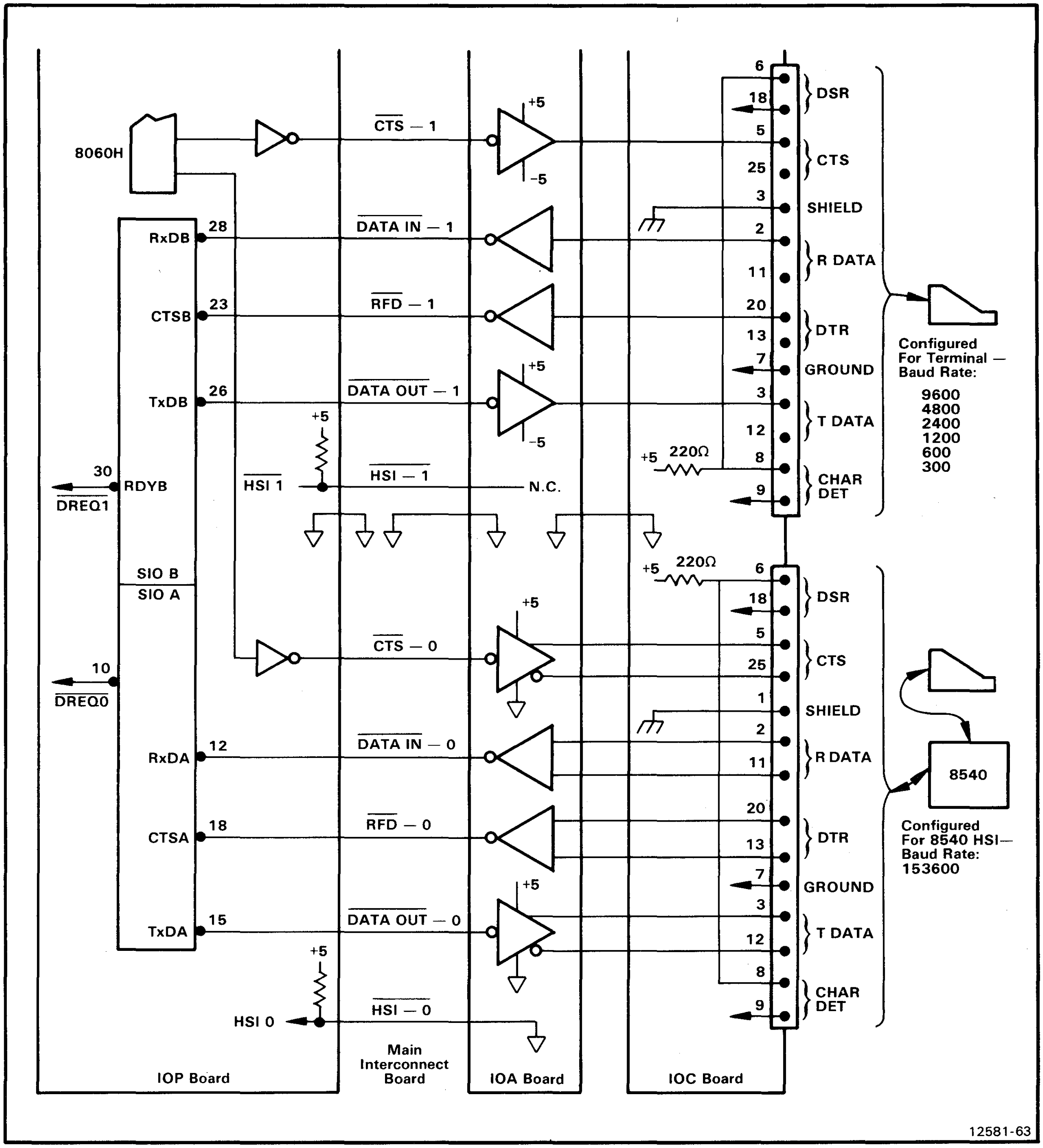


Fig. 3-3. I/O port connections to the IOP.

INTERFACING

Interfacing to an 8540 via an HSI Port

The 8560 and the 8540 communicate via interconnecting cables between the units. Figure 3-4 identifies the interconnecting signal lines for an HSI interface between the 8560 and the 8540. For more information see the 8560 Installation Guide. Also see the chapter on baud rate selection later in this section.

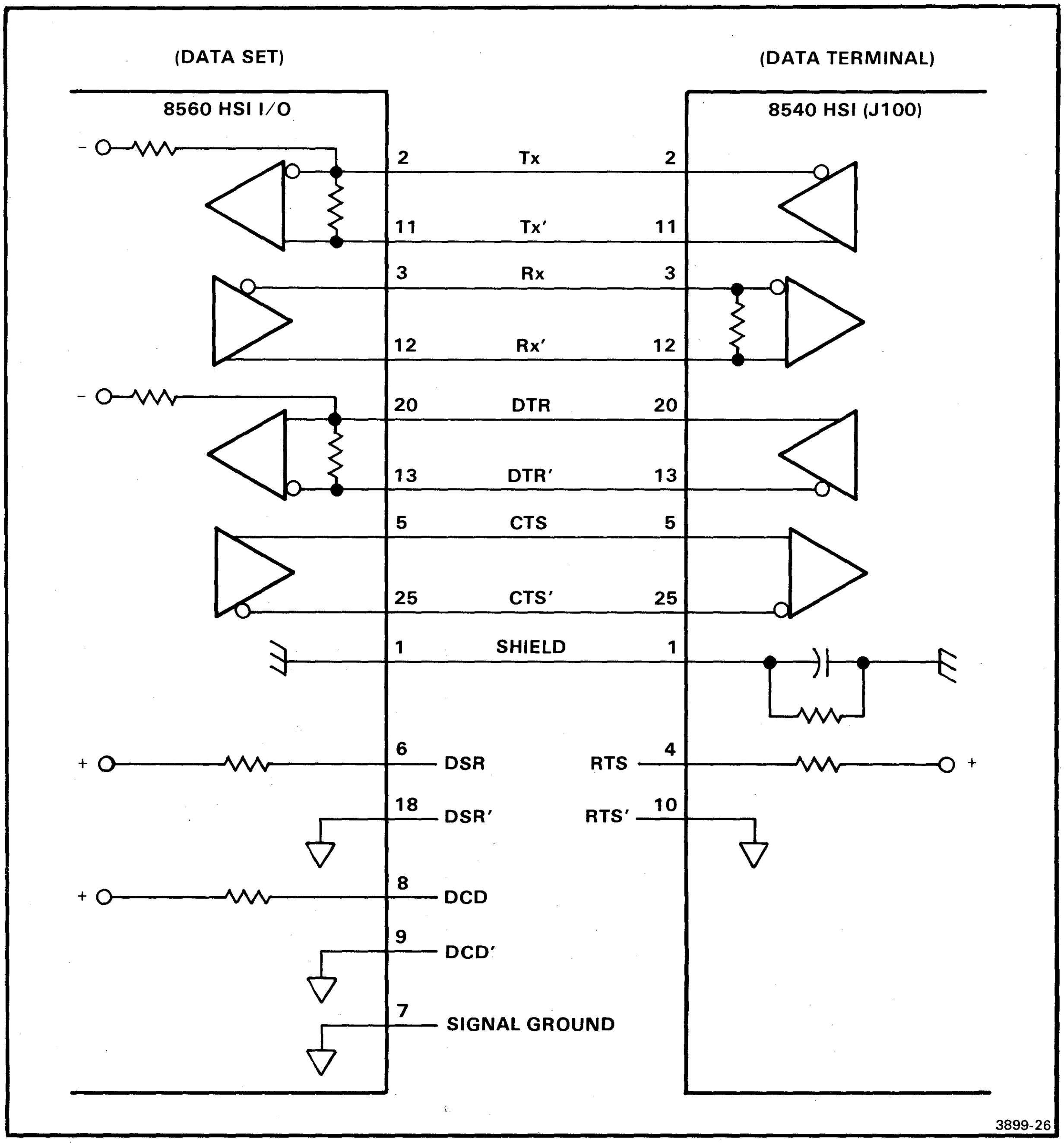


Fig. 3-4. High-Speed Interface (HSI) lines.

Interfacing to a Terminal via an HSI Port

If the terminal is connected directly to an 8560 HSI I/O port, the appropriate IOA board jumper must be repositioned to provide the RS-232-C interface protocol. (See "Baud Rate Selection" later in this section). Figure 3-5 shows the interconnecting signal lines between a typical system terminal and the 8560 MUSDU.

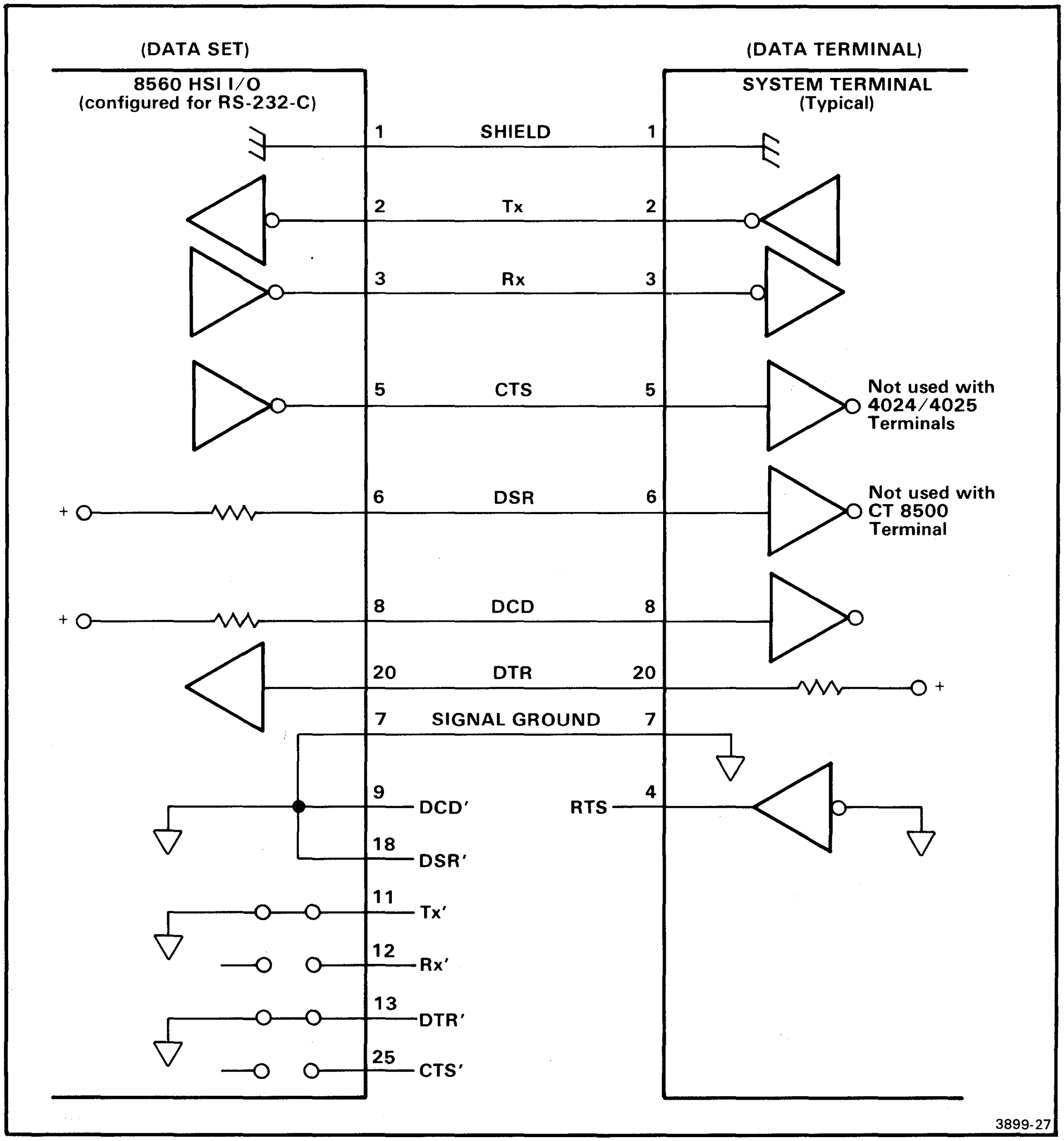


Fig. 3-5. Typical RS-232-C system terminal interface.

Interfacing to a Line Printer

Line printers may be connected directly to the 8560 LINE PRINTER connectors (J805 or J810). Figure 3-6 shows the interconnecting signal lines between an 8560 MUSDU and a typical line printer.

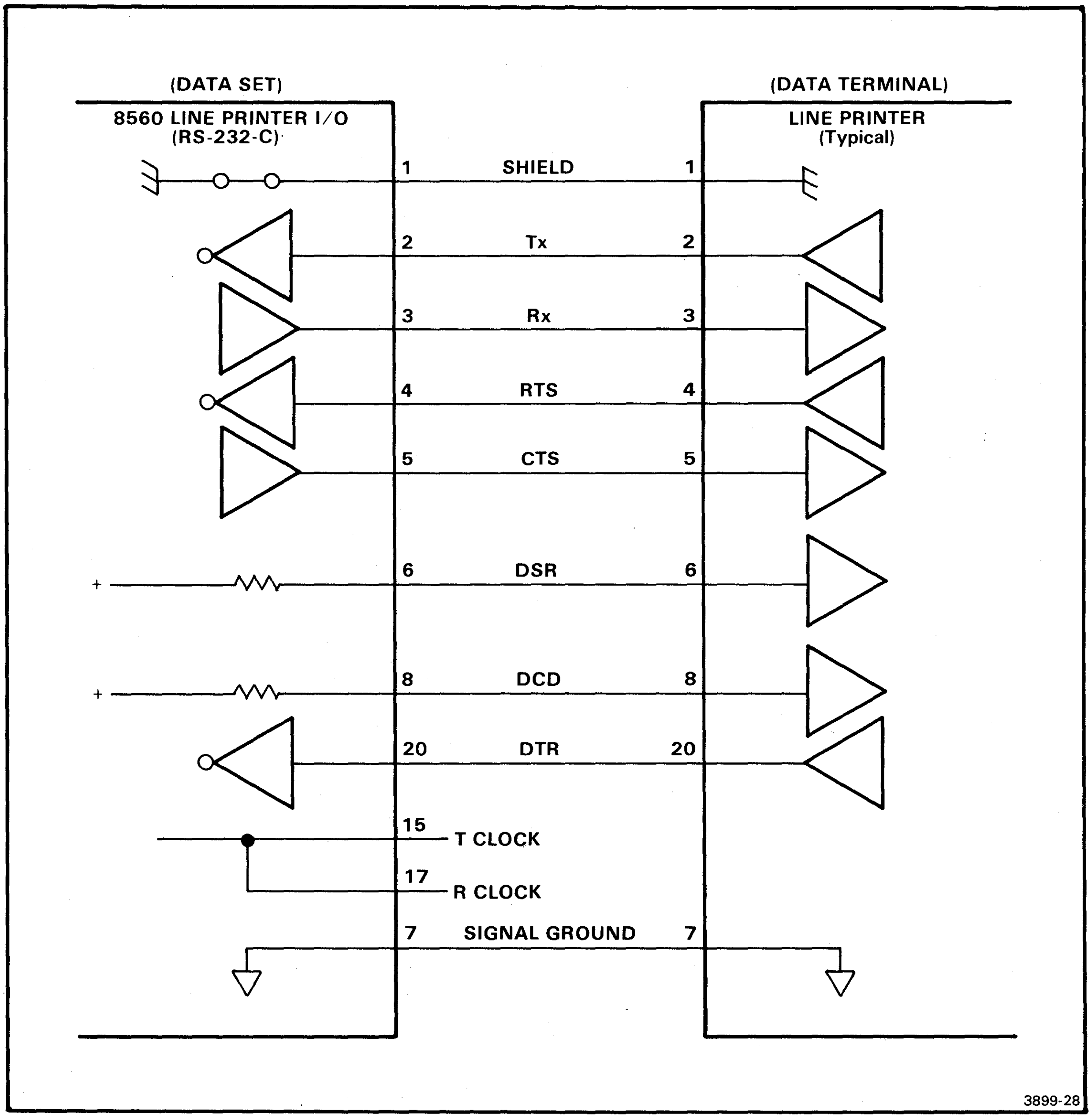


Fig. 3-6. Typical line printer interface with the 8560 MUSDU.

8540 Remote Interfacing

The 8560 can also communicate to the 8540 via the 8540 REMOTE port (J101). This is an RS-232-C-compatible interface with a maximum baud rate of 9600. Interconnecting signal lines for this interface configuration are described in Fig. 3-7.

Communications over this interface are established and maintained by the COMM commands, described in the 8540 Integration Unit System Users Manual.

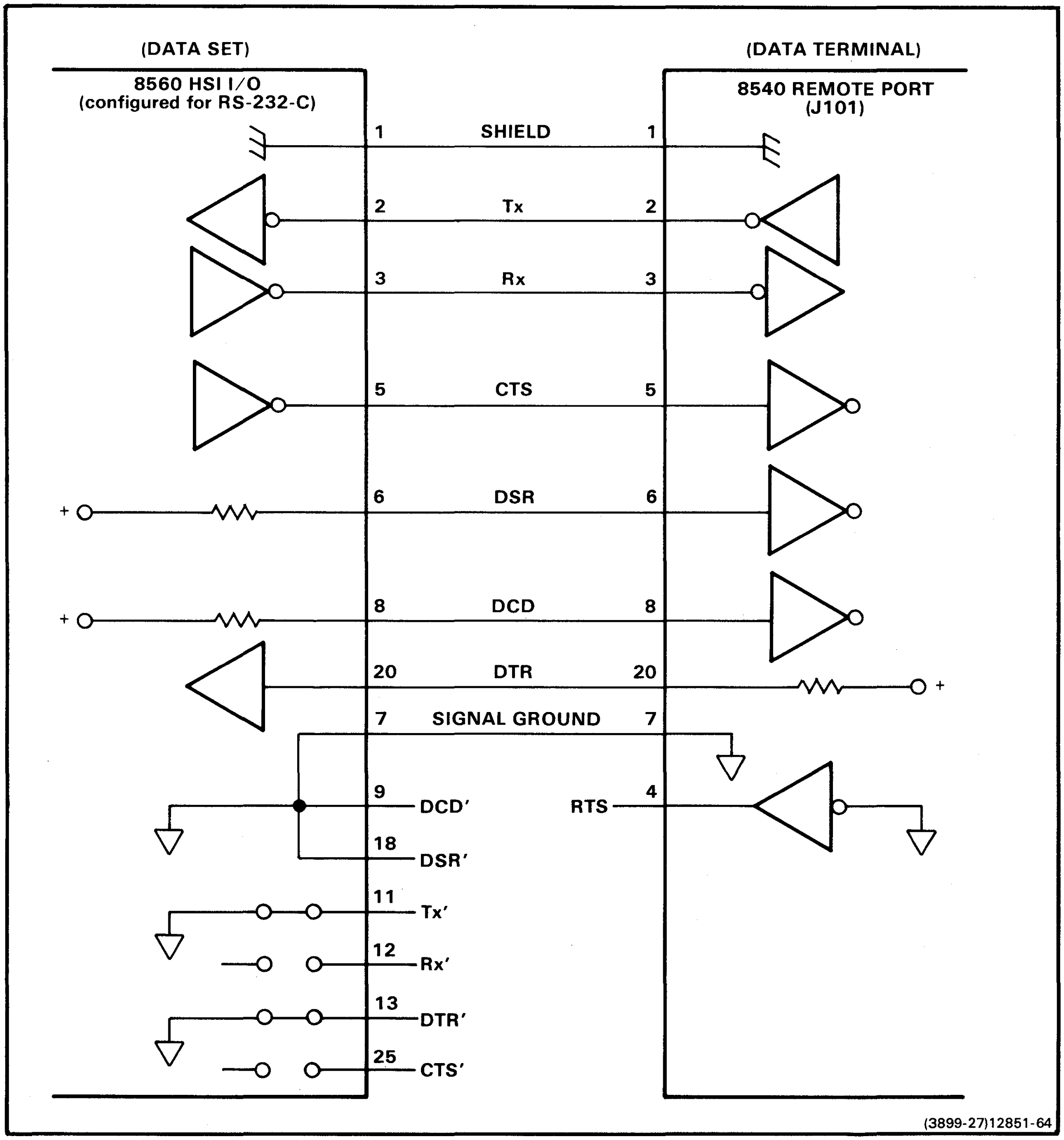


Fig. 3-7. RS-232-C interface lines between the 8560 and the 8540.

PORT CHARACTERISTICS

Introduction

The following pages summarize the RS-232-C and RS-422 protocols as they are used with the 8560. To communicate with external peripherals, the 8560 provides ten ports. Eight ports are defined as HSI ports and the remaining two are PRINTER ports.

Recall that two I/O processor boards can serve up to eight ports. Typically, these ports are defined as High-Speed Interface (HSI) ports, since they transmit and receive at a rate of 153.6 K-baud. You can, however, configure any HSI port to operate under the RS-232 protocol, and set its baud rate to any value permitted by this protocol. In RS-232-C configuration, a port is typically used for terminal communications. HSI ports are accessible at the rear panel.

Two additional port are defined as PRINTER PORTS 1 and 2. These ports always operate under RS-232-C protocol. Their baud rates, however are variable and can be set, to any speed allowable under the RS-232-c protocol. PRINTER ports are usually dedicated for line printer or terminal operations.

Note that a PRINTER PORT vector-interrupt can be select from the Utility board. (See Circuit Board Configurations later in this section). PRINTER port 1 uses a default address of 177510 and an interrupt vector address of 200. PRINTER PORT 2 uses default address 177560 and an interrupt vector address of 60. Both the PRINTER ports are identical in their wiring and communication methods.

RS-232-C Protocol

In RS-232-C protocol, data is sent from the 8560 on the IDATA line, and received by the peripheral on the RDATA line. All data byte communications are preceded by one Start bit, and terminated by one or more Stop bits. The firmware checks if the Start/Stop are present. If they are not present, a framing error is generated. You can disble the framing error with a strap. (See Circuit Board Configurations later in this section for Utility board strapping options). Parity is also checked by the 8560 unless the Utility board is strapped for the NO PARITY option. Instructions to set baud rates can be found later in this section.

The CTS (Clear to Send) line is asserted by the 8560 when the 8560 is free to receive data. The RTS (Request to Send) signal is asserted when the peripheral wishes to receive data (thereby putting the 8560 in transmit mode). The DTR signal is activated by the peripheral when it is ready to transmit or receive. Note that all signals including data are active low.

The T/R (Transmit/Receive) Clock line is an optional facility for setting communications rates by means of an external clock. This must be an even baud rate (including stop bits) determined by dividing the bit rate frequency by 16.

The 8560 conforms to the Electronic Industries Association (EIA) standard. For time durations of all signals mentioned, refer to the applicable EIA documents.

HSI/RS-422 Protocol

The RS-422 communication standard is similar to RS-232-C in terms of signals. The difference is in the method of transmission. All four principal communication lines (RDATA, TDATA, RTS and CTS) use two lines to communicate instead of one. For example, TDATA uses pins 3 and 12 instead of just pin 3 as in RS-232. In the case of RS-422, each pair are balanced lines.

In balanced lines, the signal is sent on one line in the normal fashion (as for RS-232-C), while the signal on the other line is an exact mirror image of the sent signal. This has the advantage that the differential signal is twice as large. Therefore, line interference is canceled by the signal opposition, but the differential voltage remains the same).

BAUD RATE SELECTION

Printer Ports LP1 and LP2

Printer ports LP1 and LP2 are factory strapped to transmit and receive at 2400 baud. You can change this baud rate by moving the appropriate jumper on the Utility board. Table 3-9 later in this section identifies these jumpers and provides strapping information for other available baud rates.

HSI Ports

When an HSI port is configured for HSI operation, the baud rate is fixed at 153.6 Kbaud. When an HSI port is configured (with jumpers on the IOA board) as a RS232-C port, the baud rate defaults on power-up to 2400 baud. Firmware on the IOP board then lets you search from the terminal for the baud rate matching the attached terminal.

To search for the correct baud rate, depress the BREAK key. A message on the terminal screen informs you whether or not you have obtained the correct baud rate.

JUMPERS AND STRAPS

The 8560 circuit boards provide jumpers and straps that change the board operating configuration. Most 8560 circuit boards contain straps that either are used to tailor the board for a specific function, or are used as a trouble shooting tool. The configuration tables list every board's straps and jumpers. A strap or Jumper is either IN, OUT, or connected to a position. The tables list the circuit board default strapping.

Specific jumper and strap functions are described later in this section with its associated circuit board.

The following paragraphs define jumpers and straps. They also show how you can use these straps to change board configurations or select alternate functions.

JUMPERS

In this manual, the term "jumper" refers to a small connector designed to fit across a jumper position. A "jumper position" consists of two square pins that can accommodate the placement of the jumper. Jumper positions are arranged on the circuit boards as single-position or two-position jumpers. Single-position jumpers have only two square pins, the jumper is either installed or removed. Two-position jumpers have three square pins, arranged in a straight line or "L" pattern. The jumpers may be installed on pins 1 and 2, 2 and 3, or removed. Table 3-3 shows the symbols used for jumpers on the circuit board configuration drawings that appear later in this section. Jumpers are designated with a "J".

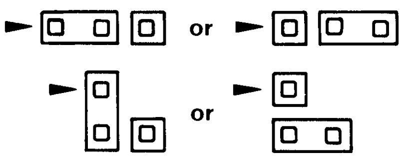
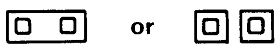
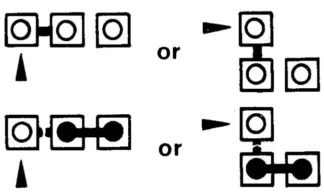
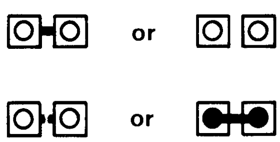
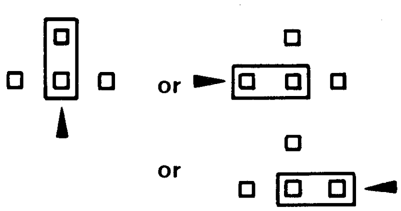
Jumpers are also found in clusters rather than singular. In that case, rather than changing an individual jumper, all jumpers in the cluster are changed al at once with the "jumper block".

A jumper block is two or more jumpers in one physical unit. Jumper blocks are usually used where you have a number of jumpers change the same function, but on different signal lines.

STRAPS

In this manual, the term "strap" refers to an ECB through-hole that may be bridged with a soldered wire to select an alternate function. A strap is also associated with a "cuttable run". That is, an ECB run between two through-holes is a strap. The run must be cut before one of the through-holes can be strapped to a third through-hole. If there is a cuttable run at the location, it must be cut before the strap is bridged, to prevent system errors. Table 3-3 shows the symbols used for straps on the circuit board configuration drawings that appear later in this section. Straps are designated with a "W".

Table 3-3
Symbols for Jumpers and Straps

Jumper/Strap Symbols	Usage
	These two-position jumpers show the jumper across pins 1 and 2 or across pins 2 and 3.
	This single-position jumper shows the jumper across the single jumper position or the jumper removed.
	These two-position straps show the cuttable runs between pins 1 and 2. The runs may be cut and the straps bridged across pins 2 and 3.
	These single-position straps show the through-holes with or without a cuttable run. The cuttable run may be cut or the through-holes may be bridged with a strap.
	The 3-position jumpers show the jumper across pins 1 and 3, or across pins 2 and 3 or across pins 3 and 4

CIRCUIT BOARD CONFIGURATIONS

In this subsection we discuss the configuration of all 8560 system circuit boards that maintain jumpers or straps. Here you will find the location of each board's jumpers, and its default strapping.

MAIN INTERCONNECT BOARD CONFIGURATION

The Main Interconnect board provides seven pairs of bus grant jumpers (J19 through J32). Each board, plugging into the Main Interconnect board, has an associated pair of bus grant jumpers. Exceptions are the LSI-11/23 and Utility boards.

Jumper pairs are set either to the PASS or to the NO PASS position. In the PASS position, the bus grant is passed to the next in-line board. In the NO PASS position the grant is passed or intercepted by the board. For example, if the jumper pair J23/30 is strapped to PASS, the bus grant is passed or intercepted by IOP board 2.

Figure 3-8 shows the location of the bus grant jumpers. As shown, all empty slots and the system memory boards are strapped to PASS. All other slots are strapped to the NO-PASS condition. If you need to change the jumpers, remove the adjacent board, and use a needle nose pliers to reposition the jumper.

Table 3-4 shows the default strapping.

Table 3-4 Bus Grant Jumpers

Jumper	Function	Default
J19/26	the jumpers in this	NO PASS
220/27	group pass the bus grant	PASS
J21/28	to the next card if the	PASS
J22/29	next in line slot is	PASS
J23/30	empty.	PASS
J24/31		PASS
J25/32		NO PASS

 @

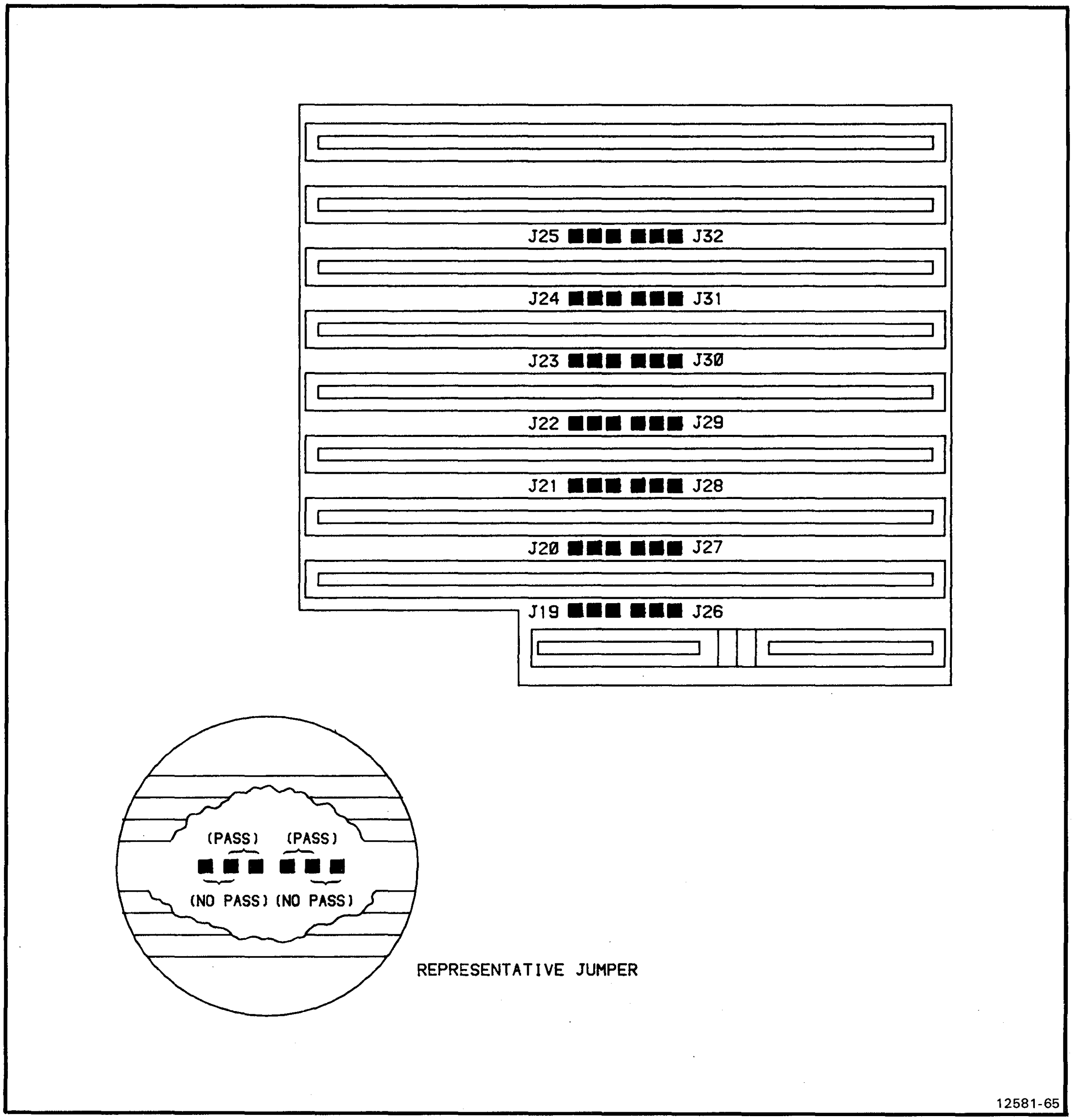


Fig. 3-8 Main Interconnect board jumper locations.

LSI-11/23 CONFIGURATION

Table 3-5 gives the default 8560 LSI-11/23 jumper configuration. Figure 3-9 shows the jumper locations on the board. for additional information please see the DEC Microcomputer and Memories handbook.

Table 3-5
Default LSI-11/23 Jumper Configuration

Jumper	In/Out	Jumper	In/Out
W1	In	W11	N/A
W2	In	W12	N/A
W4	Out	W13	N/A
W5	Out	W14	N/A
W6	In	W15	N/A
W7	Out	W16	In
W8	In	W17	In
W9	N/A	W18	In
W10	N/A	---	---

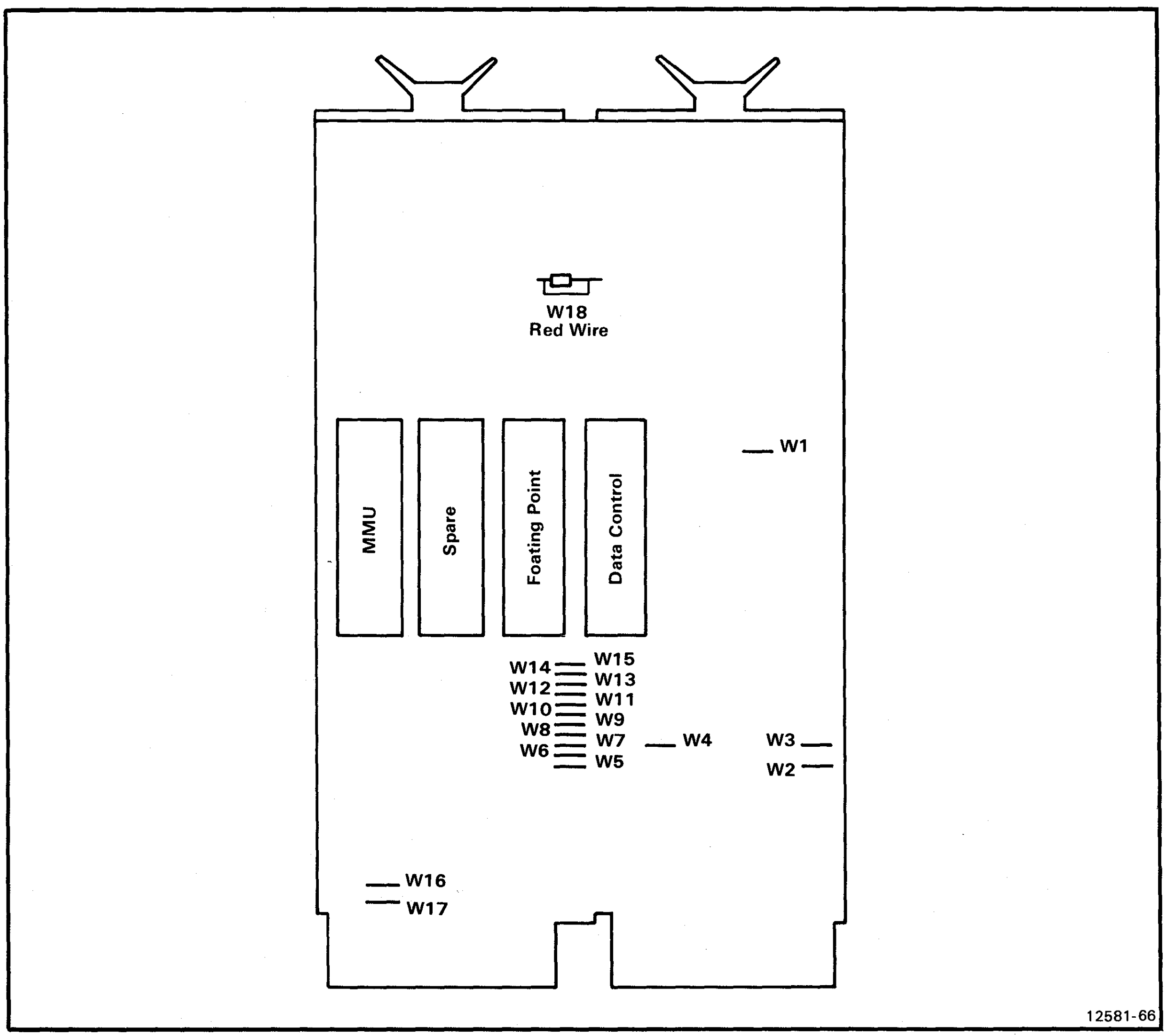


Fig. 3-9. LSI-11/23 jumper locations.

UTILITY BOARD CONFIGURATION

The following pages provide the default jumper strapping for miscellaneous jumpers and straps (Table 3-6). Furthermore, this subsection provides information on jumpers and wire straps that control the following functions:

- diagnostics control
- framing errors (Table 3-7)
- port interrupt vectors
- parity and bits/character (Table 3-8)
- RS-232 port baud rates (Table 3-9)
- port mode selection (Table 3-10)
- ROM and LTC enable
- port interface address selection (Table 3-11)
- power control enable

Figure 3-10 illustrates the Utility board. Table 3-6 shows the jumpers and straps in their default positions.

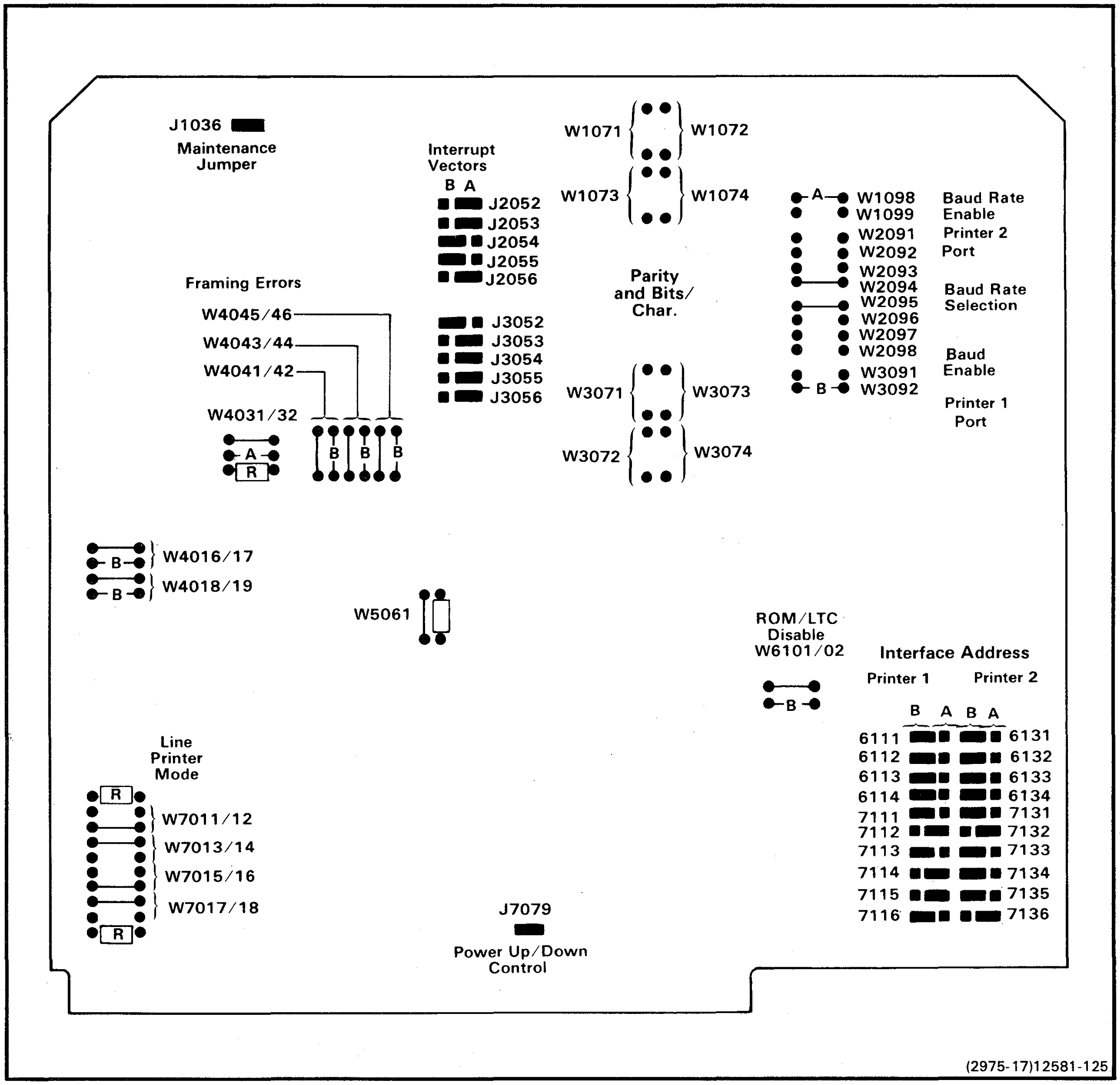


Fig. 3-10. Utility board strap and jumper locations.

Table 3-6
Utility Board Default Jumper/Strap Positions

Strap or Jumper	Function	Default Position
P1036	Maintenance	IN
W4031/32	Framing Error	B
W4041/42	Framing Error	A
W4043/44	Framing Error	A
W4045/46	Framing Error	A
W5061	Framing Error	IN
J2052	PRINTER Port 2 Int. Vector	A
J2053	PRINTER Port 2 Int. Vector	A
J2054	PRINTER Port 2 Int. Vector	B
J2055	PRINTER Port 2 Int. Vector	B
J2056	PRINTER Port 2 Int. Vector	A
J3052	PRINTER Port 1 Int. Vector	B
J3053	PRINTER Port 1 Int. Vector	A
J3054	PRINTER Port 1 Int. Vector	A
J3055	PRINTER Port 1 Int. Vector	A
J3056	PRINTER Port 1 Int. Vector	A

Table 3-6 (Cont.)
Utility Board Default Jumper/Strap Positions

Strap or Jumper	Function	Default Position
W3071	PRINTER Port 1 8 Bits/Char.	OUT
W3072	PRINTER Port 1 No Parity	OUT
W3073	PRINTER Port 1 No Parity	OUT
W3074	PRINTER Port 1 8 Bits/Char.	OUT
W1071	PRINTER Port 2 8 Bits/Char.	OUT
W1072	PRINTER Port 2 No Parity	OUT
W1073	PRINTER Port 2 No Parity	OUT
W1074	PRINTER Port 2 8 Bits/Char.	OUT
W3091	PRINTER Port 1 Prg Baud Enbl	OUT
W3092	PRINTER Port 1 Prg Baud Enbl	IN
W1098	PRINTER Port 2 Prg Baud Enbl	IN
W1099	PRINTER Port 2 Prg Baud Enbl	OUT

Table 3-6 (Cont.)
Utility Board Default Jumper/Strap Positions

Strap or Jumper	Function	Default Position
W2095	PRINTER Port 1 2400 Baud	IN
W2096	PRINTER Port 1 2400 Baud	OUT
W2097	PRINTER Port 1 2400 Baud	OUT
W2098	PRINTER Port 1 2400 Baud	OUT
W2091	PRINTER Port 2 2400 Baud	OUT
W2092	PRINTER Port 2 2400 Baud	OUT
W2093	PRINTER Port 2 2400 Baud	OUT
W2094	PRINTER Port 2 2400 Baud	IN
W7011/12	PRINTER Port 1 Non LAV-11	A
W7013/14	PRINTER Port 1 Non LAV-11	B
W4016/17	PRINTER Port 1 Non LAV-11	A
W7015/16	PRINTER Port 1 Non LAV-11	A
W7017/18	PRINTER Port 1 Non LAV-11	B
W4018/19	PRINTER Port 2 LAV-11	A

Table 3-6 (cont)
Utility Board Default Jumper/Strap Positions

Strap or Jumper	Function	Default Position
W6111 W6114	PRINTER Port 1 Interface Addr	B
W7111	PRINTER Port 1 Interface Addr	B
W7112	PRINTER Port 1 Interface Addr	A
W7113	PRINTER Port 1 Interface Addr	B
W7114 — W7115	PRINTER Port 1 Interface Addr	A
W7116	PRINTER Port 1 Interface Addr	B
W6131 — W6134	PRINTER Port 2 Interface Addr	B
W7131	PRINTER Port 2 Interface Addr	B
W7132	PRINTER Port 2 Interface Addr	A
W7133 — W7135	PRINTER Port 2 Interface Addr	B
W7136	PRINTER Port 2 Interface Addr	A
J7079	Power Control Enabled	IN

@

The Maintenance Jumper

When jumper J1036 is installed, the 8560 runs through its normal power-up sequence. If J1036 is removed, the 8560 enters the ROM-based debugging mode, and all communication with the 8560 will be through a PRINTER port.

The Framing Error Straps

The framing error straps (W4031/32, W4041/42/43/44/45/46, and W5061) determine what the LSI-11/2 will do if a framing error is detected at one of the 8560 I/O ports. Table 3-7 lists the possible actions.

Table 3-7
Framing Error Straps

Port	W4031/ 4032	W4041/ 4042	W4043/ 4044	W4045/ 4046	W5061	
Not Used	A	A	A	B	IN	RESTART @ 173000
	B	A	A	B	X	HALT
	A	A	A	B	OUT	HALT @ 173000
PRINTER 1	A	A	B	A	IN	RESTART @ 173000
	B	A	B	A	X	HALT
	A	A	B	A	OUT	HALT @ 173000
PRINTER 2	A	B	A	A	IN	RESTART @ 173000
	B	B	A	A	X	HALT
	A	B	A	A	OUT	HALT @ 173000

X=don't care

Port Interrupt Vectors

Both PRINTER ports interrupt vectors are strap selectable. The upper five bits of each eight-bit vector can be selected using J2052 through J2056 for the PRINTER port 2, and J3052 through J3056 for the PRINTER port 1. The "A" position for each jumper equals 0, and the "B" position equals 1. J2052 and J3052 set the most significant bits (bit 7), and J2056 and J3056 set the least significant bits (bit 3).

Parity and Bits/Character

Wire straps allow you to configure the parity and bits/character feature of each PRINTER port. The Utility board default-strapping is set to 8 bits/character and NO PARITY. Table 3-8 allowed port combinations.

Table 3-8
Parity and Bits/Character

PRINTER 1	W3071	W3072	W3073	W3074
PRINTER 2	W1071	W1072	W1073	W1074
8 Bits/Character	OUT	X	X	OUT
7 Bits/Character	IN	X	X	OUT
6 Bits/Character	OUT	X	X	IN
5 Bits/Character	IN	X	X	IN
Even Parity	X	OUT	IN	X
Odd Parity	X	IN	IN	X
No Parity	X	X	OUT	X

X = don't care

Baud Rate Selection

PRINTER port baud rates are factory set to 2400 baud. You can,however, change them with the wire straps on the Utility board. Table 3-9 lists the settings for each port.

Table 3-9
Baud Rate Selection Straps

PRINTER Port 1	W2095	W2096	W2097	W2098
PRINTER Port 2	W2094	W2093	W2092	W2091
External Clock	IN	IN	IN	IN
External Clock	IN	IN	IN	OUT
50 Baud	IN	IN	OUT	IN
75 Baud	IN	IN	OUT	OUT
110 Baud	OUT	OUT	OUT	OUT
134.5 Baud	IN	OUT	IN	IN
200 Baud	IN	OUT	IN	OUT
300 Baud	OUT	OUT	IN	OUT
600 Baud	IN	OUT	OUT	IN
1200 Baud	OUT	IN	OUT	OUT
1800 Baud	OUT	IN	OUT	IN
2400 Baud	IN	OUT	OUT	OUT
2400 Baud	OUT	OUT	IN	IN
4800 Baud	OUT	IN	IN	OUT
9600 Baud	OUT	IN	IN	IN

Port Mode Selection

Both PRINTER ports can operate in Digital Equipment Corporations's four LAV-11 modes. (LAV-11 modes force bit 2 of the interrupt vector to a zero.) You can also set the ports to a non-LAV-11 mode. Table 3-10 lists the modes and straps for each port.

Table 3-10
Port Mode Straps

PRINTER Port 1	W4016/4017	W7011/7012	W7013/7014
PRINTER Port 2	W4018/4019	W7015/7016	W7017/7018
LAV-11 Mode: no hold-off	A	A	A
LAV-11 Mode: hold-off while RTS is false	A	B	A
Default Strapping LAV-11 Mode: hold-off while DTSR is false	A	A	B
Non LAV-11 Mode	B	X	X

ROM and LTC Enable

The power-up diagnostic ROM, boot-up ROM, and Line-Time Clock functions of the Utility board can be disabled for trouble shooting purposes. Straps W6101 and W6102 enable or disable the ROMs and LTC. Placing both straps in the "B" position disables the ROMs and LTC. Placing the straps in the "A" position enables both. The default configuration is in position A.

Port Interface Addresses

The interface addresses for both PRINTER ports can be selected by wire jumpers. Table 3-11 lists the straps and their address values.

Table 3-11
Port Interface Address Straps

PRINTER 1	W6111	6112	6113	6114	7111	7112	7113	7114	7115	7116
PRINTER 2	W6131	6132	6133	6134	7131	7132	7133	7134	7135	7136
Bit	12	11	10	9	8	7	6	5	4	3

To select a high or a low on a particular bit, set the corresponding strap to: A (= 0), or B (= 1). Bits 1 and 2 of the address are under program control, and select one of four Utility board interface registers (see the description of the Utility board in Section 9 of this manual). Bit 0 is not used.

Power Control Enable

Jumper J7079 is used during troubleshooting to disable the power control facility of the Utility board. To disable the power control facility, remove J7079. J7079 is normally installed.

THE SYSTEM MEMORY BOARD CONFIGURATION

The Memory board jumper straps fall into three basic categories:

- Miscellaneous straps -- shown in Table 3-12,
- Bank interchange straps -- shown in Table 3-13, and
- Data/Parity interchange test straps shown in Table 3-15.

Figure 3-11 shows the jumper strap locations of the System Memory board.

Miscellaneous Straps

Except the first two straps in Table 3-12, all other memory board jumpers are used for trouble shooting. They disable signals such as the input data, clock, refresh and others.

Table 3-12
Miscellaneous Straps

Name/No	Function	Default
CG - CF (J5161)	I/O memory space selection (2K or 4K)	IN
(J6112) CA - CB - CC	configures the board either as the upper or the lower 64 K-word bank	CC-CA (a)
(J7141) CM - CL - CN	disable parity errors	CL -CM
CJ - CK (J7101)	Test Strap - disables bus output data	IN
BZ - BY (J7121)	Test Strap - disables clock signal	IN
CD - CE (J6135)	Test strap - disables refresh	IN
CL - CI (J7101)	Test Strap - disables bus timing signal	IN
J7088	Test pins for Signature Analysis	N/A

(a) This straps the board as a lower 64-K word bank.
CB - CA straps the board as a upper 64-K-word bank.

Bank Interchange Straps

Address bits 15 and 16 contain trouble shooting straps that can be used to swap the 16K-word memory banks. Tables 3-13 and 3-14 give the binary expressions under which the straps swap the memory banks.

Table 3-13
Bank Interchange Strap Functions

Straps	Address Signals	Default
W7109	ADD16H = AD16H	BJ - BN
W7113	ADD16H = AD15H	BQ - BU
W7115	ADD16H = AD16L	BS - BW
W7112	ADD16H = AD15L	BL - BP
W7108	ADD15H = AD15H	BI - BM
W7114	ADD15H = AD16H	BR - BV
W7116	ADD15H = AD15L	BT - BX
W7111	ADD15H = AD16L	BK - BO

Table 3-14
Bank Interchange Logic

Bank	Address Signal State: ADD16H	Address Signal State: ADD15H
CAS1	0	0
CAS2	0	1
CAS3	1	0
CAS4	1	1

<u>Data and Parity Swapping</u>

Table 3-15 lists the straps by which the low-byte parity bit memory may be swapped with bit 0 memory and the high order parity bit memory may be swapped with bit 8 memory. This allows parity to be read as data, hence providing testability of all memory chips on the board.

Table 3-15
Data and Parity Interchange Test Straps

Name	Signal	Function	Default
AM - AI	DNO(H)		IN
AO - AK	DNLP(H)	Swaps DNOH and DNLPH signals	OUT
AN - AJ	DNO(H)	J6078	OUT
AP - AL	DNLP(H)		IN
AE - AA	DTO(H)		IN
AG - AC	DTLP(H)	Swaps DTOH and DTLPH signals	OUT
AF - AB	DTO(H)	J5077	OUT
AH - AD	DTLP(H)		IN
AU - AQ	DN8(H)		IN
AW - AS	DNHP(H)	Swaps DN8H and DNHPH signals	OUT
AV - AR	DN8(H)	J5091	OUT
AX - AT	DNHP(HI		IN
BE - BA	DT8(H)		IN
BG - BC	DTHP(H)	Swaps DT8H and DTHPH signals	OUT
BF - BB	DT8(H)	J5108	OUT
BH - BD	DTHP(H)		OUT

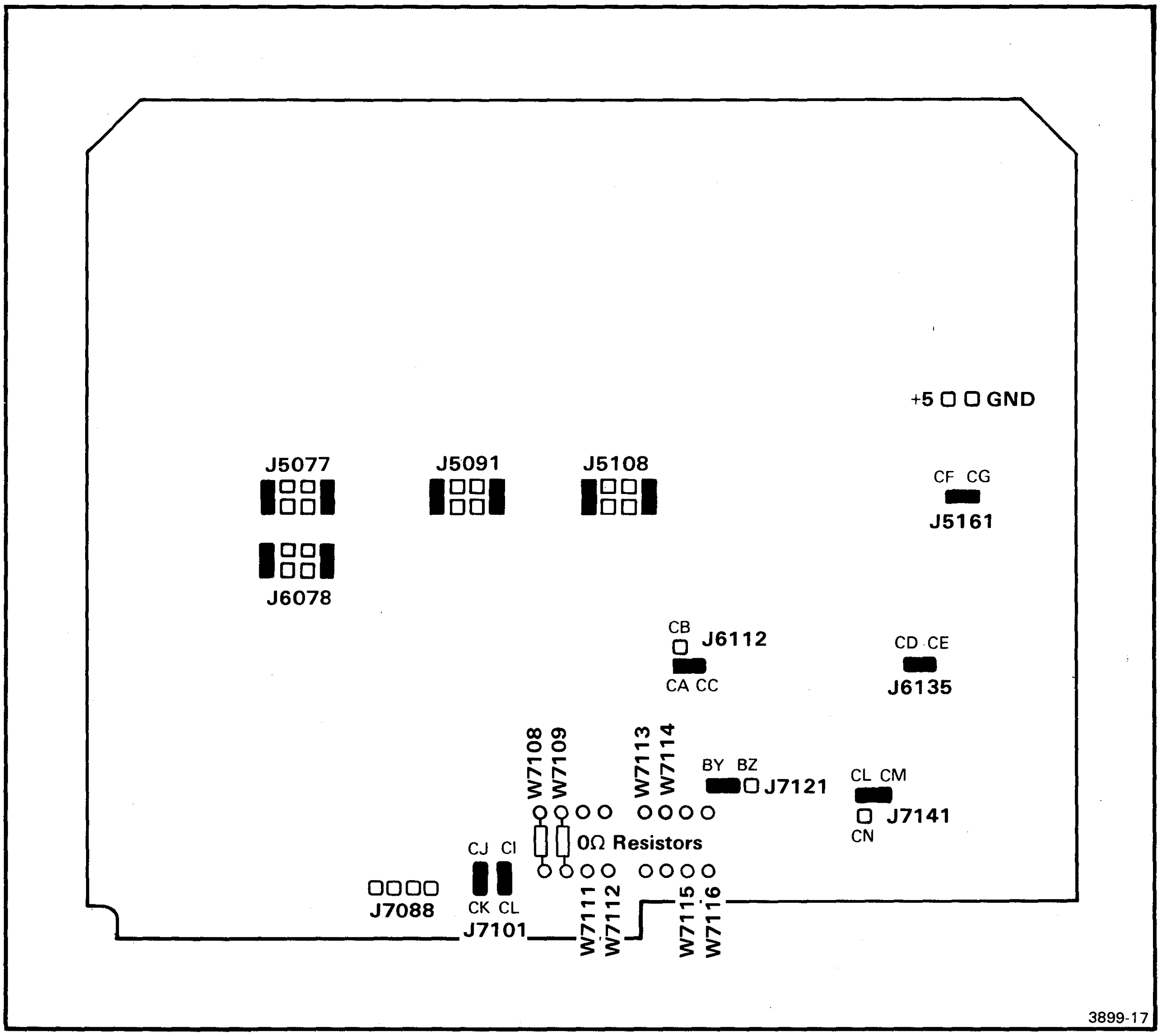


Fig. 3-11. RAM board jumper strap locations.

IOP BOARD CONFIGURATION

The IOP board provides jumper straps for the following functions:

- priority levels
- Vector Strap functions
- Signature Analysis
- Miscellaneous functions
- board selection

Interrupt Vectors

Two independent interrupt vectors that interface with the 11/23 Processor board are generated on the IOP board. The two interrupt vector circuits can be independently jumpered to establish a selected level of interrupt priority. One set of jumpers determines which interrupt lines will be asserted, and the other set of jumpers selects which lines will be monitored, when intercepting a grant from the 11/23 Processor. Table 3-16 describes the priority levels. Figure 3-12 shows the jumper arrangement for Vectors 1 and 2, and Fig. 3-13 illustrates jumper configurations for priority levels 4, 5, and 6.

Table 3-16
Interrupt Priority Assignments

Priority Level	Interrupt Lines Asserted	Interrupt Lines Monitored
4	BIRQ 4	BIRQ 5, 6
5	BIRQ 4, 5	BIRQ 6
6	BIRQ 4, 6	BIRQ 7
7	BIRQ 4, 6, 7	---- ----

Priority level 7 is used only by the 11/23, and is not user-definable.

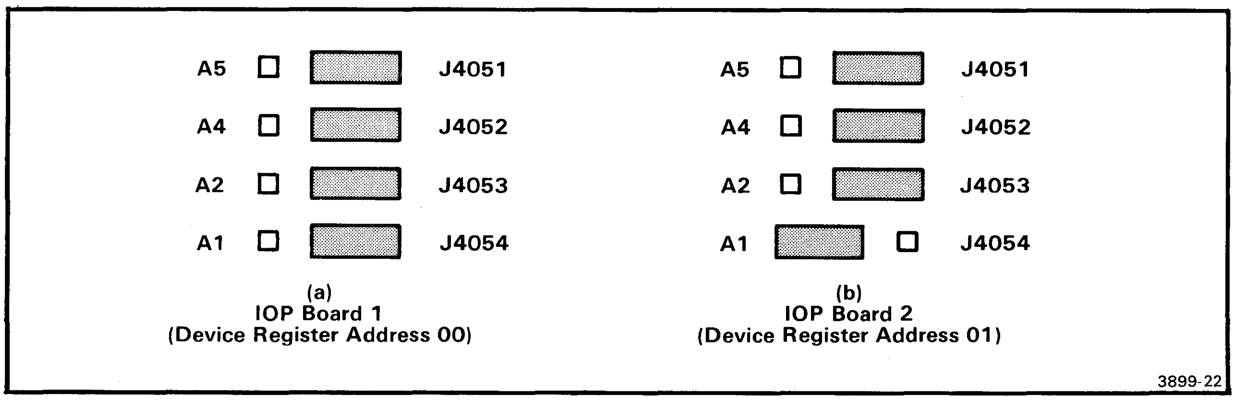


Fig. 3-12. Interrupt priority jumper arrangement.

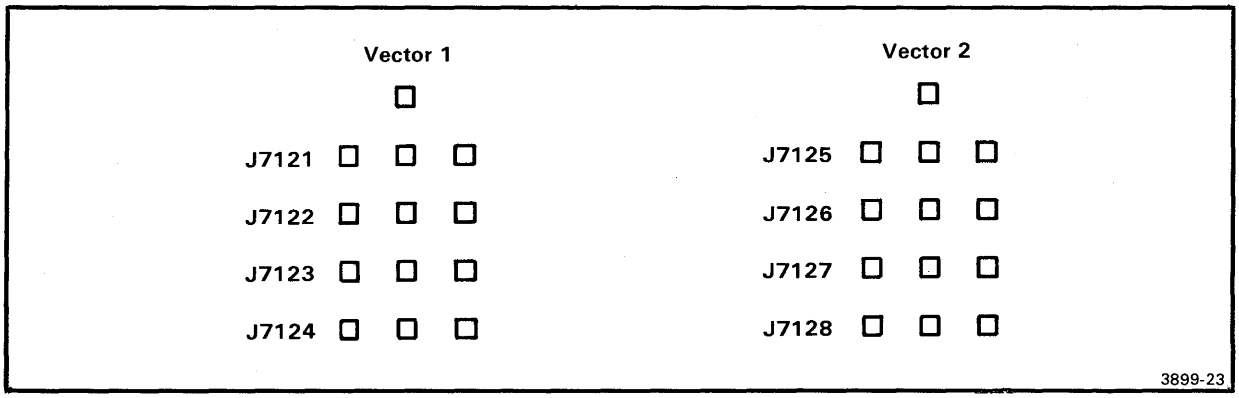


Fig. 3-13. Jumper configurations for interrupt priority levels.

Table 3-17
Miscellaneous Diagnostic Jumper Straps

Jumper	Function	Default
J2171	forced NOP	o o-o
J2172	processor testing	o o-o
J2173	testing system bus	o o-o
J2174	testing SIO DMA	o o-o
J7011	disable bus driver	IN
J3162	clock normal/slow	o o-o
J2061	Disable HRQ between 8088 and 8237	o o-o
J2041	I/O read 00 or NOP	OUT
J5161	Normal or forced OP codes	o o-o
J6171	slow clock	o o-o
J6091	Disable DC010	o o-o

Note that the default position is indicated on the board by a /.

Board Selection Straps

Device register jumper-configurations define IOP boards as either IOP 1 or IOP 2. If your system uses only one IOP board, it must be configured as IOP 1 and installed in the IOP 1 slot in the 8560 Main Interconnect board. Figure 3-14a illustrates the jumper configuration for IOP 1.

If your 8560 utilizes two IOP boards, one of these boards must be configured as IOP 1 and installed in the IOP 1 slot, as above. The second board must be configured as IOP 2 and installed in the IOP 2 slot in the card cage (see Fig. 3-14b).

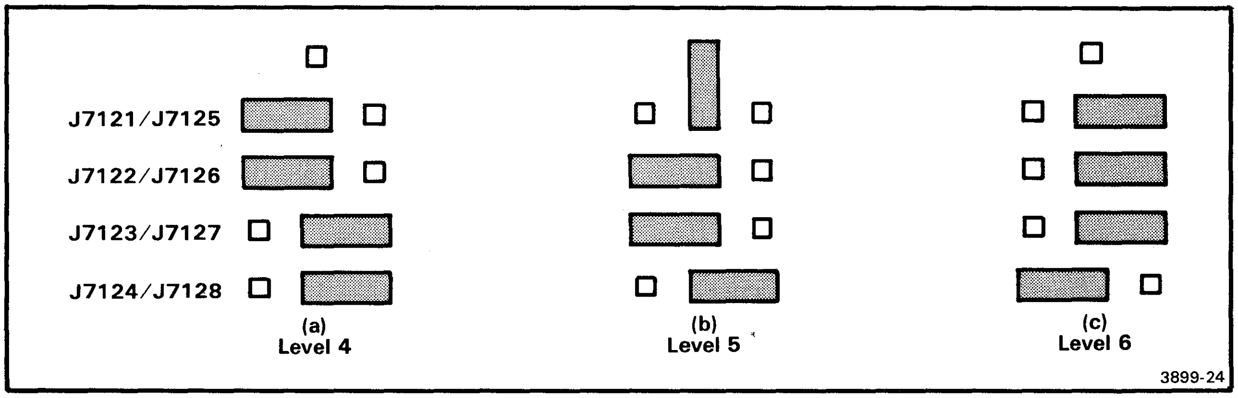


Fig. 3-14. Device register jumper positions.

Table 3-18
Memory Strapping

Jumper	Function	Default
J1081 J1082	changes U1080 from RAM to ROM	ROM
J1091 J1092	changes U1090 from RAM to ROM	RAM
J1101 J1102	changes U1100 from RAM to ROM	RAM
J1121 J1122	changes U1120 from RAM to ROM	RAM
J1131 J1132	changes U1130 from RAM to ROM	RAM

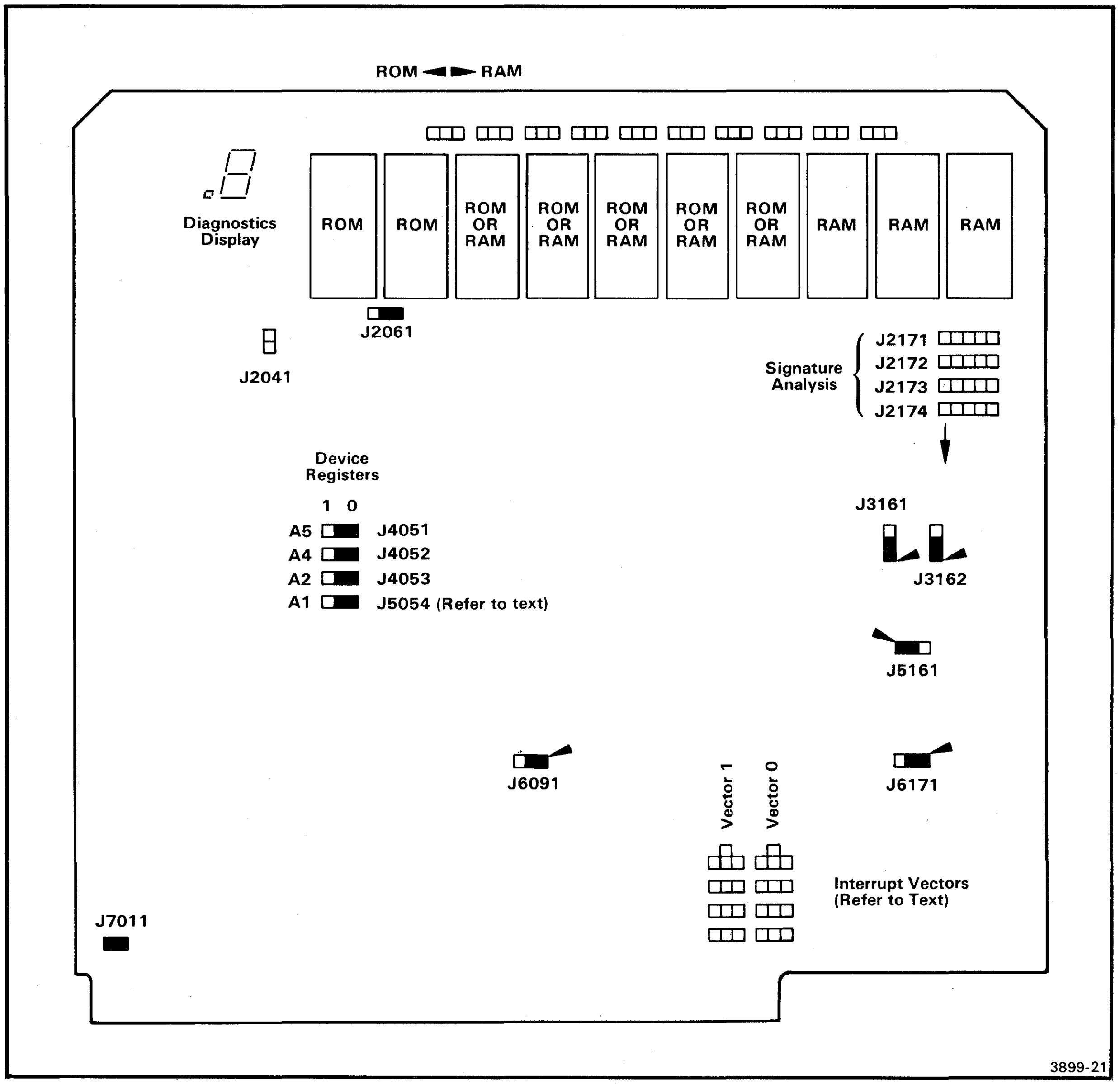
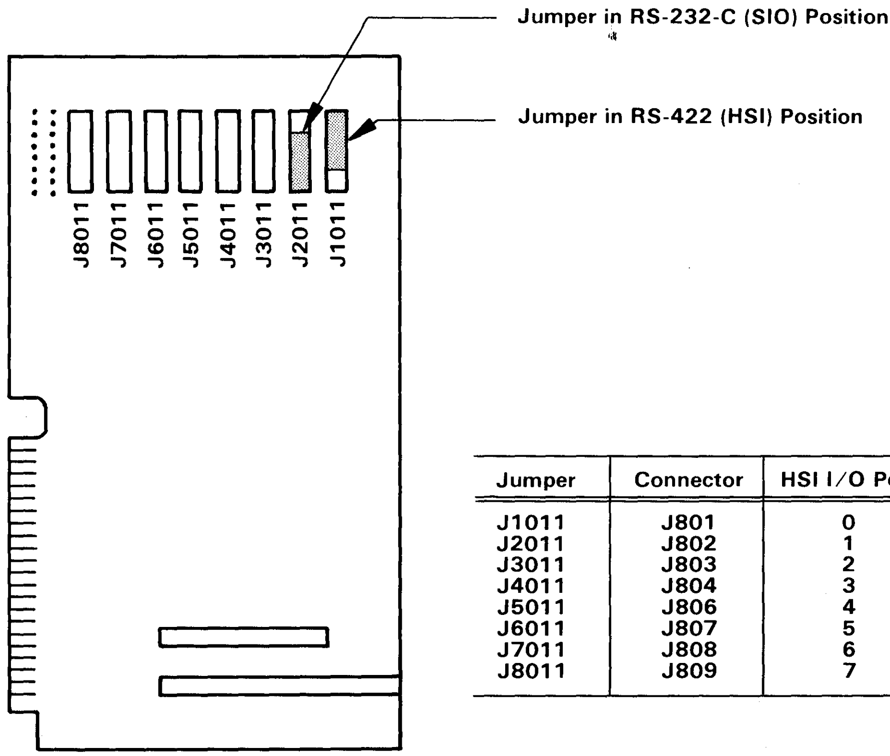


Fig. 3-15. IOP board jumper strap locations.

I/O ADAPTER (IOA) BOARD CONFIGURATION

The IOA board contains eight sets of jumper straps. J1011 through J4011 provide strapping for HSI ports 0 through 3, and J5011 through 8011 provide strapping for HSI ports 4 through 7. Each set of straps consists of eleven pair of pins. Jumper plugs for these jumpers have ten pairs of pins. By moving the jumper strap either up or down one pin, you can change the port configuration from HSI protocol to RS-232-C protocol. Figure 3-16 shows the jumper strap locations.



Jumper	Connector	HSI I/O Port
J1011	J801	0
J2011	J802	1
J3011	J803	2
J4011	J804	3
J5011	J806	4
J6011	J807	5
J7011	J808	6
J8011	J809	7

3899-15

Fig. 3-16. IOA board jumper strap locations.

I/O CONNECTOR BOARD CONFIGURATION

Figure 3-17 shows the IOC board strap locations. Straps W802 through W811 are of the plated through-hole type. These straps are associated with the communications ports. There is one strap for every port-connector. It allows you to install a resister or capacitor between the shield (of the transmission line) and ground. To install a device, you must first remove the strap. In the shipped configuration, all straps on this board are installed. Table 3-19 relates the straps to the port connectors.

Table 3-19
IOC board straps

Port	Strap	Port	Strap
J801	W8011	J805	W8051
J802	W8021	J807	W8071
J803	W8031	J808	W8081
J804	W8041	J809	W8091
J805	W8051	J810	W8101

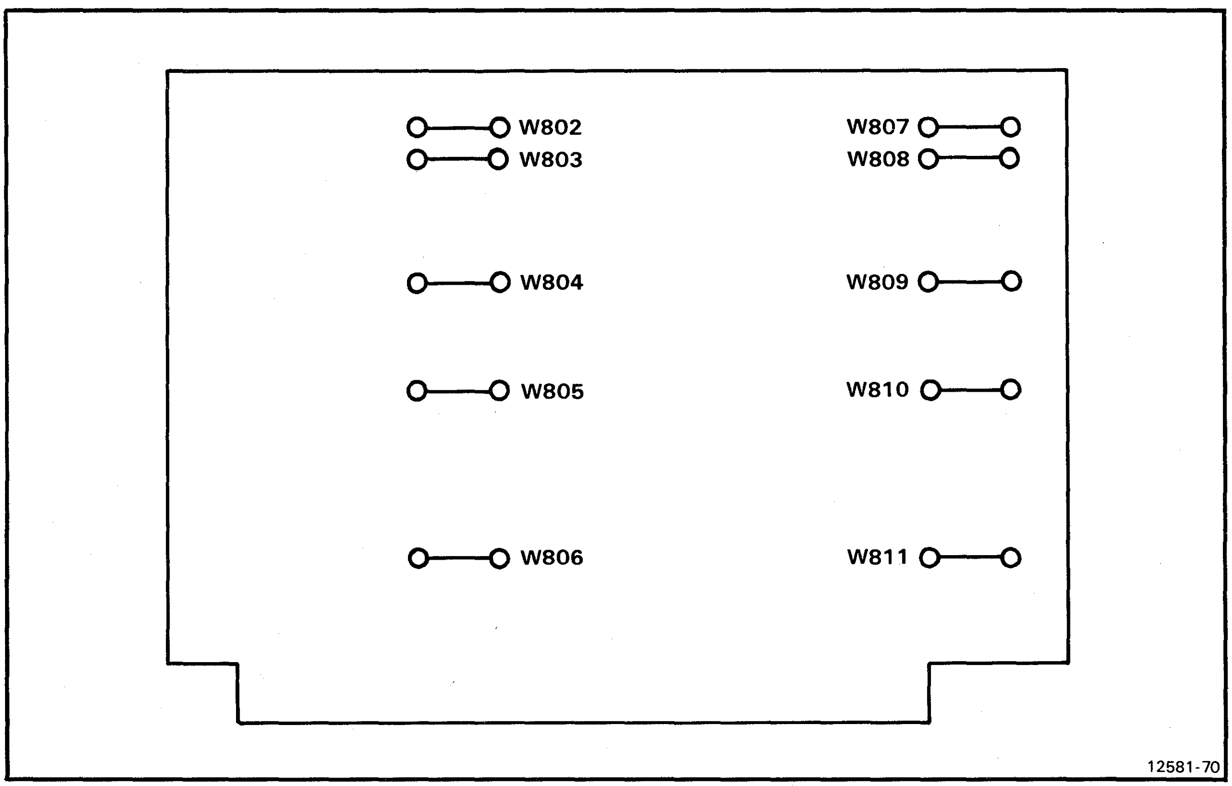


Fig. 3-17. IOC board strap locations.

PMS CONTROLLER BOARD CONFIGURATION

Figure 3-18 shows the PMS Controller board strap locations. Save for the RAM, address, and interrupt straps, all other straps on this board are used by diagnostic tests. Table 3-20 lists the jumper functions and the default jumper positions.

NOTE

If the system is in the normal upright position, all jumpers, except J1050, J1070, and J3070, are installed horizontally. Schematics show all jumpers in the default position.

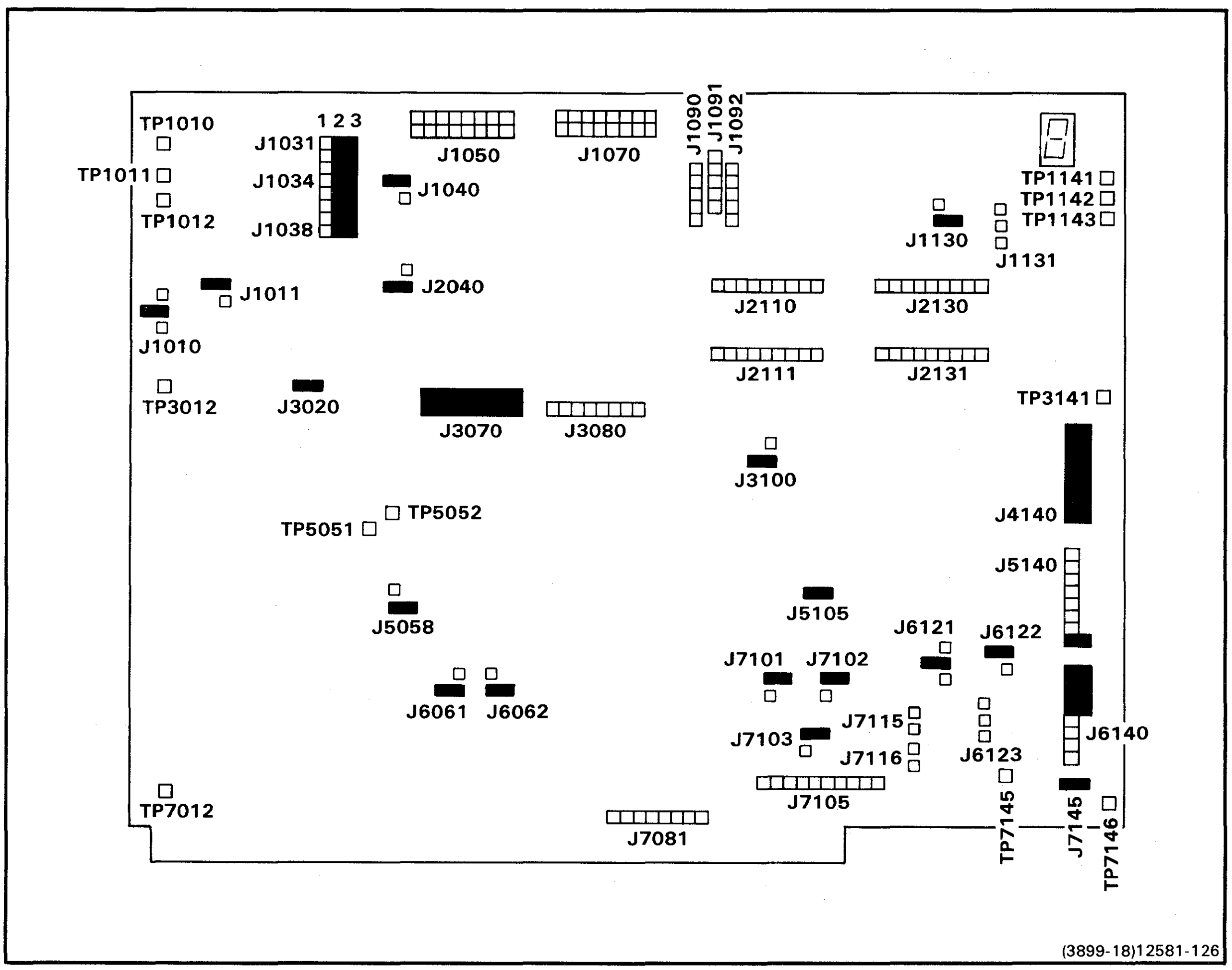


Fig. 3-18. PMS Controller jumper strap locations.

Table 3-20
PMS Controller Board Configuration

Jumper	Signal	Default Strapping and Function	
J1031	D7	o o-o	forces NOP (00) instructions
J1032	D6	o o-o	on the data bus
J1033	D5	o o-o	in the TEST position, and
J1034	D4	o o-o	allows normal bus access
J1035	D3	o o-o	in the NORMAL position.
J1036	D2	o o-o	
J1037	D1	o o-o	
J1038	D0	o o-o	
J1010	NMI(L)	o 4 1 o-o 2 o 3	causes NMI when J1131 is shorted
J1011	WAIT(L)	o-o o	the Z80 WAIT signal is available
J1040	Head Load	o-o o	the PIO controls loading of the disc heads
J2040	READ DATA(L)	o o-o	U4050 is triggered from the READ DATA(L) signal
J1050	PIO (A)	normally IN	otherwise used for port and logic
J1070	PIO (B)	normally IN	block testing
J1090 J1091 J1092		normally OUT --	used with signature analyzer
J1130		o o-o	normal position: selects 1 K-bytes of RAM
		o o o	other position selects 2 K-byte of RAM
J3070 J3090		normally IN normally OUT	these two jumpers are used in in conjunction with J1050 and 1070 to test PLL write precom- pensation logic
J4140 J5140		normally IN normally IN	these two jumpers are used (with J1050 and J1070) to test the DMA logic

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Table 3-20
PMS Controller Board Configuration (cont.)

Jumper	Signal	Strapping/Function	
J6140		normally IN	used (with J1050 and 1070 to test the Interrupt replay logic
J5058		o o-o o o o	Normal PMS address strapping Address: 777150 Other position: Address 777154
J3020	CLK1MHZ	o-o	
J3100	DMAINIT	o o-o	These jumpers are used with the PMS Controller diagnostic.
J5105	VALAD	o-o	
J6061	TDALOE	o o-o	
J6062	RINIT	o o-o	
J7145	CLK8MHZ	normally IN	isolates the main clock when out
J7115 J7116	D0 D1	normally OUT Normally OUT	selects the diagnostic mode when IN
J7101		o-o o	
J7102		o-o o	
J7103		o-o o	monitor interrupt requests
J6121		o 4 1 o-o 3 o 2	
J6122		o-o o	
J1131		normally out	diagnostic test switch shorts pins 2 and 3 and triggers DIAGIN(L)

M1220 INTERFACE BOARD CONFIGURATION

The M1220 Interface board provides jumper straps for miscellaneous trouble shooting functions. Figure 3-19 shows the M1220 board jumper strap locations.

Table 3-21
M1220 Interface Board Jumper Straps

Jumper	Function	Default
J1011	forces CNTRA0 high for diags	IN
J1012 J1013 J1041	disconnects terminators for diagnostics	IN IN IN
J3045	selects 1K or 2 K RAM	o-o
J5051	connects PIO A port	IN
J5055	connects PIO B port	IN
J6055	Signature analysis	OUT
J2011 J3011 J4011	used by diags when connected to PMSC board jumpers J1050/J1070	OUT OUT OUT

POWER SUPPLY BOARD CONFIGURATIONS

The 8560 power supply has two boards that contain jumper straps: the Regulator board and the Secondary board. Tables 3-22 and 3-23 show the jumpers and their functions. Figures 3-20 and 3-21 locate the jumpers.

Most power supply jumpers are used for trouble shooting. Except for the EXTERNAL SUPPLY connection (J6075) all jumpers are normally installed.

Table 3-22
Regulator Board Jumpers

Strap	Function	Default
J3115	overvoltage protection	IN
J3103	5V over current	IN
J3113	24V overcurrent	IN
J3111	-12V overcurrent	IN
J3101	+12V overcurrent	IN

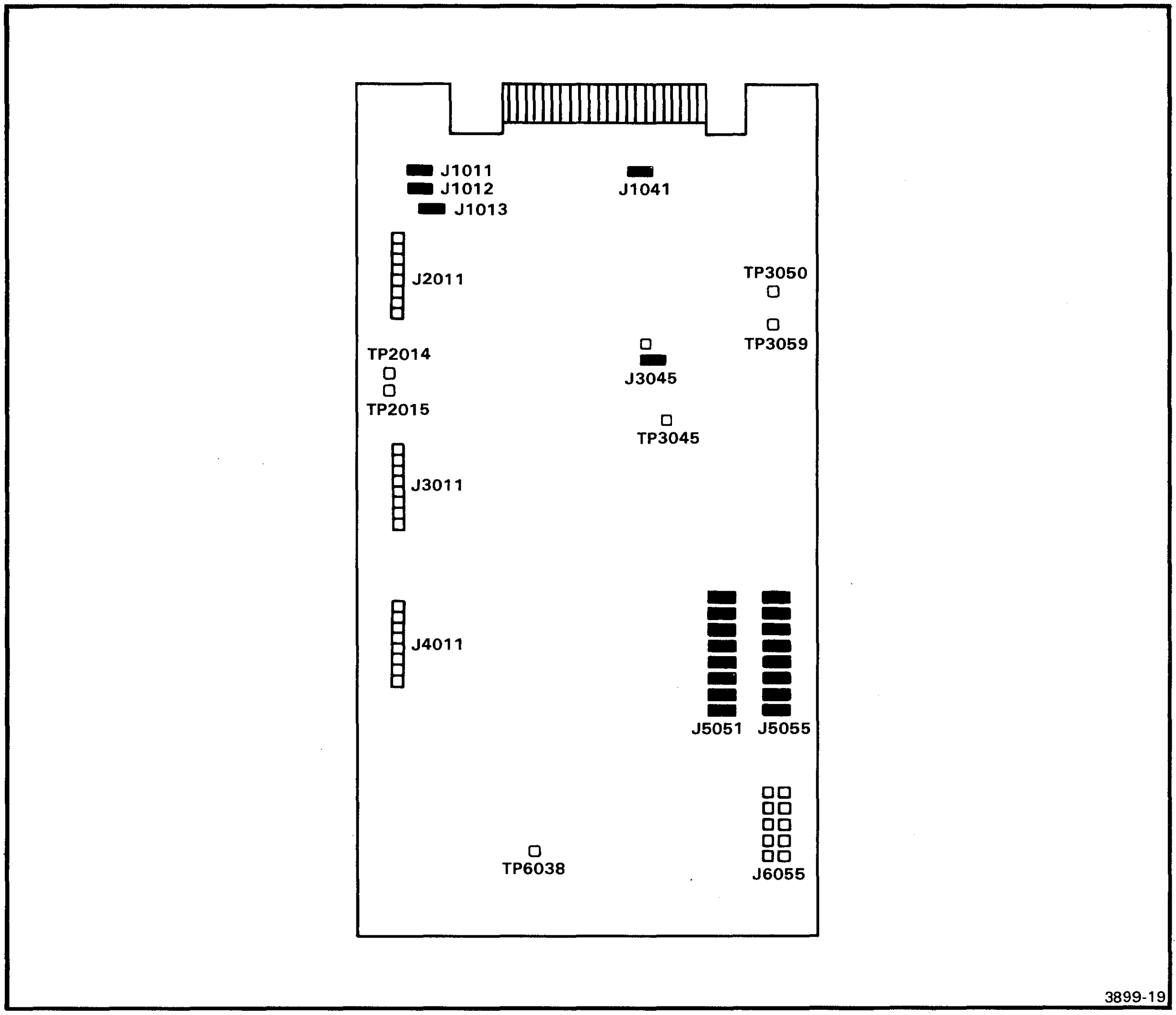

Fig. 3-19. M1220 Interface board jumper strap locations.

Table 3-23
Secondary Board Jumpers

Strap	function	Default
J6035	External Reference	1 - 2
J6048	low voltage shutdown disable	IN
J6075	External supply	OUT

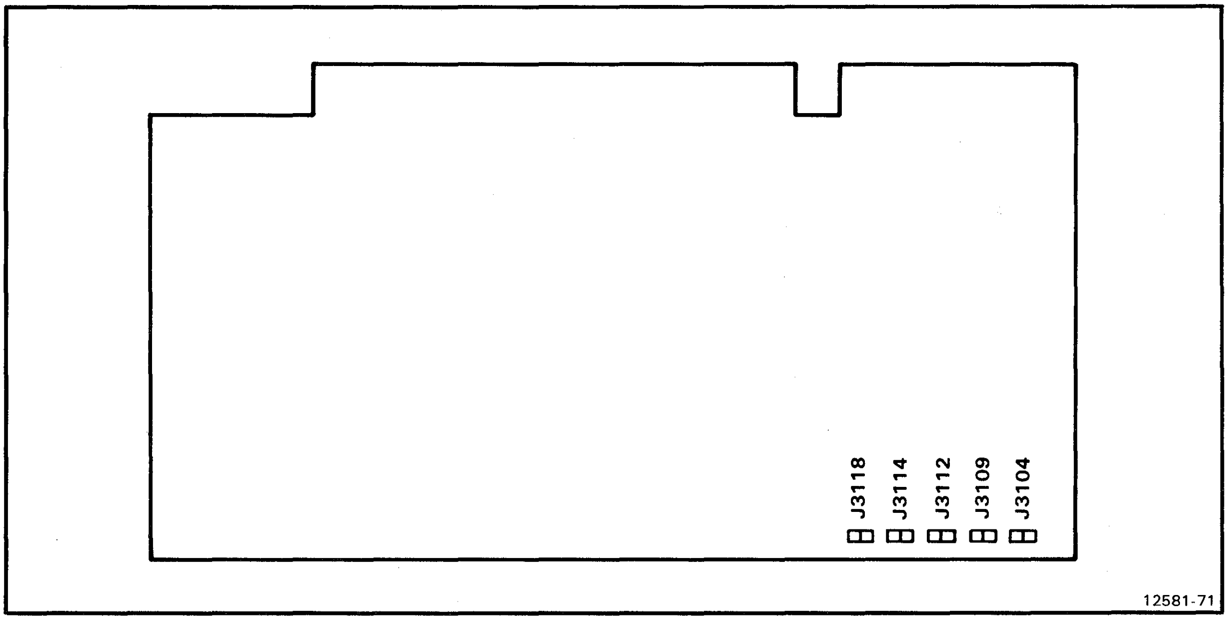

Fig. 3-20. Secondary board jumper strap locations.

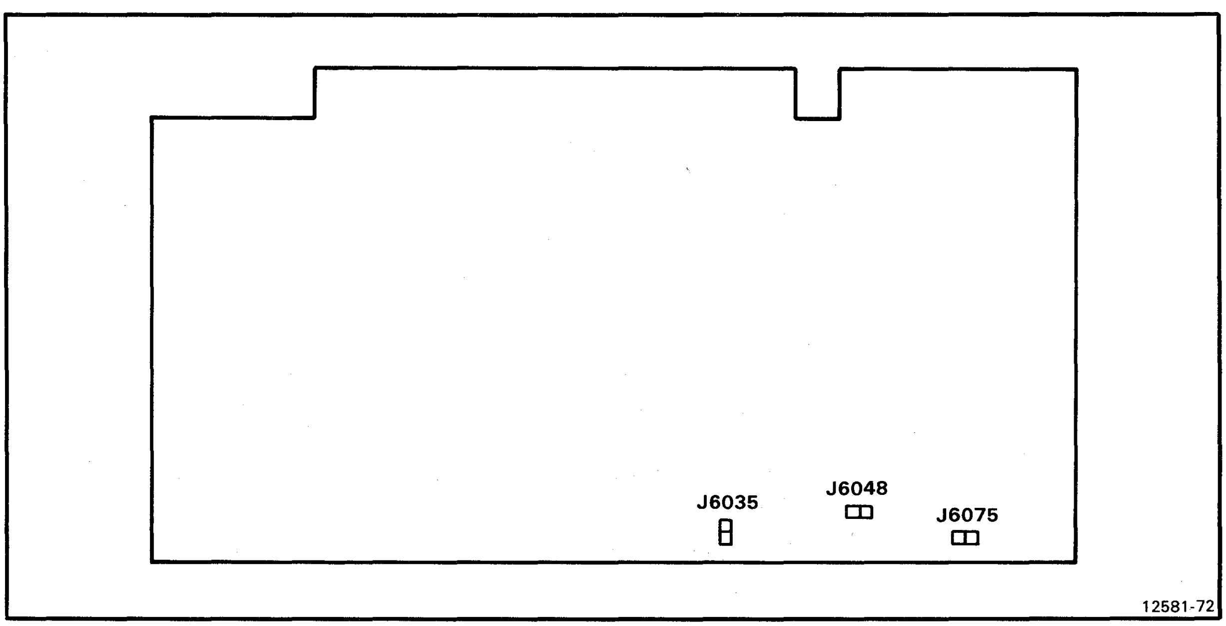

Fig. 3-21. Regulator board jumper strap locations.

Section 4

LSI-11/23 PROCESSOR

TABLES

Section 4

LSI-11/23 PROCESSOR

INTRODUCTION

The 8560 uses the Digital Equipment Corporation (DEC) LSI-11/23 16-bit microcomputer as its main control unit. The LSI-11/23 is a standard DEC dual height circuit board that is compatible with the DEC LSI-11 bus. The heart of the LSI-11/23 microcomputer is the LSI-11/23 chip set.

The LSI-11/23 has the following features and capabilities:

- 128K word address space
- four levels of vectored interrupts
- DMA
- memory management
- Octal Debugging Technique

The LSI-11/23 chip set consists of three LSI devices: a data control unit, a memory management unit, and a floating point unit.

The data/control device contains a separate data chip and control chip. The data chip contains the ALU, registers, and interface circuits for the data and address lines. The control chip contains the instruction decoder and instruction ROM.

The memory management unit facilitates multi-programming and memory protection.

The floating-point unit is an 8560 option.

OCTAL DEBUGGING TECHNIQUE

DESCRIPTION

The Octal Debugging Technique (ODT) is a built-in feature of the LSI-11/23. ODT allows you to examine and change register contents and memory locations. ODT also permits single-stepping and restarting of a user program. ODT works through the ODT terminal and responds to single character commands and octal numbers. Table 4-1 shows a summary of ODT commands. For additional information refer to the DEC Microcomputer Handbook.

The ODT Terminal

The 8560 treats any device connected to port LP2 as the ODT terminal. If a line printer is connected to this port when the processor enters ODT, it will print the address of the next instruction to be executed.

Entering ODT

ODT instructions execute only when the processor is in the HALT mode. The HALT mode is entered in one of the following ways:

- The processor executes a HALT instruction.
- The 8560 front panel HALT switch is toggled, asserting the BHALT(L) bus signal.
- A double Bus Error occurs (the stack pointer points to a non-existent memory location when the stack is used after an error condition)
- A Bus Error when the processor is attempting to input a vector from an interrupting device.

Table 4-1
ODT Command Summary

Command	ASCII	Function
x/ (Slash)	057	Prints contents of location specified by x, and leaves that location open.
<CR> (Return)	015	Closes an open location and accepts next command.
<LF> (Line Feed)	021	Closes current location and opens the next sequential location.
Rx/ (Register) or $x/	122 044	Opens a specific processor register x
S (Processor Status)	123	Opens the Processor Status Register (PS). This command must follow a "$" or "R" command
xG (Go)	107	Go to location x and start program execution.
P (Proceed)	120	Resumes execution of a program

JUMPERS

The default 8560 LSI-11/23 jumper configuration is given under "Circuit Board Configurations" in Section 3 of this manual.

Section 5

UTILITY BOARD

ILLUSTRATIONS

TABLES

Section 5

UTILITY BOARD

INTRODUCTION

The Utility board contains a collection of miscellaneous circuits providing various system functions. Figure 5-1 shows the Utility board block diagram. Figure 5-2 illustrates the serial interface registers. See Section 3 of this manual for strap locations and their functions. The Utility board has these features:

- Two RS-232-C Interfaces
- Line-Time Clock Control (LTC)
- Bootstrap ROM
- Diagnostic ROM
- Front Panel Functions (RESTART, RUN/HALT)
- Bus Termination Resistors
- Diagnostic Error Indicators (LED's)

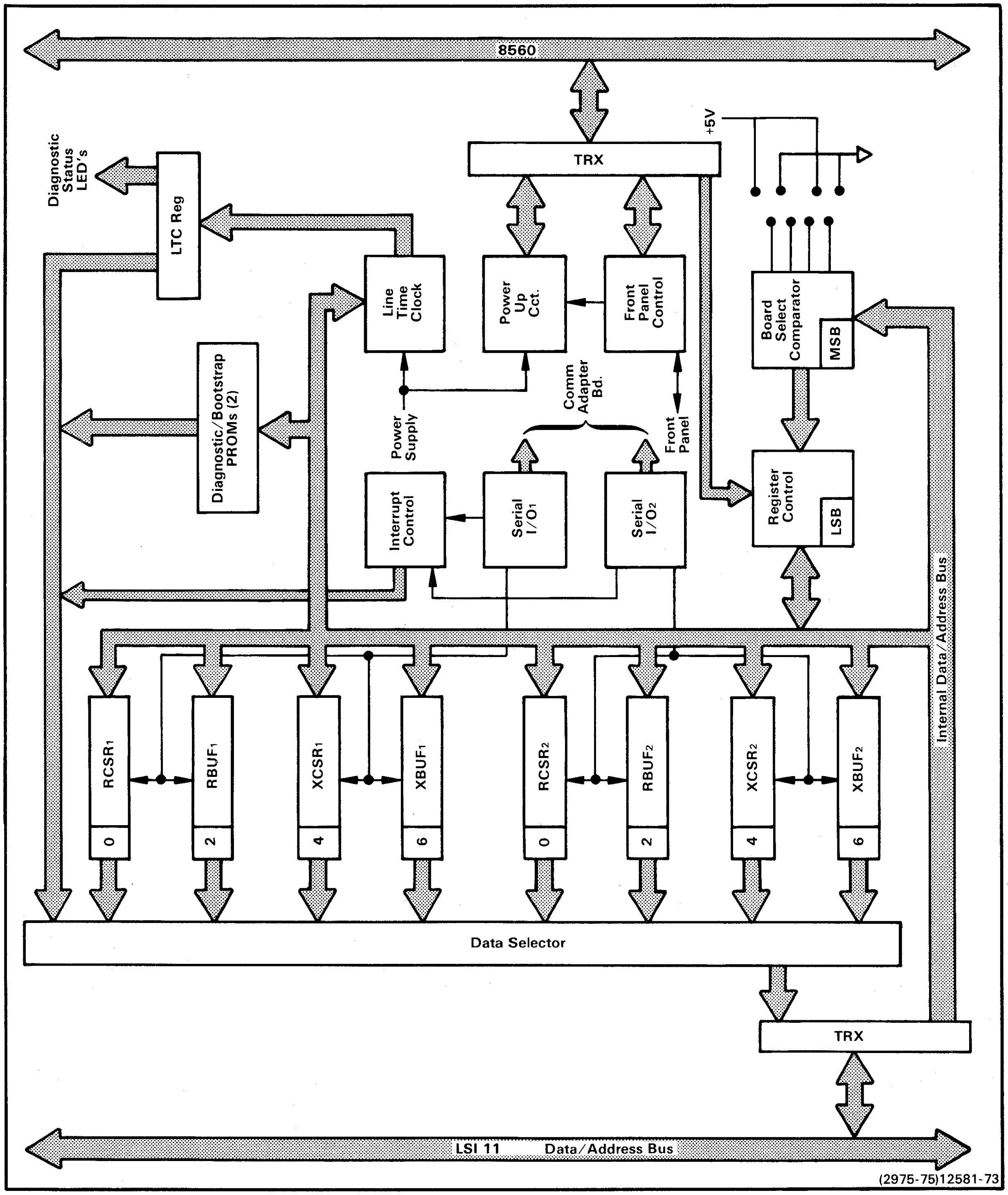

Fig. 5-1. Utility board functional block diagram.

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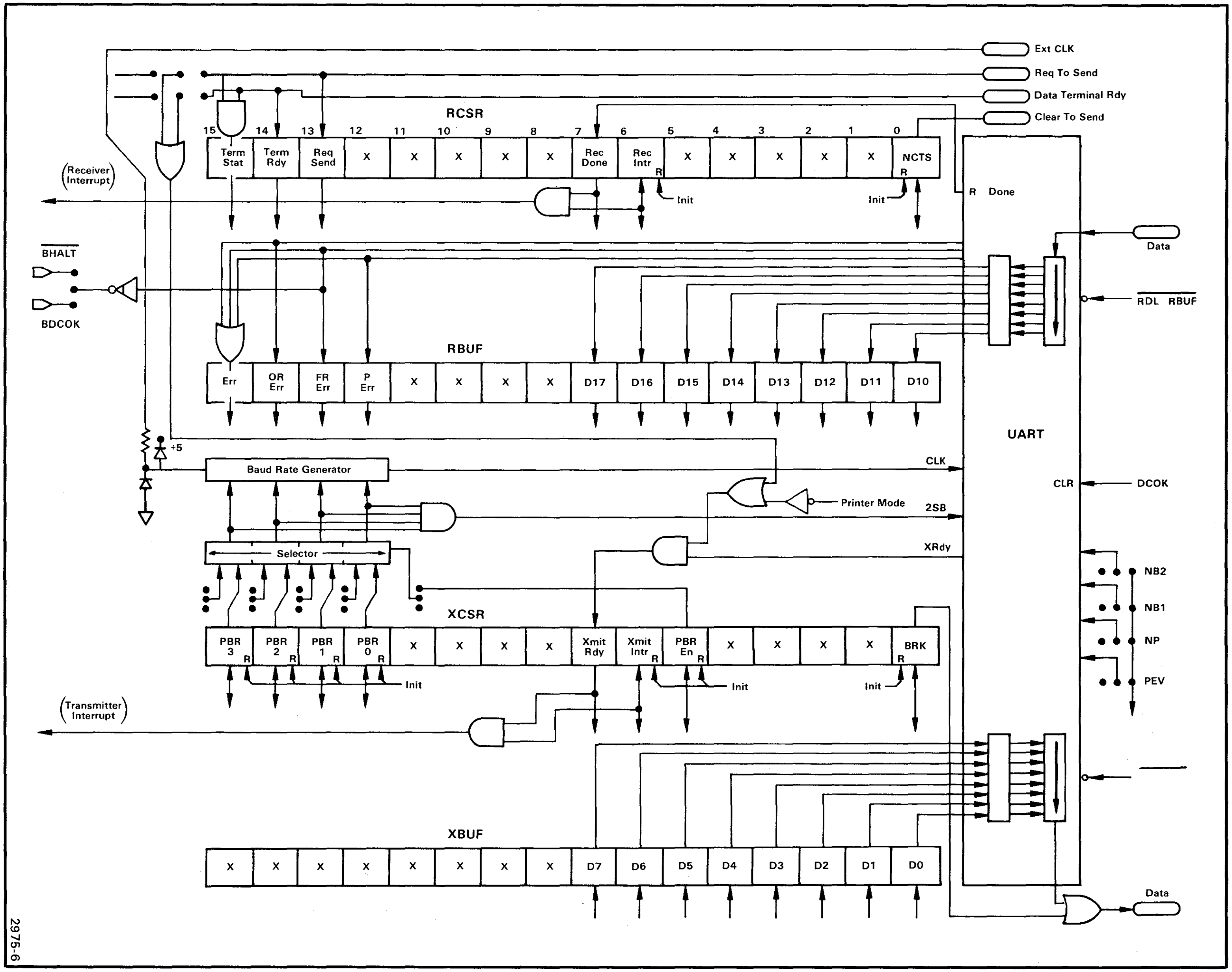

Fig. 5-2. Serial interface registers.

RS-232-C COMMUNICATIONS

The outputs and inputs of the two RS-232-C interfaces (LP1 and LP2) connect to the I/O Adapter Board. The I/O Adapter Board provides the translation between the TTL output/input of the Utility board and standard RS-232-C voltage levels. Please see " Communications" in Section 3 for more information.

You can select the baud rate for the two RS-232-C interfaces with straps on the Utility board. Available baud rates range from 50 to 9600. For more information on baud rate selection, see Section 3 of this manual.

SERIAL INTERFACE REGISTER DEFINITIONS

Register 0 - Receiver Control/Status Register (RCSR)

BIT	DESCRIPTION
15	Set when Data Terminal Ready (DTR) and Request To Send (RTS) are both received true. (Read-only bit)
14	Set when DTR is received true. (Read-only Bit).
13	Set when RTS is received true (Ready-only bit.)
12-8	NOT USED, read as 0
7	Receive done bit. Bit 7 is set when a character has been received and is ready to be read from RBUF. This bit is automatically cleared when RBUF is read or when DCOK goes false. A receiver interrupt is sent by the interface when this bit is set and the receiver interrupt is enabled (i.e., bit 6 is also set). (Read-only bit). interrupt request when a character is ready for input to the processor (i.e., bit 7 is also set). Cleared under program program control or by the INIT signal. (Read/Write bit).
5-1	NOT USED. Read as 0.
0	CTS. Drives Clear To Send (CTS). 1 = not CTS, 0 = CTS. (Read/Write bit, cleared by INIT during initialization).

Register 2 - Receiver Data Buffer (RBUF)

BIT	DESCRIPTION
15	Error. "OR" of bits 14, 13, and 12. (Read-only bit).
14	Overrun Error. This bit indicates that the previously received character was not read prior to receiving a new character. Bit 14 is cleared when DCOK is false or the receipt of a new valid character after reading the overrunning character. (Read-only bit).
13	Framing Error. When this bit is set, the incoming data was transmitted at the wrong baud rate. Bit 13 is cleared when DCOK is false or a new valid character is received. (Read-only bit).
12	Parity Error. When this bit is set, the parity of the received character does not agree with the expected parity. This bit is always 0 if no parity is selected. Bit 12 is cleared when DCOK is false or a new valid character is received. (Read-only bit).
11	NOT USED. Read as 0
7-0	Contains 5 to 8 data bits in a right-justified format. (Read-only bits).

Register 4 - Transmit Control/Status Register (XCSR)

BIT	DESCRIPTION
15-12	Programmable Baud Rate Select Bits. These bits choose the baud rate. The baud rate varies from 50 to 9600 or can be externally supplied. Bit 5 of XCSR register must be set and the baud rate enable straps for LP1 or LP2 must be installed before these bits are enabled (see Section Y). Reading these bits returns the actual baud rate. If the programmable baud rate is disabled, the baud rate jumpers are read. (read/write bits).
11-8	NOT USED. Read as 0
7	Transmitter Ready. This bit is set when the transmitter buffer (XBUF) can accept another character. When bit 7 and bit 6 are set, it initiates an interrupt sequence Bit 7 is set during power up sequence by DCOK, and cleared by writing into XBUF. hang 6 Interrupt Enable. When set, allows an interrupt sequence to start (Read/write bit). Cleared by INIT.
5	Programmable Baud Rate Enable. Bit 5 must be set for bits 15-12 to select the baud rate. Bit 5 is a read/Write bit, cleared by INIT.
4-1	NOT USED. Read as 0.
0	Break. When set, a continuous space is transmitted across the RS-232-C interface, giving the receiver a framing error. Bit 0 is a read/Write bit, cleared by INIT.

Register 6 - Transmit Data Buffer (XBUF)

BIT	DESCRIPTION
15-8	NOT USED. Read as 0.
7-0	Holds the character to be transferred to the external device. Data must be right-justified if the UART is strapped to less than 8 bits. Writing to this register initiates the transmit sequence. Write-only bits. Read as 0's.

LINE-TIME CLOCK (LTC) CONTROL

The Line-Time Clock (LTC) circuits consists of a control register and supporting logic to control the bootstrap/diagnostic ROM and the processor EVENT trigger line.

The logic is named after a characteristic of the EVENT interrupt line, which is triggered on the Utility board by a 60 Hz square wave signal derived from the 8560 power supply.

The EVENT interrupt provides a software facility allowing for real time clock applications. The presence of this signal is controlled by LTC bit 6. It is cleared (disabled) by either setting bit 6 to a zero, or during system initialization (INIT).

Other active bits in the LTC register are: bits 5 and 11 - controlling the ROM address space (see "Diagnostic and Bootstrap ROM's"); bit 7 - to monitor the line frequency clock (see LTC Register bit definition); bit 0, which is a strappable option (P1036) for software diagnostic purposes; and bits 15-11 which drive five LED's used for diagnostic status reporting.

Line-Time Clock Status Register (Address = 777546)

BIT	DESCRIPTION
15-11	Utility board LED's. The LED 's are used by the power-up self test to indicate errors and conditions (refer to Section 3 for the error codes). Writing a 0 to a bit turns on an LED. The Initialize condition sets all LED's ON. Writing a 1 turns it off. Write-only bits.
11,5	Diagnostic/Bootstrap ROM select. These bits select which bank of the diagnostic and bootstrap ROMs are located from addresses 773000 to 774776. Refer to the text under the heading "Diagnostic and Bootstrap ROMs."
10-8	NOT USED. read as 0.
7	Monitor. Set to 1 by line frequency clock signal. Cleared by program. Read/Write bit. Writing a zero clears the bit, writing a 1 does not set it. Bit 7 is set by INIT, or the line frequency clock.
6	Interrupt Enable. When 1, the line frequency clock signal asserts the BEVNT line. Read/Write bit. Cleared by INIT.
4-1	NOT USED. Read as 0.
0	Strap selected logic level for diagnostic ROM control.

DIAGNOSTIC AND BOOTSTRAP ROMS

Two 2K-byte ROM's in parallel provide 2K-words of diagnostic and bootstrap memory. This memory utilizes an address space of octal 773000 to 774776, or approximately 512 words. The memory is broken into four banks by bits 5 and 11 of the LTC register to fit into the given address space. Addressing within the address space is via bits A1-A8 and A11. The functions provided by each bank of the diagnostic and bootstrap memory are shown in Fig. 5-3.

When the 8560 is powered-up or reset, the power-up tests of bank 0 are run, and then the tests of bank 3 are run. Following completion of the power-up tests, the bootstrap routines in bank 3 are run. The 8560 first tries to boot from the flexible disk drive; if it is unable to boot from the flexible disk, it tries to boot from the hard disk. If the 8560 is unable to boot, it runs through the self test routines again.

The command interpreter in bank two will be entered after the power-up tests if J1036 is not present, or if an error is encountered. Bank 1 contains service routines for flexible disk drive alignment and RAM board signature analysis. For more information on Utility board strapping see Section 3.

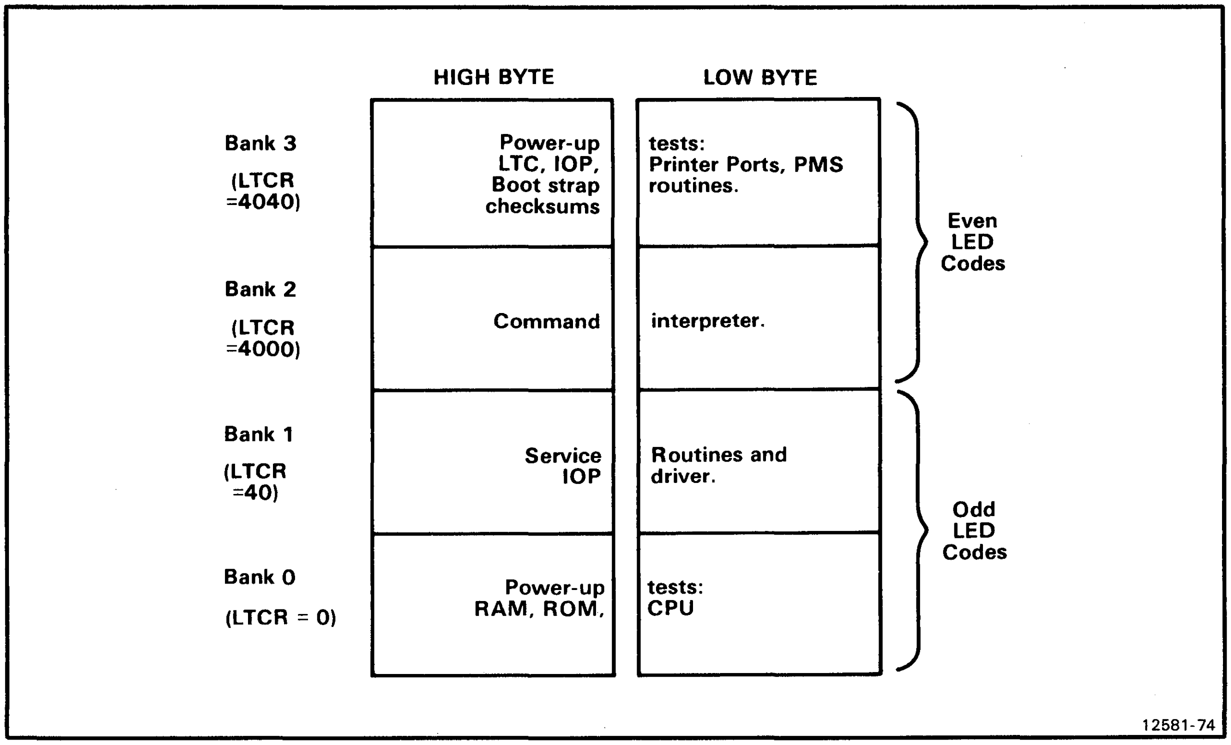

Fig. 5-3. Diagnostic and bootstrap ROM functions.

FRONT PANEL FUNCTIONS

The Utility board controls the system restart operation. When the front panel RESTART switch is toggled, the BDCOK signal goes false, forcing the processor to start execution at location 773000.

The front panel board provides the debounce circuit for the RUN/HALT and RESTART switch. When the RUN/HALT switch is in the HALT position the processor halts after the current instruction is executed.

BUS TERMINATION RESISTORS

Each bus signal is terminated on the Utility board with a resistive divider network consisting of 180 ohms to +5 Vdc and 390 ohms to ground. DMA Grant (DMG) and Interrupt Acknowledge (IAK) lines are terminated with a resistive divider network consisting of 330 ohms to +5 Vdc and 680 ohms to ground.

THE DIAGNOSTIC ERROR INDICATORS (LED'S)

Table 5-1 shows the diagnostic error indicator sequence. You view the LED's with the 8560 top cover removed from the side opposite the disc drives. The LED closest to the front is the most significant bit.

If the 8560 is powered up, it takes approximately 30 seconds to go through the sequence. If the 8560 is reset, it takes less than 5 seconds.

Table 5-1
LED Error Codes

LEDs	Octal Value	Definition
*****	37	Unable to execute firmware
-----	00	LTC error
----*	01	Initialization error
---*-	02	Printer Port 2 error
---**	03	LSI-11/23 MMU error
--*--	04	Printer Port 1 error
--*-*	05	ROM error (low byte)
--**-	06	PMS Controller error
--***	07	ROM error (high byte)
-*---	10	Page 0 RAM error
-*--*	11	Page 0 RAM error
-*-*-	12	Page 1 RAM error
-*-**	13	Page 1 RAM error
-**--	14	Page 2 RAM error
-**-*	15	Page 2 RAM error
-***-	16	Page 3 RAM error
-****	17	Page 3 RAM error
*----	20	Page 0 RAM parity fault
---	21	Page 0 RAM parity fault
---	22	Page 1 RAM parity fault
*--**	23	Page 1 RAM parity fault
---	24	Page 2 RAM parity fault
--*	25	Page 2 RAM parity fault
*-**-	26	Page 3 RAM parity fault
*-***	27	Page 3 RAM parity fault
**---	30	IOP error
**--*	31	LSI-11/23 CPU error
**-*-	32	Trying to boot from a flexible disc
***_*	33	Not used
***--	34	Debugging Mode
***-*	35	Debugging Mode
****-	36	Executing secondary boot from disc
*****	37	TNIX running

Section 6

SYSTEM MEMORY

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Section 6

SYSTEM MEMORY

INTRODUCTION

The standard 8560 Memory consists of 64 K-words of dynamic RAM on a single circuit board. Another memory board can be added to increase the 8560 memory to 128 K-words. The memory is divided into two main banks, the lower and the upper bank, with each bank containing 64K-words of storage.

Each 64 K-word memory bank, built from 16K X 1 dynamic RAM's, is contained on a separate circuit board. Each board contains four 16K banks of 16 bit words, plus byte parity. The two boards plug into any Main Interconnect board connectors J8 and J9. The two boards are identical, but straps on each board define the board either as a lower or an upper 64K memory bank. Figure 6-1 shows a block diagram of the System Memory board.

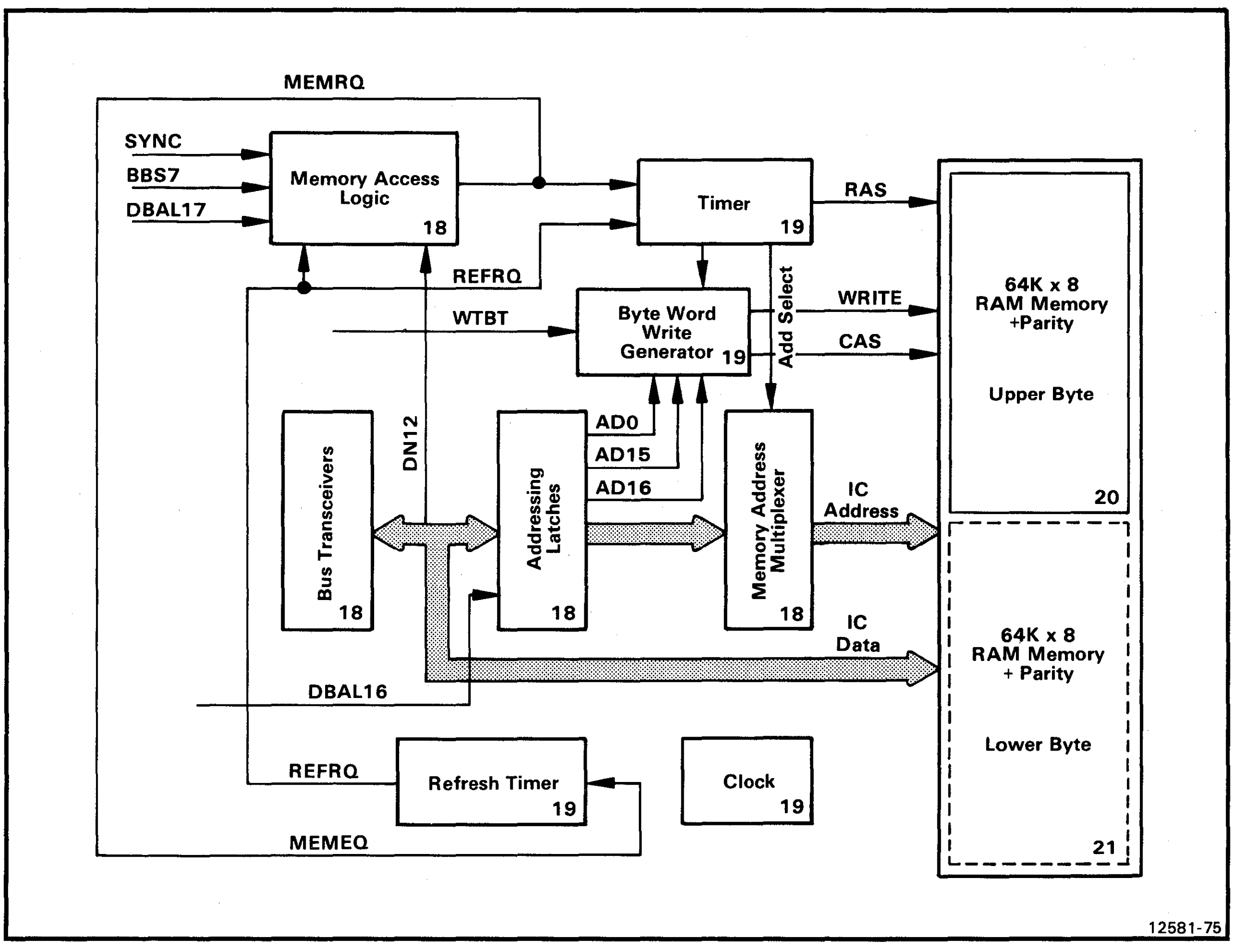

Fig. 6-1. Block diagram.

DESCRIPTION

BUS PROTOCOL 18

Address bits 15 and 16 select the proper bank. These address bits gate the CAS signal to one of the four banks via a 74S139 decoder. The RAS signal is transmitted to the four banks every time the memory is accessed. Except during a byte cycle, all chips receive the WRITE ENABLE pulse while a write cycle is in progress.

The memory interface to the LSI 11/23 bus is via four bus transceivers (U7010,U7020,U7030, and U7040) that also generate a four-bit parity. Byte parity is achieved by an exclusive OR chip (U6050) which gates the transceiver's four bit parity output.

Before the BSYNC signal goes true, the 16 data lines contain the lower 16 word address bits. When BSYNC goes true, the address bits are latched into two eight bit registers (U6060 and U6070). At the same time, the BBS7 and BDAL17 signals are sampled to determine if the memory will be accessed during that cycle.

Except in special cases, any time BSYNC goes true, a read, write or read-modify-write memory cycle is initiated. There are two exceptions: when BBS7 is true indicating an accessed peripheral, or when BDAL17 is strapped to access the optional 64K-word board.

MEMORY TIMING 19

Memory timing is provided by a 20 MHz clock (period=50 usec) located on the memory board. Shift register (U7070) provides the memory with the RAS, ADDRESS SELECT, and CAS signals. The bus signal BDOUT generates WRITE ENABLE; and the BDOUT and BDIN signals return BRPLY to the LSI-11/23. BDIN also controls the bus transceivers when data from a memory read operation must be placed on the bus by ENOUT.

A traveling ones shift register timing chain halts at state 6 until either BDOUT or BDIN goes false. This event advances the timing sequence to state T7 and allows a shift register time-out. This time-out (states 7 through 12) allows RAS to recharge the memory chips before the shift registers return to a quiescent state. After the shift register reaches the 0 state, another memory cycle may be initiated.

The state diagram in Table 6-1 corresponds to the system timing diagrams (Figure 6-2 through 6-4), and defines the system RAS/CAS generation.

Table 6-1
State Diagrams

STATE	T0	T1	T2	T3	T4	T5	T6	EVENT	SIGNAL
0	0	0	0	0	0	0	1	MEMRQ . GO(L)	---
1	1	0	0	0	0	0	1	T0(H)	RAS(L)
2	1	1	0	0	0	0	0	T1(H)	GO . T1(H). T6 (L)
3	1	1	1	0	0	0	0	T2(H)	CAS(L)
4	1	1	1	1	0	0	0	T3(H)	---
5	1	1	1	1	1	0	0	T4(H)	---
6	1	1	1	1	1	1	0	T5(H)	(Wait state)
7	1	1	1	1	1	1	1	BRPLY	(end of cycle), T6(H)
8	0	1	1	1	1	1	1	T0(L)	---
9	0	0	1	1	1	1	0	T1(L)	RAS, CAS T6(H)
10	0	0	0	1	1	1	0	T2(L)	---
11	0	0	0	0	1	1	0	T3(L)	---
12	0	0	0	0	0	1	1	T4(L)	GO . MEMRQ . T6(H)
0	0	0	0	0	0	0	1	--	---

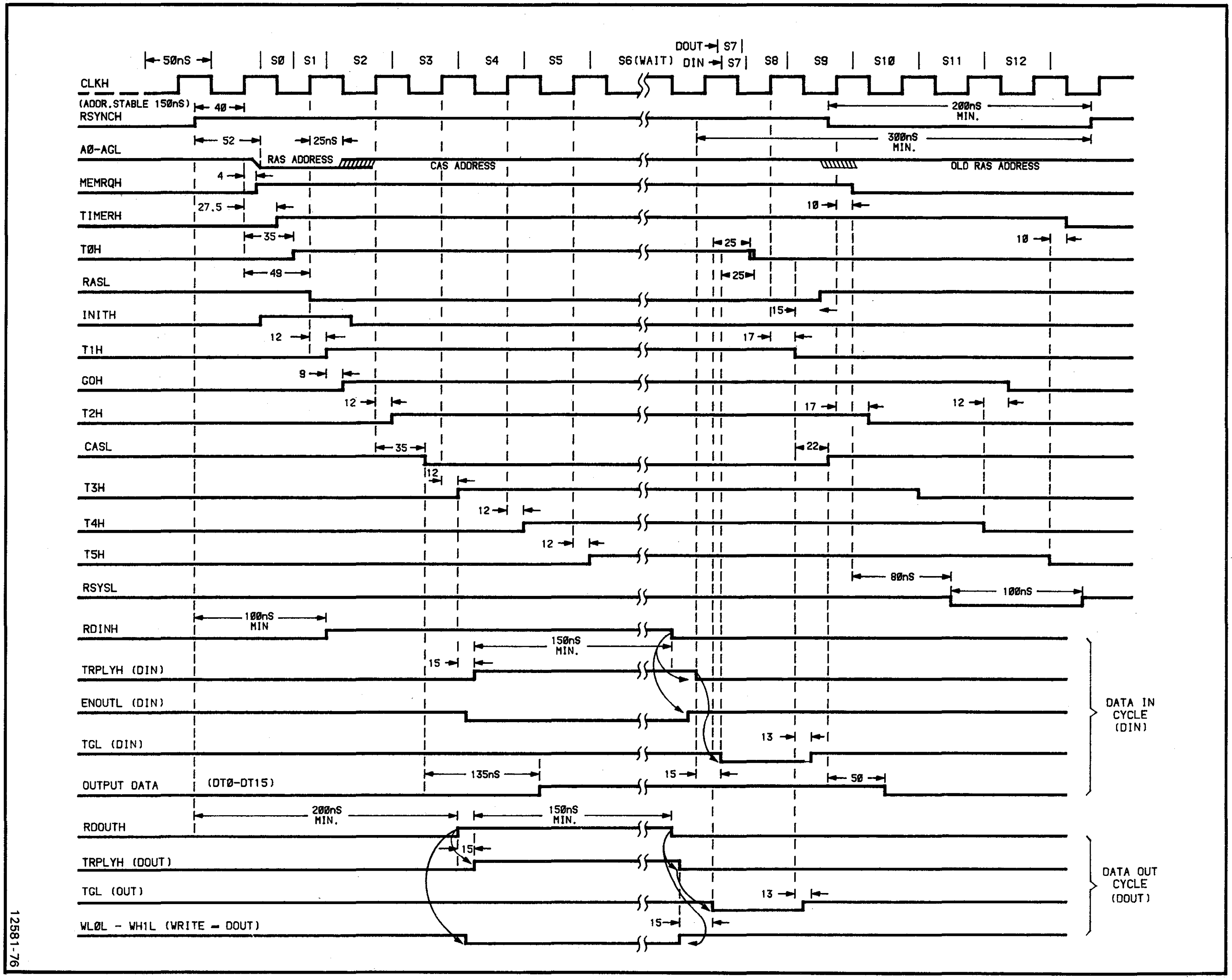

Fig. 6-2. DATI/DATO cycle.

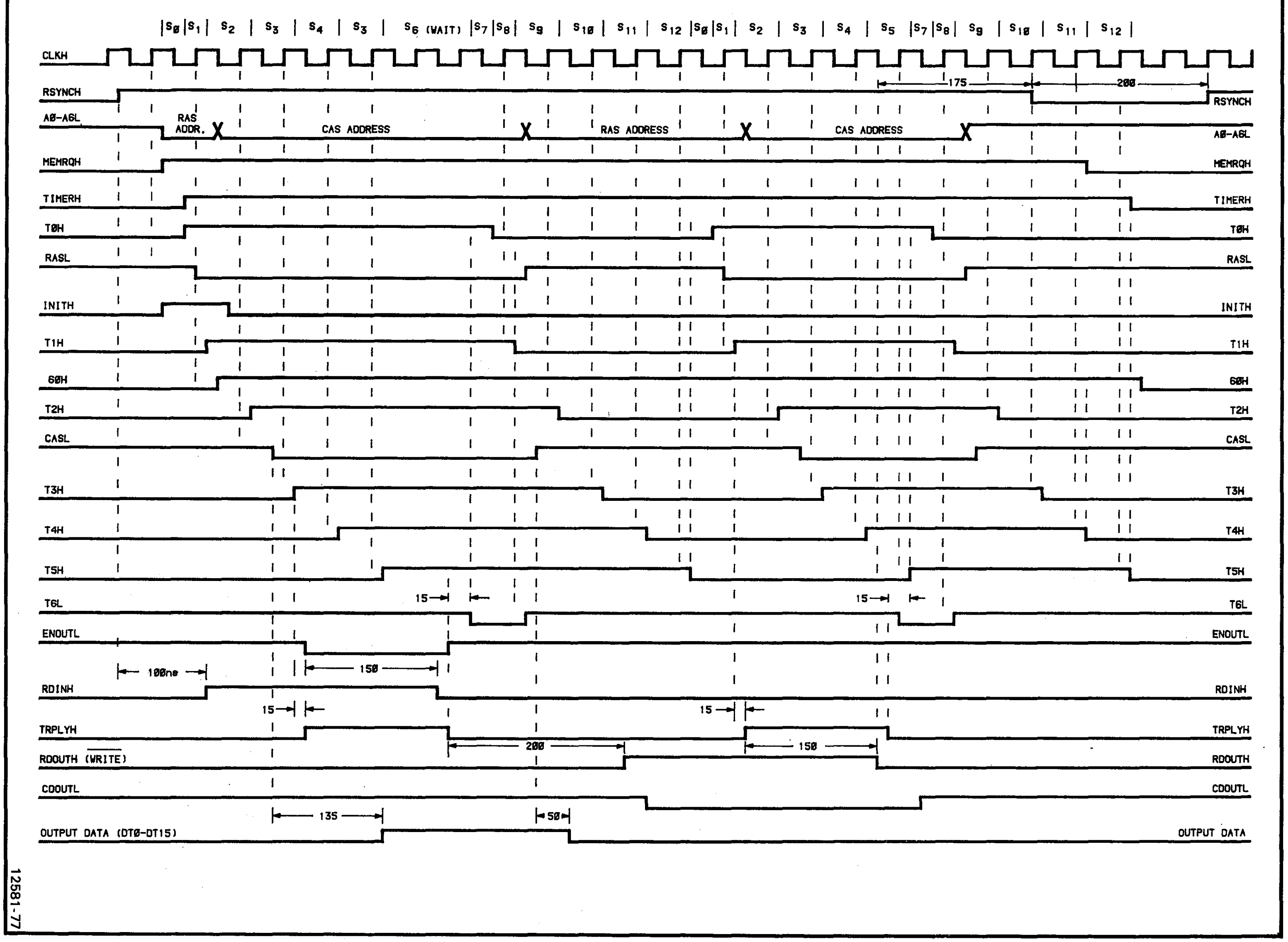

Fig. 6-3. READ-MODIFY-WRITE cycle.

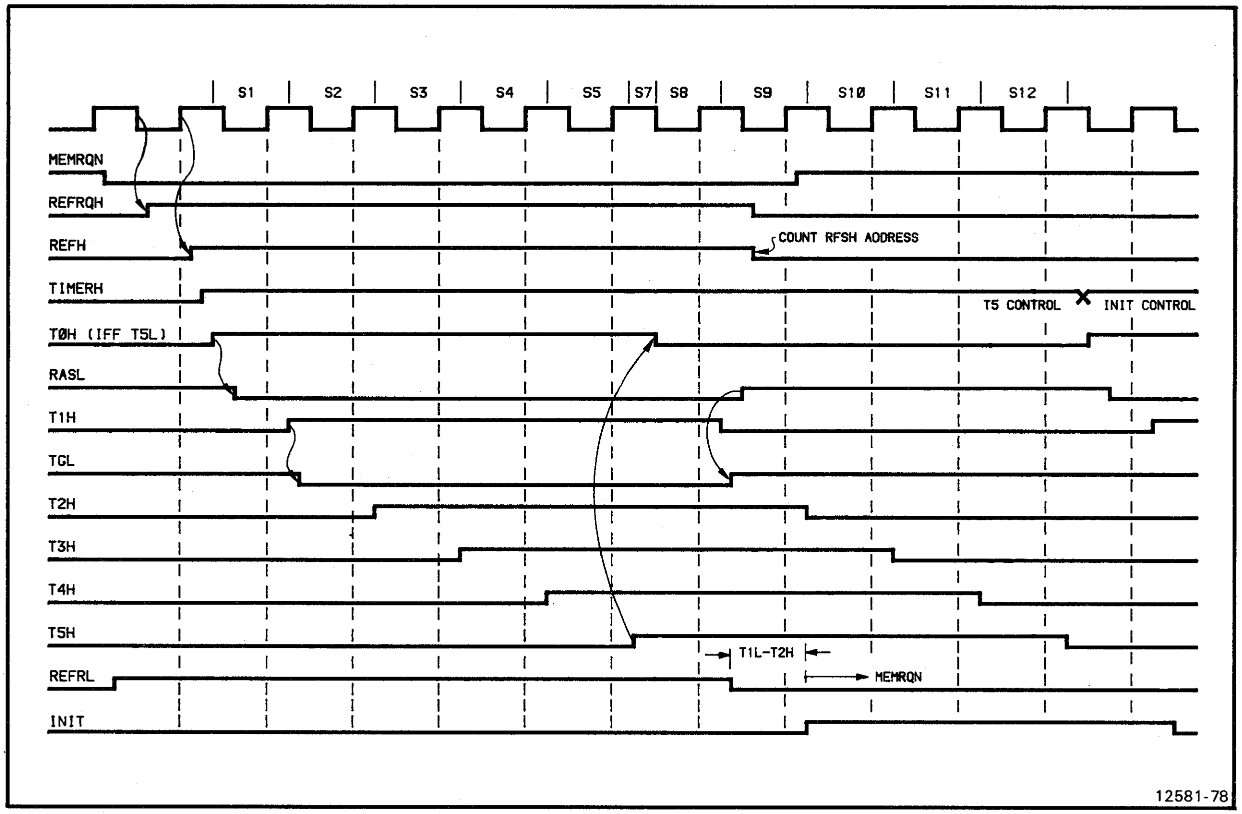

Fig. 6-4. Data Refresh cycle.

I/O MEMORY SPACE

Jumper J5161 (CG-CF) controls the size of the I/O memory space at the top of the memory. The jumper, if installed, limits the size of the I/O memory to 2 K-words. (In that case, data bit 12 (DN12H) is gated with BBS7, hence limiting the I/O memory space to 2 K-words). If the jumper is not installed (default condition), the I/O memory space is 4 K-words.

ADDRESS SELECTION 18

Memory address multiplexer (U6090) performs the RAS/CAS address selection. Bus signals BWTBT and BDAL0 determine a high/low byte write sequence as BDOUT goes true. This memory does not allow byte-read instructions. Each memory-read sequence addresses a 16-bit word, and places it on the bus. The processor arbitrates a read-byte access. Byte parity allows writing of one byte per memory access.

The read-modify-write sequence consists of two full memory cycles. The first cycle is a normal read cycle. Next is a write cycle that is set-up when WTBT is low while BSYNC is asserted and MEMRQ remains high. The write portion of this cycle is started by BDOUT

REFRESH 18

U6090, in addition to the memory address multiplexer, also contains a refresh address counter and gating logic. This logic gates the counter to the memory address lines during the refresh operation.

Count down of the 20 MHz clock generates 128 RAS-Only refresh cycles. The clock generates a complete refresh cycle every 1.6 msec. Memory access, prohibited during a refresh cycle, is delayed until the refresh operation is completed. refresh and memory- access cycle requests are sampled by different edges of the memory clock pulse, thereby preventing a race condition. The time interval between counter resets is always 13 uS. During that 13 uS interval, a refresh cycle is allowed by trailing edge of the MEMRQ signal. A counter within the memory address multiplexer maintains a count of the refresh address, and multiplexes a REFRESH cycle every 13 uS.

JUMPERS AND STRAPS

This board provides various jumpers. Except for J5161 and 6112, the System Memory board jumpers are diagnostic aids. They disable various signals such as input data, clock, refresh and others.

Jumper J5161 and J6112 are not used for diagnostics. J5161 selects the size of the memory I/O space; and J6112 configures the board either as a upper or lower memory bank.

Section 3 of this manual provides the System Memory board default strapping.

Section 7

THE I/O PROCESSOR

ILLUSTRATIONS

TABLES

Section 7

THE I/O PROCESSOR

INTRODUCTION

This section describes the I/O Processor (IOP) board hardware and its functions. Section 3 of this manual describes the IOP default jumper strapping; and Sections 13 and 16 deal with IOP diagnostics.

The IOP board is a microprocessor-controlled communications board that controls the information flow to and from 8560 external peripherals. Figure 7-1 shows the IOP block diagram.

The IOP board relieves the LSI-11/23 of most I/O processing chores that are associated with external 8560 peripheral communications. The IOP board provides four full duplex serial data channels.

For the purpose of this discussion, we divided the IOP board logic into these distinct parts.

- the kernel
- the system memory access logic
- the I/O logic
- the Interrupt vector logic
- the diagnostic registers

The IOP kernel consists of the 8088 processor (U3050), the clock logic, and 10 K-bytes of RAM and 20 k-bytes of ROM.

The system memory access logic provides memory mapping and direct-memory access functions. Memory access logic also provides various registers. The 8088 accesses the 8560 bus by treating it as a subset of its address bus.

I/O Processor I/O logic provides four data channels, I/O registers, SIO (serial I/O device) wait logic, and a baud rate generator. Typically, a 8560 with four HSI channels contains one IOP board. A second IOP board, serving another four HSI channels, is available as an option. The baud rate of each communication channel is independent. This is a function of jumper straps, a control register, and SIO channel programming.

The 8088 sets 8560 bus interrupts under firmware control. Interrupt vector circuits provide two vector ports interface with the LSI-11/23 via interrupt vector registers.

The IOP provides two diagnostic registers. One register is a write-only register, while the other is a read-only register. the output of the write-only register drives a seven-segment LED display.

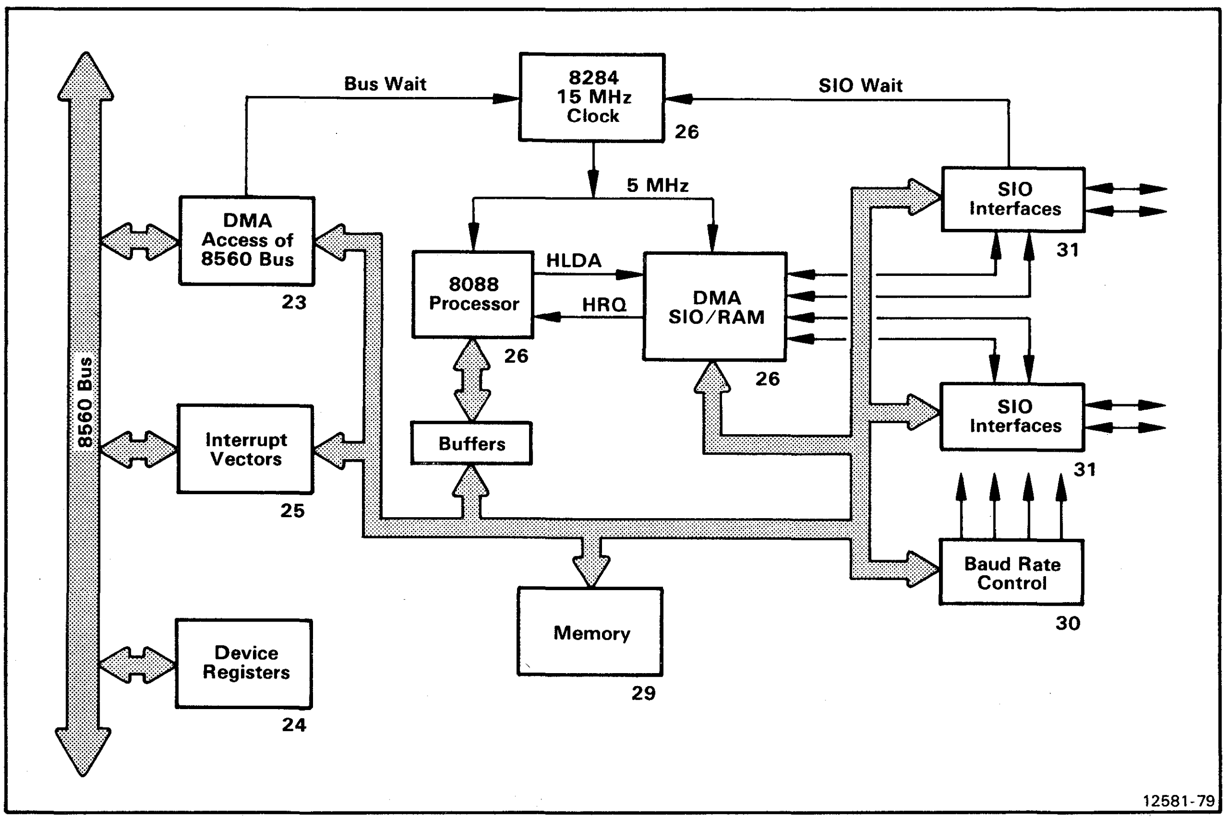

Fig. 7-1. IOP Block Diagram.

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THE KERNEL

The kernel is defined as that part of the IOP board that must be operational before any firmware or software diagnostics can be executed. The kernel encompasses the 8088 processor (U3050), the clock, and the ROM and RAM memories.

THE PROCESSOR ⟨26⟩

The heart of the IOP board is the Intel 8088 microprocessor strapped for MIN mode. The 8088 is a third generation microprocessor that can address 1 mega-byte of memory.It has an 8-bit external data path to memory and I/O , and a 16-bit wide internal data bus. To speed up instruction processing, the 8088 consists of two separate processing units within the one device: the execution unit (EU) and the Bus Interface Unit (BIU). The EU executes instructions, and the BIU fetches instructions, reads operands, and writes results.

The EU and BIU operate independently, and in most instances instruction fetch operations can overlap with instruction executions. The result is that the processor does not need to stop while an instruction is fetched, therefore reducing the overall fetch/execution time. Firmware on the IOP board provides the instructions for the 8088 processor.

THE CLOCK CIRCUIT ⟨26⟩

A 8284A Clock Generator-driver device (U3160) supplies the master clock signal for the 8088. Besides supplying the primary CPU clock signal, the 8284A also provides a hardware reset function, and a mechanism to permit insertion of bus cycle wait states.

The 8284A Clock Generator device uses an external crystal oscillating at 15 MHz. From this frequency U3160 generates a 15MHz, 5MHz, and 2.5 MHz output. The 2.5 MHz output is not used.

From the 8284A 15MHz output, a frequency dividing counter (U4170) generates 7.5 MHz and 3.75 MHz clock frequencies. The 7.5 MHz clock drives the DEC DC010 8560 bus DMA device (U6080). The 3.75 MHz clock output drives the SIO devices.

The clock logic also has an internal Schmitt trigger circuit that provides a hardware RESET function. This circuit is asserted from the 8242A's RESET input. When the RESET input is high, the RESET output is asserted synchronously with the CLK signal for four clock cycles. This causes the CPU to fetch and execute the instruction at location FFFF0. The RESET signal originates at the LSI-11/23 as INIT.

THE IOP MEMORY ALLOCATION AND ASSIGNMENTS

The IOP board provides 10 K-bytes of RAM. In addition, the 8088 can access the 8560 system memory.

The IOP board also contains 20 k-bytes of ROM. This memory contains 8088 operating firmware and various IOP service routines. Figure 7-2 shows the 8088 address space. Note that the IOP divides the memory into four quarters.

The lowest quarter (address 00000 to 3FFFF) is reserved for on-board RAM and status/control registers. The next quarter (addresses 40000 to 7FFFF) maps the 8560 bus I/O space for direct use by the 8088. The next highest quarter (addresses 80000 to BFFFF) is used to map the 8560 system memory into the 8088 memory space. Finally, the highest quarter (addresses C0000 to FFFF) is designated for on-board PROM and ROM memory.

Figure 7-3 defines the 8088 memory space hardware decoding. Note that all I/O registers are located in the 8088 memory space. The diagnostic registers, however, still reside in I/O space. Note also that, except for the DMA controller (8237), all least significant bits are don't care bits.

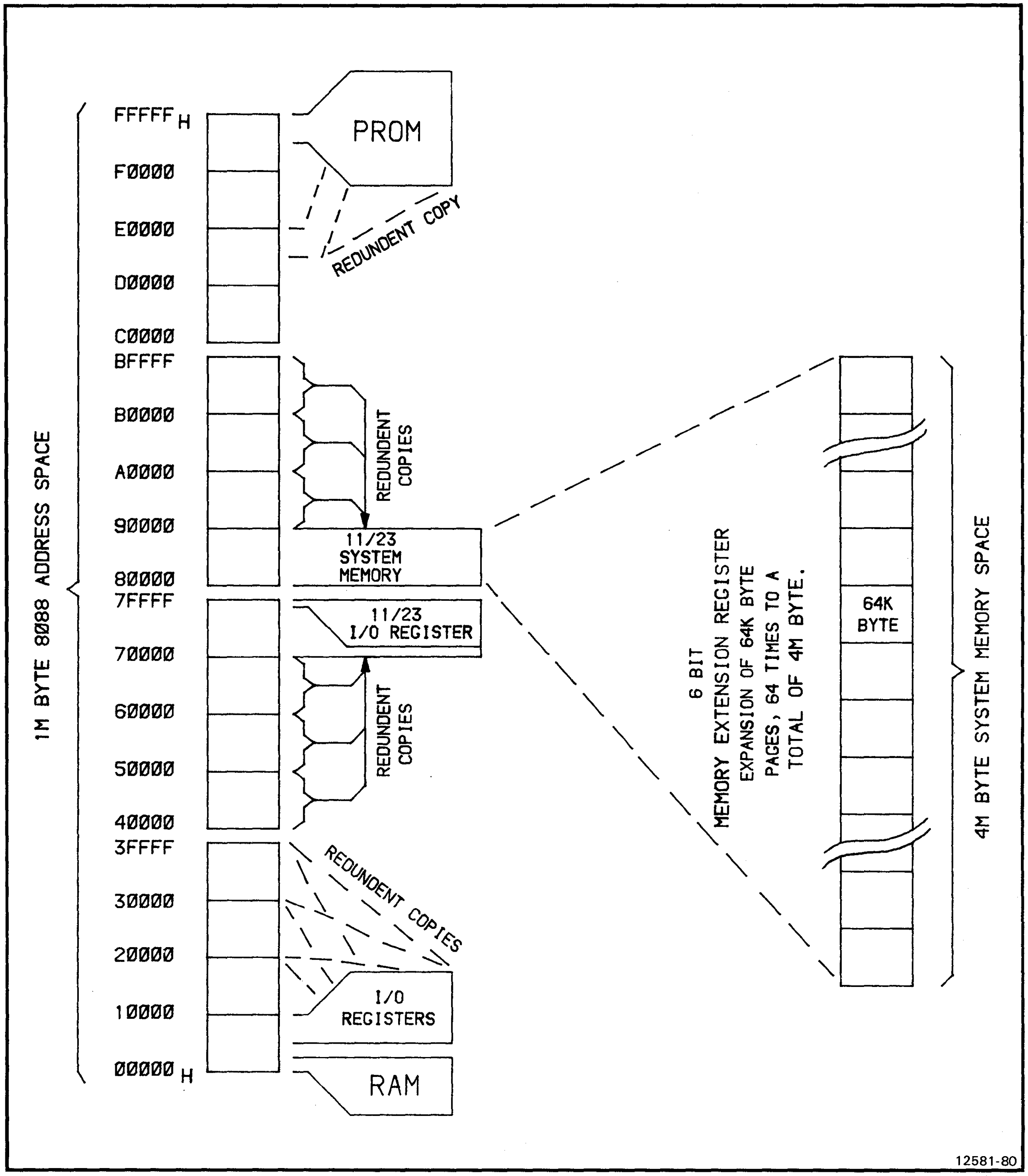


Fig. 7-2. 8088 Memory map.

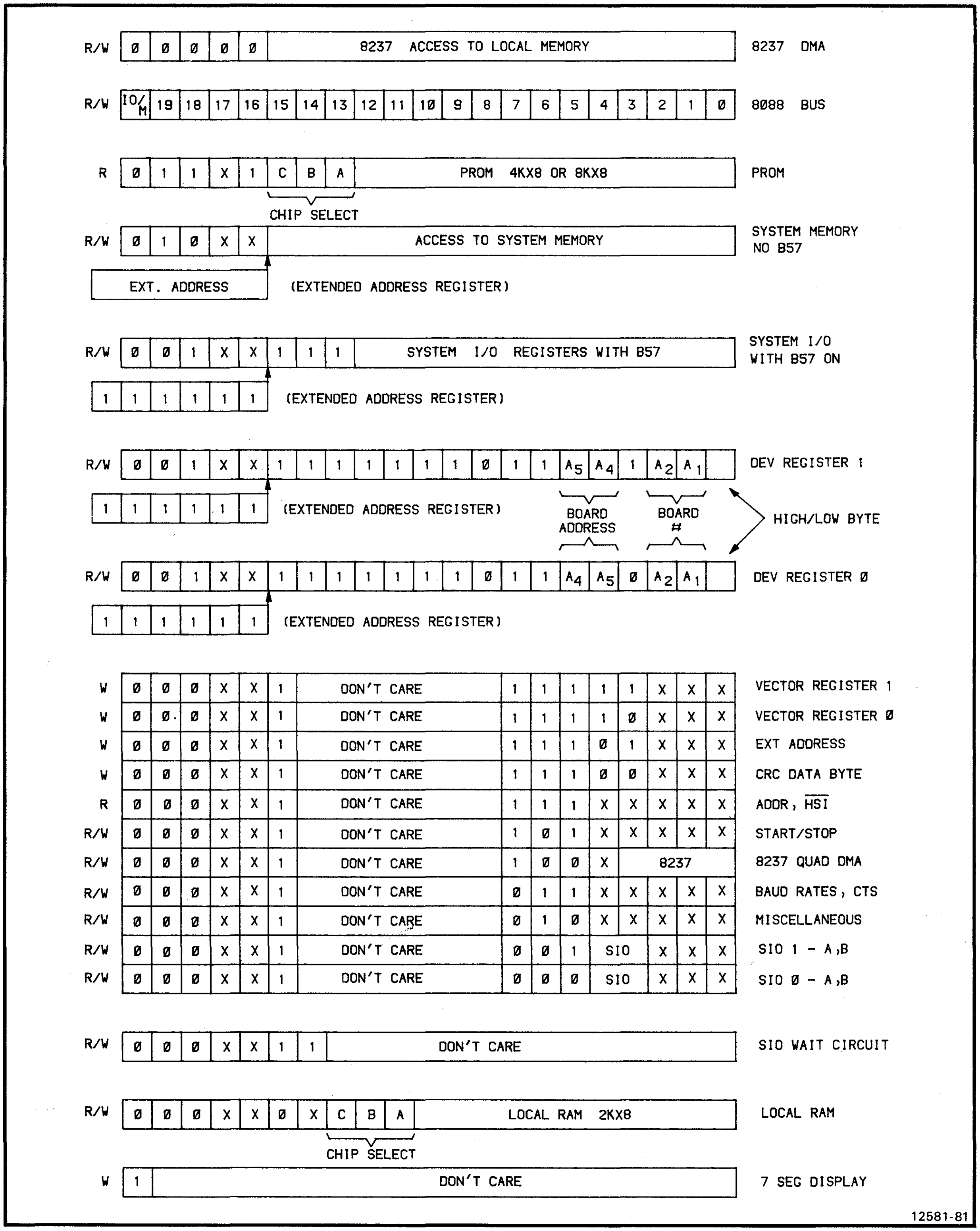


Fig. 7-3. 8088 Memory hardware decoding.

SYSTEM MEMORY ACCESS CIRCUITS

The system memory access circuits consists of DMA control circuits, and various registers and buffers.

MEMORY MAPPING

Memory mapping is a technique by which a processor can access memory space larger than that would be normally possible with a finite number of address lines. The 8088 has 20 address lines which allow direct addressing of 1 M-byte of RAM.

Since the 8560 bus provides 22 address lines, but the 8088 has only 20, the 8088 can map only a subset of the system memory.

A 6-bit address extension register allows the 8088 to address up to 4 M-bytes of system memory. The memory extension register acts as a page or bank switch for a 64 K-byte memory partition.

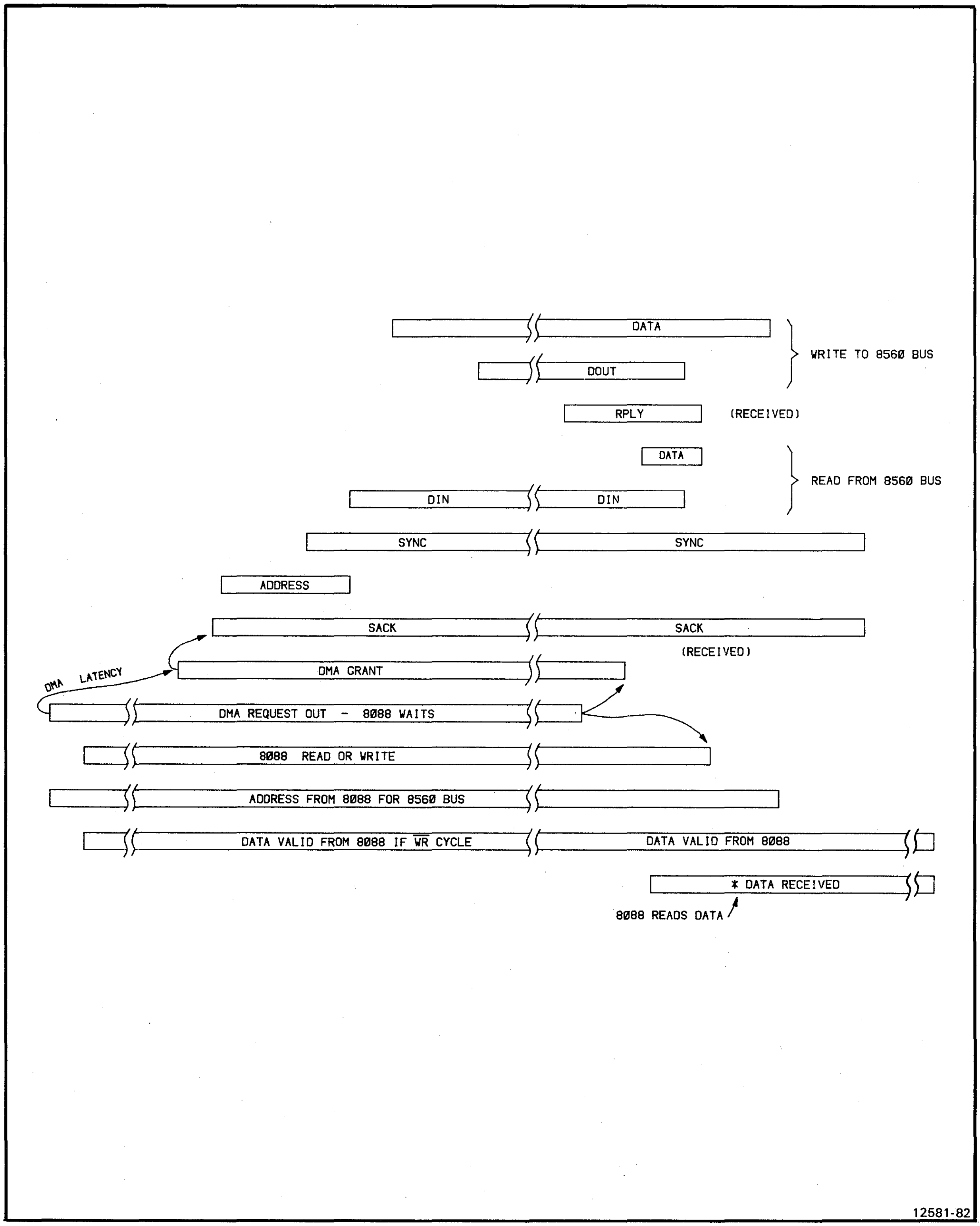
DMA CONTROL CIRCUIT 23

The IOP board provides two independent DMA control circuits: one to access the 8560 bus, and another to access the SIO logic. This text describes the 8560 bus DMA logic. The SIO DMA logic is described under "I/O Circuits" later in this section.

The 8560 bus DMA logic allows the 8088 to access address locations that are normally accessed by the LSI-11/23. The 8560 bus DMA logic consists of a DEC DC010 device (U6080) and its associated logic. The 8560 bus DMA controller is under direct control of the 8088 and provides direct access to the system memory.

Bit 7 at location 8040H determines whether a system memory DMA data transfer is in word mode or in byte-mode. With bit 7 set, all data transfer via the 8560 bus is in byte mode. If bit 7 is not set, all data transfer via the 8560 bus is in word mode.

Whenever the 8088 accesses the 8560 bus, the DMA circuit signals the 8284 to extend the 8088's read or write cycle. Figure 7-4 shows the timing relationship between the 8560 bus and the 8088. The 8088 clock logic receives a signal instructing it to wait; and the 8560 bus receives a request for bus mastership. When the request is granted, the timing progresses until either the DIN or DOUT signal goes true. The logic then waits for the accessed device to return a reply. When the reply is received, the DMA logic completes its timing and negates the WAIT signal to allow the 8088 to complete it's read or write cycle. If no reply is detected before U6170 times out, bit 6 at location 8040 is set to indicate an error condition, and U6080, the 8560 bus DMA device, is allowed to terminate the DIN or DOUT cycle.



7-4. System bus access timing.

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REGISTERS

The registers described in this subsection include the memory extension register, device registers for HSI terminal functions, 8560 bus registers and buffers, and a register that performs miscellaneous functions. Figures 7-5, 7-6, and 7-7 show the registers.

Extended Addressing Register 24

The memory extension register is a six-bit register that is used to extend the sixteen bit portion of the 8088 bus to to address the 22-bit 8560 bus. The contents of this register determine which 64 k-byte bank the 8088 can access.

Device Registers 23

The IOP has two 16-bit device registers. The register consisting of U6020 and U6040 is device register 1, designated for HSI functions. The register consisting of U6010 and U6030 is device register 0, designated for terminal functions.

Any device on the 8560 bus, such as the LSI-11/23 or the IOP, can access (read and write) these registers. Normally data is written into the registers by the LSI-11/23 and read back by the IOPs 8088 using its memory mapped 8560 bus access.

System Bus Registers and Buffers 25

Transferring data to and from the 8560 bus requires various buffers and registers. For this discussion, they have been separated into four distinct groups.

The first group consists of U7080 and U7090. These two registers work in conjunction with the DEC DC010 8560 bus DMA controller.

The next group consists of U7010, U7020, U7030, and U7040. These devices have open collectors driven to assert data on the system bus. They also have a Schmitt bus receiver to receive data from the 8560 bus.

The group consisting of U4020 and U4040 provides addresses for the 8560 bus.

The last group, consisting of U5010, U5020, U5030, and U5040 provides data-in and data-out functions. U5020 and U5040 latch the data from the 8088 bus. From there the data goes onto the 8560 bus via buffers (U7010, U7020, U7030, U7040). U5010 and U5030 receive the data from the 8560 bus buffers and latch it before it is transmitted onto the 8088 bus.

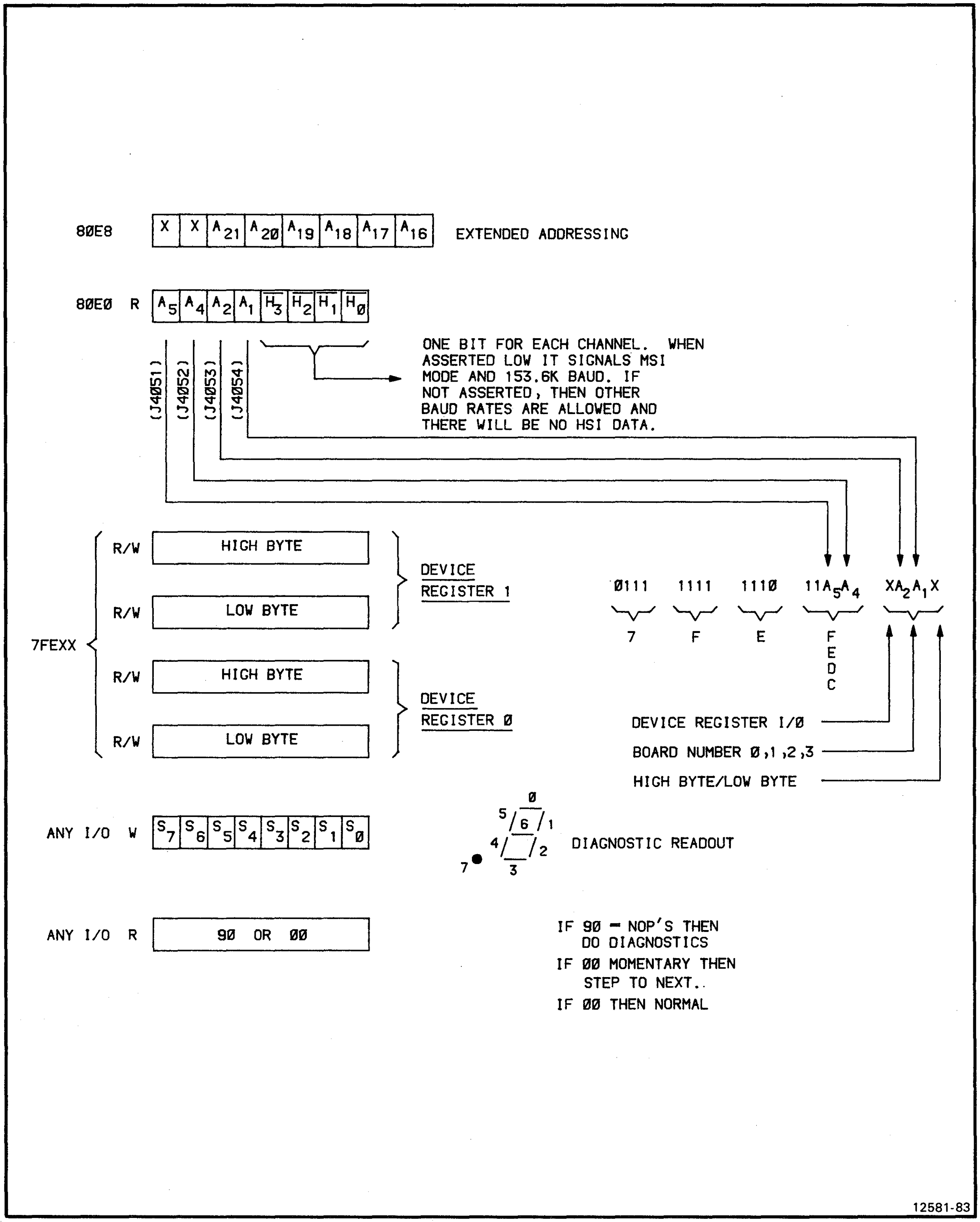

Fig. 7-5 IOP Registers part 1.

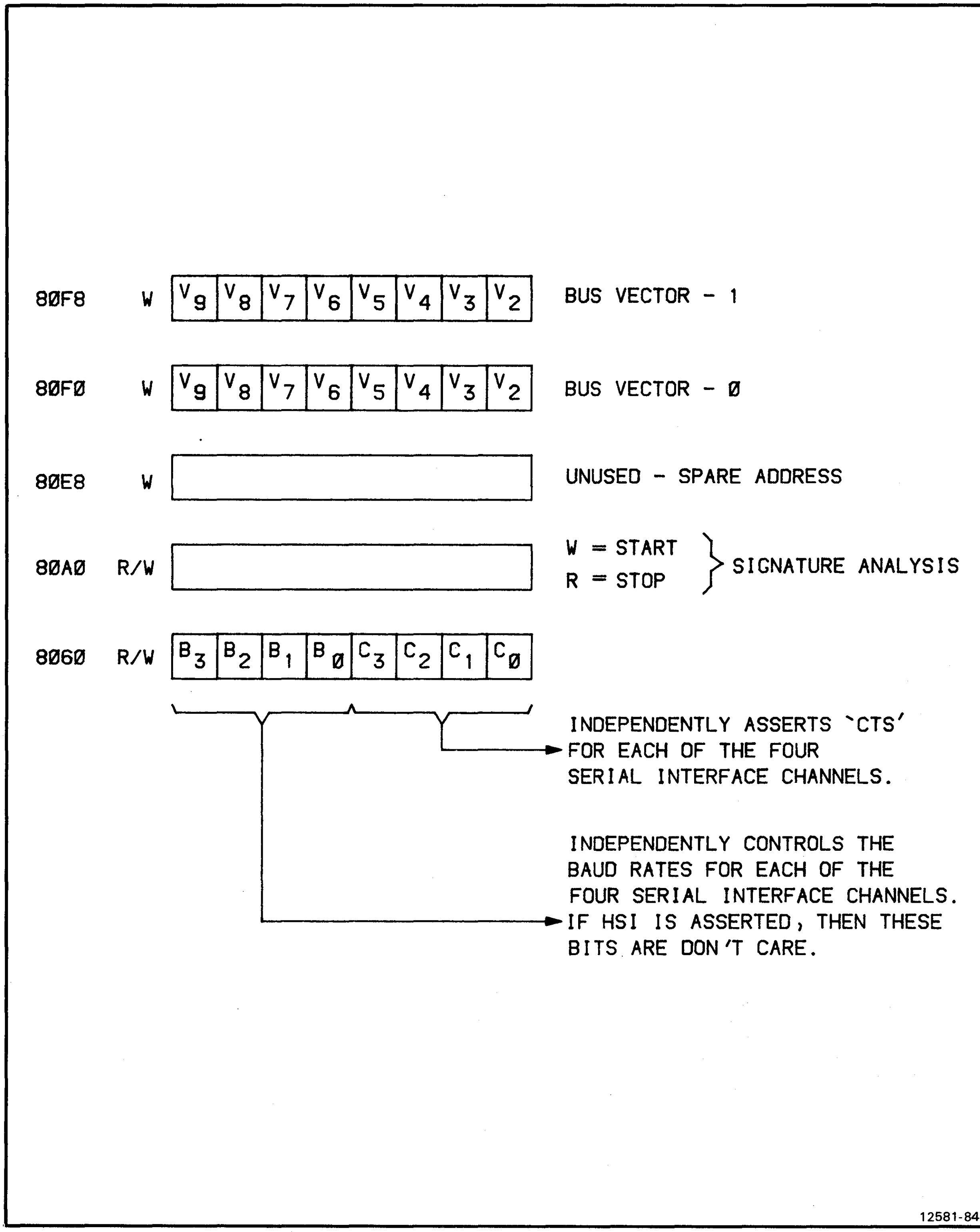

Fig. 7-6. IOP Registers part 2.

Address	Register	Group
C038 R/W	SIO CTRL 3	SIO REGISTER
C030 R/W	SIO DATA 3	
C028 R/W	SIO CTRL 2	
C020 R/W	SIO DATA 2	

Address	Register	Group
C018 R/W	SIO CTRL 1	SIO REGISTER
C010 R/W	SIO DATA 1	
C008 R/W	SIO CTRL 0	
C000 R/W	SIO DATA 0	

Address	Register	Group
808F W	MASK	8237 CONTROL REGISTER
808E R/W	(ILLEGAL)	
808D W	MASTER CLEAR	
808D R	TEMPORARY	
808C W	CLEAR BYTE FLIP FLOP	
808B W	MODE	
808A W	SINGLE MASK BIT	
8089 W	REQUEST	
8088 W	COMMAND	
8088 R	STATUS	

Address	High	Low	Group
8087 R/W	CNT HIGH 3	CNT LOW 3	8237 DMA COUNTERS AND ADDRESS REGISTERS
8086 R/W	ADDR HIGH 3	ADDR LOW 3	
8085 R/W	CNT HIGH 2	CNT LOW 2	
8084 R/W	ADDR HIGH 2	ADDR LOW 2	
8083 R/W	CNT HIGH 1	CNT LOW 1	
8082 R/W	ADDR HIGH 1	ADDR LOW 1	
8081 R/W	CNT HIGH 0	CNT LOW 0	
8080 R/W	ADDR HIGH 0	ADDR LOW 0	

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Fig. 7-7. IOP Registers part 3.

Miscellaneous Register 28

The miscellaneous register (U6060) provides various control and status functions. The Miscellaneous Register address is at location 8040. Figure 7-8 shows the register format. The text following the figure describes each bit.

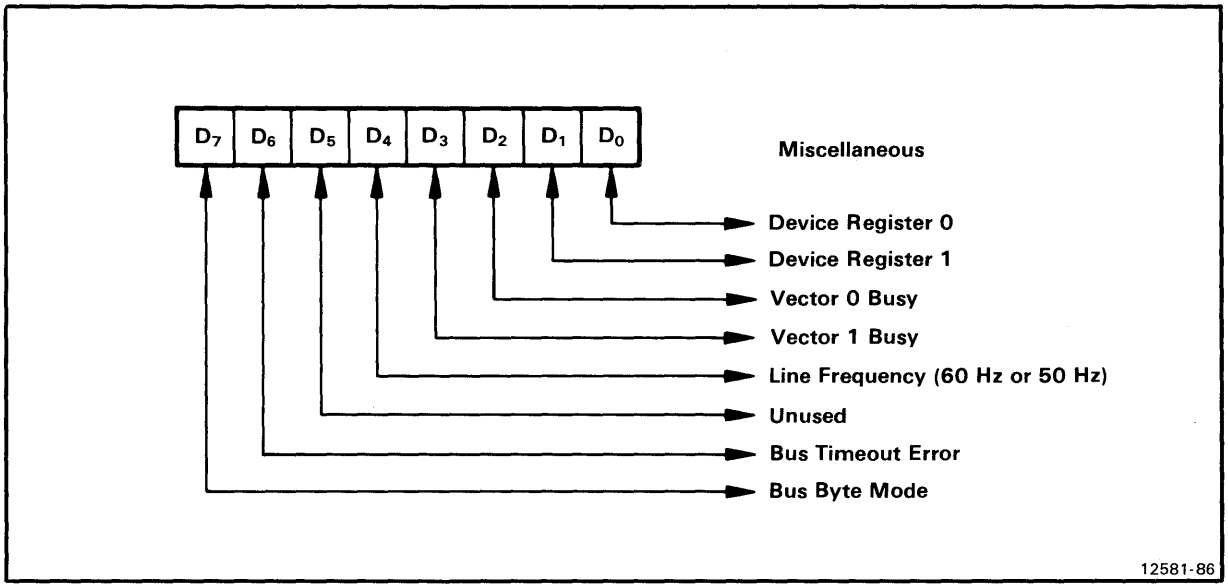

Fig. 7-8. Miscellaneous register.

(Bit 0) Device Register 0 Loaded.

When a 8560 bus master such as the LSI-11/23 writes to Device Register 0 this bit will be set. When the 8088 finds this bit set, it will take appropriate action and then clear the bit.

(Bit 1) Device Register 1 Loaded.

When a 8560 bus master writes to Device Register 1 this bit will be set. When the 8088 finds this bit set, the processor takes appropriate action and then clears the bit.

(Bit 2) Vector 0 Busy.

When the 8088 writes to the 8560 bus Vector 0 register, this bit is set. When the LSI-11/23 responds with the proper interrupt grant and the IOP intercepts the grant, bit 2 is cleared. As long as the interrupt is pending, bit D2 is read as a 1.

(Bit 3) Vector 1 Busy.

When the 8088 writes to the 8560 bus Vector 1 register, this bit is set. When the LSI-11/23 responds with the proper interrupt grant and the IOP intercepts the interrupt, this bit is cleared. As long as the interrupt is pending, the D3 bit is read as a 1.

(Bit 4) Line Frequency

The information in this bit is a square wave that has the frequency of the ac line, and a TTL-level amplitude. A firmware timing loop continually samples this bit to determines whether the unit is connected to a 50 Hz or 60 Hz power line.

(Bit 6) 8560 Bus Timeout Error R/W.

Normally this bit is cleared. However, when the 8088 accesses the 8560 bus at an invalid address and time-out occurs, this error bit is set and the 8560 bus cycle is completed. The 8088 then polls this bit, takes appropriate action and clears it.

(Bit 7) 8560 Bus Byte Mode.

If bit D7 is set, a bus cycle is generated and the 8560 bus is accessed. A write cycle exercises the 8560 bus WTBT signal.

If bit D7 is cleared, the 8088 assumes word mode, and the information contained in the even-numbered address (low byte) to be written on the bus is temporarily stored in a latch. No bus cycle is generated. Writing an odd-numbered address (high byte) then causes both high and low bytes to be transmitted to the 8560 bus as a 16-bit word.

When reading a 16-bit word from the 8560 bus, the low byte is read first, and is directly transmitted to the 8088. The next read operation then reads the high byte, but no bus cycle is generated.

I/O LOGIC

SIO ACCESS DMA CONTROLLER 26

The SIO DMA controller consists of the 8237 four channel Quad DMA controller device (U3060), the latches (U3010) and associated logic. The 8237 performs queueing tasks between the data coming from the SIO and IOP RAM. The DMA controller is programmed by the 8088, and provides direct-memory-access between the IOP memory and the SIO channels.

For each SIO channel, the 8237 puts incoming data automatically into IOP memory. The 8237 reads the data from the SIO device and sends a write pulse to the memory. The 8088 monitors the status of each channel queue. If the peripheral feeding data is an 8540, and the queue approaches an overflow condition, the CTS signal is negated to stop the 8540 from sending data until the queue can again accept it.

If, however, the peripheral feeding the data is a terminal, the CTS signal may not stop the incoming data flow. The 8237 can queue terminal data up to the limit of its queue size. Then the incoming data overruns the queue until the terminal stops transmitting data.

SIO DMA CONTROL STATUS REGISTERS

The 8237 uses eight DMA control status registers. These registers are software registers and are accessed at memory locations 8088H through 808FH. There are seven write registers and one read register. Figure 7-9 shows the registers and their bit assignment. For additional information on the SIO device, refer to the device manufacturer's specifications.

SIO INTERFACING LOGIC 31

The SIO interfacing logic controls serial data interfacing between the IOP and the 8560 on one hand, and the external workstations, such as the 8540 on the other. The SIO interfacing logic consists of U4080, U4100, and associated logic. The heart of the interfacing logic consists of two SIO devices. Each SIO device provides two IO channels, hence giving the IOP four channel capability. Both SIO devices are configured for asynchronous operation.

When interfacing the 8560 to an 8540, the I/O Adapter board is configured for RS-422 protocol, and asserts the HSI mode for the specified channel. When the HSI mode is asserted, the baud rate generator and the SIO channel assume a baud rate of 153.6 K baud.

		BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT Ø
W	8Ø8F DMAMSK	Ø	Ø	Ø	Ø	MASK 3	MASK 2	MASK 1	MASK Ø
W	8Ø8D DMAMC	MASTER CLEAR FOR 8237-2							
W	8Ø8C DMACBF	SET FOR LOW BYTE							
W	8Ø8B DMAMOD	Ø	1	Ø	AUTO REPEAT	Ø	1	ØØ - SELECT CHØ Ø1 - SELECT CH1 1Ø - SELECT CH2 11 - SELECT CH3	
W	8Ø8A DMASMB	Ø	Ø	Ø	Ø	Ø	Ø - CLR MASK 1 - SET MASK	ØØ - SELECT CHØ Ø1 - SELECT CH1 1Ø - SELECT CH2 11 - SELECT CH3	
W	8Ø89 DMAREQ	Ø	Ø	Ø	Ø	Ø	Ø - CLR REQUEST 1 - SET REQUEST	ØØ - SELECT CHØ Ø1 - SELECT CH1 1Ø - SELECT CH2 11 - SELECT CH3	
W	8Ø88 DMACMD	1	1	1	1	Ø	MASTER MASK	Ø	Ø

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Fig.7-9. SIO-DMA control status registers.

Figure 7-10 shows the connections between the IOP board the IOC (I/O Connector) board. An SIO treats the data paths as data terminal devices. The IOP channels, however, are configured as Data Sets. Therefore, signal names must change before they will match the names in the SIO literature. The upper channel in Fig. 7-10 is configured for a terminal, and all signal levels are RS-232-C protocol-compatible.

In the same figure, the lower channel illustrates HSI operation. Here, the HSI signal is asserted low and the RS-422 differential signals (CTS, RDATA, DTR, TDATA) are used for data transfer.

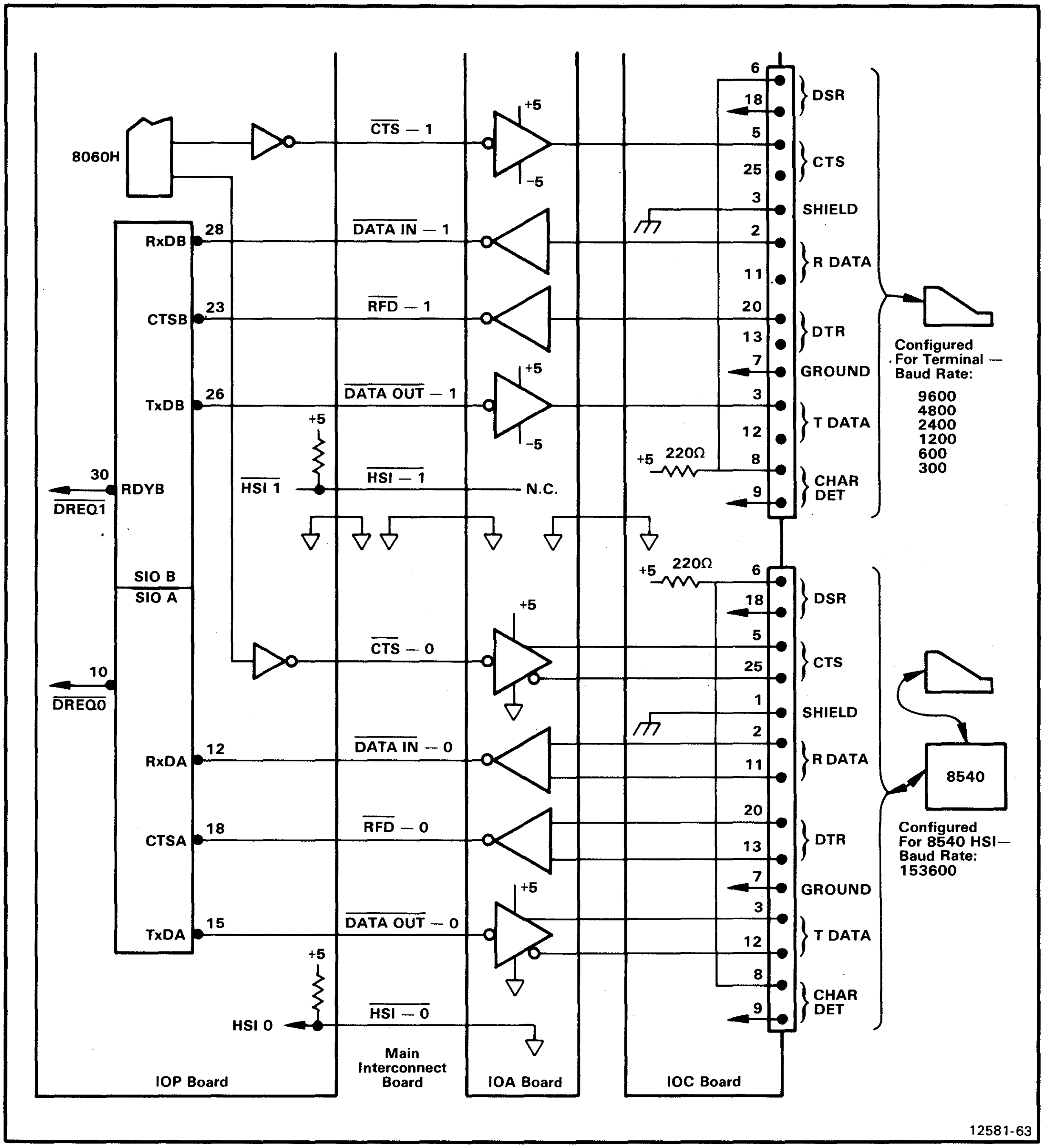

Fig. 7-10. Serial interfacing connections.

SIO REGISTERS

Recall that the IOP uses two SIO devices, with each device providing two duplex channels. Each channel has one data input/output register and one control register. The SIO multiplexes the control registers internally. Thus, the SIO provides eight write registers and three read registers to be used for status information.

If an output register is ready to accept data, the 8088 simply writes the data into the register. When the input data becomes available, it is read from the same address as the output register.

The control register is a single read/write address that multiplexes ten registers. These registers are:

WR0 - WR7 -- write registers 0 through 7
RR0 - RR2 -- read registers 0 through 2

Write register 0 contains a three-bit pointer that points to the register to be accessed next. After it has been accessed, the pointer returns to zero, thus allowing the pointer to be set for another register.

Figure 7-11 defines the previously mentioned eight write and three read registers. Bits specified as 1 and 0 are assigned to perform a specific SIO operation. Bits specified as X are "don't care" bits. For additional information refer to SIO device manufacturers literature.

	BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT Ø
W Ø	Ø	Ø	ØØØ — NULL CODE ØØ1 — NOT USED Ø1Ø — UPDATE STATUS INPUTS Ø11 — CHANNEL RESET 1ØØ — NOT USED 1Ø1 — NOT USED 11Ø — ERROR RESET 111 — NOT USED			ØØØ — REGISTER Ø ØØ1 — REGISTER 1 Ø1Ø — REGISTER 2 Ø11 — REGISTER 3 1ØØ — REGISTER 4 1Ø1 — REGISTER 5 11Ø — REGISTER 6 111 — REGISTER 7		
W 1	Ø—NORMAL 1—DMA	1	1	Ø	Ø	Ø	Ø	Ø
W 2	Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø
W 3	ØØ — R_X 5 BITS Ø1 — R_X 7 BITS 1Ø — R_X 6 BITS 11 — R_X 8 BITS		1	Ø	Ø	Ø	Ø	1
W 4	ØØ — NOT USED Ø1 — X16 CLK 1Ø — X32 CLK 11 — X64 CLK		Ø	Ø	ØØ — NOT USED Ø1 — 1 STOP BIT 1Ø — 1½ STOP BITS 11 — 2 STOP BITS		ØØ — NO PARITY ØØ — ODD PARITY 1Ø — NO PARITY 11 — EVEN PARITY	
W 5	Ø	ØØ — T_X 5 BITS Ø1 — T_X 7 BITS 1Ø — T_X 6 BITS 11 — T_X 8 BITS		BREAK	TRANSMIT ENABLE	Ø	Ø	Ø
W 6	Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø
W 7	Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø
R Ø	BREAK (LATCHED)	X	DTR (CTS)	X	X	T_X BUFF AVAILABLE	X	R_X CHAR AVAILABLE
R 1	X	FRAME ERROR (NOT LATCHED)	OVERRUN ERROR	PARITY ERROR	X	X	X	ALL SENT
R 2	X	X	X	X	X	X	X	X

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Fig. 7-11. SIO register definitions.

SIO Wait Logic ⟨28⟩

Since the 8088 clock rate is 5 MHz, and the SIO clock is 3.75 MHz, the 8088 must wait for the SIO devices. The SIO wait logic generates the wait states for the 8088. The SIO wait logic consists of a binary counter (U5160) and associated logic. The SIO wait logic provides a wait time of approximately 600 nS. This increases the read or write cycle, and allows the SIO to catch up.

The SIO wait logic responds when an address space is accessed. Both SIO devices can be addressed at 8XXX and CXXX locations. If the address is in the form 8XXX the wait circuit is inhibited. If the address is in the form CXXX, the wait circuit is enabled.

The SIO wait logic checks address bits 14 and 15 to determine whether or not the SIO wait logic is turned on. The wait logic is asserted when signal lines A14 and A15 are asserted, and A18 and A19 are unasserted,

For example, if SIO channel 0 is accessed at location 8000H, the wait logic will not respond. If, however, the same channel is accessed at address C000H, the wait logic is initialized, and the 8088's read or write cycle is extended for the required time interval. The wait logic is also asserted during an 8237 DMA cycle which moves data between the SIOs and on-board RAM.

Baud Rate Generator ⟨30⟩

The IOP baud rate generator consists of the clock generator device (U2100), latch (U2090), and multiplexers U5080, U5090, U5100, and U5110. The clock generator device generates a crystal-controlled clock frequency of 2.4576 MHz, and divides it into several frequencies. Of these, only the 153.6 KHz and 19.2 KHz frequencies are used.

For HSI operation, the SIO receives the 2.4576 MHz generator frequency. The firmware then programs the SIO for a X16 clock, effectively dividing the 2.4576 MHz frequency by 16 and generating a baud rate of 153.6 Kbaud.

For RS-232-C operation the SIO receives either the 153.6 KHz or the 19.2 KHz generator frequency. This is shown in Fig. 7-12. The firmware than programs the SIO for a X16, X32, or X64 clock, generating baud rates ranging from 300 to 9600.

Jumper straps on the IOA board change an HSI port to an RS-232-C port and vice versa. Strapped for RS-232-C, the port then transmits and receives data in baud rates that range from 300 baud through 9600 baud.

You can change baud rates on HSI ports by initiating a BREAK from the terminal key board after a port is strapped for RS-232-C. The firmware then steps through the available baud rates. At power-up, the default baud rate is 2400 baud.

HS1	B_n	SI0	GENERATOR FREQUENCY	BAUD RATE
YES	DON'T CARE	X16	2.4587 MHz	153600
NO	1	X16	1.53.6 KHz	9600
NO	1	X32	1.53.6 KHz	4800
NO	1	X64	1.53.6 K	2400
NO	0	X16	19.2 KHz	1200
NO	0	X32	19.2 KHz	600
NO	0	X64	19.2 KHz	300

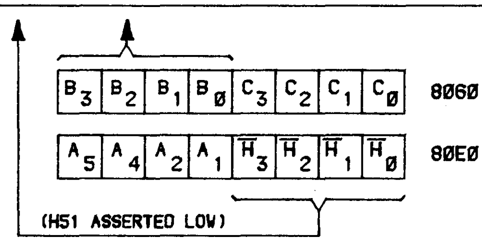

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Fig. 7-12. Baud rate control.

INTERRUPT VECTOR CIRCUITS

The vector generator logic provides vector ports for vector 0 and vector 1. Effectively, there are two independent vector circuits that interface with the LSI-11/23 via vector registers. Vector 1 is loaded at location 808F and Vector 0 is loaded at location 80F0.

VECTOR 0 ⟨25⟩

The logic for vector 0 consists of flip-flop U6110, straps, the write-only vector register (U4010), and other associated logic. The priority of Vector port 0 is strapped with jumpers J7121, J7122, J7123, and J7124. Straps J7123 and J7124 determine the transmit priority, and J7121 and J7122 determine the receive priority. In addition, bit 2 of the Miscellaneous register controls when the vector register (U4010) can be rewritten. If bit 2 is a 1, vector 0 is still pending. If bit 2 is a 0 the data from the register has been transmitted, and the register can now accept a new set of data.

VECTOR 1 ⟨25⟩

The logic for vector 1 consists of flip-flop U6110B, straps, the write-only vector register (U4030), and other associated logic. Vector 1 priority is strapped with jumpers J7125, J7126, J7127, and J7128. Straps J7127 and J7128 determine the transmit priority, and J7125 and J7126 determine the receive priority. In addition, bit 3 of the Miscellaneous register controls when the Vector register (U4030) can be rewritten. If bit 3 is a 1 , vector 1 is still pending. If bit 3 is a 0, the data from the register has been transmitted, and the register can accept new data.

VECTOR REGISTER CONTENT TRANSMISSION

When the contents of the eight-bit vector register are transmitted to the LSI-11/23, two zeros, added automatically at the LSB end, result in a 10 bit vector. This vector then points to the system memory location from which the LSI-11/23 fetches a processor status word. The next memory location contains the starting address of the LSI-11/23 interrupt routine.

Interrupt Priority Levels

As previously stated, each vector circuit can be independently strapped for a selected priority level. Each vector has two sets of straps with one set selecting the signal lines to be asserted, and the other selecting the lines to be monitored on request from the LSI-11/23. Priority levels are shown in Table 7-1. Straps and their functions are shown in Table 7-2. For additional information on board configuration and default strapping, see Section 3 of this manual.

Table 7-1
Priority Levels

Level	Lines Asserted	Lines Monitored
4	BIRQ 4	BIRQ 5, 6
5	BIRQ 4, 5	BIRQ 6
6	BIRQ 4, 6	BIRQ 7
7	BIRQ 4, 6, 7	----

Table 7-2
Vector Strap Functions

Vector 0 Strap	Vector 1 Strap	Function
J7121	J7125	IN - IRQ5, NULL, IRQ7
J7122	J7126	IN - NULL, IRQ6
J7123	J7127	OUT - NULL, IRQ5
J7124	J7128	OUT - NULL, IRQ6

DIAGNOSTIC REGISTERS

The IOP board contains two hardware diagnostic registers: U2020 (write-only) and U3030 (read-only). The 8088 accesses both registers with I/O instructions.

WRITE-ONLY REGISTER 27

The contents of the write-only register are visually displayed with a 7-segment readout (DS1031) plus decimal point. For each register bit, a zero turns the segment on and a 1 leaves it off. Figure 7-13 shows the element selection.

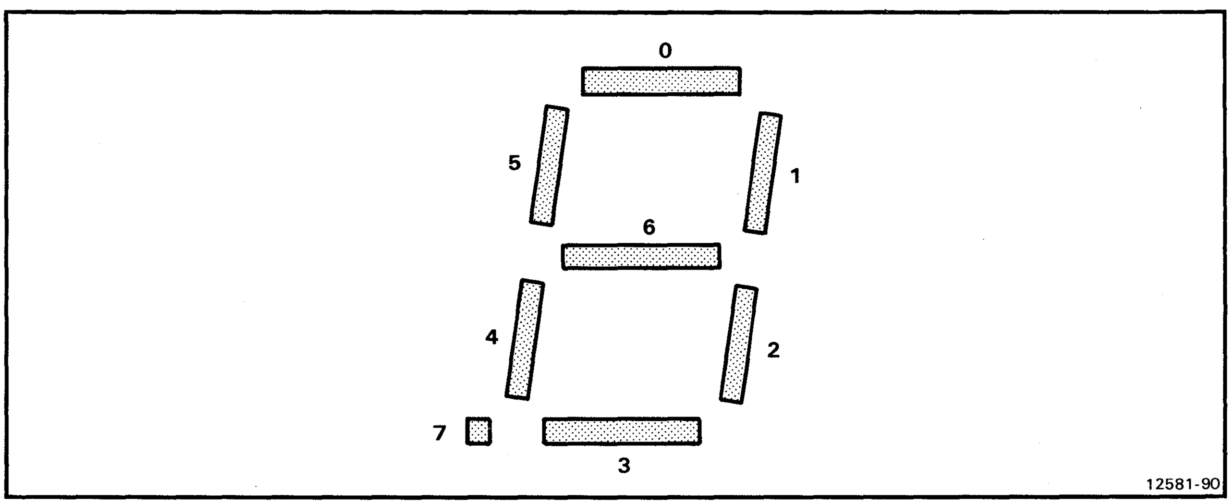

Fig. 7-13. 7-Segment decimal diagnostic display.

READ-ONLY REGISTER 27

The positions of J2041 and J5161 control the read-only register contents. If J2041 is open, and J5161 is in the default position (see Section 3), a read cycle moves the register contents into the 8088. The read-only register drives the 8088 with NOP's. The register is filled with NOP instructions when the pins of J2041 are shorted.

Typically the read-only register is read by reading I/O location 0. The read-only register can be strapped to either address 90 or 00. Installing a switch on J2041, allows you to use the read-only register for single stepping through diagnostics.

Section 8

I/O ADAPTER AND I/O CONNECTOR BOARDS

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Section 8

I/O ADAPTER AND I/O CONNECTOR BOARDS

INTRODUCTION

This section describes the I/O Connector (IOC) and the I/O Adapter (IOA) boards. The IOA board board, in conjunction with the I/O Processor and the Utility Board, services the IOC board's rear panel connectors. These four boards operate together to provide up to ten 8560 serial I/O ports. Figure 8-1 is a block diagram illustrating the 8560's serial interfacing.

Two ports are line printer ports, and operate only under RS-232-C protocol. They are designated LP1 and LP2. The remaining eight ports are typically defined as High Speed Interface HSI) ports, and are designated HSI-0 through HSI-7. HSI ports operate under either High Speed Interface protocol (electrically compatible with RS-422) or RS-232-C protocol.

The IOC board is a small circuit board without active devices that contains ten 25-pin D-type connectors. The IOC board is mounted on the rear panel with the connectors protruding through the rear panel, making them accessible from the cabinet outside. The connectors serve printer ports LP1 and LP2, and HSI ports 0 through 7.

The IOA board is a signal conversion board. mounted on the 8560 side rail toward the cabinet rear. The IOA board converts the signals from TTL levels to RS-232-C or RS-422 levels.

The following pages describe both boards.

THE IOA BOARD

The IOA board contains two identical circuits for the line printer ports and eight identical circuits serving the HSI ports. The following discussions cover only one of each ports.

LINE PRINTER PORTS 36

The IOA board contains two identical driver/receiver circuits, each serving one line printer port. This discussion covers LP1.

Line receivers U6060A, U6060B, and U8060A operate in the unbalanced mode. They receive the RDATA(Received Data), DTR (Request to Send), and DTR (Data Terminal Ready), lines. Line drivers U7060A and U7060B operate as single-ended drivers (pin 4 is high). They drive the T Data (Transmitted data) and CTS (Clear to Send) signals.

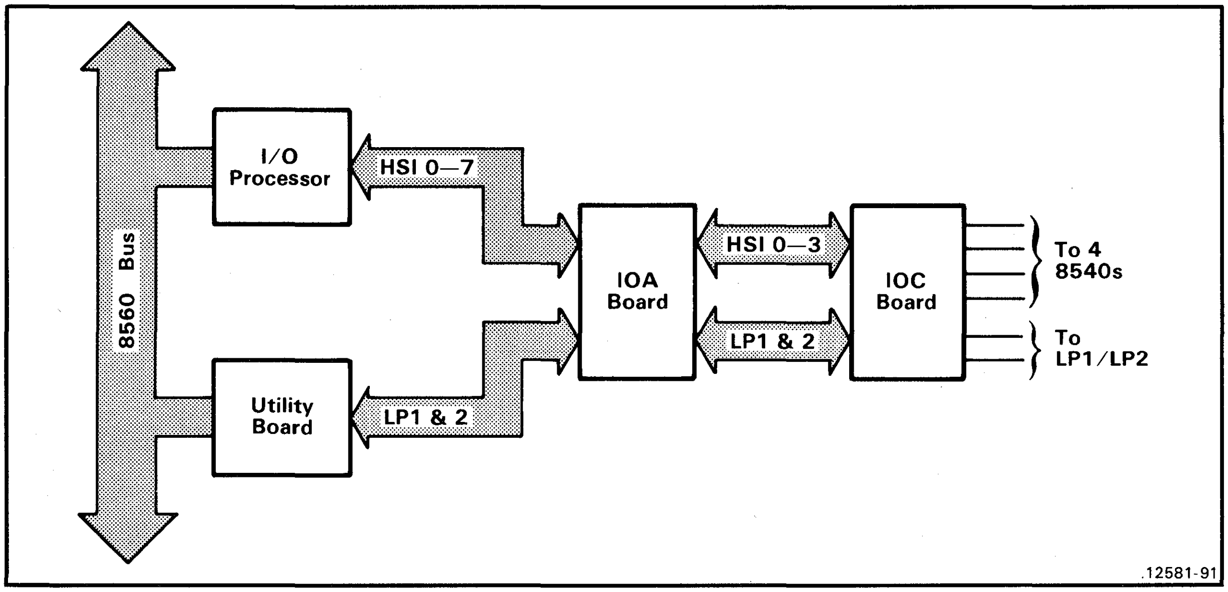


Fig. 8-1 8560 serial interfacing.

THE HSI PORTS 32 33

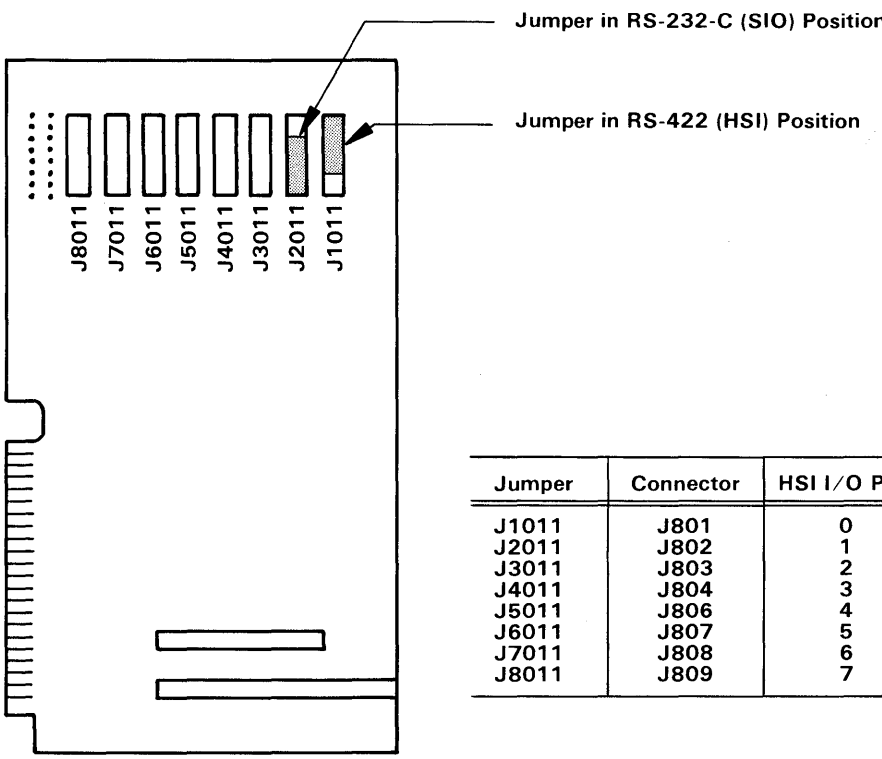
The IOA board contains eight identical circuits - one for each HSI port. The following discussion, although limited to HSI port 0, also applies to HSI ports 1 through 7.

The position of jumper block J1011 determines if the port is configured for High Speed Interface operation or for RS-232-C operation. The upper position selects High Speed Interface, and the lower position selects RS-232-C. Figure 8-2 shows all jumper block locations. Default jumper positions can be found in section 3.

When a port operates as a High Speed Interface, U1040A and U1040B are differential input receivers for the DTR and R DATA lines. During RS-232-C operation, U1040A and U1040B are connected as unbalanced line receivers for these lines. In that case, the positive inputs are grounded and the signals are applied to the negative inputs.

The T DATA and CTS lines are driven by U1030, configured as a dual differential driver (pin 4 must be low). During High Speed Interface operation, both lines are balanced. During RS-232-C operation, only the inverting outputs of U1060 are used, providing unbalanced outputs.

The HSIO signal connects J1011 to the I/O Processor. When the jumper block is in the High Speed Interface position, HSIO is grounded, indicating to the I/O Processor that High Speed Interface operation has been selected. This line is not grounded when the jumper block is in the RS-232-C position, and the I/O Processor selects one of six RS-232-C compatible baud rates.



Jumper	Connector	HSI I/O Port
J1011	J801	0
J2011	J802	1
J3011	J803	2
J4011	J804	3
J5011	J806	4
J6011	J807	5
J7011	J808	6
J8011	J809	7

3899-15

Fig. 8-2. IOA board jumper locations.

POWER SUPPLY

The IOA board receives +5V, -12V, and +12V supplies from the 8560 backplane. A -5V supply is derived from the -12V supply by U1050.

THE IOC BOARD 37

The IOC board contains ten 25-pin D connectors for ports LP1, LP2, and ports HSI 0 - HSI 7. Connector assignment for each port is shown in Table 8-1. The connector pin assignments are shown in Tables 8-2 and 8-3.

The IOC board connects to the IOA board with 20 pin connector J8102 and 72 pin connector P2.

Table 8-1
Port - Connector Assignments

Port	Connector
LP 1	J8051
LP 2	J8101
HSI 0	J8011
HSI 1	J8021
HSI 2	J8031
HSI 3	J8041
HSI 4	J8061
HSI 5	J8071
HSI 6	J8081
HSI 7	J8091

Table 8-2
HSI Port Connector Pin Assignments

Pin	Function
1	Shield
7	Signal Ground
2	R DATA -- Receive Data
11	R DATA'
3	T DATA -- Transmit Data
12	T DATA'
20	DTR -- Data Terminal Ready
13	DTR'
5	CTS -- Clear To Send
25	CTS'
6	DSR -- Data Set Ready
18	DSR'
8	CAR DET -- Carrier Detect
9	CAR DET'

Notes: 1. The DSR and CAR DET signals are always transmitted on.
2. During RS-232-C operation, only the positive (+) side of the balanced signals are used.

Table 8-3
Pin Configurations Line Printer Ports 1 and 2

Pin	Function
1	Shield
7	Signal Ground
2	R DATA - Receive Data
3	T DATA - Transmitted Data
20	DTR - Data Terminal Ready
5	CTS - Clear to Send
6	DSR - Data Set Ready
8	CAR DET - Carrier Detect
15	R CLK
17	R CLK - External Clock
4	RTS - Request to Send

Notes: 1. The DSR and CAR DET signals are always asserted.
2. The external clock input (T CLK and R CLK) is routed directly to the Utility Board.

SHIELD STRAPS

All output connector shields are grounded through a strap. You can cut these straps and bridge the gaps with passive components to deal with unusual static discharge problems.

Section 9

PERIPHERAL MASS STORAGE (PMS) CONTROLLER BOARD

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Section 9

PERIPHERAL MASS STORAGE (PMS) CONTROLLER BOARD

INTRODUCTION

The PMS Controller board, together with the M1220 Interface board, interfaces the 8560 to its flexible and hard disc drives. The PMS Controller board contains control and interface functions for the flexible disc, and control functions for the M1220 Interface board. The M1220 Interface board handles interface functions for the hard disc drive. The M1220 Interface board is described in Section 10, and the disc drives are described in Section 11.

For the purpose of this discussion the PMS Controller board is divided into these major parts:

- the Kernel
- the 8560 Clock Generator
- LS-11/23 8560 bus interfacing
- the real-time clock
- I/O logic
- the FDC controller
- the CPU wait-state generator
- diagnostic jumpers and test points

A block diagram of the PMS controller is shown in Fig. 9-1. The PMS Controller kernel consists of the Z80A processor (U1020), 16 K-bytes of read-only memory (ROM), and 2 K-bytes of random-access memory (RAM).

The clock generator provides a 4 MHz clock for the Z80A processor, and an 8 MHz clock for the FDC (Flexible Disc Controller) device.

The interfacing circuits consist of DMA circuits that transfer data to and from the system memory under control of the PMS board's Z80A processor. Furthermore, DMA disables the LSI-11/23's control of the 8560 bus, and allows the Z80A to obtain control.

The real-time clock controls flexible disc-head unloading delays.

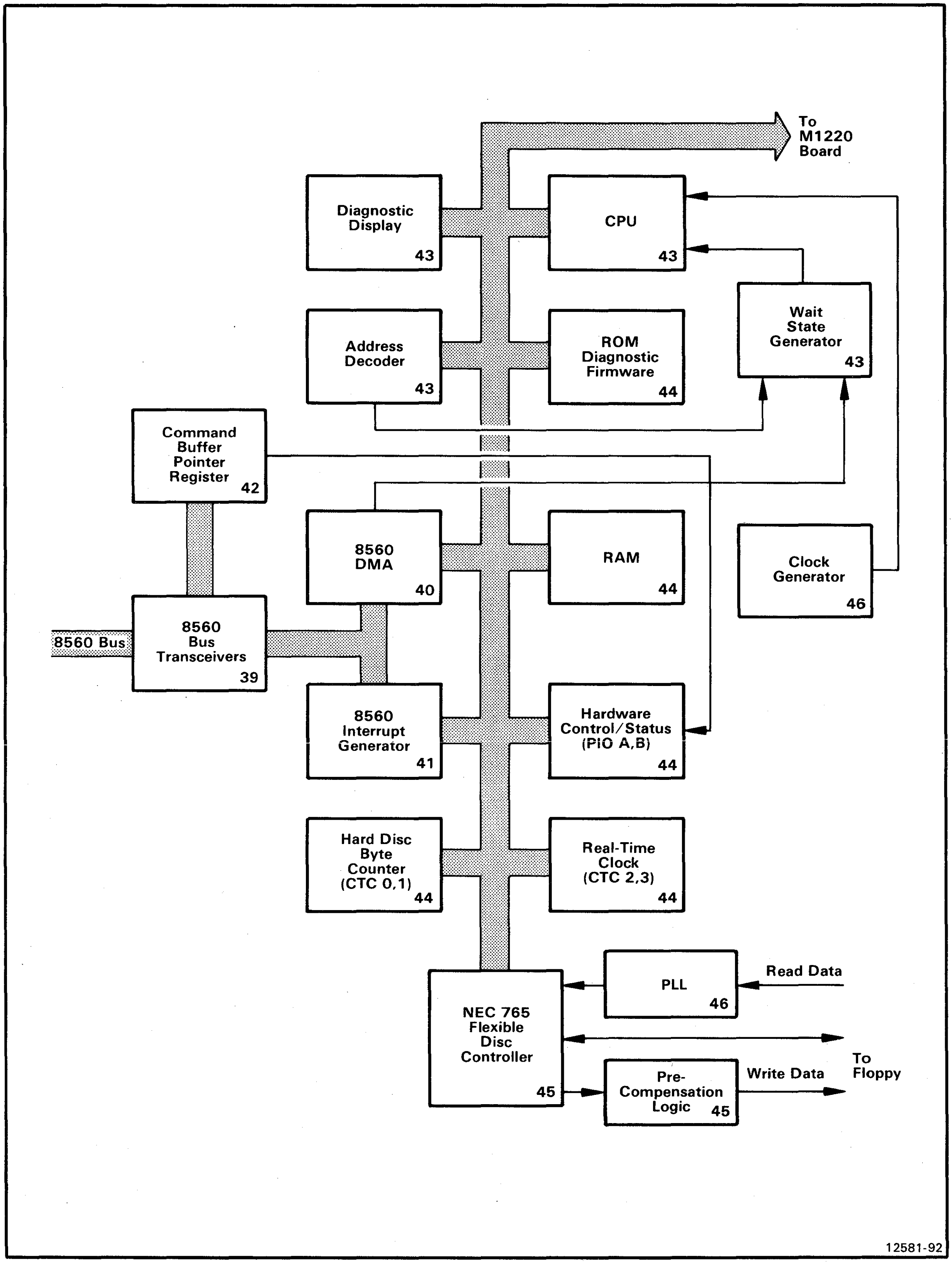

Fig. 9-1. PMS Controller board block diagram.

The I/O logic provides 8560 bus control and status to both 8560 disc drives.

The FDC circuit controls the flexible disc drives. This logic includes the pre-compensation circuit, phase-locked loop, and the driver/receiver circuits.

The CPU Wait state generator provides the wait states for the Z80A processor. It synchronizes the Z80A with the 8560 for DMA transfer, and with the data moving to and from the flexible disc.

The PMS Controller board contains a number of Jumpers. These jumpers are used for trouble shooting. Section 3 shows the jumper default positions.

THE KERNEL

The PMS Controller kernel consists of the Z80A microprocessor, 16 K-bytes of ROM and 2 K-bytes of RAM.

THE Z80A PROCESSOR 43

The PMS Controller is controlled by a Z80A microprocessor (U1020). The Z80A CPU is the heart of the kernel. It fetches instructions from ROM and performs the specified operation. 16 k-bytes of on-board ROM contain the Z80A CPU instructions, and 2 k-bytes of RAM serve as working memory. Furthermore, the Z80A provides 128 bytes of I/O space.

The memories are located partly on the PMS Controller board and partly on the M1220 Interface board. The PMS Controller board and the M1220 Interface board both contain 8 K-bytes of ROM and 1 K-byte of RAM.

The Z80A processor includes a small read/write memory which is configured into eighteen 8-bit registers, and four 16-bit registers. The registers include two sets of six general purpose registers that are used individually as 8-bit registers. The CPU also contains two sets of accumulator and flag registers.

ADDRESS DECODERS 43

The PMS Controller board has two address decoders: an I/O decoder (U3060), and a memory decoder (U3070). The two decoders are described in the following paragraphs.

I/O Decoder (U3060) 43

The I/O decoder divides the 128 bytes of Z80A I/O space into into eight 16-byte parts. Decoder U3060 is a 74LS138 3 input 8-output decoder. Table 9-1 describes the signal lines and their functions.

Table 9-1
I/O Decoder Signals

Signal	Description
	Pins 15 and 12 address the M1220 Interface board.
CTC	provides the chip-select function for the counter/timer (U1080)
PIOL	enables the Z80A PIO device (U1070)
INTVECT	Requests an interrupt from the LSI-11/23. The Z80A writes an 8-bit word to a location in I/O space. The eight bits of this location are asserted on the 8560 bus when the interrupt is acknoleged.
AWAITD	asserts CPU wait states until the data from the flexible disc is ready.
FDSEL	provides the chip select function for the disc controller device (NEC765) control and status ports.
DACK	provides a data acknowledge to the Z80A processor.

Memory Decoder (U3070) 43

The memory decoder is a 74LS138 3 input 8-output decoding device. U3070 divides the Z80A memory space for use by the PMS Controller.

The memory decoder decodes the lower 32 k-byte of Z80A memory space into 4 K-byte segments.

The MEMO and MEM1 signals are OR-ed with U6110 to read the ROM (U1100). MEM2 enables the 1 k-byte RAM on the PMS Controller board.

ERRCLR clears the error latch (U4120) after a DMA timeout has occured. ERRCLR also accesses the Buffer (U7110) via the jumper straps J7115 and J71120, therefore providing the Z80A with status information while the ROM-based diagnostic tests are executed. Also see the Wait State Generator description later in this section.

LSI-11/23 INTERFACING

This subsection covers the following interfacing logic: DMA control logic, DMA address registers, interrupt logic, and 8560 bus transceivers.

DMA CONTROL ⟨40⟩

The PMS Controller DMA circuit transfers data to and from the system memory under control of the PMS board's Z80A processor. DMA disables the LSI-11/23 and allows the Z80A to take control of the 8560 bus. The Z80A initiates DMA operations and reads or writes two bytes at a time in its upper 32 K-byte memory bank.
For the purpose of this description, the DMA control circuit has been divided into these parts:

- the DMA access trigger circuit,
- the DMA bus grant circuit,
- the DMA sequencer and output circuits
- the DMA byte counter
- the 8560 bus sync/delay ciruit

These five parts are described on the following pages in the order stated.

DMA Access Trigger ⟨41⟩

The DMA access trigger circuit consists of the flip-flops (U4130), an OR gate (part of U3020), and the decoder/multiplexer U5120.

Whenever A15 and MREQ are asserted, RFSH is unasserted , and the CLR signal goes high, U5120 is ready to be enabled. When U4130 receives the next clock pulse, U5120 is enabled and one of the U5120 outputs is asserted.

The four output signals are: WRLBT, RDLBT, WRHBT, and RDHBT.

- WRLBT and RDLBT respectively write and read the low byte
- WRHBT and RDHBT respectively write and read the high byte

The four output lines connect to DMA registers described later in this section. A DMA cycle is started when RDLBT and WRHBT are asserted.

DMA Bus Grant Circuit 40

The DMA bus grant ciruit consists of flip-flop (U3120), gate (U5120) and an inverter (U3090). U3120 detects the leading edge of the JRDMGI signal, and determines whether or not the PMS Controller needs to obtain bus mastership for a DMA transfer. If the PMS Controller does not need bus access, the bus grant circuit passes the grant to the next 8560 circuit via the DMA grant output signal TDMGO.

DMA Sequencer 40

The DMA sequencer consists Flip-flop U3120, U4030, U3110, U4040 and associated logic. This circuit is controlled by the DMA bus grant circuit, the Z80A DMA trigger circuit, and by the 8560 bus sync/delay circuit.

When a DMA access is not completed in the allotted time (approximately 8 uS), the DMA sequencer asserts the TIMOUT signal, notifying the Z80A that the DMA data transfer is incomplete. TIMOUT is cleared by the ERRCLR signal.

8560 Bus Sync/Delay Circuits 40

Near the DMA access trigger circuit is a set of nine flip-flops. These flip-flops form three circuits that delay and synchronize asynchronous information arriving from the 8560 bus.

The top-most circuit, consisting four flip-flops (U3130, U5130), accepts the JRRPLY signal, delays and synchronizes it for use on the board.

The next circuit, flip-flops U3130 and U5130, accepts the JRSYNC signal, and then delays and synchronizes it for use on the board.

The last two flip-flops synchronize internal board signals from the DMA sequencer.

DMA DATA AND ADDRESS REGISTERS

Address Comparators

U5060 and U6050 comprise the address comparators that detect when address 777150 is accessed. If the bus address matches the input address, pin 9 on both devices goes high, asserting the VALAD signal high.

As long as there is a mismatch on either device, VALAD remains low.

The strobe signal JRSYNC is derived from the BSYNC signal on the 8560 bus. When JRSYNC is asserted, VALAD(H) is latched high for as long as the PMS Controller is accessed by the LSI-11/23. The Command Buffer-Pointer Register can then be accessed.

Command Buffer Pointer Register (CBP) 42

The Command Buffer Pointer (CBP) register is the only PMS Controller hardware register that the LSI-11/23 can access directly. U5030 and U6030 form the 16-bit CBP register.

When information is written into the CBP register, the Z80A interprets that data as the address of a command buffer in the system memory.

When the Z80A reads the CBP register, it performs an DMA operation to the 8560 bus and the LSI-11/23 I/O space.

Receive Data Register 42

U5040 and U6040 form the 16-bit receive-data register. The receive-data register latches data it receives from the 8560 system memory during a DMA access.

Transmit Data Register 42

U5020 and U6020 comprise the the transmit data register. This register receives and latches the data to be transmitted to the 8560 bus from the Z80A

DMA Address Register 42

U6010 and U6010 form the DMA address register. It receives the DMA address from the Z80A address bus.

8560 INTERRUPT LOGIC 41

The interrupt circuit consists of the logic surrounding U3100 and gates U5110, U4110, U5080. This circuit generates the interrupt request signals for one of four interrupt priority levels, and responds to the acknowledge signal.

TIRQ4 is asserted for all interrupt priority levels. Jumpers J6121 and J6122 allow the use of interrupt priority levels 5, 6, and 7. (For more information on interrupt priority levels see the DEC Microcomputer handbook.)

TIRQ4 is the transmit interrupt request line that is asserted when the PMS Controller interrupts the LSI-11/23. The LSI-11/23 RIAKI signal acknowledges that the LSI-11/23 is expecting an interrupt. U3100 looks at the received data, and depending on the interrupt priority level on the 8560 bus, may pass the TIAKO signal to the next device on the 8560 bus.
The sequence is as follows:

1. the PMS Controller transmits an interrupt request to the LSI-11/23

2. the LSI-11/23 returns RIAK signal acknowledging that it received an interrupt request.

3. the PMS Controller then transmits TRPLY and asserts an interrupt vector on the 8560 bus.

8560 BUS TRANSCEIVERS 39

U7010, U7020, U7030, and U7040 buffer data and addresses from the 8560 bus. Pins 9 and 9 are the ENABLE inputs. When they are low, the PMS Controller transmits data and addresses to the system memory.

When an interrupt occurs on the bus, VECTEN is asserted. That enables U7030 and U7040, the lower 8 bits of the address word. The upper eight bits remain disabled, and float to a logical zero.

U7050,U7060, U7070, U7080, and U7090 serve the extented address lines, DMA control lines, memory access control lines, and interrupt control lines.

THE REAL TIME CLOCK 44

U1080 is a Z80 counter/timer (CTC) device that provides four programmable channnels. The real-time clock uses two of the four channels: channels 2 and 3. Channel 2 is programmed as a timer, and channel 3 is programmed as a counter. Channel 2 receives the 4 MHz clock and generates an output pulse every 2 mS. Channel 3 counts these pulses, its internal counter register overflowing every 500 mS. The Z80A monitors the real-time clock to control head unloading o the flexible disc drive.
The Z80A programs each of the sixteen pins either for anan input or for an output operation.

THE I/O CONTROLLER

8560 MEMORY ADDRESS COUNTER 44

Channel A of the Z80A PIO device (U1070) provides four additional bits that connect to the Memory address counter (U3050) These bits appear from U3050 as signal lines TAD14, TAD15, TAD16, and TAD17, and are used to convert the PMS Controller from 16-bit address space into LSI-11/23 18-bit address space.

HARDWARE CONTROL AND STATUS PORTS 44

The Z80A PIO device provides 16 output lines that provide status and control information. The sixteen lines perform the functions described in Table 9-2.

Table 9-2
Control and Status Port Signals

Signal	Description
TBS7	is an address line that designates LSI-11/23 I/O space to be accessed.
TIMEOUT	is checked after a DMA transfer to determine if a bus error occured.
CMNDCL	clears flip-flop U1130 after the PMS Controller has received an LSI-11/23 command.
FDINT	is asserted high by the FDC controller device (U1050) and is polled by the Z80A to determine if the NEC765 needs to be serviced.
DIAGIN	leads to a test pin which may be used for diagnostic operations. Under normal operation, DIAGIN is not used.
DRQ	is the data request line. It is asserted by the FDC device (NEC765) when a data byte has to be transferred.
LSIATN	is asserted when the PMS Controller has received a command. To assert the LSIATN signal low, CMNDCL must be asserted high. LSIATN is then read by the PIO.
TIRQ4	a PIO input signal - TIRQ4 is the transmit interrupt request line. When it is asserted high, the PMS Controller can not issue interrupts.
TERMCNT	terminates NEC765 data transfers. The NEC765 receives this pulse from the PIO at the end of each data transfer.
HDLOAD	is the head load line. When HDLOAD is asserted high, the heads on the flexible disc drive are loaded. When HDLOAD is asserted low, the heads are unloaded.
DLOCK	controls the phase-locked loop as it locks onto the serial data stream from the flexible disc drive.
START	is an output signal that is used for signature analysis routines.

FLEXIBLE DISC CONTROLLER

This subsection covers that part of the PMS Controller board that controls access to the Qume Datatrak 8 disc drive. For this description, the controller circuits are divided into these four parts:

- the flexible disc device and its associated circuit,
- the data pre-compensation circuit,
- the phase-locked loop circuit, and
- the flexible-disc driver circuits.

THE FDC (FLEXIBLE DISC CONTROLLER) DEVICE 45

The heart of the flexible-disc controller circuit is the programmable NEC765 disc controller device (U1050). This device performs control functions between the Z80A processor and the flexible disc drive. The NEC765 supports the IBM compatible double density format used on the 8560 disc drive.

Pins D0 through D7 connect to the Z80A data bus. These data lines provide a path for all data traveling to and from the disc. The NEC765, under control of the Z80A, performs the following operations.

- the NEC765 receives an instruction from the Z80A
- the NEC765 executes this instruction and responds to the Z80A with status information

Upon command from the operating system, the Z80A polls the NEC765 main status register at location 60. If the Z80A finds proper information in this register, the NEC765 is ready. The Z80A then sends the NEC765 an instruction in the form of one or more command bytes. An instructions may require up to 7 command bytes. Between each command byte, the Z80A polls the NEC765 main status register, making sure that the NEC756 s ready for the next command byte. The main instructions in this category are read, write, format, and seek.

When the Z80A instructs the NEC765 read from the disc, the NEC765 reads the data from the disc in serial format. The serial data is decoded by the NEC765 into an eight-bit byte. The Z80A then reads this byte and stores it at the appropriate system memory location.

When the Z80A instructs the NEC765 to write data onto the disc, the disc controller receives the data as a byte from the Z80A. The Z80A previously fetched the data from the system memory. The disc controller then encodes the data into serial format and writes it on the disc.

FLEXIBLE DISC DRIVE WRITE PRE-COMPENSATION CIRCUIT 46

Introduction

Due to the physical disc limitations, data patterns on inner disc tracks (tracks 43 through 76) are located much closer to each other than on the outer tracks. This causes the timing of bits to shift when they are read back. To overcome this problem, data is written a little sooner or later than normal. This is called write pre-compensation.

NEC765 pre-compensation signals PS0 and PS1 are always asserted high. Even though outer disc tracks need no pre-compensation, the NEC765 device provides pre-compensation for all tracks. The NEC756 device determines when compensation is needed. If pre-compensation is needed, the NEC765 device determines if the pre-compensation must be early or late.

When a data string is ready to be written, PS0 and PS1 generate a number that determines if pre-compensation is normal (no pre-compensation), or pre-compensation is early, or late. That number is seen on the inputs (A, B, C, and D) of the pre-compensation counter. The following counter inputs identify pre-compensation:

- 0 no pre-compensation
- 13 late pre-compensation
- 3 early pre-compensation

The write compensation circuit consists of the pre-compensation counter U3080, gate 4010, NAND gate 6010, and flip-flop U4080.

WDA is the encoded data output from the NEC765. WDA determines when the number generated by P0 and P1 is loaded into the pre-compensation counter, and the counter starts counting clock cycles. When WDA is asserted high, pin 9 (U3080) goes low, and loads the number at the four counter load inputs (A,B,C,D) in the counter.

Normal WRITE DATA Operation 46

For a normal write operation (no pre-compensation), both PS0 and PS1 are low, hence all four counter inputs are zero. The counter then counts four 16-MHz clock cycles and puts the WRITE DATA pulse on the disc bus. At the count of 4 the logic of inverter U4010 and NAND gate (U6100) asserts the WRITE DATA line. At the count of 8 the WRITE DATA line becomes unasserted and the writing function is complete.

Late Pre-compensation

If, however, the WRITE DATA pulse must appear on the bus late, PS0 is low, and PS1 is high, causing the counter input to see 13. When the WDA pulse becomes unasserted, pin 9 returns to a high state, causing the counter countdown. The counter, starting at 13, counts 14, 15, 0, 1, 2, 3, 4. At a count of 4, the logic consisting of U4010 an NAND gate U6100 asserts the WRITE DATA pulse. This pulse is 250 nS wide. When the count reaches 8 the WRITE DATA line becomes unasserted and the write operation is completed.

Early Pre-compensation

If the WRITE DATA must appear on the bus earlier than normal, PS0 is asserted high, and PS1 is asserted low. In this case, the A and B inputs are low, and the C and D inputs are high, thus loading the counter with a 3. As pin 9 (U3080) returns to a high state, the counter starts counting at 3. At count 4, the logic consisting of U4010 and NAND gate U6100 asserts the WRITE DATA pulse. When the count reaches 8 the WRITE DATA line becomes unasserted and the write operation is completed.

THE PHASE LOCKED LOOP (PLL) CIRCUIT 46

The PLL circuit compensates for shifts in data rates as the data is read from the disc. Shifts in data rates can occur when the disc speed changes. The PLL circuit assures, that when data comes from the disc, the read window (RDW) signal is asserted, and the data is clocked into the NEC765 at the correct frequency

The PLL circuit consists of phase comparator and low-pass filter U7120. U7120 has a V (pin 3)input and and a R input (pin 1). R is the reference input, and V is the variable input. U7120 compares the timing differences between its R and V inputs and generates signals on pins 5 and 10 based on that difference.

If the signals on R (pin 1) and V (pin 3) go through their negative transitions simultaneously, pins 5 and 10 (U7120) remain unchanged. As the difference in negative transitions between the R and V pins increases, the pulse width on either pin 5 and 10 increases.

The Darlington amplifier (U7120) sees these pulses of varying width, and averages the pulse width. From this average, the Darlington then either increases or decreases the frequency of the voltage-controlled oscillator (VCO) U7140. The adjusted VCO 16 MHz output is then feed back via U4080, U3030, U3010 to the V input of U7120.
The R-input reference signal follows the data stream from the disc. The V-input follows the frequency of the voltage-controlled oscillator. Thus the PLL circuit generates a pseudo clock called "read data window" (RDW) which the NCEC765 uses to clock the data onto the disc.

FLEXIBLE DISC DRIVERS/RECEIVERS 45

Three output devices provide the drive/receive signals for the flexible disc drive. They are U7080, U5120, and U6100.

U7080 handles the STEP, LOWCURRENT, DIRECTION, TRACK00, WRITE PROTECT, and TWO SIDED signals. U7110 and U5120 provide the DRVSEL signals. U6100 provides the WRITE DATA, HEAD LOAD, WRITE GATE, and SIDE SELECT signal. Table 9-3 describes the signals and their functions.

Table 9-3
Control and Status Port Signals

Signal	Description
STEP	This pulse causes the R/W heads to move one track in the direction of motion defined by the "Direction " line.
LOW CURRENT	This interface line switches to the 'Low Write Current mode' for tracks 43 and higher
DIRECTION	This signal defines the direction of the R/W heads when the STEP signal is asserted. A logical one defines the direction as "in". Thus, the R/W head moves toward the center of the disc (high numbered track). A logical zero defines the "out" direction and the R/W head moves towards the outer disc edge.
TRACK 00	This signal indicates when the R/W head is positioned at track zero (the outermost track). A logical one indicates that the head is positioned at track zero.
WRITE PROTECT	This signal informs the Z80A controller when a write-protected disc is installed. A logical one indicates that the disc is write-protected. The drive inhibits writing to a write-protected disc.
TWO SIDED	This interface signal indicates whether a "two sided" or a "single sided" disc is installed. A logical one indicates that a "two sided" disc is installed. A logical zero indicates a one-sided disc.

Table 9-3 (cont.)
Control and Status Port Signals

Signal	Description
DRIVE SELECT 0	This output line enables the flexible disc drive. system. In addition, the DRIVE SELECT signal lights the LED indicator in the door push button.
WRITE DATA	This interface line sees a 250 nS pulse whenever a data bit is written on the disc.
HEAD LOAD	This signal loads the R/W head against the disc. The head load signal also locks the drive door. The HEAD LOAD signal remains true for 3 seconds after the last disc operation.
WRITE GATE	This signal informs the flexible disc drive that a write operation is in progress. This signal is ANDed with WRITE PROTECT to supply the write current.
SIDE SELECT	This signal selects the proper disc side for reading or writing. A logical zero selects side 0, a logical one selects side 1.

Input Signals

U7080 has three inputs from the 8560 bus. they are: the INDEX, READ DATA, and READY signals. Table 9-4 gives the signal descriptions.

Table 9-4
Control and Status Port Signals

Signal	Description
INDEX	The INDEX signal arrives from the flexible disc drive once for every disc revolution (approximately every 166.7 mS). INDEX indicates the beginning of the track (sector 1). INDEX is asserted for a period of 1.8 mS once every revolution.
READ#DATA	This signal carries the incoming data stream from the disc when the WRITE GATE signal is unasserted and the heads are loaded.
READY	READY confirms that the drive contains a disc, the door is closed , and the disc is at operating speed.

THE CLOCK GENERATOR 46

The clock generator consists of 1/2 of U7140 and associated logic. U7140 is a voltage-controlled oscillator device with an 8MHz crystal across pins 10 and 11. The input pin (pin 12), normally connected to a control voltage, is connected here to a constant voltage. This results is a constant TTL level 8MHz clock output.

Jumper J7145 (normally in) connects the output to 1/2 of U3030, a 4-bit binary counter. This counter provides clock frequencies of 4MHz, 2MHz, 1 MHz, and 500 KHz. (Please see Section 3 for more jumper information).

The 4MHz output connects to U3040. Transistor Q1041 provides a pull-up function. Thus, the output of this circuit is a 4MHz clock with a amplitude of 5V p-p.

THE WAIT STATE GENERATOR 43

The wait state generator consists of flip-flops U3130 and U4030, and gates U3020 and U5070. The wait-state generator provides two functions:

- it generates wait states to synchronize Z80A processor speed with the data rate of the NEC765 disc controller
- it provides wait states during DMA access of the LSI-11/23.

The AWAITD signal enables Z80A wait states during flexible disc access. A wait state is not cleared until pin 1 of U1130 goes low. For this, either one of the three U5070 inputs must go high. This is caused by either one of these conditions.

- an asserted RESET signal
- an asserted NEC765 interrupt signal
- when DRQ is asserted and the disc controller (NEC765) has data, or is ready to receive data from the disc.

DIAGNOSTIC JUMPERS

The PMS Controller board has a number of diagnostic jumpers. The jumpers and their functions are shown in Table 9-5. Section 3 of this manual provides the jumper default positions.

Table 9-5 PMS Controller Diagnostic Jumpers

```
-------------------------------------------------------------------------
 Jumper | Signal |       Default Strapping and Function
=========================================================================
 J1031  |   D7   | o o-o                  o-o o   forces NOP (00) instruc-
 J1032  |   D6   | o o-o  Normal          o-o o   tions on the data bus
 J1033  |   D5   | o o-o                  o-o o   in the TEST position, and
 J1034  |   D4   | o o-o                  o-o o   allows normal bus access
 J1035  |   D3   | o o-o                  o-o o   in the NORMAL position.
 J1036  |   D2   | o o-o                  o-o o
 J1037  |   D1   | o o-o        Test      o-o o
 J1038  |   D0   | o o-o                  o-o o
-------------------------------------------------------------------------
 J1010  |        |     o   4
        |        | 1 o o   2              no NMI
        |        |     o   3
        |        |
        | NMI(L) |     o                  normal position:
        |        |   o-o                  NMI caused by a shorted J1131
        |        |     o
        |        |
        |        |     o
        |        |   o o                  NMI caused by POINTRWR(L)
        |        |     o
        |        |
-------------------------------------------------------------------------
 J1011  |WAIT(L) | o
        |        | o o                    inhibits the Z80A  WAIT signal
        |        |
        |        | o-o
        |        | o                      normal position: Z80A WAIT on
-------------------------------------------------------------------------
 J1040  |        | o-o                    Normal position: head loading
        | head   |   o                    controlled by the PIO
        | load   |
        |        | o o                    test position: head loading
        |        |   o                    controlled by the NEC765
-------------------------------------------------------------------------
 J2040  | READ   |   o                    normal position:
        | DATA(L)| o-o                    U4050A  triggered from READ DATA(L)
        |        |
        |        |   o                    test position: U4050A triggered from
        |        | o o                    500KHz master clock
-------------------------------------------------------------------------
 J1050  | PIO (A)| normally IN            used for port and logic
 J1070  | PIO (B)| normally IN            block testing
-------------------------------------------------------------------------
 J1090  |        |
 J1091  |        | normally OUT --        used with signature analyzer
 J1092  |        |
-------------------------------------------------------------------------
```

Table 9-5 (cont.) PMS Controller Diagnostic Jumpers

Jumper	Strapping/Function	
J1130	o o-o	normal position: selects 1 K-bytes of RAM
	o o o	other position selects 2 K-byte of RAM
J3070 J3090	normally IN normally OUT	these two jumpers are used in in conjunction with J1050 and 1070 to test the PLL write - precompensation logic
J4140 J5140	normally IN normally IN	these two jumpers are used (with J1050 and J1070) to test the DMA logic
J6140	normally IN	used (with J1050 and 1070 to test the Interrupt replay logic
J5058	o o-o	Normal position: address 777150
	o o o	test position: address 777154

@

Table 9-5 PMS Controller Diagnostic Jumpers (cont.)

Jumper	Signal	Strapping/Function	
J7101		o-o o	
J7102		o-o o	assert interrupt requests
J7103		o-o o o	
J6121		o-o o	monitor interrupt requests
J6123		o-o o	
J1131	DIAGNIN(L)	normally out	diagnostic test switch shorts pins 2 and 3 and triggers DIAGIN(L)
J3020	CLK1MHZ	o-o o	These jumpers, shown in normal position, are not used
J3100	DMAINIT	o-o	
J5105	VALAD	o-o	
J6061	TDALOE	o o-o	
J6062	RINIT	o o-o	
J7145	CLK8MHZ	normally IN	isolates the main clock when out
J7115	D0	normally OUT	selects the diagnostic mode when IN
J7116	D1	Normally OUT	

Section 10

MICROPOLIS M1220 INTERFACE BOARD

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Section 10

MICROPOLIS M1220 INTERFACE BOARD

INTRODUCTION

The Micropolis M1220 Interface board, henceforth called M1220 board, is a small (10 x 20 cm) piggy-back board attached to the PMS Controller board. The M1220 board interfaces to the PMS Controller board and with the Micropolis 1223-1 Winchester-type hard disc drive. The M1220 board is controlled by the PMS controller board and its Z80A processor.

Figure 10-1 shows the M1220 board block diagram. For the following discussion, the board is divided into these major parts.

- The hard disc DMA logic
- the DMA address counter
- the PIO device
- expanded memory

DESCRIPTION

THE HARD DISC DMA LOGIC 49

The hard disc DMA logic consists of two data multiplexers (U5020 and U6020), the bus transceiver U2050, and other flip-flops and gates (U3010, U4010, U2030). This DMA logic controls the data transfer between the Z80A data bus to the hard disc. The following paragraphs describe the DMA logic operations in simplified terms.

The hard disc DMA logic initiates a bus request and, after receiving control of the Z80A bus, puts the Z80A into a high impedance state. This effectively halts the Z80A. The hard disc DMA logic then assumes control of the Z80A bus. By virtue of memory mapping, the Z80A can access the LSI-11/23 memory space, and the hard disc DMA logic can access system memory. Two simultaneous DMA operations are required to move data between the hard disc and the system memory.

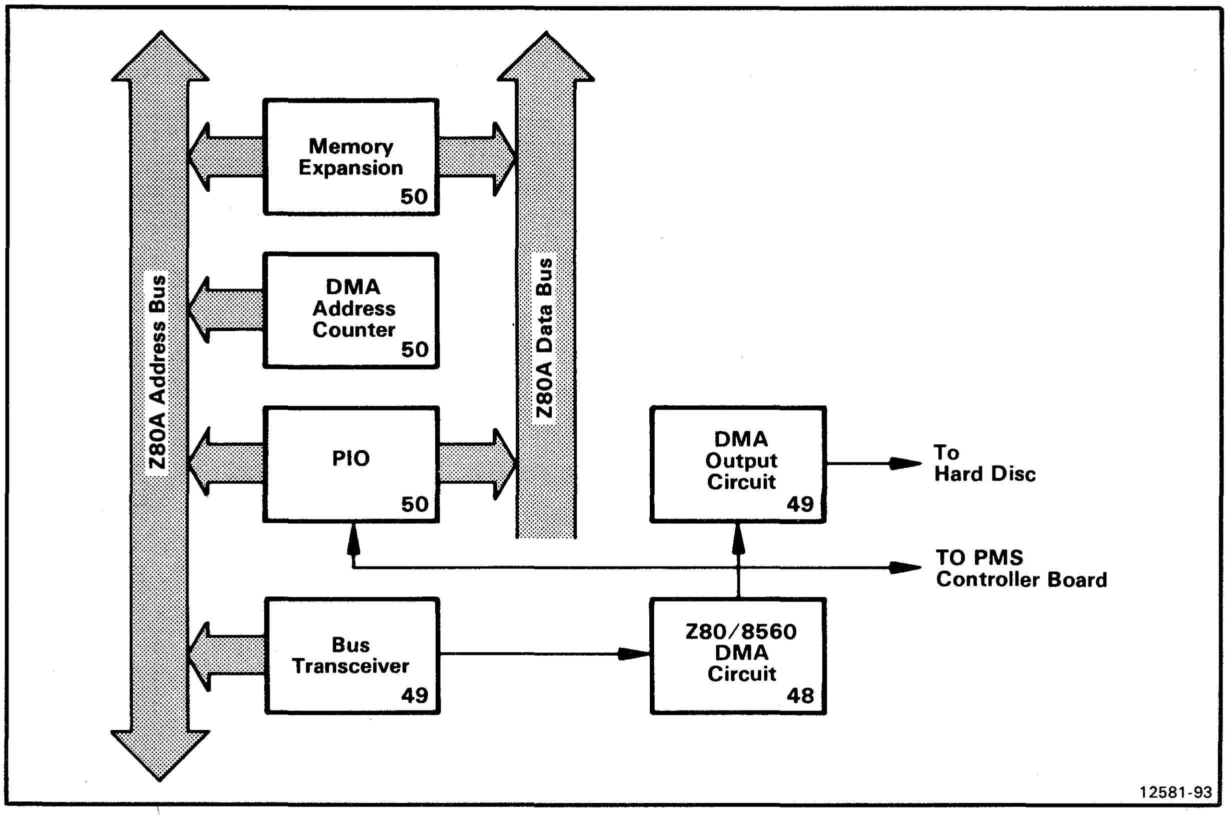

Fig. 10-1 M1220 Interface block diagram.

DLATCH(H) and DGATE(H) generate the read and write strobe signals WSTR(L) and RSTR(L). DLATCH(H) and DGATE(H) are always asserted at the same time. DLATCH(H), however, always goes low before DGATE(H). Thus, as long as DGATE(H) is asserted, this logic can access the Z80A data bus to read and to write. When the DLATCH(H) signal is asserted, the hard disc DMA logic can latch data either on the disc or into the PMS Controller DMA sequencer.

When the PMS Controller writes to the hard disc, the controller first puts the data onto the Z80A address bus via bus transceiver U2050. It then transfers the data to the hard disc buffers with WSTR(L). The WSTR(L) signal originates at the data multiplexer (U6020).

When the PMS Controller reads data from the hard disc, DLATCH(L) generates the MREQ(L) signal, and DGATE(H) asserts the RSTR(L) signal. When MREQ(L) goes high, it latches the valid data from the hard disc into the buffers on the PMS Controller board.

During a DMA operation, these handshake signals are asserted: QBUSRDY(H), BUSRQ(L), BUSAK(L), TCO(H), and XFERGAT. Table 10-1 describes the signals and their functions.

Table 10-1 DMA Handshake Signals

Signal	Description
QBUSRDY(H)	Informs the disc DMA logic when the DMA sequencer has completed its memory cycle. and when the 8560 bus is ready to receive another DMA request.
DREQ(L)	Informs the hard disc DMA logic when a byte of data is available from the hard disc, or when the disc needs byte of data.
BUSRQ(L)	Puts the Z80A in a high impedance state, relinquishing control to the hard disc DMA logic.
BUSAK(L)	Is the bus request acknowledge signal. It informs the hard disc DMA logic that it is now bus master.
TCO(H)	This counter/timer signal informs the Z80A/8560 DMA logic that a terminal count of zero was reached while counting data byte transfers.
XFERGAT(H)	XFERGAT(H) is the transfer gate signal that enables the hard disc DMA logic.

In addition to the input signals in Table 10-1, the DMA operation affects six output signals. The main signals are the write and read-strobe signals WSTR(L) and RSTR(H). Four other signals are not asserted during DMA transfer, but must remain unasserted while a DMA transfer takes place. They are: IORQ(L), M1(L), WR(L), and RFSH(L).

When the hard disc DMA logic is not enabled, the Z80A communicates with the hard disc under program control. The Z80A sends a series of command bytes to the hard disc, and the disc returns with a series of result bytes. This operation is performed with the RSTR(L), WSIR(L) and WDSEL(L) signals.

THE DMA ADDRESS COUNTER 50

The DMA address counter is a 16-bit binary counter that consists of four, 4-bit binary counter devices (U6040, U7040, U6050, and U7050). This counter counts each data byte either received from or transmitted to the hard disc. It also tracks the Z80A addresses during a DMA operation. The address counter receives the the starting address via the Z80A PIO (U3050).

THE Z80 PIO DEVICE 50

The Z80 Parallel I/O device (U3050) is a programmable two port device that interfaces between the Z80A bus and M1220 Interface. The PIO device has 6 address lines connected to the Z80A bus, and 16 I/O port data lines. The data lines connect via 16 jumper straps that are normally installed.

The PIO controls the SELECT(L) and ENABLE(L) signal lines. Since there is never more than one hard disc in the system, the PIO always communicates with controller 0. SELECT is never asserted, and ENABLE is always asserted.

MEMORY EXPANSION 50

Space limitations on the PMS Controller board restrict the number of memory devices the PMS Controller board can contain. Two additional sockets on the M1220 board overcome that problem, and provide the PMS Controller with the memory it needs. One socket accepts an 8K-byte ROM device, while the other accepts 1 K-byte of RAM.

DIAGNOSTIC JUMPERS

The M1220 board has a number of jumpers. Section 3 of this manual gives their default positions.

Section 11

THE DISC DRIVES

Page

Section 11

THE DISC DRIVES

INTRODUCTION

The 8560 provides almost 36 M-bytes of non-volatile memory. The vehicles for this storage are a double-sided, double-density flexible disc drive, and a winchester-type hard disc drive.

THE FLEXIBLE DISC DRIVE

The 8560 flexible disc drive is a Qume Corporation DataTrak 8 . This unit utilizes the standard removable eight-inch flexible IBM discs or any equivalent as storage medium.

This drive provides storage under these standards:

- 0.6M-bytes of storage capacity on a two-sided single-density disc,
- 1.2 M-bytes of storage capacity on a double-sided double density disc

The Datatrak 8 drive has a two-sided head/carriage assembly with two ceramic read/write heads that provides track-to-track access time of 3 mS.

For additional information see the DataTrak 8 Flexible Disc Drive Manual available from Tektronix Inc.

THE MICROPOLIS MODEL 1223-1 DISC DRIVE

The 8560 hard disc drive is a 35.64 M-byte Micropolis Model M1223-1 with its own intelligent interface control unit. The M1223-1 disc drive unit consists of a die-cast deck whose lower half is a closed-circuit clean area. This clean area contains three hard discs. Air is circulated through the clean area by the rotation of the disks. The air flow is directed through a 0.3 micron absolute filter.

The clean area contains no active electronic parts. Therefore, the electrical connections between this area's components and interface electronics are made with an ECB which seals the clean area from the rest of the casting.

The M1223-1 has a quartz-locked direct drive, brushless DC motor that rotates the three sealed discs. A breaking mechanism is part of the drive.

The M1223-1 is equipped with an intelligent Micropolis controller/interface. The controller/interface board is located on the top of the drive unit, and being hinged, provides access to both board sides. The controller provides the drive with error correction capability.

ATTENTION

Servicing the discs inside the clean area, requires that you remove the drive unit completely from the 8560 enclosure. The disc drive is serviced by the manufacturer only.

Service information and instructions to remove the Micropolis disc drive are given Section 15, Maintenance. For detailed information on the Micropolis M1223-1 see the Manufacturers literature.

Section 12

POWER SUPPLY

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Section 12

POWER SUPPLY

INTRODUCTION

This section describes the 8560 power supply and provides procedures for troubleshooting the supply. The material in this section consists of:

- A functional description of the 8560 Power Supply.
- A troubleshooting guide for the 8560 Power Supply.
- A bring-up procedure to return a repaired power supply to operation.

FUNCTIONAL DESCRIPTION

This subsection describes the circuitry of the 8560 Power Supply and is divided into three parts:

- A general description of an inverter-type supply.
- A description of the DC output circuitry in the 8560 Power Supply.
- A description of the power supply for the flexible disc drive motors.

INVERTER-TYPE SUPPLY DESCRIPTION

The 8560 Power Supply is an inverter-type supply. The power supply provides the four DC voltages (+5 V, +12 V, -12 V, and +24 V) required by the 8560. These voltages are generated in four steps:

1. The incoming AC line is rectified and filtered into high voltage DC.
2. The high voltage DC powers an ultrasonic oscillator called an inverter.
3. The output of the inverter is fed to an isolation transformer.
4. The waveform at each transformer secondary is rectified and filtered into low voltage DC.

The four steps are illustrated in the block diagram in Fig. 12-1.

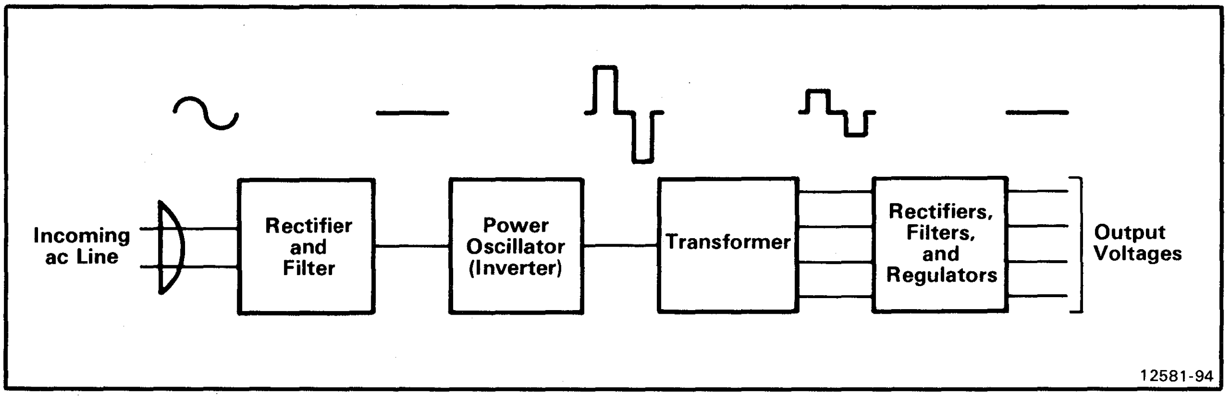


Fig. 12-1. Inverter-type supply block diagram.

DC OUTPUT CIRCUITRY

The output voltages of the supply are regulated by control circuitry that feeds information back to the inverter from the output rectifiers and filters. Three of the four output voltages (+12 V, -12 V, and +24 V) must have additional regulation; only the +5 V output can be adequately regulated by controlling just the inverter. This additional regulation is performed by the secondary regulators. The secondary regulators are controlled by the same reference voltage that controls the 5 V output. All of the control circuitry is powered by a ±15 V supply, which is separately derived from the incoming AC line.

Protection circuitry monitors the voltage outputs and the inverter, and shuts the supply down when fault conditions occur. Three types of faults external to the supply can shut the supply down:

- Line voltage below about 85 V will shut down the supply until the line voltage rises above 90 V.

- Overcurrent or overvoltage on any of the power outputs shuts down all of the outputs for about a second. The supply then tries to restart every 1 to 1.5 seconds until the fault is corrected or until the supply is turned off.

Figure 12-2 is a block diagram of the 8560 Power Supply.

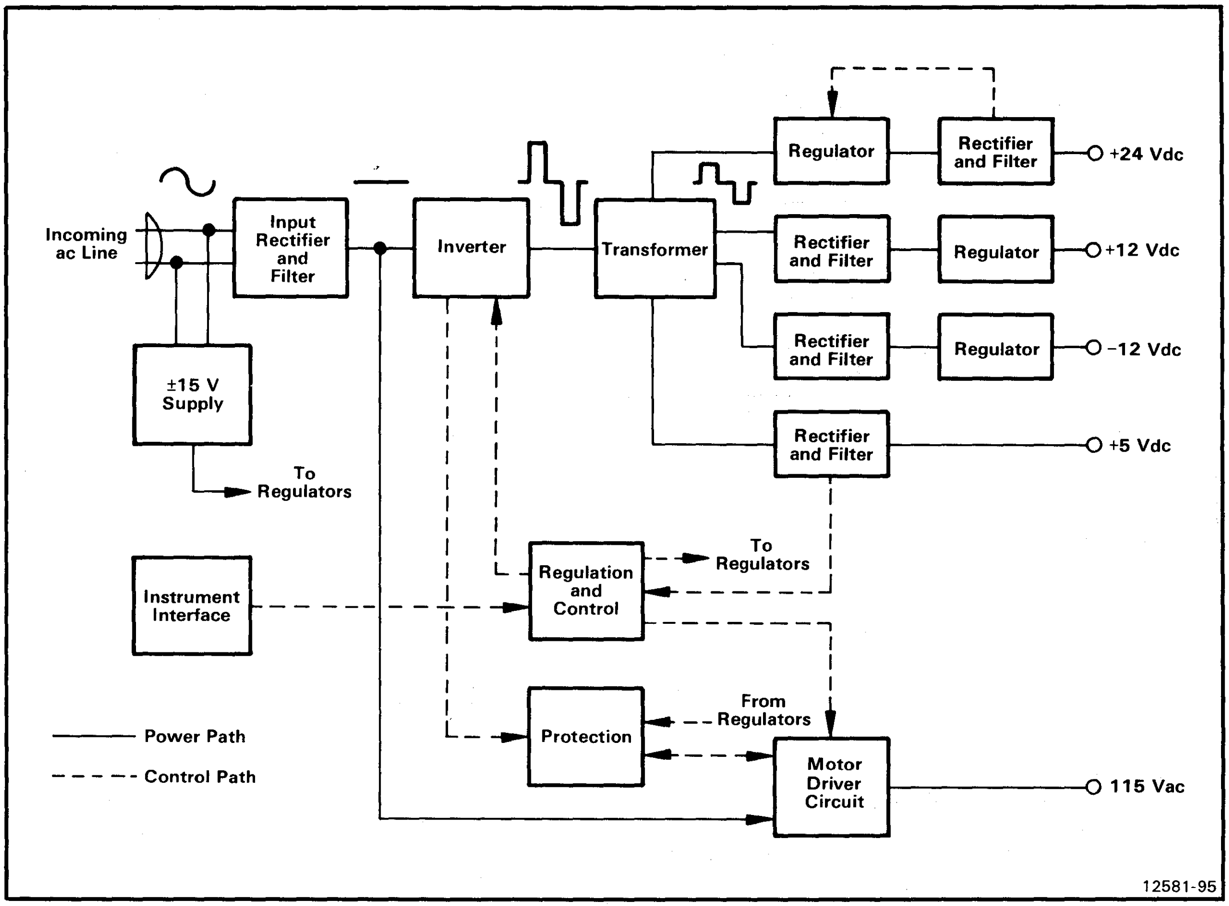


Fig. 12-2. 8560 Power Supply block diagram.

MOTOR DRIVER CIRCUIT

The 8560 Power Supply generates a 115 Vrms sine wave to power the flexible disc drive motor and fan. This 115 V output is generated by amplifying a crystal-controlled 60 Hz sine wave reference signal with a switching amplifier. The switching amplifier is connected to the same high voltage DC that powers the inverter.

The 115 V output is regulated by a signal derived from the DC supply control circuitry. Excessive output current or any of various internal faults can cause power to be removed from the switching amplifier. The protection circuitry that removes power from the switching amplifier is tied into the DC supply shutdown circuitry, so that all parts of the supply turn off and restart together.

Figure 12-3 is a block diagram of the motor driver circuit.

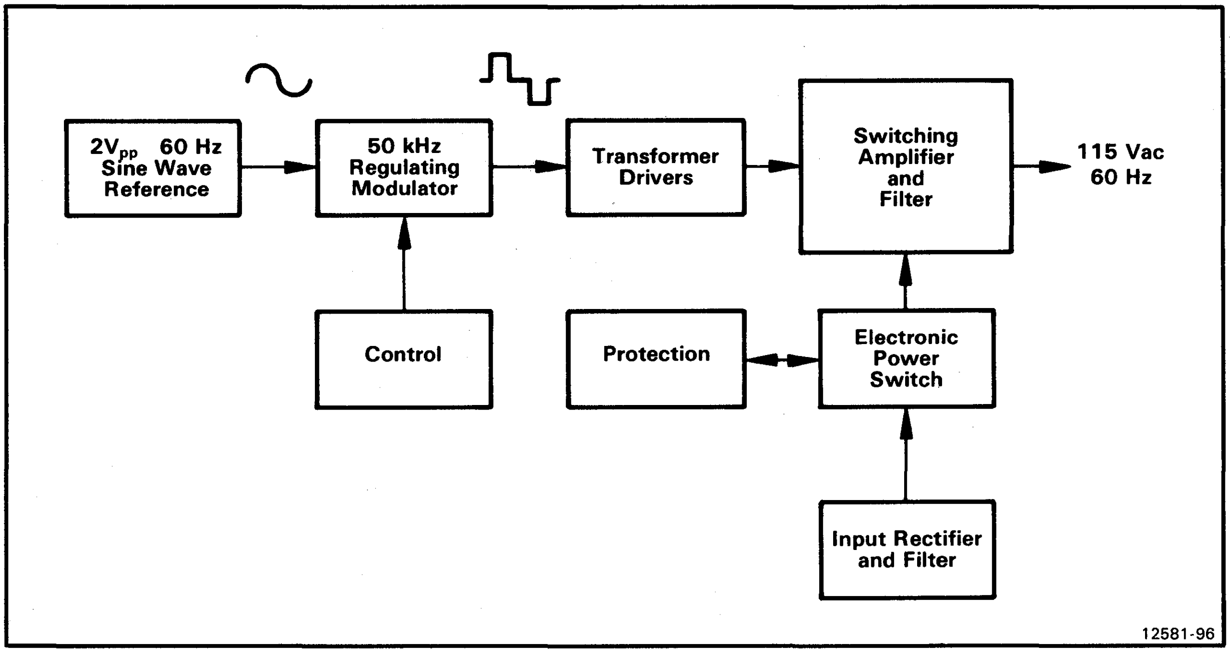


Fig. 12-3. Motor driver block diagram.

TROUBLESHOOTING GUIDE

This troubleshooting guide is intended to allow you to locate and repair most of the failures that can occur in the 8560 Power Supply. The guide is divided into two main parts:

1. Catastrophic failures

2. Non-catastrophic failures

   a. Finding what's wrong when the supply won't turn on.

   b. Troubleshooting the +24 V Secondary Regulator.

   c. Troubleshooting the +12 V and -12 V Secondary Regulators.

To troubleshoot the supply, follow the appropriate procedure in this troubleshooting guide. If you are troubleshooting a catastrophic failure, proceed to the Bring-Up Procedure later in this section after repairing the problem.

Equipment Required

The following equipment is required to perform the tasks described in this troubleshooting guide:

Equipment	Recommended Type
Soldering iron/solder	800 F tip temperature/ 63% tin, 37% lead, rosin core
Needle-nose pliers	Sturdy, with plastic grips
Screwdriver	Philips for #6 and #4 screws
Voltmeter/diode meter	Fluke Model 8030A or equivalent
Oscilloscope	TEKTRONIX 465 or equivalent

JUMPERS

Refer to Section 3 of this manual for detailed information on all power supply jumpers.

CATASTROPHIC FAILURES

Catastrophic failures generally occur while the instrument is up and running. Failures of this type cause the instrument lights to go out and the line fuse to blow. These symptoms are sometimes accompanied by a burning odor or popping noises.

Catastrophic failures most often originate in the high-voltage switching circuits of either the main inverter or motor driver. These two circuits are located on the Inverter board, which is one of three plug-in circuit boards in the 8560 Power Supply.

In the following inspection and repair procedure, the most likely causes of failure are investigated first.

Procedure

1. Make sure the 8560 is disconnected from the primary power source.

WARNING

Use insulated tools and probes at all times and observe the supplementary cautions contained in the text. Stored charge in the large capacitors of the power supply can cause severe burns and/or electric shock even when the supply is turned off.

2. To gain access to the Inverter board, remove the fan housing at the rear of the 8560. Remove the two screws closest to the rear panel on the housing's left side, and the six screws that secure the housing to the rear panel. Disconnect the two wires connected to the fan and set the fan housing aside.

3. Three plug-in circuit boards are now visible through the opening that the fan housing normally covers. The Inverter board is the lowest of these three boards. To remove the Inverter board, grasp the left side of the board firmly with a pair of insulated needle-nose pliers (see Fig. 12-4), and pull the board out.

   - Do <u>not</u> touch the metal on the pliers; high voltage may be present on the board while it is installed. Also, it's a good idea to keep away from grounded objects while pulling the board out.

   - After removing the board, allow five seconds for the capacitors to discharge before handling the board.

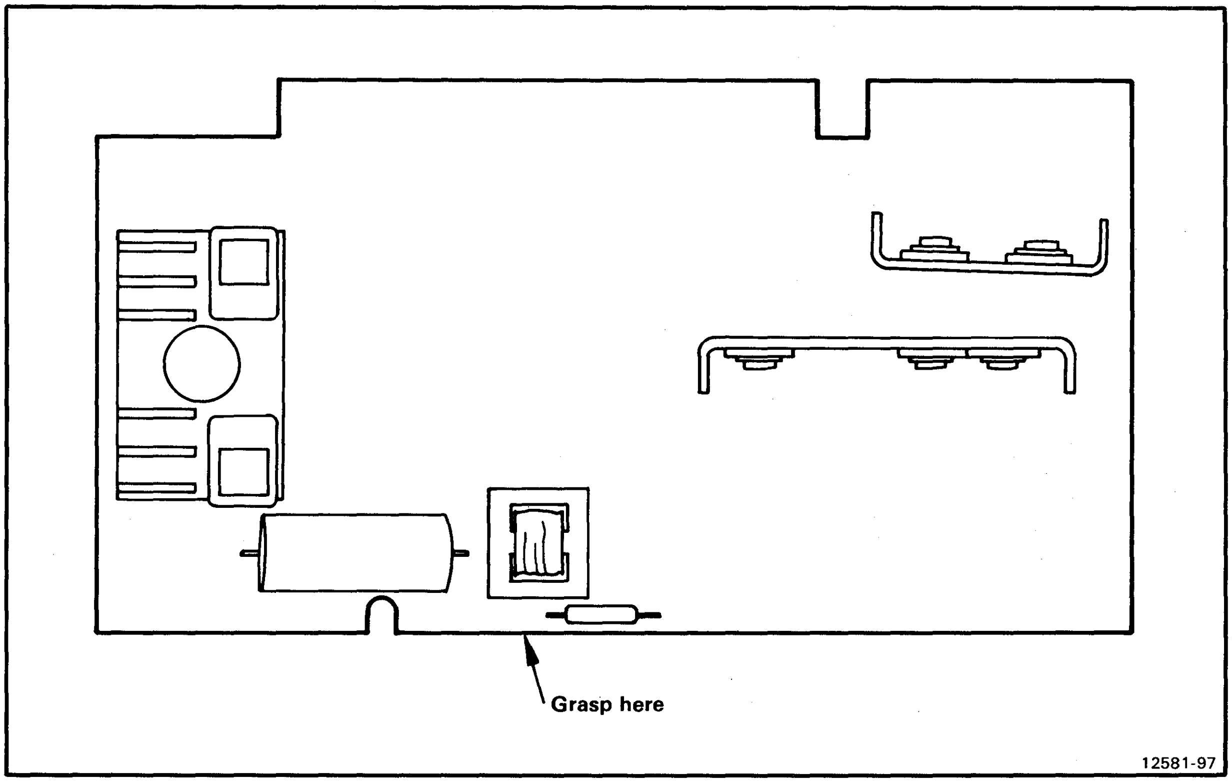


Fig. 12-4. Inverter board.

4. Notice the finned heatsink on the left side of the Inverter board. The two transistors on the finned heatsink are the main inverter's high-voltage switching components. Also notice the two bent heatsinks on the right. The five transistors on these heatsinks are the motor driver's high-voltage switching components. Look for obvious signs of failure, such as cracked transistor cases or charred circuit board.

   If the failure appears to be only in the motor driver circuit, skip to step 6. If there are no obvious signs of failure, or the main inverter circuit appears to be at fault, proceed to step 5.

NOTE

While performing the rest of the procedure, refer to the Power Supply Inverter board schematics at the rear of this manual.

5. If the failure seems to be in the main inverter, the following components (listed in descending order of probability) may have failed:

   1. High-voltage switching transistors Q2025 and Q5025

   2. Turn-off capacitors C1021 and C6019

3. Turn-off transistors Q1015 and Q6015

4. Drive transistors Q5047 and Q6049

5. Bleeder resistors R2017 and R6013

a) If either Q2025 or Q5025 is obviously damaged, remove the bad transistor(s). Be careful when removing these transistors. The two screws holding down the collector tabs of these transistors are the only secure mechanical connection between the heatsink assembly and the circuit board.

If either Q2025 or Q5025 is apparently undamaged, it should be checked in-circuit with any diode meter having a 1 mA measuring current. Forward base-collector and base-emitter voltages for good transistors are between 400 and 600 mV (see Fig. 12-5 for pinouts). Remove any transistor that shows a bad junction voltage. If neither transistor is bad, the failure probably occurred in the motor driver (proceed to step 6).

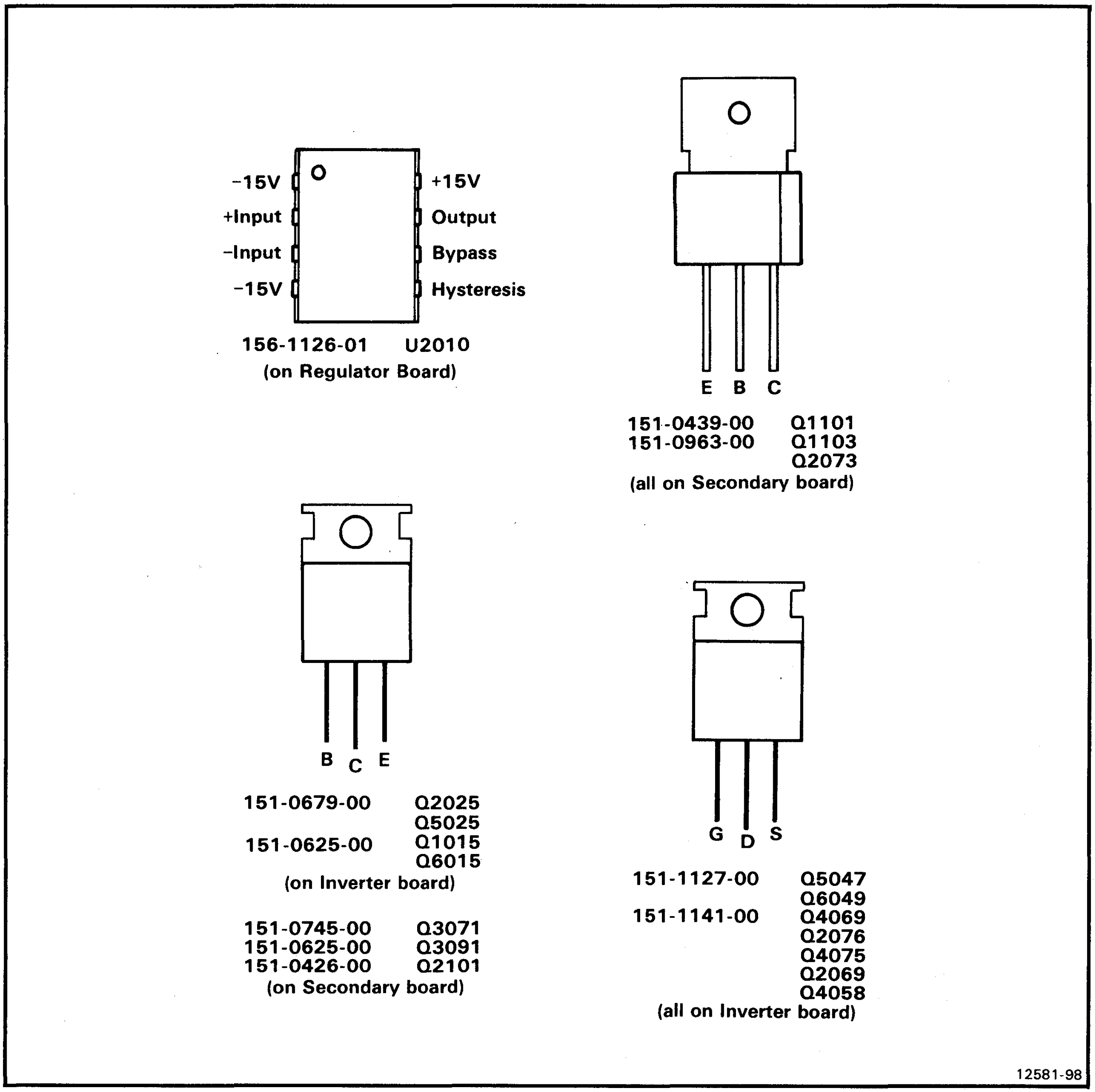


Fig. 12-5. Semiconductor component pinouts.

b) After Q2025 and Q5025 have been removed, all of the other components listed back at the beginning of step 5 can be checked with the diode meter. The capacitors should read between 1300 and 1600 mV in either direction (although a resistor failure or turn-off transistor failure could affect these readings). The turn-off transistors should show forward junction voltages between 400 and 600 mV. The bleeder resistors should read between 900 and 1100 mV in either direction. The drive transistors should eventually read between 400 and 600 mV when the positive lead of the meter is connected to the source and the negative lead to the drain. With the leads reversed, the reading should eventually rise to more than 1999 mV. ("Eventually" means that the meter may take a few seconds to charge up the capacitors in parallel with the component being measured.)

c) Replace any of the components which seem to be faulty. Rebuild the heatsink assembly. (Make sure all parts are present, including the plastic inserts and rectangular alumina washers.) Make sure there is heatsink compound under the transistors.

If the motor driver circuit is still suspect, proceed to step 6; otherwise, skip to the Bring-Up Procedure, later in this section.

6. If the failure seems to be in the motor driver, the following components (listed in descending order of probability) may have failed:

    1. High-voltage switching transistors Q4058, Q2069, Q2076, Q4069, and Q4075

    2. Gate-source protection diodes for the high-voltage switching transistors - VR3056, VR2065, VR2073, VR4065, VR4076

    3. Series diodes CR3062, CR2075, CR4062, CR4084

    4. Shutoff transistor Q3053

Less likely possibilities:

    5. Soft-start capacitor C4055

    6. Level-shift diodes VR2067, VR2074, VR4063, VR4074

a) Remove all of the high-voltage switching transistors that are obviously damaged. The remaining transistors can be tested in the same way as the main inverter drive transistors (see step 5b). The high-voltage switching transistors should be tested individually, and removed if bad. Since two or three bad transistors can cause all of them to appear bad, you should recheck all suspected transistors out of the circuit.

b) All of the other components listed at the beginning of step 6 can be checked with the diode meter once the bad transistors are removed. The gate-source protection diodes for the bad transistors should be checked in the forward (not zener) direction. Diodes showing a forward voltage outside of the 500 to 800 mV range should be removed.

The level-shift diodes for the bad transistors can also be checked. However, since these diodes are in parallel with the protection diodes, one lead of the level-shift diode will have to be lifted for the test, unless the associated protection diode has been removed. The level-shift diodes should show a forward voltage between 600 and 800 mV.

If Q4058 was bad, check Q3053 and C4055 by connecting the diode meter in both directions across C4055. With the positive lead on the collector of Q3053, the reading should be more than 1999 mV. With the leads reversed, the reading should be between 500 and 700 mV; however, if VR3056 has been removed, both readings should be more than 1999 mV. If your readings are lower than those just mentioned, remove Q3053 and repeat the measurements. If the readings are now correct, Q3053 is bad. If the reading is still bad, the capacitor is at fault, and Q3053 should be checked again to see if it's good.

Finally, check all of the series diodes. Any diode with forward voltage less than 400 mV or greater than 600 mV should be removed.

c) Replace all of the faulty components. If the heatsinks were removed, reassemble them onto the transistors (after making sure the collector tabs of any replaced transistors are adequately coated with heatsink compound). If the original screws are not available, use plastic screws when rebuilding the heatsink assemblies, to avoid shorting transistors together.

7. Proceed to the Bring-Up Procedure, later in this section.

NON-CATASTROPHIC FAILURES

The two most common non-catastrophic failures are failure of the supply to turn on, and failure of a secondary regulator to produce the correct output voltage. This part of the Troubleshooting Guide is organized as follows:

1. Finding what's wrong when the supply won't turn on.
2. Troubleshooting the +24 V Secondary Regulator.
3. Troubleshooting the +12 V and -12 V Secondary Regulators.

Follow the appropriate procedure until you've discovered and repaired the problem. Then, power up the system to verify that you have completely repaired the supply.

The Supply Won't Turn On

The 8560 power supply has many different kinds of fault sensing and protection features. This means that any of a number of things can prevent the supply from coming up when both front and rear panel power switches are turned on.

If the AC ON light on the front panel remains off, the line fuse is probably open, indicating that one of the following may have occurred:

- A catastrophic failure has occurred in the supply. See Catastrophic Failures earlier in this section.

- Your 8560 is configured for a 115 V line, but connected to a 230 V line. See "Selecting the Proper Primary Voltage", in Section 19 of this manual.

If the AC ON light is illuminated, but the 8560 doesn't power up when you turn ON the front panel DC switch, the following procedure should uncover the source of the problem.

NOTE

If the front panel switch is ON when the rear panel switch is turned ON, the AC ON light will illuminate immediately but the instrument won't power up for about a second. This is entirely normal.

Procedure

1. Remove the two top cover retainers at the rear of the mainframe and slide off the top cover. Locate the power supply top shield, which is behind the hard disc drive.

WARNING

Use extreme caution once you have removed the power supply top shield. Dangerous voltages are present underneath the top shield.

WARNING

Be careful to keep fingers and other objects out of the power supply fan blades. The fan housing has no protective covering from the inside of the supply.

Remove the four screws that secure the shield, then lift the shield off.

2. If you can hear a faint chirping sound coming from the supply about once every second, proceed to step 3.

If you cannot hear any chirping, measure the voltage at the PONPS testpoint (TP6048) and at PON on the Interconnect board (the second pin from the left on the upper row of J1010). Both of these voltages should be between 12 and 15 V, if front and rear switches are both ON.

a) If both voltages are near ground, either the front panel, or the wiring to it from the Interconnect board, is probably defective. (It is also possible that the +15 V supply circuit has failed.

Check the +15 V testpoint (TP6076). The voltage should be correct within ±5%.)

b) If only PONPS is incorrect, check the Shutdown testpoint (TP6046). If the testpoint voltage is above 11 V, proceed to step 3. The supply is probably chirping as previously described. You may not be able to hear it if you're in a noisy work area.

3. Turn off the 8560 at the rear panel power switch.

WARNING

Use insulated tools and probes at all times and observe the supplementary cautions contained in the text. Stored charge in the large capacitors of the power supply can cause severe burns and/or electric shock even when the supply is turned off.

4. Locate the fan housing at the rear of the instrument. Remove the two screws (closest to the rear panel) on the fan housing's left side and the six screws that secure it to the rear panel. Disconnect the two wires connected to the fan and set the fan housing aside.

5. Three plug-in circuit boards are visible in the rear opening. These boards are, from top to bottom, the Regulator board, the Secondary board, and the Inverter board.

WARNING

Dangerous voltages are present on the Secondary board even when the front panel power switch is turned off. Line voltage is connected to the side of the large transformer (T1011) that faces the Interconnect board.

Remove the Regulator and Secondary boards from their slots. Insert the Secondary board in the top slot, and the Regulator board in the second slot.

6. Connect the external trigger of an oscilloscope to the Shutdown testpoint on the Regulator board (TP6046). The scope's sweep rate should be set to 10 ms/div, initially. The triggering should be set to NORMal mode, DC coupling, EXTernal source, positive level, and negative slope.

7. Turn ON the 8560 with the rear panel power switch. If the front panel switch is also ON, the supply should chirp faintly as before, and a single trace should be displayed on the scope with every chirp.

If you determine that the Shutdown testpoint is not providing a trigger signal, but is staying above 11 V at all times, there are three possible causes:

- The undervoltage shutdown circuitry (U5040, U3040A) is faulty.
- The 8560 is configured for a 230 V line, but is connected to a 115 V line (see "Selecting the Proper Primary Voltage" in Section 19 of this manual).
- If the 8560 was running for some time prior to failure, the supply's thermal shutoff switch may have tripped. If so, the supply will come on again in a few minutes. When the supply comes on, check the fan for proper operation.

8. Set the scope's vertical sensitivity to 5 V/cm. Connect a probe from the vertical input of the scope to TP6046. The two traces shown in Fig. 12-6 illustrate the range of expected waveforms. If the waveform is like Fig. 12-6b, reduce the sweep speed until event Y (shown in Fig. 12-6a) is visible. Note the position of event Y on the screen; event Y occurs when the supply shuts down.

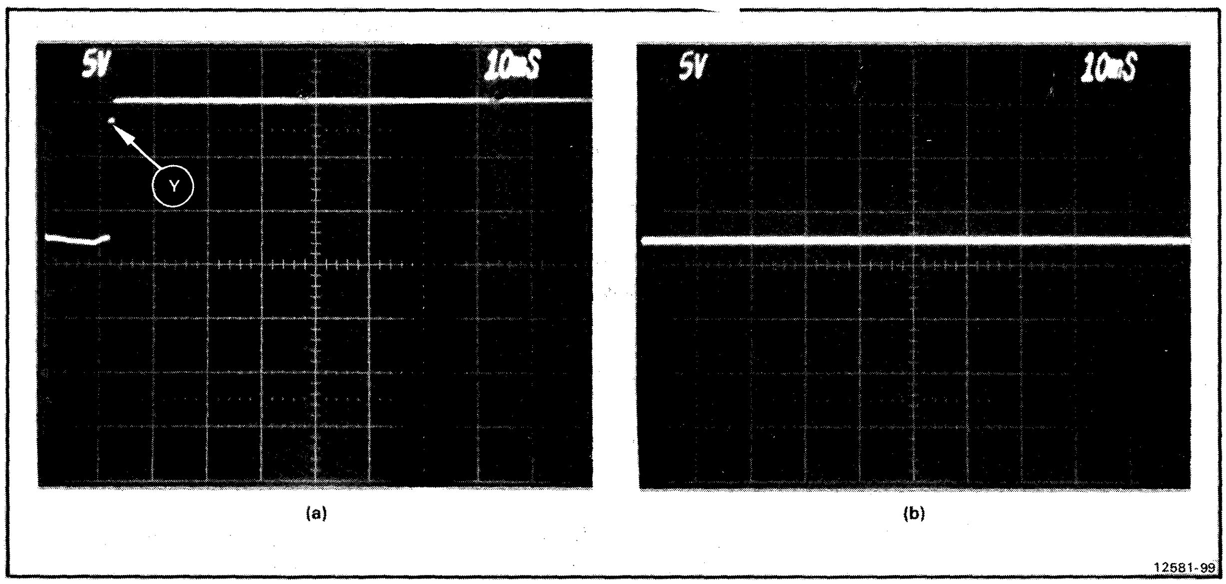


Fig. 12-6. Waveforms at Shutdown testpoint.

WARNING

Use extreme caution when servicing the Inverter board. Dangerous voltages exist on the Inverter board when the 8560 is turned on.

9. Connect the scope probe to the 15K resistor R6059 on the Inverter board, on the side of the resistor that is connected to PROTTR. There should be a 10 V negative-going spike from +15 V at the same position as event Y in Fig. 12-6a. You may have to increase the intensity of the display for the spike to become readily visible.

10. Connect the probe to the other side of R6059.

    a) If the spike amplitude is the same as in step 9, proceed to step 11.

    b) If the spike amplitude is greater than in step 9, connect the probe to the base of Q6056. If this voltage rises slowly from -15 V until event Y, and then drops back to -15 V, either an overload on the motor driver's output or fault in the motor driver itself is preventing the supply from turning on.

    If the voltage stays at -15 V, the primary current limit is being activated. There may be a fault in the main inverter control circuitry, or perhaps a secondary winding of power transformer T1011 on the Secondary board is shorted.

11. To test for an overvoltage problem on the supply outputs, connect the scope probe to each of the following testpoints on the Regulator board: +5 V Sense (TP6061), +12 V Sense (TP6043), -12 V (TP6015), +15 V (TP6076) and +24 V (TP6011).

    a) If the voltage during event Y at any of these testpoints is greater than 105% of the designated testpoint voltage, the supply is probably being shut down by the overvoltage protection circuit (U3110C on the Secondary board).

    b) If the overvoltage is on the 5 V line, the reference voltage Vref (TP6066) may have been set too high. Check Vref by measuring the voltage between TP6062 and Ground Sense (TP6056). The reading should be within 1% of 5.00 V.

    c) If the overvoltage is confined to the +24 V line, see "Troubleshooting the +24 V Secondary Regulator".

    d) If the overvoltage is confined to the +12 V or -12 V line, see "Troubleshooting the +12 V and -12 V Secondary Regulators". If the overvoltage is on the +15 V line, U1060 on the Regulator board is probably faulty.

12. If overvoltage does not seem to be the problem, there may be a short or overload on one of the supply's DC outputs. You can check this by connecting the scope's vertical input differentially across the capacitors listed in Table 12-1. The setup for this connection is accomplished as follows:

    In order to differentially connect across the +5 V and +12 V capacitors, connect a separate scope channel to each end of the capacitor you want to look at. Then, set the scope's controls so that the difference between the two channels is displayed. To connect across the +12 V and -12 V capacitors, the same method can be used if your scope has a linear range of 130 cm at a vertical sensitivity of 100 mV/cm. Otherwise, you must use a differential probe, such as the TEKTRONIX P6046. In any case, set the vertical sensitivity of the scope to 100 mV/cm for both channels, but do not change the triggering and sweep from their previous settings.

Each of the capacitors listed in Table 12-1 is the input capacitor of one of the overcurrent comparators. The listed capacitors are all located on the Secondary board. If the voltage across a given capacitor approaches within ±10 mV of ground at event Y of Fig. 12-6a, the corresponding output is being overloaded.

Table 12-1
Overcurrent Checkpoints

DC Output	Overcurrent Comparator Input Capacitor
+5 V	C3119
+12 V	C3111
-12 V	C3117
+24 V	C3113

Troubleshooting the +24 V Secondary Regulator

The output of the +24 V Secondary Regulator is determined by a switching regulator which is slaved to the +5 V regulator. The regulating element is a switching transistor (Q3071). Q3071 is driven by a comparator (U2010) through a complementary emitter follower (Q2073, Q2071). The comparator generates a switching signal through comparison of Vref with the actual output voltage. All of these components are on the Secondary board, except for U2010 on the Regulator board.

The two most common symptoms of failure in this circuit are overvoltage on the output (which causes the supply to shut down), and insufficient voltage (usually less than half the proper value, even with light loads).

Output overvoltage is usually due to a collector-emitter short in the switching transistor. This short effectively removes the regulator from the circuit. Insufficient voltage on the output is usually due to an open PNP driver transistor or a comparator that has failed (refer back to Fig. 12-5).

Procedure

1. Make sure the 8560 is disconnected from the primary power source.

WARNING

Use insulated tools and probes at all times and observe the supplementary cautions contained in the text. Stored charge in the large capacitors of the power supply can cause severe burns and/or electric shock even when the supply is turned off.

2. To gain access to the Secondary board, remove the fan housing at the rear of the 8560. Remove the two screws closest to the rear panel on the housing's left side, and the six screws securing the housing to the rear panel. Disconnect the two wires connected to the fan and set the fan housing aside.

3. Three plug-in circuit boards are now visible in the fan housing opening. The Secondary board is the middle board. To remove the board, grasp firmly with a pair of pliers and pull the board out.

4. Check the forward base-collector and base-emitter voltages of Q3071 with a diode meter. These voltages should be between 400 and 600 mV.

5. Check for a collector-emitter short by connecting the positive lead of the diode meter to the emitter and the negative lead to the collector. The reading should be more than 1999 mV for a good transistor.

6. If the switching transistor is good, check the two driver transistors in the same way. However, reverse the meter leads when checking for a collector-emitter short in the NPN driver transistor.

7. If the driver transistors are good, check the comparator while the supply is running. A failure of this component usually shows up in one of two ways: as an output that is incompatible with the inputs (for example, the positive input is above the negative input, but the output is low); or as an input that is more than a few hundred millivolts above Vref.

Troubleshooting the +12 V and -12 V Secondary Regulators

If the supply won't turn on because of overvoltage on the +12 V or -12 V outputs, or if one or both of these output lines is the wrong voltage, use Table 12-2 to find the problem. For each faulty circuit condition, the most likely bad components are listed in descending order of probability. All listed components are located on the Secondary board.

Table 12-2
±12 V Secondary Regulator Faults

Circuit Fault	Component Fault	Suspect Components +12 V	Suspect Components -12 V
Output voltage is close to ground	1. Open secondary fuse	F3091	F3081
	2. Failed op amp	U1090	U1090
	3. Open pass transistor	Q3091	Q2101
Undervoltage on output	1. Failed op amp	U1090	U1090
	2. Failed pass transistor	Q3091	Q2101
Overvoltage on output	1. Shorted pass transistor	Q3091	Q2101
	2. Failed op amp	U1090	U1090
	3. Shorted drive transistor	Q1101	Q1103

If both secondary outputs produce approximately the same undervoltage, check the output of the reference voltage buffer (U1110B, pin 7).

1. If the buffer output at pin 7 is within 1% of 5 V, replace U1090.

2. If the buffer output is out of tolerance, check the buffer input (pin 5).

   a) If the input is within 1% of 5 V, U1110B or C1111 is probably faulty. A low output indicates C1111, and a high output indicates U1110B.

   b) If the input is out of tolerance, the voltage reference (primarily VR5072 and R6067 on the Regulator board) may need adjustment or repair. In this case, the 5 V output of the supply will also be incorrect.

BRING-UP PROCEDURE

The following bring-up procedure is intended to be used after you have completed the troubleshooting procedure for catastrophic failure. This procedure enables you to fully check out the power supply and restore it to working order.

PRECONDITIONS

Before you perform the bring-up procedure, make sure that you have completed the following steps:

- The fan housing on the rear panel of the 8560 and the power supply top shield have been removed.
- The Inverter board has been investigated for failures (according to procedures outlined under Catastrophic Failures), and has been repaired as needed.
- The rear panel power switch is OFF, and the input capacitors (the large cans below the Inverter board) have discharged to a safe voltage. Discharging occurs within five minutes after line power is removed.
- The 8560's line voltage selector switch is properly set.

After verifying that all preconditions are met, refer to Fig. 12-7 and prepare the test set-up. The following equipment is required:

Equipment	Recommended Type
Soldering iron/solder	800 F tip temperature/ 63% tin, 37% lead, rosin core
Needle-nose pliers	Sturdy, with plastic grips
Screwdriver	Phillips for #6 and #4 screws
Voltmeter/diode meter	Fluke Model 8030A or equivalent
Oscilloscope	TEKTRONIX 465 or equivalent
Isolation transformer	Must have at least 8 A output capability
Variable autotransformer	Variac* with at least 8 A output capability
External power supply	Must be able to supply +/-17 V at 400 mA

* Variac is a registered trademark of the GenRad Corporation

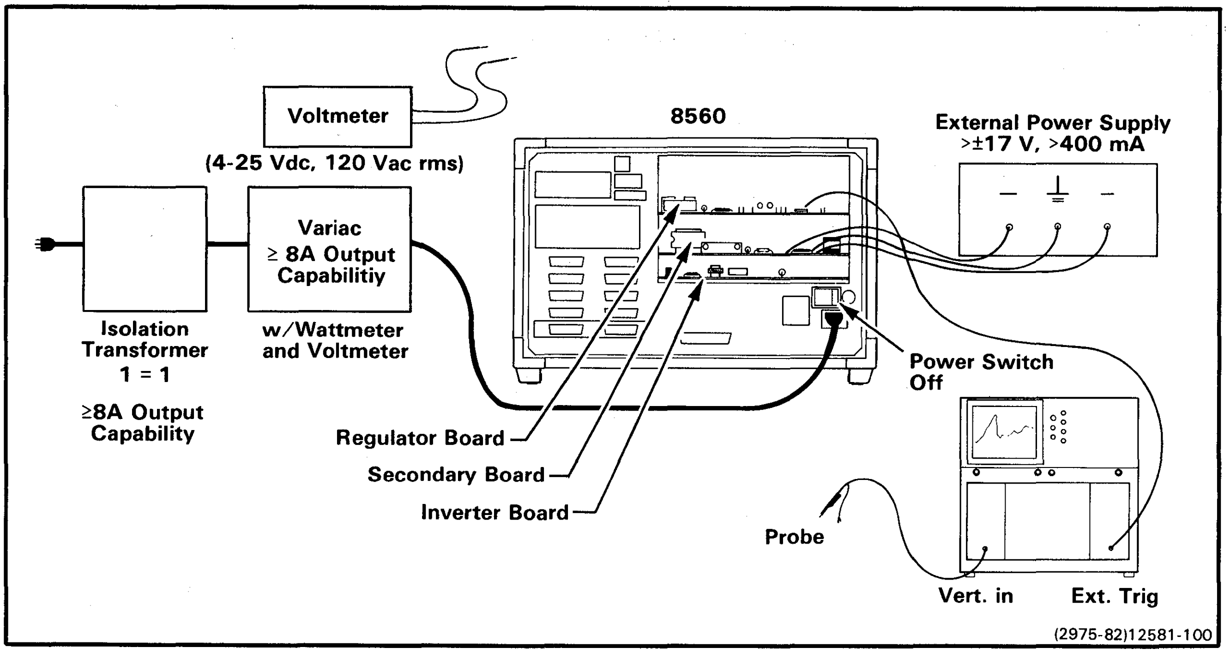


Fig. 12-7. Test equipment set-up.

After installing the test equipment, check that all instrument fuses are good.

PROCEDURE

This procedure contains enough detail to allow you to check out every primary supply characteristic except output ripple, input line frequency range, and overvoltage shutdown. It is therefore too detailed for some situations.

- If you are certain that only the main inverter failed, just follow steps 1--3, 5--14, 16, 19--22, 26 and 27.

- If you are certain that only the motor driver failed, just follow steps 1--3, 5, 8 (with no waveform), 12--18, 21 (with no waveform), 25--27.

WARNING

Use insulated tools and probes at all times and observe the supplementary cautions contained in the text. Stored charge in the large capacitors of the power supply can cause severe burns and/or electric shock even when the supply is turned off.

It is possible to operate the main inverter and motor driver separately.

- If motor driver operation is not desired, remove Q6062 on the Inverter board.

CAUTION

If you prevent main inverter operation, the line voltage produced by the Variac must be maintained at less than 110 Vrms; otherwise, circuitry may be damaged by abnormally high motor driver output voltages. When TP6046 and TP6076 are shorted together, the motor driver output is not regulated.

- If main inverter operation is not desired, connect a clip lead between the +15 V testpoint (TP6076) and the Shutdown testpoint (TP6046) on the Regulator board.

1. Remove the Inverter board from its slot and insert the Inverter extender board into the same slot. Then insert the Inverter board into the extender.

2. Make sure the external power supply is OFF. Connect leads from the external supply through a 3-pin harmonica connector to the three square pins on the Regulator board (J6075). The connections should be to +Voltage, Ground, and -Voltage, from left to right (viewed from the rear of the 8560). The supply should be set between +17 V and +40 V (nominally +20 V).

3. Make sure that the rear panel power switch and the Variac power switch are OFF. Turn ON the external power supply. Measure the voltage from the +15 V test point (TP6076) to ground (TP6025), and from the -15 V test point (TP6077) to ground on the Regulator board. If any measured voltages are not within 5% of a test point's assigned voltage, you must repair the standby regulators (U1060, Q1071) on the Secondary board before further testing. Make sure that the external supplies are not operating in a current-limited mode. The external supply current limits should be at least 400 mA each.

4. Measure the voltage from Vref (TP6066) to Ground Sense (TP6056). Adjust the trimmer on the Regulator board (R6067) until Vref is within 1% of +5.00 V.

5. Remove the undervoltage shutdown jumper (J6048) from the Regulator board. Also, remove Q6056 on the Inverter board.

6. Connect the external trigger input of the scope to the Trigger test point (TP6039) on the Regulator board. Set the scope's sweep rate to 10 μs/cm. Be sure that the external trigger is selected.

7. Connect the vertical input of the scope through a probe to the base of Q2025 on the Inverter board. Connect the ground clip of the probe to the emitter of the selected transistor. Set the vertical sensitivity to 2 V/cm.

8. Turn the 8560 DC power switch ON. The scope should display the waveform shown in Fig. 12-8, or a waveform shifted from this by 180 degrees. If the waveform is correct, proceed to step 10.

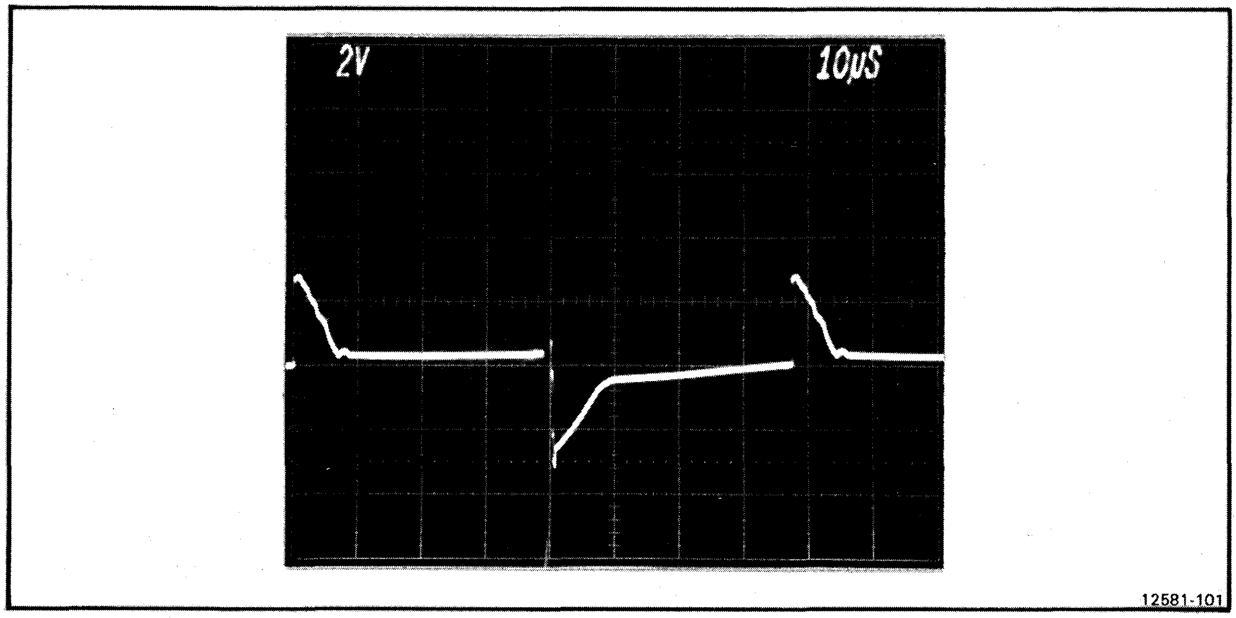


Fig. 12-8. Q2025/Q5025 base-emitter voltage waveform.

9. If the voltage does not drop from 0.7 V to -2 V, but remains near ground or 0.7 V until the negative pulse, one of the driver transistors (Q5047 or Q6049) is probably bad. If the negative pulse is less than about 3 V from base to peak, and the transition time of the falling edge of the positive pulse is less than 1 μs, the other driver transistor is probably bad.

   To check these transistors, change the scope's vertical sensitivity to 1 V/cm, and connect the probe to each of the drain tabs in turn, while connecting the ground clip to TP6069. The scope should display the waveform shown in Fig. 12-9, or a waveform shifted from this by 180 degrees. If the large positive pulse has a flat top or is severely attenuated, the transistor is defective. Replace any bad transistors with good ones. If, after you have checked these transistors, the circuit still does not seem to be working properly, proceed to step 11.

Fig. 12-9. Q5047/Q6049 drain voltage waveform.

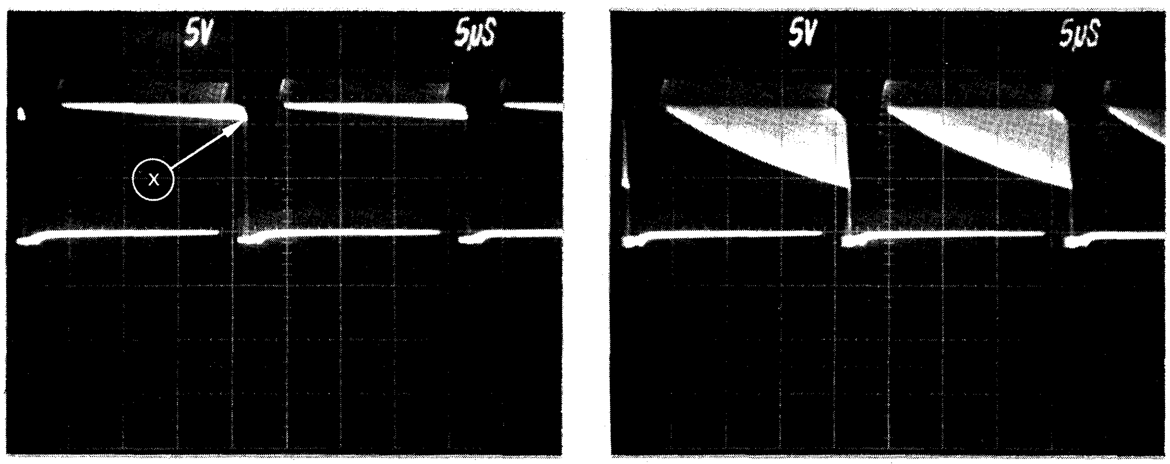
10. Check the base-emitter voltage waveform on Q5025. The waveform should have the same shape as that of Q2025, but shifted 180 degrees in phase. If the waveform does not meet this description, check for failures, as in step 9.

11. If the supply is being brought up after a catastrophic main inverter failure, check the waveforms at the gates of Q5047, Q6049, and Q6054. The waveforms at Q5047 and Q6049 should be square waves with a period between 50 and 70 μs, a high level at +15 V, and a low level at ground. These two waveforms should also be 180 degrees out of phase. The waveform at Q6054 should be a 1 μs negative-going pulse from +15 V to ground every 25 to 35 μs. If any voltage is more than a few volts away from the proper level, the transistor you are checking is probably defective, even if its drain voltage is correct. However, if the transistor under investigation checks out good, U2030 on the Regulator board is bad. One further note: if no voltage is observed on the bases of Q2025 and Q5025, and the gate waveform of Q6054 is approximately correct, Q6054 is bad.

    If you skipped step 10, go back and do it now. Then proceed to step 12.

12. Set the scope's vertical sensitivity to 5 V/cm and its sweep rate to 5 μs/cm. Move the trigger input to the Sawtooth testpoint (TP6028) on the Regulator board, and set the triggering for negative slope. Make sure that external trigger is selected. Check the gate-source voltage on Q4075 by connecting the vertical input probe to the cathode of VR4074, and the probe's ground clip to the anode of CR4085. The scope should display the waveform shown in Fig. 12-10a. If the waveform more closely resembles Fig. 12-10b, either the transistor or the zener diode

is too leaky and should be replaced. The voltage at point X in Fig. 12-10a should not drop lower than 9 V.



(a) good

(b) leaky

Fig. 12-10. Q4075 gate voltage waveforms.

Next, check the gate-source voltage of Q2069 by connecting the probe to the cathode of VR2065. Check Q4069 by connecting the probe to the cathode of VR4065. Finally, check Q2076 by connecting the probe to the cathode of VR2074. All of these waveforms should appear similar to Fig. 12-10a and not Fig. 12-10b.

The high voltage should stay near 10 V ana the low voltage should stay at ground. Replace any transistors or 12 V zener diodes that appear to be leaky during testing. Note that the transistor is most likely to be at fault.

13. Reinsert Q6056 in its socket on the Inverter board.

14. Make sure there is at least a minimum load on the 5 V supply in the 8560. (A minimum load consists of the flexible disc drive, plus the the standard circuit board configuration in the 8560 card cage.) However, do not bring up the supply with maximum load on the 5 V output. Disconnect power to the hard disc drive.

15. Connect the vertical input probe to R4059 (100 K), at the end that is nearest Q4058. Connect the ground clip to the anode of CR4042. Set the sweep rate to 5 ms/cm and set the trigger source to line.

16. Turn the Variac output voltage control to zero. Turn ON both the Variac, and the 8560 rear panel power switch.

WARNING

Use extreme caution when servicing circuitry on the Inverter board. Dangerous voltages exist on the Inverter board when the 8560 is connected to line voltage.

17. Slowly increase the Variac voltage until 12 V pulses can be seen occurring about once every second. The rise time of the pulses should be about 2 ms, and the fall time should be so short that the trace during fall is essentially invisible. If the pulses exhibit a slow fall time, or if they fail to appear at all, there is either a fault in the circuit that drives the gate of Q4058, or the gate of Q4058 is too leaky.

18. There are two vertical inputs that can be subtracted from each other on your oscilloscope (assuming that you are using a TEKTRONIX 465 or equivalent). Leave the probe that is already connected to the scope, and connect another probe to the second vertical input. Set the sensitivity of both vertical inputs to 50 V/cm. Connect the probes to either side of C2049 and connect their ground clips together. Set up the scope so that the second input is subtracted from the first. Continue to turn up the Variac voltage until a continuously visible waveform appears on the screen, or until the voltage is 90 Vrms, whichever occurs first. The waveform should be a fairly undistorted 60 Hz sine wave. If the supply does not turn on continuously, turn back to "The Supply Won't Turn On" for troubleshooting information (ignore step 2 of that procedure).

19. Remove both probes and set up the scope to observe a single vertical input again. Connect that input's probe to the emitter of Q5025 and the ground clip to the end of C3028 closest to the rear of the instrument. (C3028 is the large, white plastic film capacitor parallel to the long side of the finned heatsink.) Reconnect the trigger input to the Trigger testpoint, as in step 6. Reset the sweep rate to 10 μs/cm. The scope should display the waveform shown in Fig. 12-11a. If the waveform seems to be unstable, slowly increase the Variac voltage while watching its wattmeter. The waveform should stabilize, eventually increasing in frequency. The wattmeter should not read much over 140 W, if there is a minimum load in the instrument (see step 14). If anything indicates failure, turn the Variac down immediately. The supply may shut off at some line voltage below 90 Vrms, but if nothing else suspicious occurs, keep turning the Variac up until its output is 90 V. If the supply is operating correctly, when the Variac output is 90 V, the scope will display the waveform shown in Fig. 12-11b.

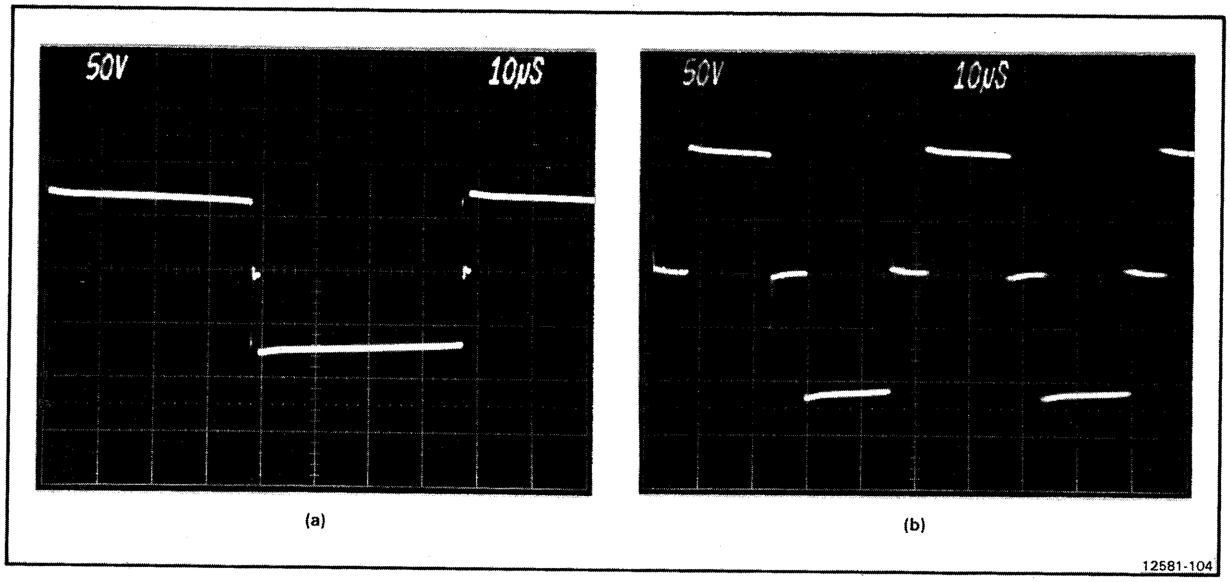


Fig. 12-11. T1011 primary winding waveforms.

If the waveform doesn't stabilize or rise in frequency, there is probably a fault in the main inverter control circuitry on the Regulator board (U3030, U5030D, U5060B, U6010, U2040, U2030, and U3040B). If the wattmeter indicates excessive power consumption, there is probably a shorted diode on the secondary side of power transformer T1011 (see the Secondary board schematics). If the supply won't come on when the Variac output is 90 V, turn to "The Supply Won't Turn On" (ignore step 2 of that procedure).

20. Connect the negative lead of your voltmeter to Ground Sense (TP6065), and the positive lead to each of the testpoints listed in Table 12-3.

Table 12-3
Regulator Board Testpoints

Testpoint Name	Testpoint Number	Expected Voltage
+5 V Sense	TP6061	+4.9 V to +5.2 V
+24 V	TP6011	+22.8 V to +25.2 V
+12 V Sense	TP6043	+11.64 V to +12.36 V
-12 V	TP6015	-11.4 V to -12.6 V

If the +24 V output is incorrect, see "Troubleshooting the +24 V Secondary Regulator" in the Troubleshooting Guide, earlier in this section. If either the +12 V or the -12 V output is incorrect, see "Troubleshooting the +12 V and -12 V Secondary Regulators", also in the Troubleshooting Guide.

21. Replace the Undervoltage Shutdown jumper (J6048) on the Regulator board. Place the voltmeter leads on the +5 V Sense testpoint (TP6061) and Ground Sense testpoint (TP6056). Vary the Variac voltage between 132 Vrms and 90 Vrms. The waveform on the scope should remain stable, and neither the positive or negative peak should go over 200 V. The voltmeter reading should remain within 1% of 5.00 V.

22. If the supply is being brought up after a catastrophic failure in the main inverter, and the supply fails to stay on over an input voltage range of 90--132 Vrms, the +24 V secondary regulator may be regulating improperly. To check the +24 V secondary regulator, set the scope's vertical sensitivity to 50 mV/cm and change the coupling to AC. With the supply running, observe the waveform at pin 3 of U2010 on the Regulator board. If this waveform does not match the waveform in Fig. 12-12 (especially if the sawtooth is smaller or nonexistent), U5030 on the Regulator board is probably faulty and should be replaced.

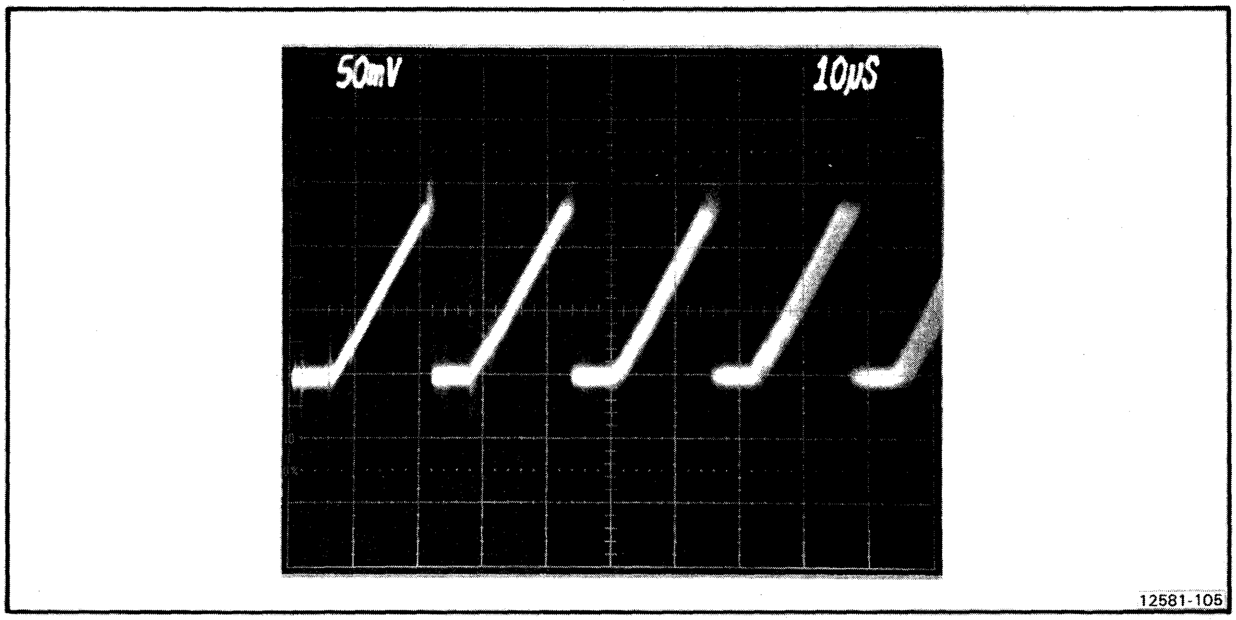


Fig. 12-12. +24 V regulator reference waveform.

23. Turn OFF the external power supply. The 8560 supply should stay on without change. Turn the Variac voltage below 90 Vrms until the supply shuts off. It should shut off at approximately 80--85 Vrms. Turn the Variac voltage back up until the supply turns back on. This should occur below 90 Vrms, and the supply should turn on cleanly, with only one chirp and no sputtering.

24. Check the overcurrent shutdown circuitry (U6040 on the Regulator board, U3110 and U1110A on the Secondary board). Connect a 5-ohm resistor from the -12 V test point (TP6015) to ground (TP6025). The supply should shut down immediately and chirp faintly every second or so until the resistor is removed. If the supply does not shut down, don't do any

further overcurrent shutdown testing until the problem in the -12 V shutdown circuitry is repaired.

If the supply does shut down, connect the 5-ohm resistor from +12 V sense (TP6043) to ground. Then, connect a 3-ohm resistor from +24 V (TP6011) to ground. In both cases, the supply should shut down and chirp until the resistor is removed. Finally, connect a 0.1 ohm resistor from the +5 V power bus to ground near the edge connector on the Regulator board. The supply should again shut down and chirp until the resistor is removed.

25. The fan and flexible disc drive motors should be running. Connect a voltmeter with insulated probes across C2049 on the Inverter board. The voltage should stay within +10%/-5% of 115 Vrms (109--126.5 V), as the Variac output voltage is varied between 90 and 132 V. Obtain a well-insulated clip lead and momentarily short out C2049 with it. The supply should shut down and restart about a second later.

WARNING

Use insulated tools and probes at all times and observe the supplementary cautions contained in the text. Stored charge in the large capacitors of the power supply can cause severe burns and/or electric shock even when the supply is turned off.

26. Turn OFF the 8560 from the rear panel. Unplug the 8560 and wait five minutes for the input capacitors to discharge to a safe voltage. Then remove all probes from the supply boards.

27. Remove the Inverter board and its extender, then insert the Inverter board into its edge connector. Be certain that the Secondary and Regulator boards are in the correct slots. Replace the top shield over the supply with its four screws. Make sure the grommet on the fan cable is fitted into the rear edge of the Inverter board, then replace the fan housing with its eight screws. Reconnect the hard disc power connector and replace any circuit boards removed during this bring-up procedure. Replace any outside covers and feet that were removed from the instrument. The supply should now be in satisfactory working order.

Section 13

FUNCTIONAL CHECK PROCEDURES

ILLUSTRATIONS

TABLES

Section 13

FUNCTIONAL CHECK PROCEDURES

GENERAL INFORMATION

INTRODUCTION

This section describes the self-testing diagnostics that are executed within the 8560 Multi-User Software Development Unit (MUSDU) every time you power-up the system or toggle the front panel RESTART switch. The diagnostics consist of seven power-up tests and three service routines.

The power-up tests check the RAM, ROM, CPU, Line-Time Clock (LTC), line printer ports, I/O Processor (IOP) board(s), and PMS Controller board. The service routines aid in alignment of the flexible disc drive heads, and exercise the low and high 64K Memory boards for examination by oscilloscope.

NOTE

Throughout this section, all addresses are shown in octal notation unless otherwise noted.

This section is organized into five parts:

- An introduction to the 8560 ROM-based diagnostics and some general background information. This part of the section includes the power-up test summary.
- Detailed descriptions of the power-up tests. This part also describes the five LEDs on the Utility board that display error codes.
- A description of the Debugging Mode, including service routines.
- A description of the Octal Debugging Technique (ODT), and a summary of ODT commands.
- A summary of error codes.

THE FIRMWARE

The 8560 power-up diagnostics and service routines, and the debugging monitor are contained in two 2K x 8-bit ROMs. The ROMs are located in the system address space as shown in Fig. 13-1.

The ROM firmware is organized as four selectable banks. Each bank consists of 512 16-bit words:

- Bank 0 tests processor-related functions:

  RAM
  ROM
  CPU

- Bank 1 contains the debugging monitor I/O routines and the service routines:

  flexible disc head alignment
  low 64K Memory board exerciser
  high 64K Memory board exerciser

- Bank 2 contains the debugging monitor;

- Bank 3 tests the I/O functions

  LTC
  line printer ports
  IOP board(s)
  PMS Controller

  and contains the bootstrap routine.

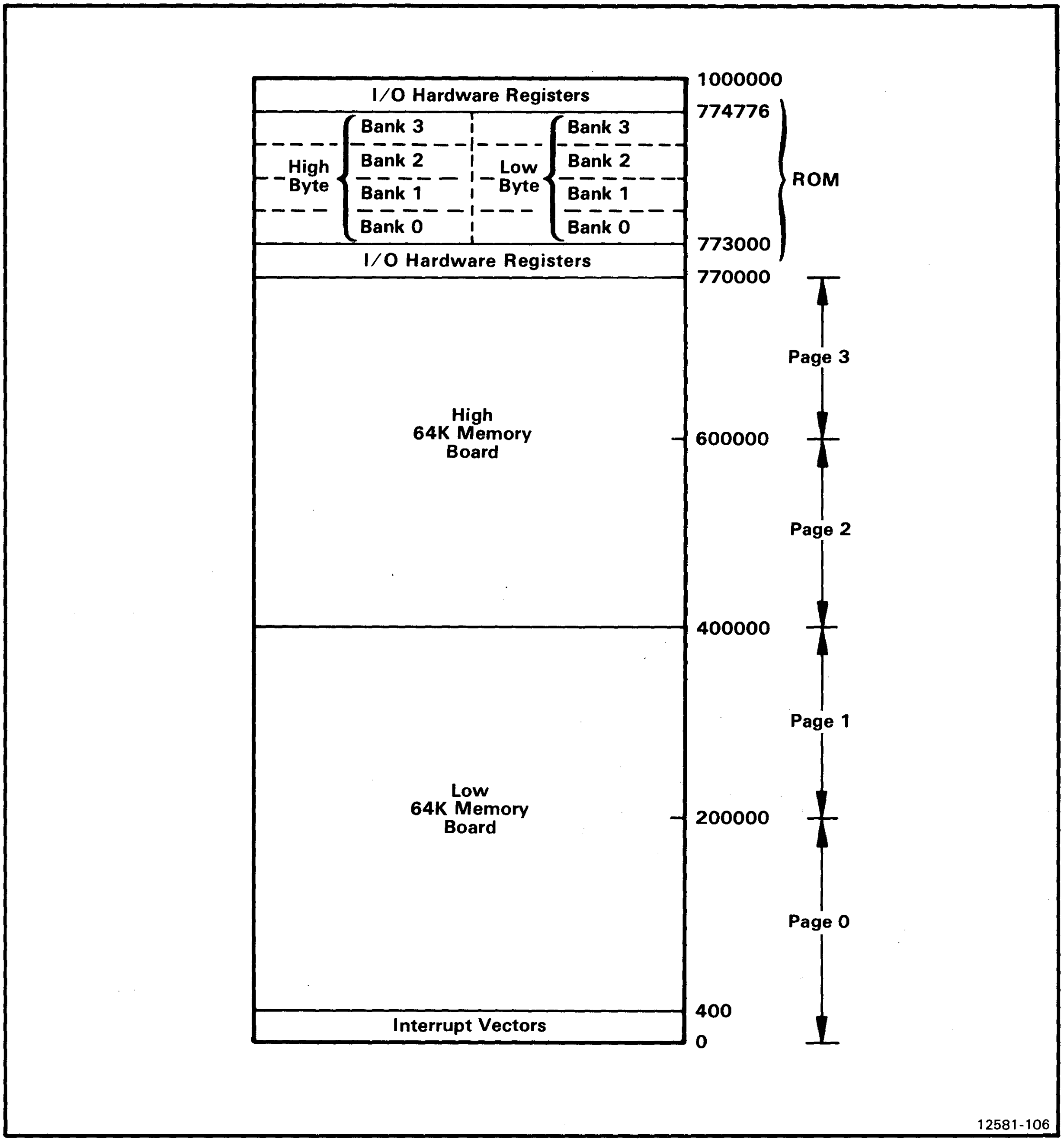


Fig. 13-1. 8560 system memory map.

HARDWARE RESTRICTIONS

In order for the power-up tests to execute properly, certain parts of the 8560 must be functioning correctly. The diagnostic firmware assumes that the LSI-11/23 processor and support circuits (power supplies, clock, and RESET circuits) are operational.

UTILITY BOARD LEDS

The Utility board contains five LEDs that represent an octal code. You can view the five LEDs when the 8560 top cover is removed. (For more information on removing the top cover, refer to the 8560 MUSDU Installation Guide.) The LEDs are mounted along the Utility board's top edge, with the least significant bit closest to the rear panel. Figure 13-2 illustrates the Utility board LEDs.

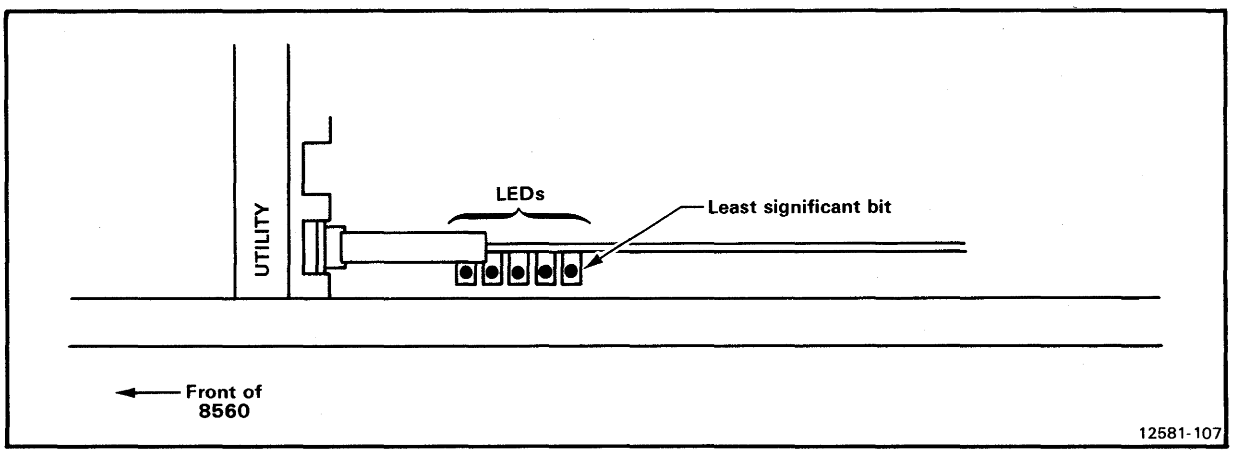


Fig. 13-2. The Utility board LEDs.

During the power-up sequence, each test-function sets the individual LEDs on or off, corresponding to the octal number representing that function. This allows you to identify the last executed test or function before the sequence was halted.

The LED error codes for the functional checks are listed in Table 13-1.

Table 13-1
LED Error Codes

LEDs(a)	Octal Value	Definition
*****	37	Unable to execute firmware
-----	00	LTC error
----*	01	Initialization error
---*-	02	Printer Port 2 error
---**	03	LSI-11/23 MMU error
--*--	04	Printer Port 1 error
--*-*	05	ROM error (low byte)
--**-	06	PMS Controller error
--***	07	ROM error (high byte)
-*---	10	Page 0 RAM error
-*--*	11	Page 0 RAM error
-*-*-	12	Page 1 RAM error
-*-**	13	Page 1 RAM error
-**--	14	Page 2 RAM error
-**-*	15	Page 2 RAM error
-***-	16	Page 3 RAM error
-****	17	Page 3 RAM error
*----	20	Page 0 RAM parity fault
---	21	Page 0 RAM parity fault
---	22	Page 1 RAM parity fault
*--**	23	Page 1 RAM parity fault
---	24	Page 2 RAM parity fault
--*	25	Page 2 RAM parity fault
*-**-	26	Page 3 RAM parity fault
*-***	27	Page 3 RAM parity fault
**---	30	IOP error
**--*	31	LSI-11/23 CPU error
**-*-	32	Trying to boot from a disc
-	33	Not used
***--	34	Debugging Mode
***-*	35	Debugging Mode
****-	36	Executing secondary boot from disc
*****	37	TNIX running

(a) The dash represents an unlit LED. The asterisk represents a lit LED.

These codes are described in detail in the error summary at the end of this section.

POWER-UP TESTS

The seven power-up tests execute automatically every time you power up the system, or toggle the front panel RESTART switch. You can also start the power-up sequence at any test by entering the appropriate Debugging Mode "t" command from a terminal. The "t" commands are described in the Debugging Mode discussion later in this section.

OPERATION

The power-up tests execute sequentially, under control of the LSI-11/23 processor. The power-up sequence executes in about 15 seconds for a system restart or 40 seconds for a power-up, and gives reasonable assurance that the system is operational. Once all power-up tests have passed, the system boots automatically.

If any power-up test fails, the LED readout identifies the test. If a terminal is installed, the diagnostics give control to the Debugging Monitor. To troubleshoot the problem, you can loop on the failed test and display the affected registers. In addition, a set of disc-based diagnostic programs (described in Section 16 of this manual) lets you further investigate the failure.

Table 13-2 summarizes the power-up tests, and lists the corresponding restart (t) commands for each test.

Table 13-2
Power-Up Tests

Name	Command	Description
Initialization and RAM Test	0t	This test initializes critical interrupt vectors, sets up the LSI-11/23's Memory Management Unit (MMU), and checks the system memory by writing various patterns to all RAM locations and then reading them back.
ROM Test	1t	This test performs a checksum test on the diagnostic ROMs located on the Utility board.
CPU Test	2t	This test verifies that the LSI-11/23 processor is functioning correctly.
LTC Test	3t	This test uses instruction timing to verify that LTC interrupts occur at either a 50 Hz or 60 Hz rate.
Printer Ports Test	4t	This test verifies that the line printer ports on the Utility board can be written to and read from.
IOP Test	5t	This test verifies that at least one IOP board is installed in the 8560 and is working properly. If two boards are installed, both are verified.
PMS Controller Test	6t	This test verifies that the PMS Controller is working properly and able to access its discs.

POWER-UP TEST DESCRIPTIONS

Introduction

The 8560 executes the seven power-up tests in the sequence shown in Table 13-2. Once the sequence is started, it continues until either completed or halted by an error. Figure 13-3 is a flowchart of the power-up diagnostics sequence.

Figure 13-4 is a block diagram of the 8560, for reference as you read the power-up test descriptions. The power-up diagnostics execute as follows:

1. The LSI-11/23 initializes the system and attempts to read from RAM location 4. If this is not possible, the PROCESSOR BUSY light dims noticeably.

2. The LSI-11/23 starts the power-up sequence at ROM location 773000. The seven power-up tests are then executed in sequence. Each test sets the LEDs to an error code during the course of the test. If a test does not pass, the LEDs remain set, identifying the failed test. If a line printer is connected to LP1 or LP2, or a terminal is connected to LP2, the diagnostics write an error message. If no line printer (or terminal connected to LP2) is installed when the test fails, the test halts the system.

3. If all tests in the power-up sequence pass, the 8560 bootstrap routine tries to boot from the flexible disc. If the routine cannot boot from the flexible disc, the routine then tries to boot from the hard disc. In the event that no bootable disc is found, the routine restarts the 8560, and the power-up sequence repeats. This cycle continues until either a bootable disc is found or the 8560 is turned off.

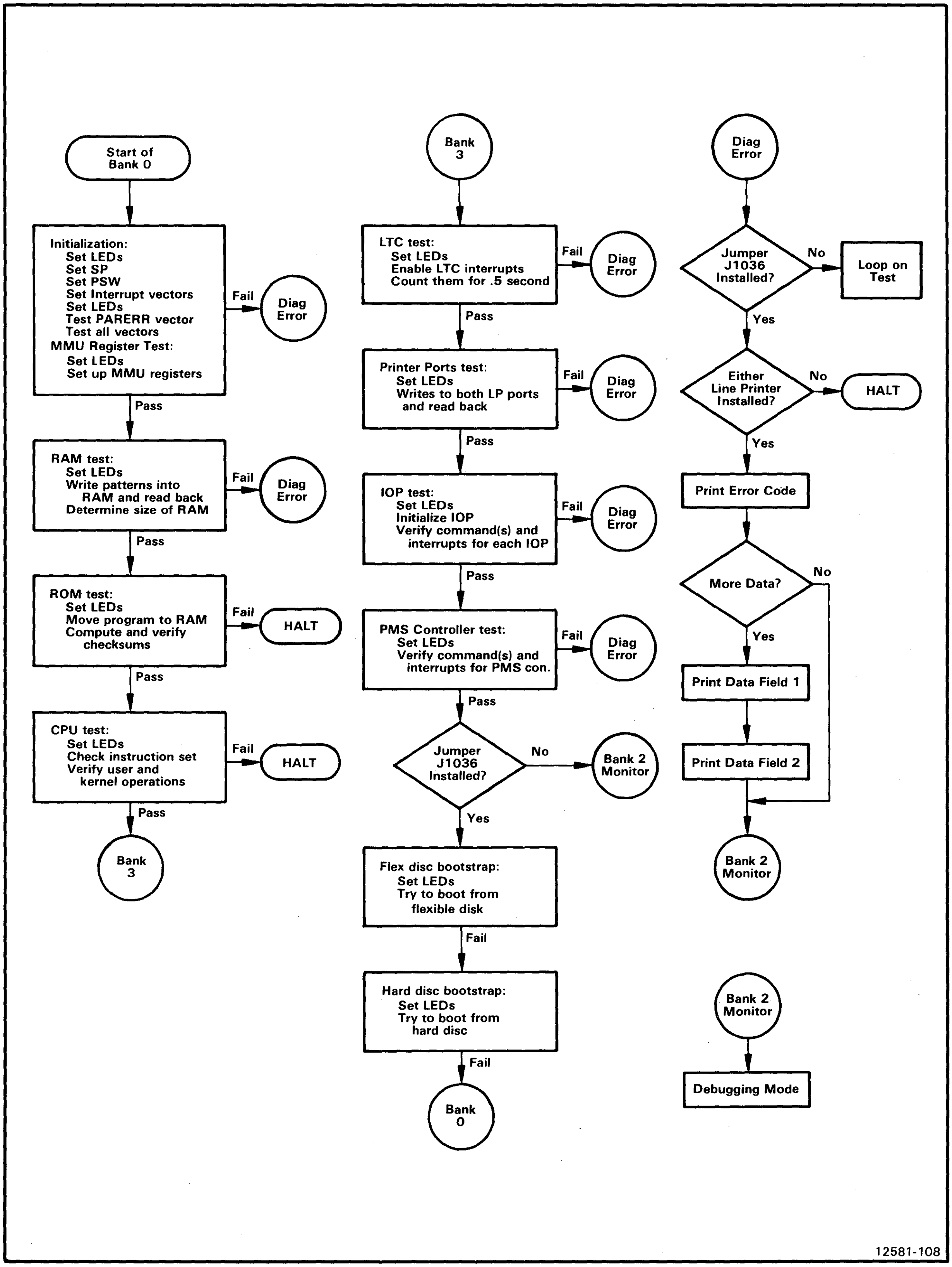


Fig. 13-3. Power-up sequence flowchart.

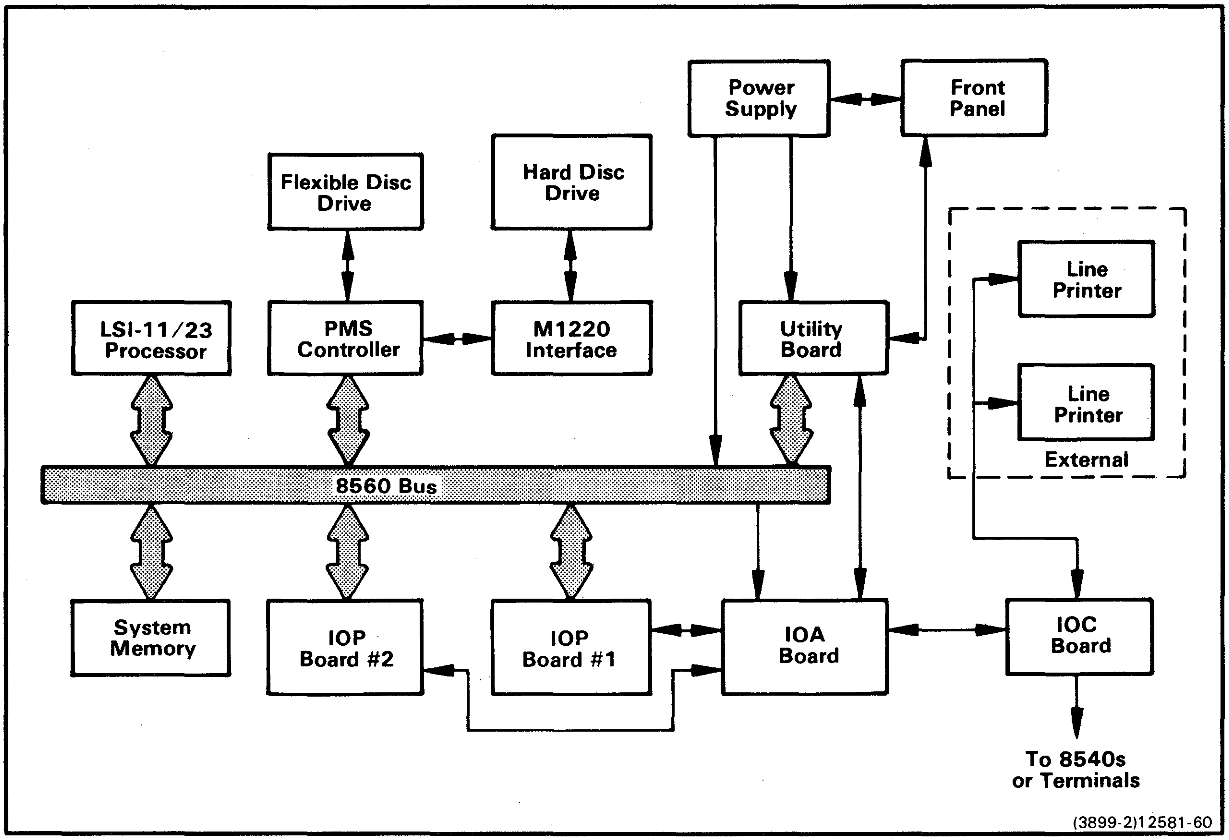


Fig. 13-4. 8560 block diagram.

Initialization and RAM Test

Command: 0t

Function: To check the addressing and data storage capability of the system memory.

Blocks Involved: LSI-11/23 Processor, Utility Board, System Memory (see Fig. 13-4).

Error Codes: LED Errors 01, 03, 10--27

Description

The initialization routine is started every time you power the system or toggle the front panel RESTART switch. This routine initializes critical interrupt vectors and sets up the LSI-11/23's Memory Management Unit (MMU) by doing the following:

1. Set the LEDs to 01 to show that the firmware is initializing.

2. Initialize the stack pointer.
3. Initialize the Processor Status Word (PSW).
4. Set all interrupt vectors (0--374) to halt at the location following the vector. (For example, a trap to 0 halts at 2.)
5. Set the LEDs to 11.
6. Check the parity error locations (114 and 116) for the correct data. Since this is the first time that RAM is read, the program halts at 116 if there is a RAM problem.
7. Write the address of the parity error handler into the parity error vector, and verify that the address was written.
8. Check all of the interrupt vectors for the correct contents, and write the address of the appropriate error handler into each vector location.
9. Set the LEDs to 03. Make sure that the MMU is disabled, and then set up each MMU register.
10. Enable the MMU.
11. Initialize the RAM test.

The RAM test verifies system memory by writing patterns into each byte of memory, and then reading each location to see if the expected data is there. To be more precise, the test starts at the beginning of free memory (location 400) and writes a counter into each location within a 128-word block. The test does a parity check on that block of memory and then complements the contents of the block. After another parity check, the test moves on to the next block of memory and repeats the process.

When the RAM test reaches the top of memory, a bus error occurs. The bus error handler then determines the size of system memory. After that, the test starts at the top of memory and reads each location to check for the expected data. If the data is correct, the location is cleared.

The RAM test can detect two types of errors: parity errors and "wrong data" errors. If a parity error occurs, the parity interrupt handler sets the "parity error" LED code and finds the address of the error. If a "wrong data" error occurs, the test branches to an error handler that determines the address of the error.

This test takes approximately 4 seconds per memory board to execute. If the test passes, the next test is automatically initialized.

ROM Test

Command: 1t

Function: To perform a checksum test on the two Utility board ROM devices.

Blocks Involved: LSI-11/23 Processor, Utility Board, System Memory (see Fig. 13-4).

Error Code: LED errors 05 and 07

Description

The ROM test performs a checksum test on the two ROM devices located on the Utility board. The 8560 contains two 2K-byte ROMs, one for the low byte and one for the high byte. This test takes only a few milliseconds to execute.

Figure 13-5 shows how the program is organized within the two ROMs. As shown, bank 0 and bank 3 of each ROM contain the power-up tests.

This test sets the LEDs to 05, and then moves all of the firmware banks from ROM into system memory. After the contents of ROM have been transferred, the ROM test performs a checksum test on the low-byte ROM. Next, the ROM test sets the LEDs to 07 and performs a checksum test on the high-byte ROM. If a ROM error occurs, the program halts with the LEDs set.

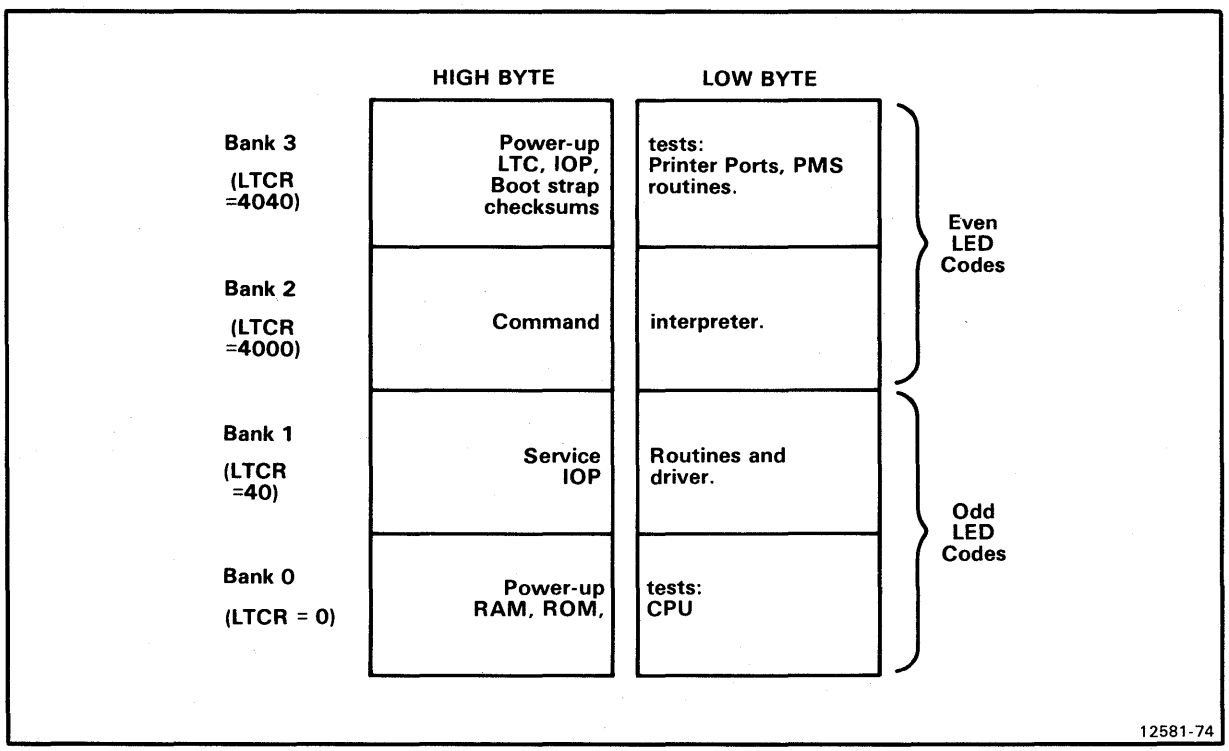


Fig. 13-5. Firmware memory map.

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CPU Test

Command: 2t

Function: To execute a representative LSI-11/23 instruction set, which indicates whether the CPU is operational.

Blocks Involved: LSI-11/23 Processor, Utility board, System Memory (see Fig. 13-4).

Error Codes: LED Error 31

Description

The CPU test checks a representative sample of LSI-11/23 instructions to determine whether the CPU is operating properly. This test takes only a few milliseconds to execute.

The test first sets the LEDs to 31, then fetches and executes instructions from ROM. The test executes the simpler instructions first and then proceeds to more complex instructions. The CPU test performs the following steps:

1. Checks a representative set of single-operand instructions with destination mode 0.

2. Checks a representative set of single-operand instructions with destination mode 0, using byte mode.

3. Checks a representative set of double-operand word instructions, using most source modes and using destination mode 0.

4. Checks a representative set of double-operand byte instructions, using various source modes and using destination mode 0.

5. Checks a representative set of word instructions, using various source modes and most destination modes.

6. Checks a representative set of byte instructions, using various source modes and various destination modes.

7. Checks the JSR, RTS, and MARK instructions, using various modes.

8. Checks the MUL, DIV, and ASHC instructions, by solving an equation and checking the result.

9. Checks that instructions operating in user and kernel mode work properly when the MMU is activated.

The CPU test checks the results of the executed instructions, and halts the LSI-11/23 if any result is not correct.

Line-Time Clock Test

Command: 3t

Function: To verify that the Line-Time Clock interrupts the LSI-11/23 at the correct rate.

Blocks Involved: LSI-11/23 Processor, Utility Board, System Memory (see Fig. 13-4).

Error Codes: LED Error 00

Description

The LTC test checks that the Line-Time Clock interrupts occur at the proper intervals. This test takes 0.5 second to execute.

The LTC test starts by setting the LEDs to 00, setting up the LTC vector, and enabling the LTC interrupts. The test then detects the first interrupt, and waits in a loop for 0.5 seconds while the LTC handler counts the number of interrupts that occur. The program then disables interrupts and checks the interrupt counter. If the frequency of the LTC is between 46 and 54 Hz, the frequency is stored as 50 Hz. If the frequency of the LTC is between 56 and 64 Hz, the frequency is stored as 60 Hz. All other frequencies are considered invalid and are reported without rounding. If an invalid frequency is reported, the test fails.

Printer Ports Test

Command: 4t

Function: To verify that the line printer ports on the Utility board can be written to and read from.

Blocks Involved: LSI-11/23 Processor, Utility board, System Memory (see Fig. 13-4).

Error Codes: LED Errors 02 and 04

Description

This test sets the LEDs to 02, then writes to the LP2 Control/Status Register, reads the register, and verifies that the same data is written and read. Next, the test sets the LEDs to 04 and repeats the same procedure for the LP1 Control/Status Register. If either register doesn't respond correctly, or if a bus error occurs when either register is accessed, the program will report the error. This test takes only a few milliseconds to execute. The main purpose of the Printer Ports test is to verify that the address jumpers on the Utility board are properly set.

I/O Processor Test

Command: 5t

Function: To verify that at least one IOP board is installed in the 8560 and is operating correctly. If two IOP boards are installed, both boards are verified.

Blocks Involved: LSI-11/23 Processor, IOP board, Utility board, System Memory (see Fig. 13-4).

Error Codes: LED Error 30

Description

This test sets the LEDs to 30, sends a command to the IOP board(s), and then verifies the interrupt and status indication sent back. If Device Register 1 on an IOP board does not respond correctly, or if a bus error occurs during a register access, the test will also report the error. Next, the test initializes the IOP board(s) as necessary for use by the operating system. This test takes only a few milliseconds to execute under normal conditions. However, if the IOP board is malfunctioning, this test could take 2 or 3 seconds to execute.

PMS Controller Test

Command: 6t

Function: To verify that the PMS Controller is operating properly and is able to access its disc drives.

Blocks Involved: LSI-11/23 Processor, PMS Controller board, Utility board, System Memory, M1220 Interface, Hard Disc Drive, Flexible Disc Drive (see Fig. 13-4).

Error Codes: LED Error 06

Description

This test sets the LEDs to 06, sends a self-test command to the PMS Controller, and then verifies the interrupt and status indication sent back. The test also reports an error if the Control Register on the PMS Controller does not respond correctly, or if a bus error occurs. This test normally takes about 5 seconds to execute, but can take up to 40 seconds if there is a malfunction. A flexible disc does not need to be inserted for the test to pass.

Further testing of the PMS Controller is performed by the boot routine, which issues a read command for the flexible disc and/or the hard disc. During an automatic boot, such errors as "drive not ready" and "no boot record on disc" don't cause the diagnostics to report an error. However, these errors are reported during a manual boot attempt.

Bootstrap Routine

Once all of the power-up tests have passed, the bootstrap routine is automatically started. In the normal power-up sequence, the firmware first attempts to boot from the flexible disc. If no flexible disc is present, or if the disc doesn't have a correct boot record, the firmware tries to boot from the hard disc. If a bootable hard disc cannot be found, the firmware repeats the power-up sequence.

THE DEBUGGING MODE

INTRODUCTION

The Debugging Mode is a firmware program that aids in troubleshooting minor system failures prior to system boot-up. The Debugging Mode requires that a terminal be connected to either LP2 or one of the IOP terminal ports (either directly or via an 8540). The Debugging Mode lets you:

- write or read any location in the 8560;
- restart the power-up routine at any test;
- boot the system manually rather than automatically;
- type in a program and execute it;
- execute any service routine.

ENTERING THE DEBUGGING MODE

You can enter the Debugging Mode under the following conditions:

- If all power-up tests pass and the maintenance jumper (J1036 on the Utility board) is not installed, the firmware automatically selects the Debugging Mode.
- If any test fails (other than ROM or CPU) and the maintenance jumper is installed, the firmware automatically selects the Debugging Mode. (Provided a terminal is installed to LP2, or line printer is installed to LP1 or LP2, allowing the error code to be printed).
- You can also enter the Debugging Mode manually by the following method:

    1. Set the RUN/HALT switch to HALT.

2. Toggle the RESTART switch.

3. Set the RUN/HALT switch to RUN.

4. Enter the following underlined characters on a terminal connected to LP2:

```
777546/ xxxxxx 4000 <CR>
P
```

Baud Rate Selection

The Debugging Mode normally communicates with your terminal at 2400 baud, but this baud rate can be changed if necessary. The following text explains what you must do to use a terminal set for a baud rate other than 2400.

If you are using the Debugging Mode from a terminal connected to LP2 or to an 8540: the Debugging Mode baud rate is determined by hardware settings (see the 8560 MUSDU Installation Guide or the 8540 Installation Guide, respectively).

If you are using a terminal connected directly to an IOP channel, the Debugging Mode baud rate will be 2400 by default. However, you can change the baud rate of any IOP channel to which your terminal is connected. First, set the baud rate of your terminal to the desired setting. Then, press the BREAK key one or more times until the "=" prompt appears on the screen. You have now programmed the channel's baud rate to match the baud rate of your terminal.

DEBUGGING MODE COMMANDS

The Debugging Mode follows a predetermined operating sequence, unless interrupted by a valid Debugging Mode command. Valid commands are listed in Table 13-3. Figure 13-6 shows the Debugging Mode program flow.

Table 13-3
Debugging Mode Commands

Command	Function
xt	Starts a power-up test or service routine specified by x (a).
f	Causes the 8560 to boot from the flexible disc.
h	Causes the 8560 to boot from the hard disc.
x/	Print contents of a location x.
RETURN	Close an open location and accept next command.
LINEFEED	Close current location and opens the next sequential location.
xg	Go to location x and start program execution.

(a) In this table, "x" is an octal number of up to six digits.

Commands may be entered in either upper or lower case. If you enter an illegal command, the firmware will print a help message.

The Debugging Mode commands are similar to the Octal Debugging Technique (ODT) commands discussed later in this section. Debugging Mode commands can be used in most situations where ODT commands are used. Differences between the two types of commands include:

- The Debugging Mode Go command accepts a 16-bit address only, and no memory mapping is allowed (as in ODT).
- In Debugging Mode, LSI-11/23 internal registers cannot be written to or read from (as in ODT).
- In Debugging Mode, the terminal does not need to be connected to LP2 (as required by ODT); the terminal can also be connected to any IOP port, or the terminal port of a connected 8540.
- The ODT Proceed command is not used in the Debugging Mode.

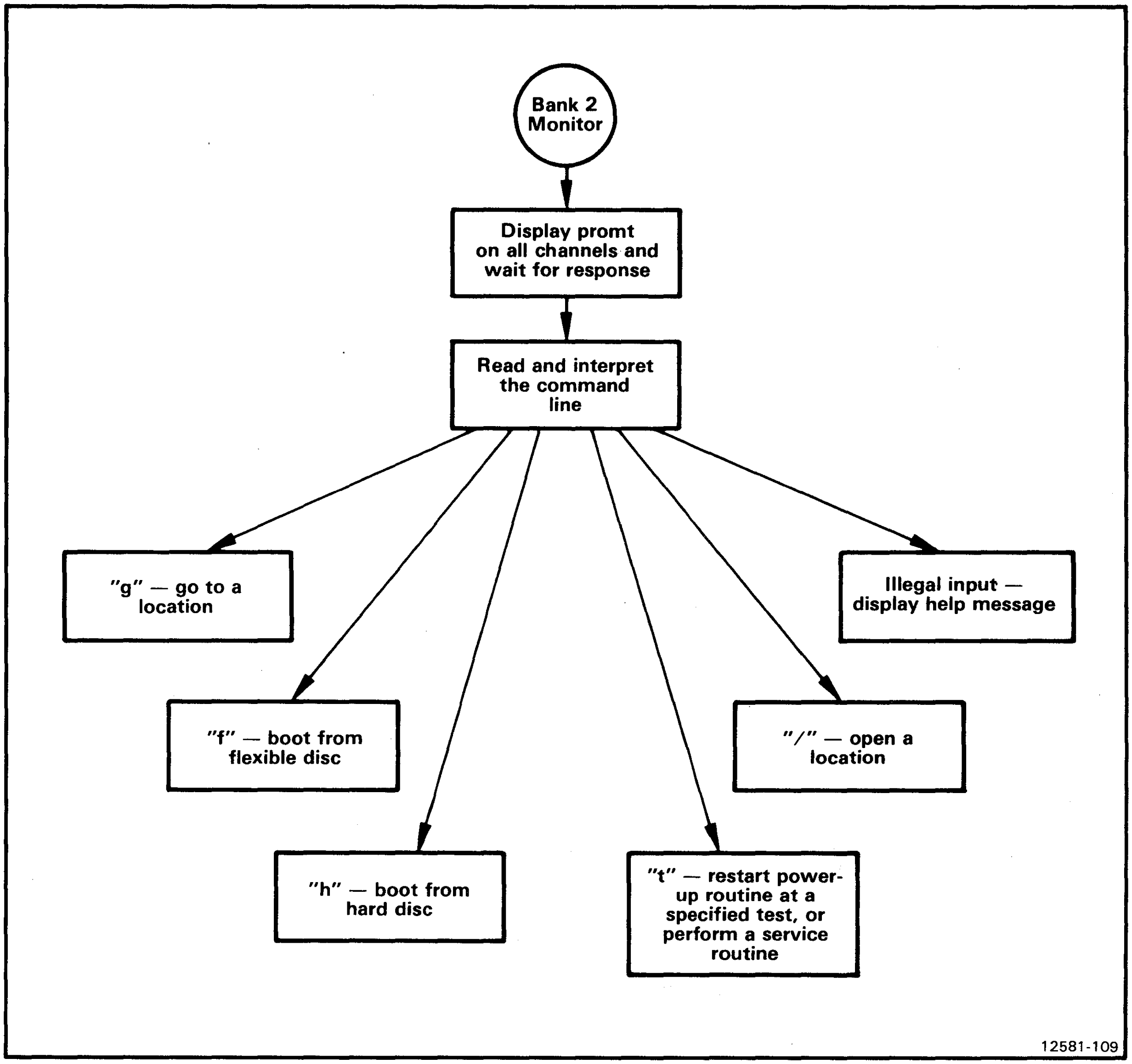

Fig. 13-6. Debugging Mode flowchart.

The Restart (t) Commands

The Debugging Mode allows you to restart the power-up sequence at any test. When the "=" prompt appears on the terminal, you can issue a command that determines where to restart the power-up sequence. The following is a list of the restart commands along with their respective functions.

0t	Initializes the power-up tests and restarts the RAM test.
1t	Restarts the ROM test.
2t	Restarts the CPU test.
3t	Restarts the LTC test.
4t	Restarts the Printer Ports test.
5t	Restarts the IOP test.
6t	Restarts the PMS Controller test.

MAINTENANCE JUMPER

If a power-up test failed, you may want to use an oscilloscope or other test equipment for further troubleshooting. This can be done by removing the maintenance jumper (J1036 on the Utility board), and RESTARTing the 8560. The system loops on any hardware failure that it finds, thus exercising the failed circuits.

However, this method of troubleshooting is effective only for solid errors. In the case of intermittent errors, the test drops out of the loop the first time the test passes.

As previously mentioned, the maintenance jumper can also be used to control access to the Debugging Mode. Table 13-4 lists the functions of jumper J1036. These functions depend on whether the power-up tests pass or fail, and on the position of J1036.

Table 13-4
Maintenance Jumper Functions

Tests pass?	J1036 position	Result
no	ON	Enter Debugging Mode (if terminal connected)
no	OFF	Loop on error
yes	ON	Boot from disc
yes	OFF	Enter Debugging Mode

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SERVICE ROUTINES

The Debugging Mode lets you access three service routines that allow you to perform flexible disc drive head alignment and an azimuth check, and perform additional memory verification. Table 13-5 summarizes the service routines.

Table 13-5
Service Routines

Name	Command	Description
Alignment Aid	7t	This service routine assists in aligning the flexible disc heads and checking the azimuth. An oscilloscope and alignment disc are required. This routine can also be used with a head-cleaning disc to clean the heads.
Low Memory Board Signal Exerciser	10t	This service routine exercises the signal paths on the low 64K Memory board, allowing an oscilloscope to troubleshoot the board.
High Memory Board Signal Exerciser	11t	This service routine exercises the signal paths on the high 64K Memory board, allowing an oscilloscope to troubleshoot the board.

Alignment Aid

Command: 7t

Function: To assist in aligning the flexible disc drive heads.

Blocks Involved: LSI-11/23 Processor, PMS Controller, Flexible Disc Drive, System Memory, Utility board (see Fig. 13-4).

Description

The following service routine description is divided into three parts:

- A supplementary procedure for flexible disc drive head alignment.
- A supplementary procedure for a flexible disc drive azimuth check.
- A procedure for cleaning the flexible disc drive heads.

Head Alignment. The Alignment Aid service routine is intended to allow you to perform a track-38 head alignment of the flexible disc drive. Refer to the DataTrak 8 Flexible Disc Drive Service Manual for the basic procedure. Use the following service routine description to supplement that procedure.

This routine displays a message telling you to type "0" to align side 0 of the disc, or "1" to align side 1. After you select the desired side of the disc, the disc drive will produce a whirring noise as the heads are loaded onto the alignment disc and moved to track 38. Once the heads move to track 38, the same message will print on the screen again.

Each time you select a side of the disc, the program alternately does a seek to either track 0 or 76, and then returns to track 38. The program then causes the disc drive to do a perpetual read to track 38, thereby reading continuously from the alignment track.

To stop this routine, press the front panel RESTART switch.

Head Azimuth Check. The Alignment Aid service routine can be used to check head azimuth as well as adjust head alignment. Refer to the DataTrak 8 Flexible Disc Drive Service Manual for the basic azimuth check procedure. Use the following description to supplement that procedure.

Before the azimuth check is performed, you must temporarily alter the Alignment Aid service routine, so that the routine will do a perpetual read to track 76. Changing the routine is accomplished by completing the following procedure:

1. Enter the Debugging Mode by removing jumper J1036 on the Utility board and RESTARTing the 8560.

2. When you see the "=" prompt, enter "124/". In response, you will see 000046 printed (the octal equivalent of 38).

3. Enter 114 (the octal equivalent of 76), followed by a RETURN.

4. In response to the "=" prompt, enter "7t", just as you would for head alignment.

After completing this procedure, the firmware will move the heads to track 76, as required in the azimuth check procedure. You select the disc side and move the heads, as outlined in the preceding Head Alignment description.

To stop this routine, press the front panel RESTART switch.

Head Cleaning Procedure. The Alignment Aid service routine can also be used to clean the flexible disc drive heads. To clean the heads, insert a head-cleaning disc in the drive, and type "7t". In response to the "side of disc" prompt, type "0". After waiting the time specified in your head-cleaning kit (usually about 30 seconds), press RESTART and remove the disc.

Memory Board Signal Exerciser

Command: 10t (low 64K Memory board) or 11t (high 64K Memory board)

Function: To exercise the signal paths on one of the 64K Memory boards, allowing an oscilloscope to be used to troubleshoot the board.

Blocks Involved: LSI-11/23 Processor, PMS Controller, Flexible Disc Drive, System Memory, Utility board (see Fig. 13-4).

Description

This service routine is used in conjunction with an oscilloscope to troubleshoot either of the 64K Memory boards by allowing you to examine activity on all of the signal lines. This routine is a loop that writes to and reads from sequential memory locations, thus stimulating all signal paths on the memory board.

To use this routine, first disable parity and refresh on the memory board you want to troubleshoot. (You can disable parity by moving jumper J7141 on the memory board to position 2. Disable refresh by removing jumper J6135 on the memory board.) Then, start the routine by entering either 10t or 11t (while in the Debugging Mode). After the routine has been started, all signal paths on the memory board will be toggling. You can now refer to the 64K Memory board schematics at the back of this manual.

TROUBLESHOOTING IN THE ODT MODE

INTRODUCTION

The Octal Debugging Technique (ODT) is a built-in feature of the LSI-11/23. ODT allows you to examine and change register contents and memory locations. ODT also permits you to single-step and restart a user program. The ODT commands and addresses (in octal) must be entered on a terminal connected to LP2.

Table 13-6 summarizes the ODT commands, and lists the ASCII code for each command. Note that the commands may be upper or lower case characters. For additional information, refer to the Microcomputer Processor Handbook, published by the Digital Equipment Corporation.

ENTERING ODT

ODT is invoked automatically by one of the following methods:

- You set the RUN/HALT switch to HALT; or
- The LSI-11/23 executes a HALT instruction.

Table 13-6
ODT Commands

Command	ASCII	Function
x/	057	Print contents of location x (a), and leave that location open.
RETURN	015	Close an open location and accept next command.
LINEFEED	021	Close current location and open the next sequential location.
rx/ or $x/	122 044	Open a specific processor register x
s	123	Open the Processor Status Register (PS). This command must follow a "$" or "r" command.
xg	107	Go to location x and start program execution.
p	120	Resume execution of a program.

(a) In this table, "x" is an octal number of up to six digits

ERROR SUMMARY

INTRODUCTION

The following text summarizes the power-up test error codes that are displayed on the Utility board LEDs, a line printer connected to LP1 or LP2, or on a terminal connected to LP2. If a line printer or terminal (connected to LP2) is installed on the 8560 before the power-up sequence, error messages are printed in the following format:

```
        LC          D1     D2

   two-digit                    six-digit octal numbers
   error code
```

LC is an octal representation of the LED error code. The code shows what the LEDs would have displayed if a line printer or terminal were not installed. D1 and D2 are optional data fields that may contain information about the error.

If for any reason the error codes were not printed, you can still find out what you missed. The error codes are stored in 8560 memory, as follows:

LC	location 52
D1	location 54
D2	location 56

If you are reading an error code from the LEDs, remember that the LED representing the least significant bit is located closest to the rear panel.

ERROR CODES

00 Error during the LTC test. If this message is printed, the data fields provide the following information:

a. If no data fields are printed after the 00, a bus error or unexpected interrupt occurred during the test.

b. If D1 is 0, no LTC interrupts at all occurred. This could be due to a broken signal path on the Utility board, a missing signal on the bus, or an incorrectly placed jumper on the CPU board.

c. If D1 is greater than 0 but less than 27, the line frequency is less than 46 Hz.

d. If D1 is greater than 40, the line frequency is greater than 64 Hz. It is also possible that the CPU is slowing down due to DMA operations of part of the system.

01 Normally this code is never printed. If the LEDs display this code, the CPU was unable to complete initialization. Failure to initialize can be due to a hung bus, a faulty CPU board, or a faulty memory board.

02 LP2 is faulty. This means that the CPU is unable to write to or read from the registers jumpered for 777560 on the Utility board. Either the Utility board is at fault, or there is an address conflict between the Utility board and another board. A good place to start checking is the jumpers on the Utility board.

03 The CPU board's Memory Management Unit (MMU) is not working properly. To find out which of the MMU's registers is at fault, divide D1 by 2; the resulting number is the number of the bad register.

04 LP1 is faulty. This means that the CPU is unable to write to or read from the registers jumpered for 777510 on the Utility board. Either the Utility board is at fault, or there is an address conflict between the Utility board and another board. Check the jumpers on the Utility board.

05 Normally this code is never printed. If the LEDs display this code, U5080 on the Utility board does not verify. Either the ROM or its associated circuitry could be bad, but first check related jumpers.

06 Error during PMS Controller test. If the message is printed, the data fields provide the following information:

a. If no data fields are printed, a bus error or invalid interrupt occurred during the test. This could mean that a PMS Controller board is not installed.

b. If D1 is 0, the program was unable to correctly write or read the PMSCBPR register on the PMS Controller board.

c. If D1 is 1, the PMS Controller did not send a valid interrupt to the CPU. Make certain that the jumpers on the PMS Controller are correctly installed.

d. If D1 is 2, the PMS Controller sent a valid interrupt to the CPU, but did not set its done bit. This could indicate DMA problems.

e. If D1 is 3, the PMS Controller reported a fatal error. D2 displays the PMS Controller error code. These codes are described at the end of Section 16 of this manual.

07 Normally this code is never printed. If the LEDs display this code, U5090 on the Utility board does not verify. Either the ROM or its associated circuitry could be bad, but first check related jumpers.

10--11 This code indicates a RAM error (other than a parity error) in page 0 (0--177777). The error could be due to addressing or data paths, or to RAM size (which must be at least 64K words). D1 displays the address (without the two most significant bits) where the error occurred, but this address could be off by ± 2. D2 displays the expected data at the location specified by D1. With this information you can open the specified location and determine which bits are not correct. The error is probably on the low 64K Memory board.

12--13 This code indicates a RAM error (other than a parity error) in page 1 (200000--377777). The error could be due to addressing or data paths, or to RAM size (which must be at least 64K words). D1 displays the address (without the two most significant bits) where the error occurred, but this address could be off by ± 2. D2 displays the expected data at the location specified by D1. With this information you can open the specified location and determine which bits are not correct. The error is probably on the low 64K Memory board.

14--15 This code indicates a RAM error (other than a parity error) in page 2 (400000--577777). The error could be due to addressing or data paths, or to RAM size (which must be at least 64K words). D1 displays the address (without the two most significant bits) where the error occurred, but this address could be off by ± 2. D2 displays the expected data at the location specified by D1. With this information you can open the specified location and determine which bits are not correct. The error is probably on the high 64K Memory board.

16--17 This code indicates a RAM error (other than a parity error) in page 3 (600000--777777). The error could be due to addressing or data paths, or to RAM size (which must be at least 64K words). D1 displays the address (without the two most significant bits) where the error occurred, but this address could be off by ± 2. D2 displays the expected data at the location specified by D1. With this information you can open the specified location and determine which bits are not correct. The error is probably on the high 64K Memory board.

20--21 This code indicates a RAM parity error in page 0 (0--177777). D1 displays the address (without the two most significant bits) where the error occurred, but this address could be off by ± 2. D2 displays where the program was when the error occurred, and so D2 is not intended for general use. To determine which of the 16 bits is at fault, you must disable parity and execute the RAM test again. (This allows the last part of the test to run.) To disable parity, move jumper J7141 on the memory board(s) to position 2. (Position 1 is indicated by the arrow on the circuit board.) The error is probably on the low 64K Memory board.

22--23 This code indicates a RAM parity error in page 1 (200000--377777). D1 displays the 16-bit address (without the two most significant bits) where the error occurred, but this address could be off by ± 2. D2 displays where the program was when the error occurred, and so D2 is not intended for general use. To determine which of the 16 bits is at fault, you must disable parity and execute the RAM test again. (This allows the last part of the test to run.) To disable parity, move jumper J7141 on the memory board(s) to position 2. (Position 1 is indicated by the arrow on the circuit board.) The error is probably on the low 64K Memory board.

24--25 This code indicates a RAM parity error in page 2 (400000--577777). D1 displays the 16-bit address (without the two most significant bits) where the error occurred, but this address could be off by ± 2. D2 displays where the program was when the error occurred, and so D2 is not intended for general use. To determine which of the 16 bits is at fault, you must disable parity and execute the RAM test again. (This allows the last part of the test to run.) To disable parity, move jumper J7141 on the memory board(s) to position 2. (Position 1 is indicated by the arrow on the circuit board.) The error is probably on the high 64K Memory board.

26--27 This code indicates a RAM parity error in page 3 (600000--777777). D1 displays the 16-bit address (without the two most significant bits) where the error occurred, but this address could be off by ± 2. D2 displays where the program was when the error occurred, and so D2 is not intended for general use. To determine which of the 16 bits is at fault, you must disable parity and execute the RAM test again. (This allows the last part of the test to run.) To disable parity, move jumper J7141 on the memory board(s) to position 2. (Position 1 is indicated by the arrow on the circuit board.) The error is probably on the high 64K Memory board.

30 Error during IOP test. The data fields provide the following information:

a. If no fields are printed, an IOP bus error occurred. Verify that there is at least one IOP board in the 8560.

NOTE

For the following cases, D2 displays the error code returned by the IOP board.

b. If D1 is 0, the firmware could not correctly write to or read from Device Register 0 on IOP board 1.

c. If D1 is 1, IOP board 1 timed out without returning an interrupt. Make sure that the jumpers on the IOP board are correctly installed.

d. If D1 is 2, IOP board 1 returned an interrupt, but the buffer was not changed. This could be due to DMA-related problems.

e. If D1 is 3, IOP board 1 detected a fatal error.

f. If D1 is 4, the firmware couldn't correctly write to or read from Device Register 0 on IOP board 2.

g. If D1 is 5, IOP board 2 timed out without returning an interrupt. Make sure that the jumpers on the IOP board are correctly installed.

h. If D1 is 6, IOP board 2 returned an interrupt, but the buffer was not changed. This could be due to DMA-related problems.

i. If D1 is 7, IOP board 2 detected a fatal error.

31 Error during CPU test, indicating that the LSI-11/23 processor is not operational. Normally this code only appears on the LEDs.

32 Normally this code appears on the LEDs as a status indication that the 8560 is trying to find a bootable disc. However, if you used the "f" or "h" command and a message is printed, the data fields provide the following information:

a. If no data fields are printed, a bus error or unexpected interrupt occurred. Check if the PMS Controller is installed.

b. If D1 is 0, the PMS Controller ignored the command to boot.

c. If D1 is 1, the PMS Controller returned a fatal error code, which appears in D2. These codes are described at the end of Section 16 of this manual.

d. If D1 is 2, the boot block on the disc was invalid because it didn't have correct data.

e. If D1 is 3, the boot block was loaded and executed, but the file system on the disc was incorrect.

33 This code is not used.

34--35 This code normally appears only on the LEDs, as a status indication that the firmware is in the Debugging Mode.

36 This code normally appears only on the LEDs. It means that a boot block was loaded from the disc, and that it is being executed.

37 This code normally appears only on the LEDs. If this code appears when power is first turned on and never changes, the firmware could not execute at all. This could be due to any of the following conditions: the 8560 RUN/HALT switch is in the HALT position, missing memory boards, a missing CPU board, or a hung bus.

If this code appears after the LEDs flash through their normal sequence, the TNIX operating system is in control of the 8560.

Section 14

ADJUSTMENT PROCEDURES

Page

Section 14

ADJUSTMENT PROCEDURES

INTRODUCTION

The only adjustment in the 8560 MUSDU is the 5 V reference adjustment in the power supply. The 5 V reference adjustment sets the level of the +12 V, -12 V, and +24 V DC outputs. This adjustment should never need to be changed in normal service.

PROCEDURE

1. Make sure the 8560 is disconnected from the primary power source.

WARNING

> Use insulated tools and probes at all times. Stored charge in the large capacitors of the power supply can cause severe burns and/or electric shock even when the supply is turned off.

2. To gain access to the 5 V reference adjustment (which is located on the Regulator board of the power supply), remove the fan housing at the rear of the 8560. Remove the fan housing by taking out the two screws closest to the rear panel on the housing's left side, and the six screws that secure the housing to the rear panel. Disconnect the two wires connected to the fan and set the fan housing aside. Three plug-in circuit boards are now visible through the opening that the fan housing normally covers. The Regulator board is the uppermost board.

3. Connect the 8560 to the primary power source. Turn ON the rear panel AC power switch, but leave the the front panel DC power switch OFF.

4. Measure the voltage between Vref (TP6066) and Ground Sense (TP6056) on the Regulator board. The voltage should be within 4.95--5.05 V. If the measured voltage is out of that range, adjust trimmer resistor R6067 (located near the right-hand edge of the board).

5. Remove the voltmeter and replace the fan housing at the rear of the 8560. The adjustment is now complete.

Section 15

MAINTENANCE

ILLUSTRATIONS

Section 15

MAINTENANCE

INTRODUCTION

This section describes preventive maintenance procedures that will help to improve equipment reliability. Techniques and aids for troubleshooting, including diagnostic testing routines, are included in the second part of the section. If the equipment fails to operate properly, corrective measures should be taken immediately; an equipment malfunction may cause additional problems to develop.

STATIC-SENSITIVE DEVICES

Some of the transistor and integrated circuit (IC) devices in this equipment are sensitive to static discharge, and can be damaged by failure to observe the proper handling precautions. Observing the following suggestions will help to minimize the possibility of such damage:

1. Minimize the handling of static-sensitive parts.

2. Transport and store static-sensitive parts in their original containers, on a metal rail, or on conductive foam. Label any container having a static-sensitive assembly or device.

3. Before handling these devices, discharge the static charge on yourself by using a wrist strap. Servicing of static-sensitive assemblies or devices should be performed only at a static-free work station, and only by qualified personnel.

4. Do not allow anything capable of generating or holding a static charge onto the work station surface.

5. Keep the leads shorted together whenever possible.

6. Pick up the part by the body, never by the leads.

7. Do not subject the part to sliding movements over any surface.

8. Avoid handling parts in areas having a floor or work surface covering that contributes to the generation of a static charge.

9. Use a soldering iron that has a connection to earth ground.

10. Use a special anti-static suction-type desoldering tool, such as the Silverstat Soldapullt, or a wick-type desoldering tool.

REDUCING SUSCEPTIBILITY TO STATIC DISCHARGE

This equipment (and its supporting system) incorporate a number of safeguards to reduce the chance of static discharge damage.

CAUTION

Violation or modification of the following safeguards can result in ground loops and/or static discharge problems.

1. The ground (earth) wire of the primary power cable is connected to the chassis where the cable enters the unit.
2. Shields of interconnecting cables are grounded to the chassis at the point of connection to each unit.
3. Ground loops have been avoided by installing a common ground between all units.

PREVENTIVE MAINTENANCE

Preventive maintenance consists of cleaning, visual inspection, and performance checks. The preventive maintenance schedule established for the equipment should be based on the amount of use, and on the environment in which the equipment is operated.

CLEANING

Clean the equipment often enough to prevent dust or dirt from accumulating in or on it. Dirt acts as a thermal insulator and prevents efficient heat dissipation. It also provides high-resistance electrical leakage paths between conductors or components in a humid environment.

CAUTION

Do not allow water to get inside any enclosed assembly or components, such as switch assemblies, potentiometers, etc. Do not clean any plastic materials with organic cleaning solvents (such as benzene, toluene, xylene, acetone, or similar compounds); such solvents may damage the plastic.

Exterior

Clean the dust from the outside of the equipment by cleaning the surface with a soft cloth or brush. Hardened dirt may be removed with a cloth dampened in water that contains a mild detergent. Abrasive cleaners should not be used.

Interior

Clean the interior by loosening accumulated dust with a dry, soft brush, then blow the loosened dirt away with low-pressure air. To clean a circuit board, remove the circuit board and clean it with a dry, soft brush. Hardened dirt or grease may be removed with a cotton-tipped applicator dampened with a solution of mild detergent and water. Abrasive cleaners should not be used.

After cleaning, allow the interior to dry thoroughly before applying power to the equipment.

VISUAL INSPECTION

After cleaning, carefully check the equipment for such defects as defective connections and damaged parts. The remedy for most visible defects is obvious. If heat-damaged parts are discovered, try to determine the cause of overheating before replacing the damaged part; otherwise, the damage may be repeated.

TROUBLESHOOTING

The following text describes general servicing information, presents selected general and specific troubleshooting procedures, then provides detailed diagnostic tests, to aid you in tracing a problem to its source. However, before beginning any troubleshooting work, you should check your warranty or service agreement. For your warranty to remain in effect, all service must be performed by Tektronix, Inc., for the first 90 days following delivery.

Your Tektronix Service Support Center is best suited to perform repairs on TEKTRONIX equipment.

SERVICING AIDS

Diagrams

Circuit diagrams appear on foldout pages in the Diagrams section of this manual. The circuit number and electrical value of each component are shown on the diagram. (See the first page of the Diagrams section for an explanation of the symbols used to identify components in this equipment.)

Components on circuit boards are assigned vertical and horizontal grid numbers which correspond to the location of the component on the circuit board. Refer to the Replaceable Electrical Parts List section for a complete description of each component and assembly.

NOTE

Corrections and modifications to the manual and equipment are described on inserts bound into the rear of the manual. Check this Change Information section for manual or instrument changes and corrections.

Circuit Board Illustrations

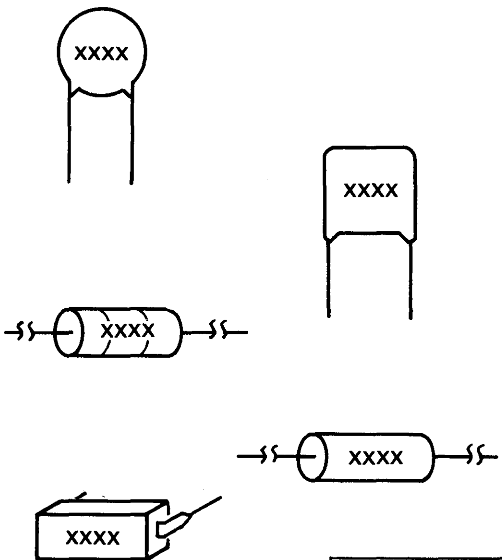
Electrical components, connectors, and test points are identified on circuit board illustrations located on the inside fold of the corresponding circuit diagram, or on the back of the preceding diagram. This allows cross-referencing between the diagram and the circuit board, and shows the physical location of components.

Capacitor Marking

The capacitance (in microfarads or picofarads) and voltage rating of any ceramic mica, plastic film, and electrolytic capacitors are marked on the side of the component body. The values of other ceramic disc and plastic film capacitors, as well as monolithic ceramic capacitors (such as DIP and glass-encapsulated types), are marked according to the code depicted in Fig. 15-1. Tantalum capacitors are marked in microfarads or according to the color code shown in Fig. 15-2.

Resistor Marking

Carbon resistors are marked according to the standard 4-band resistor color code. A fifth band, if present, defines the failure rate. Metal film resistors are marked according to either the standard 4-band resistor color code or the 5-band color code illustrated in Fig. 15-3.



Codes (all values in picofarads):

X X X X
- Tolerance (optional)
- Number of zeros following significant digits
- 2nd significant digit
- 1st significant digit

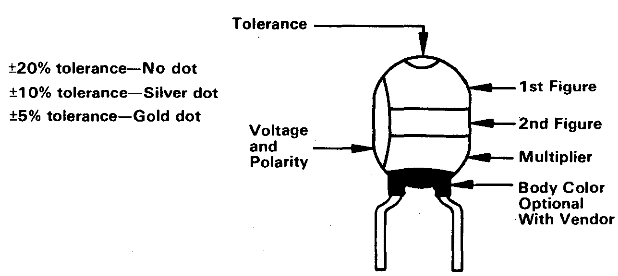
X R X X
- Tolerance (optional)
- 2nd significant digit
- Decimal point
- 1st significant digit

X X 9 X
- Tolerance (optional)
- Multiply significant digits by 0.1
- 2nd significant digit
- 1st significant digit

Tolerance Code	F	G	H	J	K	M	Z	P	W	G
Tolerance	±1%	±2%	±3%	±5%	±10%	±20%	-20/ +80%	0/ +10%	+22/ -90%	Spe- cial

3758-3

Fig. 15-1. Ceramic and film capacitor coding.



Color	+85 C Voltage	Capacitance in Picofarads 1st Figure	2nd Figure	Multiplier
Black	4	0	0	—
Brown	6	1	1	—
Red	10	2	2	—
Orange	15	3	3	—
Yellow	20	4	4	$x10^4$
Green	25	5	5	$x10^5$
Blue	35	6	6	$x10^6$
Violet	50	7	7	$x10^7$
Gray	—	8	8	—
White	—	9	9	—

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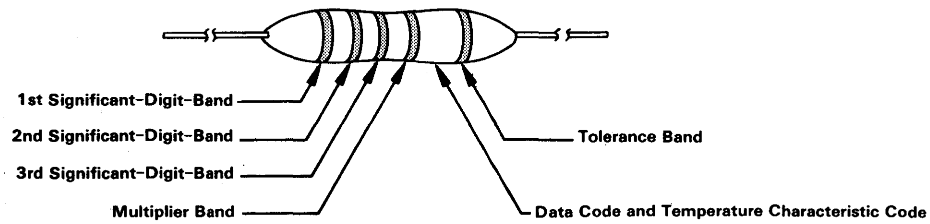
Fig. 15-2. Tantalum capacitor color code.



COLOR BAND INFORMATION

Color	1st Sig. Digit	2nd Sig. Digit	3rd Sig. Digit	Multiplier	Tolerance ± %	
Black	0	0	0	1	—	
Brown	1	1	1	10	1.	F
Red	2	2	2	100	2.	G
Orange	3	3	3	1,000	3.	H
Yellow	4	4	4	10,000	—	
Green	5	5	5	100,000	.5	D
Blue	6	6	6	1,000,000	.25	C
Violet	7	7	7	10,000,000	.1	B
Grey	8	8	8	100,000,000	.05	A
White	9	9	9	1,000,000,000	—	
Gold				.1	5.	J
Silver				.01	10.	K
No Color					15.	L
No Color					20.	M

DATA CODE INFORMATION

YYWW

Week of the year (may be from 01-52).

Last two digits of the year.

TEMPERATURE CHARACTERISTIC INFORMATION

Temperature Characteristic Code	Temperature Coefficient (PPM/°C)	Temperature Range (°C)
T-0 D (C-0)	0 to ±150	-55 to +175
T-00	0 to ±200	-55 to +175
T-1 D (C-1)	0 to ±100	-55 to +175
T-2 C (C-2)	0 to ± 50	-55 to +175
T-9 E (C-3)	0 to ± 25	-55 to +175
T-10	0 to ± 15	-20 to + 85
T-13	0 to ± 10	-20 to + 85
T-14	0 to ± 20	-20 to + 85
T-15	0 to ± 25	-20 to + 85
T-16	0 to ± 5	-20 to + 85
T-18	0 to ± 2	0 to + 60
T-18	0 to ± 5	-55 to +125
T-B	0 to ± 10	25 to +125
T-E	0 to +100 -500	-55 to +175
T-R	0 to +100 -250	-55 to +175

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Fig. 15-3. Metal film resistor color code.

Diode Code

The cathode of each glass-encased diode is indicated by a stripe, a series of stripes, or a dot. Some diodes have a diode symbol printed on one side. Figure 15-4 illustrates diode types and polarity markings.

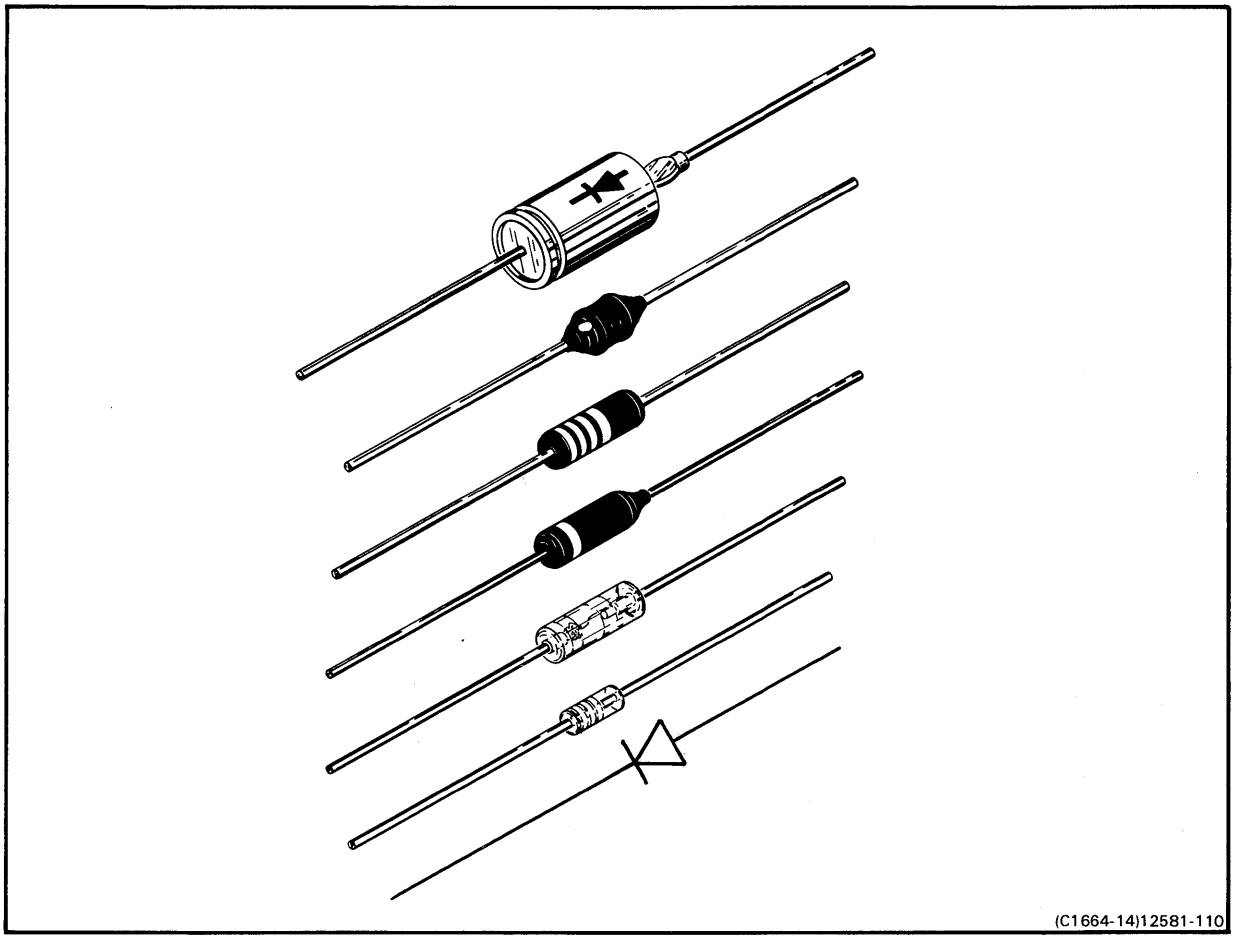

Fig. 15-4. Diode polarity marking.

Coil and Transformer Identification

Coils and transformers used in this product are identified by Tektronix part numbers. If the part number appearing on the part consists of only four numbers, a prefix number must be added to obtain the complete part number:

Classification	Part No. Prefix
Fixed Coils	108-
Variable Coils	114-
Transformers	120-

Transistor and Integrated Circuit Pin Configuration

Lead identification drawings for transistors and 3-lead integrated circuits are included with the schematic diagrams. Pin 1 identification for other integrated circuit is shown in Fig. 15-5.

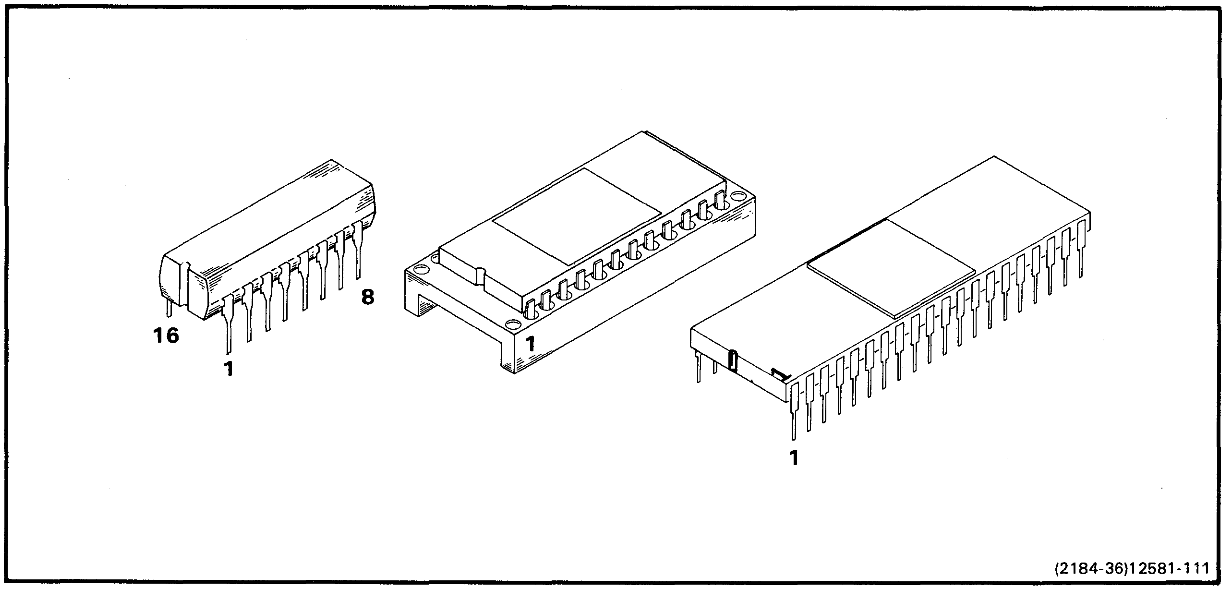

Fig. 15-5. Pin 1 identification for integrated circuits.

OBTAINING REPLACEMENT PARTS

Most electrical and mechanical parts are available through your local Tektronix Field Office or representative. The Replaceable Electrical and Mechanical Parts List sections contain information on how to order these replacement parts. Many standard electronic components can be obtained locally in less time than required to order from Tektronix, Inc. It is best to duplicate the original component as closely as possible. Parts orientation and lead dress should be duplicated, since orientation may affect circuit interaction.

If a component you have ordered has been replaced with a new or improved part, your local Field Office or representative will contact you concerning the change in the part number.

ASSEMBLY REPAIR AND EXCHANGE PROGRAM

Tektronix service centers provide replacement or repair of major equipment assemblies, in addition to complete equipment units. Contact your local service center for this service.

TROUBLESHOOTING PROCEDURES

Initial Equipment Checks

Before you start any detailed troubleshooting of the equipment, perform the following basic equipment checks:

- Check that all cabling is installed properly.
- Verify that all supporting equipment is operating correctly.
- Check power supply levels.
- Remove appropriate circuit boards and clean the edge connectors on the boards, then replace the boards in their correct positions in the equipment.

PREPARING THE 8560 FOR SERVICING POWER SUPPLIES

To inspect, replace, or calibrate the power supply, or any part thereof, the 8560 must be powered-down, the rear panel fan housing and the top cover-panel must be removed.

See Section 12 in this manual for power supply descriptions and trouble shooting guides; and see Section 14 for instructions to adjust the power supply 5V reference voltage.

REMOVING THE COVER PANELS

The 8560 has four cover panels - two side panels, one top panel and one bottom panel. These panels are flat metal sheets with a small flange at their rear edge. Each cover fits into two grooves along the top, side, or bottom of the chassis. Four plastic retainers at the rear of the cabinet hold them in place. The retainers are fastened to the rear casting with screws.

To take off the top cover, first ensure that power to the 8560 is OFF, then remove the screws and retainers as shown in Fig. 15-6. Slide the top cover towards the cabinet rear and lift it away.

To take off any other cover, first ensure that power to the 8560 is OFF, then remove the appropriate retainers and slide the cover towards the cabinet rear and lift it away.

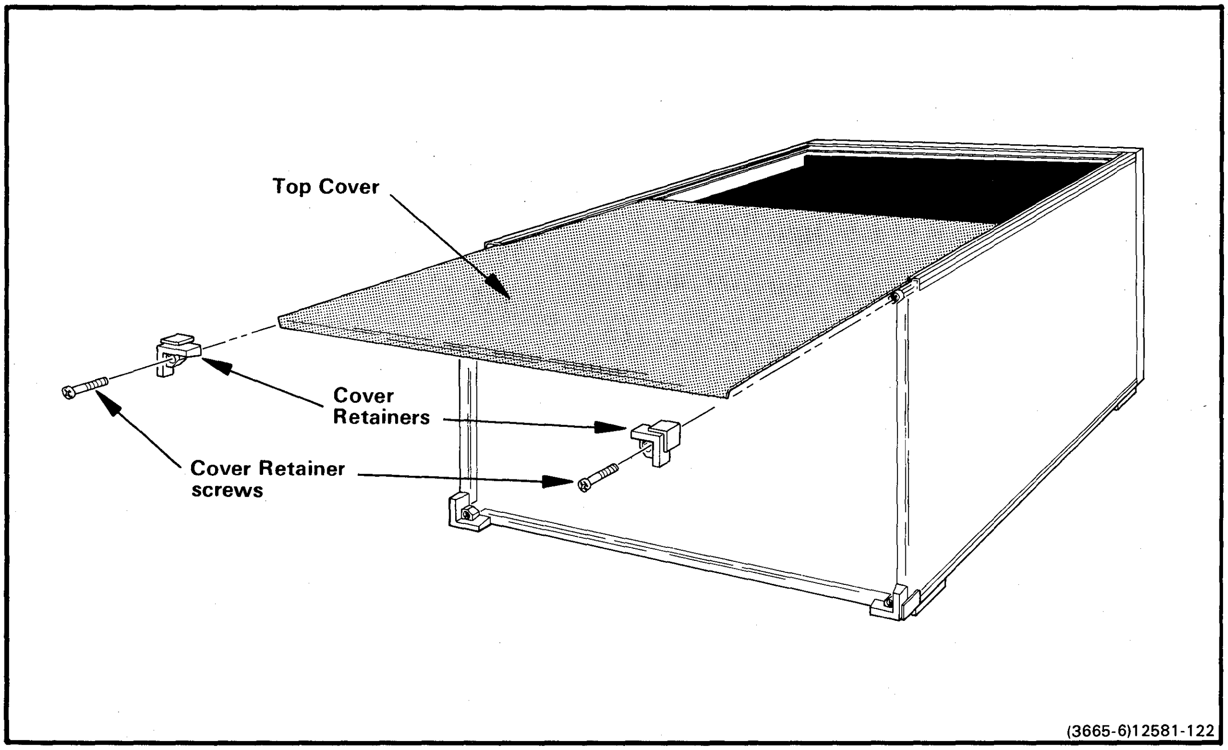

Fig. 15-6. Removing the 8560 top cover.

REMOVING THE REAR PANEL FAN HOUSING

To gain access to the 5 volt reference adjustment, the fan housing at the 8560 cabinet rear panel must be removed. Facing the cabinet rear, remove the housing as follows:

1. Remove the two horizontally mounted screws in the housing's left side.

2. Remove six additional screws (three on top and three on the bottom) that mount the housing to the rear panel. Note that the screw on the lower left is longer than the other five.

SERVICING THE MICROPOLIS DISC DRIVE

REMOVING THE M1223-1 DISC DRIVE UNIT

The following paragraphs provide instructions on how to remove the Micropolis Model M1223-1 disc drive unit. Removing this unit is fairly simple. You need only a stubby and normal size Phillips-type screw driver.

The M1223-1 disc drive unit is mounted with three screws on either side of the unit. Remove the drive in the following sequence:

1. Remove the top and side covers by removing the four plastic retainers and then sliding the covers out of their grooves towards the rear. (See the description earlier in this section.)

2. Remove all boards from the Main Interconnect board. Do not touch the static-free board surfaces.

3. Disconnect the power cable, the M1223-1 interface cable, and the hard disc-expander cable from the rear of the unit.

4. Remove three screws on the cabinet outside and the front screw in the card cage. Figure 15-7 locates the screws on the drive.

5. Then use your stubby screw driver and remove the two remaining screws, holding the unit in place.

6. Close the door of the flexible disc drive

7. Lift the unit at the back and front and carefully slide through the opening in the front panel.

CAUTION

Do not drag the unit along the top of the flexible disc drive unit.

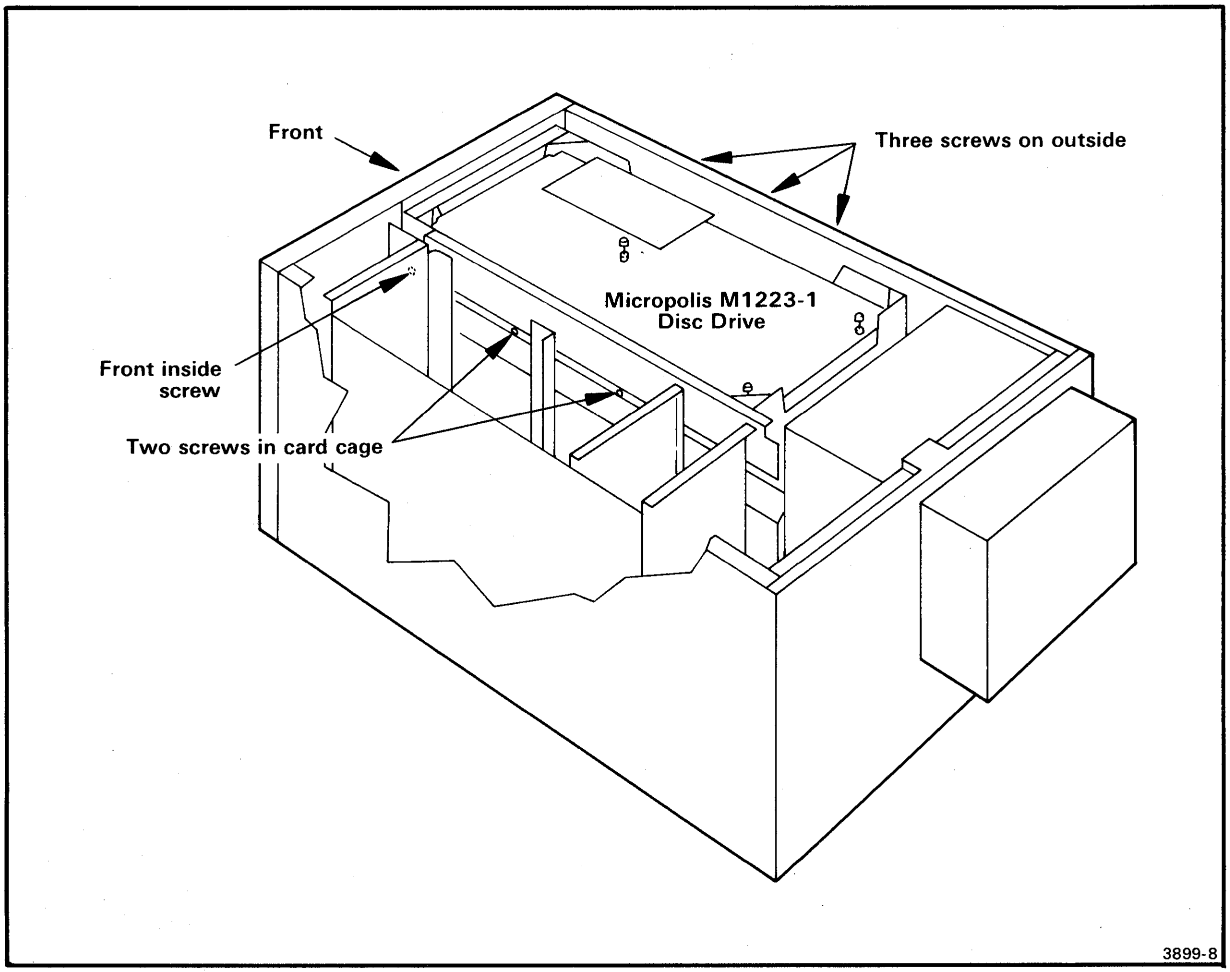

Fig. 15-7. M1220 Disc drive screw locations.

The Bad-Track ROM

Each hard disc drive unit contains a ROM device that stores the bad disc-track information. This device, a 16-pin DIP, is located on the underside of the hinged controller board near the front. You can identify the bad-track ROM by its handwritten label on top. The number on the label matches the number stenciled into the drive unit casting.

When the PMS Controller accesses any disc, the controller in the hard disc drive unit reads the information stored in the bad-track ROM, and skips the tracks identified as bad tracks.

ATTENTION

Since this information is unique for every hard disc drive unit, this ROM must remain with the drive when the controller board is returned or exchanged for service.

INSTALLING THE M1223-1 DISC DRIVE

If you are changing disc drives, your replacement drive may be without a front panel. Remove the front panel from the defective drive and reinstall it on the new drive. The front panel attaches to the drive unit with four flat head screws - two on each side. If you are reinstalling the same unit this step is not necessary.

Install a M1223-1 drive unit by reversing the procedure for removal.

1. slide the unit into the front panel opening.

2. slide it all the way back until the unit front panel aligns with the flexible disc drive front panel.

3. reinstall the six screws.

4. After the unit is installed reconnect the power and interface cable to the unit.

5. Then, reinstall the previously removed circuit boards, and install top and side covers.

6. Secure the covers with the retainer.

LOCKING AND UNLOCKING THE READ/WRITE HEADS

To minimize the possibility of damage to the read/write heads during storage and reshipment, the Micropolis drive assembly provides a head-locking device. This device must be set to the "UNLOCK" position prior to installing a new or exchanged disc drive unit; and set to the "LOCK" position prior to packing the 8560 for storage or reshipment. Section 18 in this manual provides access information for the locking device.

SERVICING THE QUME FLEXIBLE DISC DRIVE

REMOVING THE FLEXIBLE DISC DRIVE

The flexible disc drive unit is removed through the bottom of the 8560 cabinet Remove it as follows:

- Remove the cover panels as explained earlier in this section.

- Remove all boards from the Main Interconnect board.

- Remove the three outside screws

- Turn the 8560 on its drive unit side.

- Remove the three inside screws shown in Fig. 15-8 (first front, then back, then middle)
- With the 8560 front facing you, back up the drive slightly. You should now be able to get your hands behind the unit to disconnect the two power cables and the interface cable.
- After you have the cables disconnected, continue to remove the unit.

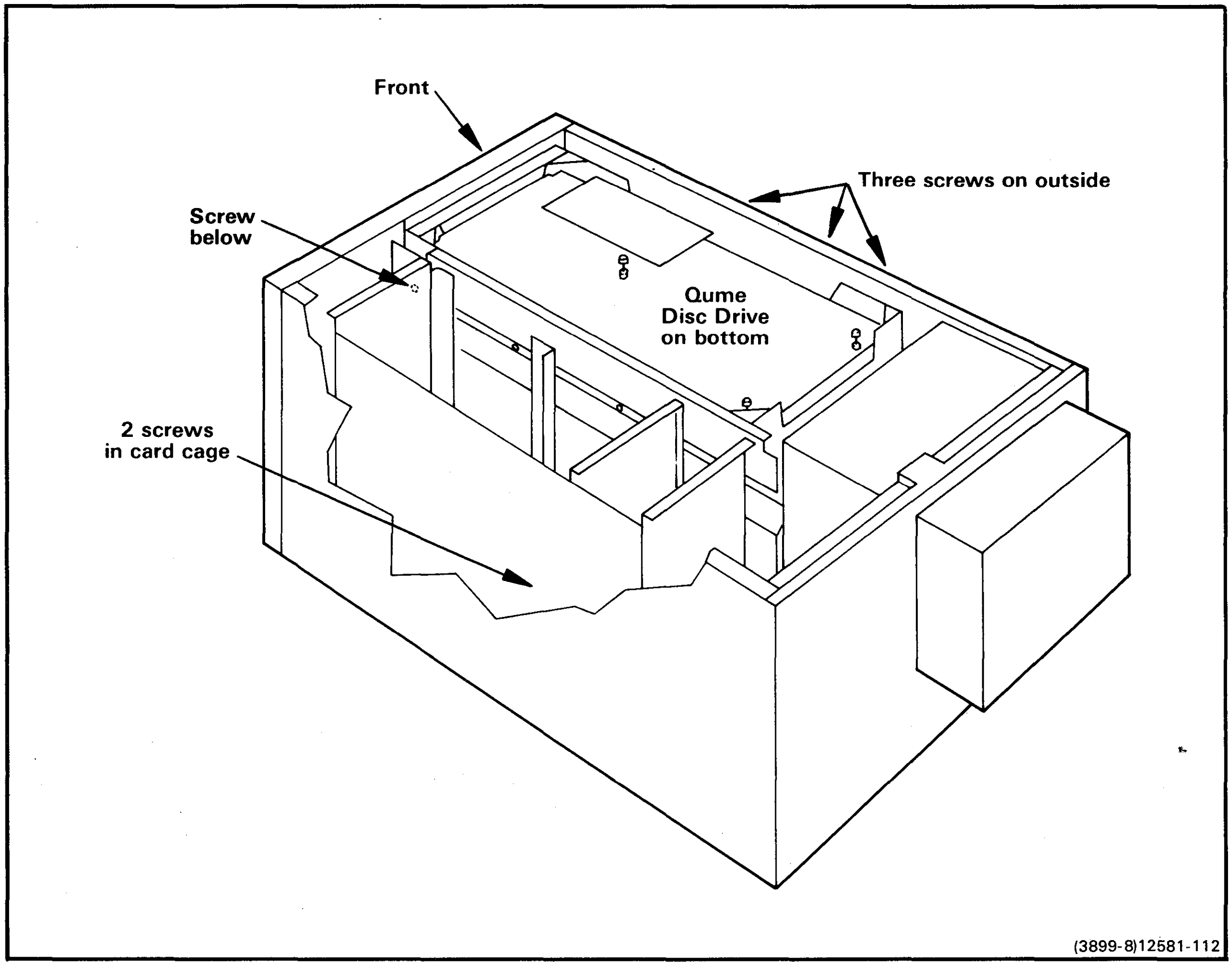

Fig. 15-8. Qume disc drive screw locations.

@

INSTALLING THE FLEXIBLE DISC DRIVE UNIT

1. To install a flexible disc drive unit reverse the removal process.
2. Then, reinstall all previously removed circuit boards on the Main Interconnect board.
3. Install top, bottom and side covers.
4. Secure the covers with the retainer.

ACCESSING THE FLEXIBLE DISC DRIVE FOR HEAD ALIGNMENT

To perform flexible disc drive head alignment or an azimuth check (using 8560 firmware), you do not need to remove the drive unit from the 8560. Instead, access the drive unit from the 8560 cabinet bottom using this procedure:

1. Remove the bottom two cover retainers at the rear of the 8560.
2. Turn the 8560 over so that it rests on either side.
3. Slide the bottom cover off the 8560 and set aside.

You now have access to all adjustments and testpoints needed to perform a firmware-aided head alignment or azimuth check. The actual procedures may be found in the DataTrak 8 Flexible Disc Drive Service Manual (with supplements to those procedures located in Section 13 of this manual).

Section 16

DISC-BASED DIAGNOSTICS

ILLUSTRATIONS

TABLES

Section 16

DISC-BASED DIAGNOSTICS

GENERAL INFORMATION

INTRODUCTION

This section describes the 8560 disc-based diagnostics. The diagnostics consist of seven individual tests:

1. RAM test - checks the 8560 system memory
2. ROM test - checks the 8560 boot and diagnostic memory
3. CPU test - checks the LSI-11/23 processor
4. LTC test - checks the Line-Time Clock
5. Printer Ports test - checks the printer ports
6. IOP test - checks the IOP channels
7. Discs test - checks the read/write capability of the discs

These tests check the same hardware as the ROM-based diagnostics discussed in Section 13 of this manual, but perform a more thorough check. In addition, a separate System Interaction test checks how well the different elements of the tested 8560 system hardware work together. The System Interaction test executes automatically every time all the diagnostic tests are executed in a series.

NOTE

Throughout this section, all addresses are shown in octal notation unless otherwise noted.

This section is organized into four major parts:

1. General information that introduces the disc-based diagnostics, gives a summary of tests and their functions, and provides other information of general interest.
2. Instructions for executing the 8560 disc-based diagnostics.
3. Detailed descriptions of the individual test routines.

4. A summary of all error messages that may be displayed on the terminal.

The disc-based diagnostics outlined in this section are distinct from the ROM-based power-up tests described in Section 13. The disc-based diagnostics are contained on a flexible disc and can be accessed from a terminal connected to LP2 or to one of the I/O Processor (IOP) terminal ports.

The 8560 disc-based diagnostics can execute either within an 8560 system or a combined 8560/8540 system.

HARDWARE RESTRICTIONS

The 8560 diagnostics work only if the 8560 kernel is operational. The 8560 kernel consists of:

- Power supplies
- LSI-11/23 processor
- The lower 32K of 64K Memory board 1
- The portion of the Utility board containing the boot ROM
- Either an IOP board or that portion of the Utility board that controls a serial I/O channel (LP2)
- The I/O Adapter (IOA) and I/O Connector (IOC) boards
- The PMS Controller
- The flexible disc drive

8560 DIAGNOSTICS OVERVIEW

The following basic procedure is used for running the diagnostics:

1. Insert the diagnostic disc into the 8560 flexible disc drive.
2. If the 8560 is already ON, toggle the front panel RESTART switch. Otherwise, turn ON the 8560.
3. Answer the questions that appear on your terminal.

The "Typical Operating Procedure" (later in this section) provides a more detailed explanation.

Figure 16-1 is a flowchart of the 8560 diagnostics procedure.

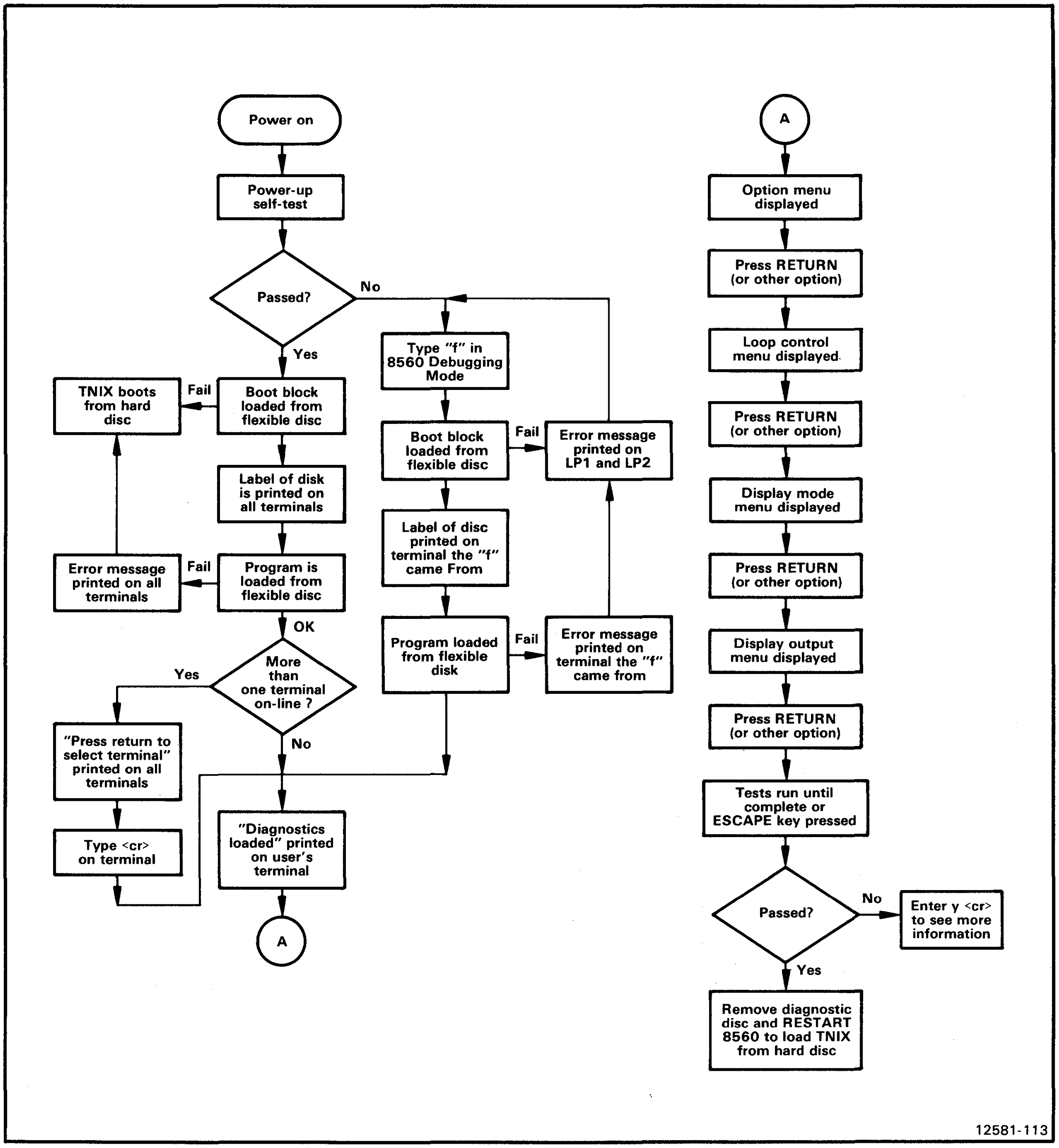

Fig. 16-1. 8560 diagnostics flowchart.

The 8560 diagnostic program, which consists of a single file called "diag60.sav", resides on one flexible disc written in the TNIX fbr file structure. The disc is self-loading; it does not require either the TNIX operating system or the hard disc for loading. Once this file is loaded, it remains in system memory until the 8560 is RESTARTed.

The diagnostics are non-destructive (that is, they will not corrupt any directories or files on the discs in the 8560). A terminal connected to any serial I/O port in the system (except LP1) may be used to communicate with the program.

8560 Menu Descriptions

To perform all 8560 diagnostics functions, four menus are provided: the Option, Loop Control, Display Mode, and Display Output menus. If you want to select a test or function listed in one of the menus, enter the number that precedes that test or function, and then press RETURN. If you want to select the default option, simply press RETURN.

The Option Menu

The Option menu is the first 8560 menu displayed on the system terminal after the 8560 has passed its power-up tests. Display 16-1 shows the Option menu as it appears on the terminal screen.

```
8560 Diagnostic Disc V1.x

Press RETURN to select terminal

******** 8560 Diagnostics - Version 1.x - Loaded ********

Option Menu
-----------

0 - Run all tests   [default]
1 - Test 8560 RAM
2 - Test 8560 ROM
3 - Test 8560 Processor
4 - Test 8560 Line-Time Clock
5 - Test 8560 Printer Ports
6 - Test 8560 IOP Channels
7 - Test 8560 Disc Drives
h - Help

Type in option {<CR>} or {0 - 7 or h and <CR>}
?
```

Display 16-1

Run all tests. This item executes the test series once. When the 8560 has passed all seven tests, the diagnostic program executes the System Interaction test. That test determines whether all checked system components interact with each other properly. If you do not specify an individual test, this option is selected by default.

Run specified tests. Items 1 through 7 are run codes that each specify an individual test routine to be executed. Help. This item displays information that explains all of the options in the display.

The Loop Control Menu

After you choose one of the Option menu tests, the diagnostic program displays the Loop Control menu. This menu allows you to select a looping option. Display 16-2 shows the format of the Loop Control menu as it appears on the terminal screen.

```
Loop Control Menu
-----------------

1 - Do not loop on test   [default]
2 - Loop on test
3 - Loop until error
h - Help

Type in loop control {<CR>} or {1 - 3 or h and <CR>}
?
```

Display 16-2

Do not loop on test. This item executes the selected test option only once. Select the "no looping" option either with a RETURN or with a 1 followed by a RETURN.

Loop on test. This item continuously repeats the selected test option until you press the ESC key.

Loop until error. This item continuously repeats the selected test option until an error is encountered, or until you press the ESC key.

Help. This item displays information that explains all of the options in the display.

Display Mode Menu

This menu is displayed after you select either item 1, 2, or 3 from the Loop Control Menu. Display 16-3 shows the Display Mode menu as it appears on the terminal. The display mode option allows you to turn the run-time status displays either on or off. (For an example of the run-time status display, see Display 16-5.) You can select either item 1, 2 or Help.

```
Display Mode Menu
-----------------

1 - Display run-time status   [default]
2 - No run-time display
h - Help

Type in mode {<CR>} or {1 - 2 or h and <CR>}
?
```

Display 16-3

Display run-time status. This option displays messages during the tests to describe what is going on. Select this option by entering a RETURN or a 1 followed by a RETURN.

No run-time display. This option disables the run-time display (but input prompt messages are still displayed).

Help. This item displays information that explains both of the options in the display.

Display Output Menu

This menu selects the peripheral device on which the test data is displayed. Display 16-4 shows the Display Output menu as it appears on the terminal. This menu is the last 8560 menu displayed. Press RETURN to display the test data on the terminal. You may alternatively display the error information on a line printer connected to either LP1 or LP2.

Help. This item displays information that explains all of the options in the display.

```
-----------------------------------------------------------
|                                                         |
|   Display Output Menu                                   |
|   -------------------                                   |
|                                                         |
|   1 - Display on terminal   [default]                   |
|   2 - Display on printer 1                              |
|   3 - Display on printer 2                              |
|   h - Help                                              |
|                                                         |
|   Type in display output {<CR>} or {1 - 3 or h and <CR>}|
|   ?                                                     |
|                                                         |
-----------------------------------------------------------
```

Display 16-4

The Diagnostics Test Series

Instead of executing tests individually, you can execute all diagnostic tests sequentially. When you press RETURN (or 0 followed by a RETURN) from the Option menu, the diagnostic program executes all tests in the sequence shown. When the tests are executed in a series, all error information is displayed at the end of the series.

While the diagnostic program is executing the test series, the program keeps you informed about test status on the terminal. As each test is executed, the terminal displays the name of each test. Each time the test series executes, the terminal displays the time that has elapsed since the test series was started.

When you execute the 8560 test series, a display similar to Display 16-5 is shown on the terminal.

```
Beginning of pass 1      Elapsed time:   0 : 0 : 0
Testing RAM...............
Testing ROM...
Testing Processor...
Testing Line Time Clock...
Testing Printer Ports...
Lpr1
Nothing connected to Lpr1 - press RETURN to continue?
Lpr2
Testing IOP channels...
IOP1....
Nothing connected to channel 3 - press RETURN to continue?
Testing disc drives...
Flex disc drive
Writing to unused blocks between 137 and 1994
Hard disc drive(s)
Writing to unused block 69599 on hard disc 0
```

Display 16-5

The System Interaction Test

When you execute all seven tests in a series, the diagnostic program automatically proceeds to the System Interaction test after the last test is executed.

The System Interaction test checks that all individual system components work together as designed. This test cannot be selected individually; it is always part of the test series. The System Interaction test requires about a minute to execute, and displays the contents of the error registers on the terminal, as shown in Display 16-6. The error register contents change continuously, as this test exercises the system. If the system passes the System Interaction test, you can be reasonably sure that your 8560 is operating properly.

```
Beginning device interaction test (error counters in octal)...
 ROM    RAM    CPU    INT    BUS    LTC    IOP1   IOP2   LPR1   LPR2   DISCS
000000 000000 000000 000000 000000 000000 000000 000000 000000 000000 000000

Results of 8560 Diagnostics V1.x  Copyright 1981, Tektronix, Inc.
8560 verification passed. Do you want to see more information?
Type y or n
?
```

Display 16-6

If you respond with a y <CR>, statistical data similar to Display 16-7 appears on the terminal.

If you respond with an n <CR>, the Option menu is displayed again.

Diagnostics Failure

If some 8560 boards do not pass a particular test, the diagnostic program displays warning messages while that test executes. After the System Interaction test is completed, you may request that the diagnostic program display statistical information as shown in Display 16-7.

```
Note: addresses and register values are listed in octal
Number of test cycles: 1       Elapsed time:   0 : 1 : 26
RAM -
   memory installed: 128 K words
ROM -
   utility board PROM part numbers: 160 1094 00 , 160 1093 00
CPU -
   standard processor installed
LTC -
   frequency = 60 hz, status: 000340
Lpr1 -
   line printer connected
   baud   rcsr   rbuf   xcsr   xbuf
   2400  040000 000000 070200 000000
Lpr2 -
   test plug connected
   baud   rcsr   rbuf   xcsr   xbuf
   2400  160000 000000 070200 000000
IOPs -
   IOP1 PROM part numbers: 160 1408 00, 160 1407 00, 160 1406 00
   HSI I/O 0 - terminal connected,  current baud rate = 2400
   HSI I/O 1 - terminal connected,  current baud rate = 2400
   HSI I/O 2 - test plug connected,  IOA set for HSI
   HSI I/O 3 - nothing connected,  IOA set for terminal

Discs -
   PMS controller board PROM part numbers: 160 1411 00 , 160 1410 00

   flexible disc: double-sided, double-density

   hard disc 0 capacity = 69599 blocks

8560 verification passed
Ready for next menu (press RETURN)?
```

Display 16-7

Display 16-7 shows statistical data from an error-free run. If any errors occur during diagnostic testing, they will be reported along with the statistical data in this display. The error messages that can be displayed by the diagnostic program are explained later in this section in the "Error Displays" discussion. These error messages let you determine whether the failures are serious enough to warrant further investigation and/or repair.

TYPICAL OPERATING PROCEDURE

The following procedure may be used to run the entire 8560 diagnostic test series once. (You can use the same procedure to run individual diagnostic tests - just select a different option in step 9.)

FIXTURES REQUIRED

The serial ports can be partially tested without any additional hardware. However, to fully exercise the 8560 ports, one or more wrap-back connectors are required. Wrap-back connectors are RS-232-type connectors wired so that output signals from the port are fed back into the same port. Thus, data transmitted by a port is received by the same port. You can order wrap-back connectors from Tektronix, Inc.

Note that a wrap-back connector is referred to as a "test plug" in displays produced by the diagnostic program.

NOTE

> When the following procedure is performed on a terminal connected directly to an IOP channel jumpered for RS-232-C operation, the terminal should be set for 2400 baud, if it can be done from the keyboard. If the terminal is not set for 2400 baud, the first message from the diagnostic program will be garbled.

PROCEDURE

1. Make sure that your terminal is turned ON and properly connected to the system. If the terminal is connected to the 8560 via an 8540, the 8540 must also be turned ON, and be in its transparent mode (refer to the 8540 System Users Manual).

2. Turn ON the 8560's AC power switch (rear panel). The AC ON light on the front panel will come on.

3. Turn on the 8560's DC power switch (front panel). The DC ON light on the front panel will come on. You will hear a whining noise as the fans and hard disc begin to spin. The PROCESSOR BUSY light will come on, and will remain on.

4. Insert the 8560 diagnostic disc into the flexible disc drive.

5. After approximately 30 seconds, the hard disc's ready light on the front panel will come on. Shortly thereafter, the flexible disc busy light on the front panel will come on as the 8560 reads the boot block off the disc.

   If the system cannot boot from the disc, refer to the "System Won't Boot" discussion, following this procedure.

6. In most 8560 terminal configurations, the message

   ```
   8560 Diagnostic Disc V1.x
   ```

   will be printed on the screen. (If your terminal is connected directly to an IOP channel jumpered for RS-232-C operation, and the baud rate of the terminal is not 2400 baud, this message may be garbled. Don't worry about it yet.)

7. If more than one terminal (and/or a line printer connected to LP2) is on-line the following message appears:

   ```
   Press RETURN to select terminal
   ```

   Press RETURN if this message appears. (If your terminal is connected directly to an IOP channel jumpered for RS-232-C operation, and the display is garbled, press the BREAK key; this selects a new baud rate. Continue pressing the BREAK key until you see the message "new baud rate selected", then press RETURN.)

8. Next, the following message will be displayed:

   ```
   ******** 8560 Diagnostics - version 1.x - loaded ********
   ```

   This message will be followed by the Option menu. (If your terminal is connected directly to an IOP channel jumpered for RS-232-C operation, and the display is garbled, press the BREAK key; this selects a new baud rate. Continue pressing the BREAK key until you see the message "new baud rate selected". Then press the ESC key to cause the Option menu to be reprinted.)

9. Press RETURN to select the "Run all tests" option.

10. The Loop Control menu will be displayed. Press RETURN to disable the looping options.

11. The Display Mode menu will be displayed. Press RETURN to enable the run-time display.

12. The Display Output Menu will be displayed. Press RETURN to direct the output to your terminal.

13. The tests will begin running. You will see a run-time display similar to that shown back in Display 16-5.

14. If the program tries to test a serial I/O port, and discovers nothing is connected to the port in the first pass of the test, the program will display the message:

    nothing connected to port x - press RETURN to continue?

    If the preceding message is displayed, you can connect a terminal or wrap-back connector to the port before you press RETURN. Note that you can rearrange connectors whenever the program is paused. This is useful if, for example, you only have one wrap-back connector and want to try it on all of the ports.

15. After the test series is completed, you will see the message:

    Verification passed. Do you want to see more information?
    Type y or n

    If you type a y and then press RETURN, the program displays information about how your 8560 is configured.

16. If you don't want to perform any more tests, remove your diagnostic disc and toggle the RESTART switch to boot the TNIX operating system.

SYSTEM WON'T BOOT

If, for some reason, the system won't boot from the diagnostic disc, read through the following four situations. Find the situation that describes what is happening to your system, and follow the directions in the accompanying text.

Situation 1. The light on the flexible disc drive flashes briefly, then the 8560 loads the operating system off the hard disc.

This means that the 8560 firmware decided that booting the flexible disc was impossible. To discover why the firmware decided this, complete the following steps:

1. Remove jumper J1036 from the Utility board.

2. Connect a line printer to LP1 or LP2, or connect a terminal to LP2. (These two ports are used by the firmware to report errors.)

3. RESTART the 8560.

4. When you see the "=" prompt on your terminal, press "f". You should see three error codes printed out. For an explanation of these error codes, refer to "Error Summary" at the end of Section 13 in this manual. These error codes should help you decide what to do.

Situation 2. The light on the flexible disc drive stays on for a period ranging from several seconds to over a minute. After the light goes out, an error message is displayed on one or more terminals (at 2400 baud). TNIX is then loaded. This means that the boot block was loaded from the disc, but the file could not be loaded.

If this situation occurs, perform the following steps:

1. If the message that was displayed was not legible, set the baud rate of your terminal to 2400 baud and RESTART the 8560.

2. If the message concerns an invalid file system, the directory and/or diagnostic file on your flexible disc may have been altered. If suspect a problem with your disc, substitute another disc.

3. If the message refers to disc read errors, there may be a problem with your flexible disc, or with your flexible disc drive. Substituting another disc or cleaning the heads may solve this problem. (A head cleaning procedure is described under the "Alignment Aid" description in Section 13 of this manual.)

   If all else fails, refer to the end of this section and look up the PMS error code that was displayed. The error code may indicate why the read error occurred.

Situation 3. Neither TNIX nor the diagnostic disc can be loaded and executed.

This generally means that a power-up self-test failed. To pinpoint the problem, complete the following steps:

1. To determine which test failed, connect a line printer to LP1 or LP2, or connect a terminal to LP2. (These two ports are used by the firmware to report errors.)

2. RESTART the 8560.

3. After you complete step 2, one of the following will occur:

   a. Within a minute, an error code is displayed.

   b. The PROCESSOR BUSY light on the front panel goes out. (If this happens, you will have to remove the 8560 top cover, and look at the error code displayed on the Utility board LEDs. Refer to Utility Board LEDs in Section 13 in this manual.)

4. To find out what the error code means, refer to the "Error Summary" at the end of Section 13 in this manual.

If the system displayed the "=" prompt on your terminal, you may be able to override the error by typing an "f". Whether you can override the error depends on the type of error detected.

Situation 4. Not only will TNIX and the diagnostic disc not load, the 8560 firmware won't run either.

This may be due to bad firmware on the Utility board. Try the following procedure:

1. Insert the diagnostic disc in the flexible disc drive.

2. Connect a terminal to LP2.

3. Set the front panel RUN/HALT switch to the HALT position.

4. Toggle the RESET switch on the front panel.

5. Set the front panel RUN/HALT switch to the RUN position.

6. You are now in ODT mode. Enter the following underlined characters on the keyboard:

```
11000/ xxxxxx 2013     <LF>
011002/ xxxxxx 0       <LF>
011004/ xxxxxx 1000    <LF>
011006/ xxxxxx 0       <LF>
011010/ xxxxxx 0       <LF>
011012/ xxxxxx 0       <LF>
011014/ xxxxxx 0       <CR>
777150/ xxxxxx 11001   <CR>
```

7. You will now hear the flexible disc drive activate. When the drive stops making noise (after about a second), enter:

```
R7/ xxxxxx 0        <CR>
P
```

8. The system should now boot from the flexible disc.

PROGRAM STOPS RUNNING

If the diagnostic program hangs up while executing, and pressing the ESC key does not produce any results, you can find out what happened by completing the following procedure:

1. Connect your terminal to LP2. Make sure that the baud rate of your terminal matches the LP2 baud rate (which is set for 2400 at the factory).

2. Raise the front panel RUN/HALT switch, and then lower it again.

3. Enter "3000g" on your terminal. If the diagnostic program is still intact in system memory, the program should display the results from the tests that were run previously.

TEST PROGRAM DESCRIPTIONS

So far we have discussed how to execute the disc-based diagnostics in an 8560. The following discussion provides a summary of the 8560 tests and detailed descriptions of each individual test routine.

TEST SUMMARY

Table 16-1 summarizes the disc-based diagnostic routines. For each routine, the table gives the test name, the run code, and a short test description. Figure 16-2 is a block diagram of the 8560. Refer to Fig. 16-2 while reading the test descriptions.

Table 16-1
Diagnostic Test Summary

Name	Run Code	Description
RAM Test	1	This test checks the system RAM.
ROM Test	2	This test performs a checksum test on bootstrap/diagnostic ROMs, and checks for a valid ROM part number. The test consists of two parts with each part testing one ROM.
CPU Test	3	This test checks selected LSI-11/23 instructions and registers. The CPU test performs a more thorough check of the instruction set than the ROM-based CPU test.
LTC Test	4	This test checks the 8560 Line-Time Clock interrupts.
Printer Ports Test	5	This test checks the two RS-232-C line printer ports.
IOP Test	6	This test checks the operation of the IOP ports and the associated DMA circuitry.
Discs Test	7	This test verifies the operation of the PMS Controller and the disc drives. The test checks the read/write capability of the discs.

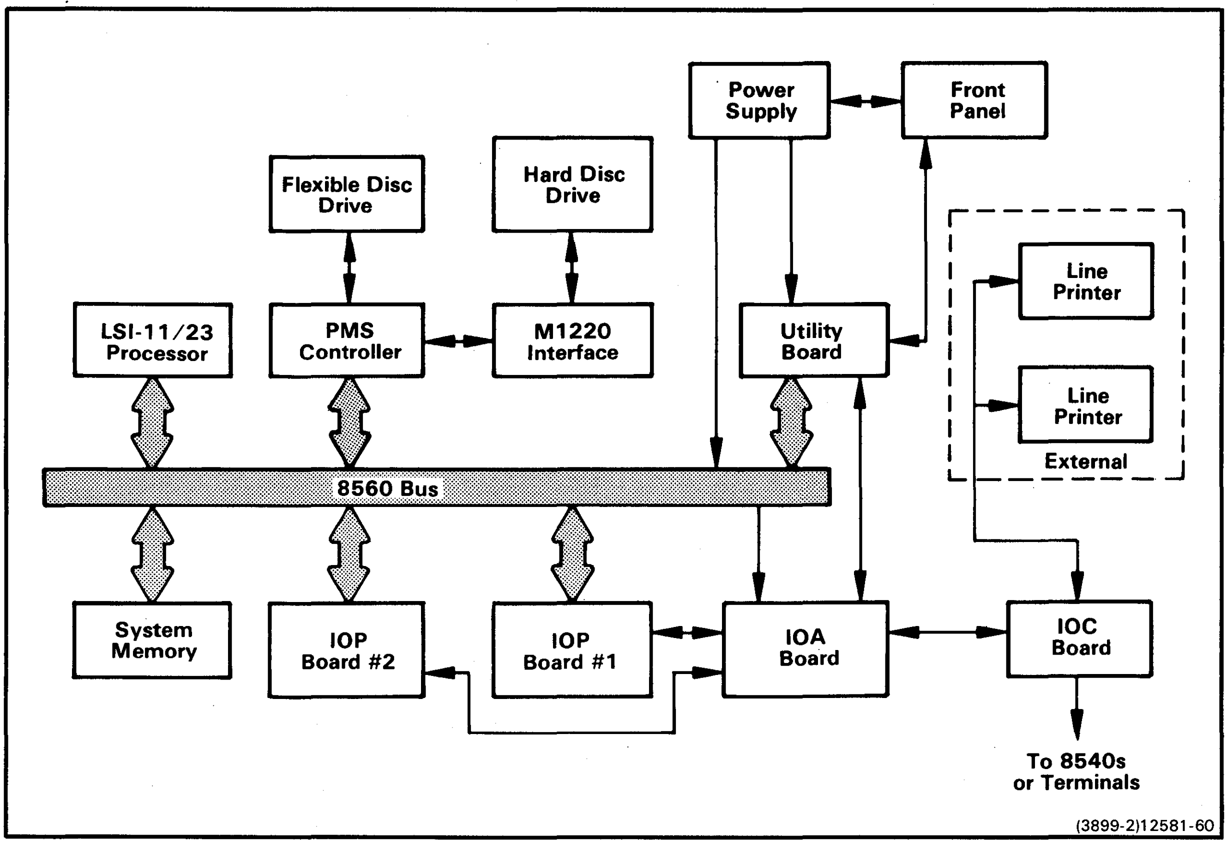

Fig. 16-2. 8560 block diagram.

RAM TEST

Run Code:	1
Function:	Checks the data storage capability of the system RAM.
Blocks Involved:	LSI-11/23 Processor, Utility Board, System Memory, IOA, IOC, and IOP boards (see Fig. 16-2).
Duration:	Up to 30 seconds.

Description

The RAM test verifies system memory by determining the size of memory, writing patterns into each location, and then reading the patterns back. If you have selected the "Run-time display" option from the Display Mode menu, the test will print out a series of period characters while executing. Each period that is printed represents a test module that is executed within the RAM test. The test performs the following steps:

1. If you selected the run-time display, the first period character of the display is printed.

2. The test first determines how much RAM is installed by writing to memory locations above the program until a bus timeout is detected, or until the test reaches 128K words. An error occurs if less than 64K words of memory is installed.

3. The test now verifies that part of RAM occupied by diagnostics by:

   a. saving the contents of each program location,

   b. writing complementary test patterns into the location,

   c. verifying that the patterns were written, and

   d. restoring the original contents of each location.

   If an error is detected, it is stored in RAM for later display.

4. The test verifies the remaining RAM in the 8560 by:

   a. printing the second period, putting the CPU in user mode, and writing 125252 into every location above the program;

   b. printing the third period, then waiting 2.5 seconds (this step is used to verify the refresh circuit);

   c. printing the fourth period, then waiting 2.5 seconds;

   d. printing the fifth period, then complementing each word of the test pattern (starting at the bottom of the test area);

   e. printing the sixth period, then verifying each location;

   f. printing the seventh period, then complementing each word of test pattern (starting at the bottom of the test area);

   g. printing the eighth period, then reading and verifying each location;

   h. printing the ninth period, then complementing each byte of the test pattern (starting at the top of the test area);

   i. printing the 10th period, then reading and verifying each location;

j. printing the 11th period, then complementing each byte of the test pattern (starting at the top of the test area);

k. printing the 12th period, then reading and verifying each location;

l. printing the 13th period, then complementing each word twice and adding 1 to each byte (starting at the bottom of the test area);

m. printing the 14th period, then reading and verifying each location;

n. printing the 15th period, then complementing each word (starting at the top of the test area);

o. printing the 16th period, reading and verifying each location, and then putting the CPU in kernel mode.

If an error occurs, the error information is stored for future display. Note that the interval between printing two successive periods varies (depending on how much memory is installed), but should never be more than about 3 seconds between any two successive periods.

If a parity error interrupt occurs during this test, the location of the error is stored, but the bit fault mask is not. (The fault mask is a 6-digit octal number, in which each non-zero bit represents a mismatch between the data written and the data read inside the given address range.) To determine which bit is at fault, you must disable parity error reporting (by moving J7141 on the 64K Memory board(s) to position 2), and run the test again. Parity should be re-enabled before you reboot TNIX.

It is possible to narrow down the possible source of a reported error, because the error message prints out both an address range and a mask of the bits that failed. For example, if a single bit failed within a narrow range of addresses, a RAM chip probably failed; the address range in the error message will allow you to pinpoint the failed chip. On the other hand, if more than one bit is set in the fault mask, it is more likely that the support circuitry for the RAMs has failed.

ROM TEST

Run Code: 2

Function: Checks the data recorded in the diagnostic/bootstrap ROMs.

Blocks Involved: LSI-11/23 Processor, Utility Board, System Memory, IOA, IOC, and IOP boards (see Fig. 16-2).

Duration: 1 second.

Description

1. Test Low-Byte ROM

The test calculates the checksum and compares it with the checksum stored in the low-byte ROM. The ROM test also reads the ROM-stored part number and determines whether that number is valid.

2. Test High-Byte ROM

The test calculates the checksum and compares it against the checksum stored in the high-byte ROM. The ROM test also reads the ROM-stored part number and determines whether the number is valid.

3. Recall Error Information

If the test is executed alone, and both ROMs have been checked, the program recalls the error information from the system memory and displays it on the terminal. If the test is executed as part of the test series, the diagnostics program displays the error at the completion of the test series.

CPU TEST

Run Code:	3
Function:	Checks the operation of the CPU by executing a representative instruction set.
Blocks Involved:	LSI-11/23 Processor, Utility Board, System Memory, IOA, IOC, and IOP boards (see Fig. 16-2).
Duration:	Less than 1 second.

Description

The CPU test checks a representative sample of LSI-11/23 instructions to determine whether the CPU is operating properly. The disc-based CPU test checks more instructions than the ROM-based test. The test executes the simpler instructions first and then proceeds to more complex instructions. The CPU test verifies most LSI-11/23 operations by checking:

1. a representative set of single-operand instructions with destination mode 0;
2. a representative set of single-operand instructions with destination mode 0, using byte mode;
3. a representative set of double-operand word instructions, using most source modes and using destination mode 0;
4. a representative set of double-operand byte instructions, using various source modes and using destination mode 0;
5. a representative set of word instructions, using various source modes and most destination modes;
6. a representative set of byte instructions, using various source modes and various destination modes;
7. the JSR, RTS, and MARK instructions, using various modes;
8. trap instructions;
9. the MUL, DIV, and ASHC instructions (by solving an equation and checking the result);
10. that instructions operating in user and kernel mode work properly when the MMU (Memory Management Unit) is on;
11. the floating point option.

The CPU test checks the results of the executed instructions. If any result is not correct, the test records the error for later display.

LTC TEST

Run Code: 4

Function: To check the frequency of interrupts from the AC power source.

Blocks Involved: LSI-11/23 Processor, Utility Board, System Memory, IOA, IOC, and IOP boards (see Fig. 16-2).

Duration: 1 second.

Description

This test verifies that the processor is correctly receiving line frequency interrupts. The test uses the Line-Time Clock to count the interrupts caused by the line frequency.

1. Initialize Interrupts

The LTC test starts by setting up the LTC vector and enabling the LTC interrupts. The test detects the first interrupt, then waits in a loop for 1 second while the LTC handler counts the number of interrupts that occur. The program then disables interrupts and checks the interrupt counter. If the frequency of the LTC is between 48 and 52 Hz, the frequency is stored as 50 Hz; if the frequency is between 58 and 62 Hz, the frequency is stored as 60 Hz. All other frequencies are considered invalid and are reported without rounding. If an invalid frequency is reported, the program logs the error and stores the frequency.

2. Display Errors

If the test is executed alone, the program recalls the error information from the memory and displays it on the terminal. If the test is executed as part of the test series, the error data is displayed at the completion of the test series.

PRINTER PORTS TEST

Run Code:	5
Function:	To check the two line printer (RS-232-C) ports.
Blocks Involved:	LS1-11/23 Processor, Utility Board, System Memory, IOA, IOC, and IOP boards (see Fig. 16-2).
Duration:	Up to 20 seconds.

Description

The Printer Ports test consists of two identical parts. The first part checks LP1, and the second checks LP2. Each part is divided into individual routines, depending on the system configuration. The Printer Ports test can check the two ports under the various conditions determined by the external port connections. This test checks port operation with the port connected to one of the following devices:

- A wrap-back connector
- A line printer
- The terminal from which the test is exercised
- An open circuit

The following test sequence is used for each printer port:

1. If the "Run-time display" option was selected from the Display Mode menu, the test displays the name of the port under test on your terminal.

2. The test determines whether the printer control registers can be accessed. If not, the test logs the error and discontinues testing this printer interface.

3. The test exercises the CTS line to determine whether any device is connected to the port. If the DTR signal is not detected, the test assumes that nothing is connected and notifies you. After you acknowledge this notification by pressing RETURN, the test again checks the port to see if any device is connected.

4. The test verifies that the bits in the interface registers can be turned on and off. If any bit fails, the test logs an error.

5. If any device is connected to the port (DTR has been detected), the test determines the vector address of the transmit interrupt. The vector address determines whether the port is strapped for terminal or printer operation. If the port is not strapped for printer operation, an error is logged.

6. If a wrap-back connector is installed, the test exercises the transmit and receive circuits by transmitting a series of characters through the wrap-back connector. The test transmits characters at various baud rates by reprogramming the interface, and checks these baud rates against the line frequency. Since this process takes about 10 seconds, the test prints out three period characters during this step.

7. If a wrap-back connector is installed, the test verifies overrun error checking by transmitting several characters without emptying the receive buffer.

8. If a line printer is connected, the test transmits the following test pattern:

```
!"#$%&'()*+,-./0123456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^
_`abcdefghijklmnopqrstuvwxyz{|}~
```

9. If the Printer Ports test is executed alone, the test retrieves the error information from the system memory and displays it on the terminal. If the test is executed as part of the test series, the error information is displayed at the end of the series.

IOP CHANNELS TEST

Run Code:	6
Function:	To check the operation of the IOP channels.
Blocks Involved:	LSI-11/23 Processor, Utility Board, System Memory, IOA, IOC, and IOP boards (see Fig. 16-2).
Duration:	Up to 30 seconds.

Description

The IOP Channels test consists of two identical parts. The first part checks IOP board 1 (channels 0--3), and the second checks IOP board 2 (channels 4--7). At least one IOP board must be installed for the test to pass; if two boards are installed, both are tested. Each of the two parts of this test are divided into individual routines, depending on the system configuration. If the jumper plug on the IOA board for a particular channel is in the RS-232-C position, the test will automatically execute a set of routines for any of the following configurations:

- a wrap-back connector,
- a terminal, or
- an open circuit

(depending on what is connected to the IOP channel).

If the jumper plug on the IOA board for a particular channel is in the HSI position, the test will automatically execute a set of routines for any of the following configurations:

- a wrap-back connector,
- an 8540, or
- an open circuit

(depending on what is connected to the IOP channel).

The following test sequence is used for each IOP board:

1. The test attempts to read the device register on the IOP board. If a bus time-out occurs, the test assumes the board is not installed, and stops testing the board.

2. If the "Run-time display" option was selected from the Display Mode menu, the test prints the name of the board under test.

3. The test issues a self-test command to the board under test. This causes the IOP board to verify its ROM, RAM, and DMA, and to verify that certain control circuits respond. On completion, the IOP writes its PROM part numbers and status into 8560 RAM, and issues an interrupt to the LSI-11/23 processor. If the test program times out without receiving the interrupt, the program logs the fact that no interrupt was received. If the status is invalid, the program logs an appropriate error code. (Note that in this part of the test, the program may ignore keyboard interrupts.)

4. After the self-test is completed, the routine tests each of the four IOP channels individually, using the following steps:

   a. If the "Run-time display" option was selected from the Display Mode menu, the routine prints a period character.

   b. The routine requests HSI status for the IOP channel. The routine uses the response to determine whether the jumper block on the IOA board is in the RS-232-C or HSI position.

   c. If the channel is jumpered for a terminal, the routine tells the IOP to assert CTS and then check for DTR. If DTR is not present, the output of the channel is assumed to be an open circuit, and the routine skips to step h.

   d. The routine "characterizes" the channel. This characterization involves telling the IOP what baud rate to use for the channel, how characters are to be echoed, and what to return if a framing error is detected. (The routine tells the IOP to return a <null> any time a framing error is detected, so you may get confusing results if you type a <null> on the keyboard while the diagnostics are running.)

   e. The routine tells the IOP to return a character if the IOP receives a character on this channel.

   f. The routine tells the IOP to transmit a RETURN on this channel. If after 0.07 seconds, the character has still not been transmitted, the routine assumes the channel is an open circuit and skips to step h.

   g. If the routine receives a RETURN from this channel, the routine assumes that a wrap-back connector is attached. If nothing is received from the channel, the routine assumes that either a terminal or an 8540 is connected (depending on the position of the IOA jumper block).

   h. The routine recharacterizes the channel, using parameters that are appropriate for the device that is connected to the channel. The routine now branches to either step i, ii, or iii (depending on which device is connected to the channel).

      i. If the test has determined that the connector is an open circuit, and if this is the first pass of the test, the routine reminds you that the circuit is open. At this point you have the option of connecting a device to the port. When you press RETURN, the routine repeats steps b through h to see if the connector is still an open circuit. If the circuit is still open, the routine goes back to the beginning of step 4 or goes on to step 5, depending on whether this is the last IOP channel to be tested.

ii. If a wrap-back connector is installed, the test exercises the transmit and receive functions of the channel by transmitting a series of characters through the wrap-back connector. The test does this at various baud rates by reprogramming the interface, and checks the throughput rate against the line frequency to determine whether the baud rate circuitry is being programmed correctly. Note that baud rate verification is performed only on channels that are jumpered for terminals; the HSI baud rate of 153.6K is not verified by this test.

iii. If a terminal or 8540 is connected to this channel, but this is not the channel that you are using (as determined by the diagnostics after boot-up), the routine transmits the message:

Diagnostics in progress. No logins.

The routine does not automatically perform character input testing in part iii, but you can still verify that this channel works. To do so, type characters on the terminal connected to this channel (or to an 8540 connected to this channel), and see that the characters are echoed.

If the IOA is set up for HSI mode, this verification also checks the baud rate of 153.6K. If a terminal is connected, you can use the BREAK key to select different baud rates (as outlined in the "Typical Operating Procedure", earlier in this section). This type of verification can be performed at any time, not just during the IOP Channels test.

5. When all four channels of the IOP board have been tested, the program displays an error count if any errors have occurred. (If the "Run-time display" option was selected from the Display Mode menu, the error count is not displayed.

6. After both boards have been checked, and if the IOP test was executed alone, the program retrieves the error information from memory and displays it on the output device. If the test was executed as part of the test series, the error information is displayed at the end of the series.

DISCS TEST

Run Code:	7
Function:	Checks the operation of the PMS Controller and the disc drives.
Blocks Involved:	LSI-11/23 Processor, Utility Board, System Memory, PMS Controller, Flexible Disc Drive, Hard Disc Drive, IOA, IOC, and IOP boards (see Fig. 16-2).
Duration:	Less than 1 minute.

Description

1. The test attempts to read the device register on the PMS Controller. If a bus time-out occurs, the test stores an error code in system memory and makes an exit.

2. The test issues a self-test command to the PMS Controller. This command causes the PMS Controller to verify its own RAM and ROM, the DMA interface, the interrupt circuitry, the interface to the disc drives, and the ability of the controller to move the heads. The test does not, however, check the read/write capability of the drives. The PMS Controller also reports back the part numbers of its PROMs.

   The program logs one or more error codes if the self-test command doesn't issue an interrupt to the LSI-11/23 or if the command returns invalid status bytes.

3. The test informs you that it is checking the flexible disc drive. The test then asks the PMS Controller what type of disc is in the flexible disc drive. If an invalid response is returned, the test logs an error code.

4. If a disc is in the flexible disc drive, the test searches the directory to locate the free (unused) blocks. If free blocks can be located, the test skips to step 5. If free blocks cannot be located, the test gives you the option of choosing a read/write test (which will erase the disc) or a read-only test on the entire disc. If the test cannot locate free blocks, one of the following conditions exists:

   - all blocks on the disc are used,
   - the directory is unreadable,
   - the directory is not a TNIX fbr-type directory, or
   - the directory is corrupted.

CAUTION

If the test is looping, do not change flexible discs after the first test pass; the test may write over used blocks on the new disc. The Discs test searches for free blocks only during the first test pass; if you substitute another disc after the free block search, the test will not perform another search.

5. If there are free blocks on the flexible disc, or if you have decided to let the program write on the disc anyway (and the disc is not write-protected), the test writes to five randomly selected blocks within the permitted range and reads back the information to verify the write operation. If a read-only test is being run, the test simply verifies the CRCs (cyclic redundancy checks) on five randomly selected blocks.

6. If there is a disc in the flexible disc drive, the test reads the first four blocks of track 0 into a high-address memory area. This is simply to verify that the boot block area on the disc is readable, and that the PMS Controller can access upper RAM addresses in the 8560.

7. If any recoverable errors were detected during the test (for example, the PMS Controller was able to read data after several tries), the number of recoverable errors is displayed. Recoverable errors are usually due to worn flexible discs or dirty heads. Unless these errors occur consistently (for example, once per test pass), they may be ignored.

8 The test informs you that it is testing the hard disc drive. The test then asks the PMS Controller what the capacity of the disc is. The disc capacity should be 69,599 blocks. If the controller returns an invalid response, the test logs an error code.

9. The test writes and reads a special reserved service block on the disc, which is not accessible by TNIX. The test compares the data to make certain the data was written correctly.

10. The test reads from ten randomly selected blocks on the disc and verifies their CRCs.

11. The test reads the first four blocks of the hard disc into a high-address memory area. This verifies that the boot block area on the disc is readable, and that the PMS Controller can access upper RAM addresses in the 8560.

12. If any recoverable errors were detected during the test, the number of these errors is displayed. Recoverable errors may result from reading blocks that were in TNIX's bad block list (and therefore not used by TNIX). Running the TNIX syschk program ensures that TNIX never accesses the bad blocks, but does not prevent diagnostics from reading the bad blocks.

13. If the Discs test is executed alone, the error data is retrieved from system memory and displayed on the terminal. If the test is executed as part of a test series, the error information is displayed at the end of the series.

DEVICE INTERACTION TEST

Run Code:	Only executes after all the other tests have been run.
Function:	Checks that all 8560 devices interact with each other properly.
Blocks Involved:	All (see Fig. 16-2).
Duration:	Less than 1 minute.

Description

This test consists of a foreground task (the RAM test described previously), and a number of background tasks that are interrupt- and DMA-controlled. These background tasks consist of parts of the LTC test, the Printer Ports test, the IOP test, and the Discs test. The ROM test and CPU test are not rerun, but the CPU is tested implicitly. If the "Run-time display" option was selected from the Display Mode menu, a set of error counters will be continuously reprinted in octal during the Device Interaction test. These error counters are also displayed on any other terminals that are on-line. If any of these error counters is not zero, the test will display a more detailed error message explaining the counter after the test is stopped.

ERROR DISPLAYS

At the end of a set of tests, you will see a display similar to Display 16-8.

```
***Warning*** NNNNN function A error(s)
  Probable source: device X
  Other possibilities: device Y, device Z
  Verification [failed or passed]. Do you want to see more information?
  Type y or n
  ?
```

Display 16-8

The following is an explanation of the messages in Display 16-8:

- "NNNNN" is the number of errors detected;
- "function A" is the name of the function that caused errors;
- "device X" is the name of the module or board that is the likely culprit; and
- "device Y" or "device Z" are less likely culprits.

When you type y <CR> to see more information, you will see a display or printout similar to that in Display 16-9. Information will appear only for those tests that you run.

```
Note: addresses and register values are listed in octal
Number of test cycles: 1      Elapsed time:   0 : 1 : 26
RAM -
   memory installed: 128 K words
ROM -
   utility board PROM part numbers: 160 1094 00 , 160 1093 00
CPU -
   standard processor installed
LTC -
   frequency = 60 hz, status: 000340
Lpr1 -
   line printer connected
   baud   rcsr   rbuf   xcsr   xbuf
   2400  040000 000000 070200 000000
Lpr2 -
   test plug connected
   baud   rcsr   rbuf   xcsr   xbuf
   2400  160000 000000 070200 000000
IOPs -
   IOP1 PROM part numbers: 160 1408 00, 160 1407 00, 160 1406 00
   HSI I/O 0 - terminal connected,  current baud rate = 2400
   HSI I/O 1 - terminal connected,  current baud rate = 2400
   HSI I/O 2 - test plug connected,  IOA set for HSI
   HSI I/O 3 - nothing connected,  IOA set for terminal

Discs -
   PMS controller board PROM part numbers: 160 1411 00 , 160 1410 00

   flexible disc: double-sided, double-density

   hard disc 0 capacity = 69599 blocks

8560 verification passed
Ready for next menu (press RETURN)?
```

Display 16-9

Display 16-9 shows statistical data from an error-free run. If any errors occurred during diagnostic testing, they will be reported along with the statistical data in this display. The error messages that can be displayed by the diagnostic program are explained in the following paragraphs.

GENERAL MESSAGES

The following messages, if they are used, appear near the top of the display. These messages do not relate specifically to any of the seven diagnostic tests.

Number of test cycles - The number of test cycles that were run or started. If you did not specify looping, there will be only one test cycle.

Elapsed time - The amount of time the test took to run. For a pass of the entire 8560 diagnostic series, this number ranges between 1 to 2 minutes, depending how the 8560 is configured for the test.

Unexpected interrupt vectored at NNNNNN - An interrupt occurred that was not anticipated by the diagnostics. The number represents the interrupt vector address. Standard 8560 interrupts include:

000004 - bus timeout or stack overflow
000010 - invalid instruction executed
000014 - BPT instruction
000020 - IOT instruction
000024 - power fluctuation
000030 - EMT instruction
000034 - TRAP instruction
000060 - LP2 I/O
000064 - LP2 (normally unused)
000100 - Line Time Clock
000114 - RAM parity error
000200 - LP1 I/O
000204 - LP1 (normally unused)
000234 - PMS Controller
000244 - floating point
000250 - memory management
000260 - PMS Controller
000270 - PMS Controller
000274 - PMS Controller
000300 - IOP 1
000304 - IOP 2
000310 - IOP 1
000314 - IOP 2

If the vector displayed is not on this list, the vector strapping on one of the boards may be incorrect. Run the diagnostic tests individually to determine which board is producing the interrupt.

Stack overflow - possible interrupt problem - The processor detected that its stack pointer was outside the legal range. This problem could occur if the CPU has to process more interrupts than it can handle. This problem could also be caused by a series of unexpected interrupts.

Run the tests individually to determine which board is causing the problem. Also look at other error messages, such as RAM errors or unexpected interrupt errors. It may be necessary to reload the program and start over.

Invalid instruction trap. Possible program error. Restart or press <esc> - The processor detected an invalid instruction. The presence of an invalid instruction probably means that part of the program has been accidentally altered. The program could have been altered by a number of problems: a CPU error, RAM error, unauthorized DMA operation by another device on the bus, or unexpected interrupts.

First press the ESC key to see if any error messages are printed. Then reload the diagnostic program and run individual tests to isolate the problem.

Memory mapping error. Possible program error. Restart or press <esc> - The processor reported a memory management exception (indicating program corruption). Memory management exceptions are generally caused either by writing to write-protected RAM, or by an unauthorized action of a diagnostic task running in user mode. Also, the program may have been corrupted by a RAM error, CPU error, Memory Management Unit (MMU) error, unauthorized DMA operation on the bus, or an unexpected interrupt. First press ESC to see if any error messages are printed. Then reload the program and run individual tests to isolate the source of the problem.

Power failure detected. Restart or press <esc> - This message is displayed if a power-fail interrupt is detected by the CPU board. A power-fail interrupt generally indicates that the DC outputs of the power supply are fluctuating.

NNNNN bus errors. - This indicates that intermittent bus reply timeouts were detected at an unknown address. You can isolate the problem by running individual tests.

NNNNN interrupt errors - This indicates that unanticipated interrupts occurred. Look for a subsequent message indicating the vector at which the interrupts occurred.

RAM-RELATED MESSAGES

The following messages display information gathered by the RAM test.

RAM error in program space. Restart or press <esc>. - An error occurred in the memory that the diagnostic program occupies. If the diagnostic program is loaded into bad memory, the program may not run properly. Note that since the program itself requires less than 32K words, it is possible to re-configure memory by changing jumpers (see "Bank Interchange Straps" in Section 3 of this manual).

NNNNN RAM error(s) - Some type of RAM error was detected. Error types include configuration errors, parity errors, and data or addressing errors. The following messages should help you isolate the problem:

Memory installed - NNN K words - NNN is the amount of memory (in K words) tested by the program. This can range from 64K words to 128K words, depending on the number and type of memory boards installed. If less than 64K words of memory is installed, an error will be reported. Normally, the board in the slot marked MEM1 will have its jumpers set for the 0--64K memory range, and the board in the MEM2 slot will have its jumpers set for the 64--128K memory range; however, the boards may be reversed with no effect on 8560 operation. The program determines how much memory is installed by writing to memory locations above the program until a bus reply timeout is detected, or until the maximum legal configuration is reached. If the diagnostics report less memory than you have installed, recheck the jumpers on the memory board(s) before you suspect a malfunctioning board.

<u>RAM error(s) in range xxxxx to xxxxx, fault mask = NNNNNN</u> - This indicates the address range where RAM errors were detected. The fault mask is a 6-digit octal number, in which each non-zero bit represents a mismatch between the data written and the data read inside the given address range.

If only parity errors were detected, the fault mask will be 0 because the program is unable to determine bit faults when a parity interrupt occurs. If necessary, you can disable parity error reporting by moving J7141 on the memory board(s) to position 2, and then rerun the test to isolate the bits at fault. (Remember to restore J7141 before reloading TNIX, however.) If the errors are in a single bit of the mask, and within a single 16K-word address range (for example, 100000 to 177777), the error is likely to be in or near the corresponding 16K RAM chip. If the range is larger than 16K words (100000 octal) or errors are detected in more than one bit, the problem may be in the support circuitry on the memory board.

Patterns in the address range or fault mask may help to isolate the problem. For example, errors that only occur within a 16K-word range may indicate a problem with the corresponding 16K-word bank of memory. A fault mask of 177400 or 000377 may indicate a problem in the byte accessing circuits.

<u>NNNNN parity error(s) were detected</u> - This indicates the number of parity interrupts that occurred during testing. If the jumpers on the memory board are set up for normal operation (that is, for running TNIX), almost all memory errors should produce a parity error interrupt. For troubleshooting the memory board, however, you should move the parity enable jumper (J7141 on the memory board) to position 2. This disables hardware error checking and allows the diagnostics to more easily isolate the error.

ROM-RELATED MESSAGES

The following messages display information gathered by the ROM test.

<u>NNNNN ROM error(s): U50xx</u> - The contents of the Utility board ROMs, which contain the 8560 bootstrap and power-up diagnostics, don't match their checksums. U50xx indicates which ROM (U5080 or U5090) failed to verify. If replacing the ROMs does not help, check for activity on the ROMs' data and address lines during the ROM test.

<u>Utility board PROM part numbers: 160-1094-xx, 160-1093-xx</u> - This message indicates which version of bootstrap/diagnostic firmware is installed in your 8560. The first number is the part number of U5080, the second is the part number of U5090. The last two digits of each part number are the version

number. If the parts are reversed or identical, your 8560 will not be able to boot automatically.

CPU-RELATED MESSAGES

The following messages display information gathered by the CPU test.

NNNNN processor error(s) - The 8560's LSI-11/23 processor did not pass its instruction set test. The CPU board is probably at fault. However, this error message may be printed if part of the program memory has been corrupted by a RAM failure or unauthorized DMA access.

standard processor installed - The LSI-11/23 processor in your 8560 has no options installed. If the diagnostic program displays this message, but your processor has the floating point option, check to be certain the floating point device is properly inserted in the correct socket before rerunning the CPU test.

floating point option installed - The LSI-11/23 processor in your 8560 has the floating point option installed.

bad floating point chip - The floating point option did not verify its instruction set test. Make certain the floating point device is properly inserted in the correct socket. If the floating point device is properly installed, the device itself is probably bad.

LTC-RELATED MESSAGES

The following messages display information gathered by the LTC test.

NNNNN line-time clock error(s) - The Line-Time Clock did not provide interrupts at the correct frequency, as measured by the processor. See the following message for information about the frequency observed by the 8560's processor. Ranges accepted by the test are 48--52 Hz, and 58--62 Hz. Note that if power supply noise (glitches) occur during the LTC test, you may see a figure of 51 Hz or 61 Hz.

frequency = NN Hz, status: NNNNNN - The frequency provided in this message should be the line frequency of the 8560 power source. If a frequency error occurs at any time during the test, the incorrect frequency will be reported in this message. If the reported frequency is too high, it may be due to power-line noise, or to a device performing excessive DMA accesses (this would effectively slow down the processor speed, which is used as a frequency reference).

NNNNNN represents the contents of the LTC status register on the Utility board. This status register normally contains either 000340 (if jumper J1036 on the Utility board is installed) or 000341 (if J1036 is removed).

missing interrupt - The expected line frequency interrupts did not occur. This may be due to a broken signal path somewhere between the power supply and the processor board, or to an unauthorized jumper on the processor board. (If jumper W4 is installed on the CPU board, the BEVENT clock line will be ignored by the processor, causing the test to fail.)

LP1- AND LP2-RELATED MESSAGES

The following messages display information gathered by the LPR test.

lpr n errors - Some type of error was detected on the specified line printer port. The following messages indicate the type of error:

incorrect address strapping - A bus reply timeout was detected when the processor attempted to access the printer port's registers. This is probably due to incorrect jumper configurations on the Utility board.

xxxxx connected - This message indicates whether a line printer or wrap-back connector (or nothing at all) was connected to the printer port. If the device was later moved to another channel, "(later removed)" will also be printed. The test uses the CTS and DTR signals to determine which device is connected. The message "nothing connected" means no DTR signal was detected, and "test plug connected" means the DTR and CTS lines were tied together.

```
 baud   rcsr   rbuf   xcsr   xbuf
xxxxxx xxxxxx xxxxxx xxxxxx xxxxxx
```

- The numbers displayed in this message indicate the status of the printer interface on the Utility board.

"baud" is the baud rate that the previously specified printer port is strapped for. If no error message is printed, the other four status fields can be ignored.

For a detailed explanation of the following registers' contents, refer back to "Serial Interface Register Definitions" in Section 5 of this manual.

- "rcsr" displays the contents of the Receiver Control/Status Register. Bits 0, 13, 14, and 15 represent various interface signals. Bit 6 is the interrupt enable bit, and bit 7 is the character received bit.

- "rbuf" displays the contents of the Receiver Data Buffer (which is the logical OR of characters that caused errors). Bits 13, 14, and 15 are error bits.

- "xcsr" displays the contents of the Transmit Control/Status Register (which indicates the transmitter's control status). Bits 12, 13, 14, and 15 represent the baud rate in use by the interface. Bits 0, 5, and 6 are various control signals. Bit 7 is the transmitter ready bit.

- "xbuf" displays the contents of the Transmit Data Buffer (which is the transmitter's output buffer). The xbuf register will always be 0 unless there is a stuck bit on the data bus.

The rcsr and rbuf registers are for diagnostic use. The xcsr and xbuf registers are used by TNIX as well as the diagnostics.

baud rate not as shipped - This message is intended primarily for factory use. When shipped, line printer ports on the Utility board are strapped for 2400 baud. If you have intentionally changed the baud rate strapping, you may ignore this message.

baud rate errors - One or more baud rates for this printer port did not seem to be correct. Baud rate verification is performed only if a wrap-back connector is connected to the port. Verification is performed by measuring the throughput rate against the line frequency. Anything that interferes with throughput or with the Line-Time Clock may also cause this test to fail. The baud rate at which the test failed is reported in the xcsr display. Note that the baud rate that failed may not be the baud rate that the port is now strapped for, because the test reprograms the baud rate.

output not present - port not fully tested - No output device was detected for this printer port, so only minimal testing was performed. In other words, the DTR and/or Transmit Ready (TRDY) signals were not present. DTR is received via the connector on the back panel. TRDY is generated by the UART on the Utility board.

output interrupt not present - port not fully tested - Although a device was connected to the printer port, the port was unable to correctly generate a transmit interrupt. This may be due either to a incorrectly set jumper on the Utility board, or to a problem with the interrupt request circuit.

LP mode not as shipped - The line printer mode straps on the Utility board are set incorrectly. TNIX requires that the line printer ports be strapped for line printers.

input not present - port not fully tested - This message is meaningful only if a wrap-back connector is installed. No data was received due to a problem with the receive (or transmit) lines on the IOA, IOC, or Utility boards. Make sure the wrap-back connector is installed properly and is wrapping the signals back. (This message may also appear if the line printer ports strapping is incorrect.)

NNNNN data errors - Receiver errors have probably occurred. If bit 13 in rbuf is set (in a preceding message), a framing error was detected. If bit 14 in the rbuf is set, an overrun occurred (characters were received faster than the program could process them). If neither of these error bits is set, an out-of-sequence character was received.

Other errors in the 8560 may also produce this error message, such as excessive DMA requests or interrupt requests. If receiver errors seem to be the cause of this message, check the UART on the Utility board.

input interrupt not present - port not fully tested - Although the rcsr indicated that characters were received by the port via the wrap-back connector, no input interrupt occurred. This may be due either to a misplaced jumper on the Utility board, or to a problem with the interrupt request circuit.

IOP-RELATED MESSAGES

NNNNN IOPx errors - Errors were detected during the IOP test in IOP board x. The following messages provide more details.

IOPn PROM part numbers: 160-xxxx-xx, 160-xxxx-xx, 160-xxxx-xx - This message indicates which firmware is installed on IOP board number n. The last two digits of each part number indicate the version number.

HSI I/O n - description - This message describes what the diagnostics have decided is connected to channel n (where n is a number between 0 and 7). If a terminal is connected, the current baud rate will also be shown. If a wrap-back connector is in use, the IOA jumper configuration will be shown. A "nothing connected" message indicates that the IOP test detected no DTR signal for this channel.

If you do not see the description that you expect, there are several different steps that you can take to find and/or correct the problem:

- Reseat the IOP board in its socket.
- Connect your terminal to the channel specified in this message, and then run the IOP test to see if characters can be transmitted and received.
- Check to see if the ROM-resident debugging monitor will communicate with this channel. (Refer to Section 13 for information on the Debugging Mode.)

For further details on how the IOP test determines what device is connected to an HSI I/O channel, refer to the IOP test description earlier in this section.

baud rate did not verify - One of the programmable terminal baud rates did not verify when throughput was checked against the Line-Time Clock. Baud rate verification is performed only if the IOA jumper block is in the terminal position and a wrap-back connector is installed. Anything that interferes with either the IOP throughput or the LTC may also cause this test to fail.

To verify that a baud rate is failing, connect a terminal to the specified channel and restart the IOP test to see if a message is displayed. If a message is displayed, but the message is garbled, try programming the channel for different baud rates by pressing the BREAK key.

missing interrupts - The expected interrupts from the IOP board did not occur within the expected time. This could be due to a throughput problem which prevents the IOP from sending or receiving characters. This could also be due to problem with the interrupt logic on the IOP board.

board does not process commands - The IOP firmware does not respond to commands issued by the system processor, although the device register on the IOP board can be accessed. This can be due to a whole range of problems.

To determine if the IOP board is operational, look at the seven-segment LED on the IOP board, and see if the LED matches any of the displays shown in Fig. 16-3.

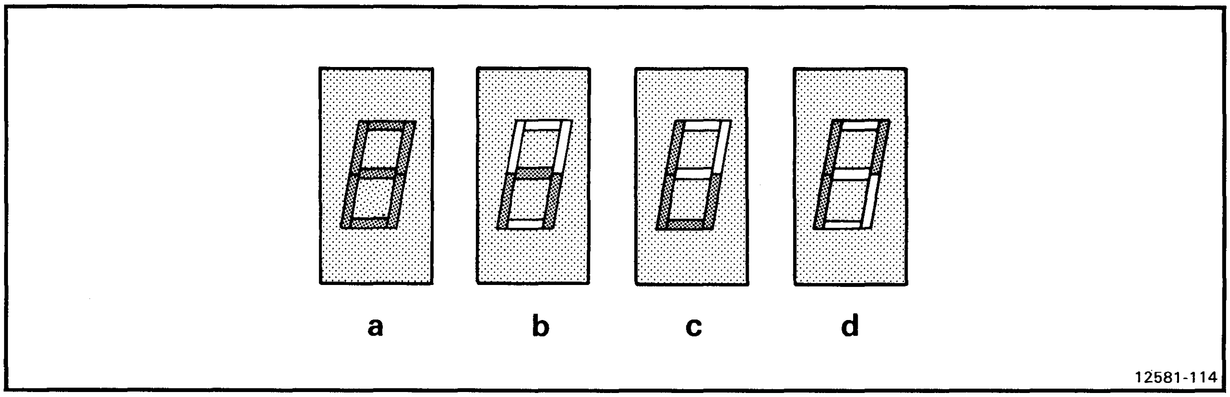

Fig. 16-3. IOP board seven segment LED.

The displays shown in Fig. 16-3 indicate the following:

a. The 8088 microprocessor is probably not running at all.

b. The self-test PROM activated normally, but could not transfer control to the other two PROMs correctly.

c. The self-test PROM correctly transferred control, but the IOP board is unable to properly communicate with the 8560 bus. This display is used only if the input power-line frequency to the 8560 is 60 Hz.

d. The self-test PROM correctly transferred control, but the IOP board is unable to properly communicate with the 8560 bus. This display is used only if the input power-line frequency to the 8560 is 50 Hz.

If the LED displays a character other than those shown in Fig. 16-3, there may be an HSI communication problem or some problem that is affecting 8088 operation.

no IOP boards installed - Bus reply timeouts occurred when the system processor tried to access IOP1 and IOP2. If you do in fact have an IOP board installed, make sure that the jumpers on the board are set properly, and that the board is firmly seated in the 8560.

IOP aborted command - The IOP board unexpectedly aborted a command that was sent to the board. Make sure that all of the connectors are firmly attached, and that you do not change any jumpers while the test is running.

missing DMA write or unexpected interrupt - More interrupts were received than could be accounted for by DMA transfers. (The software expects the number of interrupts and the number of DMA transfers to match.) The problem may be due to a DMA write problem with the IOP board.

transmit timeout - The program tried to transmit something from this channel, but was unable to transmit within the expected time period. This may be due to a removed connector, or to an intermittent DTR signal.

timeout - The program sent a command to the IOP board expecting a quick-reply, but the response did not occur as expected. This problem could occur if a connector or jumper is changed during the test, or if the IOP board spends excessive time on some previous command.

invalid character(s) received - The program thought that a wrap-back connector was connected to this channel, but the program received a character that was different than the character it sent. The problem may be on the IOA or IOP board. There is a possibility that this error message could also be caused by an IOP addressing error (for example, the IOP may have read from or written to the wrong location in system memory.)

self-test error, code = NNNNNN - The self-test command issued to the IOP board did not produce the expected response.

The self-test error code is initially set to 177777 by the diagnostic program. The IOP board will change this error code to 0 if the self-test reveals no problems and will also write a test pattern into memory. If these events do not occur as expected, this error message is displayed.

Make sure that all IOP board jumpers are correctly set, and that all three IOP PROMs are properly installed.

DISC-RELATED MESSAGES

The following messages display information gathered by the Discs test.

Timeout waiting for interrupt - This message will appear during the Discs test if the PMS Controller did not complete an operation in the expected time period. For more information, look at the messages printed after the tests are complete.

PMS RAM addressing error - This message will appear during the Discs test if the PMS Controller does not seem to be using the 8560 RAM buffers set aside for its use. This may be due to a problem with the PMS Controller bus interface. If this only occurs with the hard disc, it may indicate a problem with the M1220 interface DMA sequencer.

PMS overran buffer. Attempting restart - This message will appear during the Discs test if the PMS Controller exceeded the boundaries of its data buffer in 8560 memory. Since the diagnostic program may have lost control, the program attempts to reinitialize itself after printing this message. The problem may be due to the PMS Controller's DMA sequencer that communicates with the 8560 bus, or to some other problem on the PMS Controller board.

Writing to unused block(s).... - This message is printed during the first pass of the Discs test to reassure the user that the only blocks written to by the test are those not used by TNIX.

CAUTION

When responding to the following error message, typing a "y" and RETURN will erase the inserted flexible disc.

Cannot locate TNIX (fbr) free blocks. OK to erase flex disc? - This message is printed during the Discs test if the diagnostics are unable to determine where to write on the flexible disc. Either the disc inserted does not have an fbr directory, the directory is corrupted, or parts of the directory are unreadable. Since the 8560 diagnostic disc has a valid fbr directory on it, this message should not appear unless you have changed discs. If you press RETURN, or n <CR>, the diagnostics program will perform a read-only test on the drive. If you press y <CR>, the diagnostics will assume this is a formatted "scratch" disc, and will write and read to random blocks all over the flexible disc. If you press the ESC key, the test will be aborted, and the program will tell you whether any read errors were detected while reading the directory. The program will also specify the type of read errors.

Disc just became ready - This message will be printed during the operation of the Discs test if the corresponding disc drive has changed its "ready" status to ready. For example, if you insert a disc into the flexible disc drive while diagnostics are running, this message will be displayed. After you have started a test pass, don't do anything that might change the ready status.

Disc just became not ready - This message will be printed during the operation of the Discs test if the corresponding disc drive has changed its "ready" status to not ready. For example, if you open the door of the flexible disc drive while diagnostics are running, this message will be displayed. After you have started a test pass, don't do anything that might change the ready status.

NNNNN recoverable errors - Errors were detected during operations on the previously specified drive, but the PMS Controller automatically retried the operation, and the errors were no longer present. Unless the number of recoverable errors is excessive (one or more per test pass), the errors may be ignored. Usually, these errors are due to disc media-related problems. If these errors occurred on a flexible disc, the disc is probably worn from use or the heads are dirty. If these errors occurred on a hard disc, you can use the syschk program under TNIX to make sure that TNIX never accesses the bad blocks. (Unlike TNIX, the diagnostics have access to the bad blocks).

NNNNN disc error(s) - Non-recoverable errors were detected during the Discs test. The following messages provide more details:

controller does not respond at address - A bus reply timeout occurred when the program tried to access the device register of the PMS Controller. This may be due to incorrectly placed jumpers on the PMS Controller, an incorrectly installed board, or a problem with the bus interface circuit on the PMS Controller.

PMS Controller board PROM part numbers: 160-1411-xx, 160-1410-xx - This message indicates which version of firmware is installed. The first part number displayed is the diagnostic PROM on the PMS Controller itself. The second part number is the PROM on the M1220 piggy-back board attached to the PMS Controller. The last two digits of each part number represent the version number. If the two PROMs are reversed, or if both PROMs are the same, the system will not boot.

NNNNN controller error(s) - The PMS Controller does not seem to be functioning properly. Generally, there will be an error code listed several lines below this message that indicates more specifically what the symptom is. Look at the error code before assuming the PMS Controller is faulty.

missing interrupts - The expected interrupts from the PMS Controller did not occur. Possible causes include:

- The PMS Controller may be waiting indefinitely for a particular signal to occur. (This would happen if the M1220 board is not connected to the PMS Controller, or if one of the cables to or from the hard disc drive has not been connected properly.)

- The PMS Controller may have its jumpers set for stand-alone diagnostics. (Remember that in normal operation, the PMS Controller will usually have a 5, a 0, or a 1 in its LED display while 8560 diagnostics are running.)

- If everything else seems to be normal, the interrupt logic on the PMS Controller board may be at fault.

flexible disc: description - This message describes which type of disc (if any) is inserted in the drive. This message also reports the density, whether the disc is double-sided, and whether the write-protect notch is covered.

hard disc n not ready - The specified drive did not return a ready status. Make sure all the cables are connected. If the disc has power applied, you will hear a steadily increasing whining noise as the disc comes up to speed after power-on. Also, make sure the heads have been fully unlocked after shipment. The problem is more likely to be caused by the hard disc and its associated circuitry than by the PMS Controller.

hard disc n capacity = NNNNNN blocks - This indicates the capacity of the hard disc. Each block holds 512 bytes of user data. If the number shown is less than 69,599 blocks, not all of the heads are accessible by the PMS Controller firmware.

non-standard disc size - The capacity of the disc drive previously specified is not correct. This may be due to a PMS Controller error, or to a disc drive problem.

<u>bad blocks include: NNNNNN NNNNNN</u> - This message indicates which blocks the PMS Controller had trouble reading. The program can report up to 52 different bad blocks. If this message follows the flexible disc message, the errors may be due to worn media or to an unformatted flexible disc. On the hard disc, the blocks may be blocks that TNIX has already recorded in its bad block list. Since the diagnostics do not look at the bad block list, they may be reporting irrelevant information. To make certain TNIX does not use the bad blocks, you may want to run the syschk program supplied with TNIX.

<u>(These should be in TNIX's bad block list. If you're not sure, run syschk.)</u> - Bad blocks were detected on the hard disc. Since the diagnostics do not use the bad block list, it is possible that the bad blocks reported by the diagnostics are ones that TNIX already knows about. To be safe, you should run syschk.

<u>(Try using a new disc and/or cleaning the heads)</u> - Errors that occurred while reading the flexible disc could be due to a worn disc or dirty heads. A head-cleaning procedure is described under "Alignment Aid" in Section 13 of this manual.

<u>error codes include NNNNNN NNNNNN</u> - This message displays up to five octal error codes for each disc drive. Most of these error codes are reported by the PMS Controller board; however, some special codes are generated by the diagnostic program. In general, if the high bit (bit 15) of the code is a 1, the error was non-recoverable. If bit 15 is a 0, the error may generally be ignored unless frequent (one or more recoverable errors per test pass).

The following error codes are generated by the diagnostic program:

- 177400 - invalid disc size for this drive
- 177401 - timeout and/or missing interrupt
- 177402 - PMS Controller is not addressing 8560 RAM correctly
- 177403 - the value written to the PMS Controller's device register (PMSCBPR) is not the value being used by the PMS Controller.
- 177404 - the PMS Controller completed a read operation, but did not put anything in the 8560's data buffer.
- 177405 - the data read from the disc is not the same as the data written to it.

The following error codes are returned by the PMS Controller firmware during self-test operations:

000004 - flexible disc not ready
100000 - DMA timeout
100001 - PMS ROM checksum error
100002 - PMS RAM error
100003 - flexible command not accepted
100005 - flexible disc fault
100006 - flexible disc seek error
100010 - DMA compare error
100011 - piggy-back board ROM checksum error
100012 - piggy-back board RAM error
100013 - timeout waiting for hard disc to become ready
100014 - hard disc seek error

In addition to the previous error codes, there are approximately 40 error codes that can be returned by the PMS Controller during normal operation. These error codes are listed under three categories: software interface errors, flexible disc errors, and hard disc errors.

Software interface errors

The following errors should never occur under normal circumstances. If any of these error codes is returned, reload the diagnostic software.

100400 - 8560 address out of range
101000 - odd 8560 address
101400 - odd byte count
102400 - invalid device number
104000 - invalid command code
104400 - utility command for busy device
105000 - align command for hard disc

Flexible disc errors

010400 - drive not ready
011000 - no track 0 signal
011400 - data overrun error
012000 - ID field CRC error
012400 - bad cylinder address in ID field
013000 - wrong cylinder address encountered in ID field
013400 - bad ID fields
014000 - missing data field address mark
014400 - missing ID field address mark
015000 - control field address mark detected
015400 - attempt to access sector beyond end of track
017000 - write-protected disc
016000 - invalid cylinder address
016400 - DMA timeout during disc read
017400 - DMA timeout during disc write
052000 - block number is too large

Hard disc errors

020400 - invalid hard disc command
021000 - invalid parameter byte
021400 - drive not ready
022000 - drive fault
022400 - illegal head or cylinder address
023000 - sector not found
023400 - data error
024000 - verify (compare) error
024400 - timeout error
025000 - hard disc positioner error
025400 - drive fault during write
026000 - Micropolis performed re-try
026400 - DMA timeout during disc read
027000 - ECC performed
027400 - DMA timeout during disc write
060400 - no spare sector on track
061000 - spare sector command not for hard disc
061400 - hard disc access timeout
062000 - block number is too large

LED ERROR MESSAGE SUMMARY

The disc-based diagnostics also use the five Utility board LEDs to display error information. (The LED error displays are discussed fully in Section 13 of this manual.) A summary of the error codes is shown in Table 16-2.

Table 16-2
Diagnostic Disc LED Error Codes

LEDs	Octal Value	Definition
_	33	Booting in file from disc
***_*	35	Printing label from disc
*****	37	Program started and issued a reset
_____	00	Program cleared LEDs after starting
____*	01	Initializing RAM variables and interrupt vectors, enabling LTC interrupts, and and verifying LTC frequency
___*_	02	Program checking which IOP channels have terminals
___**	03	Program checking which line printer ports have terminals
__*__	04	Printing "Press RETURN to select terminal" on all terminals
__*_*	05	Waiting for a terminal to send a return
__**_	06	Re-initializing terminal interfaces and variables
_*_*_	12	Illegal instruction trap (program not executing properly - could not recover)
_*_**	13	Memory management trap (program not executing properly - could not recover)
*____	20	Using terminal connected to HSI I/O 0
___	21	Using terminal connected to HSI I/O 1
*__*_	22	Using terminal connected to HSI I/O 2
*__**	23	Using terminal connected to HSI I/O 3
*_*__	24	Using terminal connected to HSI I/O 4
*_*_*	25	Using terminal connected to HSI I/O 5
*_**_	26	Using terminal connected to HSI I/O 6
*_***	27	Using terminal connected to HSI I/O 7
**___	30	Using terminal connected to LP2

Section 17

ACCESSORIES

Section 17

ACCESSORIES

STANDARD ACCESSORIES

The 8560 has the following standard accessories:

- TNIX Operating System 062-5882-00
- Diagnostic Software 062-5840-00
- User Manual 070-3940-00
- User Reference Manual 070-3941-00
- User Reference Booklet 070-3942-00
- 2 Blank Flexible Discs
- 1 Power Cord (Options A1 through A5)
- Shipping Restrainer (360-1073-00)
- Shipping Restrainer (360-1074-00)
- Installation Guide 070-3899-00

OPTIONAL ACCESSORIES

The 8560 has the following optional accessories:

- Service Manual 061-2521-00
- Qume Drive Service Manual 061-2383-00
- Micropolis Drive Service Manual

Section 18

INSTALLATION

ILLUSTRATIONS

Section 18

INSTALLATION

INTRODUCTION

This section provides procedures to install the 8560 MUSDU. It describes a basic system with 64-Kbytes of system memory and one IOP board serving a maximum of four HSI channels. Section 18 does not describe optional components. Installation procedures for options are given in each option's installation manual.

This section contains only minimum operating information. For more information on how to operate the 8560, refer to your System Users Manual.

In this section, we'll discuss the steps involved in unpacking, installing, and preparing the 8560 for operation. The following subjects will be covered:

- site preparation, including space and power requirements;
- unpacking the 8560, including storage and reshipping; and
- preparing the 8560 for operation.
- storage and reshipping

SITE SELECTION AND PREPARATION

The first consideration in selecting a work site is space. Two other criteria for selecting a work station are power requirements and environmental conditions. We'll discuss each of these points in turn.

SPACE REQUIREMENTS

Here are some things to consider when locating a worksite for the 8560:

- Adequate ventilation must be provided for the 8560.
- Room must be allowed at the rear of the unit for proper cable dress.
- Storage space should be close at hand for manuals and other documents.
- Space may be required for ongoing hardware development projects.

- Space will be required for a system terminal and perhaps a line printer.

- You will want to gain access to the inside of the unit, so make sure adequate space is available behind and to the sides of the unit for removing the top cover (unit should be rotated 180 degrees when removing the top cover). Figure 18-1 shows the 8560 dimensions. Figure 18-2 shows the required circuit board clearances. boards.

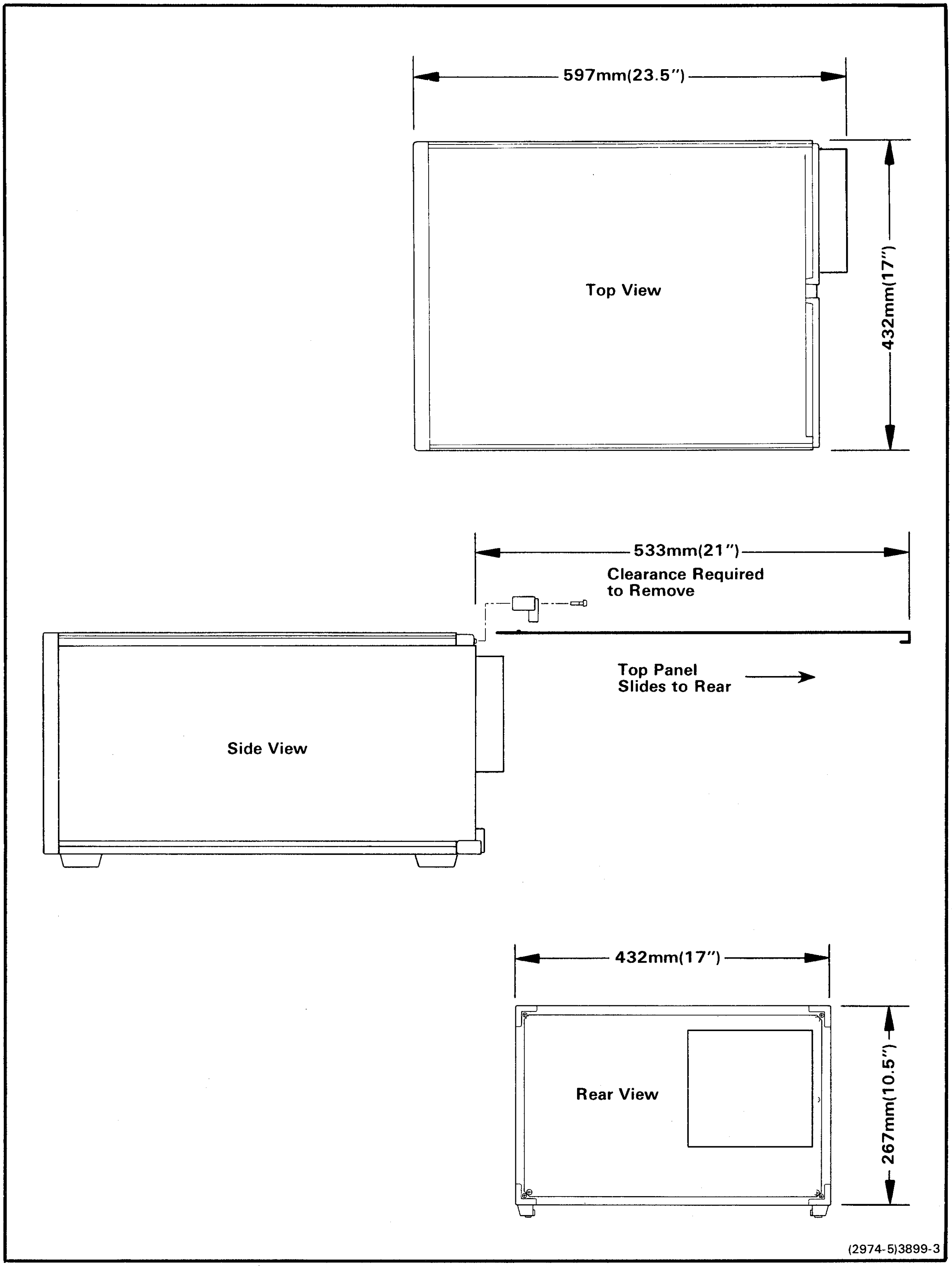

Fig. 18-1. 8560 Dimensions.

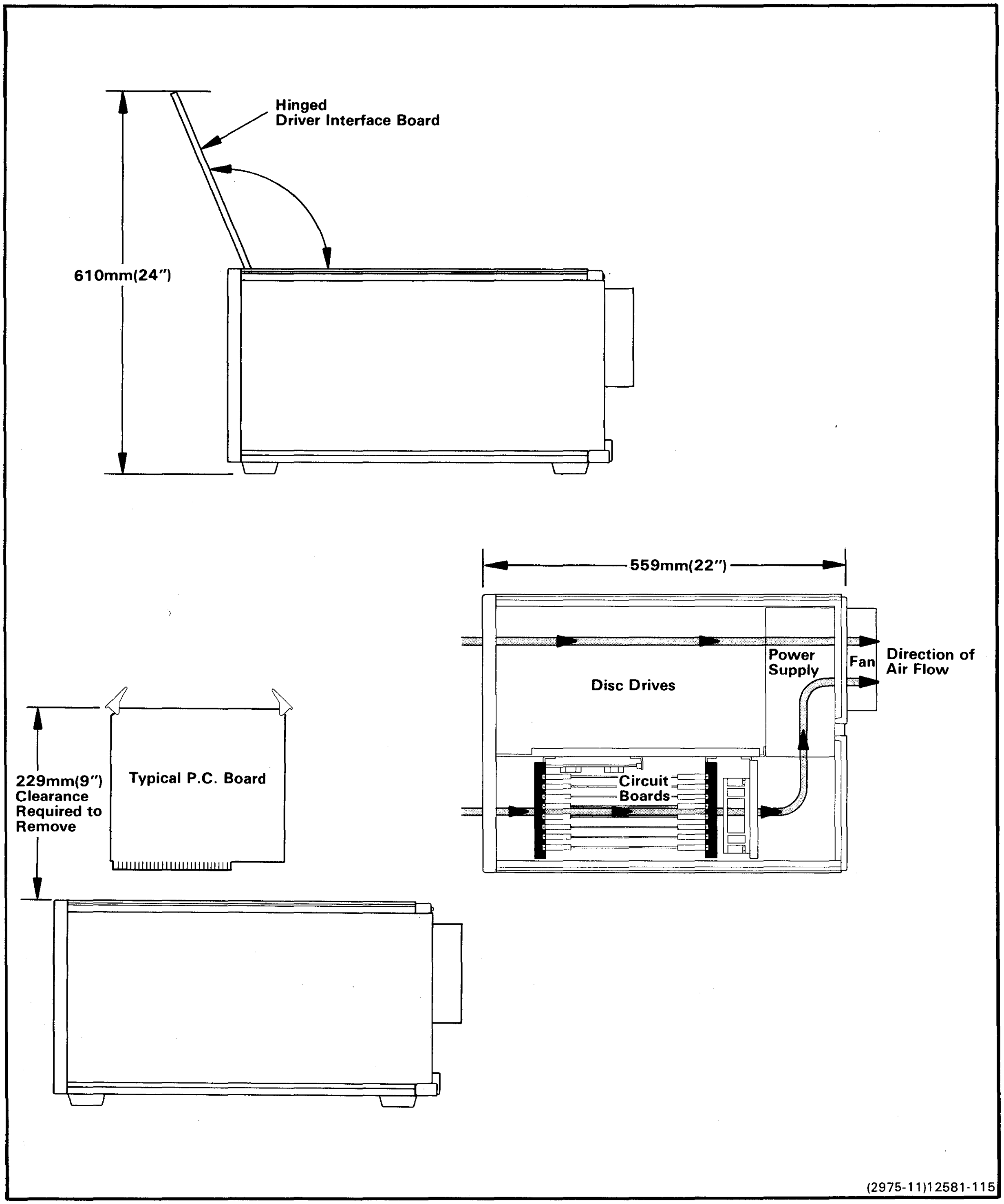

Fig. 18-2. Circuit board clearance requirements.

POWER REQUIREMENTS

The primary power requirements for the 8560 are as follows:

	115 Vac Nominal (90--132 Vac) or 230 Vac nominal (180--250 Vac)
Line Frequency	48 to 66 Hz
Line Current	8 Amps (maximum) @115V 4 Amps (maximum) @220V
Power Consumption	480 Watts

Certain electrical guidelines must be followed when preparing a work site for the 8560. They include:

1. All peripheral components at the work station must share common ground and neutral lines to avoid noisy grounds and ground loops.
2. All units must be properly grounded.
3. The work station should be on a separate power breaker switch.

ENVIRONMENTAL CONSIDERATIONS

The following considerations should be taken into account when preparing the work site.

- The area selected for the work station should be adequately lighted, air-conditioned, and dust-free.

  CAUTION

  Static electricity may damage components of the 8560. Use standard anti-static procedures when setting up the work site.

- The work area should be as static-free as possible. If carpet is used, the carpet must be static-free and treated with anti-static chemicals as often as required.
- The 8560 should be placed on a static-free work surface.
- Allowances must be made for adequate air exhaust at the rear of the unit (6" minimum).

UNPACKING THE 8560

Before you unpack the 8560, examine the carton for external damage. If you find any damage:

- Immediately notify the carrier who made delivery, and request inspection.
- Contact your nearest Tektronix Field Engineering Office or sales representative.
- Do not throw away the boxes.
- DO NOT TRY TO REPAIR THE INSTRUMENT.

REMOVING THE 8560 FROM THE CARTON

The 8560 unit is packed in a heavy-duty cardboard container, surrounded by foam packing material. A piece of cardboard covers the top of the unit. The power cord and options rest on the cardboard.

When you open the carton, remove the power cord and any other material that may rest on the cardboard, and set them aside. Remove the cardboard and set it aside.

WARNING

> Use caution when lifting the 8560 out of the box. The 8560 weighs 33 kg (72.5 pounds). Don't hurt yourself -- get some help.

Remove the 8560 and surrounding foam. Set the packing material aside (don't lose the packing material -- you'll need it again if you ever have to ship the 8560).

UNLOCKING THE HARD-DISC HEAD LOCKING DEVICE

The heads in the hard-disc drive are locked in place for protection during shipment. The locking device must be released before power is applied to the 8560.

1. After removing the 8560 from its packing carton set it on a flat surface, preferably the work site. Examine the outside of the 8560 for any damage received during shipping. If damage is found, follow the procedure found in "Repackaging and Reshipping" later in this section.

2. Turn the 8560 around so that the rear panel is facing you. Using a Phillips screwdriver, remove the two upper cover retainers, as shown in Fig. 18-3. Then slide the top cover towards you and off the 8560.

   Then remove the lower two cover retainers and remove both side panels in the same manner. For more information see Section 15.

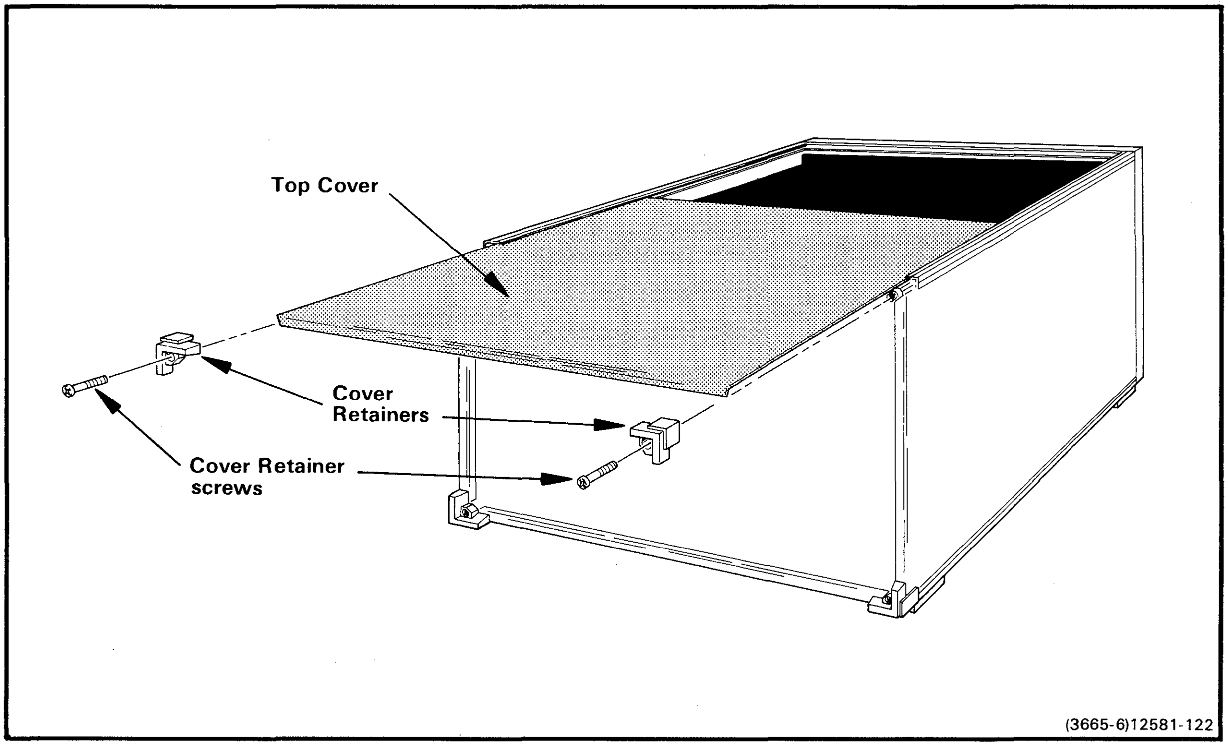

Fig. 18-3. Removing the 8560 top cover.

3. Remove the circuit board restrainer (see separate description later in this section) and remove all circuit boards from the card cage.

4. Using a normal size phillips-type screwdriver, remove the three mounting screws on the outside of the hard-disc drive, and the front inside screw. Refer to Fig. 18-4.

5. Using a stubby phillips-type screwdriver, remove the two inside screws that are accessible through the card cage.

6. At the rear of the unit, disconnect the power cable and the M1223-1 interface cable.

7. Close the door on the flexible disc drive.

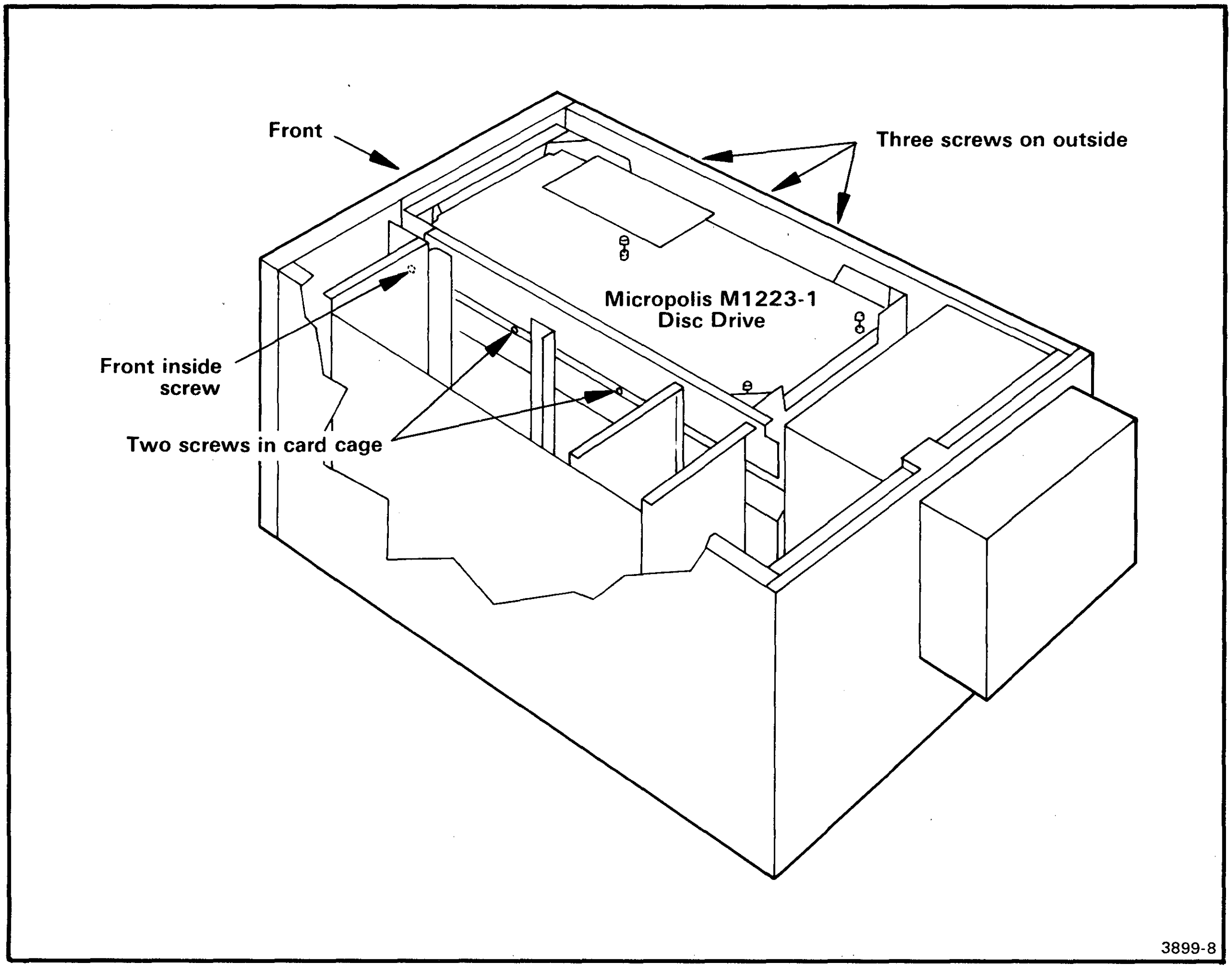

Fig. 18-4. Removal of hard-disc drive unit.

8. Lift the fixed-disc drive slightly; then carefully slide it forward until it protrudes about 3 inches through the mainframe front-panel opening.

9. The nylon locking device is located on the bottom of the disc-drive unit, near the front of the assembly. Using the special tool provided, or an equivalent wide-bladed tool, turn the screw 90 degrees clockwise, to the UNLOCK position.

10. Carefully slide the unit back into the mainframe through the front-panel opening until the front panel of the hard-disc drive unit is aligned with the front panel of the flexible disc unit.

11. Install the six mounting screws (removed in steps 4 and 5).

12. Connect the power and interface cables to the unit.

13. Install all circuit boards that were removed earlier. Be sure that circuit boards are returned to their original slots in the card cage.

REMOVING THE CIRCUIT BOARD RESTRAINER

Notice inside the 8560 that an aluminum circuit board restrainer covers the circuit boards. The restrainer holds the circuit boards in place during transport. Using a Phillips screwdriver, remove the restrainer as shown in Fig. 18-5.

CAUTION

> This step involves removing two machine screws from the 8560. Don't drop the screws into the 8560. Severe electrical damage can occur if they are left inside the unit.

Set the screws and nuts aside, and lift out the restrainer. Store the restrainer with the packing material in case you need it later. Replace the two screws and two nuts, being careful not to drop them inside the 8560.

Examine the inside of the 8560 for any loose circuit boards, cables, or connectors. If you see any damage, follow the procedure given for reporting damage.

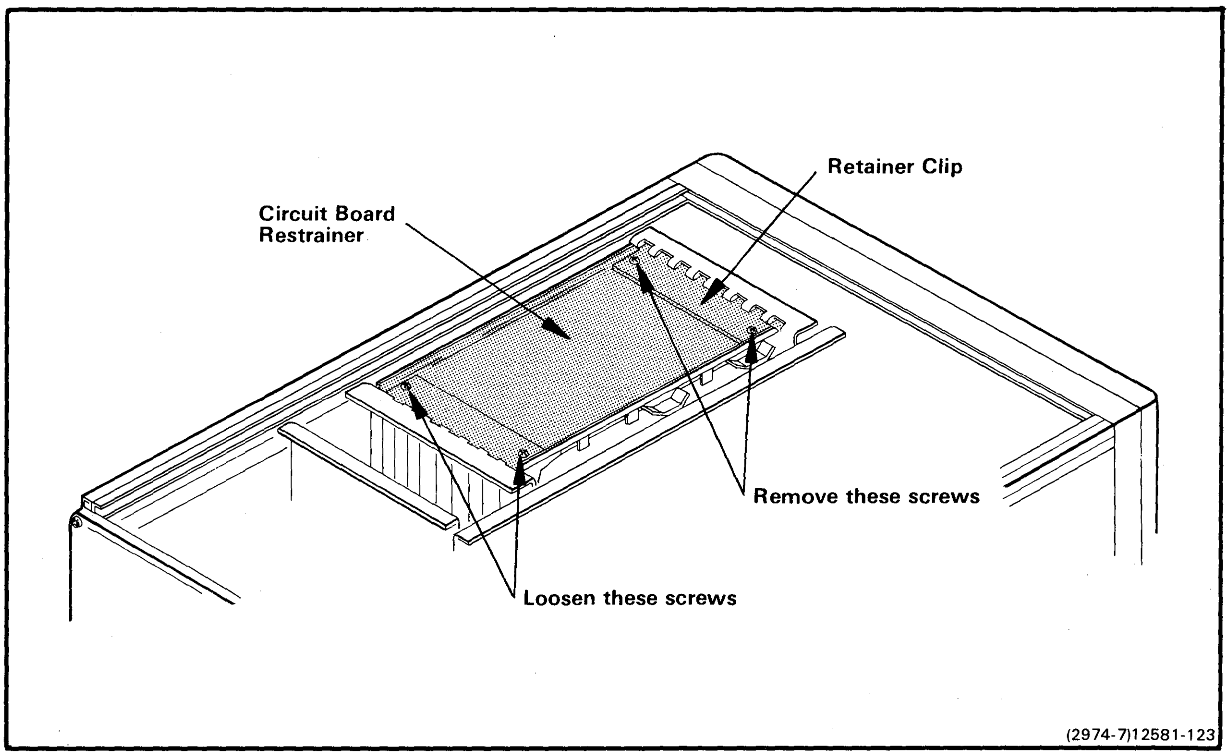

Fig. 18-5. Removing the 8560 circuit board restrainer.

REMOVING THE HARD-DISC ROTOR RESTRAINT

Movement of the disc rotor in the hard-disc drive unit during shipment is prevented by a rubber shipping restraint. This restraint and its associated caution tag must be removed before power is applied to the 8560.

1. Using a flat-blade screwdriver, loosen the three captive retaining screws on the hinged Driver Interface board (see Fig.18-6).

2. Swing the hinged board up to allow access to the hard-disc drive rotor.

3. Carefully untwist the tie wire and remove the caution tag from the disc brake arm (see Fig. 18-7).

4. Remove the rubber shipping restraint. Store this restraint with the packing materials.

<u>NOTE</u>

The rubber shipping restraint must be installed on the disc rotor any time the 8560 is shipped or stored.

5. Lower the hinged board to its normal position, then tighten the three captive screws.

6. Install the top cover and the two upper cover retainers. Tighten the retainer screws securely.

REMOVING THE FLEXIBLE DISC HEAD RESTRAINT

To prevent damage to the read/write heads in the flexible-disc drive assembly, a cardboard head restraint is installed in the disc slot during shipment or storage of the 8560. Before you operate the 8560, remove this restraint; pull outward on the cardboard tab that protrudes through the front panel of the flexible-disc drive unit. Store the cardboard head restraint with the other packing materials, for use in case the unit is stored or shipped.

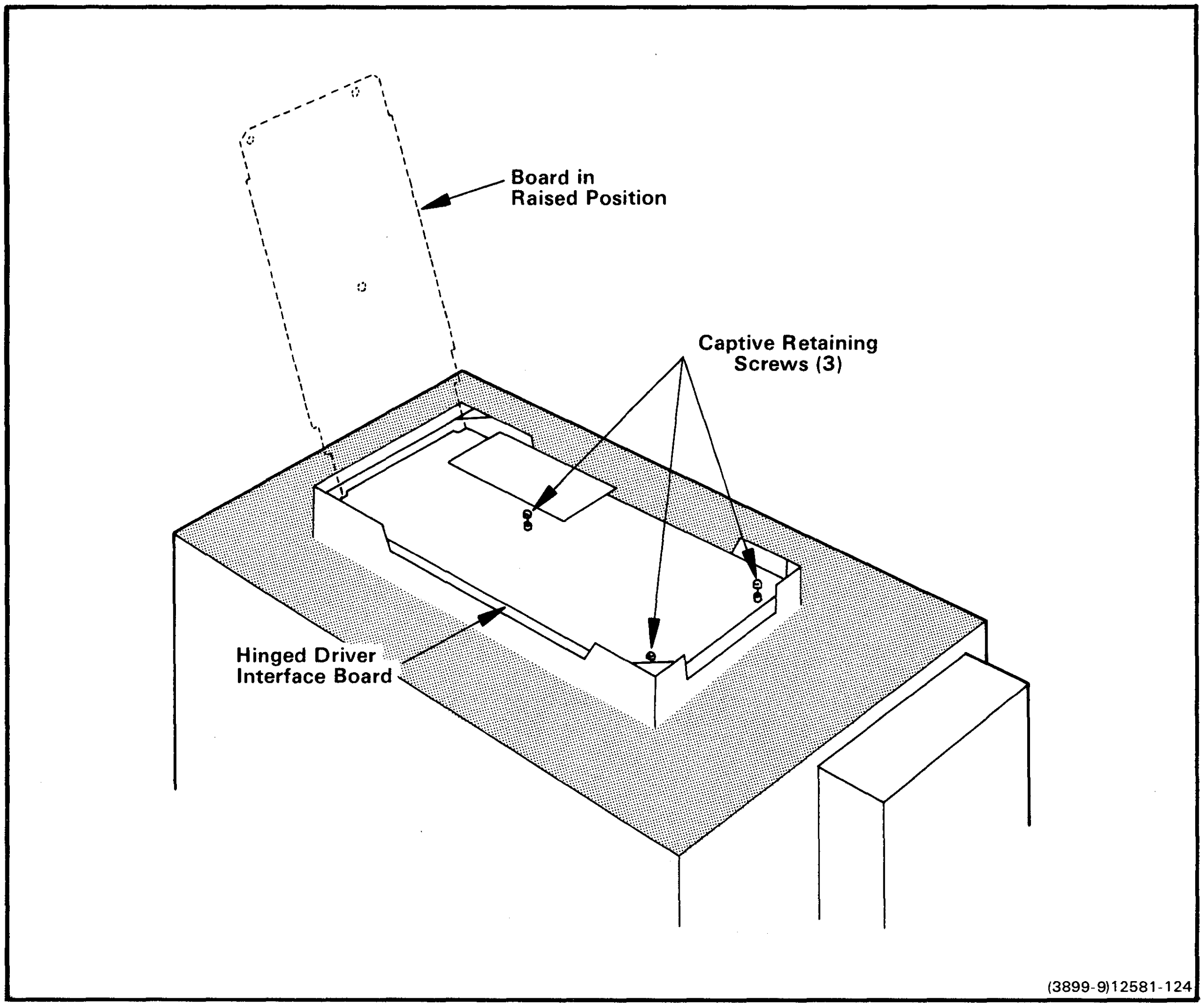

Fig. 18-6. Location of driver interface board retaining screws.

INTERNAL CABLES

The 8560 has ten internal cables. They are associated with these assemblies:

- the I/O Adapter board (2)
- the Micropolis hard disc drive (3)
- the Qume flexible disc drive (3)
- the front panel (1)
- power supply and Main Interconnect board (1)

Check that all cables are connected tightly.

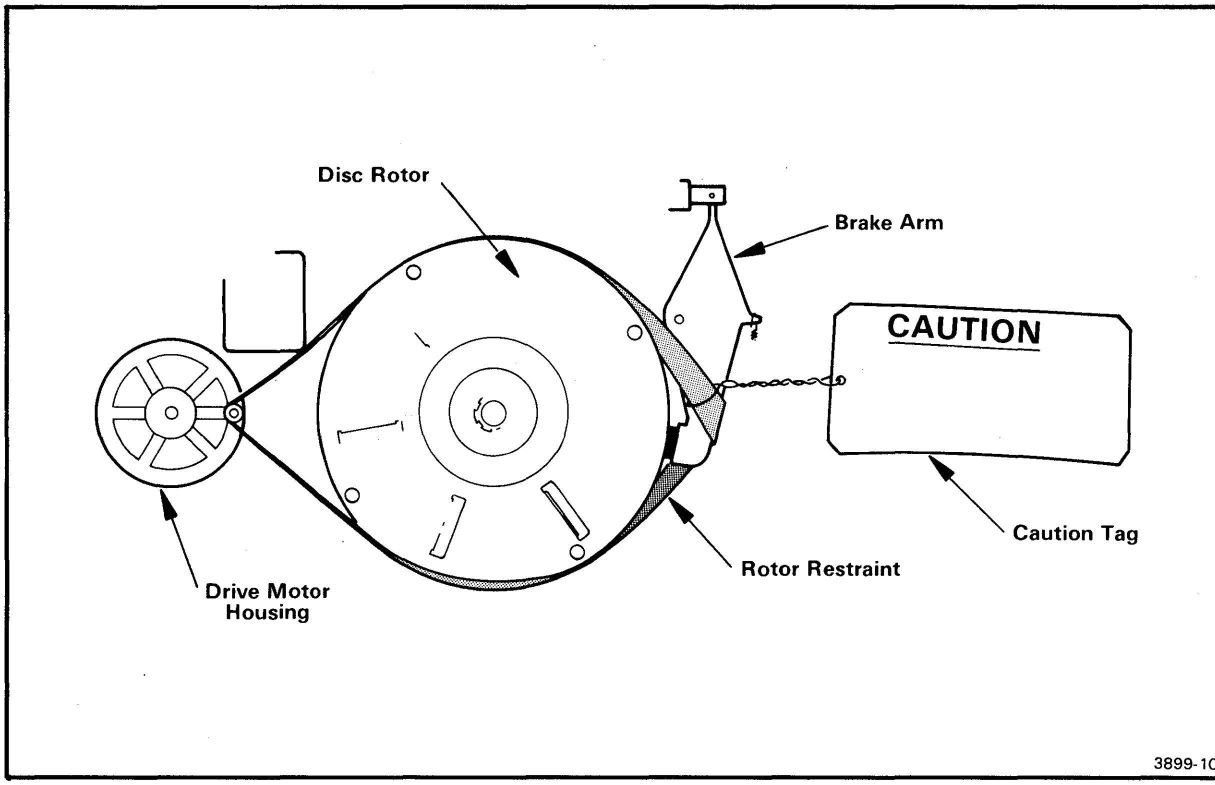

Fig. 18-7. Hard-disc drive rotor shipping restraint.

REPLACING THE COVERS

The 8560 covers are replaced in the following manner:

1. From the rear panel, slide the cover into the appropriate two grooves located along the instruments edges.

2. Continue to insert the cover into the grooves, until the right-angle flange at its rear edge is flush with the rear panel of the 8560 chassis.

3. Place a cover retainer at each upper rear corner of the 8560, covering the right-angle flange of the top cover.

4. Thread the screws through the cover retainers and tighten them.

PREPARING THE 8560 FOR OPERATION

SELECTING THE PROPER PRIMARY VOLTAGE

The 8560 is configured to plug into the primary power source available at your work site. If, for some reason, you need to change power sources, use the following procedure. Refer to Fig. 18-8.

1. Notice the small plate at the lower part of the rear panel. panel. Using a Phillips screw driver, remove the screws holding the plate.

2. The power range selector switch is located under the plate. It selects either 115 or 230 volt 8560-operation.

3. Set the switch to the correct primary power range.

   CAUTION

   The fuse rating depends on the voltage selected. For 115 volt operation, use a 3AG, 8 amp, 250 volt, medium-blow (5 sec.) fuse. For 230 volt operation, use a 3AG, 4 Amp, 250 volt, medium-blow (5 sec.) fuse. The proper fuse must be used.

4. Install a fuse with the proper rating into the line fuse holder.

5. Replace the switch cover plate so that the new voltage range is indicated.

RACK MOUNT PROCEDURE

If the 8560 includes the rack-mount option, you'll find rack-mount hardware in the bottom of the 8560 shipping carton. The rack-mount slides are already mounted to the sides of the 8560. The slide guides must be installed in the equipment rack.

Figure 18-9 illustrates the guide orientation. Install the guides in the rack with the hardware provided. Tighten all screws securely. When the guides are mounted, slide the 8560 into the rack, keeping cable dress in mind.

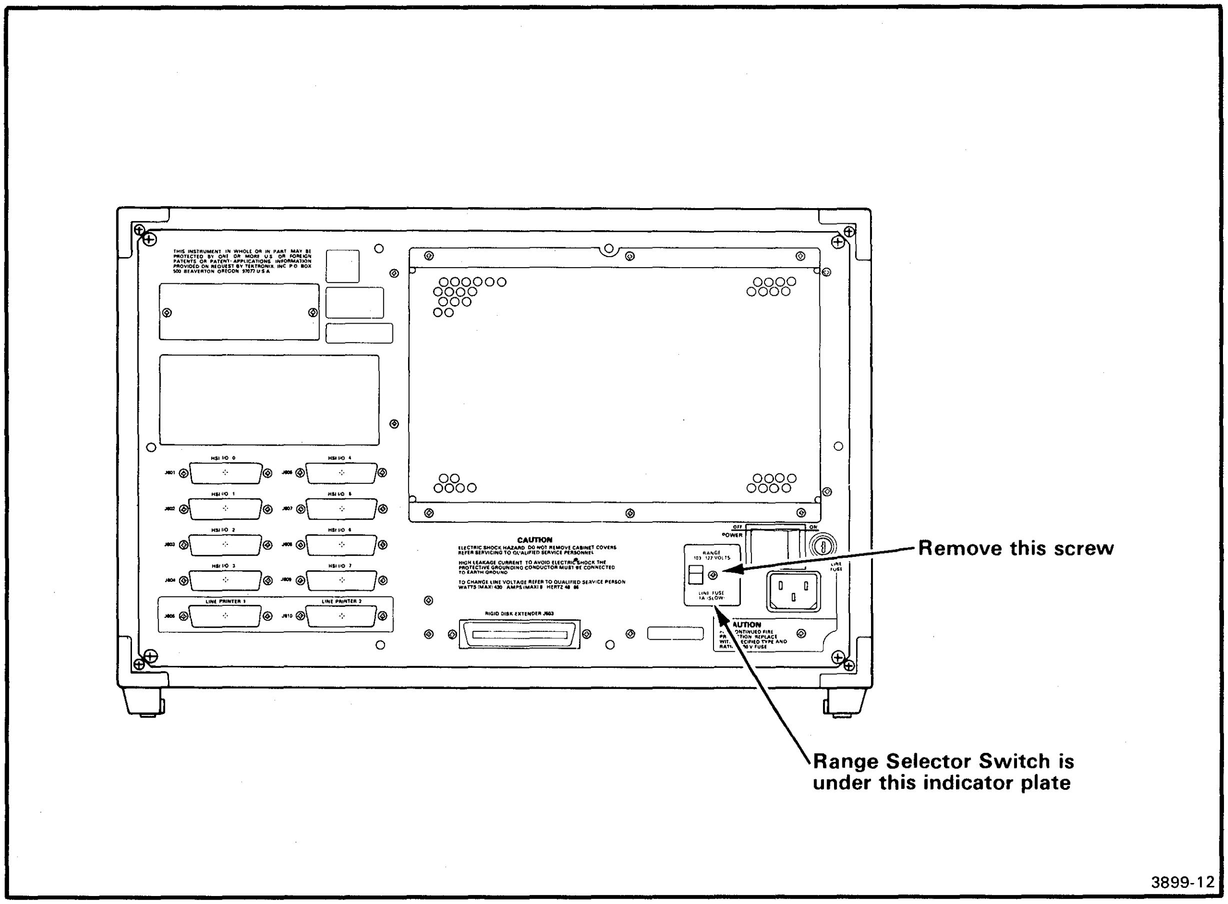

Fig. 18-8. Selecting the primary power voltage range.

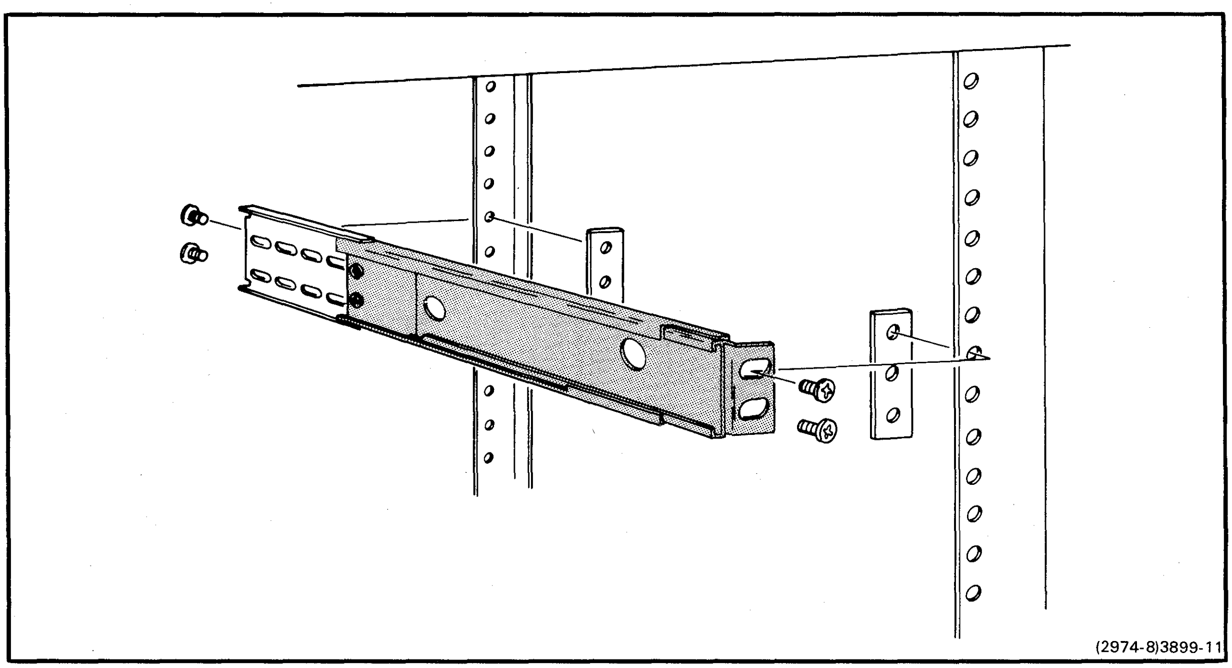

Fig. 18-9. Rack-mount guide orientation.

STORAGE AND RESHIPPING

When the 8560, is to be placed in storage or reshipped, it's best to repack it as it was originally shipped from the factory. For this reason, be sure to save the carton and packing material in which your equipment was shipped. To repack the 8560, simply follow the unpacking instructions in reverse order. The following paragraphs describe further considerations that must be made when storing or reshipping an 8560.

STORAGE

Observe the following considerations whenever you place the 8560 in storage:

- Provide adequate protection from dust.
- Do not exceed the humidity or temperature limitations of the instrument, as outlined under Specifications, Section 6 of this manual.
- Store the carton upright. Do not compress the carton or stack heavy objects upon it.

RESHIPPING

If the unit must be shipped to the factory or service center, the following steps should be taken:

- Note the serial number of the unit on the back panel and any other relevant numbers or symbols needed for identification. (This information is required for fault notification correspondence, which should be sent separately.)
- Set the disc-locking device on the hard disc to "LOCK". To access the lock, use the procedure given to unlock the device earlier in this section.
- Wrap the unit in durable waterproof material such as heavy polyethylene, and tape securely. This step should be carried out only in a dry atmosphere, and with the unit cool to the touch.
- Pack the unit in a sturdy box (heavy cardboard is acceptable for land shipments), lined with 76 mm (3 inches) of medium density foam or expanded polystyrene.

- Cables, adapters, and other accessories should be wrapped separately and attached by tape to the inner liner at a break in the foam, or taped to a separate platform mounted above the foam or polystyrene (as used in the original shipping). In the latter case, a sheet of 25 mm (1 inch) minimum thick foam should be taped above the cable package.

- Seal the carton with reinforced packaging tape and identify the sender, the unit number, and the serial number on the outside of the carton.

- Notify the factory or your sales representative of your intent to ship the instrument, and await their acknowledgement, before you do ship an 8560.

Section 19

REFERENCE MATERIAL

ILLUSTRATIONS

TABLES

Section 19

REFERENCE MATERIAL

INTRODUCTION

This section describes Main Interconnect board connector-wiring. Section 19 allows you to relate at a quick glance pins and signal names for each system board. Furthermore, Section 19 shortly describes the 8560 bus signals and their functions.

BACK PLANE CONNECTOR CONFIGURATIONS

Figures 19-1 through 19-6 show eight Main Interconnect board connector configurations. As shown, each figure repeats all LSI-11/23 lines , hence relating the 100-line 8560 bus to the 72-line DEC Q-bus.

Since a connector configuration depends on the type of board the connector serves, each connector configuration is different. Connectors for board pairs, however, are identical. Connectors for Memory board 1 and 2 are wired identical, as are the connectors for IOP 1 and 2.

The following pages show the Main Interconnect board connector configurations for these connectors:

- J3/J4 -- LSI-11/23 Processor (Fig. 19-1)
- J6 -- PMS controller (Fig. 19-2)
- J8 -- Optional 64 K-word Memory board (Fig. 19-3)
- J9 -- Standard 64-K-word Memory board (Fig. 19-3)
- J10 -- Future GPIB Option (Fig. 19-4)
- J11 -- I/O Processor board 2 (Fig. 19-5)
- J12 -- I/O Processor board 1 (Fig. 19-5)
- J13 -- Utility board (Fig. 19-6)

J3 LSI-11/23 PROCESSOR

COMPONENT SIDE (LSI-11 bus)

	2	
	4	
	6	
	8	
	1Ø	
	12	
	14	
	16	
	18	
	2Ø	
BIRQ5 L	22	
BIRQ6 L	24	
BDAL 16 L	26	
BDAL 17 L	28	
SSPARE 1	3Ø	
SSPARE 2	32	
SSPARE 3	34	
GND	36	
MSPARE A	38	
MSPARE A	4Ø	
GND	42	
BDMR L	44	
BHALT L	46	
BREF L	48	
+12 B	5Ø	
GND	52	
PSPARE 1	54	
+5 B	56	
	58	
	6Ø	
	62	
	64	
BDCOK H	66	
BPOK H	68	
BDAL 18 L	7Ø	
BDAL 19 L	72	
BDAL 2Ø L	74	
BDAL 21 L	76	
SSPARE 8	78	
GND	8Ø	
MSPARE B	82	
MSPARE B	84	
GND	86	
BSACK L	88	
BIRQ7 L	9Ø	
BEVNT L	92	
+12 B	94	
GND	96	
PSPARE 2	98	
+5V	1ØØ	

BACK SIDE (LSI-11 bus)

	1	
	3	
	5	
	7	
	9	
	11	
	13	
	15	
	17	
	19	
+5V	21	
-12V	23	
GND	25	
+12V	27	
BDOUT L	29	
BRPLY L	31	
BDIN L	33	
BSYNC L	35	
BWTBT L	37	
BIRQ L	39	
BIAKI L	41	
BIAKO L	43	
BBS7 L	45	
BDMGI L	47	
BDMGO L	49	
BINIT L	51	
BDALØ L	53	
BDAL1 L	55	
	57	
	59	
	61	
	63	
+5V	65	
-12V	67	
GND	69	
+12V	71	
BDAL2 L	73	
BDAL3 L	75	
BDAL4 L	77	
BDAL5 L	79	
BDAL6 L	81	
BDAL7 L	83	
BDAL8 L	85	
BDAL9 L	87	
BDAL1Ø L	89	
BDAL11 L	91	
BDAL12 L	93	
BDAL13 L	95	
BDAL14 L	97	
BDAL15 L	99	

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Fig. 19-1. J3 LSI-11-23 Processor.

J6 PMS CONTROLLER

COMPONENT SIDE

LSI-11 bus		
	2	DRIVE SELECT4 L
	4	DIRECTION L
	6	STEP L
	8	WRITE DATA L
	1Ø	WRITE DATA L
	12	TRACK ØØ L
	14	WRITE PROTECT L
	16	REA DATA L
	18	*
	2Ø	*
BIRQ5 L	22	
BIRQ6 L	24	
BDAL 16 L	26	
BDAL 17 L	28	
SSPARE 1	3Ø	
SSPARE 2	32	
SSPARE 3	34	
GND	36	
MSPARE A	38	
MSPARE A	4Ø	
GND	42	
BDMR L	44	
BHALT L	46	
BREF L	48	
+12 B	5Ø	
GND	52	
PSPARE 1	54	
+5 B	56	
	58	NOT USED
	6Ø	NOT USED
	62	W/WRWRL
	64	RD FLTRSW/WRWR L
BDCOK H	66	
BPOK H	68	
BDAL 18 L	7Ø	
BDAL 19 L	72	
BDAL 2Ø L	74	
BDAL 21 L	76	
SSPARE 8	78	
GND	8Ø	
MSPARE B	82	
MSPARE B	84	
GND	86	
BSACK L	88	
BIRQ7 L	9Ø	
BEVNT L	92	
+12 B	94	
GND	96	
PSPARE 2	98	
+5V	1ØØ	

BACK SIDE

LSI-11 bus		
	1	DRIVE SELECT3 L
	3	DRIVE SELECT2 L
	5	DRIVE SELECT1 L
	7	*
	9	READY L
	11	MUDEX L
	13	HEADLOAD L
	15	*
	17	SIDE SELECT L
	19	DISC CHANGE L
+5V	21	
-12V	23	
GND	25	
+12V	27	
BDOUT L	29	
BRPLY L	31	
BDIN L	33	
BSYNC L	35	
BWTBT L	37	
BIRQ L	39	
BIAKI L	41	
BIAKO L	43	
BBS7 L	45	
BDMGI L	47	
BDMGO L	49	
BINIT L	51	
BDALØ L	53	
BDAL1 L	55	
	57	TWO SIDED L
	59	*
	61	*
	63	NOT USED
+5V	65	
-12V	67	
GND	69	
+12V	71	
BDAL2 L	73	
BDAL3 L	75	
BDAL4 L	77	
BDAL5 L	79	
BDAL6 L	81	
BDAL7 L	83	
BDAL8 L	85	
BDAL9 L	87	
BDAL1Ø L	89	
BDAL11 L	91	
BDAL12 L	93	
BDAL13 L	95	
BDAL14 L	97	
BDAL15 L	99	

* CONNECTED BUT NOT USED

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Fig. 19-2. J6 PMS controller.

J8 AND J9 SYSTEM MEMORY BOARDS 2 AND 1

COMPONENT SIDE

LSI-11

	2	
	4	
	6	
	8	
	1Ø	
	12	
	14	
	16	
	18	
	2Ø	
BIRQ5 L	22	
BIRQ6 L	24	
BDAL 16 L	26	
BDAL 17 L	28	
SSPARE 1	3Ø	
SSPARE 2	32	
SSPARE 3	34	
GND	36	
MSPARE A	38	
MSPARE A	4Ø	
GND	42	
BDMR L	44	
BHALT L	46	
BREF L	48	
+12 B	5Ø	
GND	52	
PSPARE 1	54	
+5 B	56	
	58	
	6Ø	
	62	
	64	
BDCOK H	66	
BPOK H	68	
BDAL 18 L	7Ø	
BDAL 19 L	72	
BDAL 2Ø L	74	
BDAL 21 L	76	
SSPARE 8	78	
GND	8Ø	
MSPARE B	82	
MSPARE B	84	
GND	86	
BSACK L	88	
BIRQ7 L	9Ø	
BEVNT L	92	
+12 B	94	
GND	96	
PSPARE 2	98	
+5V	1ØØ	

BACK SIDE

LSI-11

	1	
	3	
	5	
	7	
	9	
	11	
	13	
	15	
	17	
	19	
+5V	21	
-12V	23	
GND	25	
+12V	27	
BDOUT L	29	
BRPLY L	31	
BDIN L	33	
BSYNC L	35	
BWTBT L	37	
BIRQ L	39	
BIAKI L	41	
BIAKO L	43	
BB57 L	45	
BDM6I L	47	
BDM6O L	49	
BINIT L	51	
BDALØ L	53	
BDAL1 L	55	
	57	
	59	
	61	
	63	
+5V	65	
-12V	67	
GND	69	
+12V	71	
BDAL2 L	73	
BDAL3 L	75	
BDAL4 L	77	
BDAL5 L	79	
BDAL6 L	81	
BDAL7 L	83	
BDAL8 L	85	
BDAL9 L	87	
BDAL1Ø L	89	
BDAL11 L	91	
BDAL12 L	93	
BDAL13 L	95	
BDAL14 L	97	
BDAL15 L	99	

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Fig. 19-3. J8 and J9 System memory board 2 and 1.

J10 FUTURE GPIB OPTION

COMPONENT SIDE

LSI-11 bus

	2	*
	4	*
	6	*
	8	*
	10	*
	12	*
	14	*
	16	*
	18	*
	20	*
BIRQ5 L	22	
BIRQ6 L	24	
BDAL 16 L	26	
BDAL 17 L	28	
SSPARE 1	30	
SSPARE 2	32	
SSPARE 3	34	
GND	36	
MSPARE A	38	
MSPARE A	40	
GND	42	
BDMR L	44	
BHALT L	46	
BREF L	48	
+12 B	50	
GND	52	
PSPARE 1	54	
+5 B	56	
	58	*
	60	*
	62	*
	64	*
BDCOK H	66	
BPOK H	68	
BDAL 18 L	70	
BDAL 19 L	72	
BDAL 20 L	74	
BDAL 21 L	76	
SSPARE 8	78	
GND	80	
MSPARE B	82	
MSPARE B	84	
GND	86	
BSACK L	88	
BIRQ7 L	90	
BEVNT L	92	
+12 B	94	
GND	96	
PSPARE 2	98	
+5V	100	

BACK SIDE

LSI-11 bus

	1	*
	3	*
	5	*
	7	*
	9	*
	11	*
	13	*
	15	*
	17	*
	19	*
+5V	21	
-12V	23	
GND	25	
+12V	27	
BDOUT L	29	
BRPLY L	31	
BDIN L	33	
BSYNC L	35	
BWTBT L	37	
BIRQ L	39	
BIAKI L	41	
BIAKO L	43	
BBS7 L	45	
BDMGI L	47	
BDMGO L	49	
BINIT L	51	
BDAL0 L	53	
BDAL1 L	55	
	57	*
	59	*
	61	*
	63	*
+5V	65	
-12V	67	
GND	69	
+12V	71	
BDAL2 L	73	
BDAL3 L	75	
BDAL4 L	77	
BDAL5 L	79	
BDAL6 L	81	
BDAL7 L	83	
BDAL8 L	85	
BDAL9 L	87	
BDAL10 L	89	
BDAL11 L	91	
BDAL12 L	93	
BDAL13 L	95	
BDAL14 L	97	
BDAL15 L	99	

* CONNECTED, BUT NOT USED

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Fig. 19-4. J10 Unused -- future GPIB option.

J11 AND J12 I/P PROCESSOR BOARDS 2 AND 1

COMPONENT SIDE

LSI-11 bus			
	2	CLK	
	4	DTR-0	L
	6	SERIN-Ø	L
	8	2SA-Ø	H
	1Ø	CTS-3	L
	12	SEROUT	L
	14	DTR-3	L
	16	HSI-3	L
	18	SERIN-3	L
	2Ø	LINE PR	
BIRQ5 L	22		
BIRQ6 L	24		
BDAL 16 L	26		
BDAL 17 L	28		
SSPARE 1	3Ø		
SSPARE 2	32		
SSPARE 3	34		
GND	36		
MSPARE A	38		
MSPARE A	4Ø		
GND	42		
BDMR L	44		
BHALT L	46		
BREF L	48		
+12 B	5Ø		
GND	52		
PSPARE 1	54		
+5 B	56		
	58	NOT USED	
	6Ø	NOT USED	
	62	NOT USED	
	64	NOT USED	
BDCOK H	66		
BPOK H	68		
BDAL 18 L	7Ø		
BDAL 19 L	72		
BDAL 2Ø L	74		
BDAL 21 L	76		
SSPARE 8	78		
GND	8Ø		
MSPARE B	82		
MSPARE B	84		
GND	86		
BSACK L	88		
BIRQ7 L	9Ø		
BEVNT L	92		
+12 B	94		
GND	96		
PSPARE 2	98		
+5V	1ØØ		

BACK SIDE

LSI-11 bus			
	1	CTS-Ø	L
	3	SEROUT-Ø	L
	5	HSI-Ø	L
	7	CTS-1	L
	9	SEROUT-1	L
	11	DTR-1	L
	13	HSI-1	L
	15	SERIN-1	L
	17	CTS-2	L
	19	SEROUT-2	L
+5V	21		
-12V	23		
GND	25		
+12V	27		
BDOUT L	29		
BRPLY L	31		
BDIN L	33		
BSYNC L	35		
BWTBT L	37		
BIRQ L	39		
BIAKI L	41		
BIAKO L	43		
BB57 L	45		
BDMGI L	47		
BDMGO L	49		
BINIT L	51		
BDALØ L	53		
BDAL1 L	55		
	57	NOT USED	
	59	DTR-2	L
	61	HSI-2	L
	63	SERIN-2	L
+5V	65		
-12V	67		
GND	69		
+12V	71		
BDAL2 L	73		
BDAL3 L	75		
BDAL4 L	77		
BDAL5 L	79		
BDAL6 L	81		
BDAL7 L	83		
BDAL8 L	85		
BDAL9 L	87		
BDAL1Ø L	89		
BDAL11 L	91		
BDAL12 L	93		
BDAL13 L	95		
BDAL14 L	97		
BDAL15 L	99		

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Fig. 19-5. J11 and J12 I/O Processor 2 and 1.

J13 UTILITY BOARD

COMPONENT SIDE

LSI-11 bus			
	2	POWER	L
	4	DTR2	L
	6	EXTCLKQ	L
	8	SEROUT2	L
	10	SERIN2	L
	12	RTS 2	L
	14	CTS 2	L
	16	NOT USED	
	18	NOT USED	
	20	ACOK	H
BIRQ5 L	22		
BIRQ6 L	24		
BDAL 16 L	26		
BDAL 17 L	28		
SSPARE 1	30		
SSPARE 2	32		
SSPARE 3	34		
GND	36		
MSPARE A	38		
MSPARE A	40		
GND	42		
BDMR L	44		
BHALT L	46		
BREF L	48		
+12 B	50		
GND	52		
PSPARE 1	54		
+5 B	56		
	58	RUN/HALT	L
	60	RESTART	L
	62	PROCBUSY	L
	64	NOT USED	
BDCOK H	66		
BPOK H	68		
BDAL 18 L	70		
BDAL 19 L	72		
BDAL 20 L	74		
BDAL 21 L	76		
SSPARE 8	78		
GND	80		
MSPARE B	82		
MSPARE B	84		
GND	86		
BSACK L	88		
BIRQ7 L	90		
BEVNT L	92		
+12 B	94		
GND	96		
PSPARE 2	98		
+5V	100		

BACK SIDE

LSI-11 bus			
	1	DCON	L
	3	DTRI	L
	5	EXTCLK	
	7	SERIN	
	9	SEROUT	
	11	RST1	L
	13	CTS1	L
	15	NOT USED	
	17	NOT USED	
	19		
+5V	21		
-12V	23		
GND	25		
+12V	27		
BDOUT L	29		
BRPLY L	31		
BDIN L	33		
BSYNC L	35		
BWTBT L	37		
BIRQ L	39		
BIAKI L	41		
BIAKO L	43		
BBS7 L	45		
BDMGI L	47		
BDMGO L	49		
BINIT L	51		
BDAL0 L	53		
BDAL1 L	55		
	57	HSFE	L
	59	NOT USED	
	61	NOT USED	
	63	NOT USED	
+5V	65		
-12V	67		
GND	69		
+12V	71		
BDAL2 L	73		
BDAL3 L	75		
BDAL4 L	77		
BDAL5 L	79		
BDAL6 L	81		
BDAL7 L	83		
BDAL8 L	85		
BDAL9 L	87		
BDAL10 L	89		
BDAL11 L	91		
BDAL12 L	93		
BDAL13 L	95		
BDAL14 L	97		
BDAL15 L	99		

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Fig. 19-6. J13 Utility board.

8560 BUS SIGNALS

Table 19-1 describes the LSI-11/23 bus signals.

Table 19-1. LSI-11/23 Bus Signal Descriptions

Mnemonic	Description
BSPARE1 BSPARE2	Bus Spare (Not Assigned, Reserved for DEC use.)
BADL16 BADL17	Extended address bits
GND	Ground--System signal ground and dc return.
BDMRL	Direct Memory Access (DMA) Request--A device asserts this signal to request bus mastership. The processor arbitrates bus mastership between itself and all DMA devices on the bus. If the processor is not bus master (it has completed a bus cycle and BSYNC L is not being asserted by the processor), it grants bus mastership to the requesting device by asserting BDMGO L. The device responds by negating BDMR L and asserting BSACK L.
BHALT L	Processor Halt--When BHALT L is asserted, the processor responds by halting normal program execution. External interrupts are ignored but memory refresh interrupts (enabled if W4 on the processor module is removed) and DMA request/grant sequences are enabled. When in the HALT state, the processor executes the ODT microcode and the console device operation is invoked.
BREF L	Memory Refresh--Asserted by a processor microcode generated refresh interrupt sequence (when enabled) or by an external device. This signal forces all dynamic MOS memory units to be activated for each BSYNC L/BDIN L bus transaction.
BDCOK H	DC Power OK--Power supply-generated signal that is asserted when there is sufficient dc voltage available to sustain reliable system operation.

Table 19-1. (cont.) LSI-11/23 Bus Signal Descriptions

Mnemonic	Description
BPOK H	Power OK--Asserted by the power supply when primary power is normal. When negated during processor operation, a power fail trap sequence is initiated.
BSACK L	This signal is asserted by a DMA device in response to the processor's BDMGO L signal, indicating that the DMA device is bus master.
BSPARE6	Bus Spare (Not assigned. Reserved for DEC use.)
BEVNT L	External Event Interrupt Request--When the processor is asserted, the processor responds (if PS bit 7 is 00 by entering a service routine via vector address 100 (octal). A typical use of this is a line time clock interrupt.
PSPARE4	Spare (Not assigned).
PSPARE2	Spare (Not assigned).
+5	+5 V Power--Normal +5 V dc system power.
+5	+5 V Power--Normal +5 V dc system power.
-12	-12 V Power--12 V dc power for devices requiring this voltage.
+12	+12 V Power--+12 V dc system power.
BDOUT L	Data Output--BDOUT, when asserted, implies that valid data is available on BDALO-15 L and that an output transfer, with respect to the bus master device, is taking place. BDOUT L signal must assert BRPLY L to complete the transfer.

Table 19-1. (cont.) LSI-11/23 Bus Signal Descriptions

Mnemonic	Description
BRPLY L	Reply--BRPLY is asserted in response to BDIN L or BDOUT L and during 1AK transaction. BRPLY L is generated by a slave device to indicate that its data is on the BDAL bus or that it has accepted output data from the bus.
BDIN L	Data Input--BDIN L is used for two types of bus operation: 1. When asserted during BSYNC L time, BDIN L implies an input transfer with respect to the current bus master, and requires a response (BRPLY L). BDIN L is asserted when the master device is ready to accept data from a slave device. 2. When asserted without BSYNC, BDIN L indicates that an interrupt operation is occurring.
BSYNC L	Synchronize--BSYNC L is asserted by the bus master to indicate that it has placed an address on BDALO--15. The transfer is in process until BSYNC L is negated.
BWTBT L	Write/BWTBT L is used in two ways to control a bus cycle: 1. It is asserted during the leading edge of BSYNC L to indicate that an output sequence is to follow (DATO or DATOB), rather than an input sequence. 2. It is asserted during BDOUT L, in a DATOB bus cycle, for byte addressing.
BIRQ L	Interrupt Request--A device asserts this signal when its Interrupt Enable and Interrupt Request flip-flops are set. If the processor's PS word bit 7 is 0, the processor responds by acknowledging the request by asserting BDIN L and BIAKO L.

Table 19-1. (cont.) LSI-11/23 Bus Signal Descriptions

Mnemonic	Description
BIAKI L BIAKO L	Interrupt Acknowledge Input and Interrupt Acknowledge Output--This is an interrupt acknowledge signal which is generated by the processor in response to an interrupt request (BIRQ L). The processor asserts BIAKO L, which is routed to the BIAKI L pin of the first device on the bus. If it is requesting an interrupt, it will inhibit passing BIAKO L. If it is not asserting BIRQ L, the device will pass BIAKI L to the next (lower priority) device via its BIAKO L pin and the lower priority device's BIAKI L pin.
BBS7 L	Bank 7 Select--The bus master asserts BBS7 L when an address in the upper 4K bank (address in the 28-32K range) is placed on the bus. BSYNC L is then asserted and BBS7 L remains active for the duration of the addressing portion of the bus cycle.
BDMGI L BDMGO L	DMA Grant-input and DMA Grant Output--This is the processor-generated daisy-chained signal which grants bus mastership to the highest priority DMA device along the bus. The processor generates BDMGO L, which is routed to the BDMGI L pin of the first device on the bus. If the processor requests the bus, it will inhibit passing BDMGO L. If it is not requesting the bus, it will pass the BDMGI L signal to the next (lower priority) device via its BDMGO L pin. The device asserting BDMR L is the device requesting the bus, and it responds to the BDMGI L signal by negative BDMR, asserting BSACK L, assuming bus mastership, and executing the required bus cycle.

Table 19-1. (cont.) LSI-11/23 Bus Signal Descriptions

Mnemonic	Description
BINIT L	Initialize--BINIT is asserted by the processor to initialize or clear all devices connected to the I/O bus. The signal is generated in response to a power-up condition (the negated condition of BDCOK H).
BDALO L BDALI L	Data/Address Lines--These two lines are part of the 16-line data/address bus over which address and data information are placed on the bus by the bus master device. The same device then either receives input data from, or outputs data to the addressed lines.
+5	+5 V Power--Normal +5 V dc system power.
-12	-12 V Power-- -12 V dc power for devices requiring this voltage.
+12	+12 V Power-- +12 V system power.
BDAL2 L BDAL3 L BDAL4 L BDAL5 L BDAL6 L BDAL7 L BDAL8 L BDAL9 L BDAL10 L BDAL11 L BDAL12 L BDAL13 L BDAL14 L BDAL15 L	Data Address Lines.

SECTION 20

REPLACEABLE ELECTRICAL PARTS

PARTS ORDERING INFORMATION

Replacement parts are available from or through your local Tektronix, Inc. Field Office or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number, instrument type or number, serial number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix, Inc. Field Office or representative will contact you concerning any change in part number.

Change information, if any, is located at the rear of this manual.

LIST OF ASSEMBLIES

A list of assemblies can be found at the beginning of the Electrical Parts List. The assemblies are listed in numerical order. When the complete component number of a part is known, this list will identify the assembly in which the part is located.

CROSS INDEX-MFR. CODE NUMBER TO MANUFACTURER

The Mfr. Code Number to Manufacturer index for the Electrical Parts List is located immediately after this page. The Cross Index provides codes, names and addresses of manufacturers of components listed in the Electrical Parts List.

ABBREVIATIONS

Abbreviations conform to American National Standard Y1.1.

COMPONENT NUMBER (column one of the Electrical Parts List)

A numbering method has been used to identify assemblies, subassemblies and parts. Examples of this numbering method and typical expansions are illustrated by the following:

Example a.

component number

A23R1234 — A23 R1234

Assembly number — Circuit number

Read: Resistor 1234 of Assembly 23

Example b.

component number

A23A2R1234 — A23 A2 R1234

Assembly number — Subassembly number — Circuit number

Read: Resistor 1234 of Subassembly 2 of Assembly 23

Only the circuit number will appear on the diagrams and circuit board illustrations. Each diagram and circuit board illustration is clearly marked with the assembly number. Assembly numbers are also marked on the mechanical exploded views located in the Mechanical Parts List. The component number is obtained by adding the assembly number prefix to the circuit number.

The Electrical Parts List is divided and arranged by assemblies in numerical sequence (e.g., assembly A1 with its subassemblies and parts, precedes assembly A2 with its subassemblies and parts).

Chassis-mounted parts have no assembly number prefix and are located at the end of the Electrical Parts List.

TEKTRONIX PART NO. (column two of the Electrical Parts List)

Indicates part number to be used when ordering replacement part from Tektronix.

SERIAL/MODEL NO. (columns three and four of the Electrical Parts List)

Column three (3) indicates the serial number at which the part was first used. Column four (4) indicates the serial number at which the part was removed. No serial number entered indicates part is good for all serial numbers.

NAME & DESCRIPTION (column five of the Electrical Parts List)

In the Parts List, an Item Name is separated from the description by a colon (:). Because of space limitations, an Item Name may sometimes appear as incomplete. For further Item Name identification, the U.S. Federal Cataloging Handbook H6-1 can be utilized where possible.

MFR. CODE (column six of the Electrical Parts List)

Indicates the code number of the actual manufacturer of the part. (Code to name and address cross reference can be found immediately after this page.)

MFR. PART NUMBER (column seven of the Electrical Parts List)

Indicates actual manufacturers part number.

CROSS INDEX—MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip
000FG	RIFA WORLD PRODUCTS INC.	7625 BUSH LAKE RD P.O. BOX 35263	MINNEAPOLIS, MN 55435
000FJ	MARCOM SWITCHES INC.	67 ALBANY STREET	CAZENOVIA, N.Y. 13035
000GU	SUPERTEX INC.	1225 BORDEAUX DRIVE	SUNNYVALE, CA 94086
000IG	FUJITSU-AMERICA INC.	1208 E. ARQUES AVE.	SUNNYVALE, CA 94086
000JK	HITACHI AMERICAN LTD	C/O CROWN ELECTRONICS	TUALATIN, ORE 97062
00853	SANGAMO ELECTRIC CO., S. CAROLINA DIV.	P O BOX 128	PICKENS, SC 29671
01121	ALLEN-BRADLEY COMPANY	1201 2ND STREET SOUTH	MILWAUKEE, WI 53204
01281	TRW ELECTRONIC COMPONENTS, SEMICONDUCTOR OPERATIONS	14520 AVIATION BLVD.	LAWNDALE, CA 90260
01295	TEXAS INSTRUMENTS, INC., SEMICONDUCTOR GROUP	P O BOX 5012, 13500 N CENTRAL EXPRESSWAY	DALLAS, TX 75222
01807	PETERSEN RADIO COMPANY, INC.	2800 WEST BROADWAY	COUNCIL BLUFFS, IN 51501
02111	SPECTROL ELECTRONICS CORPORATION	17070 EAST GALE AVENUE	CITY OF INDUSTRY, CA 91745
03508	GENERAL ELECTRIC COMPANY, SEMI-CONDUCTOR PRODUCTS DEPARTMENT	ELECTRONICS PARK	SYRACUSE, NY 13201
04222	AVX CERAMICS, DIVISION OF AVX CORP.	P O BOX 867, 19TH AVE. SOUTH	MYRTLE BEACH, SC 29577
04713	MOTOROLA, INC., SEMICONDUCTOR PROD. DIV.	5005 E MCDOWELL RD,PO BOX 20923	PHOENIX, AZ 85036
05828	GENERAL INSTRUMENT CORP ELECTRONIC SYSTEMS DIV.	600 W JOHN ST.	HICKSVILLE LI, NY 11802
07263	FAIRCHILD SEMICONDUCTOR, A DIV. OF FAIRCHILD CAMERA AND INSTRUMENT CORP.	464 ELLIS STREET	MOUNTAIN VIEW, CA 94042
09023	CORNELL-DUBILIER ELECTRONIC DIVISION FEDERAL PACIFIC ELECTRIC CO.	2652 DALRYMPLE ST.	SANFORD, NC 27330
09353	C AND K COMPONENTS, INC.	103 MORSE STREET	WATERTOWN, MA 02172
12954	SIEMENS CORPORATION, COMPONENTS GROUP	8700 E THOMAS RD, P O BOX 1390	SCOTTSDALE, AZ 85252
12969	UNITRODE CORPORATION	580 PLEASANT STREET	WATERTOWN, MA 02172
14433	ITT SEMICONDUCTORS	3301 ELECTRONICS WAY P O BOX 3049	WEST PALM BEACH, FL 33402
14552	MICRO SEMICONDUCTOR CORP.	2830 E FAIRVIEW ST.	SANTA ANA, CA 92704
14752	ELECTRO CUBE INC.	1710 S. DEL MAR AVE.	SAN GABRIEL, CA 91776
15454	RODAN INDUSTRIES, INC.	2905 BLUE STAR ST.	ANAHEIM, CA 92806
15476	DIGITAL EQUIPMENT CORP.	146 MAIN ST.	MAYNARD, MA 01754
16299	CORNING GLASS WORKS, ELECTRONIC COMPONENTS DIVISION	3900 ELECTRONICS DR.	RALEIGH, NC 27604
18324	SIGNETICS CORP.	811 E. ARQUES	SUNNYVALE, CA 94086
20932	EMCON DIV OF ILLINOIS TOOL WORKS INC.	11620 SORRENTO VALLEY RD P O BOX 81542	SAN DIEGO, CA 92121
24546	CORNING GLASS WORKS, ELECTRONIC COMPONENTS DIVISION	550 HIGH STREET	BRADFORD, PA 16701
27012	MICRO DEVICES, CORPORATION	1881 SOUTHLAND BLVD.	DAYTON, OHIO 45439
27014	NATIONAL SEMICONDUCTOR CORP.	2900 SEMICONDUCTOR DR.	SANTA CLARA, CA 95051
32997	BOURNS, INC., TRIMPOT PRODUCTS DIV.	1200 COLUMBIA AVE.	RIVERSIDE, CA 92507
34335	ADVANCED MICRO DEVICES	901 THOMPSON PL.	SUNNYVALE, CA 94086
34649	INTEL CORP.	3065 BOWERS AVE.	SANTA CLARA, CA 95051
50088	MOSTEK CORP.	1400 UPFIELD DR.	CARROLLTON, TX 75006
50522	MONSANTO CO., ELECTRONIC SPECIAL PRODUCTS	3400 HILLVIEW AVENUE	PALO ALTO, CA 94304
50558	ELECTRONIC CONCEPTS, INC.	526 INDUSTRIAL WAY WEST	EATONTOWN, NJ 07724
52847	UNITED STATES CRYSTAL CORPORATION	3605 MCCART	FORT WORTH, TX 76110
54473	MATSUSHITA ELECTRIC, CORP. OF AMERICA	1 PANASONIC WAY	SECAUCUS, NJ 07094
54563	SANIVOID CO.	881 S GRAND AVE.	PASADENA, CA 91105
55210	GETTIG ENG. AND MFG. COMPANY	PO BOX 85, OFF ROUTE 45	SPRING MILLS, PA 16875
55680	NICHICON/AMERICA/CORP.	6435 N PROESEL AVENUE	CHICAGO, IL 60645
56289	SPRAGUE ELECTRIC CO.	87 MARSHALL ST.	NORTH ADAMS, MA 01247
56708	ZILOG INC.	14060 BUBB RD.	CUPERTINO, CA 95014
59660	TUSONIX INC.	2155 N FORBES BLVD	TUCSON, AZ 85705
71400	BUSSMAN MFG., DIVISION OF MCGRAW-EDISON CO.	2536 W. UNIVERSITY ST.	ST. LOUIS, MO 63107
71468	ITT CANNON ELECTRIC	666 E. DYER RD.	SANTA ANA, CA 92702
72619	DIALIGHT, DIV. AMPEREX ELECTRONIC	203 HARRISON PLACE	BROOKLYN, NY 11237
72982	ERIE TECHNOLOGICAL PRODUCTS, INC.	644 W. 12TH ST.	ERIE, PA 16512
73138	BECKMAN INSTRUMENTS, INC., HELIPOT DIV.	2500 HARBOR BLVD.	FULLERTON, CA 92634
75042	TRW ELECTRONIC COMPONENTS, IRC FIXED RESISTORS, PHILADELPHIA DIVISION	401 N. BROAD ST.	PHILADELPHIA, PA 19108
75378	CTS KNIGHTS, INC.	400 REIMANN AVE.	SANDWICH, IL 60548

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CROSS INDEX—MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip
75915	LITTELFUSE, INC.	800 E. NORTHWEST HWY	DES PLAINES, IL 60016
80009	TEKTRONIX, INC.	P O BOX 500	BEAVERTON, OR 97077
81483	INTERNATIONAL RECTIFIER CORP.	9220 SUNSET BLVD.	LOS ANGELES, CA 90069
82877	ROTRON, INC.	7-9 HASBROUCK LANE	WOODSTOCK, NY 12498
84411	TRW ELECTRONIC COMPONENTS, TRW CAPACITORS	112 W. FIRST ST.	OGALLALA, NE 69153
87034	ILLUMINATED PRODUCTS INC., A SUB OF OAK INDUSTRIES, INC.	2620 SUSAN ST, PO BOX 11930	SANTA ANA, CA 92711
90201	MALLORY CAPACITOR CO., DIV. OF P. R. MALLORY AND CO., INC.	3029 E. WASHINGTON STREET P. O. BOX 372	INDIANAPOLIS, IN 46206
91637	DALE ELECTRONICS, INC.	P. O. BOX 609	COLUMBUS, NE 68601
93410	ESSEX INTERNATIONAL, INC., CONTROLS DIV. LEXINGTON PLANT	P. O. BOX 1007	MANSFIELD, OH 44903

Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A10	670-7208-00			CKT BOARD ASSY:MAIN INTERCONNECT	80009	670-7208-00
	----- -----			(NO ELECTRICAL PARTS)		
A15	119-1447-00			CKT BOARD ASSY:MODULE	54563	5013326-00
A20	670-7218-00			CKT BOARD ASSY:UTILITY	80009	670-7218-00
A25	670-7184-00			CKT BOARD ASSY:64K MEMORY	80009	670-7184-00
	----- -----			(STANDARD AND OPTION 03 ONLY)		
A30	670-7330-00			CKT BOARD ASSY:I/O PROCESSOR	80009	670-7330-00
	----- -----			(STANDARD AND OPTION 03 ONLY)		
A35	670-7308-00			CKT BOARD ASSY:I.O ADAPTER	80009	670-7308-00
A40	670-7306-00			CKT BOARD ASSY:I/O CONNECTOR	80009	670-7306-00
A45	670-7185-00	B010100	B010173	CKT BOARD ASSY:PMS CONTROLLER	80009	670-7185-00
A45	670-7185-01	B010174		CKT BOARD ASSY:PMS CONTROLLER	80009	670-7185-01
A50	670-7186-00			CKT BOARD ASSY:M1220 IFC	80009	670-7186-00
A60	670-7412-00			CKT BOARD ASSY:PS INTERCONNECT	80009	670-7412-00
A62	670-7183-00			CKT BOARD ASSY:INVERTER	80009	670-7183-00
A64	670-7182-00			CKT BOARD ASSY:REGULATOR	80009	670-7182-00
A66	670-7181-00			CKT BOARD ASSY:SECONDARY	80009	670-7181-00
A68	670-6237-00			CKT BOARD ASSY:SD PS CAPACITOR	80009	670-6237-00
A70	670-7474-00			CKT BOARD ASSY:FRONT PANEL	80009	670-7474-00
A15	----- -----			CKT BOARD ASSY:MODULE		
A15C1	283-0786-00			CAP.,FXD,MICA D:745PF,1%,500V	09023	CD19FD(745)F03
A15C2	283-0786-00			CAP.,FXD,MICA D:745PF,1%,500V	09023	CD19FD(745)F03
A15C3	290-0297-00			CAP.,FXD,ELCTLT:39UF,10%,10V	56289	150D396X9010B2
A15C4	281-0813-00			CAP.,FXD CER DI:0.047UF,20%,50V	04222	GC705-E-473M
A15C5	281-0813-00			CAP.,FXD CER DI:0.047UF,20%,50V	04222	GC705-E-473M
A15C6	281-0813-00			CAP.,FXD CER DI:0.047UF,20%,50V	04222	GC705-E-473M
A15C7	281-0813-00			CAP.,FXD CER DI:0.047UF,20%,50V	04222	GC705-E-473M
A15C8	281-0813-00			CAP.,FXD CER DI:0.047UF,20%,50V	04222	GC705-E-473M
A15C9	281-0813-00			CAP.,FXD CER DI:0.047UF,20%,50V	04222	GC705-E-473M
A15C10	281-0813-00			CAP.,FXD CER DI:0.047UF,20%,50V	04222	GC705-E-473M
A15C11	281-0813-00			CAP.,FXD CER DI:0.047UF,20%,50V	04222	GC705-E-473M
A15C12	281-0813-00			CAP.,FXD CER DI:0.047UF,20%,50V	04222	GC705-E-473M
A15C13	281-0813-00			CAP.,FXD CER DI:0.047UF,20%,50V	04222	GC705-E-473M
A15C14	281-0813-00			CAP.,FXD CER DI:0.047UF,20%,50V	04222	GC705-E-473M
A15C15	281-0813-00			CAP.,FXD CER DI:0.047UF,20%,50V	04222	GC705-E-473M
A15C16	281-0813-00			CAP.,FXD CER DI:0.047UF,20%,50V	04222	GC705-E-473M
A15C17	281-0813-00			CAP.,FXD CER DI:0.047UF,20%,50V	04222	GC705-E-473M
A15C18	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	04222	GC70-1C103K
A15C19	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	04222	GC70-1C103K
A15C20	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	04222	GC70-1C103K
A15C21	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	04222	GC70-1C103K
A15C22	283-0198-00			CAP.,FXD,CER DI:0.22UF,20%,50V	72982	8121N083Z5U0224
A15C23	283-0198-00			CAP.,FXD,CER DI:0.22UF,20%,50V	72982	8121N083Z5U0224
A15C24	283-0198-00			CAP.,FXD,CER DI:0.22UF,20%,50V	72982	8121N083Z5U0224
A15C25	283-0198-00			CAP.,FXD,CER DI:0.22UF,20%,50V	72982	8121N083Z5U0224
A15C26	283-0198-00			CAP.,FXD,CER DI:0.22UF,20%,50V	72982	8121N083Z5U0224
A15C27	290-0135-00			CAP.,FXD,ELCTLT:15UF,20%,20V	56289	150D156X0020B2
A15C28	290-0135-00			CAP.,FXD,ELCTLT:15UF,20%,20V	56289	150D156X0020B2
A15C29	290-0261-00			CAP.,FXD,ELCTLT:6.8UF,10%,35V	12954	D6R8B35K1
A15C30	281-0813-00			CAP.,FXD CER DI:0.047UF,20%,50V	04222	GC705-E-473M
A15C31	281-0813-00			CAP.,FXD CER DI:0.047UF,20%,50V	04222	GC705-E-473M
A15C32	281-0813-00			CAP.,FXD CER DI:0.047UF,20%,50V	04222	GC705-E-473M
A15C33	281-0813-00			CAP.,FXD CER DI:0.047UF,20%,50V	04222	GC705-E-473M
A15C34	283-0796-00			CAP.,FXD,MICA DI:100PF,5%,500V	09023	CD10FD101J03
A15D1	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R

Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A15E1	156-0948-00			MICROCIRCUIT,DI:QUAD D FLIP-FLOP	01295	SN74S175J
A15E2	156-0180-00			MICROCIRCUIT,DI:QUAD 2-INPUT NAND GATE	01295	SN74S00(N OR J)
A15E3	156-0738-00			MICROCIRCUIT,DI:QUADR HEX D TYPE FF	80009	156-0738-00
A15E4	156-1058-00			MICROCIRCUIT,DI:OCTAL SCHMITT TRIGGER BFR	01295	SN74S240J
A15E5	156-1046-00			MICROCIRCUIT,DI:OCTAL D TYPE EDGE TRIG FF	01295	SN74LS113
A15E6	156-1600-00			MICROCIRCUIT,DI:DUAL RETRIG MONO MULTIVIB	01295	SN74LS123NP3
A15E7	307-0676-00			RES NTWK,FXD,FI:14,330 OHM,14,680 OHM,0.1W	01121	316E331681
A15E9	156-0459-00			MICROCIRCUIT,DI:QUAD 2-INPUT AND GATE	01295	SN74S08(N OR J)
A15E10	156-0865-00			MICROCIRCUIT,DI:OCTAL D TYPE FF W/CLEAR	01295	SN74LS273 N OR J
A15E11	156-0388-00			MICROCIRCUIT,DI:DUAL D-TYPE FLIP-FLOP	80009	156-0388-00
A15E12	118-0646-00			MICROCKT,INTFC:QUAD UNIFIED BUS XCVR	27014	DS8641N
A15E13	156-1179-00			MICROCIRCUIT,DI:OCTAL BUFFER W/3 STATE	01295	74S241N
A15E14	156-0323-00			MICROCIRCUIT,DI:HEX. INVERTER	01295	SN74S04N
A15E15	118-1108-00			OSCILLATOR:13.824MHZ,0.05%	54563	1812131-00
A15E17	156-0718-00			MICROCIRCUIT,DI:TRIPLE 3-INP POS-NOR GATES	80009	156-0718-00
A15E18	156-0304-00			MICROCIRCUIT,DI:DUAL 4-INPUT,NAND GATE	18324	N74S20A
A15E19	156-1055-00			MICROCIRCUIT,DI:QUAD NOR UNIFIED BUS RCVR	27014	DS8640N
A15E20	156-0914-00			MICROCIRCUIT,DI:OCT ST BFR W/3-STATE OUT	01295	SN74LS240
A15E21	156-0703-00			MICROCIRCUIT,DI:4-2-3-2 INPUTAND-OR GATES	07263	74S64PC
A15E22	156-1046-00			MICROCIRCUIT,DI:OCTAL D TYPE EDGE TRIG FF	01295	SN74LS113
A15E23	118-1003-00			MICROCIRCUIT,DI:32 X 8 TS PROM	54563	23266A1-00
A15E24	156-0331-00			MICROCIRCUIT,DI:DUAL D-TYPE,FLIP-FLOP	80009	156-0331-00
A15E25	156-1055-00			MICROCIRCUIT,DI:QUAD NOR UNIFIED BUS RCVR	27014	DS8640N
A15E26	307-0406-00			RES.,FXD,FILM:NETWORK,4.3 AND 7.5K OHM,2%	91637	LDP16-00-5XX
A15E27	156-0735-00			MICROCIRCUIT,DI:4-BIT BISTABLE LATCH	80009	156-0735-00
A15E28	156-0480-00			MICROCIRCUIT,DI:QUAD 2-INPUT AND GATE	01295	SN74LS08(N OR J)
A15E29	156-0388-00			MICROCIRCUIT,DI:DUAL D-TYPE FLIP-FLOP	80009	156-0388-00
A15E30	156-0914-00			MICROCIRCUIT,DI:OCT ST BFR W/3-STATE OUT	01295	SN74LS240
A15E31	118-1106-00			MICROCIRCUIT,DI:DATA CONTROL HYBRID	54563	5700000-01
A15E32	156-0739-00			MICROCIRCUIT,DI:QUAD 2-INP OR GATE	80009	156-0739-00
A15E33	156-0690-00			MICROCIRCUIT,DI:QUAD 2-INP NOR GATE	01295	SN74S02N
A15E34	118-0646-00			MICROCKT,INTFC:QUAD UNIFIED BUS XCVR	27014	DS8641N
A15E35	118-1389-00			MICROCIRCUIT,DI:QUAD J-K FLIP FLOP	54563	1915367-00
A15E36	156-0386-00			MICROCIRCUIT,DI:TRIPLE 3-INPUT NAND GATE	04713	SN74LS10N OR J
A15E37	156-1618-00			MICROCIRCUIT,DI:QUAD BUS TRANSCEIVER	34335	AM2908DCB
A15E38	156-1046-00			MICROCIRCUIT,DI:OCTAL D TYPE EDGE TRIG FF	01295	SN74LS113
A15E40	156-0645-00			MICROCIRCUIT,DI:HEX SCHMITT-TRIG INVERTER	80009	156-0645-00
A15E41	156-0481-00			MICROCIRCUIT,DI:TRIPLE 3-INPUT AND GATE	07263	74LS11(PC OR DC)
A15E42	307-0676-00			RES NTWK,FXD,FI:14,330 OHM,14,680 OHM,0.1W	01121	316E331681
A15E43	156-1618-00			MICROCIRCUIT,DI:QUAD BUS TRANSCEIVER	34335	AM2908DCB
A15E44	156-0118-00			MICROCIRCUIT,DI:J-K MASTER-SLAVE FLIP-FLOP	80009	156-0118-00
A15E45	156-0382-00			MICROCIRCUIT,DI:QUAD 2-INPUT NAND GATE	01295	SN74LS00(N OR J)
A15E46	156-1058-00			MICROCIRCUIT,DI:OCTAL SCHMITT TRIGGER BFR	01295	SN74S240J
A15E47	156-1618-00			MICROCIRCUIT,DI:QUAD BUS TRANSCEIVER	34335	AM2908DCB
A15E49	156-0331-00			MICROCIRCUIT,DI:DUAL D-TYPE,FLIP-FLOP	80009	156-0331-00
A15E50	156-0703-00			MICROCIRCUIT,DI:4-2-3-2 INPUTAND-OR GATES	07263	74S64PC
A15E51	307-0676-00			RES NTWK,FXD,FI:14,330 OHM,14,680 OHM,0.1W	01121	316E331681
A15E52	156-1618-00			MICROCIRCUIT,DI:QUAD BUS TRANSCEIVER	34335	AM2908DCB
A15E53	156-0956-00			MICROCIRCUIT,DI:OCTAL BFR W/3 STATE OUT	04713	SN74LS244N OR J
A15E54	156-0469-00			MICROCIRCUIT,DI:3-LINE TO 8-LINE DECODER	01295	SN74LS138N
A15E55	156-1618-00			MICROCIRCUIT,DI:QUAD BUS TRANSCEIVER	34335	AM2908DCB
A15E56	156-1618-00			MICROCIRCUIT,DI:QUAD BUS TRANSCEIVER	34335	AM2908DCB
A15E58	156-1046-00			MICROCIRCUIT,DI:OCTAL D TYPE EDGE TRIG FF	01295	SN74LS113
A15E59	156-0403-00			MICROCIRCUIT,DI:HEX. INV W/OPEN COLL OUTPS	80009	156-0403-00
A15Q1	151-0223-00			TRANSISTOR:SILICON,NPN	04713	SPS8026
A15R1	315-0473-00			RES.,FXD,CMPSN:47K OHM,5%,0.25W	01121	CB4735
A15R2	315-0473-00			RES.,FXD,CMPSN:47K OHM,5%,0.25W	01121	CB4735

Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A15R3	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
A15R4	315-0681-00			RES.,FXD,CMPSN:680 OHM,5%,0.25W	01121	CB6815
A15R5	315-0681-00			RES.,FXD,CMPSN:680 OHM,5%,0.25W	01121	CB6815
A15R6	315-0621-00			RES.,FXD,CMPSN:620 OHM,5%,0.25W	01121	CB6215
A15R7	315-0222-00			RES.,FXD,CMPSN:2.2K OHM,5%,0.25W	01121	CB2225
A15R8	315-0223-00			RES.,FXD,CMPSN:22K OHM,5%,0.25W	01121	CB2235
A15R9	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
A15R10	315-0152-00			RES.,FXD,CMPSN:1.5K OHM,5%,0.25W	01121	CB1525
A15R11	315-0512-00			RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	01121	CB5125
A15R12	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
A15R13	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
A15R14	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A15R15	315-0181-00			RES.,FXD,CMPSN:180 OHM,5%,0.25W	01121	CB1815
A15R16	315-0181-00			RES.,FXD,CMPSN:180 OHM,5%,0.25W	01121	CB1815
A15R17	315-0271-00			RES.,FXD,CMPSN:270 OHM,5%,0.25W	01121	CB2715
A15R18	315-0181-00			RES.,FXD,CMPSN:180 OHM,5%,0.25W	01121	CB1815
A15R19	315-0181-00			RES.,FXD,CMPSN:180 OHM,5%,0.25W	01121	CB1815
A15R20	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
A15R21	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
A15R22	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
A15R23	315-0152-00			RES.,FXD,CMPSN:1.5K OHM,5%,0.25W	01121	CB1525
A15R24	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A15R25	315-0681-00			RES.,FXD,CMPSN:680 OHM,5%,0.25W	01121	CB6815
A15R26	315-0681-00			RES.,FXD,CMPSN:680 OHM,5%,0.25W	01121	CB6815
A15R27	315-0681-00			RES.,FXD,CMPSN:680 OHM,5%,0.25W	01121	CB6815
A15R28	315-0681-00			RES.,FXD,CMPSN:680 OHM,5%,0.25W	01121	CB6815
A15R29	315-0151-00			RES.,FXD,CMPSN:150 OHM,5%,0.25W	01121	CB1515
A15R30	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A15R31	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A15W3	131-0566-00			BUS CONDUCTOR:DUMMY RES,2.375,22 AWG	55210	L-2007-1

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A20	----- -----			CKT BOARD ASSY:UTILITY		
A20C1022	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A20C1031	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A20C1051	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A20C1057	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A20C1063	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A20C1092	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A20C1108	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A20C1119	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A20C2079	290-0804-00			CAP.,FXD,ELCTLT:10UF,+50-10%,25V	55680	25ULA10V-T
A20C2082	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A20C2121	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A20C3031	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A20C3069	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A20C3093	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A20C3096	283-0095-00			CAP.,FXD,CER DI:56PF,10%,200V	72982	855-535A560K
A20C3117	283-0095-00			CAP.,FXD,CER DI:56PF,10%,200V	72982	855-535A560K
A20C3131	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A20C4029	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A20C4051	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A20C4057	283-0032-00			CAP.,FXD,CER DI:470PF,5%,500V	72982	0831085Z5E00471J
A20C4058	290-0804-00			CAP.,FXD,ELCTLT:10UF,+50-10%,25V	55680	25ULA10V-T
A20C4069	283-0167-00			CAP.,FXD,CER DI:0.1UF,10%,100V	72982	8131N145X5R0104K
A20C4079	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A20C4109	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A20C5041	290-0804-00			CAP.,FXD,ELCTLT:10UF,+50-10%,25V	55680	25ULA10V-T
A20C5056	281-0816-00			CAP.,FXD,CER DI:82PF,5%,100V	20932	201-E0-100AT820J
A20C5063	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	59660	831-519-Z5U-102P
A20C5119	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A20C6011	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A20C6021	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A20C6043	290-0804-00			CAP.,FXD,ELCTLT:10UF,+50-10%,25V	55680	25ULA10V-T
A20C6046	290-0776-00			CAP.,FXD,ELCTLT:22UF,+50-10%,10V	55680	10ULA22V-T
A20C6047	283-0177-00			CAP.,FXD,CER DI:1UF,+80-20%,25V	56289	273C5
A20C6053	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A20C6054	283-0078-00			CAP.,FXD,CER DI:0.001UF,20%,500V	56289	20C114A8
A20C6139	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A20C7037	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A20C7038	290-0804-00			CAP.,FXD,ELCTLT:10UF,+50-10%,25V	55680	25ULA10V-T
A20C7039	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A20C7041	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A20C7059	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A20C7067	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A20C7078	290-0776-00			CAP.,FXD,ELCTLT:22UF,+50-10%,10V	55680	10ULA22V-T
A20C7092	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A20C7098	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A20C7117	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A20CR4037	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A20CR5051	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A20CR6039	152-0075-00			SEMICOND DEVICE:GE,25V,40MA	14433	G866
A20CR7098	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A20CR7099	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A20CR7105	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A20CR7106	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A20DS1021	150-1020-00			LAMP,LED:RED,5 VOLTS	72619	555-2007
A20DS1022	150-1020-00			LAMP,LED:RED,5 VOLTS	72619	555-2007
A20DS1023	150-1020-00			LAMP,LED:RED,5 VOLTS	72619	555-2007

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A20DS1031	150-1020-00			LAMP,LED:RED,5 VOLTS	72619	555-2007
A20DS1032	150-1020-00			LAMP,LED:RED,5 VOLTS	72619	555-2007
A20R1035	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
A20R2051	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
A20R3041	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
A20R3107	315-0106-00			RES.,FXD,CMPSN:10M OHM,5%,0.25W	01121	CB1065
A20R4021	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
A20R4028	315-0621-00			RES.,FXD,CMPSN:620 OHM,5%,0.25W	01121	CB6215
A20R4032	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
A20R4039	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
A20R4047	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A20R4059	315-0273-00			RES.,FXD,CMPSN:27K OHM,5%,0.25W	01121	CB2735
A20R4068	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
A20R5028	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A20R5029	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A20R5031	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
A20R5032	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
A20R5038	315-0273-00			RES.,FXD,CMPSN:27K OHM,5%,0.25W	01121	CB2735
A20R5039	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
A20R5048	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
A20R5049	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
A20R5052	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
A20R5053	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
A20R5062	315-0332-00			RES.,FXD,CMPSN:3.3K OHM,5%,0.25W	01121	CB3325
A20R5064	315-0203-00			RES.,FXD,CMPSN:20K OHM,5%,0.25W	01121	CB2035
A20R5111	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A20R5121	315-0222-00			RES.,FXD,CMPSN:2.2K OHM,5%,0.25W	01121	CB2225
A20R5122	315-0222-00			RES.,FXD,CMPSN:2.2K OHM,5%,0.25W	01121	CB2225
A20R5129	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
A20R5131	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A20R6031	315-0391-00			RES.,FXD,CMPSN:390 OHM,5%,0.25W	01121	CB3915
A20R6033	321-0382-00			RES.,FXD,FILM:93.1K OHM,1%,0.125W	91637	MFF1816G93101F
A20R6034	321-0341-00			RES.,FXD,FILM:34.8K OHM,1%,0.125W	91637	MFF1816G34801F
A20R6035	321-0350-00			RES.,FXD,FILM:43.2K OHM,1%,0.125W	91637	MFF1816G43201F
A20R6036	321-0341-00			RES.,FXD,FILM:34.8K OHM,1%,0.125W	91637	MFF1816G34801F
A20R6037	321-0341-00			RES.,FXD,FILM:34.8K OHM,1%,0.125W	91637	MFF1816G34801F
A20R6038	321-0352-00			RES.,FXD,FILM:45.3K OHM,1%,0.125W	91637	MFF1816G45301F
A20R6041	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
A20R6042	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
A20R6044	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
A20R6045	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
A20R6052	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
A20R6055	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A20R6059	321-0290-00			RES.,FXD,FILM:10.2K OHM,1%,0.125W	91637	MFF1816G10201F
A20R6111	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A20R6121	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A20R6131	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A20R7008	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
A20R7018	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
A20R7023	315-0331-00			RES.,FXD,CMPSN:330 OHM,5%,0.25W	01121	CB3315
A20R7024	315-0681-00			RES.,FXD,CMPSN:680 OHM,5%,0.25W	01121	CB6815
A20R7045	315-0681-00			RES.,FXD,CMPSN:680 OHM,5%,0.25W	01121	CB6815
A20R7047	315-0681-00			RES.,FXD,CMPSN:680 OHM,5%,0.25W	01121	CB6815
A20R7054	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
A20R7055	315-0681-00			RES.,FXD,CMPSN:680 OHM,5%,0.25W	01121	CB6815
A20R7056	315-0331-00			RES.,FXD,CMPSN:330 OHM,5%,0.25W	01121	CB3315
A20R7065	315-0331-00			RES.,FXD,CMPSN:330 OHM,5%,0.25W	01121	CB3315

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A20R7066	315-0331-00			RES.,FXD,CMPSN:330 OHM,5%,0.25W	01121	CB3315
A20R7098	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
A20R7099	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
A20RP1091	307-0542-00			RES,NTWK,FXD,FI:10K OHM,5%,0.125W	91637	MSP06A01-103J
A20RP3092	307-0542-00			RES,NTWK,FXD,FI:10K OHM,5%,0.125W	91637	MSP06A01-103J
A20RP7030	307-0547-00			RES NTWK,FXD,FI:DUAL,180 X 390 OHM,5%,1.5W	73138	898-5-R180/390
A20RP7060	307-0547-00			RES NTWK,FXD,FI:DUAL,180 X 390 OHM,5%,1.5W	73138	898-5-R180/390
A20RP7080	307-0547-00			RES NTWK,FXD,FI:DUAL,180 X 390 OHM,5%,1.5W	73138	898-5-R180/390
A20U1010	156-0480-02			MICROCIRCUIT,DI:QUAD 2 INP & GATE	01295	SN74LS08NP3
A20U1020	156-0391-02			MICROCIRCUIT,DI:HEX LATCH W/CLEAR	01295	SN74LS174
A20U1030	156-0388-03			MICROCIRCUIT,DI:DUAL D FLIP-FLOP	07263	74LS74A
A20U1040	156-0535-02			MICROCIRCUIT,DI:3-STATE HEX BUFFER,SCRN	27014	DM8097NA+
A20U1050	156-0470-02			MICROCIRCUIT,DI:8 INP DATA SEL W/3 STATE	01295	SN74LS251
A20U1060	156-0470-02			MICROCIRCUIT,DI:8 INP DATA SEL W/3 STATE	01295	SN74LS251
A20U1070	156-0361-00			MICROCIRCUIT,DI:UNIV A SYN RCVR XMTR	80009	156-0361-00
A20U1080	156-0865-02			MICROCIRCUIT,DI:OCTAL D-TYPE FF W/CLEAR	01295	SN74LS273NP3
A20U1090	156-0530-02			MICROCIRCUIT,DI:QUAD 2 INP MUX	01295	SN74LS157P3
A20U1100	156-0850-02			MICROCIRCUIT,DI:PRGM BIT RATE GEN SCRN	07263	4702BDCQR
A20U1110	156-0470-02			MICROCIRCUIT,DI:8 INP DATA SEL W/3 STATE	01295	SN74LS251
A20U2010	156-0541-02			MICROCIRCUIT,DI:DUAL 2 TO 4 LINE DCDR	01295	SN74LS139NP3
A20U2020	156-0388-03			MICROCIRCUIT,DI:DUAL D FLIP-FLOP	07263	74LS74A
A20U2030	156-0388-03			MICROCIRCUIT,DI:DUAL D FLIP-FLOP	07263	74LS74A
A20U2040	156-0382-02			MICROCIRCUIT,DI:QUAD 2-INP NAND GATE	01295	SN74LS00
A20U2050	156-0470-02			MICROCIRCUIT,DI:8 INP DATA SEL W/3 STATE	01295	SN74LS251
A20U2060	156-0471-02			MICROCIRCUIT,DI:DUAL 4/1 LINE DATA SEL,SCRN	01295	SN74LS253NP3
A20U2080	156-0470-02			MICROCIRCUIT,DI:8 INP DATA SEL W/3 STATE	01295	SN74LS251
A20U2100	156-0478-02			MICROCIRCUIT,DI:DUAL 4 INP & GATE,BURN-IN	01295	SN74LS21NP3
A20U2110	156-0470-02			MICROCIRCUIT,DI:8 INP DATA SEL W/3 STATE	01295	SN74LS251
A20U2120	156-0219-02			MICROCIRCUIT,DI:8 BIT PRIORITY ENCODER	80009	156-0219-02
A20U3010	156-0382-02			MICROCIRCUIT,DI:QUAD 2-INP NAND GATE	01295	SN74LS00
A20U3020	156-0219-02			MICROCIRCUIT,DI:8 BIT PRIORITY ENCODER	80009	156-0219-02
A20U3030	156-0392-03			MICROCIRCUIT,DI:QUAD LATCH W/CLEAR	01295	SN74LS175NP3
A20U3040	156-0464-02			MICROCIRCUIT,DI:DUAL 4 INP NAND GATE	01295	SN74LS20
A20U3050	156-0385-02			MICROCIRCUIT,DI:HEX INVERTER	01295	SN74LS04
A20U3060	156-0471-02			MICROCIRCUIT,DI:DUAL 4/1 LINE DATA SEL,SCRN	01295	SN74LS253NP3
A20U3070	156-0361-00			MICROCIRCUIT,DI:UNIV A SYN RCVR XMTR	80009	156-0361-00
A20U3080	156-0865-02			MICROCIRCUIT,DI:OCTAL D-TYPE FF W/CLEAR	01295	SN74LS273NP3
A20U3090	156-0530-02			MICROCIRCUIT,DI:QUAD 2 INP MUX	01295	SN74LS157P3
A20U3100	156-0850-02			MICROCIRCUIT,DI:PRGM BIT RATE GEN SCRN	07263	4702BDCQR
A20U3120	156-0390-02			MICROCIRCUIT,DI:DUAL 4/2 LINE DCDR/DEMUX	01295	SN74LS155
A20U3130	156-0385-02			MICROCIRCUIT,DI:HEX INVERTER	01295	SN74LS04
A20U4010	156-0479-02			MICROCIRCUIT,DI:QUAD 2-INP OR GATE	01295	SN74LS32NP3
A20U4020	156-0388-03			MICROCIRCUIT,DI:DUAL D FLIP-FLOP	07263	74LS74A
A20U4030	156-0382-02			MICROCIRCUIT,DI:QUAD 2-INP NAND GATE	01295	SN74LS00
A20U4040	156-0718-03			MICROCIRCUIT,DI:TRIPLE 3-INP NOR GATE	01295	SN74LS27
A20U4050	156-0718-03			MICROCIRCUIT,DI:TRIPLE 3-INP NOR GATE	01295	SN74LS27
A20U4060	156-0480-02			MICROCIRCUIT,DI:QUAD 2 INP & GATE	01295	SN74LS08NP3
A20U4080	156-0470-02			MICROCIRCUIT,DI:8 INP DATA SEL W/3 STATE	01295	SN74LS251
A20U4090	156-0470-02			MICROCIRCUIT,DI:8 INP DATA SEL W/3 STATE	01295	SN74LS251
A20U4100	156-0386-02			MICROCIRCUIT,DI:TRIPLE 3 INP NAND GATE	01295	SN74LS10NP3
A20U4110	156-0382-02			MICROCIRCUIT,DI:QUAD 2-INP NAND GATE	01295	SN74LS00
A20U4120	156-0390-02			MICROCIRCUIT,DI:DUAL 4/2 LINE DCDR/DEMUX	01295	SN74LS155
A20U4130	156-0388-03			MICROCIRCUIT,DI:DUAL D FLIP-FLOP	07263	74LS74A
A20U5010	156-0480-02			MICROCIRCUIT,DI:QUAD 2 INP & GATE	01295	SN74LS08NP3
A20U5020	156-0388-03			MICROCIRCUIT,DI:DUAL D FLIP-FLOP	07263	74LS74A
A20U5030	156-0411-02			MICROCIRCUIT,LI:QUAD COMPARATOR,SEL	04713	MLM339LDS
A20U5040	156-0153-02			MICROCIRCUIT,DI:HEX INVERTER BUFFER	27014	DM8006

Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A20U5050	156-0405-03			MICROCIRCUIT,DI:DUAL RETRIG MONOSTABLE MV	07263	SL81751
A20U5060	156-0405-03			MICROCIRCUIT,DI:DUAL RETRIG MONOSTABLE MV	07263	SL81751
A20U5070	156-1065-01			MICROCIRCUIT,DI:OCTAL D TYPE TRANS LATCHES	34335	AM74LS373
A20U5080	160-1094-00			MICROCIRCUIT,DI:2048 X 8 EPROM	80009	160-1094-00
A20U5090	160-1093-00			MICROCIRCUIT,DI:2048 X 8 EPROM	80009	160-1093-00
A20U5100	156-0383-02			MICROCIRCUIT,DI:QUAD 2-INP NOR GATE	01295	SN74LS02
A20U5110	156-0385-02			MICROCIRCUIT,DI:HEX INVERTER	01295	SN74LS04
A20U5120	156-0382-02			MICROCIRCUIT,DI:QUAD 2-INP NAND GATE	01295	SN74LS00
A20U5130	156-0385-02			MICROCIRCUIT,DI:HEX INVERTER	01295	SN74LS04
A20U6010	156-0383-02			MICROCIRCUIT,DI:QUAD 2-INP NOR GATE	01295	SN74LS02
A20U6020	156-0385-02			MICROCIRCUIT,DI:HEX INVERTER	01295	SN74LS04
A20U6040	156-0645-02			MICROCIRCUIT,DI:SCHMITT-TRIG POS-NAND	01295	SN74LS14
A20U6050	156-0645-02			MICROCIRCUIT,DI:SCHMITT-TRIG POS-NAND	01295	SN74LS14
A20U6070	156-0653-02			MICROCIRCUIT,DI:QUAD UNIFIED BUS XVER INV	27014	D58838
A20U6080	156-0653-02			MICROCIRCUIT,DI:QUAD UNIFIED BUS XVER INV	27014	D58838
A20U6090	156-0653-02			MICROCIRCUIT,DI:QUAD UNIFIED BUS XVER INV	27014	D58838
A20U6100	156-0539-01			MICROCIRCUIT,DI:6 BIT UNIFIEDBUS COMPTR	80009	156-0539-01
A20U6110	156-0539-01			MICROCIRCUIT,DI:6 BIT UNIFIEDBUS COMPTR	80009	156-0539-01
A20U6130	156-0539-01			MICROCIRCUIT,DI:6 BIT UNIFIEDBUS COMPTR	80009	156-0539-01
A20U7020	156-0653-02			MICROCIRCUIT,DI:QUAD UNIFIED BUS XVER INV	27014	D58838
A20U7040	156-0455-02			MICROCIRCUIT,DI:HEX BUS RECEIVER	80009	156-0455-02
A20U7050	156-0653-02			MICROCIRCUIT,DI:QUAD UNIFIED BUS XVER INV	27014	D58838
A20U7070	156-0653-02			MICROCIRCUIT,DI:QUAD UNIFIED BUS XVER INV	27014	D58838
A20U7090	156-0653-02			MICROCIRCUIT,DI:QUAD UNIFIED BUS XVER INV	27014	D58838
A20U7100	156-0866-02			MICROCIRCUIT,DI:13 INP NAND GATES,SCRN	80009	156-0866-02
A20U7110	156-0539-01			MICROCIRCUIT,DI:6 BIT UNIFIEDBUS COMPTR	80009	156-0539-01
A20U7130	156-0539-01			MICROCIRCUIT,DI:6 BIT UNIFIEDBUS COMPTR	80009	156-0539-01
A20VR6032	152-0437-00			SEMICOND DEVICE:ZENER,SI,8.2V,2%,0.4W	14552	TD332679
A20W1098	131-0566-00			BUS CONDUCTOR:DUMMY RES,2.375,22 AWG	55210	L-2007-1
A20W2094	131-0566-00			BUS CONDUCTOR:DUMMY RES,2.375,22 AWG	55210	L-2007-1
A20W2095	131-0566-00			BUS CONDUCTOR:DUMMY RES,2.375,22 AWG	55210	L-2007-1
A20W3091	131-0566-00			BUS CONDUCTOR:DUMMY RES,2.375,22 AWG	55210	L-2007-1
A20W4016	131-0566-00			BUS CONDUCTOR:DUMMY RES,2.375,22 AWG	55210	L-2007-1
A20W4018	131-0566-00			BUS CONDUCTOR:DUMMY RES,2.375,22 AWG	55210	L-2007-1
A20W4031	131-0566-00			BUS CONDUCTOR:DUMMY RES,2.375,22 AWG	55210	L-2007-1
A20W4041	131-0566-00			BUS CONDUCTOR:DUMMY RES,2.375,22 AWG	55210	L-2007-1
A20W4043	131-0566-00			BUS CONDUCTOR:DUMMY RES,2.375,22 AWG	55210	L-2007-1
A20W4045	131-0566-00			BUS CONDUCTOR:DUMMY RES,2.375,22 AWG	55210	L-2007-1
A20W5061	131-0566-00			BUS CONDUCTOR:DUMMY RES,2.375,22 AWG	55210	L-2007-1
A20W6101	131-0566-00			BUS CONDUCTOR:DUMMY RES,2.375,22 AWG	55210	L-2007-1
A20W7012	131-0566-00			BUS CONDUCTOR:DUMMY RES,2.375,22 AWG	55210	L-2007-1
A20W7013	131-0566-00			BUS CONDUCTOR:DUMMY RES,2.375,22 AWG	55210	L-2007-1
A20W7016	131-0566-00			BUS CONDUCTOR:DUMMY RES,2.375,22 AWG	55210	L-2007-1
A20W7017	131-0566-00			BUS CONDUCTOR:DUMMY RES,2.375,22 AWG	55210	L-2007-1
A20Y3111	158-0124-00			XTAL UNIT,QTZ:2.4576 MHZ,0.05% PARALLEL	75378	MP-024

Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A25	----- -----			CKT BOARD ASSY:64K MEMORY		
A25C1011	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A25C1021	283-0423-00			CAP.,FXD,CER DI:0.22UF,+80-20%,50V	04222	DG015E224Z
A25C1031	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A25C1041	283-0423-00			CAP.,FXD,CER DI:0.22UF,+80-20%,50V	04222	DG015E224Z
A25C1051	283-0423-00			CAP.,FXD,CER DI:0.22UF,+80-20%,50V	04222	DG015E224Z
A25C1061	283-0423-00			CAP.,FXD,CER DI:0.22UF,+80-20%,50V	04222	DG015E224Z
A25C1071	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A25C1081	283-0423-00			CAP.,FXD,CER DI:0.22UF,+80-20%,50V	04222	DG015E224Z
A25C1091	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A25C1101	283-0423-00			CAP.,FXD,CER DI:0.22UF,+80-20%,50V	04222	DG015E224Z
A25C1111	283-0423-00			CAP.,FXD,CER DI:0.22UF,+80-20%,50V	04222	DG015E224Z
A25C1121	283-0423-00			CAP.,FXD,CER DI:0.22UF,+80-20%,50V	04222	DG015E224Z
A25C1131	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A25C1141	283-0423-00			CAP.,FXD,CER DI:0.22UF,+80-20%,50V	04222	DG015E224Z
A25C1151	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A25C1161	283-0423-00			CAP.,FXD,CER DI:0.22UF,+80-20%,50V	04222	DG015E224Z
A25C2011	283-0423-00			CAP.,FXD,CER DI:0.22UF,+80-20%,50V	04222	DG015E224Z
A25C2021	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A25C2031	283-0423-00			CAP.,FXD,CER DI:0.22UF,+80-20%,50V	04222	DG015E224Z
A25C2041	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A25C2051	283-0423-00			CAP.,FXD,CER DI:0.22UF,+80-20%,50V	04222	DG015E224Z
A25C2061	283-0423-00			CAP.,FXD,CER DI:0.22UF,+80-20%,50V	04222	DG015E224Z
A25C2071	283-0423-00			CAP.,FXD,CER DI:0.22UF,+80-20%,50V	04222	DG015E224Z
A25C2081	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A25C2091	283-0423-00			CAP.,FXD,CER DI:0.22UF,+80-20%,50V	04222	DG015E224Z
A25C2101	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A25C2111	283-0423-00			CAP.,FXD,CER DI:0.22UF,+80-20%,50V	04222	DG015E224Z
A25C2121	283-0423-00			CAP.,FXD,CER DI:0.22UF,+80-20%,50V	04222	DG015E224Z
A25C2131	283-0423-00			CAP.,FXD,CER DI:0.22UF,+80-20%,50V	04222	DG015E224Z
A25C2141	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A25C2151	283-0423-00			CAP.,FXD,CER DI:0.22UF,+80-20%,50V	04222	DG015E224Z
A25C2161	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A25C3011	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A25C3021	283-0423-00			CAP.,FXD,CER DI:0.22UF,+80-20%,50V	04222	DG015E224Z
A25C3031	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A25C3041	283-0423-00			CAP.,FXD,CER DI:0.22UF,+80-20%,50V	04222	DG015E224Z
A25C3051	283-0423-00			CAP.,FXD,CER DI:0.22UF,+80-20%,50V	04222	DG015E224Z
A25C3061	283-0423-00			CAP.,FXD,CER DI:0.22UF,+80-20%,50V	04222	DG015E224Z
A25C3071	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A25C3081	283-0423-00			CAP.,FXD,CER DI:0.22UF,+80-20%,50V	04222	DG015E224Z
A25C3091	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A25C3101	283-0423-00			CAP.,FXD,CER DI:0.22UF,+80-20%,50V	04222	DG015E224Z
A25C3111	283-0423-00			CAP.,FXD,CER DI:0.22UF,+80-20%,50V	04222	DG015E224Z
A25C3121	283-0423-00			CAP.,FXD,CER DI:0.22UF,+80-20%,50V	04222	DG015E224Z
A25C3131	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A25C3141	283-0423-00			CAP.,FXD,CER DI:0.22UF,+80-20%,50V	04222	DG015E224Z
A25C3151	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A25C3161	283-0423-00			CAP.,FXD,CER DI:0.22UF,+80-20%,50V	04222	DG015E224Z
A25C4011	283-0423-00			CAP.,FXD,CER DI:0.22UF,+80-20%,50V	04222	DG015E224Z
A25C4021	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A25C4031	283-0423-00			CAP.,FXD,CER DI:0.22UF,+80-20%,50V	04222	DG015E224Z
A25C4041	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A25C4051	283-0423-00			CAP.,FXD,CER DI:0.22UF,+80-20%,50V	04222	DG015E224Z
A25C4061	283-0423-00			CAP.,FXD,CER DI:0.22UF,+80-20%,50V	04222	DG015E224Z
A25C4071	283-0423-00			CAP.,FXD,CER DI:0.22UF,+80-20%,50V	04222	DG015E224Z
A25C4081	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z

Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A25C4091	283-0423-00			CAP.,FXD,CER DI:0.22UF,+80-20%,50V	04222	DG015E224Z
A25C4101	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A25C4111	283-0423-00			CAP.,FXD,CER DI:0.22UF,+80-20%,50V	04222	DG015E224Z
A25C4121	283-0423-00			CAP.,FXD,CER DI:0.22UF,+80-20%,50V	04222	DG015E224Z
A25C4131	283-0423-00			CAP.,FXD,CER DI:0.22UF,+80-20%,50V	04222	DG015E224Z
A25C4141	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A25C4151	283-0423-00			CAP.,FXD,CER DI:0.22UF,+80-20%,50V	04222	DG015E224Z
A25C4161	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A25C5031	283-0423-00			CAP.,FXD,CER DI:0.22UF,+80-20%,50V	04222	DG015E224Z
A25C5041	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A25C5051	283-0423-00			CAP.,FXD,CER DI:0.22UF,+80-20%,50V	04222	DG015E224Z
A25C5061	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A25C5111	283-0423-00			CAP.,FXD,CER DI:0.22UF,+80-20%,50V	04222	DG015E224Z
A25C5121	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A25C5131	283-0423-00			CAP.,FXD,CER DI:0.22UF,+80-20%,50V	04222	DG015E224Z
A25C5141	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A25C5151	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A25C5153	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A25C5155	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A25C5157	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A25C5161	290-0782-00			CAP.,FXD,ELCTLT:4.7UF,+75-10%,35V	55680	35ULA4R7V-T
A25C5162	290-0782-00			CAP.,FXD,ELCTLT:4.7UF,+75-10%,35V	55680	35ULA4R7V-T
A25C5163	290-0782-00			CAP.,FXD,ELCTLT:4.7UF,+75-10%,35V	55680	35ULA4R7V-T
A25C5164	290-0782-00			CAP.,FXD,ELCTLT:4.7UF,+75-10%,35V	55680	35ULA4R7V-T
A25C6011	290-0782-00			CAP.,FXD,ELCTLT:4.7UF,+75-10%,35V	55680	35ULA4R7V-T
A25C6013	290-0782-00			CAP.,FXD,ELCTLT:4.7UF,+75-10%,35V	55680	35ULA4R7V-T
A25C6015	290-0782-00			CAP.,FXD,ELCTLT:4.7UF,+75-10%,35V	55680	35ULA4R7V-T
A25C6017	290-0782-00			CAP.,FXD,ELCTLT:4.7UF,+75-10%,35V	55680	35ULA4R7V-T
A25C6021	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A25C6023	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A25C6025	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A25C6027	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A25C6051	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A25C6155	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A25C6161	283-0330-00			CAP.,FXD,CER DI:100PF,5%,50V	72982	8111N068C0G0101J
A25C6163	283-0330-00			CAP.,FXD,CER DI:100PF,5%,50V	72982	8111N068C0G0101J
A25C7011	283-0423-00			CAP.,FXD,CER DI:0.22UF,+80-20%,50V	04222	DG015E224Z
A25C7021	283-0423-00			CAP.,FXD,CER DI:0.22UF,+80-20%,50V	04222	DG015E224Z
A25C7031	283-0423-00			CAP.,FXD,CER DI:0.22UF,+80-20%,50V	04222	DG015E224Z
A25C7032	290-0107-00			CAP.,FXD,ELCTLT:25UF,+75-10%,25V	56289	30D256G025DB9
A25C7041	283-0423-00			CAP.,FXD,CER DI:0.22UF,+80-20%,50V	04222	DG015E224Z
A25C7051	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A25C7053	290-0745-00			CAP.,FXD,ELCTLT:22UF,+50-10%,25V	56289	502D225
A25C7071	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A25C7101	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A25C7111	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A25C7123	283-0615-00			CAP.,FXD,MICA D:33PF,5%,500V	00853	D155E330J0
A25C7131	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A25C7161	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A25CR7065	152-0279-00			SEMICOND DEVICE:ZENER,0.4W,5.1V,5%	04713	SZG35010RL
A25R5071	315-0220-00			RES.,FXD,CMPSN:22 OHM,5%,0.25W	01121	CB2205
A25R5072	315-0220-00			RES.,FXD,CMPSN:22 OHM,5%,0.25W	01121	CB2205
A25R5073	315-0220-00			RES.,FXD,CMPSN:22 OHM,5%,0.25W	01121	CB2205
A25R5074	315-0220-00			RES.,FXD,CMPSN:22 OHM,5%,0.25W	01121	CB2205
A25R5075	315-0220-00			RES.,FXD,CMPSN:22 OHM,5%,0.25W	01121	CB2205
A25R5081	315-0220-00			RES.,FXD,CMPSN:22 OHM,5%,0.25W	01121	CB2205
A25R5082	315-0220-00			RES.,FXD,CMPSN:22 OHM,5%,0.25W	01121	CB2205

Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A25R5083	315-0220-00			RES.,FXD,CMPSN:22 OHM,5%,0.25W	01121	CB2205
A25R5084	315-0220-00			RES.,FXD,CMPSN:22 OHM,5%,0.25W	01121	CB2205
A25R5085	315-0220-00			RES.,FXD,CMPSN:22 OHM,5%,0.25W	01121	CB2205
A25R5091	315-0220-00			RES.,FXD,CMPSN:22 OHM,5%,0.25W	01121	CB2205
A25R5092	315-0220-00			RES.,FXD,CMPSN:22 OHM,5%,0.25W	01121	CB2205
A25R5093	315-0220-00			RES.,FXD,CMPSN:22 OHM,5%,0.25W	01121	CB2205
A25R5094	315-0220-00			RES.,FXD,CMPSN:22 OHM,5%,0.25W	01121	CB2205
A25R5095	315-0220-00			RES.,FXD,CMPSN:22 OHM,5%,0.25W	01121	CB2205
A25R5096	315-0220-00			RES.,FXD,CMPSN:22 OHM,5%,0.25W	01121	CB2205
A25R5111	315-0220-00			RES.,FXD,CMPSN:22 OHM,5%,0.25W	01121	CB2205
A25R5112	315-0220-00			RES.,FXD,CMPSN:22 OHM,5%,0.25W	01121	CB2205
A25R5113	315-0220-00			RES.,FXD,CMPSN:22 OHM,5%,0.25W	01121	CB2205
A25R5157	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A25R5158	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A25R5159	315-0152-00			RES.,FXD,CMPSN:1.5K OHM,5%,0.25W	01121	CB1525
A25R6021	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A25R6022	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A25R6023	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A25R6024	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A25R7019	308-0767-00			RES.,FXD,WW:1.1 OHM,5%,1W	75042	BW20-1R100J
A25R7067	301-0301-00			RES.,FXD,CMPSN:300 OHM,5%,0.50W	01121	EB3015
A25R7102	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A25R7103	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A25R7133	315-0821-00			RES.,FXD,CMPSN:820 OHM,5%,0.25W	01121	CB8215
A25R7135	315-0821-00			RES.,FXD,CMPSN:820 OHM,5%,0.25W	01121	CB8215
A25R7137	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A25R7139	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A25R7155	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A25R7161	315-0152-00			RES.,FXD,CMPSN:1.5K OHM,5%,0.25W	01121	CB1525
A25U1010	156-0968-02			MICROCIRCUIT,DI:16384 X 1 DYNAMIC RAM	80009	156-0968-02
A25U1020	156-0968-02			MICROCIRCUIT,DI:16384 X 1 DYNAMIC RAM	80009	156-0968-02
A25U1030	156-0968-02			MICROCIRCUIT,DI:16384 X 1 DYNAMIC RAM	80009	156-0968-02
A25U1040	156-0968-02			MICROCIRCUIT,DI:16384 X 1 DYNAMIC RAM	80009	156-0968-02
A25U1050	156-0968-02			MICROCIRCUIT,DI:16384 X 1 DYNAMIC RAM	80009	156-0968-02
A25U1060	156-0968-02			MICROCIRCUIT,DI:16384 X 1 DYNAMIC RAM	80009	156-0968-02
A25U1070	156-0968-02			MICROCIRCUIT,DI:16384 X 1 DYNAMIC RAM	80009	156-0968-02
A25U1080	156-0968-02			MICROCIRCUIT,DI:16384 X 1 DYNAMIC RAM	80009	156-0968-02
A25U1090	156-0968-02			MICROCIRCUIT,DI:16384 X 1 DYNAMIC RAM	80009	156-0968-02
A25U1100	156-0968-02			MICROCIRCUIT,DI:16384 X 1 DYNAMIC RAM	80009	156-0968-02
A25U1110	156-0968-02			MICROCIRCUIT,DI:16384 X 1 DYNAMIC RAM	80009	156-0968-02
A25U1120	156-0968-02			MICROCIRCUIT,DI:16384 X 1 DYNAMIC RAM	80009	156-0968-02
A25U1130	156-0968-02			MICROCIRCUIT,DI:16384 X 1 DYNAMIC RAM	80009	156-0968-02
A25U1140	156-0968-02			MICROCIRCUIT,DI:16384 X 1 DYNAMIC RAM	80009	156-0968-02
A25U1150	156-0968-02			MICROCIRCUIT,DI:16384 X 1 DYNAMIC RAM	80009	156-0968-02
A25U1160	156-0968-02			MICROCIRCUIT,DI:16384 X 1 DYNAMIC RAM	80009	156-0968-02
A25U2010	156-0968-02			MICROCIRCUIT,DI:16384 X 1 DYNAMIC RAM	80009	156-0968-02
A25U2020	156-0968-02			MICROCIRCUIT,DI:16384 X 1 DYNAMIC RAM	80009	156-0968-02
A25U2030	156-0968-02			MICROCIRCUIT,DI:16384 X 1 DYNAMIC RAM	80009	156-0968-02
A25U2040	156-0968-02			MICROCIRCUIT,DI:16384 X 1 DYNAMIC RAM	80009	156-0968-02
A25U2050	156-0968-02			MICROCIRCUIT,DI:16384 X 1 DYNAMIC RAM	80009	156-0968-02
A25U2060	156-0968-02			MICROCIRCUIT,DI:16384 X 1 DYNAMIC RAM	80009	156-0968-02
A25U2070	156-0968-02			MICROCIRCUIT,DI:16384 X 1 DYNAMIC RAM	80009	156-0968-02
A25U2080	156-0968-02			MICROCIRCUIT,DI:16384 X 1 DYNAMIC RAM	80009	156-0968-02
A25U2090	156-0968-02			MICROCIRCUIT,DI:16384 X 1 DYNAMIC RAM	80009	156-0968-02
A25U2100	156-0968-02			MICROCIRCUIT,DI:16384 X 1 DYNAMIC RAM	80009	156-0968-02
A25U2110	156-0968-02			MICROCIRCUIT,DI:16384 X 1 DYNAMIC RAM	80009	156-0968-02
A25U2120	156-0968-02			MICROCIRCUIT,DI:16384 X 1 DYNAMIC RAM	80009	156-0968-02

Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A25U2130	156-0968-02			MICROCIRCUIT,DI:16384 X 1 DYNAMIC RAM	80009	156-0968-02
A25U2140	156-0968-02			MICROCIRCUIT,DI:16384 X 1 DYNAMIC RAM	80009	156-0968-02
A25U2150	156-0968-02			MICROCIRCUIT,DI:16384 X 1 DYNAMIC RAM	80009	156-0968-02
A25U2160	156-0968-02			MICROCIRCUIT,DI:16384 X 1 DYNAMIC RAM	80009	156-0968-02
A25U3010	156-0968-02			MICROCIRCUIT,DI:16384 X 1 DYNAMIC RAM	80009	156-0968-02
A25U3020	156-0968-02			MICROCIRCUIT,DI:16384 X 1 DYNAMIC RAM	80009	156-0968-02
A25U3030	156-0968-02			MICROCIRCUIT,DI:16384 X 1 DYNAMIC RAM	80009	156-0968-02
A25U3040	156-0968-02			MICROCIRCUIT,DI:16384 X 1 DYNAMIC RAM	80009	156-0968-02
A25U3050	156-0968-02			MICROCIRCUIT,DI:16384 X 1 DYNAMIC RAM	80009	156-0968-02
A25U3060	156-0968-02			MICROCIRCUIT,DI:16384 X 1 DYNAMIC RAM	80009	156-0968-02
A25U3070	156-0968-02			MICROCIRCUIT,DI:16384 X 1 DYNAMIC RAM	80009	156-0968-02
A25U3080	156-0968-02			MICROCIRCUIT,DI:16384 X 1 DYNAMIC RAM	80009	156-0968-02
A25U3090	156-0968-02			MICROCIRCUIT,DI:16384 X 1 DYNAMIC RAM	80009	156-0968-02
A25U3100	156-0968-02			MICROCIRCUIT,DI:16384 X 1 DYNAMIC RAM	80009	156-0968-02
A25U3110	156-0968-02			MICROCIRCUIT,DI:16384 X 1 DYNAMIC RAM	80009	156-0968-02
A25U3120	156-0968-02			MICROCIRCUIT,DI:16384 X 1 DYNAMIC RAM	80009	156-0968-02
A25U3130	156-0968-02			MICROCIRCUIT,DI:16384 X 1 DYNAMIC RAM	80009	156-0968-02
A25U3140	156-0968-02			MICROCIRCUIT,DI:16384 X 1 DYNAMIC RAM	80009	156-0968-02
A25U3150	156-0968-02			MICROCIRCUIT,DI:16384 X 1 DYNAMIC RAM	80009	156-0968-02
A25U3160	156-0968-02			MICROCIRCUIT,DI:16384 X 1 DYNAMIC RAM	80009	156-0968-02
A25U4010	156-0968-02			MICROCIRCUIT,DI:16384 X 1 DYNAMIC RAM	80009	156-0968-02
A25U4020	156-0968-02			MICROCIRCUIT,DI:16384 X 1 DYNAMIC RAM	80009	156-0968-02
A25U4030	156-0968-02			MICROCIRCUIT,DI:16384 X 1 DYNAMIC RAM	80009	156-0968-02
A25U4040	156-0968-02			MICROCIRCUIT,DI:16384 X 1 DYNAMIC RAM	80009	156-0968-02
A25U4050	156-0968-02			MICROCIRCUIT,DI:16384 X 1 DYNAMIC RAM	80009	156-0968-02
A25U4060	156-0968-02			MICROCIRCUIT,DI:16384 X 1 DYNAMIC RAM	80009	156-0968-02
A25U4070	156-0968-02			MICROCIRCUIT,DI:16384 X 1 DYNAMIC RAM	80009	156-0968-02
A25U4080	156-0968-02			MICROCIRCUIT,DI:16384 X 1 DYNAMIC RAM	80009	156-0968-02
A25U4090	156-0968-02			MICROCIRCUIT,DI:16384 X 1 DYNAMIC RAM	80009	156-0968-02
A25U4100	156-0968-02			MICROCIRCUIT,DI:16384 X 1 DYNAMIC RAM	80009	156-0968-02
A25U4110	156-0968-02			MICROCIRCUIT,DI:16384 X 1 DYNAMIC RAM	80009	156-0968-02
A25U4120	156-0968-02			MICROCIRCUIT,DI:16384 X 1 DYNAMIC RAM	80009	156-0968-02
A25U4130	156-0968-02			MICROCIRCUIT,DI:16384 X 1 DYNAMIC RAM	80009	156-0968-02
A25U4140	156-0968-02			MICROCIRCUIT,DI:16384 X 1 DYNAMIC RAM	80009	156-0968-02
A25U4150	156-0968-02			MICROCIRCUIT,DI:16384 X 1 DYNAMIC RAM	80009	156-0968-02
A25U4160	156-0968-02			MICROCIRCUIT,DI:16384 X 1 DYNAMIC RAM	80009	156-0968-02
A25U5010	156-0320-03			MICROCIRCUIT,DI:TRIPLE 3 INP NAND GATE	01295	SN74S11NP3
A25U5020	156-0331-03			MICROCIRCUIT,DI:DUAL D TYPE POSITIVE EDGE	80009	156-0331-03
A25U5030	156-0968-02			MICROCIRCUIT,DI:16384 X 1 DYNAMIC RAM	80009	156-0968-02
A25U5040	156-0968-02			MICROCIRCUIT,DI:16384 X 1 DYNAMIC RAM	80009	156-0968-02
A25U5050	156-0968-02			MICROCIRCUIT,DI:16384 X 1 DYNAMIC RAM	80009	156-0968-02
A25U5060	156-0968-02			MICROCIRCUIT,DI:16384 X 1 DYNAMIC RAM	80009	156-0968-02
A25U5110	156-0968-02			MICROCIRCUIT,DI:16384 X 1 DYNAMIC RAM	80009	156-0968-02
A25U5120	156-0968-02			MICROCIRCUIT,DI:16384 X 1 DYNAMIC RAM	80009	156-0968-02
A25U5130	156-0968-02			MICROCIRCUIT,DI:16384 X 1 DYNAMIC RAM	80009	156-0968-02
A25U5140	156-0968-02			MICROCIRCUIT,DI:16384 X 1 DYNAMIC RAM	80009	156-0968-02
A25U6030	156-0739-02			MICROCIRCUIT,DI:QUAD 2 INP ORGATE,SCRN	01295	SN74S32
A25U6040	156-0180-04			MICROCIRCUIT,DI:QUAD 2 INP NAND GATE	01295	SN74S00NP3
A25U6050	156-0652-02			MICROCIRCUIT,DI:QUAD 2-INPUT EXCL NOR GATES	01295	SN74LS255NP3
A25U6060	156-0865-02			MICROCIRCUIT,DI:OCTAL D-TYPE FF W/CLEAR	01295	SN74LS273NP3
A25U6070	156-0865-02			MICROCIRCUIT,DI:OCTAL D-TYPE FF W/CLEAR	01295	SN74LS273NP3
A25U6090	156-0965-02			MICROCIRCUIT,LI:ADRS MUX & REFRESH CNTR,SCR	80009	156-0965-02
A25U6100	156-1058-01			MICROCIRCUIT,DI:OCTAL ST BFR W/3 STATE OUT	01295	SN74S240J4
A25U6110	156-0693-02			MICROCIRCUIT,DI:DECODER/DEMULTIPLEXER	27014	DM74S139
A25U6120	156-0331-03			MICROCIRCUIT,DI:DUAL D TYPE POSITIVE EDGE	80009	156-0331-03
A25U6130	156-0459-02			MICROCIRCUIT,DI:QUAD 2 INPUT & GATE,BURN	01295	SN74S08
A25U6140	156-0323-02			MICROCIRCUIT,DI:HEX INVERTER,BURN-IN	01295	SN74S04

Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A25U6150	156-0180-04			MICROCIRCUIT,DI:QUAD 2 INP NAND GATE	01295	SN74S00NP3
A25U6160	156-0733-02			MICROCIRCUIT,DI:DUAL MONOSTABLE MV,BURN-IN	04713	SN74LS221N/J
A25U7010	156-1618-00			MICROCIRCUIT,DI:QUAD BUS TRANSCEIVER	34335	AM2908DCB
A25U7020	156-1618-00			MICROCIRCUIT,DI:QUAD BUS TRANSCEIVER	34335	AM2908DCB
A25U7030	156-1618-00			MICROCIRCUIT,DI:QUAD BUS TRANSCEIVER	34335	AM2908DCB
A25U7040	156-1618-00			MICROCIRCUIT,DI:QUAD BUS TRANSCEIVER	34335	AM2908DCB
A25U7050	156-0966-01			MICROCIRCUIT,DI:DUAL 5 INP NOR GATES	80009	156-0966-01
A25U7060	156-0459-02			MICROCIRCUIT,DI:QUAD 2 INPUT & GATE,BURN	01295	SN74S08
A25U7070	156-0738-04			MICROCIRCUIT,DI:HEX D FF W/CLEAR,BURN-IN	01295	SN74S174(JP4)
A25U7080	156-0653-02			MICROCIRCUIT,DI:QUAD UNIFIED BUS XVER INV	27014	D58838
A25U7090	156-0653-02			MICROCIRCUIT,DI:QUAD UNIFIED BUS XVER INV	27014	D58838
A25U7100	156-0323-02			MICROCIRCUIT,DI:HEX INVERTER,BURN-IN	01295	SN74S04
A25U7110	156-0392-03			MICROCIRCUIT,DI:QUAD LATCH W/CLEAR	01295	SN74LS175NP3
A25U7120	156-0323-02			MICROCIRCUIT,DI:HEX INVERTER,BURN-IN	01295	SN74S04
A25U7130	156-0459-02			MICROCIRCUIT,DI:QUAD 2 INPUT & GATE,BURN	01295	SN74S08
A25U7140	156-0331-03			MICROCIRCUIT,DI:DUAL D TYPE POSITIVE EDGE	80009	156-0331-03
A25U7150	156-1172-01			MICROCIRCUIT,DI:DUAL 4 BIT CNTR,BURN IN	01295	SN74LS393
A25U7160	156-0331-03			MICROCIRCUIT,DI:DUAL D TYPE POSITIVE EDGE	80009	156-0331-03
A25VR7019	152-0761-00			SEMICOND DEVICE:TRANSIENT SUPPR,1.5 JOULE	01281	TVP1505A
A25Y7159	158-0154-00			XTAL UNIT,QTZ:20MHZ,0.015%,PARALLEL	75378	MP 200

Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A30	----- -----			CKT BOARD ASSY:I/O PROCESSOR		
A30C1011	290-0847-00			CAP.,FXD,ELCTLT:47UF,+50-10%,10 V	54473	ECE-B1AV470S
A30C1041	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A30C1051	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A30C1061	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A30C1081	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A30C1091	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A30C1101	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A30C1121	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A30C1131	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A30C1151	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A30C1161	290-0847-00			CAP.,FXD,ELCTLT:47UF,+50-10%,10 V	54473	ECE-B1AV470S
A30C1171	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A30C2011	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A30C2021	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A30C2031	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A30C2051	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A30C2061	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A30C2081	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A30C2091	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A30C2101	283-0095-00			CAP.,FXD,CER DI:56PF,10%,200V	72982	855-535A560K
A30C2102	283-0095-00			CAP.,FXD,CER DI:56PF,10%,200V	72982	855-535A560K
A30C2131	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A30C2141	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A30C2151	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A30C2161	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A30C2171	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A30C3171	283-0175-00			CAP.,FXD,CER DI:10PF,5%,200V	72982	8101B210C0G0100J
A30C4011	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A30C4021	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A30C4031	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A30C4041	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A30C4051	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A30C4111	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A30C4121	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A30C4131	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A30C4141	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A30C4151	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A30C4171	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A30C5121	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A30C5131	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A30C5141	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A30C5151	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A30C6051	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A30C6071	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A30C6101	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A30C6172	283-0144-00			CAP.,FXD,CER DI:33PF,1%,500V	72982	801-547P2G330G
A30C7011	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A30C7011	290-0847-00			CAP.,FXD,ELCTLT:47UF,+50-10%,10 V	54473	ECE-B1AV470S
A30C7021	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A30C7031	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A30C7041	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A30C7051	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A30C7071	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A30C7091	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A30C7101	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A30C7102	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	59660	831-519-Z5U-102I

Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A30C7111	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A30C7121	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A30C7131	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A30C7141	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A30C7151	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A30C7161	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A30C7171	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A30DS1031	150-1037-00			LAMP,LED,RDOUT:7 SEGMENT,LH DECIMAL,ORANGE	50522	MAN 3620A
A30Q6171	151-0221-00			TRANSISTOR:SILICON,PNP	04713	SPS246
A30R2041	315-0222-00			RES.,FXD,CMPSN:2.2K OHM,5%,0.25W	01121	CB2225
A30R2091	315-0222-00			RES.,FXD,CMPSN:2.2K OHM,5%,0.25W	01121	CB2225
A30R2111	315-0106-00			RES.,FXD,CMPSN:10M OHM,5%,0.25W	01121	CB1065
A30R2161	315-0272-00			RES.,FXD,CMPSN:2.7K OHM,5%,0.25W	01121	CB2725
A30R2171	315-0272-00			RES.,FXD,CMPSN:2.7K OHM,5%,0.25W	01121	CB2725
A30R5171	315-0122-00			RES.,FXD,CMPSN:1.2K OHM,5%,0.25W	01121	CB1225
A30R5172	315-0221-00			RES.,FXD,CMPSN:220 OHM,5%,0.25W	01121	CB2215
A30R5173	315-0220-00			RES.,FXD,CMPSN:22 OHM,5%,0.25W	01121	CB2205
A30R7061	315-0681-00			RES.,FXD,CMPSN:680 OHM,5%,0.25W	01121	CB6815
A30R7071	315-0331-00			RES.,FXD,CMPSN:330 OHM,5%,0.25W	01121	CB3315
A30R7072	315-0331-00			RES.,FXD,CMPSN:330 OHM,5%,0.25W	01121	CB3315
A30R7073	315-0681-00			RES.,FXD,CMPSN:680 OHM,5%,0.25W	01121	CB6815
A30R7101	315-0331-00			RES.,FXD,CMPSN:330 OHM,5%,0.25W	01121	CB3315
A30R7102	315-0681-00			RES.,FXD,CMPSN:680 OHM,5%,0.25W	01121	CB6815
A30R7141	315-0681-00			RES.,FXD,CMPSN:680 OHM,5%,0.25W	01121	CB6815
A30R7151	315-0331-00			RES.,FXD,CMPSN:330 OHM,5%,0.25W	01121	CB3315
A30RP1021	307-0636-00			RES NTWK,FXD,FI:8,330 OHM,2%,0.125W	01121	316B331
A30RP5111	307-0650-00			RES NTWK,FXD,FI:9,2.7K OHM,5%,0.150W	32997	4310R-101-272
A30U1040	156-0469-02			MICROCIRCUIT,DI:3/8 LINE DCDR	01295	SN74LS138NP3
A30U1050	160-1408-00			MICROCIRCUIT,DI:4096 X 8 EPROM	80009	160-1408-00
A30U1060	160-1407-00			MICROCIRCUIT,DI:8192 X 8 EPROM	80009	160-1407-00
A30U1080	160-1406-00			MICROCIRCUIT,DI:8192 X 8 EPROM	80009	160-1406-00
A30U1090	160-1409-00			MICROCIRCUIT,DI:8192 X 8 EPROM	80009	160-1409-00
A30U1120	156-1594-00			MICROCIRCUIT,DI:1024 X 8 SPRAM,4118-4A	000JK	HM6116P-3
A30U1130	156-1594-00			MICROCIRCUIT,DI:1024 X 8 SPRAM,4118-4A	000JK	HM6116P-3
A30U1150	156-1594-00			MICROCIRCUIT,DI:1024 X 8 SPRAM,4118-4A	000JK	HM6116P-3
A30U1160	156-1594-00			MICROCIRCUIT,DI:1024 X 8 SPRAM,4118-4A	000JK	HM6116P-3
A30U1170	156-1594-00			MICROCIRCUIT,DI:1024 X 8 SPRAM,4118-4A	000JK	HM6116P-3
A30U2010	156-1111-02			MICROCIRCUIT,DI:OCTAL BUS TRANSCEIVERS	80009	156-1111-02
A30U2020	156-0865-02			MICROCIRCUIT,DI:OCTAL D-TYPE FF W/CLEAR	01295	SN74LS273NP3
A30U2030	156-0956-02			MICROCIRCUIT,DI:OCTAL BFR W/3 STATE OUT	01295	SN74LS244NP3
A30U2040	156-0694-02			MICROCIRCUIT,DI:DCDR/3 LINE TO 8 LINE,SCRN	07263	74S138DCQR
A30U2080	156-1065-01			MICROCIRCUIT,DI:OCTAL D TYPE TRANS LATCHES	34335	AM74LS373
A30U2090	156-0874-02			MICROCIRCUIT,DI:8 BIT ADDRESSABLE LCH	80009	156-0874-02
A30U2100	156-0850-02			MICROCIRCUIT,DI:PRGM BIT RATE GEN SCRN	07263	4702BDCQR
A30U2130	156-0396-02			MICROCIRCUIT,DI:QUAD 2-INP 3-STATE BFR,SCRN	27014	DM8094N/A+
A30U2140	156-0479-02			MICROCIRCUIT,DI:QUAD 2-INP OR GATE	01295	SN74LS32NP3
A30U2150	156-0480-02			MICROCIRCUIT,DI:QUAD 2 INP & GATE	01295	SN74LS08NP3
A30U2160	156-0479-02			MICROCIRCUIT,DI:QUAD 2-INP OR GATE	01295	SN74LS32NP3
A30U3010	156-1065-01			MICROCIRCUIT,DI:OCTAL D TYPE TRANS LATCHES	34335	AM74LS373
A30U3020	156-1065-01			MICROCIRCUIT,DI:OCTAL D TYPE TRANS LATCHES	34335	AM74LS373
A30U3030	156-0956-02			MICROCIRCUIT,DI:OCTAL BFR W/3 STATE OUT	01295	SN74LS244NP3
A30U3040	156-1065-01			MICROCIRCUIT,DI:OCTAL D TYPE TRANS LATCHES	34335	AM74LS373
A30U3050	156-1609-00			MICROCIRCUIT,DI:8 BIT MICROPROCESSOR	34649	D8088
A30U3060	156-1606-00			MICROCIRCUIT,DI:DMA CONTROLLER	34649	(CORD)8237-2
A30U3110	156-0479-02			MICROCIRCUIT,DI:QUAD 2-INP OR GATE	01295	SN74LS32NP3
A30U3120	156-0481-02			MICROCIRCUIT,DI:TRIPLE 3 INP & GATE	27014	DM74LS11NA+
A30U3130	156-0480-02			MICROCIRCUIT,DI:QUAD 2 INP & GATE	01295	SN74LS08NP3

Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A30U3140	156-0385-02			MICROCIRCUIT,DI:HEX INVERTER	01295	SN74LS04
A30U3150	156-0693-02			MICROCIRCUIT,DI:DECODER/DEMULTIPLEXER	27014	DM74S139
A30U3160	156-1428-02			MICROCIRCUIT,DI:CLOCK GENERATOR & DRIVER	34649	D8284A
A30U4010	156-0982-03			MICROCIRCUIT,DI:OCTAL-D-EDGE FF,SCRN	07263	74LS374
A30U4020	156-0956-02			MICROCIRCUIT,DI:OCTAL BFR W/3 STATE OUT	01295	SN74LS244NP3
A30U4030	156-0982-03			MICROCIRCUIT,DI:OCTAL-D-EDGE FF,SCRN	07263	74LS374
A30U4040	156-0956-02			MICROCIRCUIT,DI:OCTAL BFR W/3 STATE OUT	01295	SN74LS244NP3
A30U4060	156-0804-02			MICROCIRCUIT,DI:QUADRUPLE S-R LATCH	01295	SN74LS279NP3
A30U4070	156-0479-02			MICROCIRCUIT,DI:QUAD 2-INP OR GATE	01295	SN74LS32NP3
A30U4080	156-1424-01			MICROCIRCUIT,DI:SERIAL INPUT/OUTPUT	56708	Z80A-SIO/ICS-01
A30U4100	156-1424-01			MICROCIRCUIT,DI:SERIAL INPUT/OUTPUT	56708	Z80A-SIO/ICS-01
A30U4110	156-0391-02			MICROCIRCUIT,DI:HEX LATCH W/CLEAR	01295	SN74LS174
A30U4120	156-0480-02			MICROCIRCUIT,DI:QUAD 2 INP & GATE	01295	SN74LS08NP3
A30U4130	156-0469-02			MICROCIRCUIT,DI:3/8 LINE DCDR	01295	SN74LS138NP3
A30U4140	156-0469-02			MICROCIRCUIT,DI:3/8 LINE DCDR	01295	SN74LS138NP3
A30U4150	156-0479-02			MICROCIRCUIT,DI:QUAD 2-INP OR GATE	01295	SN74LS32NP3
A30U4160	156-0480-02			MICROCIRCUIT,DI:QUAD 2 INP & GATE	01295	SN74LS08NP3
A30U4170	156-0653-02			MICROCIRCUIT,DI:QUAD UNIFIED BUS XVER INV	27014	D58838
A30U5010	156-1065-01			MICROCIRCUIT,DI:OCTAL D TYPE TRANS LATCHES	34335	AM74LS373
A30U5020	156-1065-01			MICROCIRCUIT,DI:OCTAL D TYPE TRANS LATCHES	34335	AM74LS373
A30U5030	156-1065-01			MICROCIRCUIT,DI:OCTAL D TYPE TRANS LATCHES	34335	AM74LS373
A30U5040	156-1065-01			MICROCIRCUIT,DI:OCTAL D TYPE TRANS LATCHES	34335	AM74LS373
A30U5050	156-0956-02			MICROCIRCUIT,DI:OCTAL BFR W/3 STATE OUT	01295	SN74LS244NP3
A30U5060	156-0956-02			MICROCIRCUIT,DI:OCTAL BFR W/3 STATE OUT	01295	SN74LS244NP3
A30U5070	156-0865-02			MICROCIRCUIT,DI:OCTAL D-TYPE FF W/CLEAR	01295	SN74LS273NP3
A30U5080	156-0994-02			MICROCIRCUIT,DI:8 INPUT DATA SEL/MUX	01295	SN74LS151NP3
A30U5090	156-0994-02			MICROCIRCUIT,DI:8 INPUT DATA SEL/MUX	01295	SN74LS151NP3
A30U5100	156-0994-02			MICROCIRCUIT,DI:8 INPUT DATA SEL/MUX	01295	SN74LS151NP3
A30U5110	156-0994-02			MICROCIRCUIT,DI:8 INPUT DATA SEL/MUX	01295	SN74LS151NP3
A30U5120	156-0385-02			MICROCIRCUIT,DI:HEX INVERTER	01295	SN74LS04
A30U5130	156-0479-02			MICROCIRCUIT,DI:QUAD 2-INP OR GATE	01295	SN74LS32NP3
A30U5140	156-0382-02			MICROCIRCUIT,DI:QUAD 2-INP NAND GATE	01295	SN74LS00
A30U5150	156-0383-02			MICROCIRCUIT,DI:QUAD 2-INP NOR GATE	01295	SN74LS02
A30U5160	156-0422-02			MICROCIRCUIT,DI:UP/DOWN SYN BINARY CNTR	01295	SN74LS191
A30U5170	156-0422-02			MICROCIRCUIT,DI:UP/DOWN SYN BINARY CNTR	01295	SN74LS191
A30U6010	156-0982-03			MICROCIRCUIT,DI:OCTAL-D-EDGE FF,SCRN	07263	74LS374
A30U6020	156-0982-03			MICROCIRCUIT,DI:OCTAL-D-EDGE FF,SCRN	07263	74LS374
A30U6030	156-0982-03			MICROCIRCUIT,DI:OCTAL-D-EDGE FF,SCRN	07263	74LS374
A30U6040	156-0982-03			MICROCIRCUIT,DI:OCTAL-D-EDGE FF,SCRN	07263	74LS374
A30U6050	156-0539-01			MICROCIRCUIT,DI:6 BIT UNIFIEDBUS COMPTR	80009	156-0539-01
A30U6060	156-0956-02			MICROCIRCUIT,DI:OCTAL BFR W/3 STATE OUT	01295	SN74LS244NP3
A30U6070	156-0386-02			MICROCIRCUIT,DI:TRIPLE 3 INP NAND GATE	01295	SN74LS10NP3
A30U6080	156-1605-00			MICROCIRCUIT,DI:DIRECT MEMORY ACCESS	15476	DC01019.14038
A30U6090	156-0388-03			MICROCIRCUIT,DI:DUAL D FLIP-FLOP	07263	74LS74A
A30U6100	156-0386-02			MICROCIRCUIT,DI:TRIPLE 3 INP NAND GATE	01295	SN74LS10NP3
A30U6110	156-0388-03			MICROCIRCUIT,DI:DUAL D FLIP-FLOP	07263	74LS74A
A30U6120	156-0718-03			MICROCIRCUIT,DI:TRIPLE 3-INP NOR GATE	01295	SN74LS27
A30U6130	156-0388-03			MICROCIRCUIT,DI:DUAL D FLIP-FLOP	07263	74LS74A
A30U6140	156-0645-02			MICROCIRCUIT,DI:SCHMITT-TRIG POS-NAND	01295	SN74LS14
A30U6150	156-0480-02			MICROCIRCUIT,DI:QUAD 2 INP & GATE	01295	SN74LS08NP3
A30U6160	156-0323-02			MICROCIRCUIT,DI:HEX INVERTER,BURN-IN	01295	SN74S04
A30U6170	156-1172-01			MICROCIRCUIT,DI:DUAL 4 BIT CNTR,BURN IN	01295	SN74LS393
A30U7010	156-0653-02			MICROCIRCUIT,DI:QUAD UNIFIED BUS XVER INV	27014	D58838
A30U7020	156-0653-02			MICROCIRCUIT,DI:QUAD UNIFIED BUS XVER INV	27014	D58838
A30U7030	156-0653-02			MICROCIRCUIT,DI:QUAD UNIFIED BUS XVER INV	27014	D58838
A30U7040	156-0653-02			MICROCIRCUIT,DI:QUAD UNIFIED BUS XVER INV	27014	D58838
A30U7050	156-0465-02			MICROCIRCUIT,DI:8 INP NAND GATE	01295	SN74LS30NP3

Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A30U7070	156-0653-02			MICROCIRCUIT,DI:QUAD UNIFIED BUS XVER INV	27014	D58838
A30U7080	156-0653-02			MICROCIRCUIT,DI:QUAD UNIFIED BUS XVER INV	27014	D58838
A30U7090	156-0653-02			MICROCIRCUIT,DI:QUAD UNIFIED BUS XVER INV	27014	D58838
A30U7100	156-0653-02			MICROCIRCUIT,DI:QUAD UNIFIED BUS XVER INV	27014	D58838
A30U7110	156-0479-02			MICROCIRCUIT,DI:QUAD 2-INP OR GATE	01295	SN74LS32NP3
A30U7130	156-0480-02			MICROCIRCUIT,DI:QUAD 2 INP & GATE	01295	SN74LS08NP3
A30U7140	156-0718-03			MICROCIRCUIT,DI:TRIPLE 3-INP NOR GATE	01295	SN74LS27
A30U7150	156-0382-02			MICROCIRCUIT,DI:QUAD 2-INP NAND GATE	01295	SN74LS00
A30U7160	156-0382-02			MICROCIRCUIT,DI:QUAD 2-INP NAND GATE	01295	SN74LS00
A30U7170	156-0388-03			MICROCIRCUIT,DI:DUAL D FLIP-FLOP	07263	74LS74A
A30Y2121	158-0124-00			XTAL UNIT,QTZ:2.4576 MHZ,0.05% PARALLEL	75378	MP-024
A30Y3170	158-0135-00			XTAL UNIT,QTZ:14.7456 MHZ,0.01%,SERIES	01807	OBD

Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A35	----- -----			CKT BOARD ASSY:I/O ADAPTER		
A35C1011	283-0193-00			CAP.,FXD,CER DI:510PF,2%,100V	72982	8121N130C0G0511G
A35C1012	283-0193-00			CAP.,FXD,CER DI:510PF,2%,100V	72982	8121N130C0G0511G
A35C1013	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A35C1031	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A35C1041	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A35C2011	283-0193-00			CAP.,FXD,CER DI:510PF,2%,100V	72982	8121N130C0G0511G
A35C2012	283-0193-00			CAP.,FXD,CER DI:510PF,2%,100V	72982	8121N130C0G0511G
A35C2031	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A35C2051	290-0745-00			CAP.,FXD,ELCTLT:22UF,+50-10%,25V	56289	502D225
A35C2052	290-0745-00			CAP.,FXD,ELCTLT:22UF,+50-10%,25V	56289	502D225
A35C3011	283-0193-00			CAP.,FXD,CER DI:510PF,2%,100V	72982	8121N130C0G0511G
A35C3012	283-0193-00			CAP.,FXD,CER DI:510PF,2%,100V	72982	8121N130C0G0511G
A35C3013	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A35C3031	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A35C3041	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A35C3061	290-0745-00			CAP.,FXD,ELCTLT:22UF,+50-10%,25V	56289	502D225
A35C4011	283-0193-00			CAP.,FXD,CER DI:510PF,2%,100V	72982	8121N130C0G0511G
A35C4012	283-0193-00			CAP.,FXD,CER DI:510PF,2%,100V	72982	8121N130C0G0511G
A35C4013	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A35C4031	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A35C5011	283-0193-00			CAP.,FXD,CER DI:510PF,2%,100V	72982	8121N130C0G0511G
A35C5012	283-0193-00			CAP.,FXD,CER DI:510PF,2%,100V	72982	8121N130C0G0511G
A35C5013	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A35C5031	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A35C5041	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A35C6011	283-0193-00			CAP.,FXD,CER DI:510PF,2%,100V	72982	8121N130C0G0511G
A35C6012	283-0193-00			CAP.,FXD,CER DI:510PF,2%,100V	72982	8121N130C0G0511G
A35C6013	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A35C6031	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A35C6061	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A35C7011	283-0193-00			CAP.,FXD,CER DI:510PF,2%,100V	72982	8121N130C0G0511G
A35C7012	283-0193-00			CAP.,FXD,CER DI:510PF,2%,100V	72982	8121N130C0G0511G
A35C7013	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A35C7031	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A35C7041	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A35C7061	283-0193-00			CAP.,FXD,CER DI:510PF,2%,100V	72982	8121N130C0G0511G
A35C7061	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A35C7062	283-0193-00			CAP.,FXD,CER DI:510PF,2%,100V	72982	8121N130C0G0511G
A35C7063	283-0193-00			CAP.,FXD,CER DI:510PF,2%,100V	72982	8121N130C0G0511G
A35C7064	283-0193-00			CAP.,FXD,CER DI:510PF,2%,100V	72982	8121N130C0G0511G
A35C8011	283-0193-00			CAP.,FXD,CER DI:510PF,2%,100V	72982	8121N130C0G0511G
A35C8012	283-0193-00			CAP.,FXD,CER DI:510PF,2%,100V	72982	8121N130C0G0511G
A35C8013	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A35R2041	315-0123-00			RES.,FXD,CMPSN:12K OHM,5%,0.25W	01121	CB1235
A35R2042	315-0201-00			RES.,FXD,CMPSN:200 OHM,5%,0.25W	01121	CB2015
A35R2043	315-0123-00			RES.,FXD,CMPSN:12K OHM,5%,0.25W	01121	CB1235
A35R2044	315-0201-00			RES.,FXD,CMPSN:200 OHM,5%,0.25W	01121	CB2015
A35R2045	315-0201-00			RES.,FXD,CMPSN:200 OHM,5%,0.25W	01121	CB2015
A35R2046	315-0123-00			RES.,FXD,CMPSN:12K OHM,5%,0.25W	01121	CB1235
A35R2047	315-0201-00			RES.,FXD,CMPSN:200 OHM,5%,0.25W	01121	CB2015
A35R2048	315-0123-00			RES.,FXD,CMPSN:12K OHM,5%,0.25W	01121	CB1235
A35R4041	315-0123-00			RES.,FXD,CMPSN:12K OHM,5%,0.25W	01121	CB1235
A35R4042	315-0201-00			RES.,FXD,CMPSN:200 OHM,5%,0.25W	01121	CB2015
A35R4043	315-0123-00			RES.,FXD,CMPSN:12K OHM,5%,0.25W	01121	CB1235
A35R4044	315-0201-00			RES.,FXD,CMPSN:200 OHM,5%,0.25W	01121	CB2015
A35R4045	315-0201-00			RES.,FXD,CMPSN:200 OHM,5%,0.25W	01121	CB2015

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A35R4046	315-0123-00			RES.,FXD,CMPSN:12K OHM,5%,0.25W	01121	CB1235
A35R4047	315-0201-00			RES.,FXD,CMPSN:200 OHM,5%,0.25W	01121	CB2015
A35R4048	315-0123-00			RES.,FXD,CMPSN:12K OHM,5%,0.25W	01121	CB1235
A35R6041	315-0123-00			RES.,FXD,CMPSN:12K OHM,5%,0.25W	01121	CB1235
A35R6042	315-0201-00			RES.,FXD,CMPSN:200 OHM,5%,0.25W	01121	CB2015
A35R6043	315-0123-00			RES.,FXD,CMPSN:12K OHM,5%,0.25W	01121	CB1235
A35R6044	315-0201-00			RES.,FXD,CMPSN:200 OHM,5%,0.25W	01121	CB2015
A35R6045	315-0201-00			RES.,FXD,CMPSN:200 OHM,5%,0.25W	01121	CB2015
A35R6046	315-0123-00			RES.,FXD,CMPSN:12K OHM,5%,0.25W	01121	CB1235
A35R6047	315-0201-00			RES.,FXD,CMPSN:200 OHM,5%,0.25W	01121	CB2015
A35R6048	315-0123-00			RES.,FXD,CMPSN:12K OHM,5%,0.25W	01121	CB1235
A35R6061	315-0123-00			RES.,FXD,CMPSN:12K OHM,5%,0.25W	01121	CB1235
A35R6062	315-0123-00			RES.,FXD,CMPSN:12K OHM,5%,0.25W	01121	CB1235
A35R6063	315-0123-00			RES.,FXD,CMPSN:12K OHM,5%,0.25W	01121	CB1235
A35R7061	315-0123-00			RES.,FXD,CMPSN:12K OHM,5%,0.25W	01121	CB1235
A35R7061	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A35R7062	315-0123-00			RES.,FXD,CMPSN:12K OHM,5%,0.25W	01121	CB1235
A35R8041	315-0123-00			RES.,FXD,CMPSN:12K OHM,5%,0.25W	01121	CB1235
A35R8042	315-0201-00			RES.,FXD,CMPSN:200 OHM,5%,0.25W	01121	CB2015
A35R8043	315-0123-00			RES.,FXD,CMPSN:12K OHM,5%,0.25W	01121	CB1235
A35R8044	315-0201-00			RES.,FXD,CMPSN:200 OHM,5%,0.25W	01121	CB2015
A35R8045	315-0201-00			RES.,FXD,CMPSN:200 OHM,5%,0.25W	01121	CB2015
A35R8046	315-0123-00			RES.,FXD,CMPSN:12K OHM,5%,0.25W	01121	CB1235
A35R8047	315-0201-00			RES.,FXD,CMPSN:200 OHM,5%,0.25W	01121	CB2015
A35R8048	315-0123-00			RES.,FXD,CMPSN:12K OHM,5%,0.25W	01121	CB1235
A35R8049	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A35R8061	315-0123-00			RES.,FXD,CMPSN:12K OHM,5%,0.25W	01121	CB1235
A35U1030	156-1316-00			MICROCKT,INTFC:QUAD 3 STATE SINGLE ENDED	80009	156-1316-00
A35U1040	156-1315-00			MICROCKT,INTFC:QUAD DIFFERENTIAL RECEIVER	34335	AM26LS32
A35U2030	156-1316-00			MICROCKT,INTFC:QUAD 3 STATE SINGLE ENDED	80009	156-1316-00
A35U2050	156-0846-00			MICROCIRCUIT,LI:VOLTAGE REGULATOR	04713	MC7905CT
A35U3030	156-1316-00			MICROCKT,INTFC:QUAD 3 STATE SINGLE ENDED	80009	156-1316-00
A35U3040	156-1315-00			MICROCKT,INTFC:QUAD DIFFERENTIAL RECEIVER	34335	AM26LS32
A35U4030	156-1316-00			MICROCKT,INTFC:QUAD 3 STATE SINGLE ENDED	80009	156-1316-00
A35U5030	156-1316-00			MICROCKT,INTFC:QUAD 3 STATE SINGLE ENDED	80009	156-1316-00
A35U5040	156-1315-00			MICROCKT,INTFC:QUAD DIFFERENTIAL RECEIVER	34335	AM26LS32
A35U6030	156-1316-00			MICROCKT,INTFC:QUAD 3 STATE SINGLE ENDED	80009	156-1316-00
A35U6060	156-1315-00			MICROCKT,INTFC:QUAD DIFFERENTIAL RECEIVER	34335	AM26LS32
A35U7030	156-1316-00			MICROCKT,INTFC:QUAD 3 STATE SINGLE ENDED	80009	156-1316-00
A35U7040	156-1315-00			MICROCKT,INTFC:QUAD DIFFERENTIAL RECEIVER	34335	AM26LS32
A35U7060	156-1316-00			MICROCKT,INTFC:QUAD 3 STATE SINGLE ENDED	80009	156-1316-00
A35U8030	156-1316-00			MICROCKT,INTFC:QUAD 3 STATE SINGLE ENDED	80009	156-1316-00
A35U8060	156-1315-00			MICROCKT,INTFC:QUAD DIFFERENTIAL RECEIVER	34335	AM26LS32

Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A40	----- -----			CKT BOARD ASSY:I/O CONNECTOR		
A40J8001	131-1178-03			CONN,RCPT,ELEC:CKT BD,36/72 CONT	80009	131-1178-03
A40J8011	131-1437-00			CONN,RCPT,ELEC:25 FEMALE CONTACT	71468	DB25S-F179
A40J8021	131-1437-00			CONN,RCPT,ELEC:25 FEMALE CONTACT	71468	DB25S-F179
A40J8031	131-1437-00			CONN,RCPT,ELEC:25 FEMALE CONTACT	71468	DB25S-F179
A40J8041	131-1437-00			CONN,RCPT,ELEC:25 FEMALE CONTACT	71468	DB25S-F179
A40J8051	131-1437-00			CONN,RCPT,ELEC:25 FEMALE CONTACT	71468	DB25S-F179
A40J8101	131-1437-00			CONN,RCPT,ELEC:25 FEMALE CONTACT	71468	DB25S-F179
A40RP1011	307-0594-00			RES NTWK,FXD FI:7,220 OHM,2%,1.0W	91637	CSP08G01221G
A40RP2011	307-0594-00			RES NTWK,FXD FI:7,220 OHM,2%,1.0W	91637	CSP08G01221G
A40RP3011	307-0594-00			RES NTWK,FXD FI:7,220 OHM,2%,1.0W	91637	CSP08G01221G

Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A45	----- -----			CKT BOARD ASSY:PMS CONTROLLER		
A45C1019	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A45C1036	281-0819-00			CAP.,FXD,CER DI:33PF,5%,50V	72982	8035BC0G330
A45C1040	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A45C1090	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A45C1093	281-0814-00			CAP.,FXD,CER DI:100PF,10%,100V	04222	GC70-1-A101K
A45C1119	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A45C3011	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A45C3021	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A45C3031	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A45C3041	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A45C3081	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A45C3111	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A45C3121	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A45C3131	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A45C3141	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A45C4071	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A45C4091	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A45C4101	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A45C4111	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A45C4121	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A45C4130	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A45C5011	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A45C5021	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A45C5031	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A45C5041	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A45C5055	283-0334-00			CAP.,FXD,CER DI:130PF,+1-2%,500V	72982	8121N501C0G0131G
A45C5056	283-0334-00			CAP.,FXD,CER DI:130PF,+1-2%,500V	72982	8121N501C0G0131G
A45C5061	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A45C5071	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A45C5081	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A45C5091	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A45C5101	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A45C5111	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A45C6051	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A45C6071	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A45C6081	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A45C6091	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A45C7011	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A45C7021	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A45C7031	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A45C7041	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A45C7051	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A45C7061	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A45C7079	290-0107-00			CAP.,FXD,ELCTLT:25UF,+75-10%,25V	56289	30D256G025DB9
A45C7119	290-0107-00			CAP.,FXD,ELCTLT:25UF,+75-10%,25V	56289	30D256G025DB9
A45C7121	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A45C7134	281-0812-00			CAP.,FXD,CER DI:1000PF,10%,100V	72982	8035D9AADX7R102K
A45C7135	283-0339-00			CAP.,FXD,CER DI:0.22UF.10%,50V	72982	8131N075W5R224K
A45C7136	283-0159-00			CAP.,FXD,CER DI:18PF,5%,50V	72982	8111B065C0G0180J
A45C7137	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A45C7138	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A45C7139	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A45C7141	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A45C7147	283-0164-00			CAP.,FXD,CER DI:2.2UF,20%,25V	72982	8141N037Z5U0225M
A45DS1017	150-1014-00			LAMP,LED:RED,50MA	07263	MV5054-1
A45DS1140	150-1037-00			LAMP,LED,RDOUT:7 SEGMENT,LH DECIMAL,ORANGE	50522	MAN 3620A

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A45Q2040	151-0221-00			TRANSISTOR:SILICON,PNP	04713	SPS246
A45R1015	315-0391-00			RES.,FXD,CMPSN:390 OHM,5%,0.25W	01121	CB3915
A45R1031	315-0220-00			RES.,FXD,CMPSN:22 OHM,5%,0.25W	01121	CB2205
A45R1032	315-0220-00			RES.,FXD,CMPSN:22 OHM,5%,0.25W	01121	CB2205
A45R1033	315-0221-00			RES.,FXD,CMPSN:220 OHM,5%,0.25W	01121	CB2215
A45R1034	315-0122-00			RES.,FXD,CMPSN:1.2K OHM,5%,0.25W	01121	CB1225
A45R1035	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A45R1042	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
A45R1051	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A45R1091	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
A45R1092	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
A45R1131	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A45R3121	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A45R4008	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A45R5053	321-0262-00			RES.,FXD,FILM:5.23K OHM,1%,0.125W	91637	MFF1816G52300F
A45R5054	321-0291-00			RES.,FXD,FILM:10.5K OHM,1%,0.125W	91637	MFF1816G10501F
A45R5057	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
A45R5071	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A45R6145	315-0333-00			RES.,FXD,CMPSN:33K OHM,5%,0.25W	01121	CB3335
A45R7071	315-0331-00			RES.,FXD,CMPSN:330 OHM,5%,0.25W	01121	CB3315
A45R7072	315-0331-00			RES.,FXD,CMPSN:330 OHM,5%,0.25W	01121	CB3315
A45R7073	315-0331-00			RES.,FXD,CMPSN:330 OHM,5%,0.25W	01121	CB3315
A45R7074	315-0331-00			RES.,FXD,CMPSN:330 OHM,5%,0.25W	01121	CB3315
A45R7075	315-0681-00			RES.,FXD,CMPSN:680 OHM,5%,0.25W	01121	CB6815
A45R7076	315-0681-00			RES.,FXD,CMPSN:680 OHM,5%,0.25W	01121	CB6815
A45R7077	315-0681-00			RES.,FXD,CMPSN:680 OHM,5%,0.25W	01121	CB6815
A45R7078	315-0681-00			RES.,FXD,CMPSN:680 OHM,5%,0.25W	01121	CB6815
A45R7101	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A45R7103	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A45R7121	315-0200-00			RES.,FXD,CMPSN:20 OHM,5%,0.25W	01121	CB2005
A45R7122	315-0200-00			RES.,FXD,CMPSN:20 OHM,5%,0.25W	01121	CB2005
A45R7123	315-0200-00			RES.,FXD,CMPSN:20 OHM,5%,0.25W	01121	CB2005
A45R7131	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
A45R7132	315-0821-00			RES.,FXD,CMPSN:820 OHM,5%,0.25W	01121	CB8215
A45R7133	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A45R7146	315-0564-00			RES.,FXD,CMPSN:560K OHM,5%,0.25W	01121	CB5645
A45RP1110	307-0446-00			RES,NTWK,FXD FI:10K OHM,20%,(9) RES	91637	MSP10A01-103M
A45RP1130	307-0446-00			RES,NTWK,FXD FI:10K OHM,20%,(9) RES	91637	MSP10A01-103M
A45RP2110	307-0446-00			RES,NTWK,FXD FI:10K OHM,20%,(9) RES	91637	MSP10A01-103M
A45RP2130	307-0446-00			RES,NTWK,FXD FI:10K OHM,20%,(9) RES	91637	MSP10A01-103M
A45RP2140	307-0636-00			RES NTWK,FXD,FI:8,330 OHM,2%,0.125W	01121	316B331
A45RP7081	307-0611-00			RES NTWK,FXD FI:7,150 OHM,5%,1.125W	32997	4308R101-151J
A45U1020	156-0983-01			MICROCIRCUIT,DI:MICROPROCESSOR-8-BIT,SCRN	50088	MK3880P-4
A45U1050	156-1412-00			MICROCIRCUIT,DI:SGL/DBL DENS FLOPPY DISC	34649	8272
A45U1070	156-1612-00			MICROCIRCUIT,DI:PARALLEL I/O,SCRN	50088	MK3881(N-4)MKX
A45U1080	156-1620-00			MICROCIRCUIT,DI:COUNTER TIMER CIRCUIT	56708	Z-80ACTC
A45U1100	160-1411-00			MICROCIRCUIT,DI:8192 X 8 EPROM	80009	160-1411-00
A45U1120	156-1382-00			MICROCIRCUIT,DI:1024 X 8 STATIC RAM	50088	MK4118A P-4
A45U1130	156-0388-03			MICROCIRCUIT,DI:DUAL D FLIP-FLOP	07263	74LS74A
A45U3010	156-0388-03			MICROCIRCUIT,DI:DUAL D FLIP-FLOP	07263	74LS74A
A45U3020	156-0382-02			MICROCIRCUIT,DI:QUAD 2-INP NAND GATE	01295	SN74LS00
A45U3030	156-1172-01			MICROCIRCUIT,DI:DUAL 4 BIT CNTR,BURN IN	01295	SN74LS393
A45U3040	156-0030-03			MICROCIRCUIT,DI:QUAD 2-INPUT NAND GATE	27014	DM8000
A45U3050	156-0422-02			MICROCIRCUIT,DI:UP/DOWN SYN BINARY CNTR	01295	SN74LS191
A45U3060	156-0469-02			MICROCIRCUIT,DI:3/8 LINE DCDR	01295	SN74LS138NP3
A45U3070	156-0469-02			MICROCIRCUIT,DI:3/8 LINE DCDR	01295	SN74LS138NP3
A45U3080	156-0784-02			MICROCIRCUIT,DI:SYNC 4 BIT BINARY COUNTER	27014	DM74LS163ANA+

Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A45U3090	156-0645-02			MICROCIRCUIT,DI:SCHMITT-TRIG POS-NAND	01295	SN74LS14
A45U3100	156-0388-03			MICROCIRCUIT,DI:DUAL D FLIP-FLOP	07263	74LS74A
A45U3110	156-0388-03			MICROCIRCUIT,DI:DUAL D FLIP-FLOP	07263	74LS74A
A45U3120	156-0388-03			MICROCIRCUIT,DI:DUAL D FLIP-FLOP	07263	74LS74A
A45U3130	156-0391-02			MICROCIRCUIT,DI:HEX LATCH W/CLEAR	01295	SN74LS174
A45U3140	156-0865-02			MICROCIRCUIT,DI:OCTAL D-TYPE FF W/CLEAR	01295	SN74LS273NP3
A45U4010	156-0385-02			MICROCIRCUIT,DI:HEX INVERTER	01295	SN74LS04
A45U4020	156-1172-01			MICROCIRCUIT,DI:DUAL 4 BIT CNTR,BURN IN	01295	SN74LS393
A45U4030	156-0388-03			MICROCIRCUIT,DI:DUAL D FLIP-FLOP	07263	74LS74A
A45U4040	156-0388-03			MICROCIRCUIT,DI:DUAL D FLIP-FLOP	07263	74LS74A
A45U4050	156-0733-02			MICROCIRCUIT,DI:DUAL MONOSTABLE MV,BURN-IN	04713	SN74LS221N/J
A45U4060	156-0798-02			MICROCIRCUIT,DI:DUAL 14 TO 1 LINE SEL/MUX	01295	SN74LS153
A45U4070	156-0385-02			MICROCIRCUIT,DI:HEX INVERTER	01295	SN74LS04
A45U4080	156-0388-03			MICROCIRCUIT,DI:DUAL D FLIP-FLOP	07263	74LS74A
A45U4090	156-0383-02			MICROCIRCUIT,DI:QUAD 2-INP NOR GATE	01295	SN74LS02
A45U4100	156-0383-02			MICROCIRCUIT,DI:QUAD 2-INP NOR GATE	01295	SN74LS02
A45U4110	156-0382-02			MICROCIRCUIT,DI:QUAD 2-INP NAND GATE	01295	SN74LS00
A45U4120	156-0804-02			MICROCIRCUIT,DI:QUADRUPLE S-R LATCH,SCRN	01295	SN74LS279NP3
A45U4130	156-0388-03			MICROCIRCUIT,DI:DUAL D FLIP-FLOP	07263	74LS74A
A45U5010	156-1065-01			MICROCIRCUIT,DI:OCTAL D TYPE TRANS LATCHES	34335	AM74LS373
A45U5020	156-0982-03			MICROCIRCUIT,DI:OCTAL-D-EDGE FF,SCRN	07263	74LS374
A45U5030	156-0982-03			MICROCIRCUIT,DI:OCTAL-D-EDGE FF,SCRN	07263	74LS374
A45U5040	156-0982-03			MICROCIRCUIT,DI:OCTAL-D-EDGE FF,SCRN	07263	74LS374
A45U5060	156-0539-01			MICROCIRCUIT,DI:6 BIT UNIFIEDBUS COMPTR	80009	156-0539-01
A45U5070	156-0718-03			MICROCIRCUIT,DI:TRIPLE 3-INP NOR GATE	01295	SN74LS27
A45U5080	156-0386-02			MICROCIRCUIT,DI:TRIPLE 3 INP NAND GATE	01295	SN74LS10NP3
A45U5090	156-0385-02			MICROCIRCUIT,DI:HEX INVERTER	01295	SN74LS04
A45U5100	156-0388-03			MICROCIRCUIT,DI:DUAL D FLIP-FLOP	07263	74LS74A
A45U5110	156-0480-02			MICROCIRCUIT,DI:QUAD 2 INP & GATE	01295	SN74LS08NP3
A45U5120	156-0541-02			MICROCIRCUIT,DI:DUAL 2 TO 4 LINE DCDR	01295	SN74LS139NP3
A45U5130	156-0392-03			MICROCIRCUIT,DI:QUAD LATCH W/CLEAR	01295	SN74LS175NP3
A45U6010	156-1065-01			MICROCIRCUIT,DI:OCTAL D TYPE TRANS LATCHES	34335	AM74LS373
A45U6020	156-0982-03			MICROCIRCUIT,DI:OCTAL-D-EDGE FF,SCRN	07263	74LS374
A45U6025	156-0982-03			MICROCIRCUIT,DI:OCTAL-D-EDGE FF,SCRN	07263	74LS374
A45U6030	156-0982-03			MICROCIRCUIT,DI:OCTAL-D-EDGE FF,SCRN	07263	74LS374
A45U6040	156-0982-03			MICROCIRCUIT,DI:OCTAL-D-EDGE FF,SCRN	07263	74LS374
A45U6050	156-0539-01			MICROCIRCUIT,DI:6 BIT UNIFIEDBUS COMPTR	80009	156-0539-01
A45U6060	156-0653-02			MICROCIRCUIT,DI:QUAD UNIFIED BUS XVER INV	27014	D58838
A45U6070	156-0653-02			MICROCIRCUIT,DI:QUAD UNIFIED BUS XVER INV	27014	D58838
A45U6080	156-0383-02			MICROCIRCUIT,DI:QUAD 2-INP NOR GATE	01295	SN74LS02
A45U6090	156-0480-02			MICROCIRCUIT,DI:QUAD 2 INP & GATE	01295	SN74LS08NP3
A45U6100	156-0145-02			MICROCIRCUIT,DI:QUAD 2-INP NAND BFR	01295	SN7438
A45U6110	156-0481-02			MICROCIRCUIT,DI:TRIPLE 3 INP & GATE	27014	DM74LS11NA+
A45U7010	156-0653-02			MICROCIRCUIT,DI:QUAD UNIFIED BUS XVER INV	27014	D58838
A45U7020	156-0653-02			MICROCIRCUIT,DI:QUAD UNIFIED BUS XVER INV	27014	D58838
A45U7030	156-0653-02			MICROCIRCUIT,DI:QUAD UNIFIED BUS XVER INV	27014	D58838
A45U7040	156-0653-02			MICROCIRCUIT,DI:QUAD UNIFIED BUS XVER INV	27014	D58838
A45U7050	156-0653-02			MICROCIRCUIT,DI:QUAD UNIFIED BUS XVER INV	27014	D58838
A45U7060	156-0653-02			MICROCIRCUIT,DI:QUAD UNIFIED BUS XVER INV	27014	D58838
A45U7080	156-1058-01			MICROCIRCUIT,DI:OCTAL ST BFR W/3 STATE OUT	01295	SN74S240J4
A45U7090	156-0653-02			MICROCIRCUIT,DI:QUAD UNIFIED BUS XVER INV	27014	D58838
A45U7110	156-1179-01			MICROCIRCUIT,DI:OCTAL BFR,W/3 STATE OUT	01295	SN74S241 JP3
A45U7120	156-0124-02			MICROCIRCUIT,DI:PHASE/FREQ DETECTOR,SCRN	80009	156-0124-02
A45U7140	156-0121-02			MICROCIRCUIT,DI:DUAL VOLTAGE-CONT MV,SCRN	80009	156-0121-02
A45Y6130	158-0202-00			XTAL UNIT,QTZ:8.0MHZ,0.015%,PARALLEL	75378	MP 080

Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A50	----- -----			CKT BOARD ASSY:M1220 IFC		
A50C1044	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A50C2019	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A50C2029	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A50C2059	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A50C3019	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A50C4029	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A50C4031	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A50C5015	290-0107-00			CAP.,FXD,ELCTLT:25UF,+75-10%,25V	56289	30D256G025DB9
A50C6019	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A50C6029	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A50C6039	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A50C6049	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A50C6059	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A50R1012	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
A50R1013	315-0331-00			RES.,FXD,CMPSN:330 OHM,5%,0.25W	01121	CB3315
A50R1014	315-0221-00			RES.,FXD,CMPSN:220 OHM,5%,0.25W	01121	CB2215
A50R1020	315-0331-00			RES.,FXD,CMPSN:330 OHM,5%,0.25W	01121	CB3315
A50R1021	315-0221-00			RES.,FXD,CMPSN:220 OHM,5%,0.25W	01121	CB2215
A50R1022	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
A50R1023	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
A50R1024	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
A50R1030	315-0331-00			RES.,FXD,CMPSN:330 OHM,5%,0.25W	01121	CB3315
A50R1031	315-0221-00			RES.,FXD,CMPSN:220 OHM,5%,0.25W	01121	CB2215
A50R1032	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
A50R1033	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
A50R1034	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
A50R1042	315-0331-00			RES.,FXD,CMPSN:330 OHM,5%,0.25W	01121	CB3315
A50R1043	315-0221-00			RES.,FXD,CMPSN:220 OHM,5%,0.25W	01121	CB2215
A50R3042	315-0513-00			RES.,FXD,CMPSN:51K OHM,5%,0.25W	01121	CB5135
A50R6051	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
A50RP2059	307-0675-00			RES NTWK,FXD FI:9,1K OHM,2%,1.25W	01121	210A102
A50U2010	156-0480-02			MICROCIRCUIT,DI:QUAD 2 INP & GATE	01295	SN74LS08NP3
A50U2020	156-0093-02			MICROCIRCUIT,DI:HEX INV BUFFER,BURN-IN	27014	DM8016
A50U2030	156-0383-02			MICROCIRCUIT,DI:QUAD 2-INP NOR GATE	01295	SN74LS02
A50U2040	156-0645-02			MICROCIRCUIT,DI:SCHMITT-TRIG POS-NAND	01295	SN74LS14
A50U2050	156-1597-00			MICROCIRCUIT,DI:OCTAL 3-STATE BIDIRECTIONAL	34335	AMZ8103PC
A50U3010	156-0481-02			MICROCIRCUIT,DI:TRIPLE 3 INP & GATE	27014	DM74LS11NA+
A50U3020	160-1410-00			MICROCIRCUIT,DI:8192 X 8 EPROM	80009	160-1410-00
A50U3030	156-1382-00			MICROCIRCUIT,DI:1024 X 8 STATIC RAM	50088	MK4118A P-4
A50U3050	156-1612-00			MICROCIRCUIT,DI:PARALLEL I/O,SCRN	50088	MK3881(N-4)MKX
A50U4010	156-0392-03			MICROCIRCUIT,DI:QUAD LATCH W/CLEAR	01295	SN74LS175NP3
..50U4030	156-0852-02			MICROCIRCUIT,DI:HEX DRVR W/3 STATE INP	80009	156-0852-02
A50U4040	156-0388-03			MICROCIRCUIT,DI:DUAL D FLIP-FLOP	07263	74LS74A
A50U5010	156-0388-03			MICROCIRCUIT,DI:DUAL D FLIP-FLOP	07263	74LS74A
A50U5020	156-0994-02			MICROCIRCUIT,DI:8 INPUT DATA SEL/MUX	01295	SN74LS151NP3
A50U5040	156-0381-02			MICROCIRCUIT,DI:QUAD 2-INP EXCL OR GATE	01295	SN74LS86
A50U6010	156-0388-03			MICROCIRCUIT,DI:DUAL D FLIP-FLOP	07263	74LS74A
A50U6020	156-0994-02			MICROCIRCUIT,DI:8 INPUT DATA SEL/MUX	01295	SN74LS151NP3
A50U6030	156-0956-02			MICROCIRCUIT,DI:OCTAL BFR W/3 STATE OUT	01295	SN74LS244NP3
A50U6040	156-0784-02			MICROCIRCUIT,DI:SYNC 4 BIT BINARY COUNTER	27014	DM74LS163ANA+
A50U6050	156-0784-02			MICROCIRCUIT,DI:SYNC 4 BIT BINARY COUNTER	27014	DM74LS163ANA+
A50U7010	156-0388-03			MICROCIRCUIT,DI:DUAL D FLIP-FLOP	07263	74LS74A
A50U7020	156-0382-02			MICROCIRCUIT,DI:QUAD 2-INP NAND GATE	01295	SN74LS00
A50U7030	156-0956-02			MICROCIRCUIT,DI:OCTAL BFR W/3 STATE OUT	01295	SN74LS244NP3
A50U7040	156-0784-02			MICROCIRCUIT,DI:SYNC 4 BIT BINARY COUNTER	27014	DM74LS163ANA+
A50U7050	156-0784-02			MICROCIRCUIT,DI:SYNC 4 BIT BINARY COUNTER	27014	DM74LS163ANA+

Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A60	----- -----			CKT BOARD ASSY:PS INTERCONNECT		
A60CR4065	152-0574-00			SEMICOND DEVICE:SILICON,120V,0.15A	80009	152-0574-00
A60CR4066	152-0574-00			SEMICOND DEVICE:SILICON,120V,0.15A	80009	152-0574-00
A60E6025	119-0181-00			ARSR,ELEC SURGE:230V,GAS FILLED	80009	119-0181-00
A60E6035	119-0181-00			ARSR,ELEC SURGE:230V,GAS FILLED	80009	119-0181-00
A60F6055	159-0125-00			FUSE,THERMAL:150 DEG C OPEN30A MAX,AX LDS	27012	4300A
A60R4045	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
A60R6015	307-0746-00			RES.,THERMAL:5 OHM,10%,7A/DEG C	15454	SG-6
A60R6045	307-0746-00			RES.,THERMAL:5 OHM,10%,7A/DEG C	15454	SG-6
A60W1065	131-0566-00			BUS CONDUCTOR:DUMMY RES,2.375,22 AWG	55210	L-2007-1

Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A62	----- -----			CKT BOARD ASSY:INVERTER		
A62C1021	283-0194-00			CAP.,FXD,CER DI:4.7UF,20%,50V	72982	8151N057Z5U0475M
A62C1048	285-1096-00			CAP.,FXD,PLSTC:1UF,10%,50V	14752	230B1B105K
A62C2019	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
A62C2049	285-1123-00			CAP.,FXD,PLSTC:1UF,20%,200V	50558	ME2-2190
A62C2068	283-0176-00			CAP.,FXD,CER DI:0.0022UF,20%,50V	72982	8121B058X7R0222M
A62C2081	283-0176-00			CAP.,FXD,CER DI:0.0022UF,20%,50V	72982	8121B058X7R0222M
A62C3028	285-1226-00			CAP.,FXD,PLASTIC:2.6UF,10%,200V	84411	TRW-35
A62C3047	283-0126-00			CAP.,FXD,CER DI:82PF,5%,1000V	56289	33C180
A62C3049	283-0220-00			CAP.,FXD,CER DI:0.01UF,20%,50V	72982	8121N075X7R0103M
A62C4029	283-0078-00			CAP.,FXD,CER DI:0.001UF,20%,500V	56289	20C114A8
A62C4038	283-0220-00			CAP.,FXD,CER DI:0.01UF,20%,50V	72982	8121N075X7R0103M
A62C4055	283-0220-00			CAP.,FXD,CER DI:0.01UF,20%,50V	72982	8121N075X7R0103M
A62C4056	281-0814-00			CAP.,FXD,CER DI:100PF,10%,100V	04222	GC70-1-A101K
A62C4068	283-0176-00			CAP.,FXD,CER DI:0.0022UF,20%,50V	72982	8121B058X7R0222M
A62C4078	283-0176-00			CAP.,FXD,CER DI:0.0022UF,20%,50V	72982	8121B058X7R0222M
A62C5012	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
A62C5051	290-0846-00			CAP.,FXD,ELCTLT:47UF,-10+75%,35 WVDC	54473	ECE-A35V47LU
A62C5081	281-0819-00			CAP.,FXD,CER DI:33PF,5%,50V	72982	8035BC0G330
A62C5084	290-0846-00			CAP.,FXD,ELCTLT:47UF,-10+75%,35 WVDC	54473	ECE-A35V47LU
A62C5085	283-0212-00			CAP.,FXD,CER DI:2UF,20%,50V	72982	8141N064Z5U205M
A62C6019	283-0194-00			CAP.,FXD,CER DI:4.7UF,20%,50V	72982	8151N057Z5U0475M
A62C6029	285-1226-00			CAP.,FXD,PLASTIC:2.6UF,10%,200V	84411	TRW-35
A62C6041	285-1192-00			CAP.,FXD,PPR DI:0.0022UF,20%,250VAC	000FG	PME271Y422
A62C6051	283-0212-00			CAP.,FXD,CER DI:2UF,20%,50V	72982	8141N064Z5U205M
A62C6061	283-0220-00			CAP.,FXD,CER DI:0.01UF,20%,50V	72982	8121N075X7R0103M
A62C6085	281-0819-00			CAP.,FXD,CER DI:33PF,5%,50V	72982	8035BC0G330
A62CR1016	152-0066-00			SEMICOND DEVICE:SILICON,400V,750MA	14433	LG4016
A62CR1017	152-0066-00			SEMICOND DEVICE:SILICON,400V,750MA	14433	LG4016
A62CR1018	152-0398-00			SEMICOND DEVICE:SILICON,200V,1A	04713	SR3609RL
A62CR1019	152-0066-00			SEMICOND DEVICE:SILICON,400V,750MA	14433	LG4016
A62CR1041	152-0769-00			SEMICOND DEVICE:RECT BRIDGE,SI,400V	05828	KBPC804
A62CR2011	152-0398-00			SEMICOND DEVICE:SILICON,200V,1A	04713	SR3609RL
A62CR2022	152-0400-00			SEMICOND DEVICE:SILICON,400V,1A	80009	152-0400-00
A62CR2023	152-0400-00			SEMICOND DEVICE:SILICON,400V,1A	80009	152-0400-00
A62CR2045	152-0400-00			SEMICOND DEVICE:SILICON,400V,1A	80009	152-0400-00
A62CR2062	152-0400-00			SEMICOND DEVICE:SILICON,400V,1A	80009	152-0400-00
A62CR2072	152-0400-00			SEMICOND DEVICE:SILICON,400V,1A	80009	152-0400-00
A62CR2075	152-0400-00			SEMICOND DEVICE:SILICON,400V,1A	80009	152-0400-00
A62CR3013	152-0398-00			SEMICOND DEVICE:SILICON,200V,1A	04713	SR3609RL
A62CR3062	152-0400-00			SEMICOND DEVICE:SILICON,400V,1A	80009	152-0400-00
A62CR4042	152-0661-00			SEMICOND DEVICE:RECT,SI,600V,3A,FAST	04713	MR856
A62CR4058	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A62CR4062	152-0400-00			SEMICOND DEVICE:SILICON,400V,1A	80009	152-0400-00
A62CR4067	152-0400-00			SEMICOND DEVICE:SILICON,400V,1A	80009	152-0400-00
A62CR4084	152-0400-00			SEMICOND DEVICE:SILICON,400V,1A	80009	152-0400-00
A62CR4085	152-0400-00			SEMICOND DEVICE:SILICON,400V,1A	80009	152-0400-00
A62CR6014	152-0066-00			SEMICOND DEVICE:SILICON,400V,750MA	14433	LG4016
A62CR6016	152-0398-00			SEMICOND DEVICE:SILICON,200V,1A	04713	SR3609RL
A62CR6017	152-0066-00			SEMICOND DEVICE:SILICON,400V,750MA	14433	LG4016
A62CR6018	152-0066-00			SEMICOND DEVICE:SILICON,400V,750MA	14433	LG4016
A62CR6021	152-0400-00			SEMICOND DEVICE:SILICON,400V,1A	80009	152-0400-00
A62CR6022	152-0400-00			SEMICOND DEVICE:SILICON,400V,1A	80009	152-0400-00
A62CR6052	152-0779-00			SEMICOND DEVICE:RECT,SI,200V,0.75A	05828	RW02M
A62CR6081	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A62CR6084	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A62F1046	159-0114-00			FUSE,CARTRIDGE:1A,125VAC,FAST-BLOW	71400	GFA 1

Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A62L1029	108-0742-00			COIL,RF:83UH,TOROIDAL	80009	108-0742-00
A62L3031	108-0742-00			COIL,RF:83UH,TOROIDAL	80009	108-0742-00
A62L3044	108-0993-00			COIL,RF:FIXED,400UH	80009	108-0993-00
A62Q1015	151-0625-00			TRANSISTOR:SILICON,PNP	03508	D45H11
A62Q2025	151-0679-00			TRANSISTOR:SILICON,NPN	04713	SJE362
A62Q2069	151-1141-00			TRANSISTOR:SILICON,N-CHANNEL,FET	81483	IRF9523
A62Q2076	151-1141-00			TRANSISTOR:SILICON,N-CHANNEL,FET	81483	IRF9523
A62Q3051	151-0188-00			TRANSISTOR:SILICON,PNP	04713	SPS6868K
A62Q3053	151-0699-00			TRANSISTOR:SILICON,NPN	12969	U2TA508
A62Q4045	151-0232-00			TRANSISTOR:SILICON,NPN,DUAL	80009	151-0232-00
A62Q4054	151-0508-00			TRANSISTOR:UJT,SI,2N6027,TO-98	03508	2N6027
A62Q4058	151-1141-00			TRANSISTOR:SILICON,N-CHANNEL,FET	81483	IRF9523
A62Q4069	151-1141-00			TRANSISTOR:SILICON,N-CHANNEL,FET	81483	IRF9523
A62Q4075	151-1141-00			TRANSISTOR:SILICON,N-CHANNEL,FET	81483	IRF9523
A62Q5025	151-0679-00			TRANSISTOR:SILICON,NPN	04713	SJE362
A62Q5047	151-1127-00			TRANSISTOR:SILICON,N-CHANNEL	000GU	VN0204T5
A62Q5079	151-1121-00			TRANSISTOR:FE,N CHANNEL,SI,VN-3	000GU	N01003N3
A62Q6015	151-0625-00			TRANSISTOR:SILICON,PNP	03508	D45H11
A62Q6049	151-1127-00			TRANSISTOR:SILICON,N-CHANNEL	000GU	VN0204T5
A62Q6054	151-1128-00			TRANSISTOR:SILICON,P-CHANNEL	81483	IRF9523
A62Q6056	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
A62Q6062	151-0254-00			TRANSISTOR:SILICON,NPN	03508	X38L3118
A62Q6066	151-1121-00			TRANSISTOR:FE,N CHANNEL,SI,VN-3	000GU	N01003N3
A62Q6067	151-1120-00			TRANSISTOR:FE,P CHANNEL,SI,VP3	000GU	VP0106N3
A62Q6069	151-1121-00			TRANSISTOR:FE,N CHANNEL,SI,VN-3	000GU	N01003N3
A62Q6087	151-1120-00			TRANSISTOR:FE,P CHANNEL,SI,VP3	000GU	VP0106N3
A62Q6088	151-1121-00			TRANSISTOR:FE,N CHANNEL,SI,VN-3	000GU	N01003N3
A62R1047	315-0105-00			RES.,FXD,CMPSN:1M OHM,5%,0.25W	01121	CB1055
A62R1053	301-0430-00			RES.,FXD,CMPSN:43 OHM,5%,0.50W	01121	EB4305
A62R1084	315-0390-00			RES.,FXD,CMPSN:39 OHM,5%,0.25W	01121	CB3905
A62R2017	315-0102-03			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A62R2018	307-0115-00			RES.,FXD,CMPSN:7.5 OHM,5%,0.25W	01121	CB75G5
A62R2029	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
A62R2064	315-0105-00			RES.,FXD,CMPSN:1M OHM,5%,0.25W	01121	CB1055
A62R2066	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
A62R2071	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
A62R2083	315-0105-00			RES.,FXD,CMPSN:1M OHM,5%,0.25W	01121	CB1055
A62R3036	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
A62R3051	307-0093-00			RES.,FXD,CMPSN:1.2 OHM,5%,0.50W	01121	EB12G5
A62R3052	307-0093-00			RES.,FXD,CMPSN:1.2 OHM,5%,0.50W	01121	EB12G5
A62R3055	315-0393-00			RES.,FXD,CMPSN:39K OHM,5%,0.25W	01121	CB3935
A62R4034	308-0387-00			RES.,FXD,WW:178 OHM,1%,3W	91637	RS2B-B178R0F
A62R4036	303-0683-00			RES.,FXD,CMPSN:68K OHM,5%,1W	01121	GB6835
A62R4037	303-0623-00			RES.,FXD,CMPSN:62K OHM,5%,1W	01121	GB6235
A62R4046	321-0358-00			RES.,FXD,FILM:52.3K OHM,1%,0.125W	91637	MFF1816G52301F
A62R4047	315-0622-00			RES.,FXD,CMPSN:6.2K OHM,5%,0.25W	01121	CB6225
A62R4051	321-0449-00			RES.,FXD,FILM:464K OHM,1%,0.125W	91637	MFF1816G46402F
A62R4052	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A62R4053	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
A62R4057	315-0393-00			RES.,FXD,CMPSN:39K OHM,5%,0.25W	01121	CB3935
A62R4059	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
A62R4064	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
A62R4066	315-0105-00			RES.,FXD,CMPSN:1M OHM,5%,0.25W	01121	CB1055
A62R4075	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
A62R4077	315-0105-00			RES.,FXD,CMPSN:1M OHM,5%,0.25W	01121	CB1055
A62R5014	307-0115-00			RES.,FXD,CMPSN:7.5 OHM,5%,0.25W	01121	CB75G5
A62R6013	315-0102-03			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025

Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A62R6046	308-0779-00			RES.,FXD,WW:2 OHM,1%,3W	91637	NS2B2R00F
A62R6053	301-0201-00			RES.,FXD,CMPSN:200 OHM,5%,0.50W	01121	EB2015
A62R6054	315-0514-00			RES.,FXD,CMPSN:510K OHM,5%,0.25W	01121	CB5145
A62R6058	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A62R6059	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
A62R6063	315-0152-00			RES.,FXD,CMPSN:1.5K OHM,5%,0.25W	01121	CB1525
A62R6064	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
A62R6065	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
A62R6071	315-0390-00			RES.,FXD,CMPSN:39 OHM,5%,0.25W	01121	CB3905
A62R6082	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
A62R6083	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
A62SW3018	260-0724-00			SWITCH,THRMSTC:NC,OPEN 83.3,CL 66.7,10V	93410	430-367
A62T1075	120-1409-00			TRANSFORMER,RF:HF MOTOR BASE DRIVE	80009	120-1409-00
A62T2059	120-1410-00			TRANSFORMER,RF:POWER CONVERTER	80009	120-1410-00
A62T5072	120-1409-00			TRANSFORMER,RF:HF MOTOR BASE DRIVE	80009	120-1409-00
A62T6045	120-1403-00			TRANSFORMER,RF:DRIVER,CONVERTER	80009	120-1403-00
A62T6055	120-1432-00			TRANSFORMER,RF:CURRENT	80009	120-1432-00
A62TP6069	214-0579-00			TERM,TEST POINT:BRS CD PL	80009	214-0579-00
A62U5060	156-1562-00			CPLR,OPTPELECTR:LED & PHOTO DARLINGTON	04713	4N29A
A62U6060	156-1562-00			CPLR,OPTPELECTR:LED & PHOTO DARLINGTON	04713	4N29A
A62U6070	156-1478-01			MICROCIRCUIT:QUAD 2-INP AND GATE	04713	MC14081BCLDS
A62VR2065	152-0405-00			SEMICOND DEVICE:ZENER,1W,15V,5%	80009	152-0405-00
A62VR2067	152-0168-00			SEMICOND DEVICE:ZENER,0.4W,12V,5%	04713	SZG35009K4
A62VR2073	152-0405-00			SEMICOND DEVICE:ZENER,1W,15V,5%	80009	152-0405-00
A62VR2074	152-0168-00			SEMICOND DEVICE:ZENER,0.4W,12V,5%	04713	SZG35009K4
A62VR3056	152-0405-00			SEMICOND DEVICE:ZENER,1W,15V,5%	80009	152-0405-00
A62VR4039	152-0168-00			SEMICOND DEVICE:ZENER,0.4W,12V,5%	04713	SZG35009K4
A62VR4063	152-0168-00			SEMICOND DEVICE:ZENER,0.4W,12V,5%	04713	SZG35009K4
A62VR4065	152-0405-00			SEMICOND DEVICE:ZENER,1W,15V,5%	80009	152-0405-00
A62VR4074	152-0168-00			SEMICOND DEVICE:ZENER,0.4W,12V,5%	04713	SZG35009K4
A62VR4076	152-0405-00			SEMICOND DEVICE:ZENER,1W,15V,5%	80009	152-0405-00
A62VR6057	152-0647-00			SEMICOND DEVICE:ZENER,0.4W,6.8V,5%	80009	152-0647-00
A62W1045	195-3149-00			LEAD ELECTRICAL:18 AWG,5.0 L,8-01	80009	195-3149-00
A62W2041	195-3149-00			LEAD ELECTRICAL:18 AWG,5.0 L,8-01	80009	195-3149-00

Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A64	----- -----			CKT BOARD ASSY:REGULATOR		
A64C1011	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
A64C1015	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
A64C1016	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
A64C1032	281-0861-00			CAP.,FXD,CER DI:270PF,5%,50V	04222	GC105A271J
A64C1036	290-0846-00			CAP.,FXD,ELCTLT:47UF,-10+75%,35 WVDC	54473	ECE-A35V47LU
A64C1041	290-0846-00			CAP.,FXD,ELCTLT:47UF,-10+75%,35 WVDC	54473	ECE-A35V47LU
A64C1045	290-0916-00			CAP.,FXD,ELCTLT:2200UF,+50-10%,35V	55680	35ULB2200V-T
A64C2011	283-0100-00			CAP.,FXD,CER DI:0.0047UF,10%,200V	56289	273C3
A64C2018	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
A64C2041	290-0782-00			CAP.,FXD,ELCTLT:4.7UF,+75-10%,35V	55680	35ULA4R7V-T
A64C2048	281-0814-00			CAP.,FXD,CER DI:100PF,10%,100V	04222	GC70-1-A101K
A64C2051	283-0167-00			CAP.,FXD,CER DI:0.1UF,10%,100V	72982	8131N145X5R0104K
A64C2053	290-0922-00			CAP.,FXD,ELCTLT:1000UF,+50-10%,50V	55680	50ULB1000-VT
A64C2064	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
A64C2071	290-0745-00			CAP.,FXD,ELCTLT:22UF,+50-10%,25V	56289	502D225
A64C3013	290-0782-00			CAP.,FXD,ELCTLT:4.7UF,+75-10%,35V	55680	35ULA4R7V-T
A64C3015	283-0341-00			CAP.,FXD,CER DI:0.047UF,10%,100V	72982	8121N153X7R0473K
A64C3016	281-0865-00			CAP.,FXD,CER DI:1000PF,5%,100V	16299	OBD
A64C3017	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
A64C3018	281-0786-00			CAP.,FXD,CER DI:150PF,10%,100V	72982	8035D2AADX5P151K
A64C3019	281-0757-00			CAP.,FXD,CER DI:10PF,20%,100V	72982	8035-D-COG-100G
A64C3021	281-0757-00			CAP.,FXD,CER DI:10PF,20%,100V	72982	8035-D-COG-100G
A64C3022	281-0786-00			CAP.,FXD,CER DI:150PF,10%,100V	72982	8035D2AADX5P151K
A64C3023	281-0786-00			CAP.,FXD,CER DI:150PF,10%,100V	72982	8035D2AADX5P151K
A64C3024	281-0786-00			CAP.,FXD,CER DI:150PF,10%,100V	72982	8035D2AADX5P151K
A64C3026	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
A64C3053	290-0922-00			CAP.,FXD,ELCTLT:1000UF,+50-10%,50V	55680	50ULB1000-VT
A64C3072	290-0745-00			CAP.,FXD,ELCTLT:22UF,+50-10%,25V	56289	502D225
A64C4019	290-0846-00			CAP.,FXD,ELCTLT:47UF,-10+75%,35 WVDC	54473	ECE-A35V47LU
A64C4023	285-1234-00			CAP.,FXD,PLASTIC:0.0039UF,5%,200V	84411	X463UW
A64C4024	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	04222	GC70-1C103K
A64C4028	283-0341-00			CAP.,FXD,CER DI:0.047UF,10%,100V	72982	8121N153X7R0473K
A64C4029	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
A64C4031	285-1049-00			CAP.,FXD,PLSTC:0.01UF,1%,200V	14752	230B1C103F
A64C4038	281-0814-00			CAP.,FXD,CER DI:100PF,10%,100V	04222	GC70-1-A101K
A64C4053	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
A64C4054	281-0762-00			CAP.,FXD,CER DI:27PF,20%,100V	72982	8035D9AADC0G270M
A64C4055	281-0762-00			CAP.,FXD,CER DI:27PF,20%,100V	72982	8035D9AADC0G270M
A64C4058	281-0865-00			CAP.,FXD,CER DI:1000PF,5%,100V	16299	OBD
A64C4061	283-0100-00			CAP.,FXD,CER DI:0.0047UF,10%,200V	56289	273C3
A64C4062	290-0745-00			CAP.,FXD,ELCTLT:22UF,+50-10%,25V	56289	502D225
A64C4063	283-0167-00			CAP.,FXD,CER DI:0.1UF,10%,100V	72982	8131N145X5R0104K
A64C4065	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
A64C4066	281-0865-00			CAP.,FXD,CER DI:1000PF,5%,100V	16299	OBD
A64C5011	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
A64C5012	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
A64C5014	281-0865-00			CAP.,FXD,CER DI:1000PF,5%,100V	16299	OBD
A64C5019	281-0814-00			CAP.,FXD,CER DI:100PF,10%,100V	04222	GC70-1-A101K
A64C5021	281-0537-00			CAP.,FXD,CER DI:0.68PF,20%,600V	80009	281-0537-00
A64C5022	290-0846-00			CAP.,FXD,ELCTLT:47UF,-10+75%,35 WVDC	54473	ECE-A35V47LU
A64C5033	281-0537-00			CAP.,FXD,CER DI:0.68PF,20%,600V	80009	281-0537-00
A64C5037	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	04222	GC70-1C103K
A64C5053	290-0782-00			CAP.,FXD,ELCTLT:4.7UF,+75-10%,35V	55680	35ULA4R7V-T
A64C5059	285-1050-00			CAP.,FXD,PLSTC:0.1UF,1%,200V	14752	230B1C104F
A64C5061	285-1050-00			CAP.,FXD,PLSTC:0.1UF,1%,200V	14752	230B1C104F
A64C5073	290-0846-00			CAP.,FXD,ELCTLT:47UF,-10+75%,35 WVDC	54473	ECE-A35V47LU

Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A64C5074	290-0846-00			CAP.,FXD,ELCTLT:47UF,-10+75%,35 WVDC	54473	ECE-A35V47LU
A64C6018	281-0865-00			CAP.,FXD,CER DI:1000PF,5%,100V	16299	OBD
A64C6031	281-0865-00			CAP.,FXD,CER DI:1000PF,5%,100V	16299	OBD
A64C6037	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
A64C6038	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
A64C6041	283-0212-00			CAP.,FXD,CER DI:2UF,20%,50V	72982	8141N064Z5U205M
A64C6046	281-0814-00			CAP.,FXD,CER DI:100PF,10%,100V	04222	GC70-1-A101K
A64C6065	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
A64C6066	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
A64CR1032	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A64CR1051	152-0585-00			SEMICOND DEVICE:SILICON,BRIDGE,200V,1A	80009	152-0585-00
A64CR2019	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A64CR2021	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A64CR2024	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A64CR2025	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A64CR2049	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A64CR2061	152-0066-00			SEMICOND DEVICE:SILICON,400V,750MA	14433	LG4016
A64CR2062	152-0066-00			SEMICOND DEVICE:SILICON,400V,750MA	14433	LG4016
A64CR2063	152-0066-00			SEMICOND DEVICE:SILICON,400V,750MA	14433	LG4016
A64CR2068	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A64CR2072	152-0066-00			SEMICOND DEVICE:SILICON,400V,750MA	14433	LG4016
A64CR3014	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A64CR3026	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A64CR3031	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A64CR3032	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A64CR3033	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A64CR3034	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A64CR3035	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A64CR3036	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A64CR3042	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A64CR3043	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A64CR3051	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A64CR4015	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A64CR4032	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A64CR4037	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A64CR4041	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A64CR4042	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A64CR4045	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A64CR4064	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A64CR5026	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A64CR5036	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A64CR6013	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A64CR6014	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A64CR6025	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A64CR6029	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A64CR6043	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A64CR6053	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A64CR6055	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A64CR6061	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A64Q1034	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
A64Q1035	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
A64Q1062	151-0301-00			TRANSISTOR:SILICON,PNP	27014	2N2907A
A64Q1070	151-0464-00			TRANSISTOR:SILICON,NPN	04713	SJE412
A64Q3015	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
A64Q3025	151-1066-00			TRANSISTOR:SILICON,FE,P-CHANNEL	80009	151-1066-00
A64Q3026	151-1066-00			TRANSISTOR:SILICON,FE,P-CHANNEL	80009	151-1066-00
A64Q3029	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677

Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A64Q3037	151-0188-00			TRANSISTOR:SILICON,PNP	04713	SPS6868K
A64Q3038	151-0188-00			TRANSISTOR:SILICON,PNP	04713	SPS6868K
A64Q4015	151-0188-00			TRANSISTOR:SILICON,PNP	04713	SPS6868K
A64Q4016	151-0188-00			TRANSISTOR:SILICON,PNP	04713	SPS6868K
A64Q4017	151-0188-00			TRANSISTOR:SILICON,PNP	04713	SPS6868K
A64Q4019	151-0232-00			TRANSISTOR:SILICON,NPN,DUAL	80009	151-0232-00
A64Q4038	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
A64Q4046	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
A64Q4047	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
A64Q5053	151-0192-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS6521	04713	SPS8801
A64Q6019	151-1005-00			TRANSISTOR:SILICON,JFE,N-CHANNEL	80009	151-1005-00
A64Q6021	151-1066-00			TRANSISTOR:SILICON,FE,P-CHANNEL	80009	151-1066-00
A64Q6025	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
A64Q6026	151-0188-00			TRANSISTOR:SILICON,PNP	04713	SPS6868K
A64Q6047	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
A64R1012	315-0200-00			RES.,FXD,CMPSN:20 OHM,5%,0.25W	01121	CB2005
A64R1018	315-0514-00			RES.,FXD,CMPSN:510K OHM,5%,0.25W	01121	CB5145
A64R1021	301-0331-00			RES.,FXD,CMPSN:330 OHM,5%,0.50W	01121	EB3315
A64R1023	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A64R1031	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A64R1032	315-0302-00			RES.,FXD,CMPSN:3K OHM,5%,0.25W	01121	CB3025
A64R1033	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
A64R1034	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A64R2012	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A64R2017	315-0822-00			RES.,FXD,CMPSN:8.2K OHM,5%,0.25W	01121	CB8225
A64R2021	315-0822-00			RES.,FXD,CMPSN:8.2K OHM,5%,0.25W	01121	CB8225
A64R2022	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
A64R2023	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
A64R2029	301-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.50W	01121	EB2025
A64R2033	301-0152-00			RES.,FXD,CMPSN:1.5K OHM,5%,0.50W	01121	EB1525
A64R2034	321-0264-00			RES.,FXD,FILM:5.49K OHM,1%,0.125W	91637	MFF1816G54900F
A64R2036	321-0243-00			RES.,FXD,FILM:3.32K OHM,1%,0.125W	91637	MFF1816G33200F
A64R2037	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
A64R2038	315-0222-00			RES.,FXD,CMPSN:2.2K OHM,5%,0.25W	01121	CB2225
A64R2047	315-0822-00			RES.,FXD,CMPSN:8.2K OHM,5%,0.25W	01121	CB8225
A64R2065	321-0234-00			RES.,FXD,FILM:2.67K OHM,1%,0.125W	91637	MFF1816G26700F
A64R2066	321-0134-00			RES.,FXD,FILM:243 OHM,1%,0.125W	91637	MFF1816G243R0F
A64R2067	301-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.50W	01121	EB1025
A64R3011	321-0310-00			RES.,FXD,FILM:16.5K OHM,1%,0.125W	91637	MFF1816G16501F
A64R3012	321-0385-00			RES.,FXD,FILM:100K OHM,1%,0.125W	91637	MFF1816G10002F
A64R3013	321-0288-00			RES.,FXD,FILM:9.76K OHM,1%,0.125W	91637	MFF1816G97600F
A64R3014	315-0203-00			RES.,FXD,CMPSN:20K OHM,5%,0.25W	01121	CB2035
A64R3015	315-0132-00			RES.,FXD,CMPSN:1.3K OHM,5%,0.25W	01121	CB1325
A64R3018	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
A64R3023	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
A64R3024	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
A64R3025	301-0152-00			RES.,FXD,CMPSN:1.5K OHM,5%,0.50W	01121	EB1525
A64R3027	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
A64R3028	321-0188-00			RES.,FXD,FILM:887 OHM,1%,0.125W	91637	MFF1816G887R0F
A64R3029	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A64R3042	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
A64R3044	315-0622-00			RES.,FXD,CMPSN:6.2K OHM,5%,0.25W	01121	CB6225
A64R3045	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
A64R3046	315-0273-00			RES.,FXD,CMPSN:27K OHM,5%,0.25W	01121	CB2735
A64R3047	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A64R3051	315-0203-00			RES.,FXD,CMPSN:20K OHM,5%,0.25W	01121	CB2035
A64R3052	321-0358-00			RES.,FXD,FILM:52.3K OHM,1%,0.125W	91637	MFF1816G52301F

Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A64R3062	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
A64R3063	315-0273-00			RES.,FXD,CMPSN:27K OHM,5%,0.25W	01121	CB2735
A64R4011	321-0280-00			RES.,FXD,FILM:8.06K OHM,1%,0.125W	91637	MFF1816G80600F
A64R4012	321-0280-00			RES.,FXD,FILM:8.06K OHM,1%,0.125W	91637	MFF1816G80600F
A64R4013	321-0253-00			RES.,FXD,FILM:4.22K OHM,1%,0.125W	91637	MFF1816G42200F
A64R4014	321-0260-00			RES.,FXD,FILM:4.99K OHM,1%,0.125W	91637	MFF1816G49900F
A64R4015	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
A64R4021	315-0203-00			RES.,FXD,CMPSN:20K OHM,5%,0.25W	01121	CB2035
A64R4022	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
A64R4031	315-0183-00			RES.,FXD,CMPSN:18K OHM,5%,0.25W	01121	CB1835
A64R4032	315-0134-00			RES.,FXD,CMPSN:130K OHM,5%,0.25W	01121	CB1345
A64R4033	315-0273-00			RES.,FXD,CMPSN:27K OHM,5%,0.25W	01121	CB2735
A64R4034	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
A64R4035	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
A64R4036	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
A64R4037	315-0222-00			RES.,FXD,CMPSN:2.2K OHM,5%,0.25W	01121	CB2225
A64R4043	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
A64R4044	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
A64R4045	315-0273-00			RES.,FXD,CMPSN:27K OHM,5%,0.25W	01121	CB2735
A64R4047	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A64R4048	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
A64R4049	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
A64R4051	321-0318-00			RES.,FXD,FILM:20K OHM,1%,0.125W	91637	MFF1816G20001F
A64R4052	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
A64R4056	315-0226-00			RES.,FXD,CMPSN:22M OHM,5%,0.25W	01121	CB2265
A64R4067	315-0563-00			RES.,FXD,CMPSN:56K OHM,5%,0.25W	01121	CB5635
A64R5014	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
A64R5015	315-0563-00			RES.,FXD,CMPSN:56K OHM,5%,0.25W	01121	CB5635
A64R5016	315-0822-00			RES.,FXD,CMPSN:8.2K OHM,5%,0.25W	01121	CB8225
A64R5017	315-0822-00			RES.,FXD,CMPSN:8.2K OHM,5%,0.25W	01121	CB8225
A64R5018	315-0302-00			RES.,FXD,CMPSN:3K OHM,5%,0.25W	01121	CB3025
A64R5019	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
A64R5023	315-0302-00			RES.,FXD,CMPSN:3K OHM,5%,0.25W	01121	CB3025
A64R5024	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
A64R5025	315-0226-00			RES.,FXD,CMPSN:22M OHM,5%,0.25W	01121	CB2265
A64R5027	315-0622-00			RES.,FXD,CMPSN:6.2K OHM,5%,0.25W	01121	CB6225
A64R5028	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
A64R5029	315-0563-00			RES.,FXD,CMPSN:56K OHM,5%,0.25W	01121	CB5635
A64R5038	321-0318-00			RES.,FXD,FILM:20K OHM,1%,0.125W	91637	MFF1816G20001F
A64R5039	321-0280-00			RES.,FXD,FILM:8.06K OHM,1%,0.125W	91637	MFF1816G80600F
A64R5041	321-0322-00			RES.,FXD,FILM:22.1K OHM,1%,0.125W	91637	MFF1816G22101F
A64R5045	315-0222-00			RES.,FXD,CMPSN:2.2K OHM,5%,0.25W	01121	CB2225
A64R5046	315-0162-00			RES.,FXD,CMPSN:1.6K OHM,5%,0.25W	01121	CB1625
A64R5048	321-0246-00			RES.,FXD,FILM:3.57K OHM,1%,0.125W	91637	MFF1816G35700F
A64R5049	321-0188-00			RES.,FXD,FILM:887 OHM,1%,0.125W	91637	MFF1816G887R0F
A64R5051	321-0318-00			RES.,FXD,FILM:20K OHM,1%,0.125W	91637	MFF1816G20001F
A64R5065	315-0683-00			RES.,FXD,CMPSN:68K OHM,5%,0.25W	01121	CB6835
A64R5066	315-0112-00			RES.,FXD,CMPSN:1.1K OHM,5%,0.25W	01121	CB1125
A64R5071	321-0210-00			RES.,FXD,FILM:1.5K OHM,1%,0.125W	91637	MFF1816G15000F
A64R6011	315-0226-00			RES.,FXD,CMPSN:22M OHM,5%,0.25W	01121	CB2265
A64R6012	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
A64R6022	315-0184-00			RES.,FXD,CMPSN:180K OHM,5%,0.25W	01121	CB1845
A64R6023	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
A64R6025	315-0622-00			RES.,FXD,CMPSN:6.2K OHM,5%,0.25W	01121	CB6225
A64R6026	301-0152-00			RES.,FXD,CMPSN:1.5K OHM,5%,0.50W	01121	EB1525
A64R6027	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
A64R6028	315-0203-00			RES.,FXD,CMPSN:20K OHM,5%,0.25W	01121	CB2035

Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A64R6032	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
A64R6033	321-0188-00			RES.,FXD,FILM:887 OHM,1%,0.125W	91637	MFF1816G887R0F
A64R6034	321-0279-00			RES.,FXD,FILM:7.87K OHM,1%,0.125W	91637	MFF1816G78700F
A64R6035	315-0510-00			RES.,FXD,CMPSN:51 OHM,5%,0.25W	01121	CB5105
A64R6039	315-0514-00			RES.,FXD,CMPSN:510K OHM,5%,0.25W	01121	CB5145
A64R6044	315-0622-00			RES.,FXD,CMPSN:6.2K OHM,5%,0.25W	01121	CB6225
A64R6045	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
A64R6051	315-0622-00			RES.,FXD,CMPSN:6.2K OHM,5%,0.25W	01121	CB6225
A64R6052	315-0622-00			RES.,FXD,CMPSN:6.2K OHM,5%,0.25W	01121	CB6225
A64R6054	315-0363-00			RES.,FXD,CMPSN:36K OHM,5%,0.25W	01121	CB3635
A64R6056	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
A64R6057	321-0412-00			RES.,FXD,FILM:191K OHM,1%,0.125W	91637	MFF1816G19102F
A64R6058	321-0203-00			RES.,FXD,FILM:1.27K OHM,1%,0.125W	91637	MFF1816G12700F
A64R6063	321-0995-00			RES.,FXD,FILM:549K OHM,1%,0.125W	24546	NA55D5493F
A64R6064	321-0995-00			RES.,FXD,FILM:549K OHM,1%,0.125W	24546	NA55D5493F
A64R6067	311-1340-00			RES.,VAR,NONWIR:1K OHM,10%,0.50W	02111	43P102T672
A64R6071	321-0279-00			RES.,FXD,FILM:7.87K OHM,1%,0.125W	91637	MFF1816G78700F
A64R6072	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
A64TP6011	214-0579-00			TERM,TEST POINT:BRS CD PL	80009	214-0579-00
A64TP6015	214-0579-00			TERM,TEST POINT:BRS CD PL	80009	214-0579-00
A64TP6025	214-0579-00			TERM,TEST POINT:BRS CD PL	80009	214-0579-00
A64TP6028	214-0579-00			TERM,TEST POINT:BRS CD PL	80009	214-0579-00
A64TP6033	214-0579-00			TERM,TEST POINT:BRS CD PL	80009	214-0579-00
A64TP6039	214-0579-00			TERM,TEST POINT:BRS CD PL	80009	214-0579-00
A64TP6043	214-0579-00			TERM,TEST POINT:BRS CD PL	80009	214-0579-00
A64TP6046	214-0579-00			TERM,TEST POINT:BRS CD PL	80009	214-0579-00
A64TP6048	214-0579-00			TERM,TEST POINT:BRS CD PL	80009	214-0579-00
A64TP6056	214-0579-00			TERM,TEST POINT:BRS CD PL	80009	214-0579-00
A64TP6059	214-0579-00			TERM,TEST POINT:BRS CD PL	80009	214-0579-00
A64TP6061	214-0579-00			TERM,TEST POINT:BRS CD PL	80009	214-0579-00
A64TP6066	214-0579-00			TERM,TEST POINT:BRS CD PL	80009	214-0579-00
A64TP6076	214-0579-00			TERM,TEST POINT:BRS CD PL	80009	214-0579-00
A64TP6077	214-0579-00			TERM,TEST POINT:BRS CD PL	80009	214-0579-00
A64U1060	156-1161-00			MICROCIRCUIT,LI:VOLTAGE REGULATOR	27014	LM317T
A64U2010	156-1126-01			MICROCIRCUIT,LI:VOLTAGE COMPARATOR,SEL	01295	LM311JG4
A64U2020	156-0350-05			MICROCIRCUIT,DI:QUAD 2 INPUT NAND GATE,CHK	80009	156-0350-05
A64U2030	156-0524-02			MICROCIRCUIT,DI:TRIPLE 3-INPUT NAND GATES	80009	156-0524-02
A64U2040	156-0350-05			MICROCIRCUIT,DI:QUAD 2 INPUT NAND GATE,CHK	80009	156-0350-05
A64U3030	156-1126-01			MICROCIRCUIT,LI:VOLTAGE COMPARATOR,SEL	01295	LM311JG4
A64U3040	156-0366-02			MICROCIRCUIT,DI:DUAL D FLIP-FLOP,CHK	80009	156-0366-02
A64U5030	156-0411-02			MICROCIRCUIT,LI:QUAD COMPARATOR,SEL	04713	MLM339LDS
A64U5040	156-1225-01			MICROCIRCUIT,LI:DUAL COMPARATOR,SCREENED	27014	LM393N/AT
A64U5050	156-1337-00			MICROCIRCUIT,DI:17 STAGE PROGRAMMABLE	27014	MM5369AA/N
A64U5060	156-0158-07			MICROCIRCUIT,LI:DUAL OPNL AMPL,SCREENED	04713	MC1458UDS
A64U6010	156-1191-00			MICROCIRCUIT,LI:DUAL BI-FET OP-AMPL,8 DIP	01295	TL072CP
A64U6040	156-0402-03			MICROCIRCUIT,LI:TIMER,TESTED	80009	156-0402-03
A64VR2035	152-0662-00			SEMICOND DEVICE:ZENER,0.4W,5V,1%	04713	SZG195
A64VR2073	152-0243-00			SEMICOND DEVICE:ZENER,0.4W,15V,5%	14552	TD3810983
A64VR4025	152-0486-00			SEMICOND DEVICE:ZENER,0.25W,6.2V,5%	80009	152-0486-00
A64VR4026	152-0486-00			SEMICOND DEVICE:ZENER,0.25W,6.2V,5%	80009	152-0486-00
A64VR4027	152-0166-00			SEMICOND DEVICE:ZENER,0.4W,6.2V,5%	04713	SZ11738
A64VR4039	152-0667-00			SEMICOND DEVICE:ZENER,0.4W,3.0V,2%	80009	152-0667-00
A64VR4051	152-0166-00			SEMICOND DEVICE:ZENER,0.4W,6.2V,5%	04713	SZ11738
A64VR5013	152-0281-00			SEMICOND DEVICE:ZENER,0.4W,22V,5%	12954	1N969B
A64VR5047	152-0662-00			SEMICOND DEVICE:ZENER,0.4W,5V,1%	04713	SZG195
A64VR5072	152-0317-00			SEMICOND DEVICE:ZENER,0.25W,6.2V,5%	04713	SZG20012
A64VR6024	152-0166-00			SEMICOND DEVICE:ZENER,0.4W,6.2V,5%	04713	SZ11738
A64Y4057	158-0105-00			XTAL UNIT,QTZ:3.579545 MHZ,+/-0.035%,PRL	52847	158-0105-00

Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A66	----- -----			CKT BOARD ASSY:SECONDARY		
A66C1041	281-0770-00			CAP.,FXD,CER DI:0.001UF,20%,100V	72982	8035D9AADX5R102M
A66C1051	290-0964-00			CAP.,FXD,ELCTLT:1200UF,+100-10%,12V	90201	VPR122N012E1L1J
A66C1053	290-0964-00			CAP.,FXD,ELCTLT:1200UF,+100-10%,12V	90201	VPR122N012E1L1J
A66C1081	281-0823-00			CAP.,FXD,CER DI:470PF,10%,50V	12969	CGB471KDN
A66C1083	281-0785-00			CAP.,FXD,CER DI:68PF,10%,100V	72982	8035D2AADC0G680K
A66C1091	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
A66C1093	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
A66C1101	281-0785-00			CAP.,FXD,CER DI:68PF,10%,100V	72982	8035D2AADC0G680K
A66C1103	281-0823-00			CAP.,FXD,CER DI:470PF,10%,50V	12969	CGB471KDN
A66C1105	283-0167-00			CAP.,FXD,CER DI:0.1UF,10%,100V	72982	8131N145X5R0104K
A66C1107	283-0167-00			CAP.,FXD,CER DI:0.1UF,10%,100V	72982	8131N145X5R0104K
A66C1111	290-0782-00			CAP.,FXD,ELCTLT:4.7UF,+75-10%,35V	55680	35ULA4R7V-T
A66C1113	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
A66C2071	290-0946-00			CAP.,FXD,ELCTLT:270UF,10+100%,40V	90201	VPR271N040E1E1C
A66C2091	290-0946-00			CAP.,FXD,ELCTLT:270UF,10+100%,40V	90201	VPR271N040E1E1C
A66C3031	281-0815-00			CAP.,FXD,CER DI:0.027UF,20%,50V	72982	8005D9AABW5R273M
A66C3033	281-0815-00			CAP.,FXD,CER DI:0.027UF,20%,50V	72982	8005D9AABW5R273M
A66C3061	281-0771-00			CAP.,FXD,CER DI:0.0022UF,20%,200V	56289	292C Z5U222M200B
A66C3063	281-0772-00			CAP.,FXD,CER DI:0.0047UF,10%,100V	04222	GC701C472K
A66C3093	290-0946-00			CAP.,FXD,ELCTLT:270UF,10+100%,40V	90201	VPR271N040E1E1C
A66C3111	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	04222	GC70-1C103K
A66C3113	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	04222	GC70-1C103K
A66C3115	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	04222	GC70-1C103K
A66C3117	283-0339-00			CAP.,FXD,CER DI:0.22UF.10%,50V	72982	8131N075W5R224K
A66C3119	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	04222	GC70-1C103K
A66CR1041	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A66CR1043	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A66CR1061	152-0582-00			SEMICOND DEVICE:SILICON,20V,3A	80009	152-0582-00
A66CR2071	152-0720-00			SEMICOND DEVICE:SILICON,100V,7A	80009	152-0720-00
A66CR3011	152-0784-00			SEMICOND DEVICE:RECT,SI,FAST RCVY,200V,5.0	04713	SR3688
A66CR3013	152-0784-00			SEMICOND DEVICE:RECT,SI,FAST RCVY,200V,5.0	04713	SR3688
A66CR3015	152-0714-00			SEMICOND DEVICE:RECT,SI,SCHOTTKY,40V,50A	01281	1N6098
A66CR3031	152-0398-00			SEMICOND DEVICE:SILICON,200V,1A	04713	SR3609RL
A66CR3033	152-0398-00			SEMICOND DEVICE:SILICON,200V,1A	04713	SR3609RL
A66CR3035	152-0714-00			SEMICOND DEVICE:RECT,SI,SCHOTTKY,40V,50A	01281	1N6098
A66CR3061	152-0661-00			SEMICOND DEVICE:RECT,SI,600V,3A,FAST	04713	MR856
A66CR3063	152-0661-00			SEMICOND DEVICE:RECT,SI,600V,3A,FAST	04713	MR856
A66CR3071	152-0661-00			SEMICOND DEVICE:RECT,SI,600V,3A,FAST	04713	MR856
A66CR3073	152-0661-00			SEMICOND DEVICE:RECT,SI,600V,3A,FAST	04713	MR856
A66F1071	159-0152-00			FUSE,WIRE LEAD:5A,125V,FAST BLOW	75915	275-005
A66F3081	159-0015-01			FUSE,CARTRIDGE:3AG,3A,250V,FAST-BLOW	71400	GJV3
A66F3091	159-0015-01			FUSE,CARTRIDGE:3AG,3A,250V,FAST-BLOW	71400	GJV3
A66L1051	108-1125-00			COIL,RF:FIXED,2.3UH	80009	108-1125-00
A66L2041	108-1126-00			COIL,RF:FIXED,10.5UH	80009	108-1126-00
A66L2071	108-1098-00			OIL,RF:FIXED,110UH	80009	108-1098-00
A66L2081	108-0981-00			COIL,RF:FIXED,270UH	80009	108-0981-00
A66L3081	108-0993-00			COIL,RF:FIXED,400UH	80009	108-0993-00
A66L3091	108-0993-00			COIL,RF:FIXED,400UH	80009	108-0993-00
A66Q1031	151-1120-00			TRANSISTOR:FE,P-CHANNEL,SI,VP3	000GU	VP0106N3
A66Q1041	151-1120-00			TRANSISTOR:FE,P-CHANNEL,SI,VP-3	000GU	VP0106N3
A66Q1101	151-0439-00			TRANSISTOR:SILICON,NPN	80009	151-0439-00
A66Q1103	151-0463-00			TRANSISTOR:SILICON,PNP	80009	151-0463-00
A66Q2071	151-0302-00			TRANSISTOR:SILICON,NPN	07263	S038487
A66Q2073	151-0463-00			TRANSISTOR:SILICON,PNP	80009	151-0463-00
A66Q2101	151-0426-00			TRANSISTOR:SILICON,NPN	80009	151-0426-00
A66Q3071	151-0745-00			TRANSISTOR:SILICON,PNP	000IG	2SA1077G

Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A66Q3091	151-0625-00			TRANSISTOR:SILICON,PNP	03508	D45H11
A66R1041	315-0331-00			RES.,FXD,CMPSN:330 OHM,5%,0.25W	01121	CB3315
A66R1043	315-0331-00			RES.,FXD,CMPSN:330 OHM,5%,0.25W	01121	CB3315
A66R1051	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A66R1061	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A66R1063	308-0678-00			RES.,FXD,WW:0.1 OHM,5%,2W	75042	BWH-R1000J
A66R1065	308-0678-00			RES.,FXD,WW:0.1 OHM,5%,2W	75042	BWH-R1000J
A66R1071	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
A66R1081	308-0678-00			RES.,FXD,WW:0.1 OHM,5%,2W	75042	BWH-R1000J
A66R1083	308-0678-00			RES.,FXD,WW:0.1 OHM,5%,2W	75042	BWH-R1000J
A66R1091	315-0304-00			RES.,FXD,CMPSN:300K OHM,5%,0.25W	01121	CB3045
A66R1093	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A66R1095	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
A66R1101	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A66R1103	315-0304-00			RES.,FXD,CMPSN:300K OHM,5%,0.25W	01121	CB3045
A66R1105	321-0332-00			RES.,FXD,FILM:28K OHM,1%,0.125W	91637	MFF1816G28001F
A66R1106	321-0318-00			RES.,FXD,FILM:20K OHM,1%,0.125W	91637	MFF1816G20001F
A66R1107	321-0310-00			RES.,FXD,FILM:16.5K OHM,1%,0.125W	91637	MFF1816G16501F
A66R1108	315-0510-00			RES.,FXD,CMPSN:51 OHM,5%,0.25W	01121	CB5105
A66R1109	315-0510-00			RES.,FXD,CMPSN:51 OHM,5%,0.25W	01121	CB5105
A66R1111	321-0347-00			RES.,FXD,FILM:40.2K OHM,1%,0.125W	91637	MFF1816G40201F
A66R1112	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
A66R1113	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
A66R1115	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A66R1117	321-0193-00			RES.,FXD,FILM:1K OHM,1%,0.125W	91637	MFF1816G10000F
A66R1118	321-0397-00			RES.,FXD,FILM:133K OHM,1%,0.125W	91637	MFF1816G13302F
A66R1119	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A66R2021	315-0331-00			RES.,FXD,CMPSN:330 OHM,5%,0.25W	01121	CB3315
A66R2031	315-0510-00			RES.,FXD,CMPSN:51 OHM,5%,0.25W	01121	CB5105
A66R2033	315-0510-00			RES.,FXD,CMPSN:51 OHM,5%,0.25W	01121	CB5105
A66R2091	303-0201-00			RES.,FXD,CMPSN:200 OHM,5%,1W	01121	GB2015
A66R2093	303-0201-00			RES.,FXD,CMPSN:200 OHM,5%,1W	01121	GB2015
A66R2111	321-0193-00			RES.,FXD,FILM:1K OHM,1%,0.125W	91637	MFF1816G10000F
A66R2112	321-0338-00			RES.,FXD,FILM:32.4K OHM,1%,0.125W	91637	MFF1816G32401F
A66R2113	315-0331-00			RES.,FXD,CMPSN:330 OHM,5%,0.25W	01121	CB3315
A66R2114	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A66R2115	315-0331-00			RES.,FXD,CMPSN:330 OHM,5%,0.25W	01121	CB3315
A66R2116	315-0331-00			RES.,FXD,CMPSN:330 OHM,5%,0.25W	01121	CB3315
A66R2117	315-0331-00			RES.,FXD,CMPSN:330 OHM,5%,0.25W	01121	CB3315
A66R2118	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A66R2119	315-0331-00			RES.,FXD,CMPSN:330 OHM,5%,0.25W	01121	CB3315
A66R3021	307-0007-00			RES.,FXD,CMPSN:2.7 OHM,10%,2W	01121	GB27G1
A66R3023	307-0007-00			RES.,FXD,CMPSN:2.7 OHM,10%,2W	01121	GB27G1
A66R3031	308-0818-00			RES,FXD,WW:0.005 OHM,3%,10W	91637	RH10-65/.005 3%
A66R3061	303-0620-00			RES.,FXD,CMPSN:62 OHM,5%,1W	01121	GB6205
A66R3063	305-0330-00			RES.,FXD,CMPSN:33 OHM,5%,2W	01121	HB3305
A66R3081	308-0290-00			RES.,FXD,WW:8 OHM,5%,5W	91637	CW2A-8R000J
A66R3101	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A66R3102	321-0407-00			RES.,FXD,FILM:169K OHM,1%,0.125W	91637	MFF1816G16902F
A66R3103	321-0193-00			RES.,FXD,FILM:1K OHM,1%,0.125W	91637	MFF1816G10000F
A66R3104	321-0374-00			RES.,FXD,FILM:76.8K OHM,1%,0.125W	91637	MFF1816G76801F
A66R3105	321-0193-00			RES.,FXD,FILM:1K OHM,1%,0.125W	91637	MFF1816G10000F
A66R3106	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A66R3107	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
A66R3111	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A66R3113	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
A66T1011	120-1408-00			XFMR,PWR,STPDN:HIGH FREQUENCY	80009	120-1408-00

Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A66TP2111	214-0579-00			TERM,TEST POINT:BRS CD PL	80009	214-0579-00
A66TP2113	214-0579-00			TERM,TEST POINT:BRS CD PL	80009	214-0579-00
A66TP2115	214-0579-00			TERM,TEST POINT:BRS CD PL	80009	214-0579-00
A66TP2117	214-0579-00			TERM,TEST POINT:BRS CD PL	80009	214-0579-00
A66TP2119	214-0579-00			TERM,TEST POINT:BRS CD PL	80009	214-0579-00
A66U1090	156-0158-07			MICROCIRCUIT,LI:DUAL OPNL AMPL,SCREENED	04713	MC1458UDS
A66U1110	156-1225-01			MICROCIRCUIT,LI:DUAL COMPARATOR,SCREENED	27014	LM393N/AT
A66U3110	156-0411-02			MICROCIRCUIT,LI:QUAD COMPARATOR,SEL	04713	MLM339LDS
A66VR2111	152-0147-00			SEMICOND DEVICE:ZENER,0.4W,27V,5%	04713	SZ50622KRL
A66VR2113	152-0175-01			SEMICOND DEVICE:ZENER,0.4W,5.6V,5%	80009	152-0175-01
A66VR2115	152-0243-00			SEMICOND DEVICE:ZENER,0.4W,15V,5%	14552	TD3810983
A66VR2117	152-0571-00			SEMICOND DEVICE:ZENER,0.4W,16V,5%	80009	152-0571-00
A66VR2119	152-0702-00			SEMICOND DEVICE:ZENER,500MW,13V,2%	04713	SZG30214RL

Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A68	----- -----			CKT BOARD ASSY:PS CAPACITOR		
A68C1010	290-0885-00			CAP.,FXD,ELCTLT:1600UF,+50-10%,200V	90201	CGS162T200V4L3PH
A68C1020	290-0885-00			CAP.,FXD,ELCTLT:1600UF,+50-10%,200V	90201	CGS162T200V4L3PH
A68R1011	303-0623-00			RES.,FXD,CMPSN:62K OHM,5%,1W	01121	GB6235
A68R1012	303-0623-00			RES.,FXD,CMPSN:62K OHM,5%,1W	01121	GB6235
A70	----- -----			CKT BOARD ASSY:FRONT PANEL		
A70C1027	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
A70R1012	303-0751-00			RES.,FXD,CMPSN:750 OHM,5%,1W	01121	GB7515
A70R1022	301-0131-00			RES.,FXD,CMPSN:130 OHM,5%,0.50W	01121	EB1315
A70R1024	315-0332-00			RES.,FXD,CMPSN:3.3K OHM,5%,0.25W	01121	CB3325
A70R1025	315-0332-00			RES.,FXD,CMPSN:3.3K OHM,5%,0.25W	01121	CB3325
A70R1026	315-0332-00			RES.,FXD,CMPSN:3.3K OHM,5%,0.25W	01121	CB3325
A70R1027	315-0332-00			RES.,FXD,CMPSN:3.3K OHM,5%,0.25W	01121	CB3325
A70R1028	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
A70U1010	156-0382-02			MICROCIRCUIT,DI:QUAD 2-INP NAND GATE	01295	SN74LS00

Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
				CHASSIS PARTS		
B610	119-1024-00			FAN,VENTILATING:115V,18W,3100RPM,115 CFM	82877	028316
DS1032	150-1064-00			LT EMITTING DIO:YELLOW,585NM,40 MA MAX	50522	MV5374C
DS1038	150-1064-00			LT EMITTING DIO:YELLOW,585NM,40 MA MAX	50522	MV5374C
DS1052	150-0093-01			LAMP,INCAND:5V,0.06A,0.05MSCP,SEL	87034	9AS15
F000	159-0174-00			FUSE,CARTRIDGE:3AG,8A,250V,5 SEC	71400	ABC-8
	----- -----			(STANDARD ONLY)		
F000	159-0017-00			FUSE,CARTRIDGE:3AG,4A,250V,FAST BLOW	71400	MTH4
	----- -----			(OPTIONS A1,A2,A3,A4 & A5)		
F100	159-0025-00			FUSE,CARTRIDGE:3AG,0.5A,250V,FAST-BLOW	71400	AGC 1/2
FL652	119-1313-00			FILTER,RFI:10A,115-230V,50-400HZ	56289	10JX5441A
S615	260-1967-00			SWITCH,SLIDE:DPDT,5A/250V,10A/125V MKD	000FJ	4021.0512
S650	260-1989-00			SWITCH,ROCKER:DPST,16A,250VAC	000FJ	1602.0121
S1014	260-1867-00			SWITCH,TOGGLE:SPDT,0.4A,20V	09353	7108-J61-CB8
S1024	260-1868-00			SWITCH,TOGGLE:SPDT,0.4A,20V	09353	7101-J61-CB8
S1045	260-2028-00			SWITCH,ROCKER:DPDT,0.4A,20VAC	000FJ	OBD
T660	120-1256-00			XFMR,PWR,STPDN:LF	80009	120-1256-00

Section 21
DIAGRAMS

Standards

The following American National Standard Institute standards are used in the preparation of Tektronix, Inc. diagrams.

Graphic Symbols	ANSI Y32.2–1975
Logic Symbols	ANSI Y32.14–1973 (Positive logic. Logic symbols depict the logical function performed and may differ from the manufacturer's data.)
Abbreviations	ANSI Y1.1–1972
Drafting Practices	ANSI Y14.15–1966
Line Conventions And Lettering	ANSI Y14.2–1973
Letter Symbols	ANSI Y10.5–1968

Component Values

Electrical components shown on the diagrams are in the following units unless noted otherwise:

Capacitors = Values one or greater are in picofarads (pF). Values less than one are in microfarads (μF).

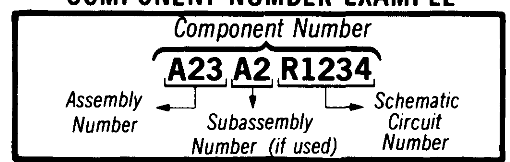
Resistors = Ohms (Ω)

The following special symbols may appear on the diagrams:

Assembly Numbers and Grid Coordinates

Each circuit board in the instrument is assigned an assembly number (e.g. A20). This number appears on the component location illustration, the schematics, and the component lookup table. The Replaceable Electrical Parts list also uses the number to list components by assembly. The following illustration shows an example of a component number in the Electrical Parts list.

COMPONENT NUMBER EXAMPLE



Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List.

Both the schematics and the component locator illustration have locating grids. A lookup table is assigned to each schematic. The lookup table gives the component location in both the associated schematic, and on the component locator illustration.

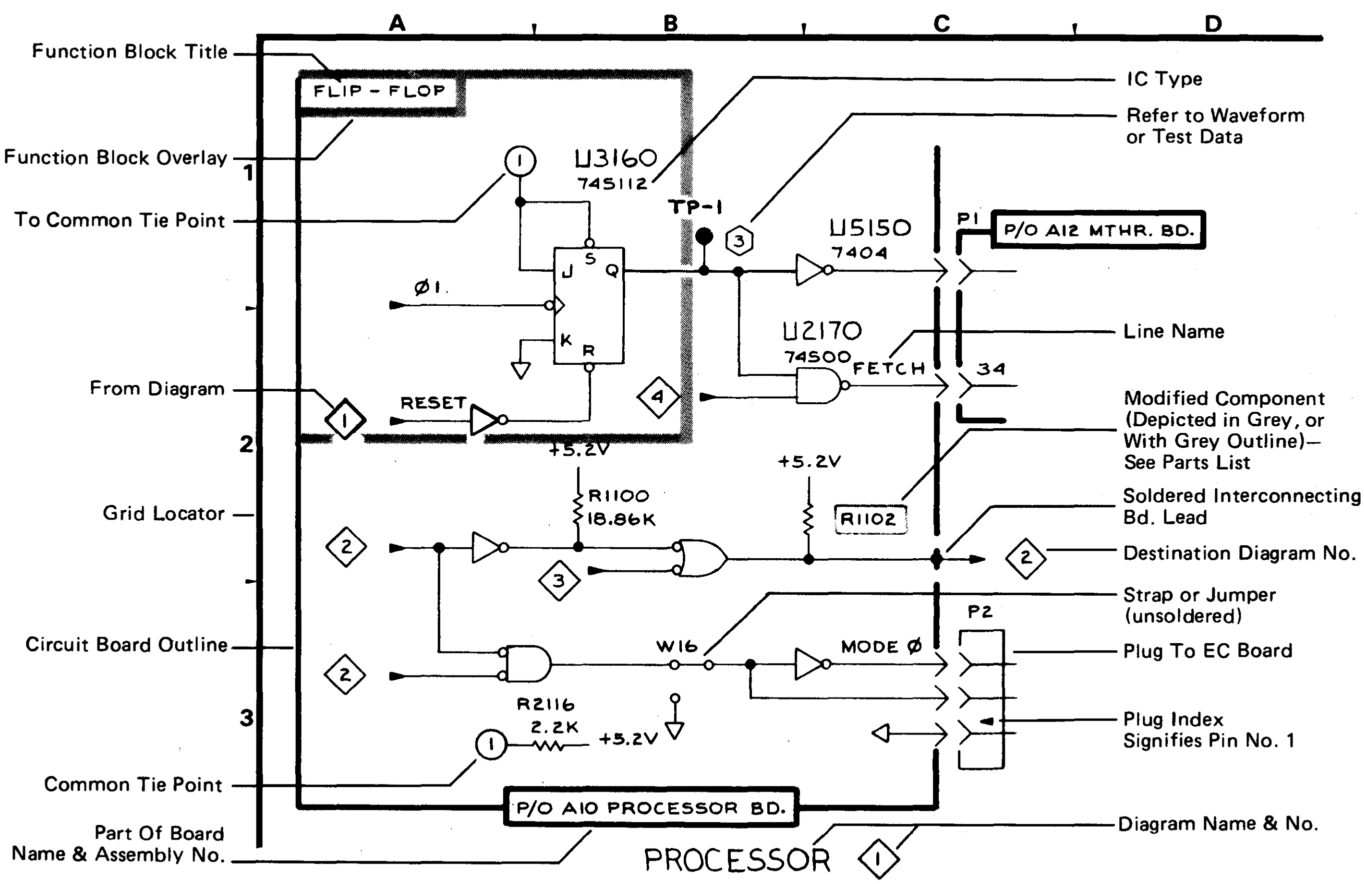
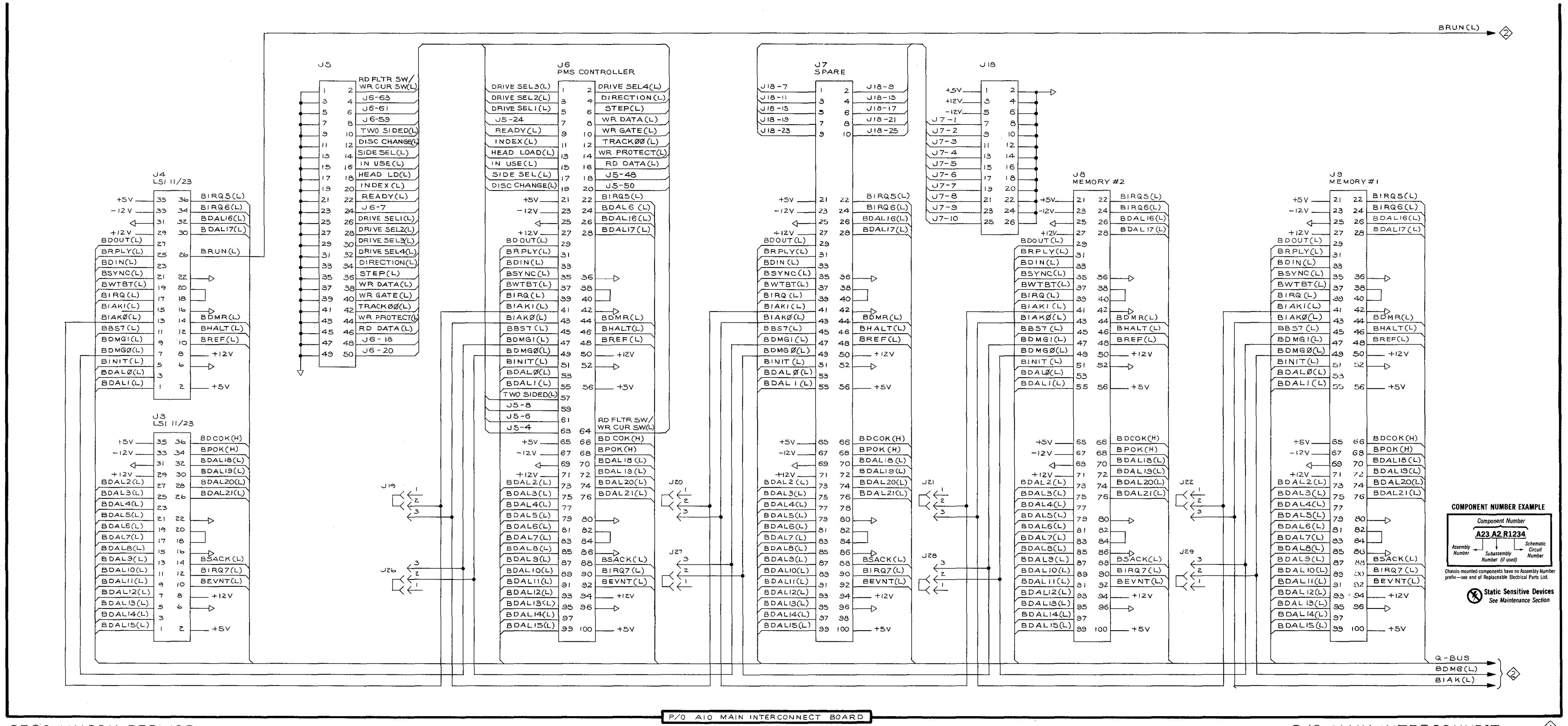


Table 21-1
IC Pin Information

DEVICE	VCC	GND	DEVICE	VCC	GND
26LS30	1	8	74LS153	16	8
26LS32	16	8	74LS155	16	8
4024			74LS157	16	8
4044			74LS163	16	8
4116	9	16	74LS174	16	8
4118	24	12	74LS175	16	8
7400(LS)	14	7	74LS191	16	8
74LS02	14	7	74LS221	16	8
74LS04	14	7	74S241	20	10
7406	14	7	74LS244	20	10
74LS08	14	7	74LS245	20	10
74LS10	14	7	74LS251	16	8
74LS11	14	7	74LS253	16	8
74LS14	14	7	74LS259	16	8
7416	14	7	74LS260	14	7
74LS20	14	7	74LS266	14	7
74LS21	14	7	74LS275	20	10
74LS27	14	7	74LS279	16	8
74LS30	14	7	74LS367	16	8
74LS32	14	7	74LS373	20	10
7438	14	7	74LS374	20	10
74LS74	14	7	74LS393	14	7
74LS86	14	7	8094		
74LS130	16	8	8136		
74LS139	16	8	8837		
74148	16	8	8838		
74LS151	16	8	9602		
			Z80A		

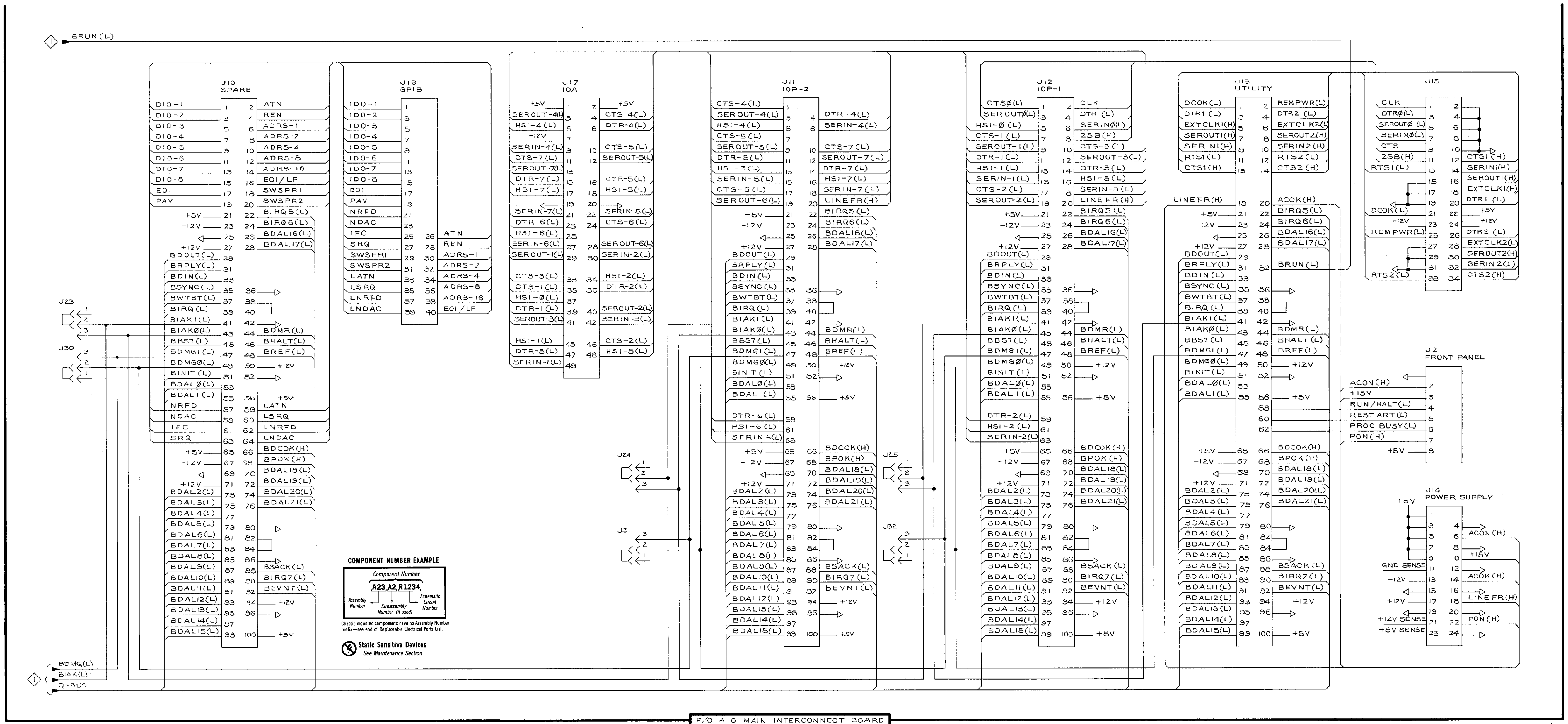


8560 MUSDU SERVICE

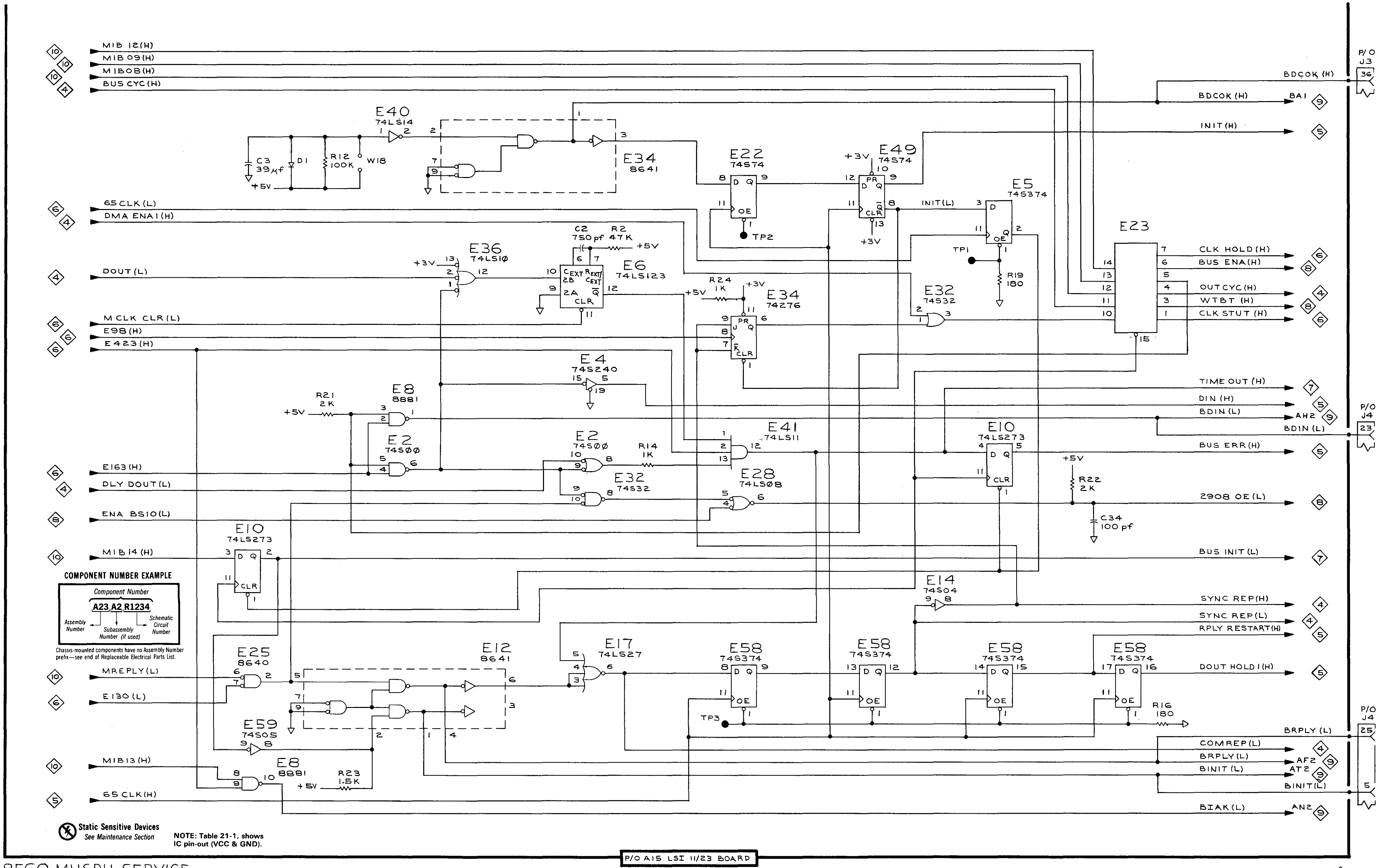
@ 12581-01

P/O MAIN INTERCONNECT 1

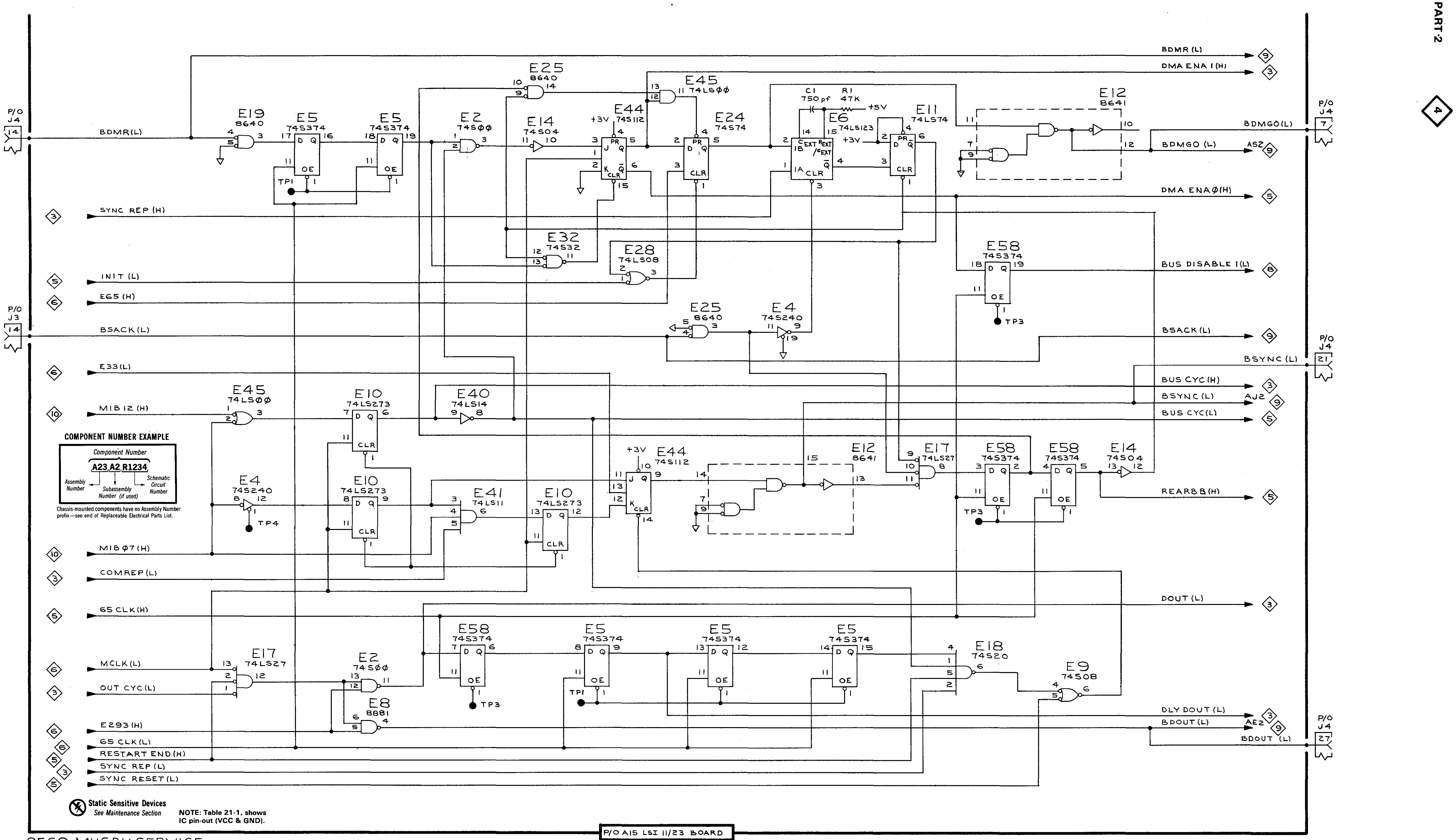
P/O MAIN INTERCONNECT 1

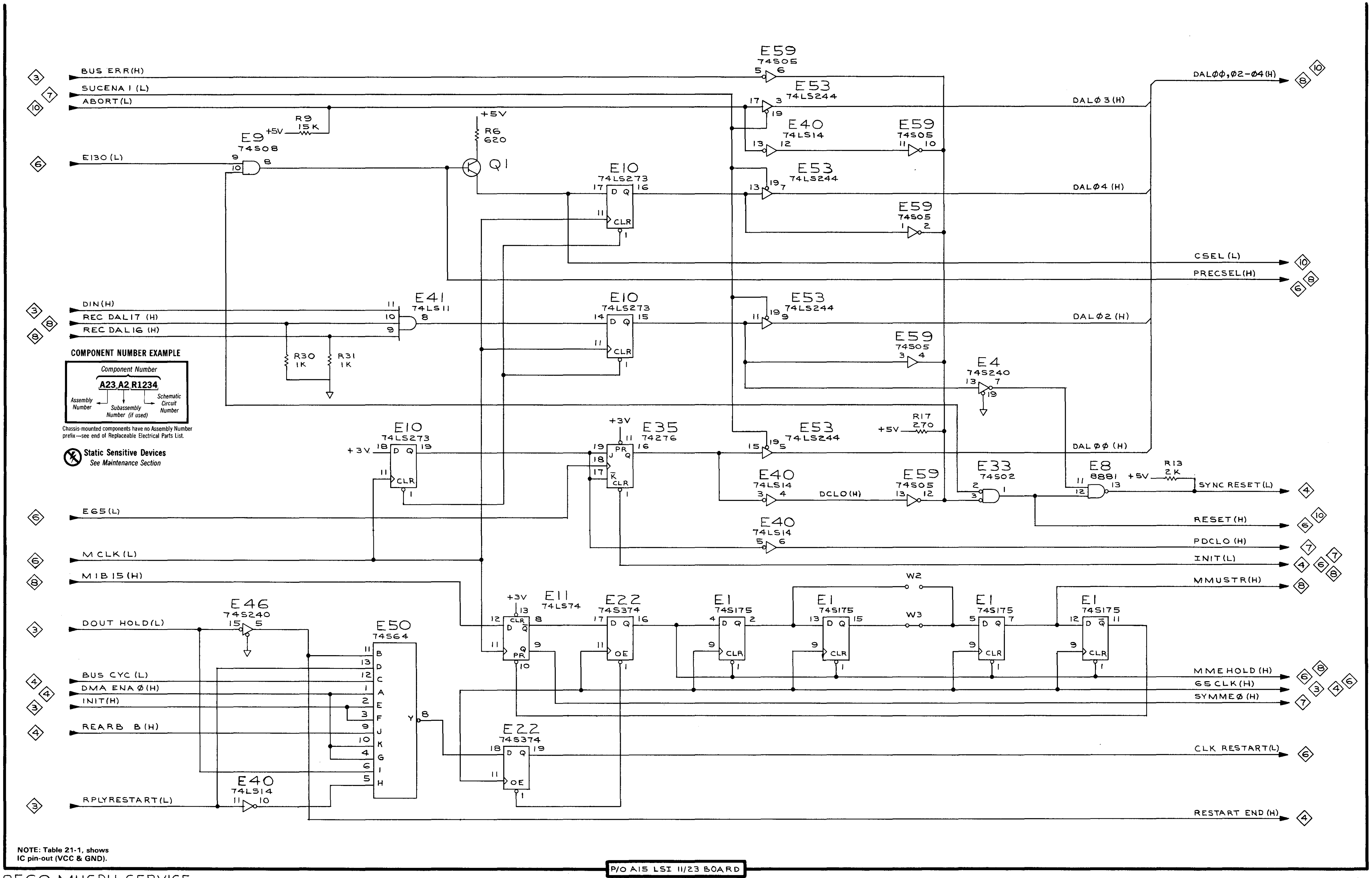


P/O MAIN INTERCONNECT 2

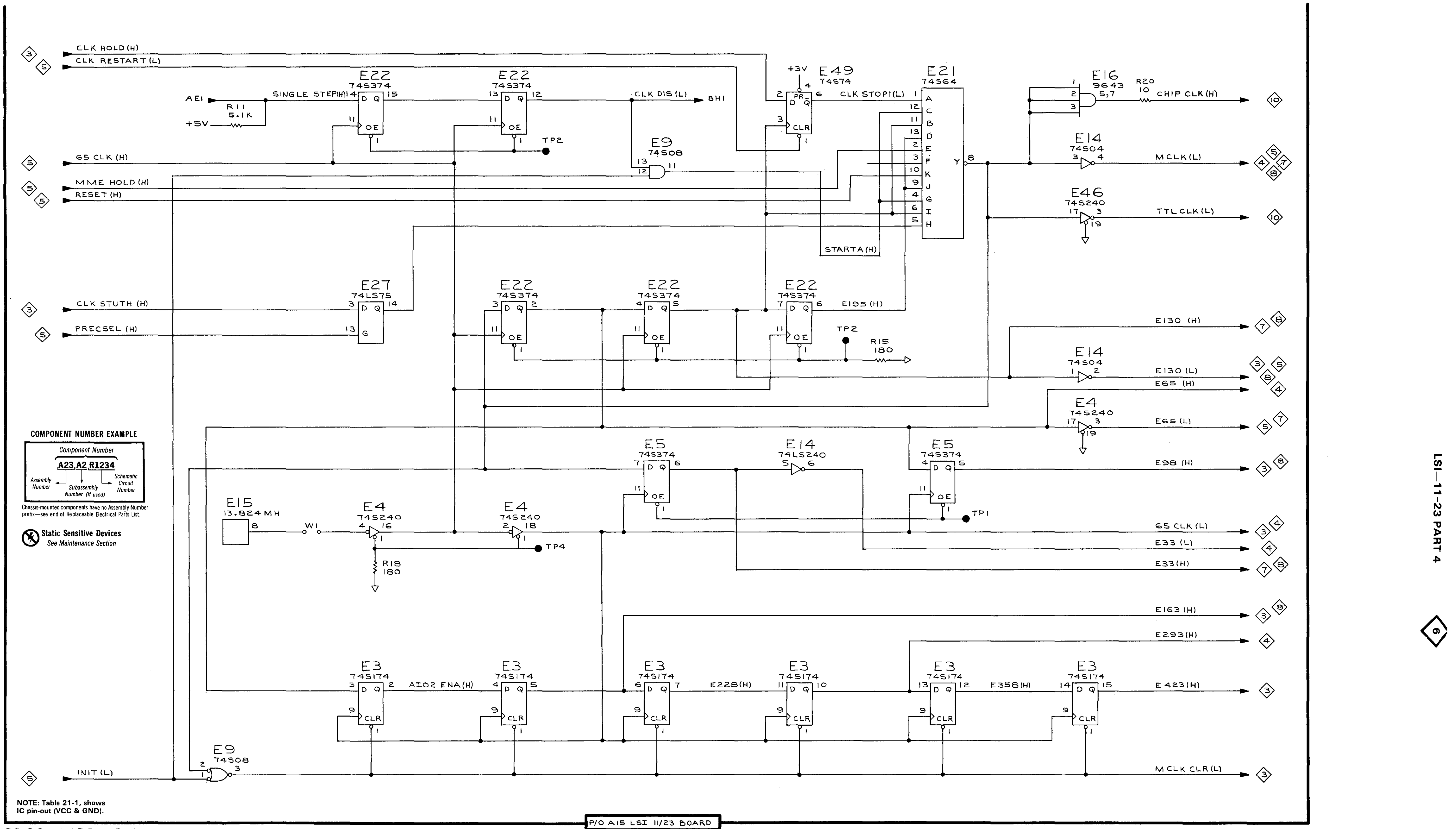


MIB 12(H)
MIB 09(H)
MIB08(H)
BUS CYC(H)
65CLK(L)
DMA ENA1(H)
DOUT(L)
M CLK CLR(L)
E98(H)
E423(H)
E163(H)
DLY DOUT(L)
ENA BS10(L)
MIB 14(H)
MREPLY(L)
E130(L)
MIB13(H)
65 CLK(H)
E40 74LS14
E34 8641
E22 74S74
E49 74S74
E5 74S374
E23
E36 74LS10
E6 74LS123
E34 74276
E32 74S32
E4 74S240
E8 8881
E2 74S00
E41 74LS11
E28 74LS08
E10 74LS273
E14 74S04
E25 8640
E12 8641
E17 74LS27
E58 74S374
E59 74S05
C3 39µf
D1
R12 100K
W18
C2 750pf
R2 47K
R24 1K
R21 2K
R14 1K
R19 180
R22 2K
C34 100pf
R16 180
R23 1.5K
TP1
TP2
TP3
+5V
+3V
BDCOK (H)
INIT(H)
INIT(L)
CLK HOLD(H)
BUS ENA(H)
OUT CYC(H)
WTBT (H)
CLK STUT (H)
TIME OUT (H)
DIN (H)
BDIN (L)
BUS ERR(H)
2908 OE(L)
BUS INIT (L)
SYNC REP(H)
SYNC REP(L)
RPLY RESTART(H)
DOUT HOLD1(H)
BRPLY (L)
COMREP(L)
BINIT (L)
BIAK(L)
BA1
AH2
AF2
AT2
AN2
P/O J3
P/O J4
COMPONENT NUMBER EXAMPLE
Component Number
A23 A2 R1234
Assembly Number
Subassembly Number (if used)
Schematic Circuit Number
Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List.
Static Sensitive Devices See Maintenance Section
NOTE: Table 21-1, shows IC pin-out (VCC & GND).

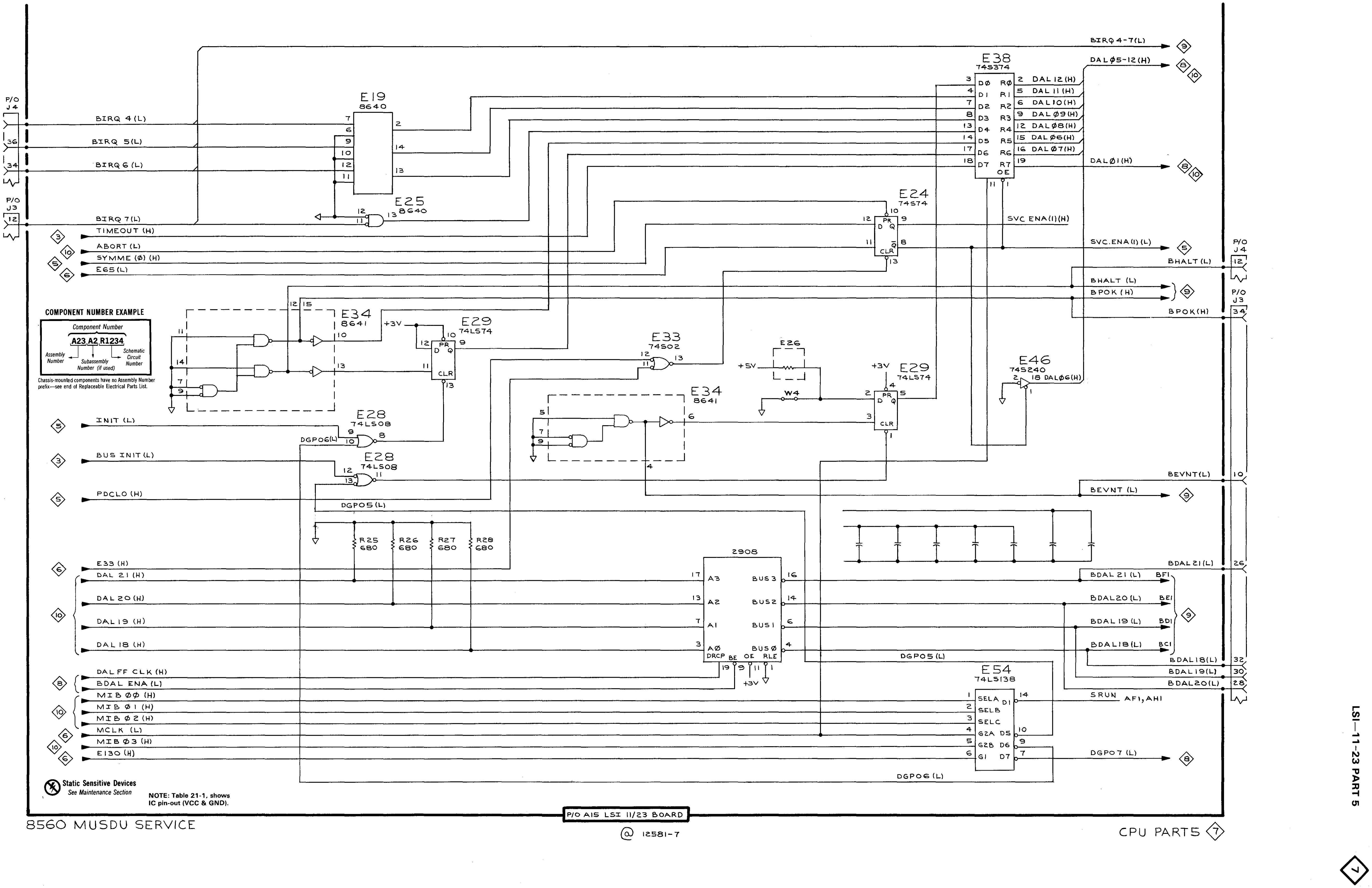

BDMR(L)
DMA ENA 1 (H)
BDMGO(L)
BDMGO (L)
DMA ENAØ(H)
SYNC REP (H)
INIT (L)
E65 (H)
BSACK(L)
BUS DISABLE 1(L)
BSYNC (L)
E33(L)
BUS CYC(H)
MIB 12 (H)
BUS CYC(L)
REARBB(H)
MIBØ7(H)
COMREP(L)
65 CLK(H)
DOUT (L)
MCLK(L)
OUT CYC(L)
E293 (H)
65 CLK(L)
RESTART END(H)
SYNC REP (L)
SYNC RESET(L)
DLY DOUT (L)
BDOUT (L)
P/O J4
P/O J3
E19 8640
E5 74S374
E2 74SØØ
E14 74S04
E44 74S112
E24 74S74
E25 8640
E45 74LSØØ
E6 74LS123
C1 750pf
R1 47K
E11 74LS74
E12 8641
E32 74S32
E28 74LS08
E58 74S374
E4 74S240
E10 74LS273
E40 74LS14
E41 74LS11
E17 74LS27
E8 8881
E18 74S20
E9 74S08
TP1
TP3
TP4
COMPONENT NUMBER EXAMPLE
Component Number
A23 A2 R1234
Assembly Number
Subassembly Number (if used)
Schematic Circuit Number
Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List.
Static Sensitive Devices
See Maintenance Section
NOTE: Table 21-1, shows IC pin-out (VCC & GND).
P/O A15 LSI 11/23 BOARD

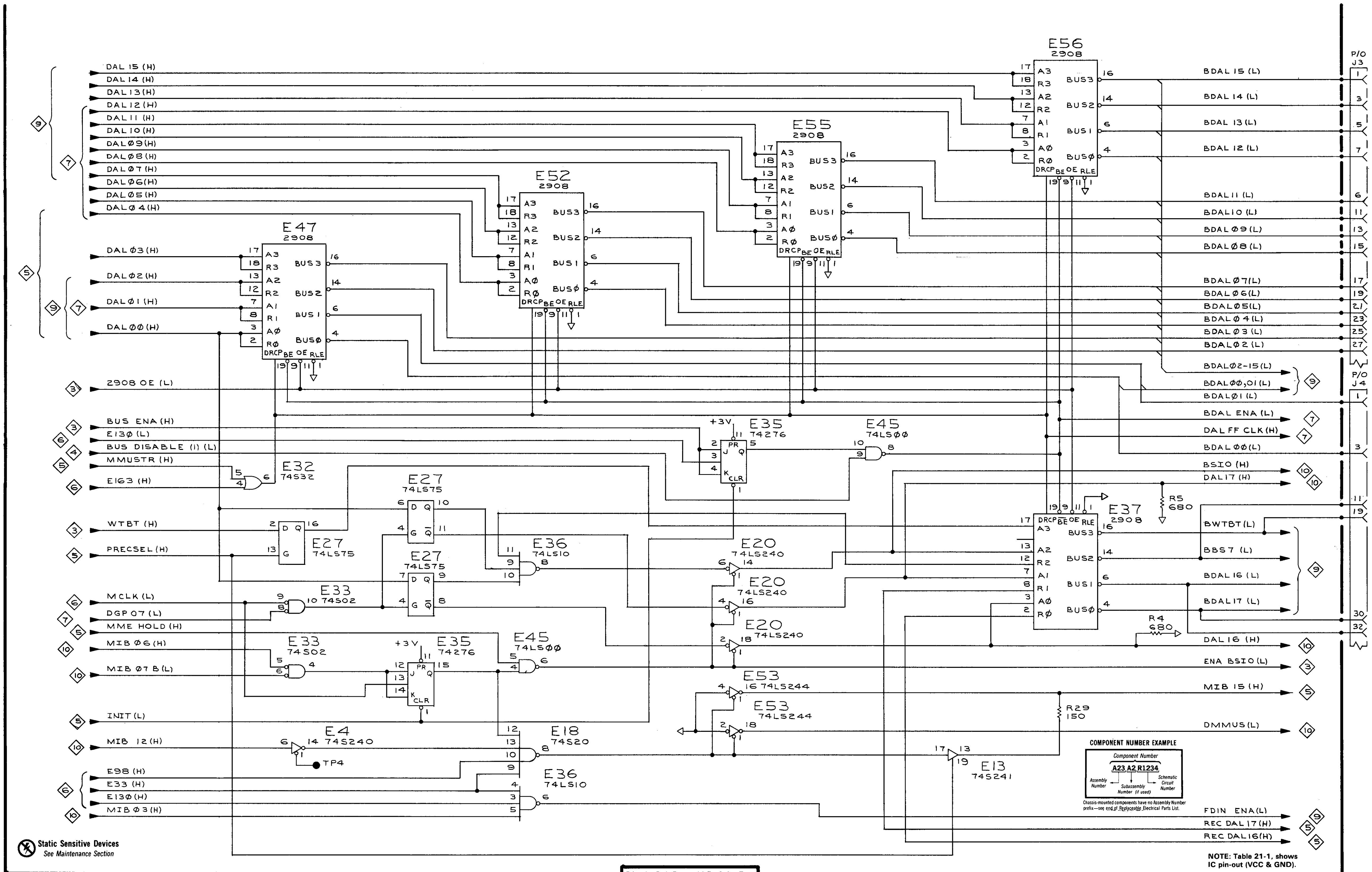


LSI—11-23 PART 3

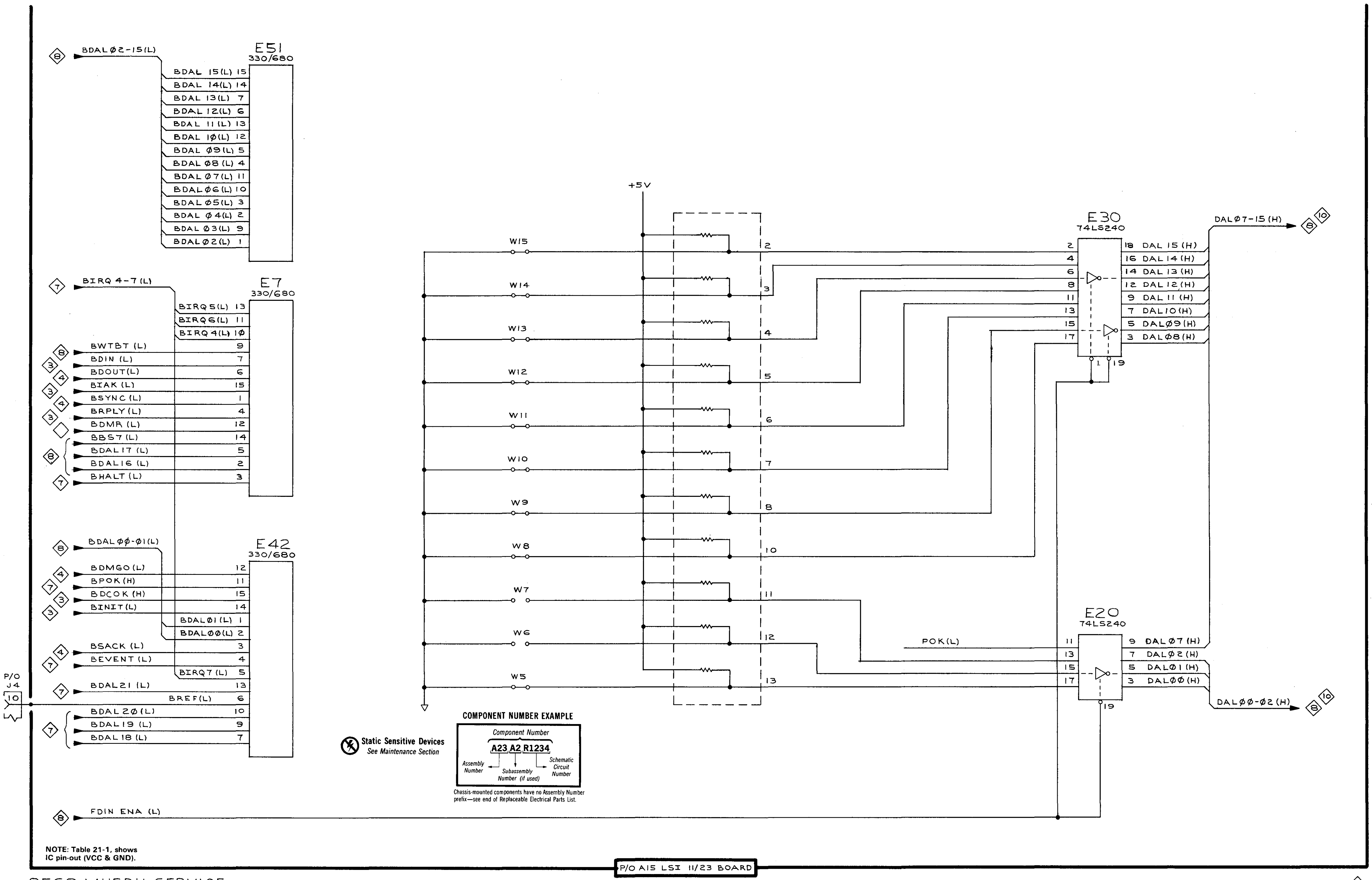


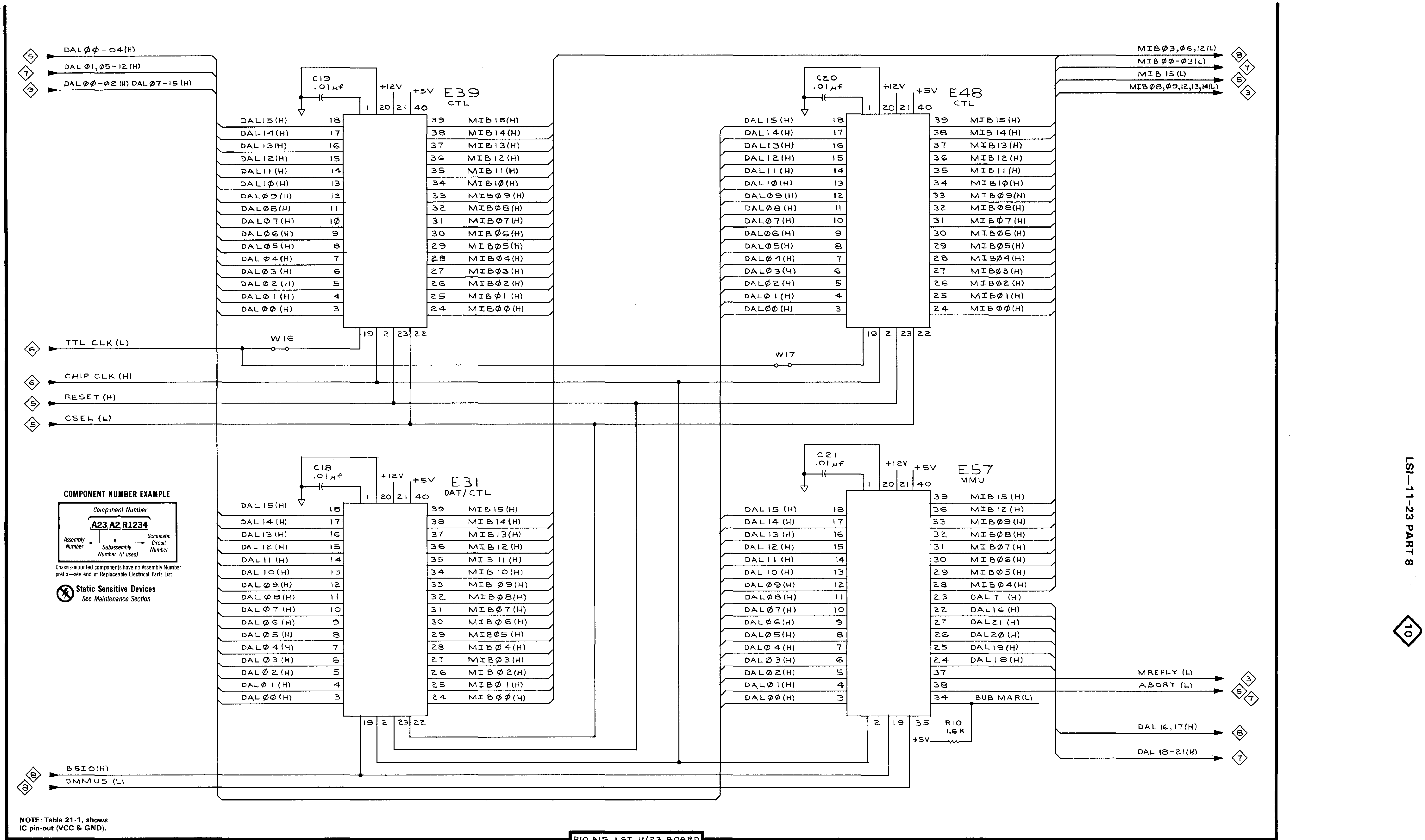
CLK HOLD (H)
CLK RESTART (L)
E22 74S374
SINGLE STEP(H)
AEI
R11 5.1K
+5V
CLK DIS (L)
BH1
TP2
E9 74S08
E49 74S74
+3V
CLK STOP1(L)
E21 74S64
E16 9643
R20 10
CHIP CLK (H)
E14 74S04
MCLK (L)
E46 74S240
TTL CLK (L)
65 CLK (H)
MME HOLD (H)
RESET (H)
STARTA (H)
E27 74LS75
CLK STUTH (H)
PRECSEL (H)
E195 (H)
R15 180
E130 (H)
E130 (L)
E65 (H)
E4 74S240
E65 (L)
E5 74S374
E14 74LS240
E98 (H)
TP1
E15 13.824 MH
W1
TP4
R18 180
65 CLK (L)
E33 (L)
E33 (H)
E163 (H)
E293 (H)
E3 74S174
AI02 ENA (H)
E228 (H)
E358 (H)
E423 (H)
INIT (L)
MCLK CLR (L)
COMPONENT NUMBER EXAMPLE
Component Number
A23 A2 R1234
Assembly Number
Subassembly Number (if used)
Schematic Circuit Number
Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List.
Static Sensitive Devices
See Maintenance Section
NOTE: Table 21-1, shows IC pin-out (VCC & GND).
P/O A15 LSI 11/23 BOARD
LSI—11—23 PART 4


BIRQ 4-7(L)
DALØ5-12(H)
E38
74S374
E19
8640
BIRQ 4(L)
BIRQ 5(L)
BIRQ 6(L)
BIRQ 7(L)
E25
8640
E24
74S74
SVC ENA(I)(H)
SVC.ENA(I)(L)
TIMEOUT (H)
ABORT (L)
SYMME (Ø) (H)
E65(L)
BHALT (L)
BPOK (H)
BPOK(H)
COMPONENT NUMBER EXAMPLE
Component Number
A23 A2 R1234
Assembly Number
Subassembly Number (if used)
Schematic Circuit Number
Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List.
E34
8641
E29
74LS74
E33
74S02
E26
W4
E46
74S240
INIT (L)
E28
74LS08
BUS INIT(L)
PDCLO (H)
DGPO6(L)
DGPO5(L)
BEVNT(L)
BEVNT (L)
R25 680
R26 680
R27 680
R28 680
2908
E33 (H)
DAL 21 (H)
DAL 20 (H)
DAL 19 (H)
DAL 18 (H)
BDAL21(L)
BDAL 21 (L)
BDAL20(L)
BDAL 19 (L)
BDAL18(L)
BDAL18(L)
BDAL19(L)
BDAL20(L)
DAL FF CLK (H)
BDAL ENA (L)
MIB ØØ (H)
MIB Ø1 (H)
MIB Ø2 (H)
MCLK (L)
MIB Ø3 (H)
E130 (H)
E54
74LS138
SRUN
AF1, AH1
DGPO7 (L)
Static Sensitive Devices
See Maintenance Section
NOTE: Table 21-1, shows IC pin-out (VCC & GND).
P/O A15 LSI 11/23 BOARD
LSI—11-23 PART 5



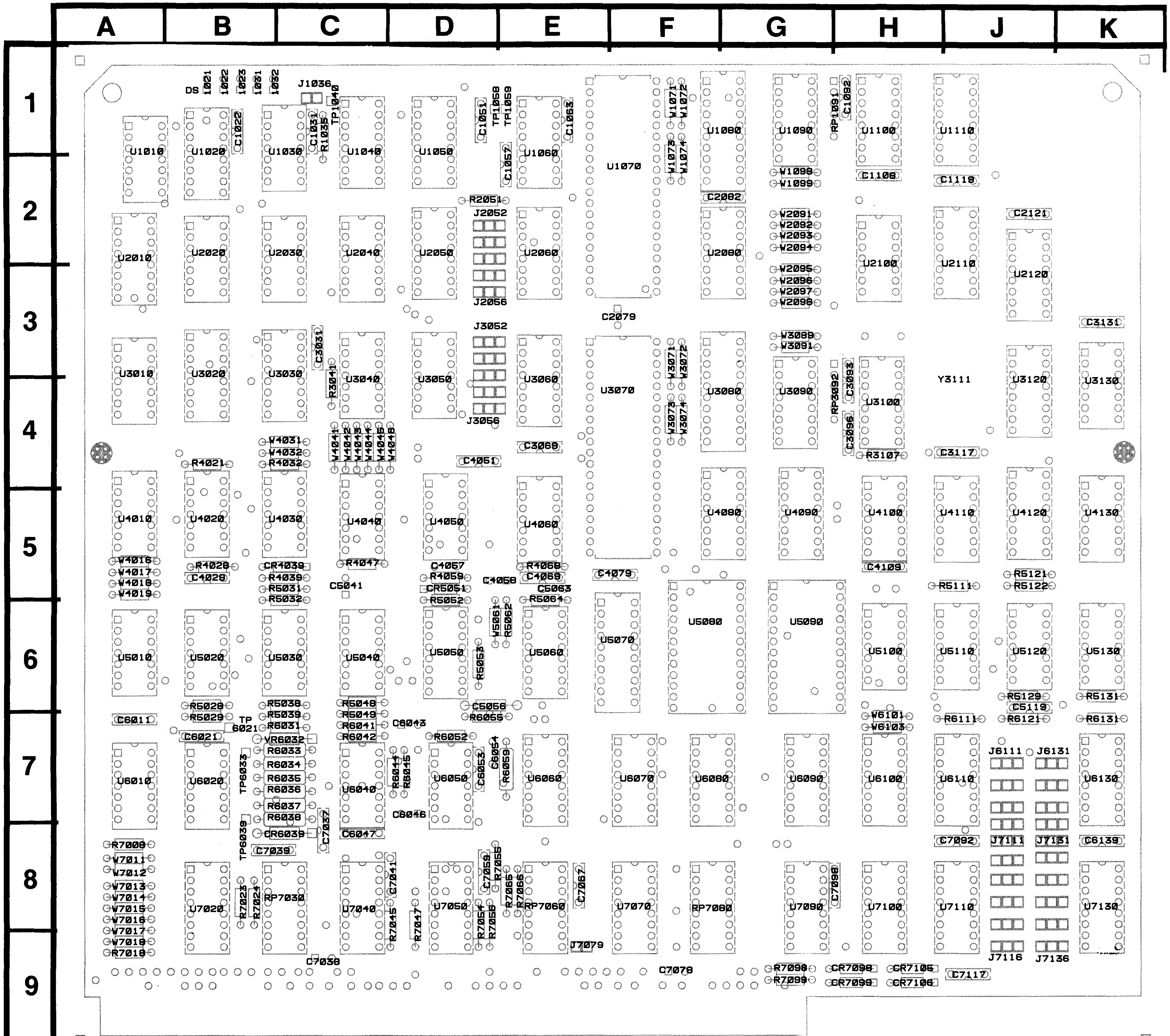
P/O A15 LSI 11/23 BOARD


BDALØ2-15(L)
E51
330/680
BDAL 15(L) 15
BDAL 14(L) 14
BDAL 13(L) 7
BDAL 12(L) 6
BDAL 11(L) 13
BDAL 1Ø(L) 12
BDAL Ø9(L) 5
BDAL Ø8(L) 4
BDAL Ø7(L) 11
BDAL Ø6(L) 10
BDAL Ø5(L) 3
BDAL Ø4(L) 2
BDAL Ø3(L) 9
BDAL Ø2(L) 1
BIRQ 4-7(L)
E7
330/680
BIRQ5(L) 13
BIRQ6(L) 11
BIRQ4(L) 1Ø
BWTBT (L) 9
BDIN (L) 7
BDOUT(L) 6
BIAK (L) 15
BSYNC (L) 1
BRPLY(L) 4
BDMR (L) 12
BBS7(L) 14
BDAL17 (L) 5
BDAL16 (L) 2
BHALT (L) 3
BDALØØ-Ø1(L)
E42
330/680
BDMGO(L) 12
BPOK(H) 11
BDCOK (H) 15
BINIT(L) 14
BDALØ1(L) 1
BDALØØ(L) 2
BSACK (L) 3
BEVENT (L) 4
BIRQ7 (L) 5
BDAL21 (L) 13
BREF(L) 6
BDAL2Ø(L) 10
BDAL19 (L) 9
BDAL18 (L) 7
P/O J4
10
+5V
W15
W14
W13
W12
W11
W10
W9
W8
W7
W6
W5
E30
74LS240
18 DAL 15 (H)
16 DAL 14 (H)
14 DAL 13 (H)
12 DAL 12 (H)
9 DAL 11 (H)
7 DAL10 (H)
5 DALØ9 (H)
3 DALØ8 (H)
DALØ7-15 (H)
E20
74LS240
POK(L)
9 DALØ7 (H)
7 DALØ2 (H)
5 DALØ1 (H)
3 DALØØ (H)
DALØØ-Ø2 (H)
FDIN ENA (L)
Static Sensitive Devices
See Maintenance Section
COMPONENT NUMBER EXAMPLE
Component Number
A23 A2 R1234
Assembly Number
Subassembly Number (if used)
Schematic Circuit Number
Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List.
NOTE: Table 21-1, shows IC pin-out (VCC & GND).
P/O A15 LSI 11/23 BOARD

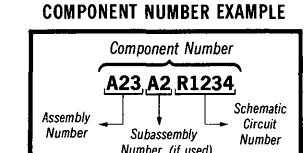


DALØØ-04(H)
DAL Ø1,Ø5-12(H)
DAL ØØ-Ø2(H) DAL Ø7-15(H)
C19 .01µf
+12V
+5V
E39
CTL
DAL15(H) 18
DAL14(H) 17
DAL13(H) 16
DAL12(H) 15
DAL11(H) 14
DAL1Ø(H) 13
DALØ9(H) 12
DALØ8(H) 11
DALØ7(H) 1Ø
DALØ6(H) 9
DALØ5(H) 8
DALØ4(H) 7
DALØ3(H) 6
DALØ2(H) 5
DALØ1(H) 4
DALØØ(H) 3
39 MIB15(H)
38 MIB14(H)
37 MIB13(H)
36 MIB12(H)
35 MIB11(H)
34 MIB1Ø(H)
33 MIBØ9(H)
32 MIBØ8(H)
31 MIBØ7(H)
30 MIBØ6(H)
29 MIBØ5(H)
28 MIBØ4(H)
27 MIBØ3(H)
26 MIBØ2(H)
25 MIBØ1(H)
24 MIBØØ(H)
C20 .01µf
E48
CTL
MIBØ3,Ø6,12(L)
MIBØØ-Ø3(L)
MIB 15(L)
MIBØ8,Ø9,12,13,14(L)
TTL CLK(L)
W16
W17
CHIP CLK(H)
RESET(H)
CSEL (L)
C18 .01µf
E31
DAT/CTL
C21 .01µf
E57
MMU
23 DAL 7 (H)
22 DAL16(H)
27 DAL21(H)
26 DAL2Ø(H)
25 DAL19(H)
24 DAL18(H)
37 MREPLY (L)
38 ABORT (L)
34 BUB MAR(L)
R10 1.5K
+5V
DAL 16,17(H)
DAL 18-21(H)
BSIO(H)
DMMUS (L)
COMPONENT NUMBER EXAMPLE
Component Number
A23 A2 R1234
Assembly Number
Subassembly Number (if used)
Schematic Circuit Number
Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List.
Static Sensitive Devices
See Maintenance Section
NOTE: Table 21-1, shows IC pin-out (VCC & GND).
P/O A15 LSI 11/23 BOARD
LSI—11-23 PART 8
10

UTILITY COMPONENT LOCATIONS



COMPONENT NUMBER EXAMPLE

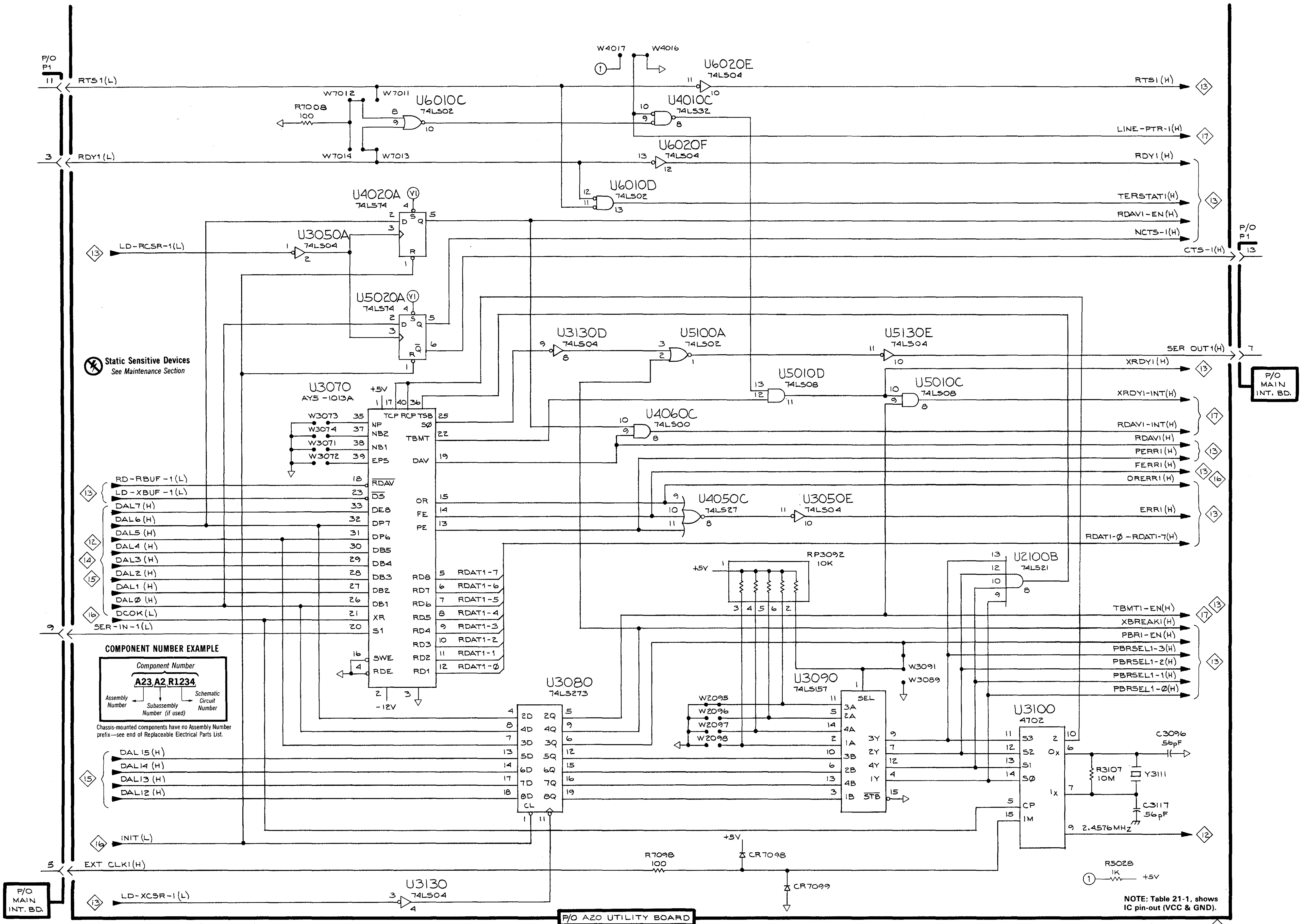


Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List.

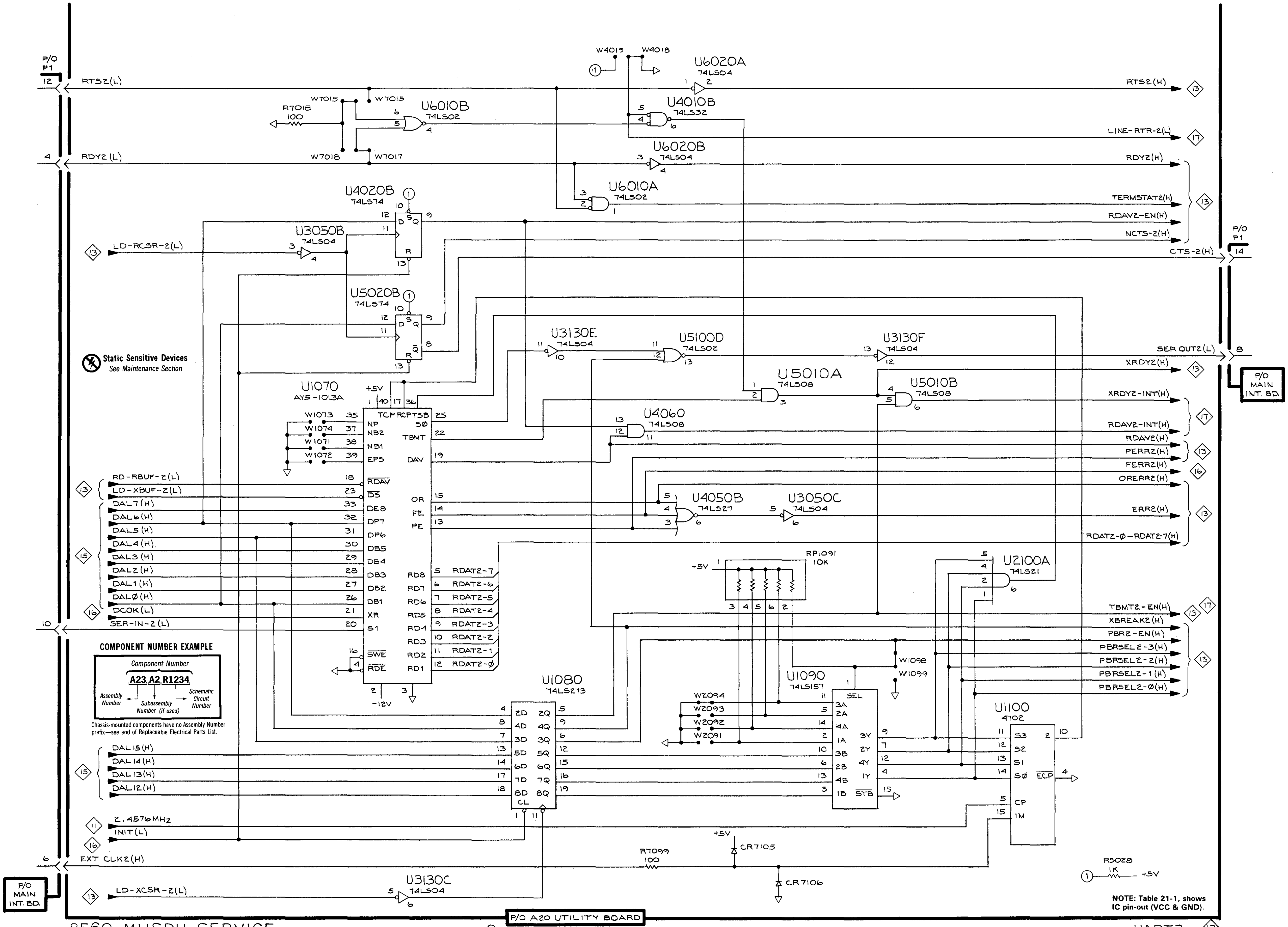
Static Sensitive Devices
See Maintenance Section

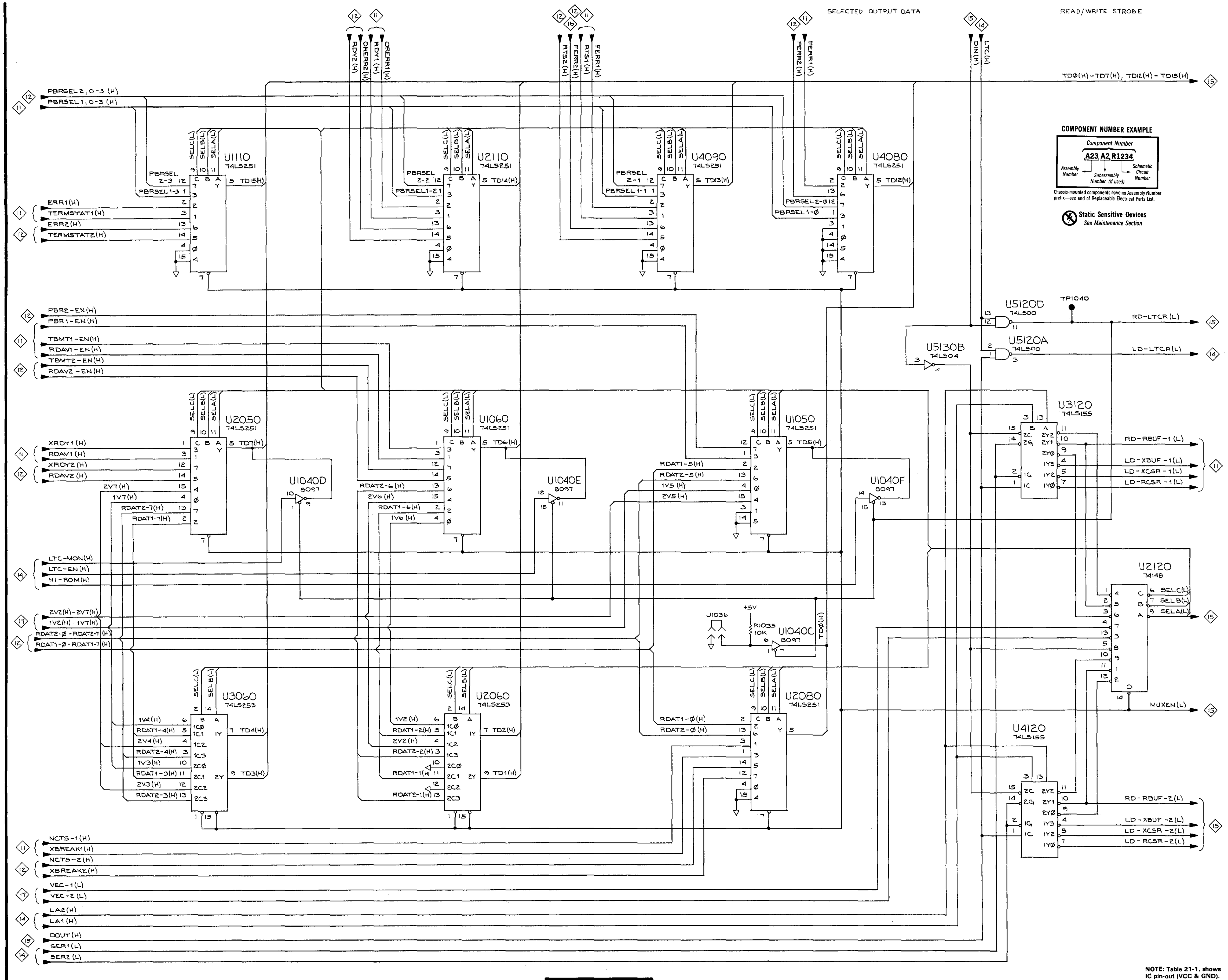
12581-127

Fig. 21-1. A20—Utility Board.



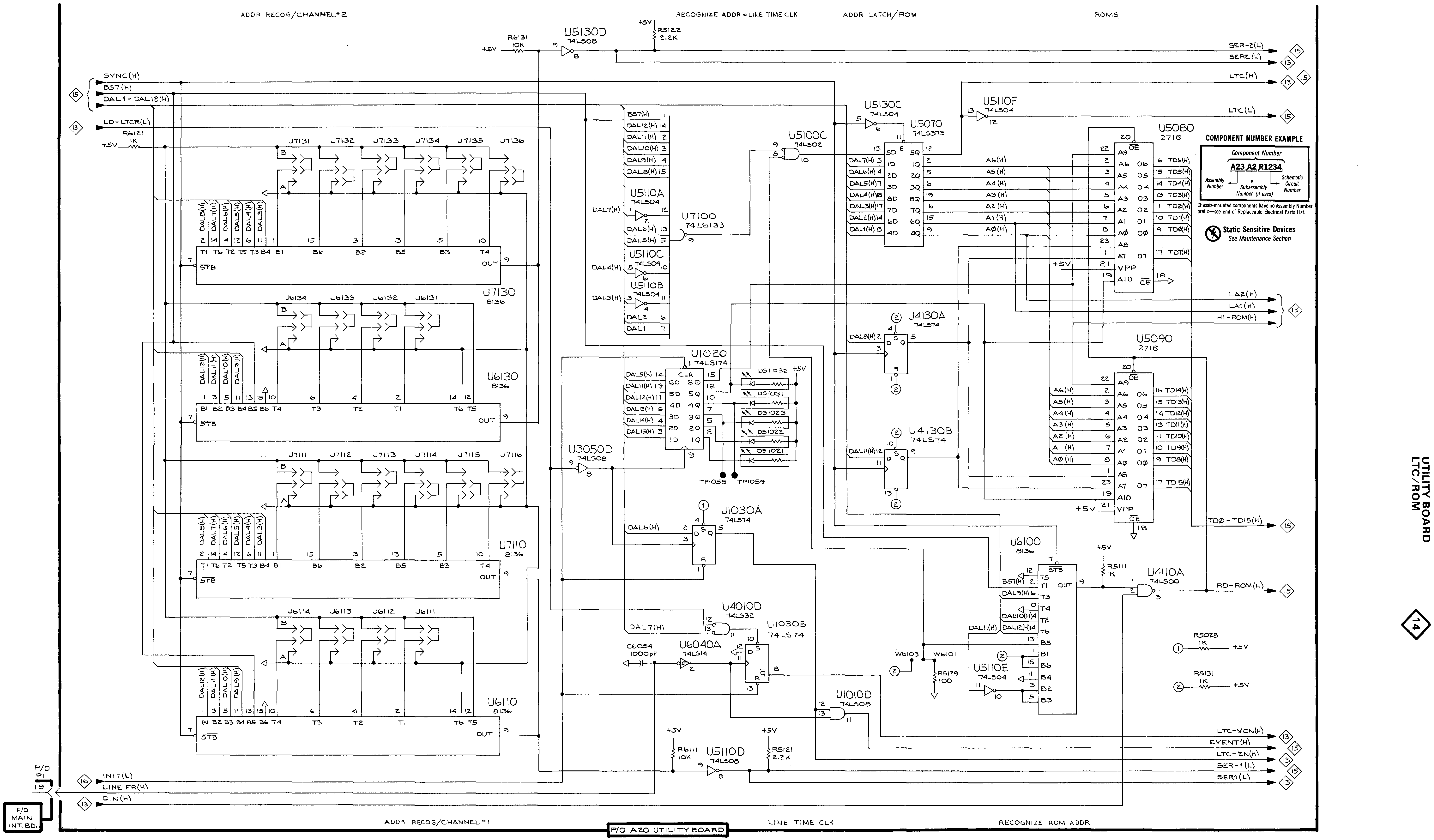
UTILITY BOARD UART 1

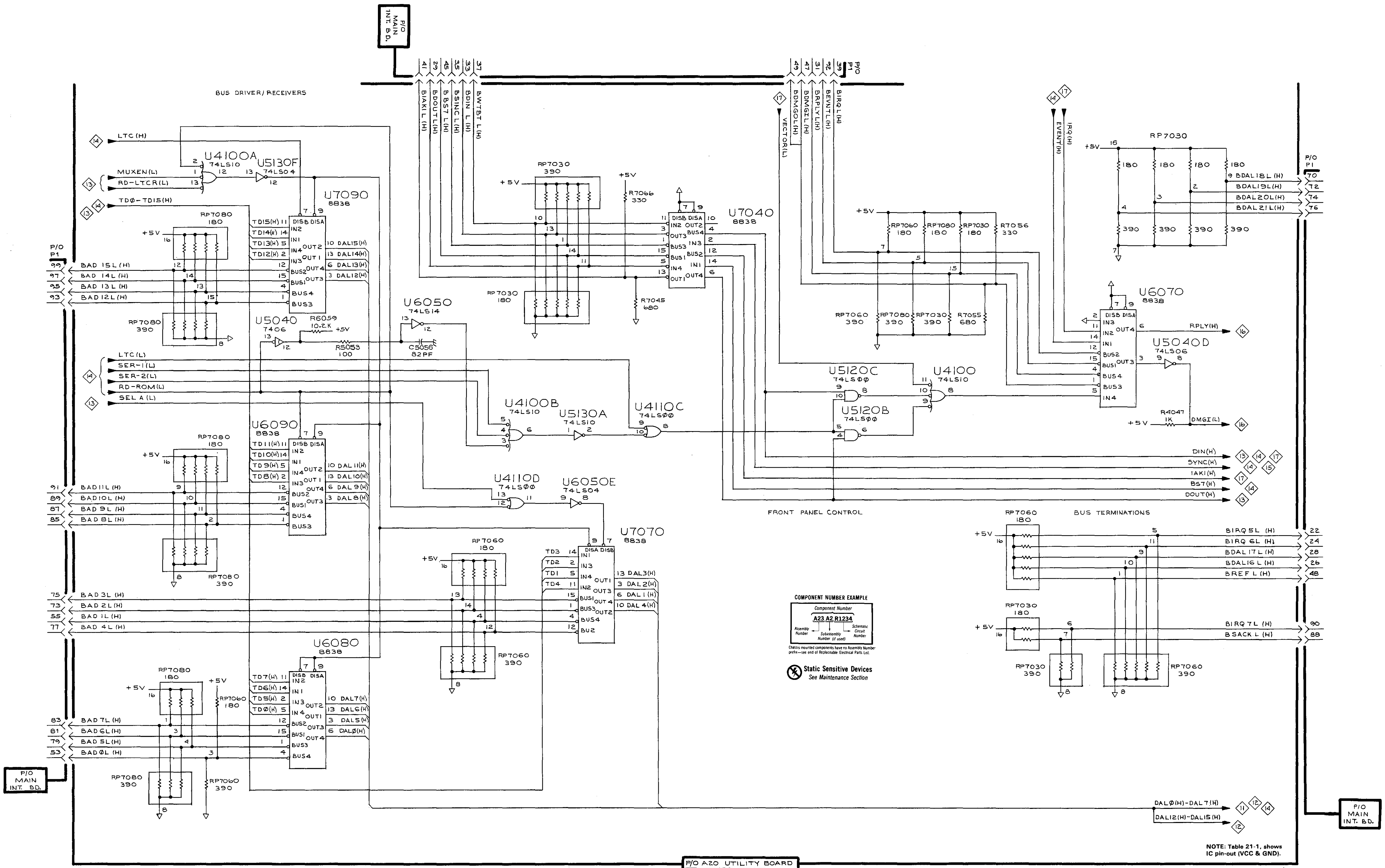

P/O P1
RTS2(L)
RDY2(L)
W4019
W4018
U6020A
74LS04
W7015
R7018
100
U6010B
74LS02
U4010B
74LS32
W7018
W7017
U6020B
74LS04
RTS2(H)
LINE-RTR-2(L)
RDY2(H)
U4020B
74LS74
U6010A
74LS02
TERMSTAT2(H)
RDAV2-EN(H)
NCTS-2(H)
CTS-2(H)
U3050B
74LS04
LD-RCSR-2(L)
U5020B
74LS74
U3130E
74LS04
U5100D
74LS02
U3130F
74LS04
SER OUT2(L)
XRDY2(H)
P/O MAIN INT. BD.
Static Sensitive Devices
See Maintenance Section
U1070
AY5-1013A
+5V
U5010A
74LS08
U5010B
74LS08
XRDY2-INT(H)
U4060
74LS08
RDAV2-INT(H)
RDAV2(H)
PERR2(H)
FERR2(H)
ORERR2(H)
W1073
W1074
W1071
W1072
TCP RCP TSB
NP
NB2
NB1
EPS
SØ
TBMT
DAV
RDAV
DS
OR
FE
PE
DE8
DP7
DP6
DB5
DB4
DB3
DB2
DB1
XR
S1
SWE
RDE
RD8
RD7
RD6
RD5
RD4
RD3
RD2
RD1
RD-RBUF-2(L)
LD-XBUF-2(L)
DAL7(H)
DAL6(H)
DAL5(H)
DAL4(H)
DAL3(H)
DAL2(H)
DAL1(H)
DALØ(H)
DCOK(L)
SER-IN-2(L)
U4050B
74LS27
U3050C
74LS04
ERR2(H)
RDAT2-Ø—RDAT2-7(H)
RDAT2-7
RDAT2-6
RDAT2-5
RDAT2-4
RDAT2-3
RDAT2-2
RDAT2-1
RDAT2-Ø
RP1091
10K
U2100A
74LS21
TBMT2-EN(H)
XBREAK2(H)
PBR2-EN(H)
PBRSEL2-3(H)
PBRSEL2-2(H)
PBRSEL2-1(H)
PBRSEL2-Ø(H)
W1098
W1099
COMPONENT NUMBER EXAMPLE
Component Number
A23 A2 R1234
Assembly Number
Subassembly Number (if used)
Schematic Circuit Number
Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List.
-12V
U1080
74LS273
U1090
74LS157
W2094
W2093
W2092
W2091
SEL
STB
U1100
4702
ECP
CP
IM
DAL15(H)
DAL14(H)
DAL13(H)
DAL12(H)
2.4576MHz
INIT(L)
EXT CLK2(H)
+5V
CR7105
R7099
100
CR7106
R5028
1K
U3130C
74LS04
LD-XCSR-2(L)
NOTE: Table 21-1, shows IC pin-out (VCC & GND).
P/O A20 UTILITY BOARD



UTILITY BOARD
SERIAL I/O

P/O A20 UTILITY BOARD


ADDR RECOG/CHANNEL #2
RECOGNIZE ADDR & LINE TIME CLK
ADDR LATCH/ROM
ROMS
U5130D 74LS08
U5100C 74LS02
U5070 74LS373
U5110F 74LS04
U5080 2716
U5090 2716
U7100 74LS133
U7130 8136
U6130 8136
U7110 8136
U6110 8136
U1020 74LS174
U3050D 74LS08
U1030A 74LS74
U4130A 74LS74
U4130B 74LS74
U6100 8136
U4110A 74LS00
U4010D 74LS32
U1030B 74LS74
U6040A 74LS14
U1010D 74LS08
U5110D 74LS08
U5110E 74LS04
SER-2(L)
SER2(L)
LTC(H)
LTC(L)
LA2(H)
LA1(H)
HI-ROM(H)
TD0-TD15(H)
RD-ROM(L)
LTC-MON(H)
EVENT(H)
LTC-EN(H)
SER-1(L)
SER1(L)
SYNC(H)
BS7(H)
DAL1-DAL12(H)
LD-LTCR(L)
INIT(L)
LINE FR(H)
DIN(H)
P/O MAIN INT. BD.
COMPONENT NUMBER EXAMPLE
Static Sensitive Devices
See Maintenance Section
ADDR RECOG/CHANNEL #1
P/O A20 UTILITY BOARD
LINE TIME CLK
RECOGNIZE ROM ADDR
UTILITY BOARD
LTC/ROM



UTILITY BOARD 8560
BUS CONTROL

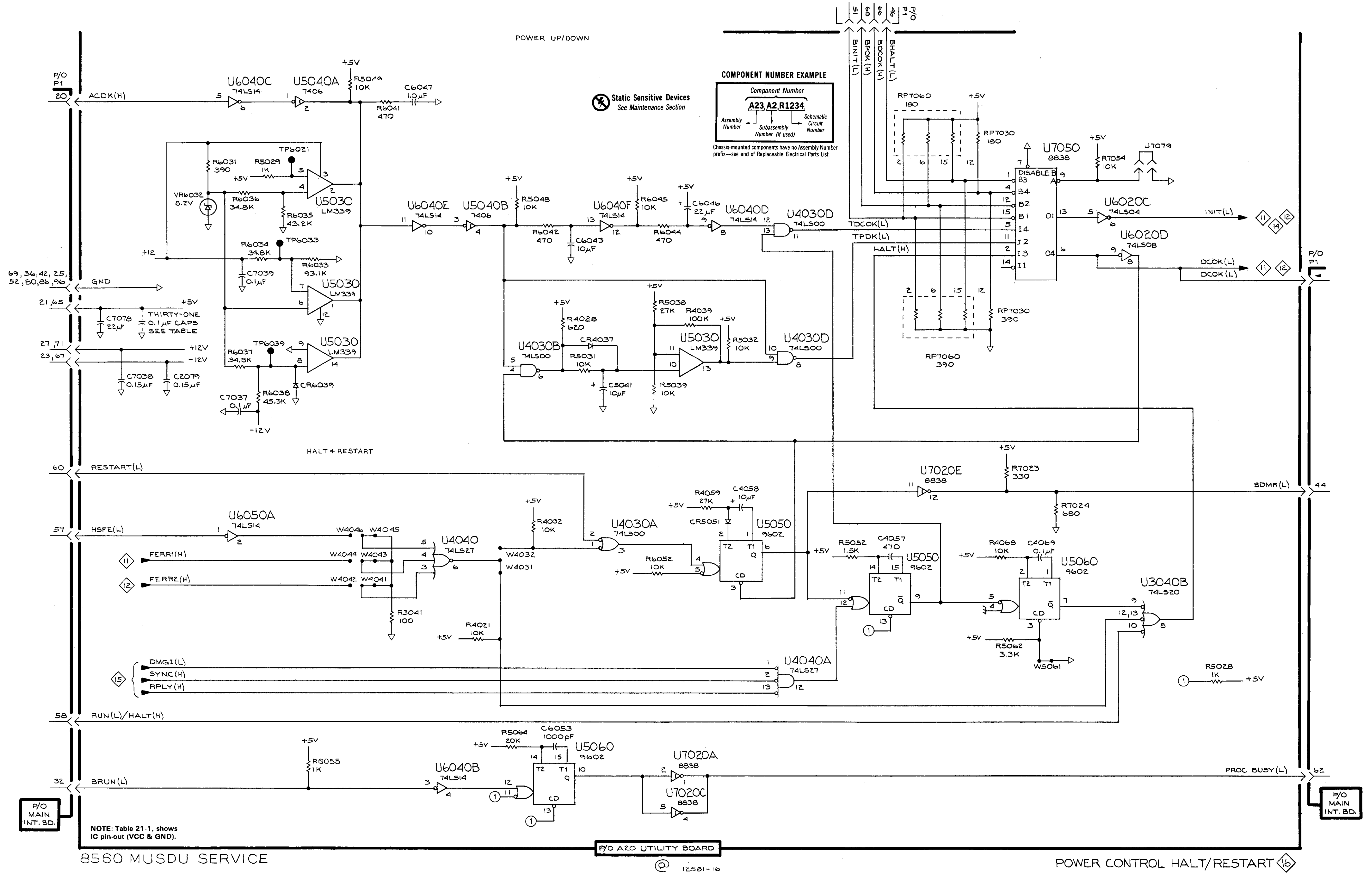
8560 MUSDU SERVICE

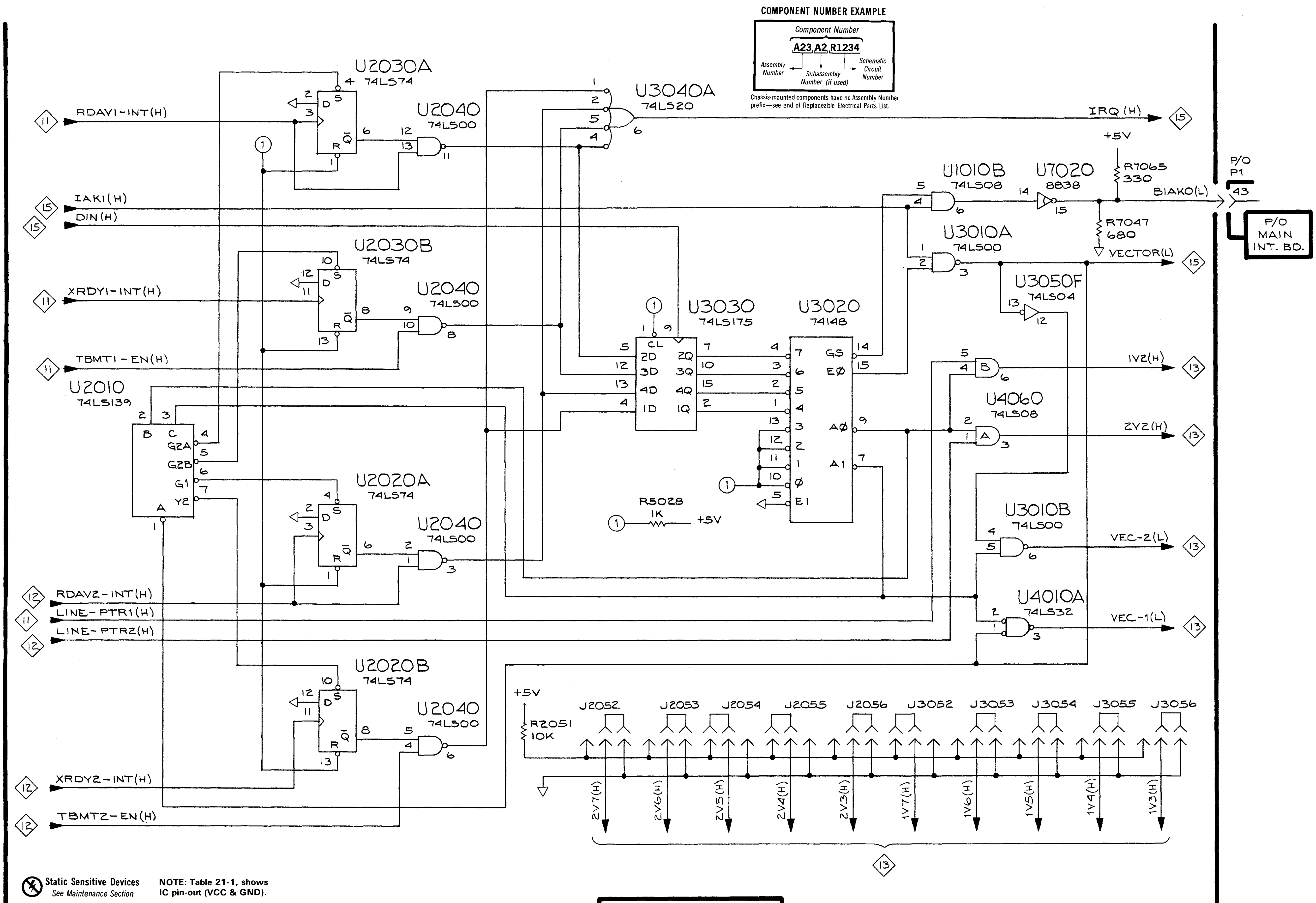
12581-15

8560 BUS CONTROL 15

Table 21-2
Thirty-One 0.1 μF
Decoupling Capacitors

C1022	C4051
C1031	C4079
C1051	C4109
C1057	C5119
C1063	C6011
C1092	C6021
C1108	C6053
C1119	C6139
C2082	C7037
C2121	C7039
C3031	C7041
C3069	C7059
C3093	C7067
C3131	C7098
C4029	C7092
	C7117





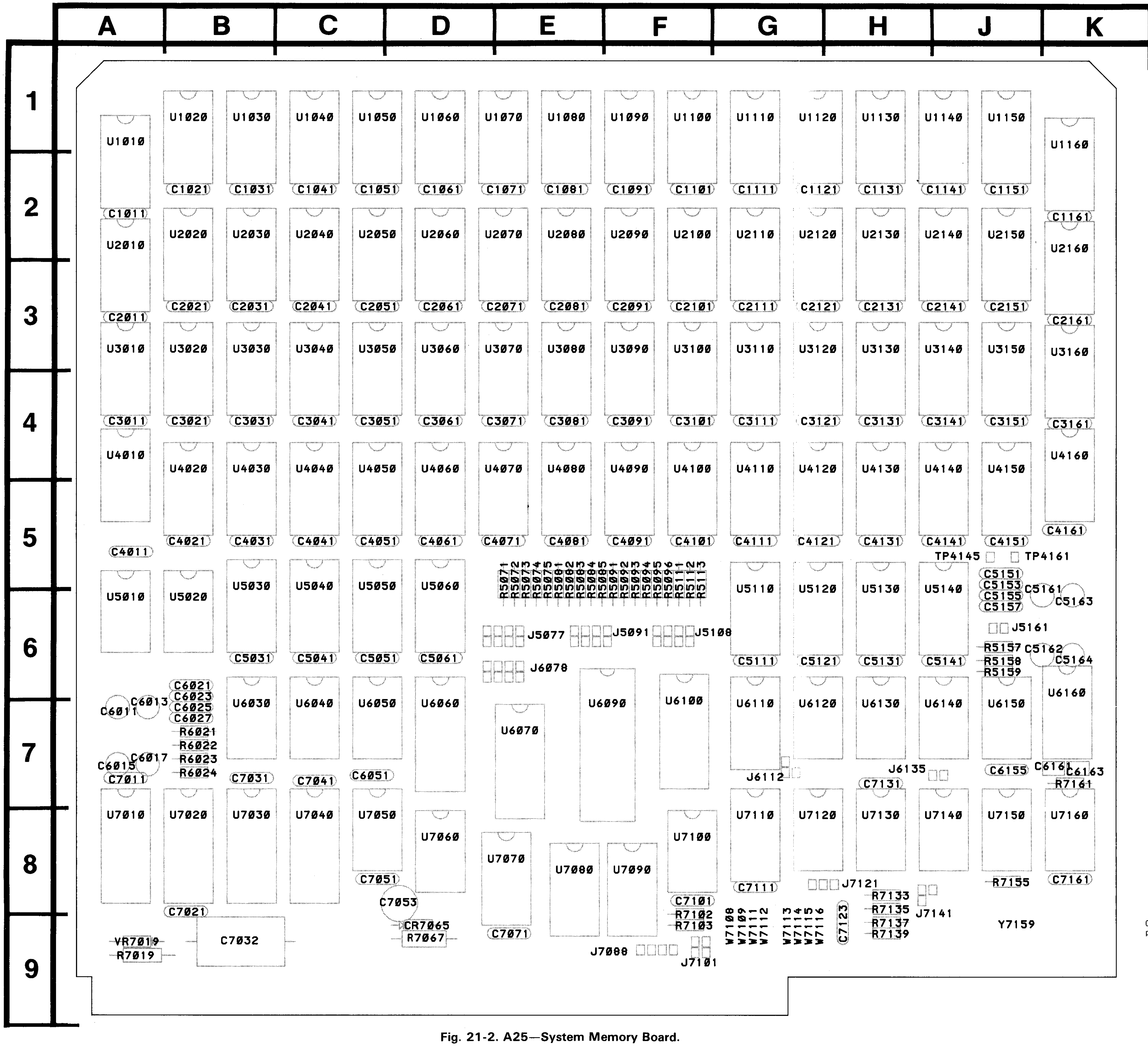
Static Sensitive Devices
See Maintenance Section

NOTE: Table 21-1, shows IC pin-out (VCC & GND).

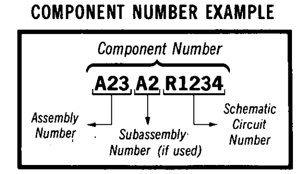
P/O A20 UTILITY BOARD

UTILITY BOARD
INTERRUPT CONTROL

17



COMPONENT NUMBER EXAMPLE



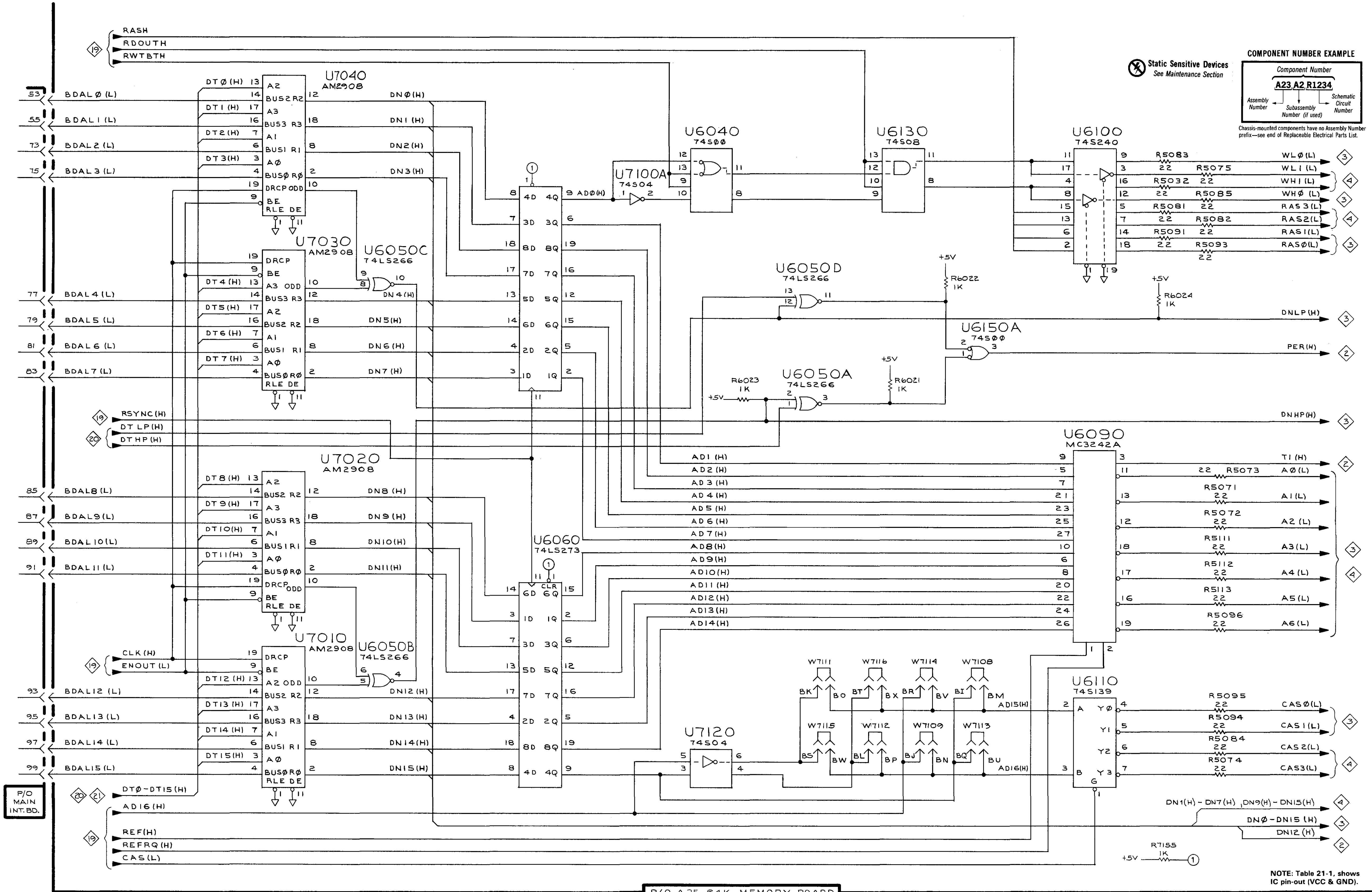
Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List.

Static Sensitive Devices
See Maintenance Section

12581-128

Fig. 21-2. A25—System Memory Board.

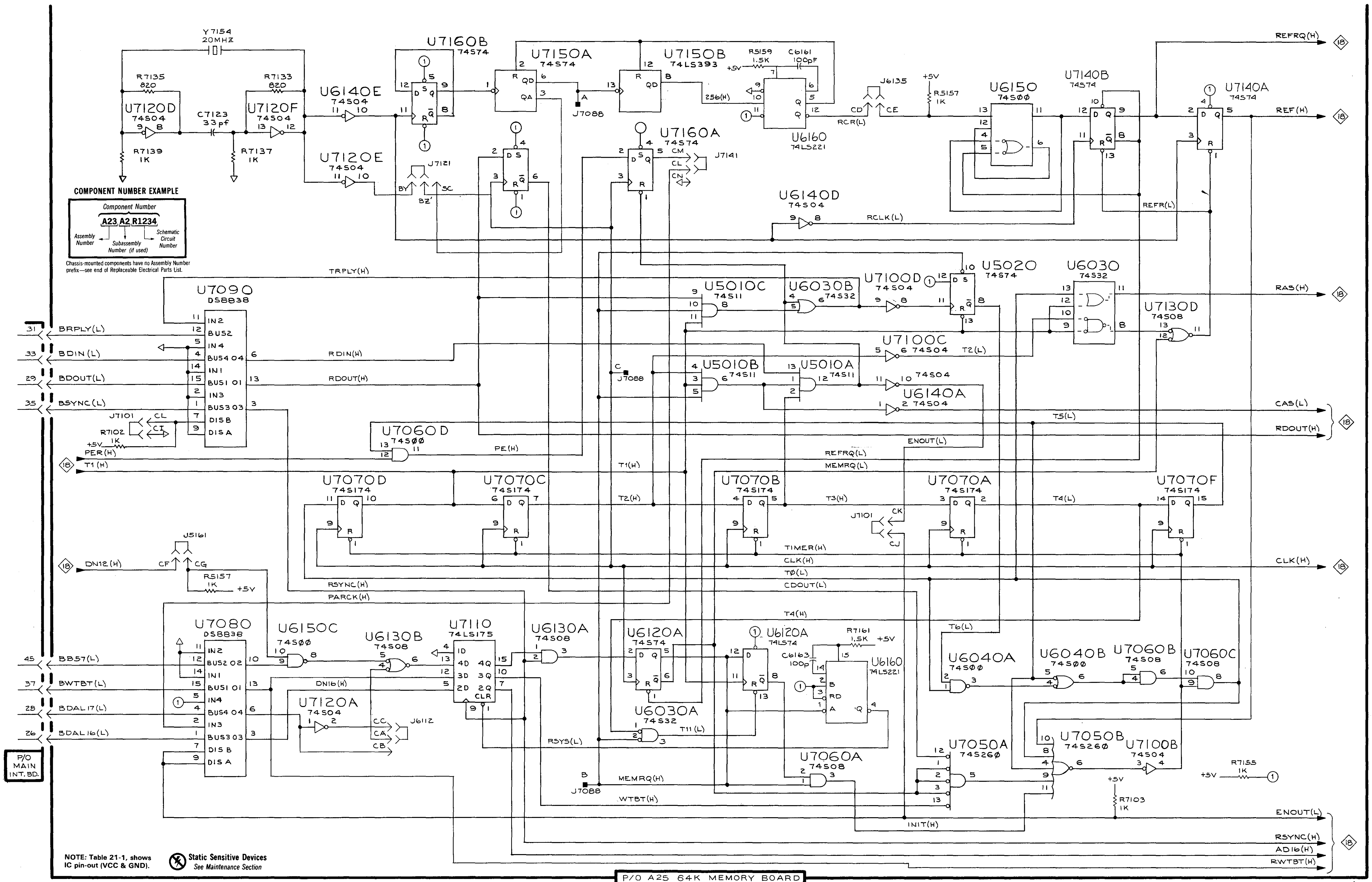
@



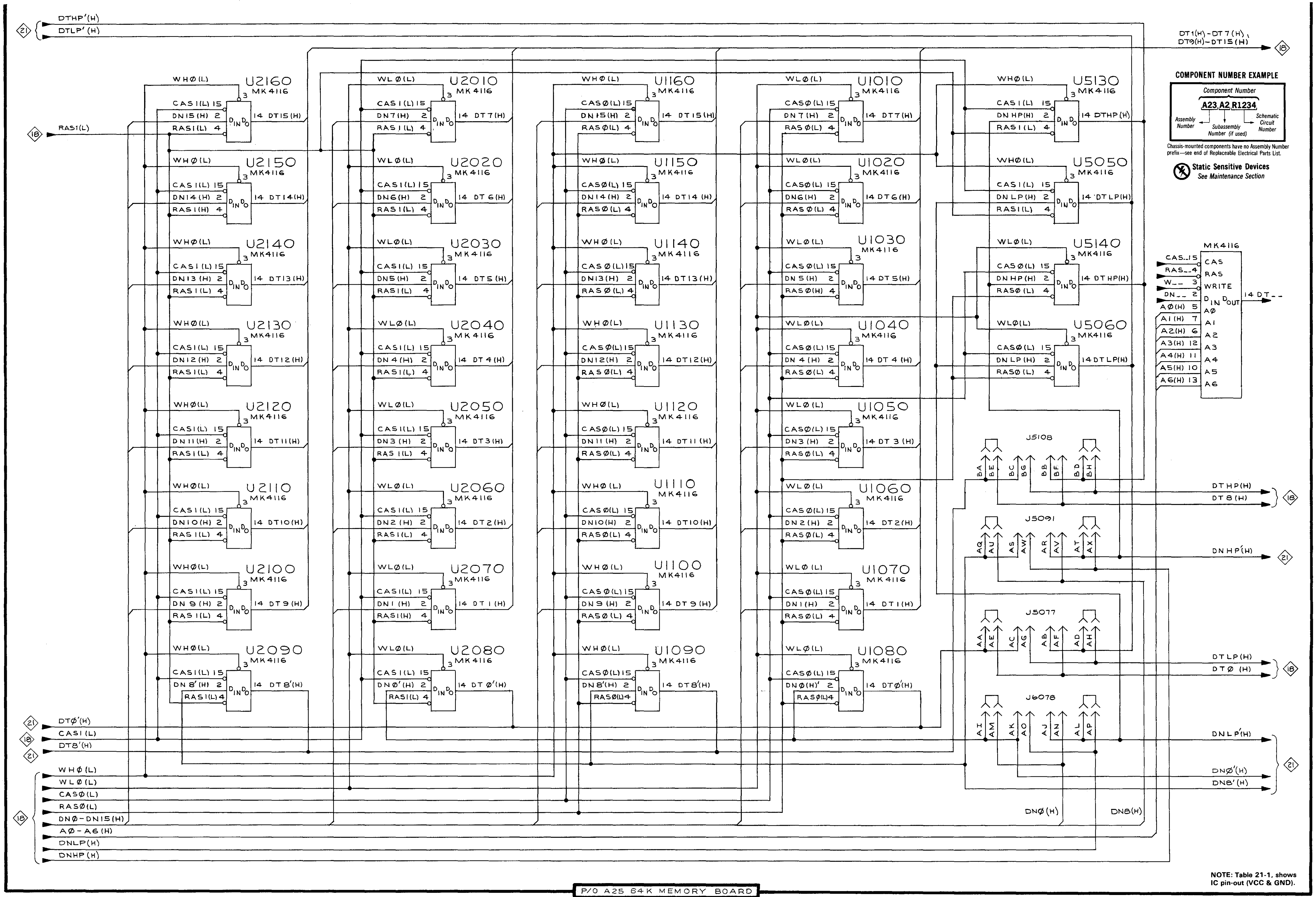
MEMORY BOARD BUS INTERFACE CIRCUITS

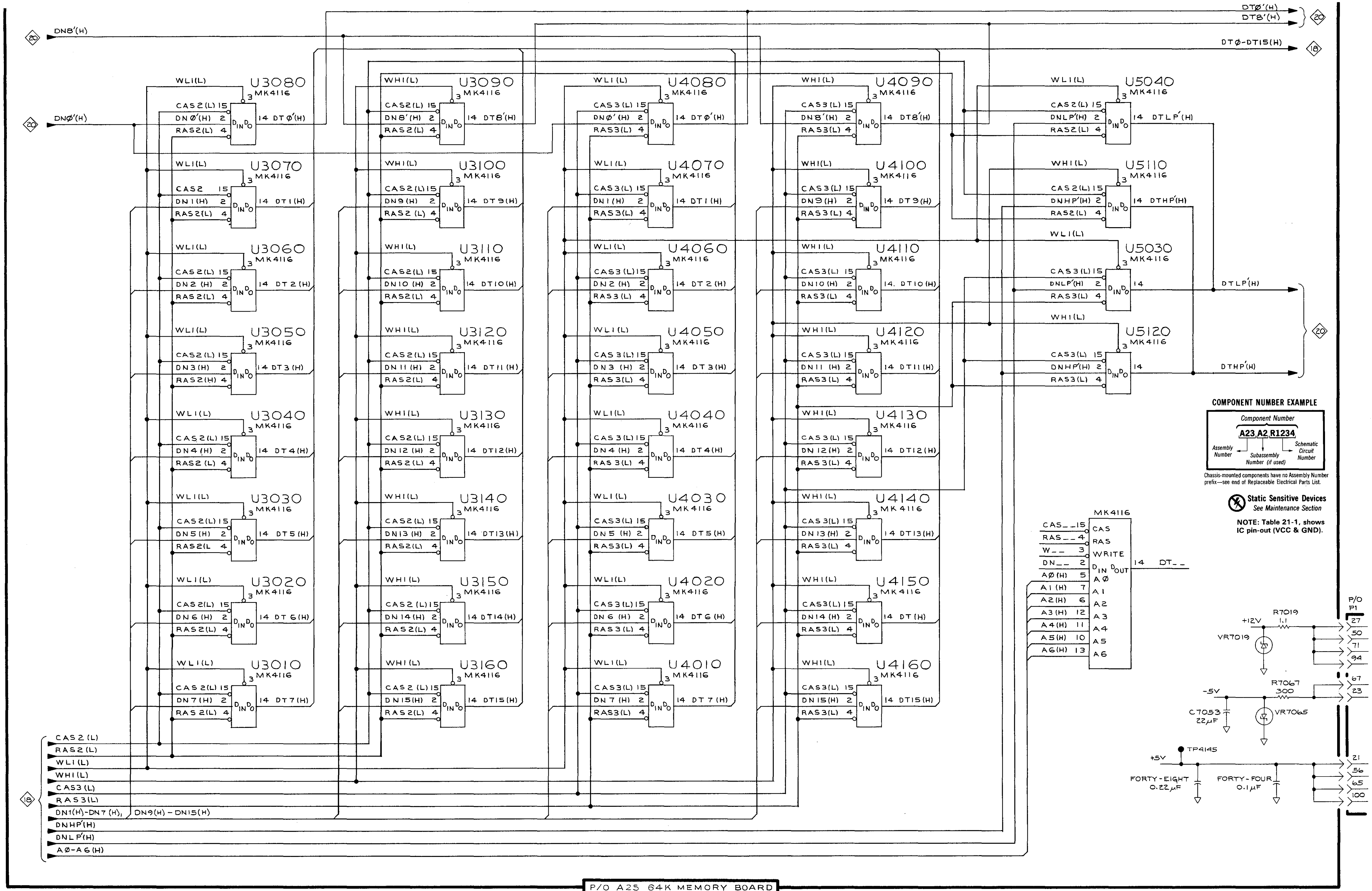
18

@ 12581-18



RAM BOARD TIMING AND CONTROL


DTHP'(H)
DTLP'(H)
DT1(H)-DT7(H), DT9(H)-DT15(H)
RAS1(L)
U2160 MK4116
U2150 MK4116
U2140 MK4116
U2130 MK4116
U2120 MK4116
U2110 MK4116
U2100 MK4116
U2090 MK4116
U2010 MK4116
U2020 MK4116
U2030 MK4116
U2040 MK4116
U2050 MK4116
U2060 MK4116
U2070 MK4116
U2080 MK4116
U1160 MK4116
U1150 MK4116
U1140 MK4116
U1130 MK4116
U1120 MK4116
U1110 MK4116
U1100 MK4116
U1090 MK4116
U1010 MK4116
U1020 MK4116
U1030 MK4116
U1040 MK4116
U1050 MK4116
U1060 MK4116
U1070 MK4116
U1080 MK4116
U5130 MK4116
U5050 MK4116
U5140 MK4116
U5060 MK4116
COMPONENT NUMBER EXAMPLE
Component Number
A23 A2 R1234
Assembly Number
Subassembly Number (if used)
Schematic Circuit Number
Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List.
Static Sensitive Devices
See Maintenance Section
MK4116
CAS
RAS
WRITE
D_{IN} D_{OUT}
A0 A1 A2 A3 A4 A5 A6
J5108
J5091
J5077
J6078
DTHP(H)
DT8(H)
DNHP'(H)
DTLP(H)
DT0(H)
DNLP'(H)
DN0'(H)
DN8'(H)
DN0(H)
DN8(H)
DT0'(H)
CAS1(L)
DT8'(H)
WH0(L)
WL0(L)
CAS0(L)
RAS0(L)
DN0-DN15(H)
A0-A6(H)
DNLP(H)
DNHP(H)
NOTE: Table 21-1, shows IC pin-out (VCC & GND).
P/O A25 64K MEMORY BOARD



RAM BOARD UPPER TWO BANKS

21

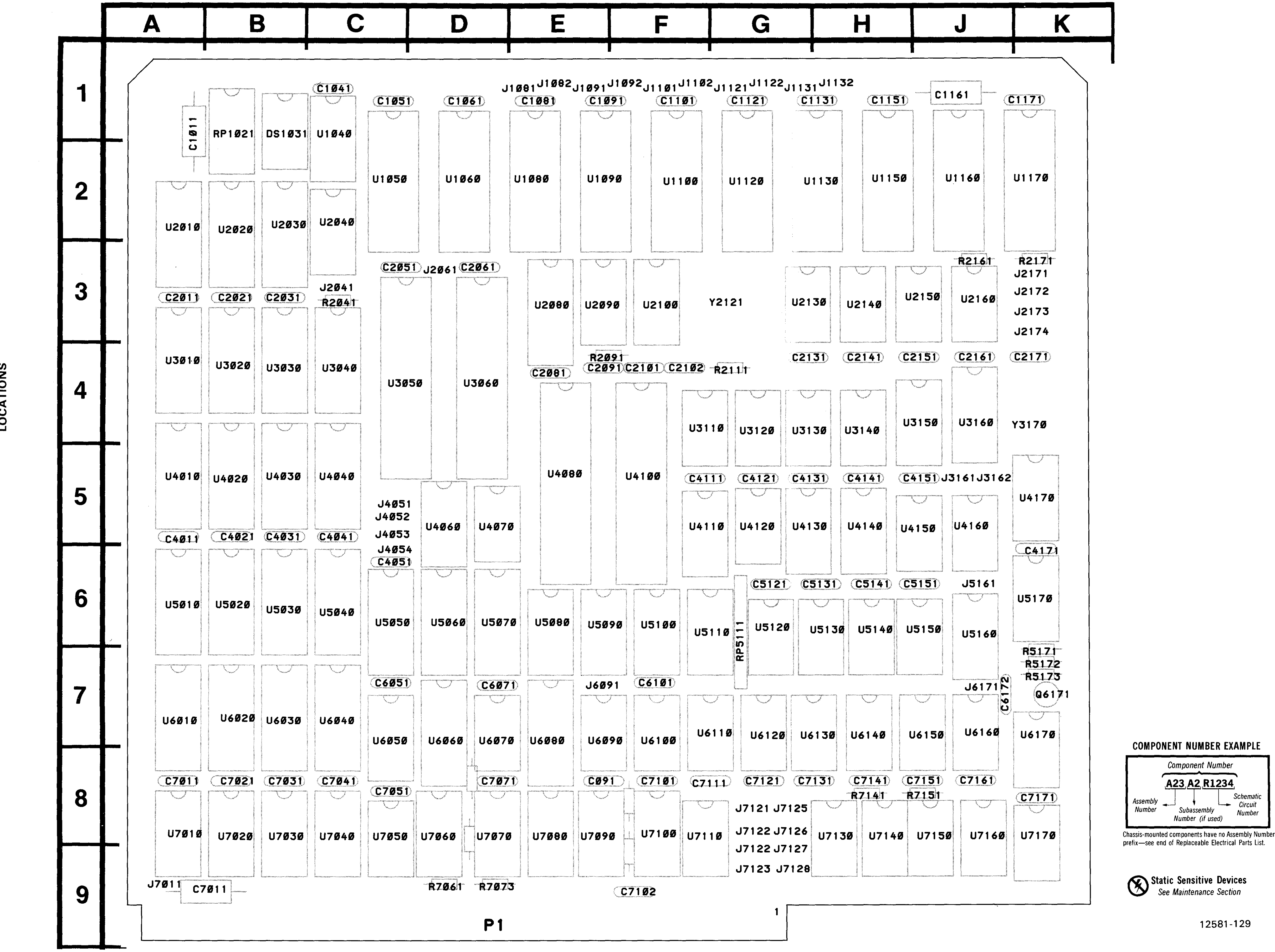
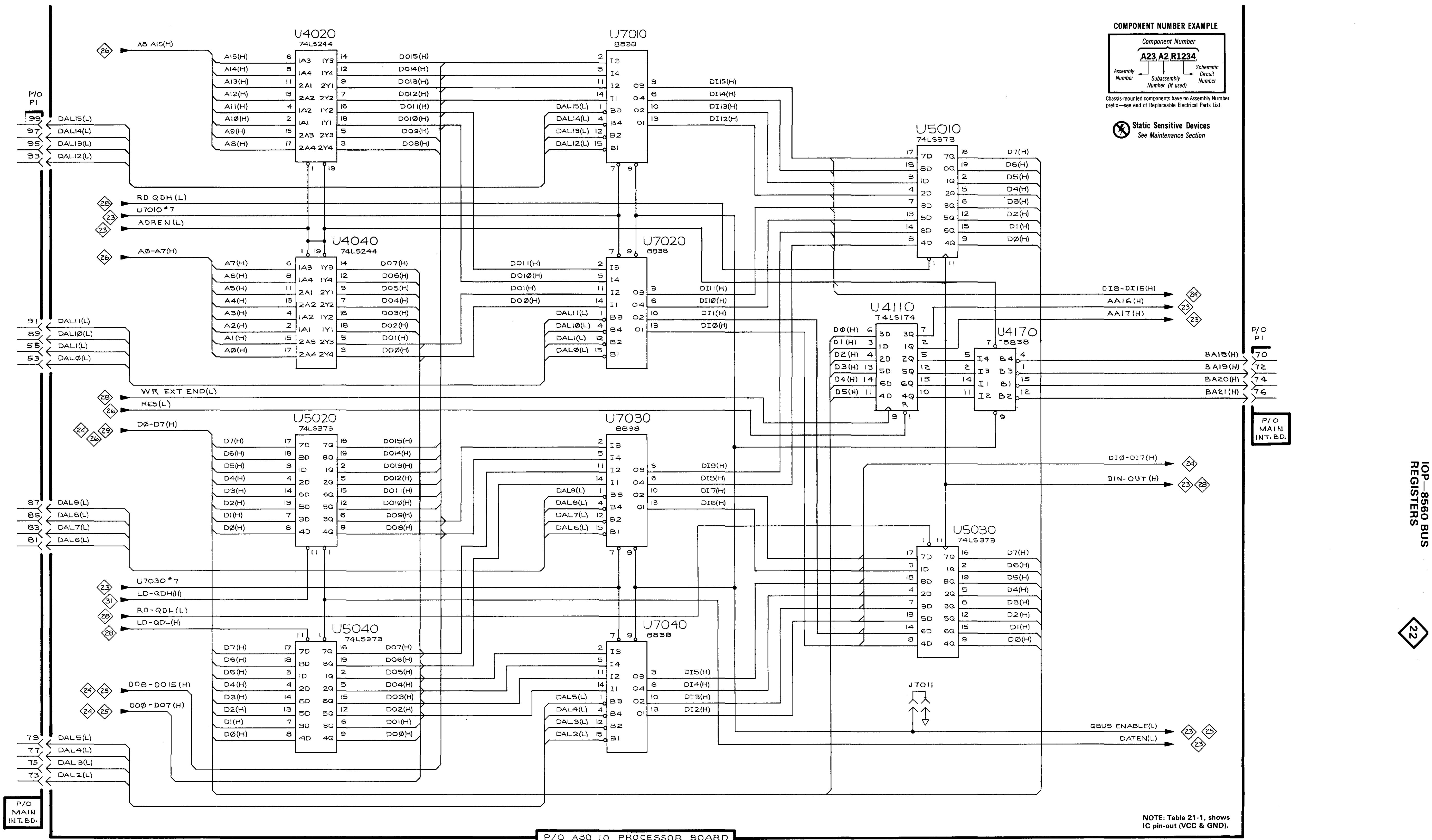
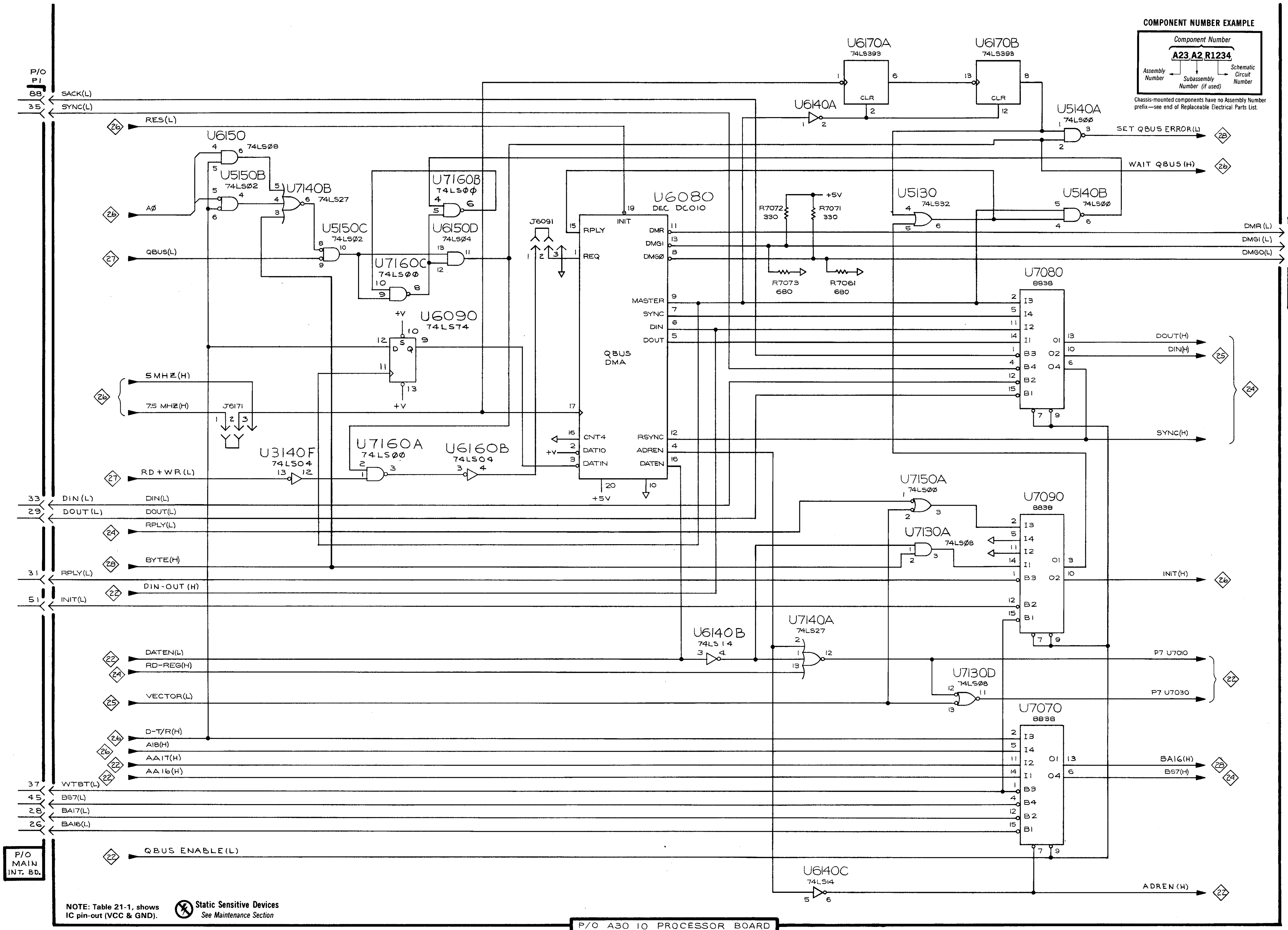


Fig. 21-3. A30—I/O Processor Board.


U4020
74LS244
U7010
8838
U4040
74LS244
U7020
8838
U5020
74LS373
U7030
8838
U5040
74LS373
U7040
8838
U5010
74LS373
U4110
74LS174
U4170
8838
U5030
74LS373
JT011
A8-A15(H)
A0-A7(H)
RD QDH(L)
U7010*7
ADREN(L)
WR EXT END(L)
RES(L)
D0-D7(H)
U7030*7
LD-QDH(H)
RD-QDL(L)
LD-QDL(H)
DO8-DO15(H)
DO0-DO7(H)
DI8-DI15(H)
AA16(H)
AA17(H)
BA18(H)
BA19(H)
BA20(H)
BA21(H)
DI0-DI7(H)
DIN-OUT(H)
QBUS ENABLE(L)
DATEN(L)
P/O P1
P/O MAIN INT.BD.
COMPONENT NUMBER EXAMPLE
Component Number
A23 A2 R1234
Assembly Number
Subassembly Number (if used)
Schematic Circuit Number
Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List.
Static Sensitive Devices
See Maintenance Section
NOTE: Table 21-1, shows IC pin-out (VCC & GND).
P/O A30 IO PROCESSOR BOARD
@ 12581-22
IOP—8560 BUS REGISTERS



NOTE: Table 21-1, shows IC pin-out (VCC & GND).

P/O A30 IO PROCESSOR BOARD

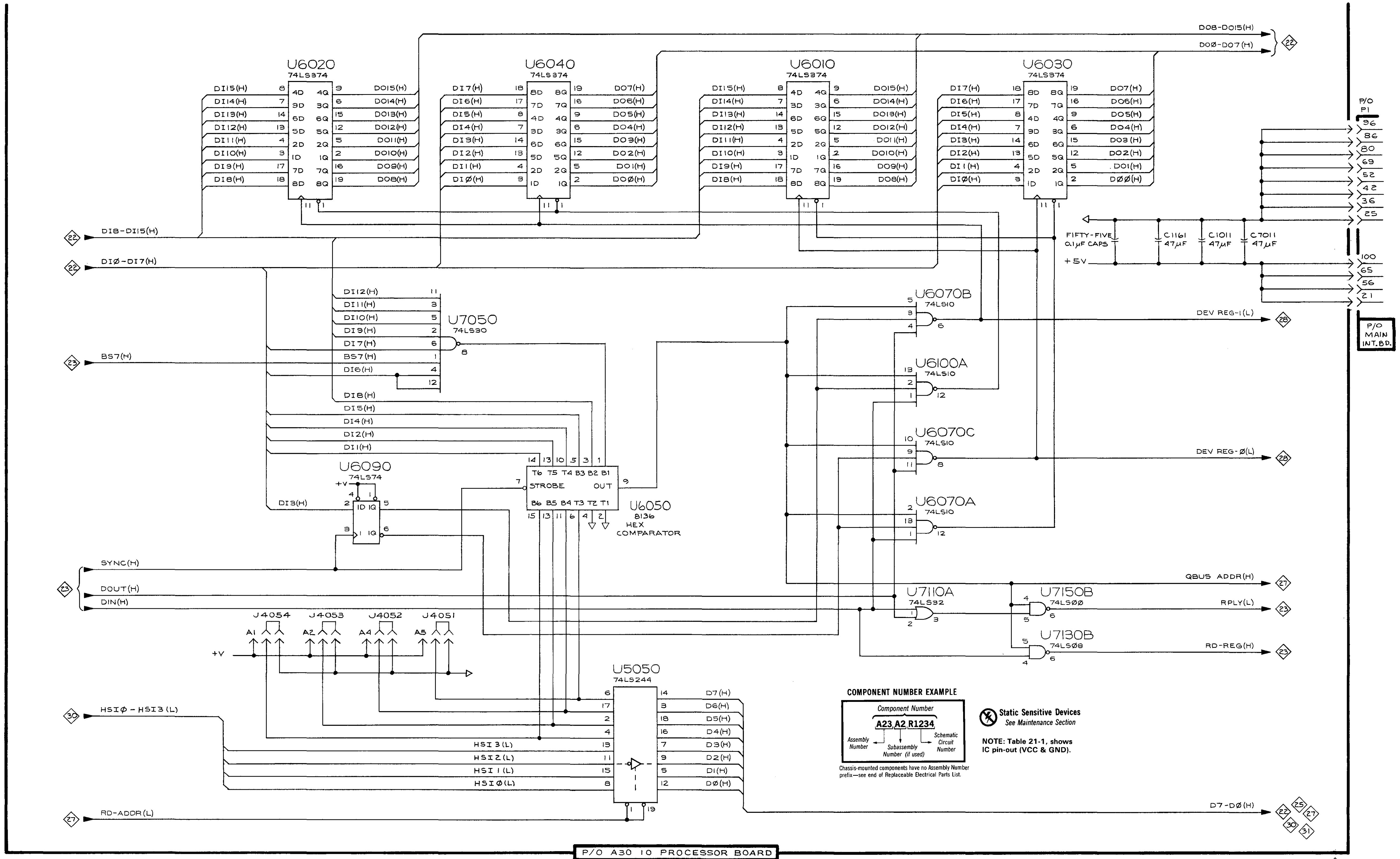
@ 12581-23

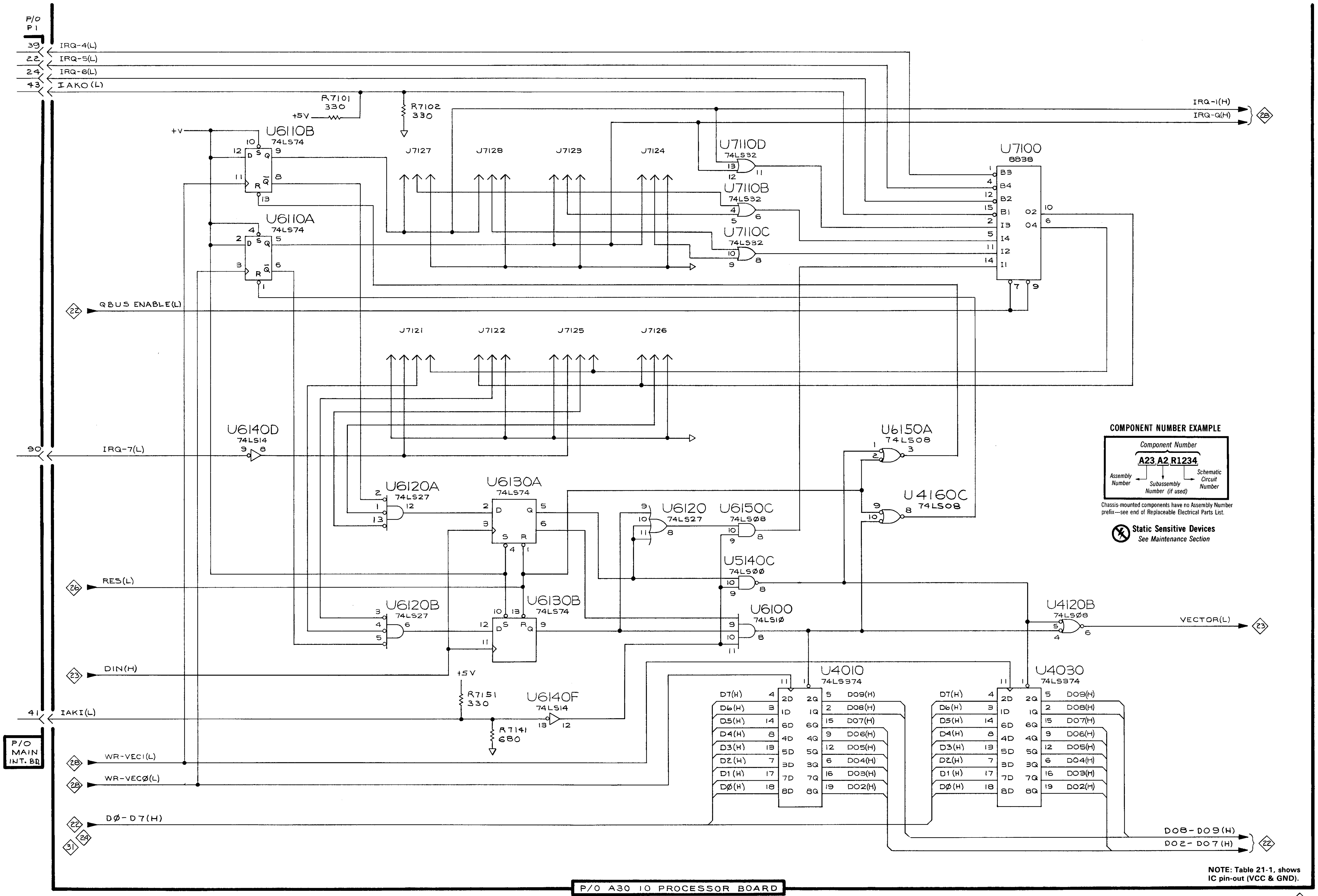
8560 BUS DMA ACCESS CONTROL (23)

IOP DMA ACCESS CONTROL

Table 21-3
Fifty-Five 0.1 μF
Decoupling Capacitors

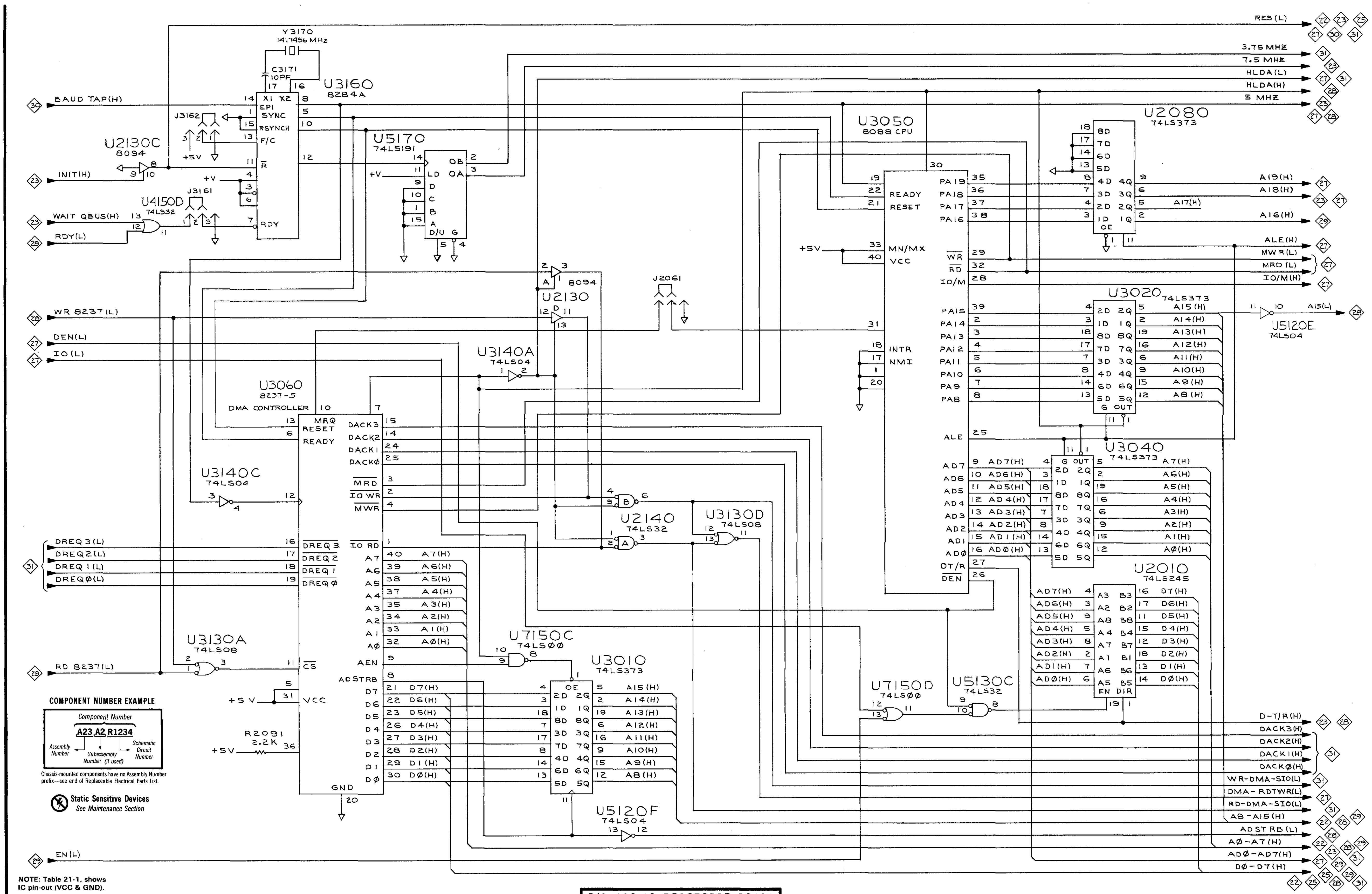
C1041	C2141	C5151
C1051	C2151	C6051
C1061	C2161	C6071
C1081	C2171	C6101
C1091	C4011	C7011
C1101	C4021	C7021
C1121	C4031	C7031
C1131	C4041	C7041
C1151	C4051	C7051
C1171	C4111	C7071
C2011	C4121	C7091
C2021	C4131	C7101
C2031	C4141	C7111
C2051	C4151	C7121
C2061	C4171	C7131
C2081	C5121	C7141
C2091	C5131	C7151
C2131	C5141	C7161



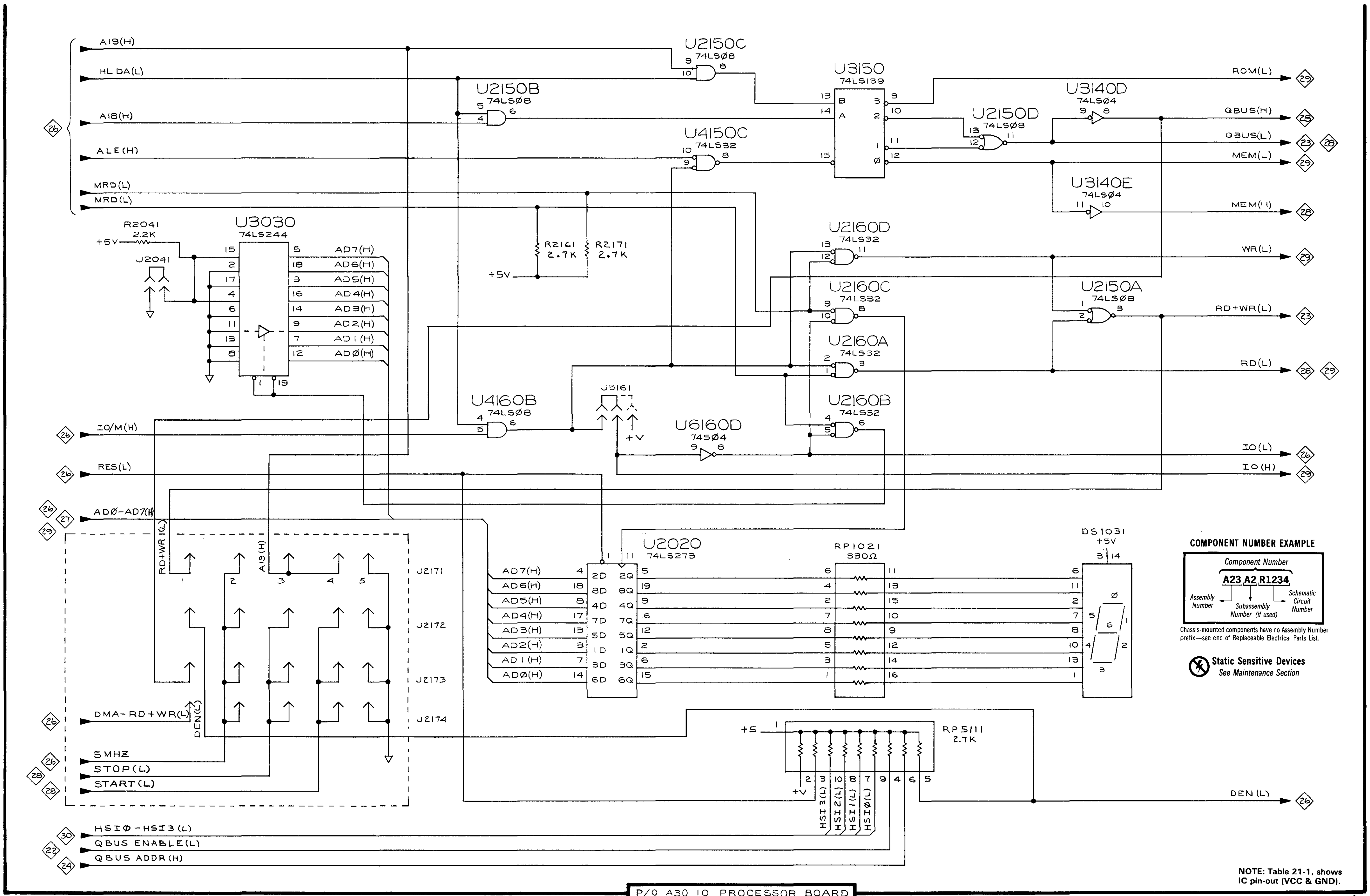


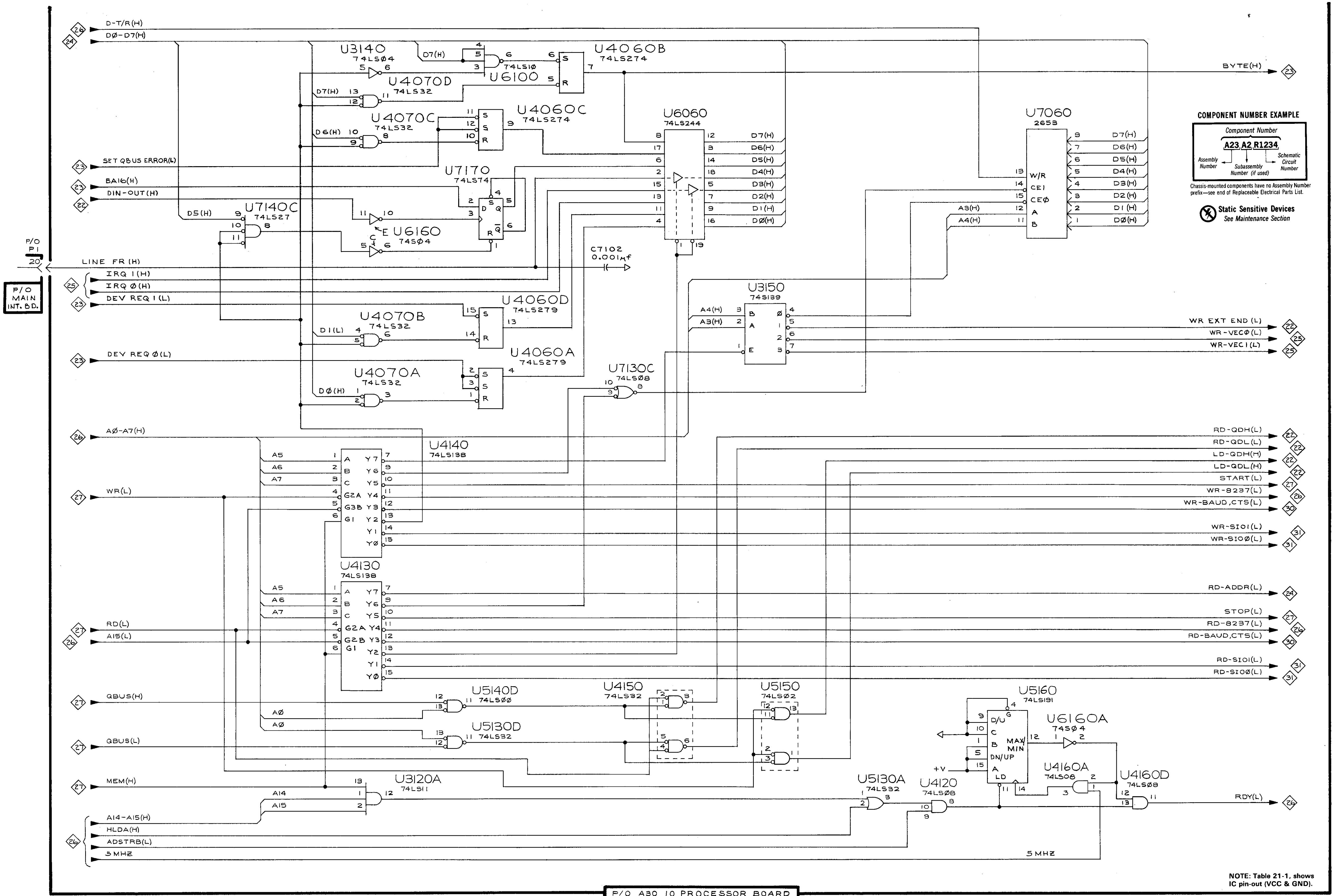
IOP INTERRUPT VECTOR LOGIC

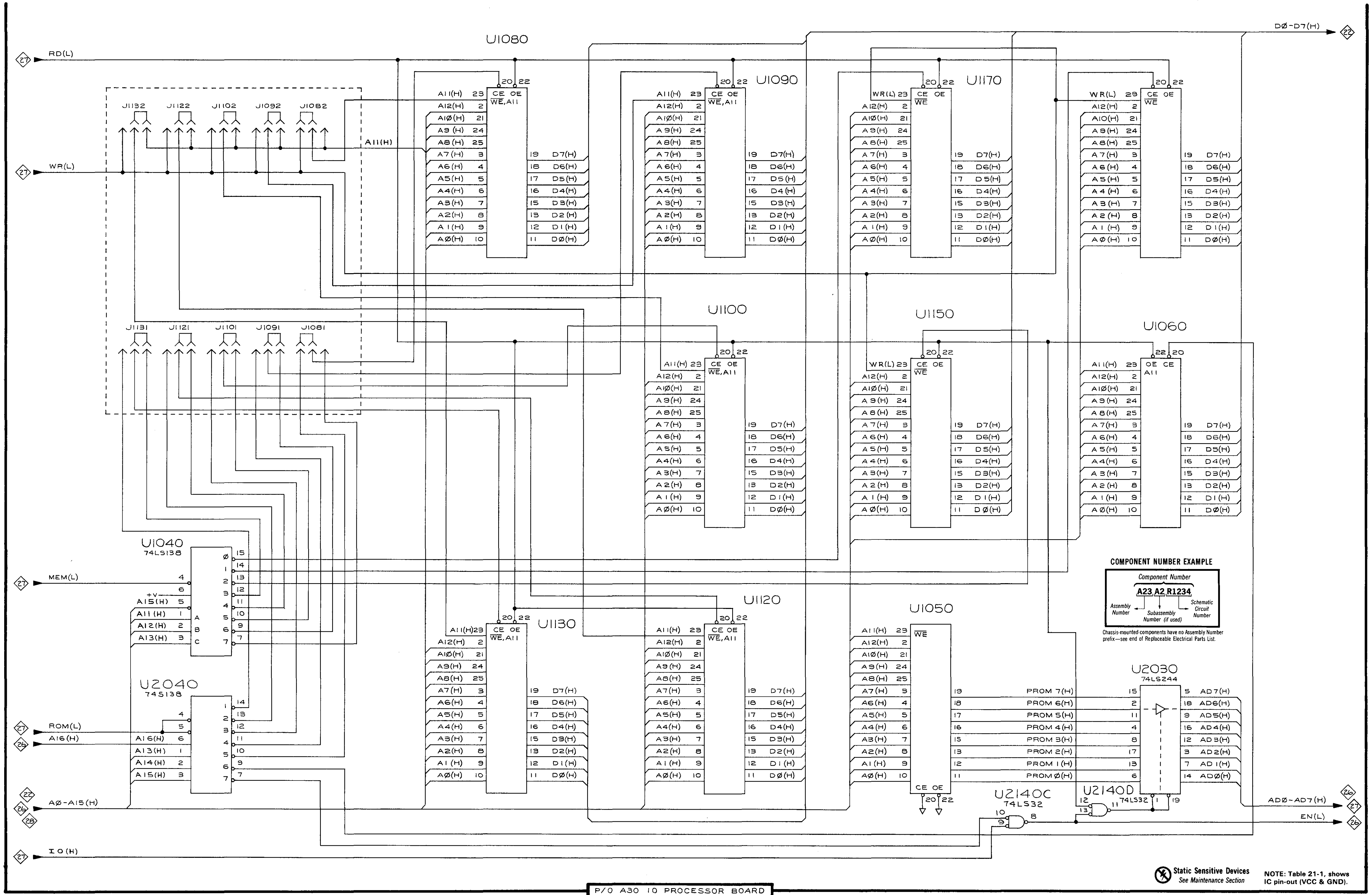
25

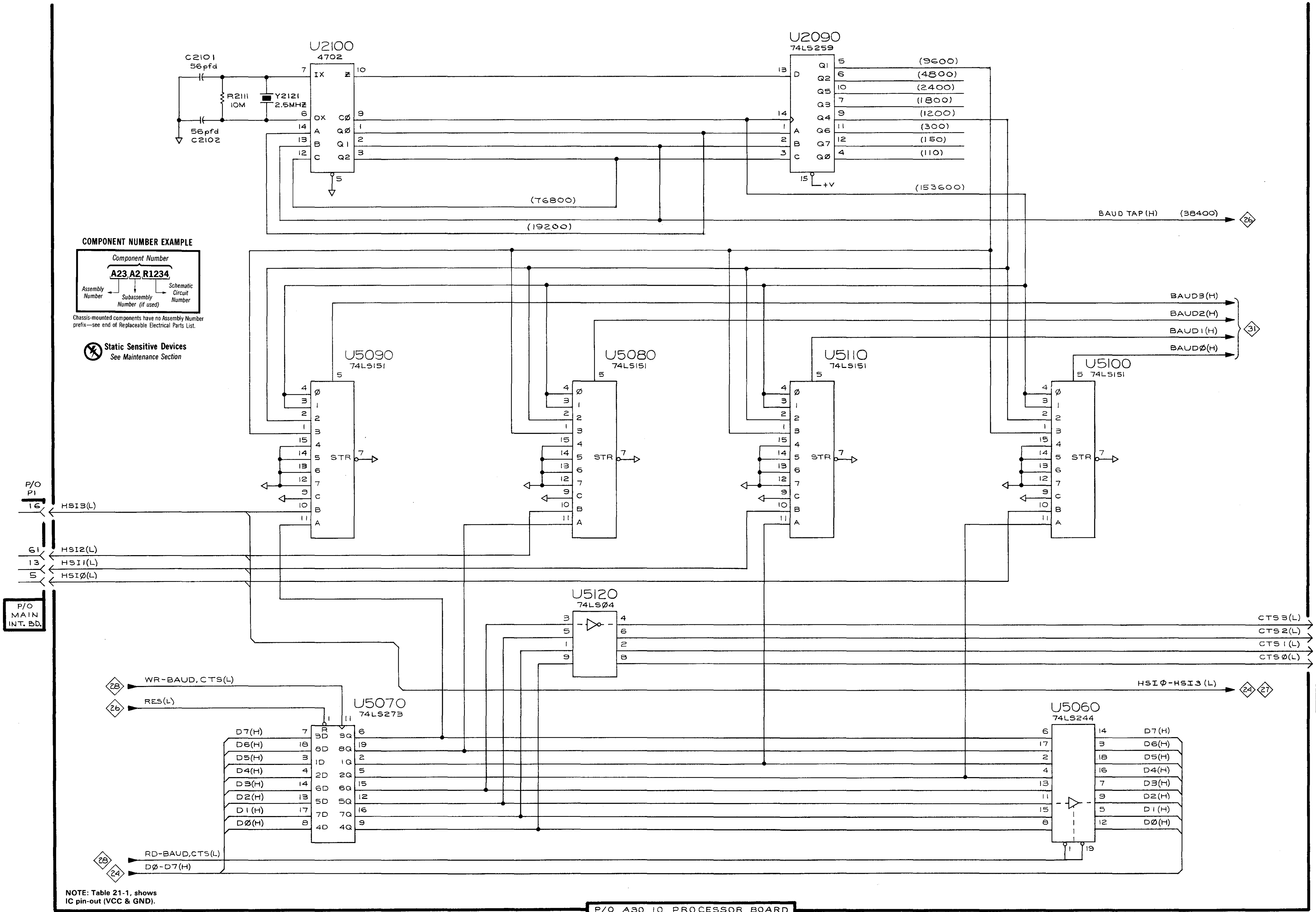


P/O A30 IO PROCESSOR BOARD


A19(H)
HL DA(L)
A18(H)
ALE(H)
MRD(L)
MRD(L)
R2041
2.2K
+5V
J2041
U3030
74LS244
AD7(H)
AD6(H)
AD5(H)
AD4(H)
AD3(H)
AD2(H)
AD1(H)
ADØ(H)
U2150C
74LSØ8
U2150B
74LSØ8
U4150C
74LS32
U3150
74LS139
U3140D
74LSØ4
U2150D
74LSØ8
U3140E
74LSØ4
ROM(L)
QBUS(H)
QBUS(L)
MEM(L)
MEM(H)
R2161
2.7K
R2171
2.7K
+5V
U2160D
74LS32
WR(L)
U2160C
74LS32
U2150A
74LSØ8
RD+WR(L)
U2160A
74LS32
RD(L)
U4160B
74LSØ8
J5161
U6160D
74SØ4
U2160B
74LS32
IO/M(H)
IO(L)
RES(L)
IO(H)
ADØ-AD7(H)
RD+WR(L)
A19(H)
J2171
J2172
J2173
J2174
DMA-RD+WR(L)
DEN(L)
5MHZ
STOP(L)
START(L)
U2020
74LS273
RP1021
330Ω
DS1031
+5V
+5
RP5111
2.7K
HSI3(L)
HSI2(L)
HSI1(L)
HSIØ(L)
DEN(L)
HSIØ-HSI3(L)
QBUS ENABLE(L)
QBUS ADDR(H)
COMPONENT NUMBER EXAMPLE
Component Number
A23 A2 R1234
Assembly Number
Subassembly Number (if used)
Schematic Circuit Number
Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List.
Static Sensitive Devices
See Maintenance Section
NOTE: Table 21-1, shows IC pin-out (VCC & GND).
P/O A30 IO PROCESSOR BOARD

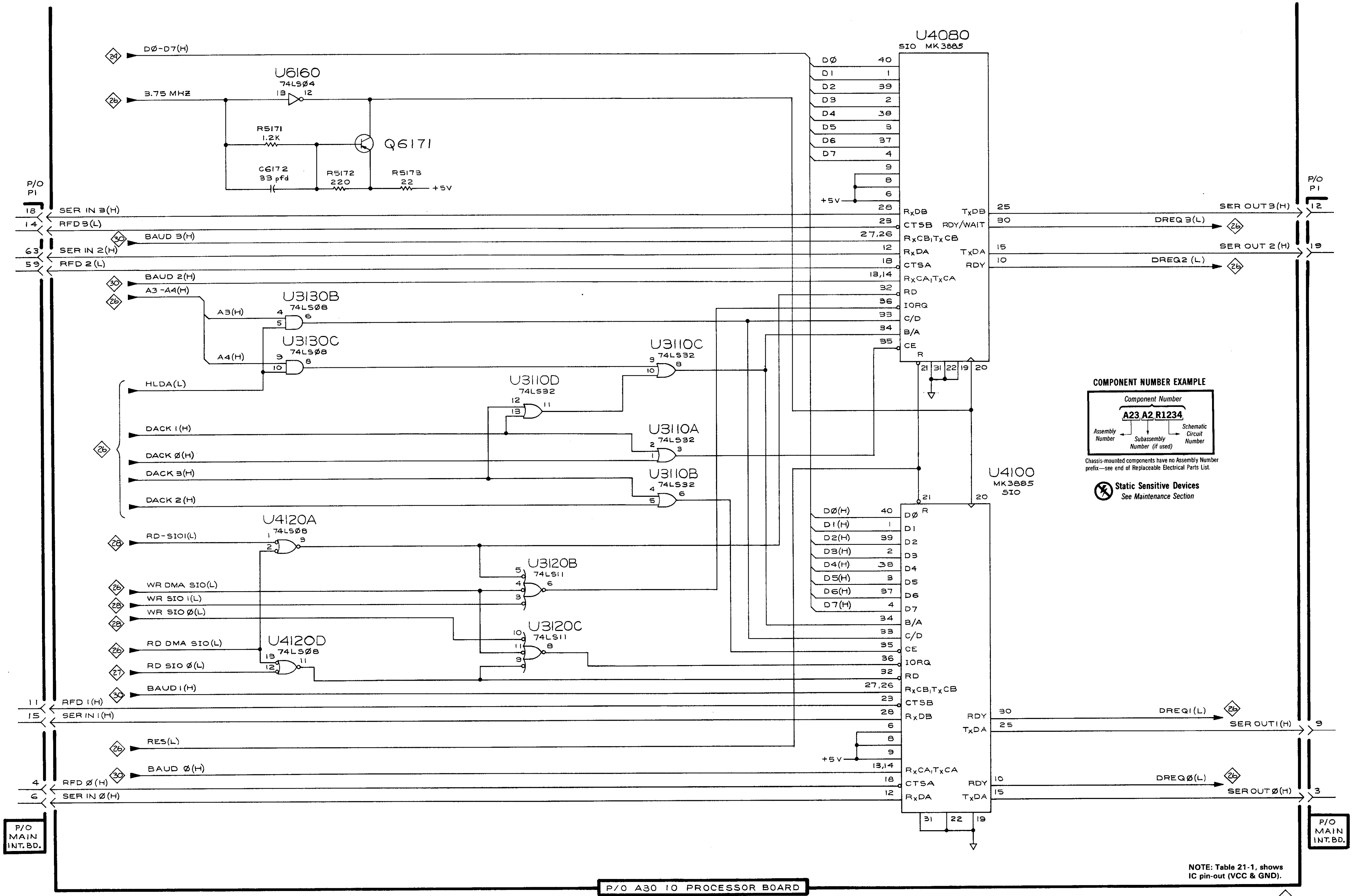

D-T/R(H)
DØ-D7(H)
U3140
74LSØ4
U4060B
74LS274
U6100
74LS10
U4070D
74LS32
U4070C
74LS32
U4060C
74LS274
U6060
74LS244
U7060
2653
BYTE(H)
SET QBUS ERROR(L)
BA16(H)
DIN-OUT(H)
U7170
74LS74
U7140C
74LS27
U6160
74SØ4
D5(H)
P/O
P1
20
LINE FR (H)
C7102
0.001μf
IRQ 1(H)
IRQ Ø(H)
DEV REQ 1 (L)
P/O
MAIN
INT. BD.
U4070B
74LS32
U4060D
74LS279
U3150
74S139
DEV REQ Ø(L)
U4070A
74LS32
U4060A
74LS279
U7130C
74LSØ8
WR EXT END (L)
WR-VECØ(L)
WR-VEC1(L)
AØ-A7(H)
U4140
74LS138
RD-QDH(L)
RD-QDL(L)
LD-QDH(H)
LD-QDL(H)
START(L)
WR(L)
WR-8237(L)
WR-BAUD,CTS(L)
WR-SIO1(L)
WR-SIOØ(L)
U4130
74LS138
RD-ADDR(L)
STOP(L)
RD(L)
A15(L)
RD-8237(L)
RD-BAUD,CTS(L)
RD-SIO1(L)
RD-SIOØ(L)
QBUS(H)
U5140D
74LSØØ
U4150
74LS32
U5150
74LSØ2
U5160
74LS191
QBUS(L)
U5130D
74LS32
U6160A
74SØ4
MEM(H)
U3120A
74LS11
U5130A
74LS32
U4120
74LSØ8
U4160A
74LSØ8
U4160D
74LSØ8
RDY(L)
A14-A15(H)
HLDA(H)
ADSTRB(L)
5MHZ
COMPONENT NUMBER EXAMPLE
Component Number
A23 A2 R1234
Assembly Number
Subassembly Number (if used)
Schematic Circuit Number
Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List.
Static Sensitive Devices
See Maintenance Section
NOTE: Table 21-1, shows IC pin-out (VCC & GND).
P/O A30 IO PROCESSOR BOARD


U1080
U1090
U1170
U1100
U1150
U1060
U1120
U1130
U1050
U1040
74LS138
U2040
74S138
U2030
74LS244
U2140C
74LS32
U2140D
74LS32
J1132 J1122 J1102 J1092 J1082
J1131 J1121 J1101 J1091 J1081
RD(L)
WR(L)
MEM(L)
ROM(L)
A16(H)
AØ-A15(H)
IO(H)
DØ-D7(H)
ADØ-AD7(H)
EN(L)
A11(H)
PROM 7(H)
PROM 6(H)
PROM 5(H)
PROM 4(H)
PROM 3(H)
PROM 2(H)
PROM 1(H)
PROM Ø(H)
COMPONENT NUMBER EXAMPLE
Component Number
A23 A2 R1234
Assembly Number
Subassembly Number (if used)
Schematic Circuit Number
Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List.
Static Sensitive Devices
See Maintenance Section
NOTE: Table 21-1, shows IC pin-out (VCC & GND).
P/O A30 IO PROCESSOR BOARD



IOP BAUD RATE CONTROL

30



8560 MUSDU SERVICE

@ 12581-31

SERIAL INTERFACE LOGIC 31

IOP SERIAL INTERFACE LOGIC

31

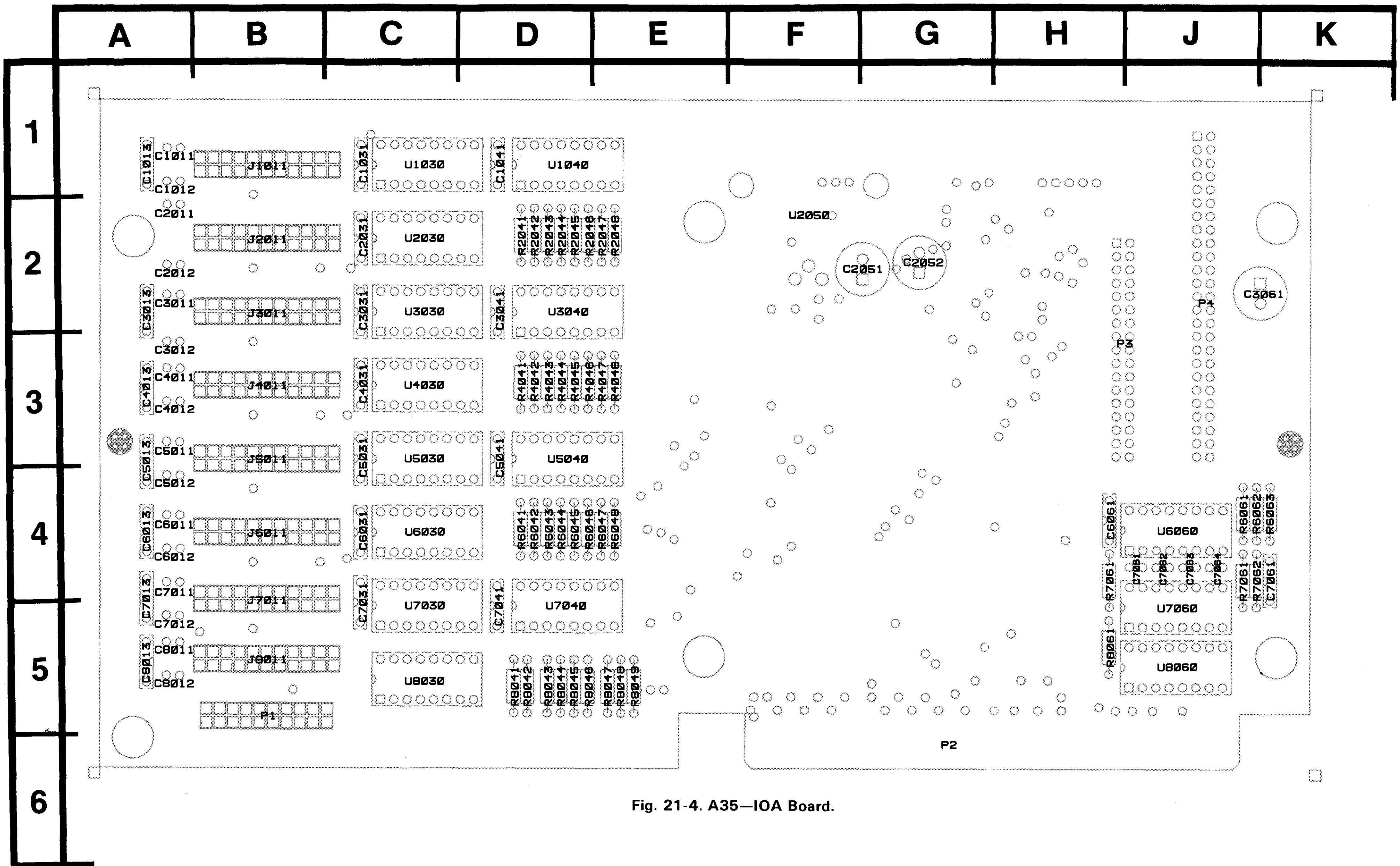
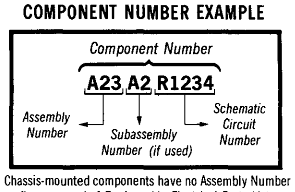


Fig. 21-4. A35—IOA Board.

COMPONENT NUMBER EXAMPLE



Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List.

Static Sensitive Devices
See Maintenance Section

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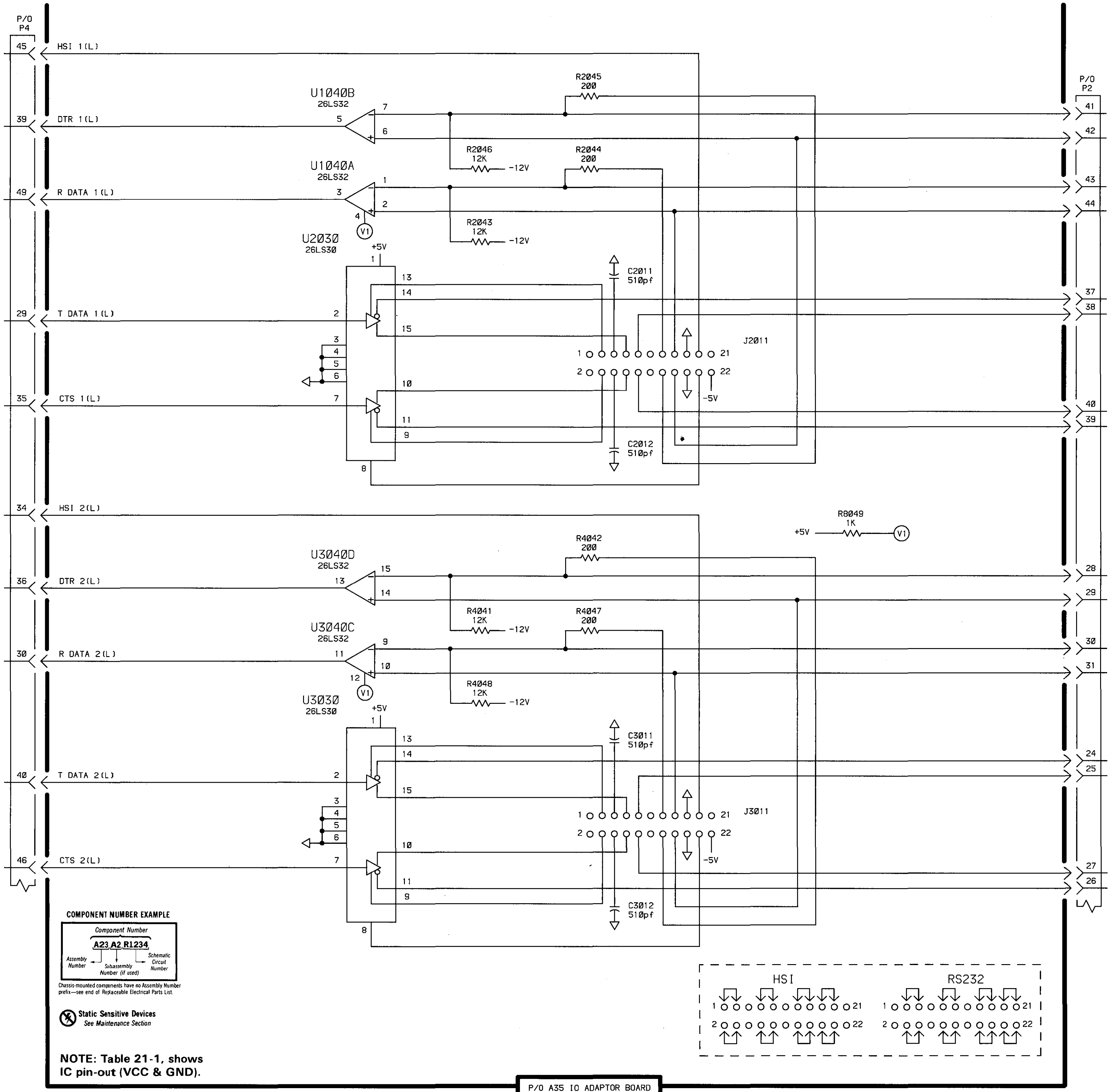
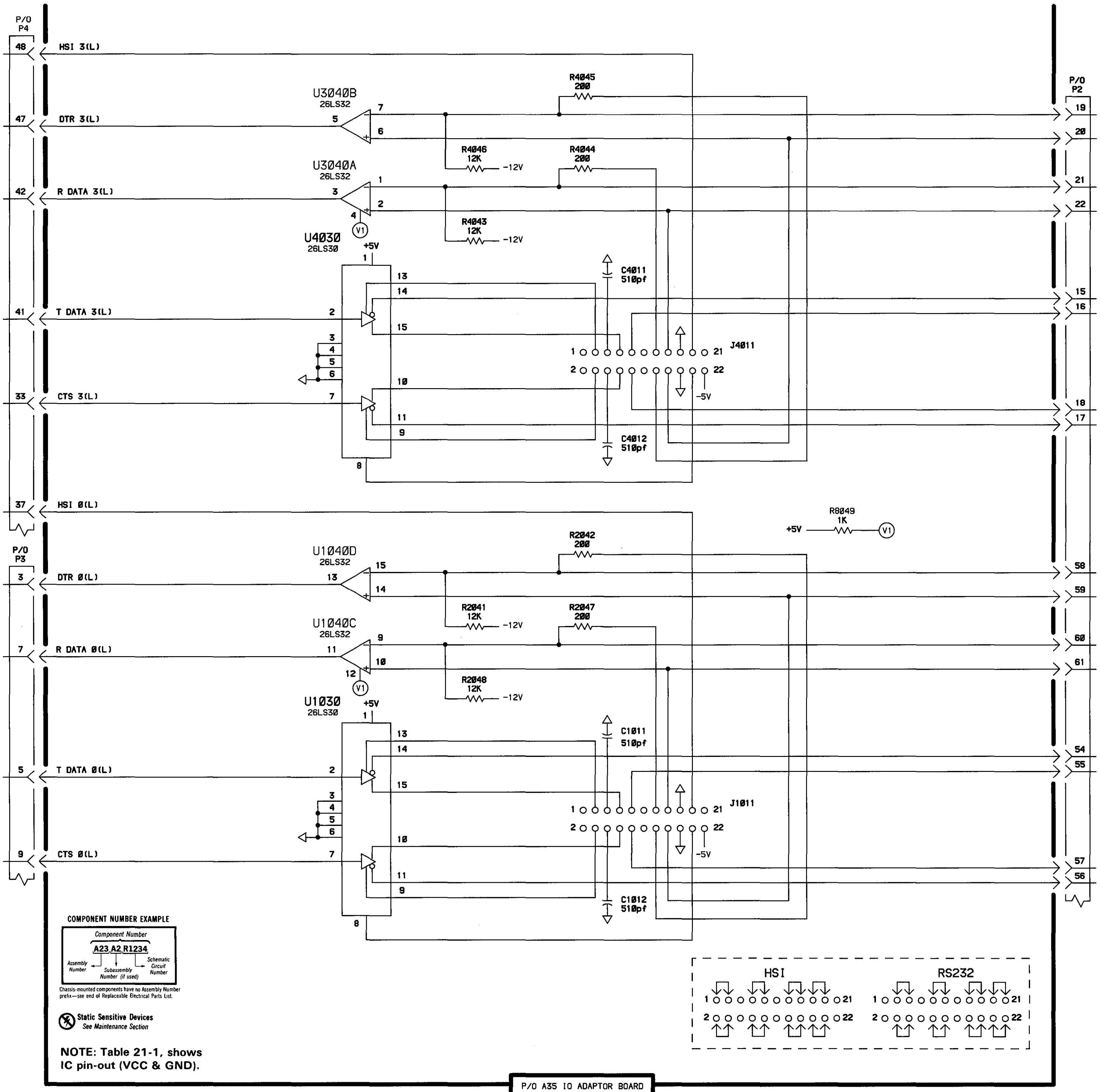
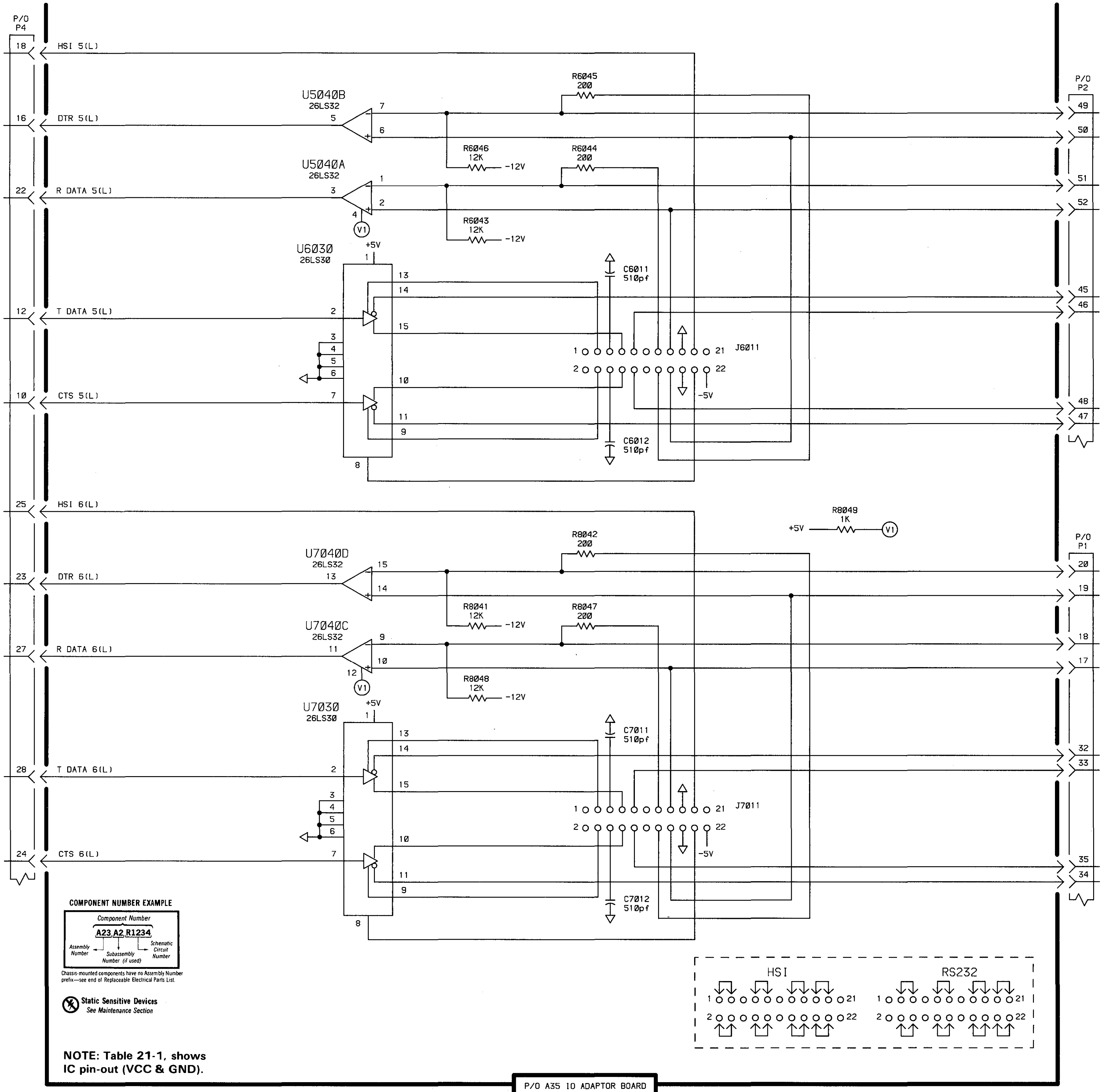
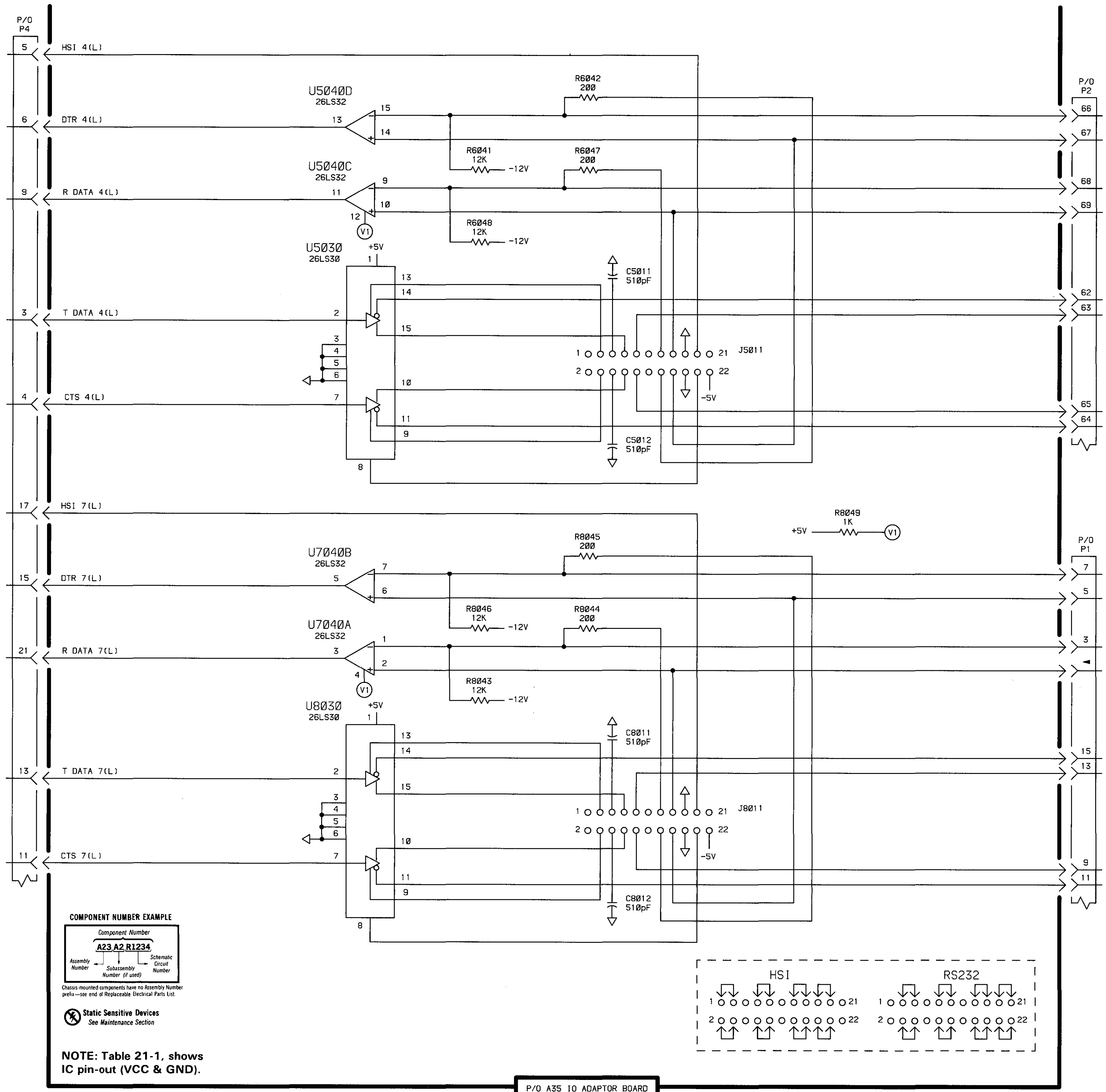


NOTE: Table 21-1, shows IC pin-out (VCC & GND).

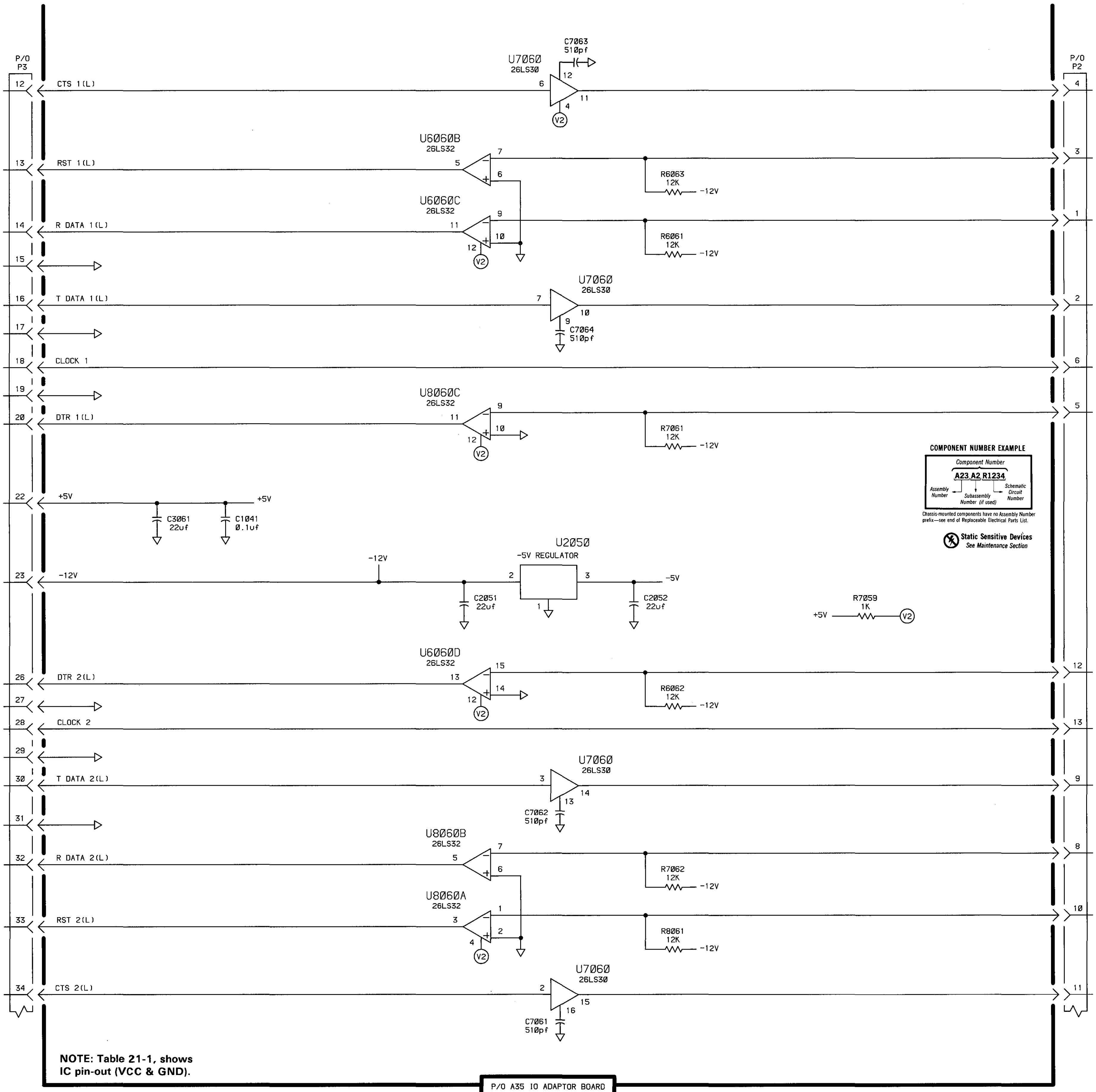


P/O P4
48
HSI 3(L)
47
DTR 3(L)
42
R DATA 3(L)
41
T DATA 3(L)
33
CTS 3(L)
37
HSI Ø(L)
P/O P3
3
DTR Ø(L)
7
R DATA Ø(L)
5
T DATA Ø(L)
9
CTS Ø(L)
U3Ø4ØB
26LS32
U3Ø4ØA
26LS32
U4Ø3Ø
26LS3Ø
U1Ø4ØD
26LS32
U1Ø4ØC
26LS32
U1Ø3Ø
26LS3Ø
+5V
R4Ø45
2ØØ
R4Ø46
12K
R4Ø44
2ØØ
R4Ø43
12K
-12V
C4Ø11
51Øpf
C4Ø12
51Øpf
J4Ø11
-5V
R8Ø49
1K
+5V
V1
R2Ø42
2ØØ
R2Ø41
12K
R2Ø47
2ØØ
R2Ø48
12K
C1Ø11
51Øpf
C1Ø12
51Øpf
J1Ø11
P/O P2
19
20
21
22
15
16
18
17
58
59
60
61
54
55
57
56
HSI
RS232
COMPONENT NUMBER EXAMPLE
Component Number
A23 A2 R1234
Assembly Number
Subassembly Number (if used)
Schematic Circuit Number
Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List.
Static Sensitive Devices
See Maintenance Section
NOTE: Table 21-1, shows IC pin-out (VCC & GND).
P/O A35 IO ADAPTOR BOARD


P/O P4
HSI 5(L)
DTR 5(L)
R DATA 5(L)
T DATA 5(L)
CTS 5(L)
HSI 6(L)
DTR 6(L)
R DATA 6(L)
T DATA 6(L)
CTS 6(L)
U5040B 26LS32
U5040A 26LS32
U6030 26LS30
U7040D 26LS32
U7040C 26LS32
U7030 26LS30
R6045 200
R6046 12K
R6044 200
R6043 12K
R8042 200
R8041 12K
R8047 200
R8048 12K
R8049 1K
+5V
-12V
-5V
C6011 510pf
C6012 510pf
C7011 510pf
C7012 510pf
J6011
J7011
P/O P2
P/O P1
COMPONENT NUMBER EXAMPLE
Component Number
A23 A2 R1234
Assembly Number
Subassembly Number (if used)
Schematic Circuit Number
Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List.
Static Sensitive Devices
See Maintenance Section
NOTE: Table 21-1, shows IC pin-out (VCC & GND).
HSI
RS232
P/O A35 IO ADAPTOR BOARD



NOTE: Table 21-1, shows IC pin-out (VCC & GND).


P/O P3
P/O P2
CTS 1(L)
RST 1(L)
R DATA 1(L)
T DATA 1(L)
CLOCK 1
DTR 1(L)
+5V
-12V
DTR 2(L)
CLOCK 2
T DATA 2(L)
R DATA 2(L)
RST 2(L)
CTS 2(L)
U7060 26LS30
C7063 510pf
U6060B 26LS32
U6060C 26LS32
U6060D 26LS32
U8060C 26LS32
U8060B 26LS32
U8060A 26LS32
R6063 12K
R6061 12K
R7061 12K
R6062 12K
R7062 12K
R8061 12K
C7064 510pf
C7062 510pf
C7061 510pf
C3061 22uf
C1041 0.1uf
U2050
-5V REGULATOR
C2051 22uf
C2052 22uf
-5V
R7059 1K
COMPONENT NUMBER EXAMPLE
Component Number
A23 A2 R1234
Assembly Number
Subassembly Number (if used)
Schematic Circuit Number
Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List.
Static Sensitive Devices
See Maintenance Section
NOTE: Table 21-1, shows IC pin-out (VCC & GND).
P/O A35 IO ADAPTOR BOARD

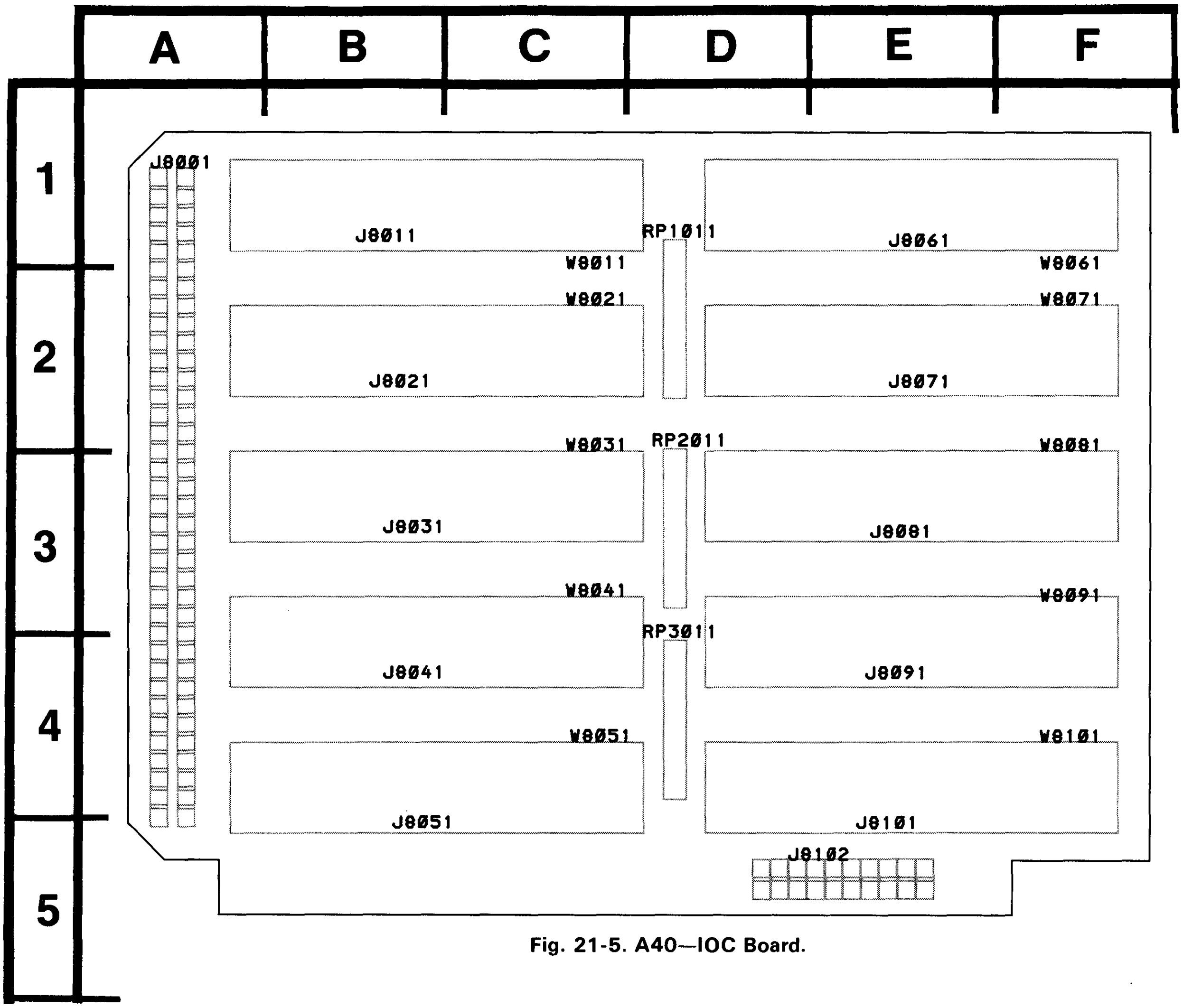
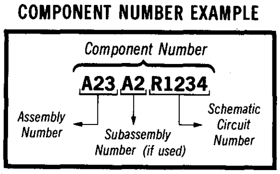


Fig. 21-5. A40—IOC Board.

COMPONENT NUMBER EXAMPLE



Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List.

Static Sensitive Devices
See Maintenance Section

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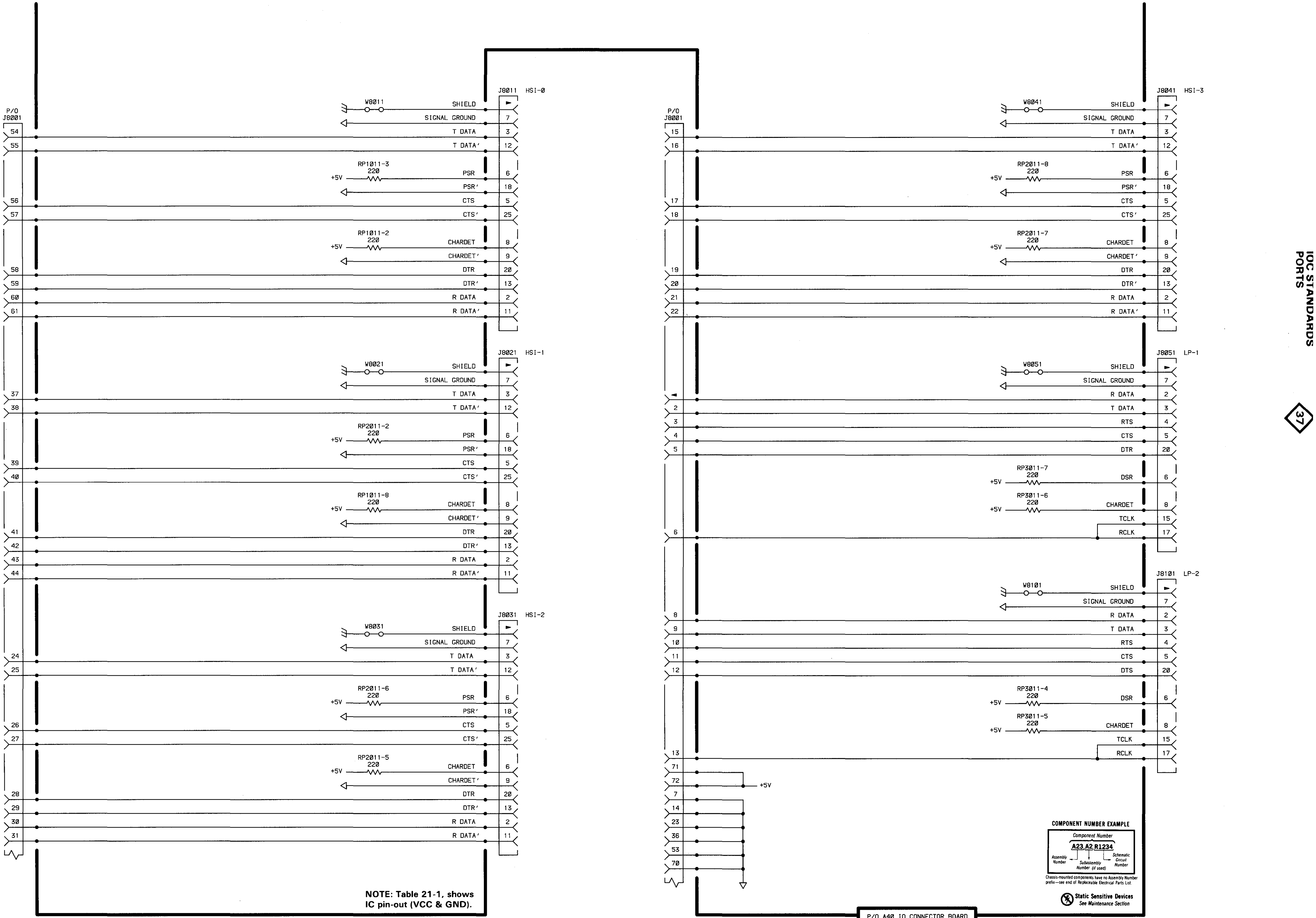
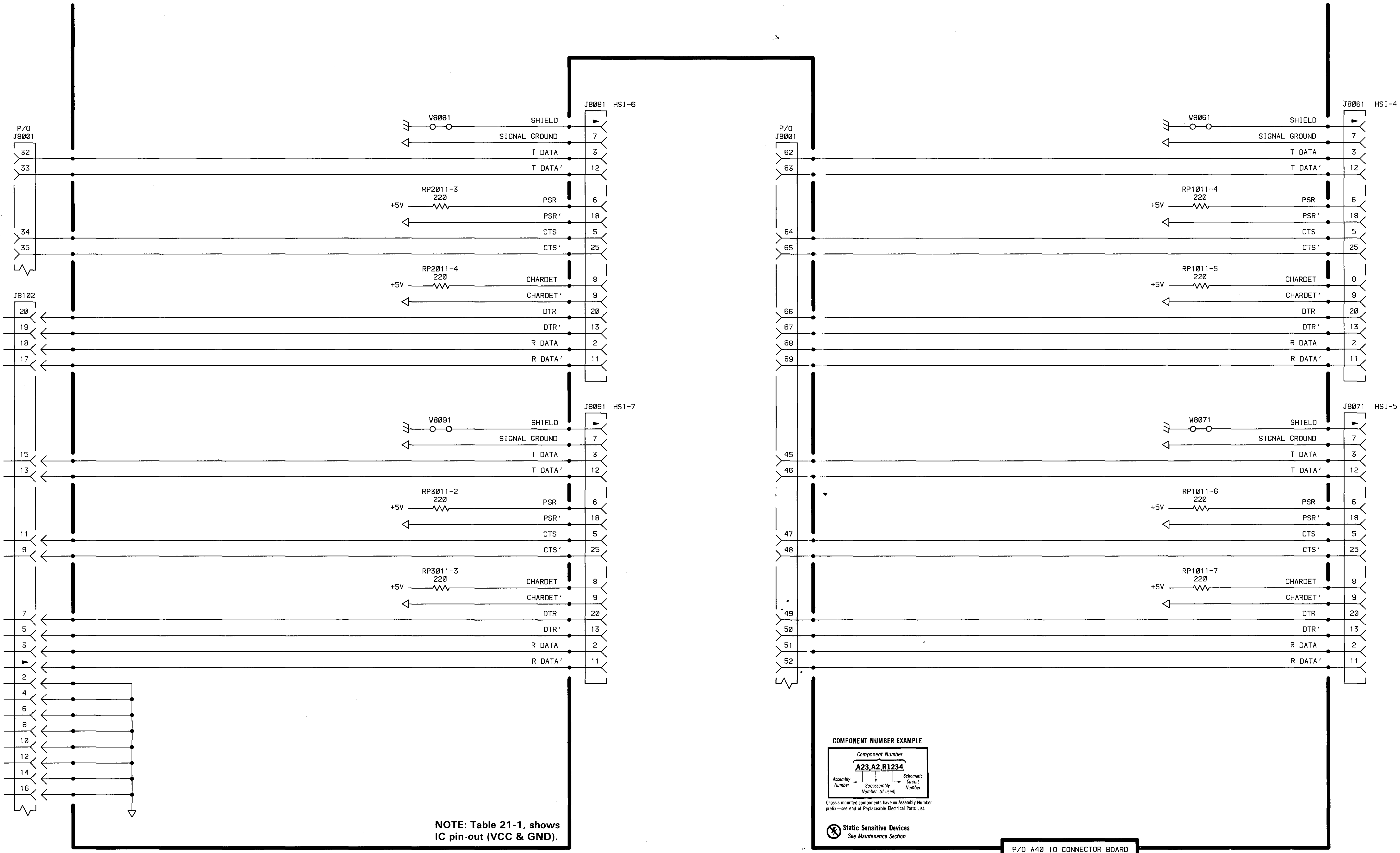
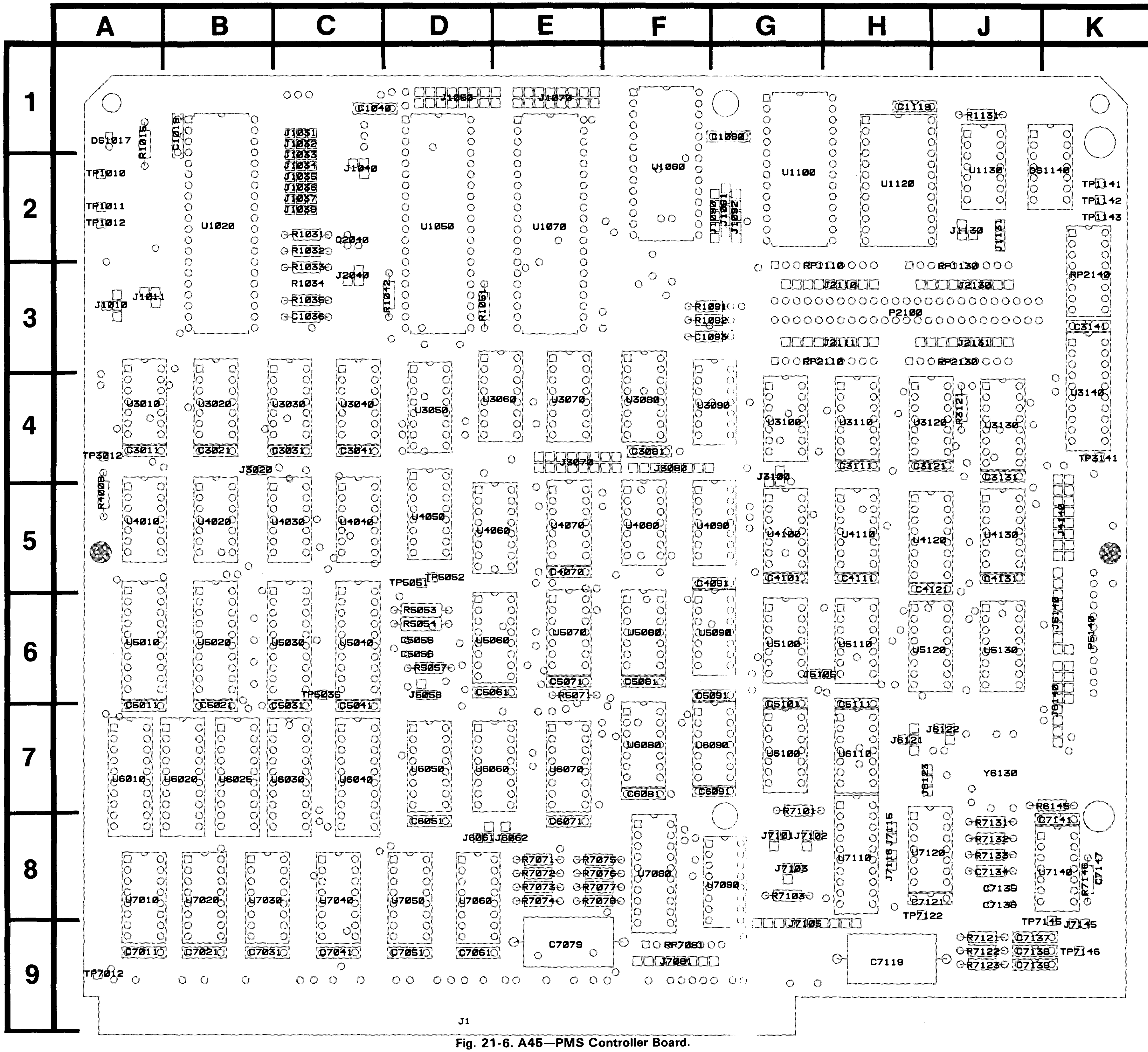


P/O J8001
J8011 HSI-0
J8021 HSI-1
J8031 HSI-2
J8041 HSI-3
J8051 LP-1
J8101 LP-2
SHIELD
SIGNAL GROUND
T DATA
T DATA'
PSR
PSR'
CTS
CTS'
CHARDET
CHARDET'
DTR
DTR'
R DATA
R DATA'
RTS
DSR
TCLK
RCLK
DTS
+5V
220
W8011
W8021
W8031
W8041
W8051
W8101
RP1011-3
RP1011-2
RP1011-8
RP2011-2
RP2011-6
RP2011-5
RP2011-8
RP2011-7
RP3011-7
RP3011-6
RP3011-4
RP3011-5
NOTE: Table 21-1, shows IC pin-out (VCC & GND).
P/O A40 IO CONNECTOR BOARD
COMPONENT NUMBER EXAMPLE
Static Sensitive Devices
See Maintenance Section
IOC STANDARDS PORTS

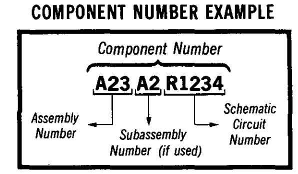


P/O J8001
J8102
J8081 HSI-6
J8091 HSI-7
J8061 HSI-4
J8071 HSI-5
W8081
W8091
W8061
W8071
SHIELD
SIGNAL GROUND
T DATA
T DATA'
RP2011-3 220
RP2011-4 220
RP3011-2 220
RP3011-3 220
RP1011-4 220
RP1011-5 220
RP1011-6 220
RP1011-7 220
+5V
PSR
PSR'
CTS
CTS'
CHARDET
CHARDET'
DTR
DTR'
R DATA
R DATA'
NOTE: Table 21-1, shows
IC pin-out (VCC & GND).
COMPONENT NUMBER EXAMPLE
Component Number
A23 A2 R1234
Assembly Number
Subassembly Number (if used)
Schematic Circuit Number
Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List.
Static Sensitive Devices
See Maintenance Section
P/O A40 IO CONNECTOR BOARD

PMS CONTROLLER
COMPONENT LOCATIONS



COMPONENT NUMBER EXAMPLE



Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List.

Static Sensitive Devices
See Maintenance Section

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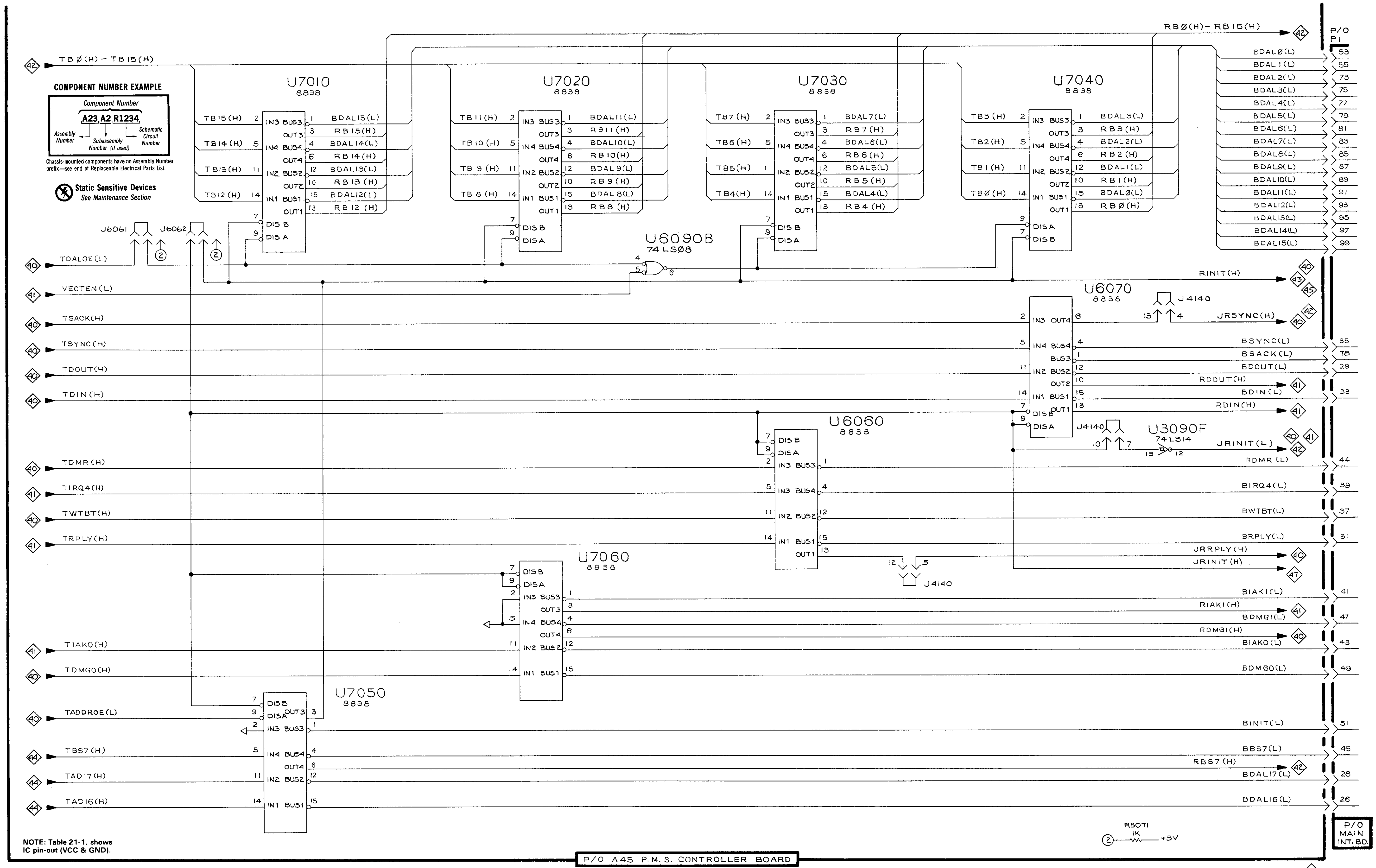
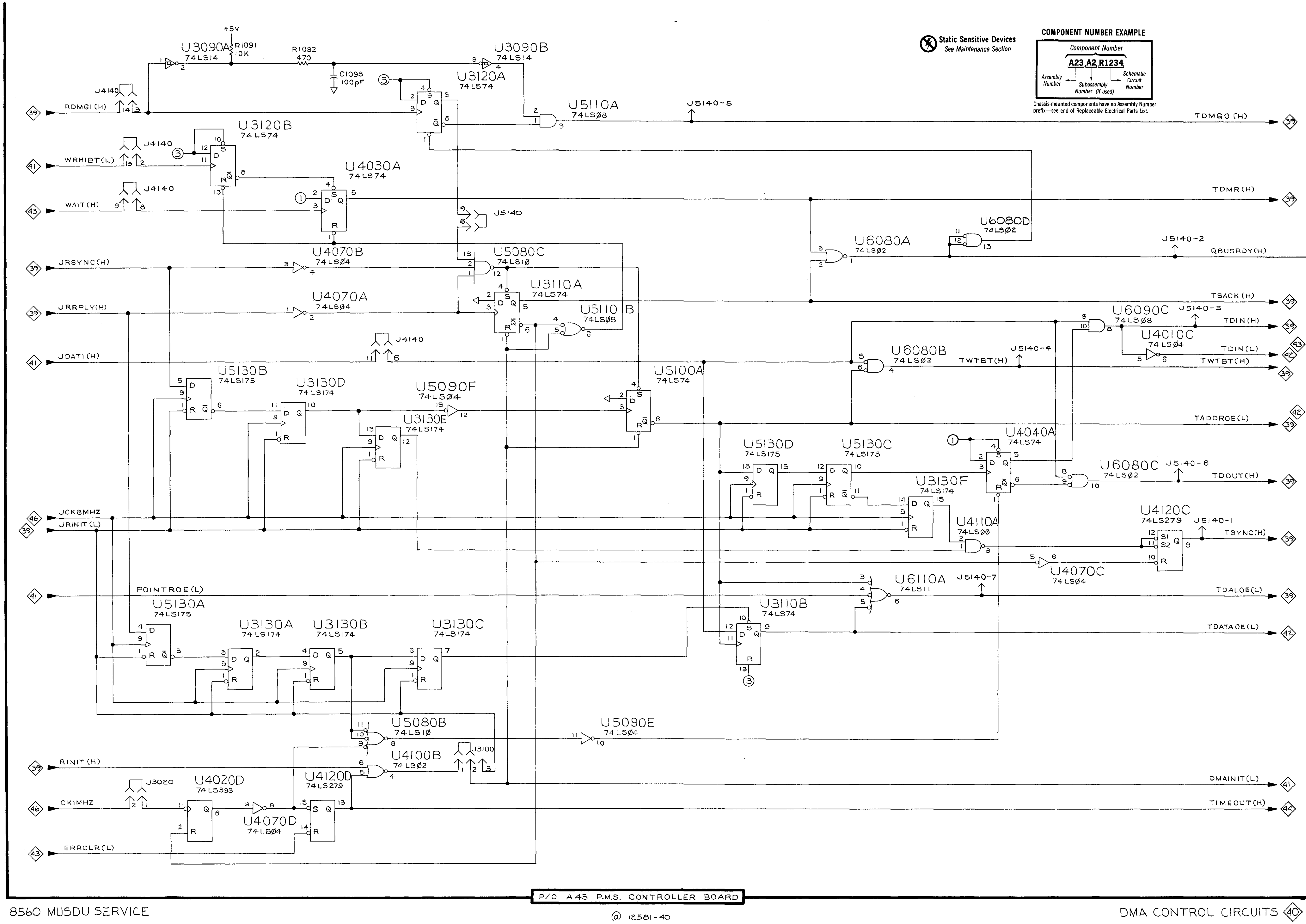
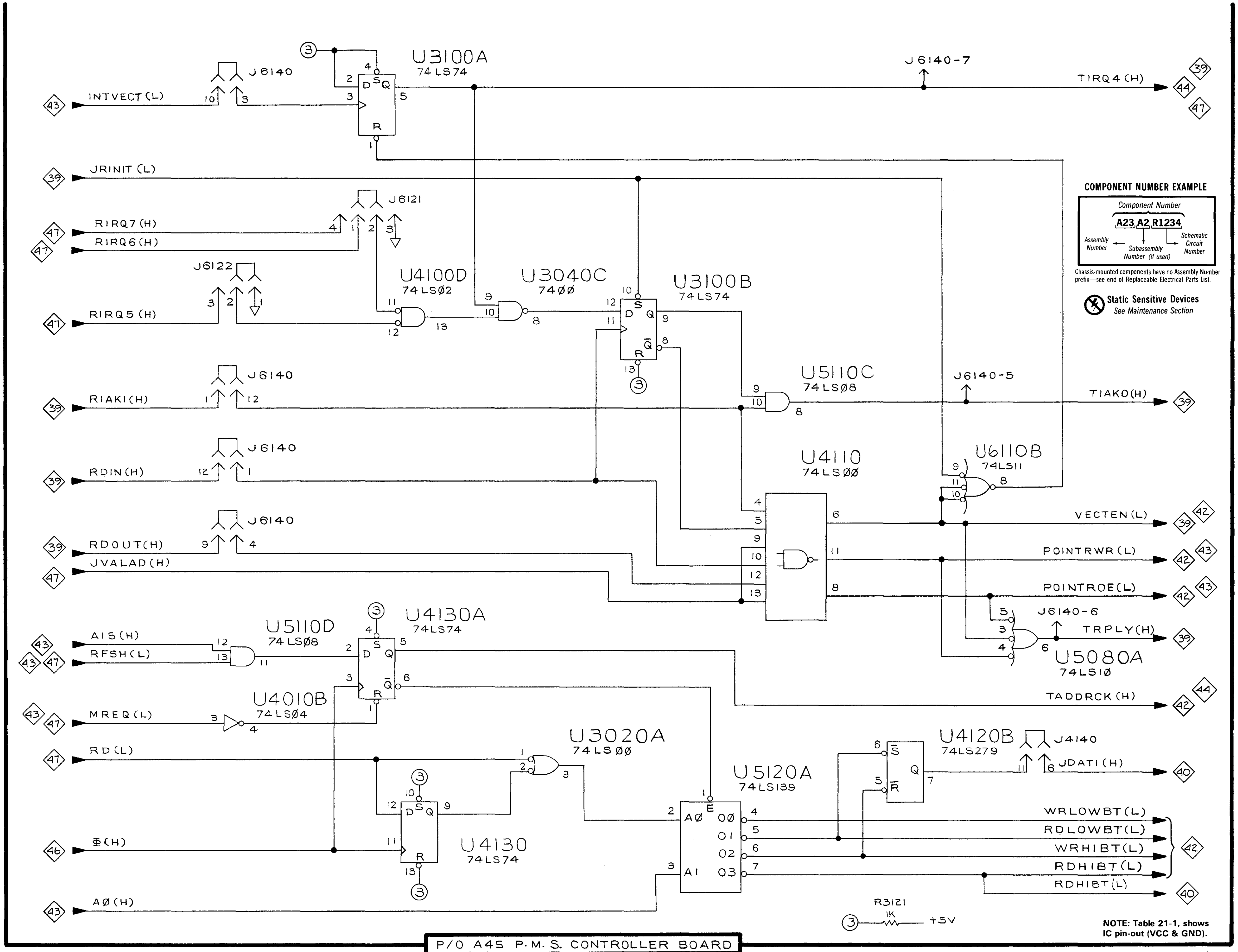
Fig. 21-6. A45—PMS Controller Board.

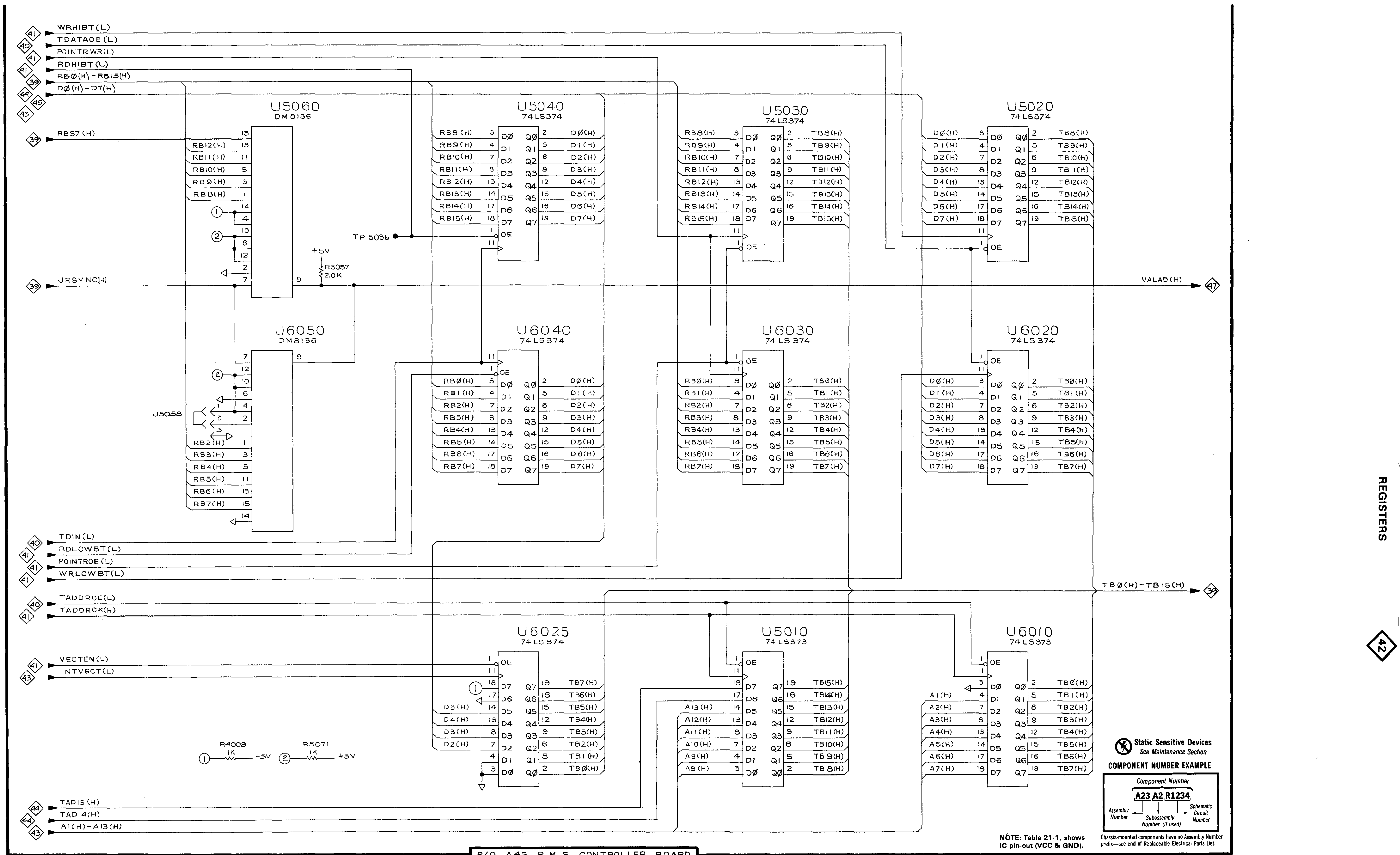
@

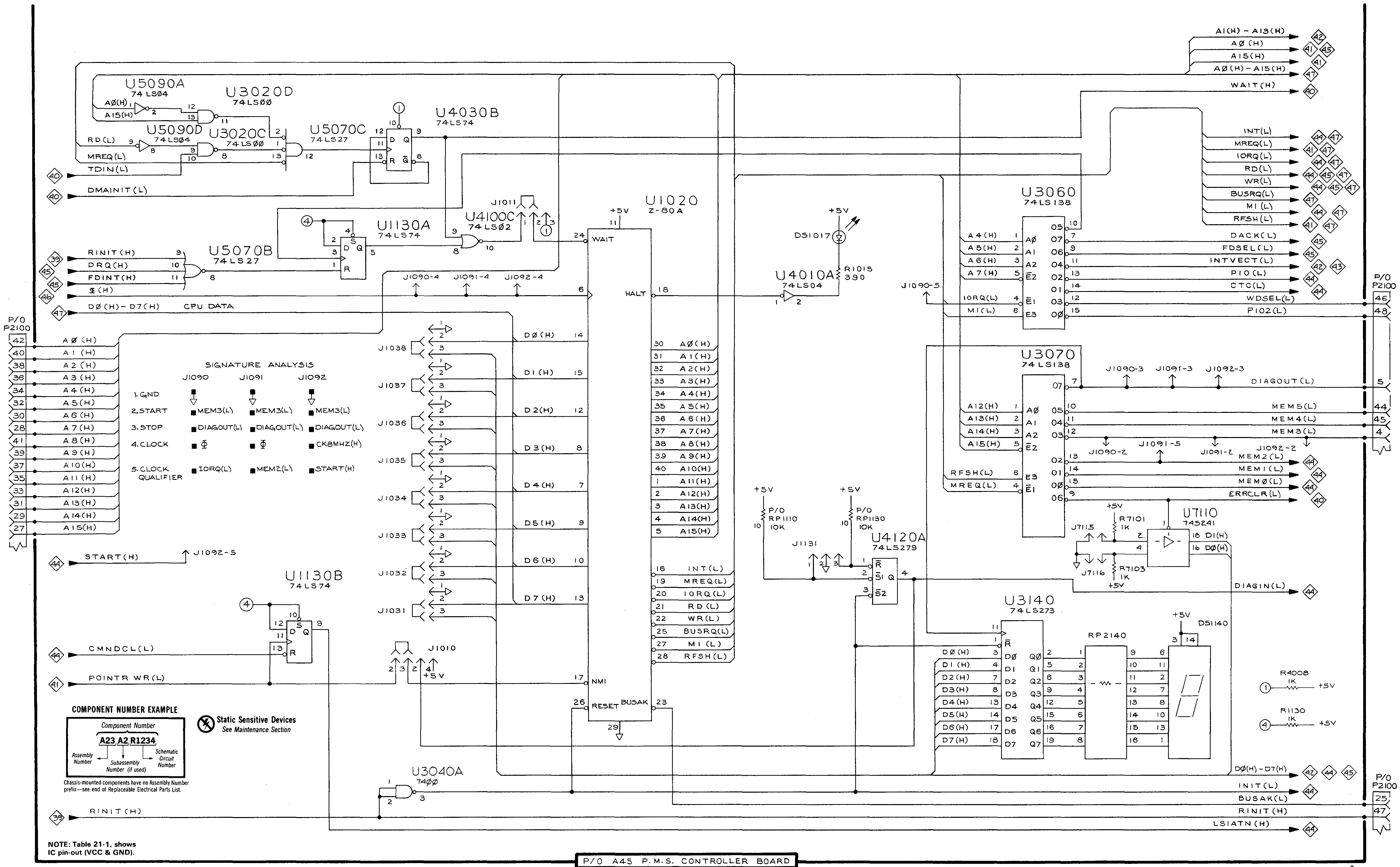

COMPONENT NUMBER EXAMPLE
Component Number
A23 A2 R1234
Assembly Number
Subassembly Number (if used)
Schematic Circuit Number
Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List.
Static Sensitive Devices
See Maintenance Section
U7010
8838
U7020
8838
U7030
8838
U7040
8838
U6090B
74LS08
U6070
8838
U6060
8838
U7060
8838
U7050
8838
U3090F
74LS14
TBØ(H) - TB15(H)
RBØ(H)- RB15(H)
TDALOE(L)
VECTEN(L)
TSACK(H)
TSYNC(H)
TDOUT(H)
TDIN(H)
TDMR(H)
TIRQ4(H)
TWTBT(H)
TRPLY(H)
TIAKO(H)
TDMGO(H)
TADDROE(L)
TBS7(H)
TAD17(H)
TAD16(H)
RINIT(H)
JRSYNC(H)
BSYNC(L)
BSACK(L)
BDOUT(L)
RDOUT(H)
BDIN(L)
RDIN(H)
JRINIT(L)
BDMR(L)
BIRQ4(L)
BWTBT(L)
BRPLY(L)
JRRPLY(H)
JRINIT(H)
BIAKI(L)
RIAKI(H)
BDMGI(L)
RDMGI(H)
BIAKO(L)
BDMGO(L)
BINIT(L)
BBS7(L)
RBS7(H)
BDAL17(L)
BDAL16(L)
J6061
J6062
J4140
R5071
1K
+5V
P/O P1
P/O MAIN INT. BD.
NOTE: Table 21-1, shows IC pin-out (VCC & GND).
P/O A45 P.M.S. CONTROLLER BOARD


Static Sensitive Devices
See Maintenance Section
COMPONENT NUMBER EXAMPLE
Component Number
A23 A2 R1234
Assembly Number
Subassembly Number (if used)
Schematic Circuit Number
Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List.
RDMGI(H)
WRHIBT(L)
WAIT(H)
JRSYNC(H)
JRRPLY(H)
JDATI(H)
JCK8MHZ
JRINIT(L)
POINTROE(L)
RINIT(H)
CKIMHZ
ERRCLR(L)
U3090A 74LS14
U3090B 74LS14
U3120A 74LS74
U3120B 74LS74
U4030A 74LS74
U5110A 74LS08
U4070B 74LS04
U5080C 74LS10
U4070A 74LS04
U3110A 74LS74
U5110B 74LS08
U6080A 74LS02
U6080D 74LS02
U5130B 74LS175
U3130D 74LS174
U5090F 74LS04
U3130E 74LS174
U5100A 74LS74
U6090C 74LS08
U4010C 74LS04
U6080B 74LS02
U4040A 74LS74
U5130D 74LS175
U5130C 74LS175
U3130F 74LS174
U6080C 74LS02
U4110A 74LS00
U4120C 74LS279
U4070C 74LS04
U6110A 74LS11
U3110B 74LS74
U5130A 74LS175
U3130A 74LS174
U3130B 74LS174
U3130C 74LS174
U5080B 74LS10
U5090E 74LS04
U4100B 74LS02
U4120D 74LS279
U4020D 74LS393
U4070D 74LS04
+5V
R1091 10K
R1092 470
C1093 100pF
J4140
J5140
J3100
J3020
J5140-5
J5140-2
J5140-3
J5140-4
J5140-6
J5140-1
J5140-7
P/O P2100
TDMGO(H)
TDMR(H)
QBUSRDY(H)
TSACK(H)
TDIN(H)
TDIN(L)
TWTBT(H)
TADDROE(L)
TDOUT(H)
TSYNC(H)
TDALOE(L)
TDATAOE(L)
DMAINIT(L)
TIMEOUT(H)
P/O A45 P.M.S. CONTROLLER BOARD
@ 12581-40

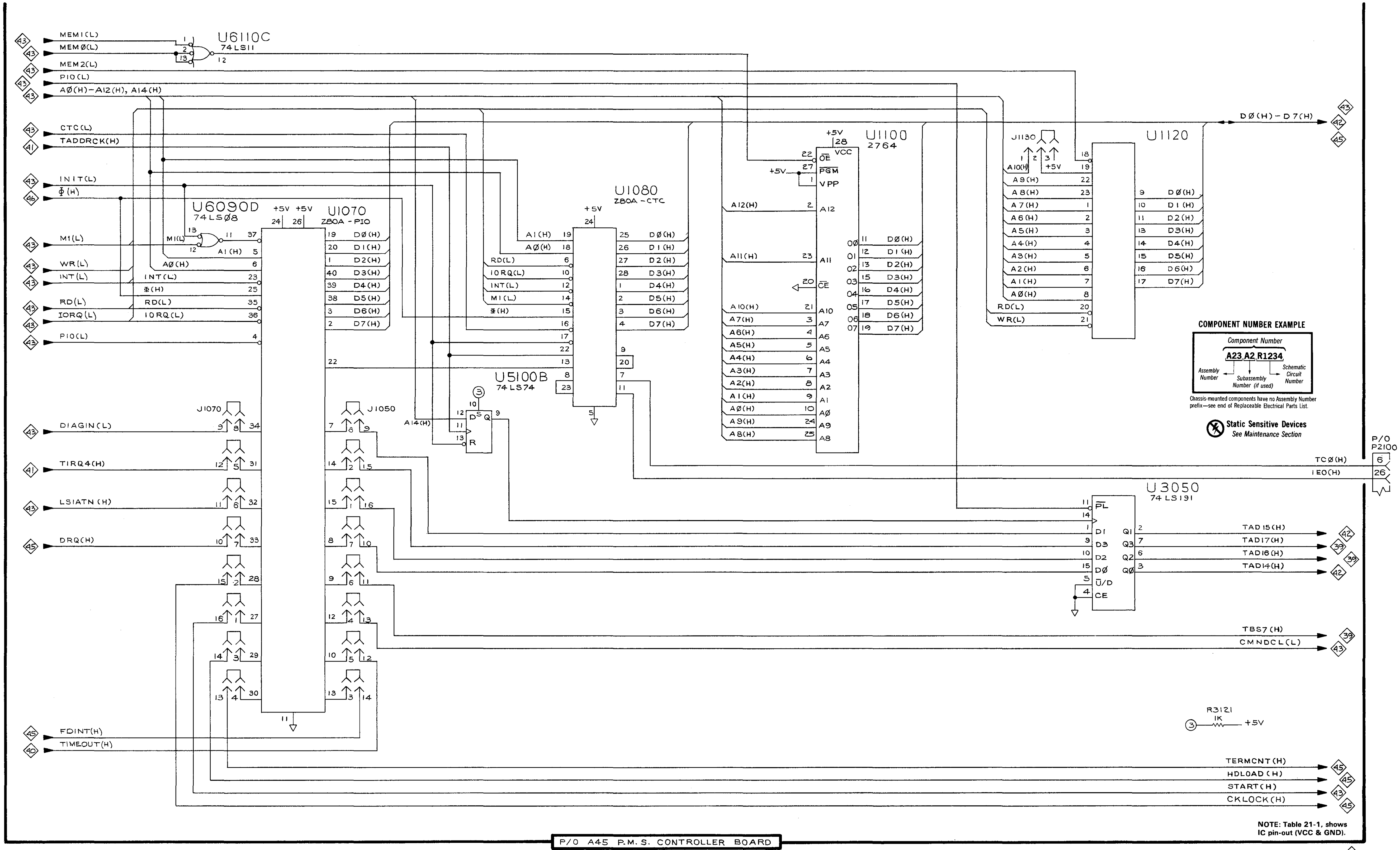


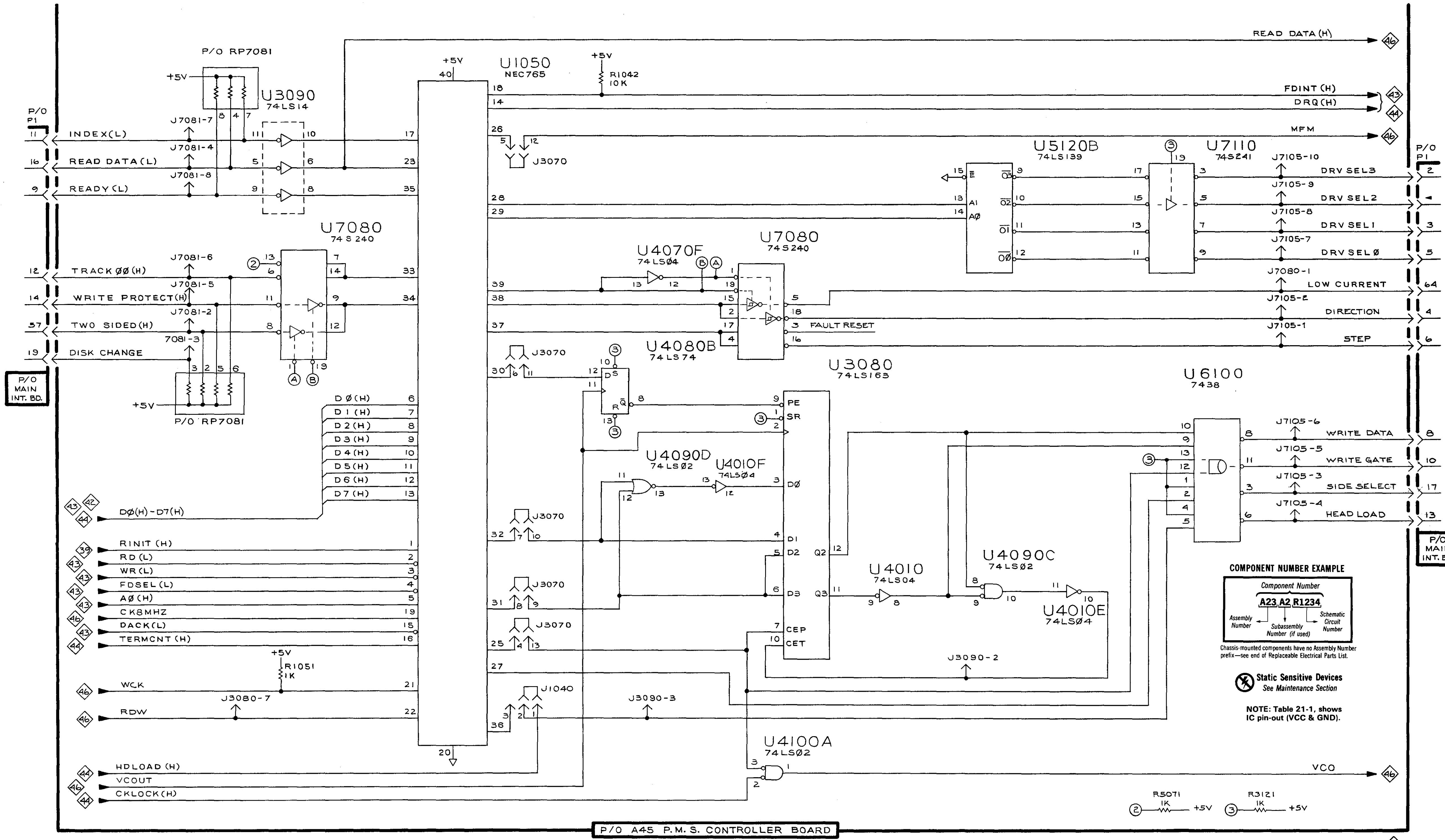
U3100A
74LS74
J6140
INTVECT (L)
J6140-7
TIRQ4 (H)
JRINIT (L)
J6121
RIRQ7 (H)
RIRQ6 (H)
J6122
RIRQ5 (H)
U4100D
74LS02
U3040C
7400
U3100B
74LS74
U5110C
74LS08
J6140-5
TIAKO(H)
RIAKI(H)
RDIN(H)
U4110
74LS00
U6110B
74LS11
VECTEN (L)
RDOUT(H)
JVALAD(H)
POINTRWR (L)
POINTROE(L)
A15 (H)
RFSH (L)
U5110D
74LS08
U4130A
74LS74
J6140-6
TRPLY(H)
U5080A
74LS10
U4010B
74LS04
TADDRCK (H)
MREQ(L)
U3020A
74LS00
U4120B
74LS279
J4140
JDATI (H)
RD(L)
U5120A
74LS139
WRLOWBT(L)
RDLOWBT(L)
WRHIBT(L)
RDHIBT(L)
RDHIBT(L)
Φ(H)
U4130
74LS74
AØ (H)
R3121
1K
+5V
COMPONENT NUMBER EXAMPLE
Component Number
A23 A2 R1234
Assembly Number
Subassembly Number (if used)
Schematic Circuit Number
Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List.
Static Sensitive Devices
See Maintenance Section
NOTE: Table 21-1, shows IC pin-out (VCC & GND).
P/O A45 P.M.S. CONTROLLER BOARD


WRHIBT(L)
TDATAOE(L)
POINTRWR(L)
RDHIBT(L)
RBØ(H)-RB15(H)
DØ(H)-D7(H)
U5060
DM8136
U5040
74LS374
U5030
74LS374
U5020
74LS374
RBS7(H)
TP 5036
+5V
R5057
2.0K
JRSYNC(H)
VALAD(H)
U6050
DM8136
U6040
74LS374
U6030
74LS374
U6020
74LS374
J5058
TDIN(L)
RDLOWBT(L)
POINTROE(L)
WRLOWBT(L)
TB0(H)-TB15(H)
TADDROE(L)
TADDRCK(H)
U6025
74LS374
U5010
74LS373
U6010
74LS373
VECTEN(L)
INTVECT(L)
R4008
1K
R5071
1K
+5V
TAD15(H)
TAD14(H)
A1(H)-A13(H)
Static Sensitive Devices
See Maintenance Section
COMPONENT NUMBER EXAMPLE
Component Number
A23 A2 R1234
Assembly Number
Subassembly Number (if used)
Schematic Circuit Number
Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List.
NOTE: Table 21-1, shows IC pin-out (VCC & GND).
P/O A45 P.M.S. CONTROLLER BOARD
REGISTERS
42

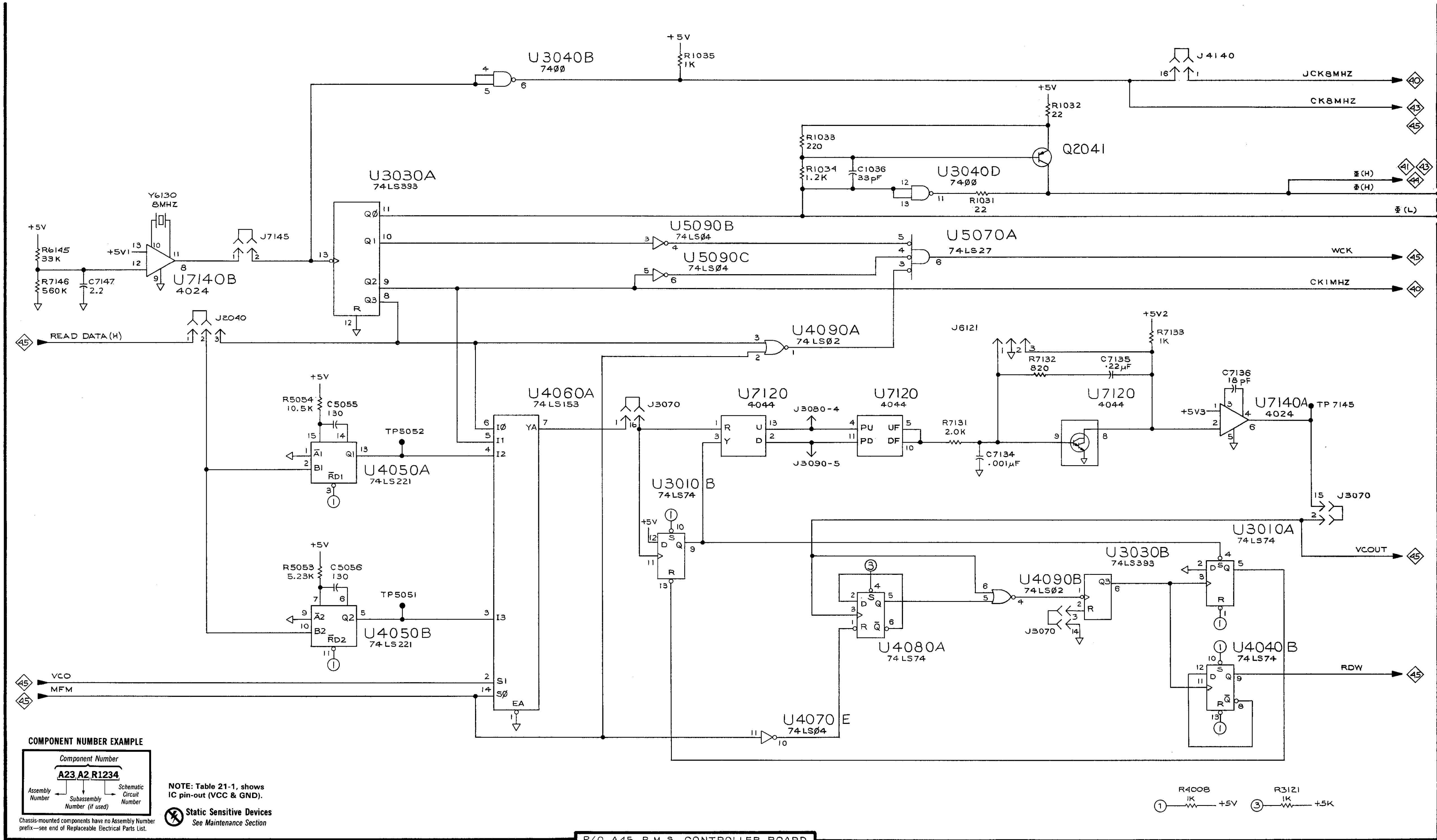


U5090A 74LS04
U3020D 74LS00
U5090D 74LS04
U3020C 74LS00
U5070C 74LS27
U4030B 74LS74
U1130A 74LS74
U4100C 74LS02
U5070B 74LS27
U1020 Z-80A
U4010A 74LS04
U3060 74LS138
U3070 74LS138
U4120A 74LS279
U7110 74S241
U3140 74LS273
U1130B 74LS74
U3040A 7400
RP2140
DS1017
DS1140
R1015 390
R7101 1K
R7103 1K
R4008 1K
R1130 1K
P/O RP1110 10K
P/O RP1130 10K
AØ(H)
A15(H)
RD(L)
MREQ(L)
TDIN(L)
DMAINIT(L)
RINIT(H)
DRQ(H)
FDINT(H)
Φ(H)
DØ(H)-D7(H) CPU DATA
START(H)
CMNDCL(L)
POINTR WR(L)
WAIT
HALT
NMI
RESET
BUSAK
+5V
A1(H)-A13(H)
AØ(H)-A15(H)
WAIT(H)
INT(L)
IORQ(L)
WR(L)
BUSRQ(L)
M1(L)
RFSH(L)
DACK(L)
FDSEL(L)
INTVECT(L)
PIO(L)
CTC(L)
WDSEL(L)
PIO2(L)
DIAGOUT(L)
MEM5(L)
MEM4(L)
MEM3(L)
MEM2(L)
MEM1(L)
MEMØ(L)
ERRCLR(L)
D1(H)
DIAGIN(L)
INIT(L)
BUSAK(L)
LSIATN(H)
P/O P2100
SIGNATURE ANALYSIS
J1090 J1091 J1092
1. GND
2. START MEM3(L) MEM3(L) MEM3(L)
3. STOP DIAGOUT(L) DIAGOUT(L) DIAGOUT(L)
4. CLOCK Φ Φ CK8MHZ(H)
5. CLOCK QUALIFIER IORQ(L) MEM2(L) START(H)
COMPONENT NUMBER EXAMPLE
Component Number
A23 A2 R1234
Assembly Number
Subassembly Number (if used)
Schematic Circuit Number
Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List.
Static Sensitive Devices
See Maintenance Section
NOTE: Table 21-1, shows IC pin-out (VCC & GND).
P/O A45 P.M.S. CONTROLLER BOARD


MEM1(L)
MEMØ(L)
MEM2(L)
PIO(L)
AØ(H)-A12(H), A14(H)
CTC(L)
TADDRCK(H)
INIT(L)
Φ(H)
M1(L)
WR(L)
INT(L)
RD(L)
IORQ(L)
U6110C
74LS11
U6090D
74LSØ8
U1070
Z80A-PIO
U1080
Z80A-CTC
U1100
2764
U1120
J1130
U5100B
74LS74
J1070
J1050
DIAGIN(L)
TIRQ4(H)
LSIATN(H)
DRQ(H)
FDINT(H)
TIMEOUT(H)
DØ(H)-D7(H)
U3050
74LS191
TADI5(H)
TADI7(H)
TADI6(H)
TADI4(H)
TBS7(H)
CMNDCL(L)
TCØ(H)
IEO(H)
P/O
P2100
R3121
1K
+5V
TERMCNT(H)
HDLOAD(H)
START(H)
CKLOCK(H)
COMPONENT NUMBER EXAMPLE
Component Number
A23 A2 R1234
Assembly Number
Subassembly Number (if used)
Schematic Circuit Number
Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List.
Static Sensitive Devices
See Maintenance Section
NOTE: Table 21-1, shows IC pin-out (VCC & GND).
P/O A45 P.M.S. CONTROLLER BOARD



PMS CONTROLLER FLEXIBLE DISC CONTROLLER 45



COMPONENT NUMBER EXAMPLE

Component Number
A23 A2 R1234
Assembly Number
Subassembly Number (if used)
Schematic Circuit Number

Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List.

NOTE: Table 21-1, shows IC pin-out (VCC & GND).

Static Sensitive Devices
See Maintenance Section

P/O A45 P.M.S. CONTROLLER BOARD

PMS CONTROLLER
PRECOMMAND AND
PLL LOGIC

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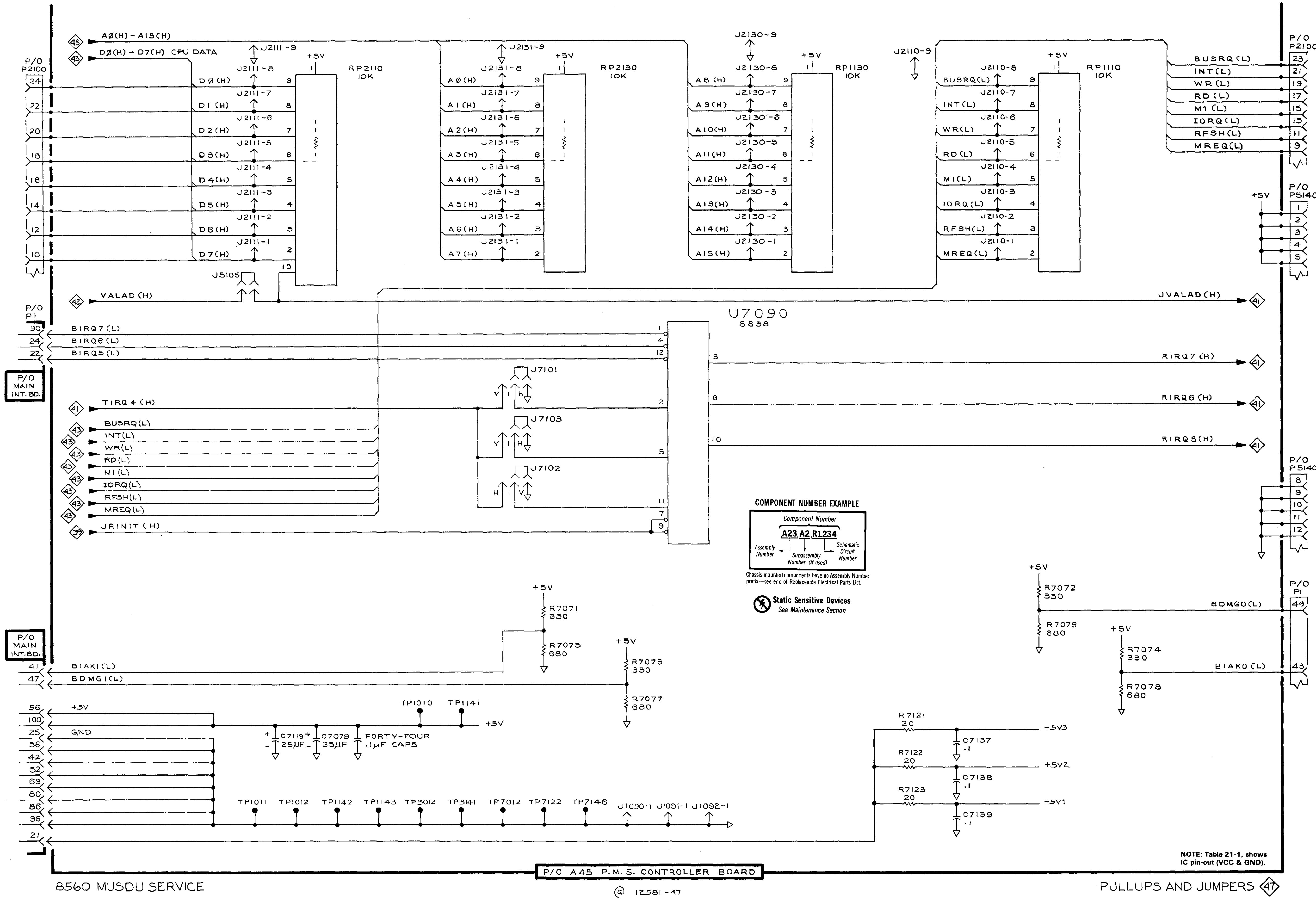
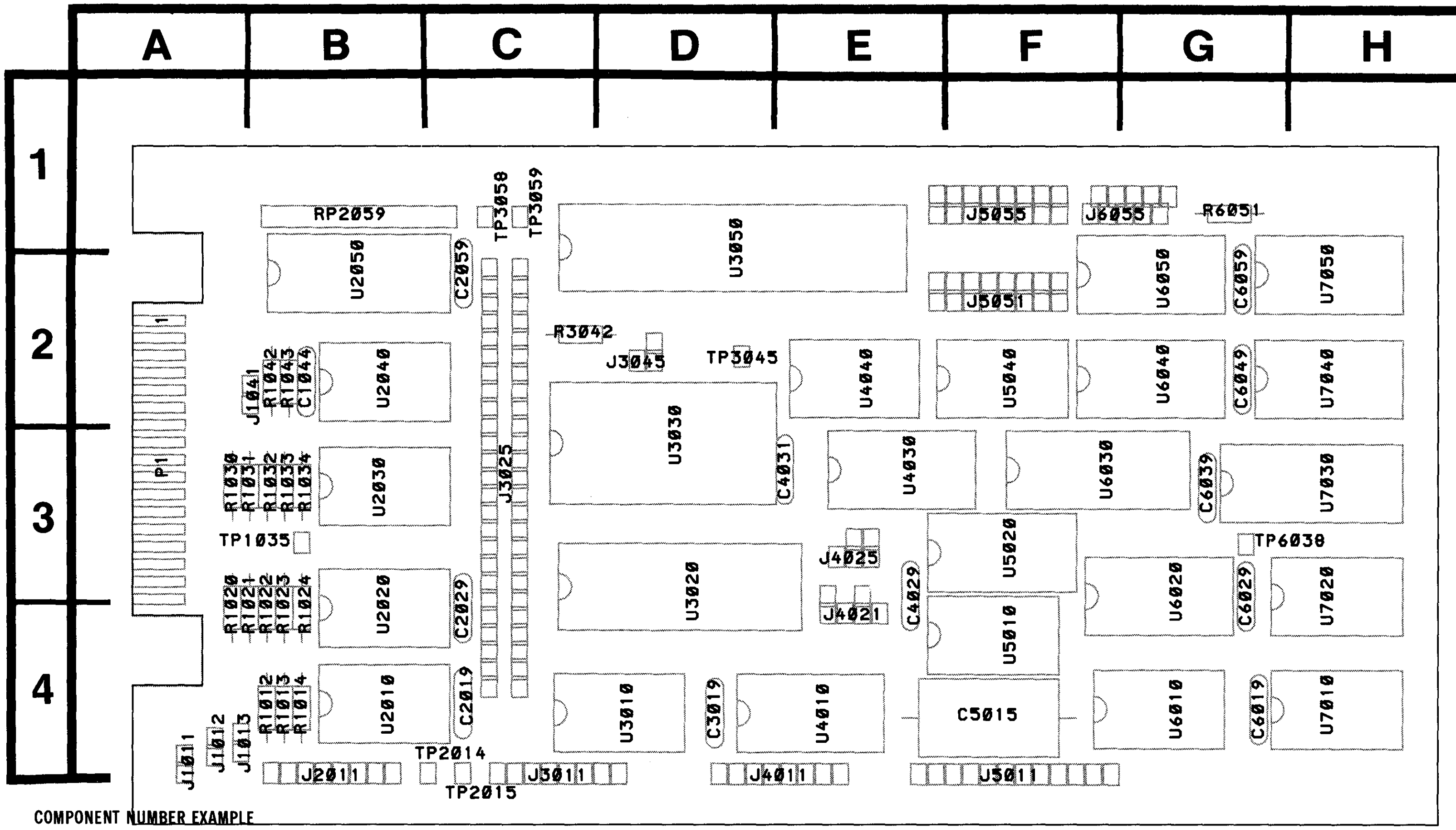
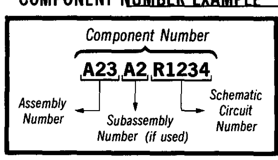
Table 21-4
Forty-Four 0.1 μF
Decoupling Capacitors

C1019	C5041
C1040	/c5061
C1090	C5071
C1119	C5081
C3011	C5091
C3021	C5101
C3031	C5111
C3041	C6051
C3081	C6071
C3111	C6081
C3121	C6091
C3131	C7011
C3141	C7021
C4071	C7031
C4091	C7041
C4101	C7051
C4111	C7061
C4121	C7121
C4130	C7141
C5011	C7137
C5021	C7138
C5031	C7139





COMPONENT NUMBER EXAMPLE



Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List.

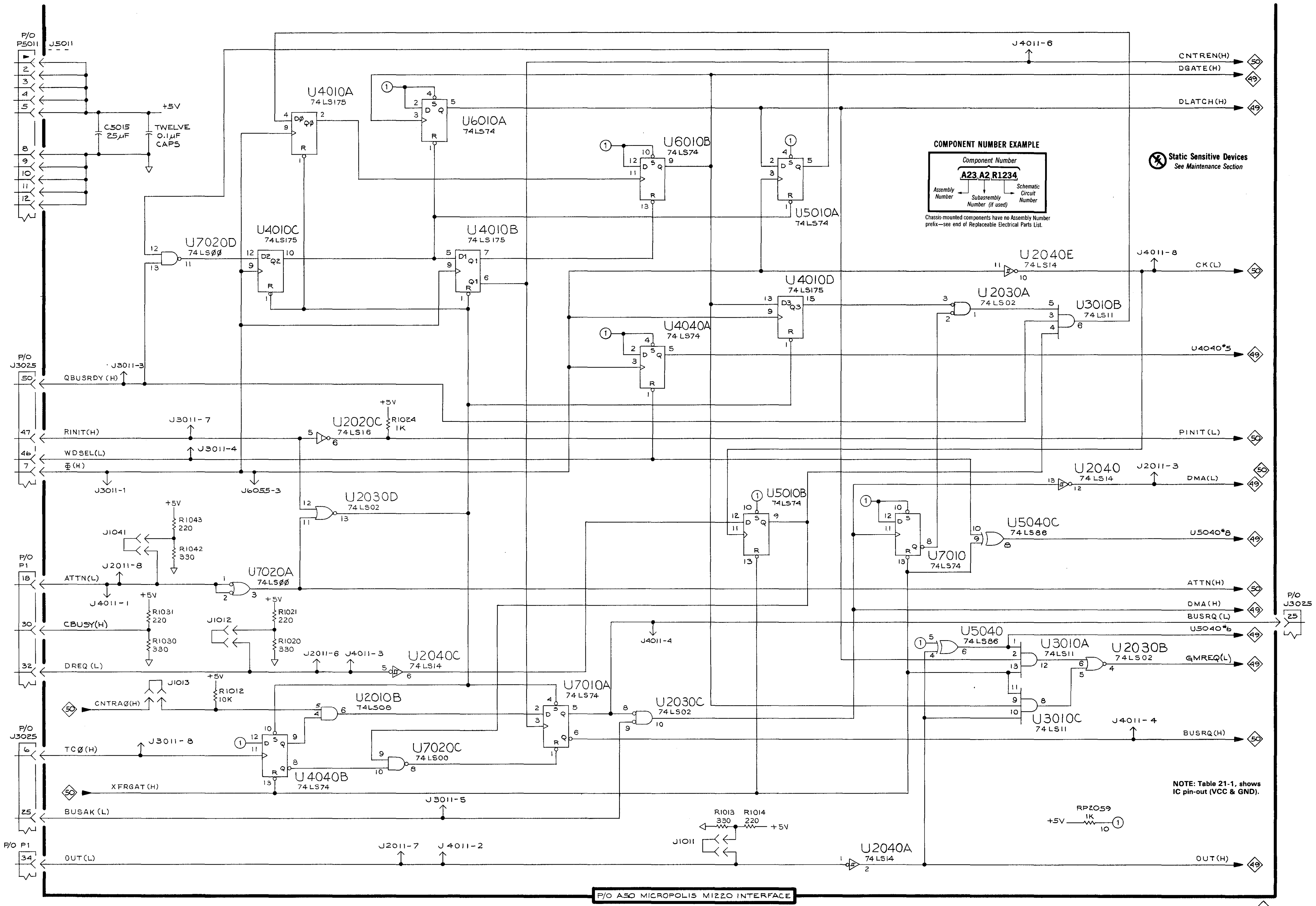
Fig. 21-7. A50—M1220 Board.

Static Sensitive Devices
See Maintenance Section

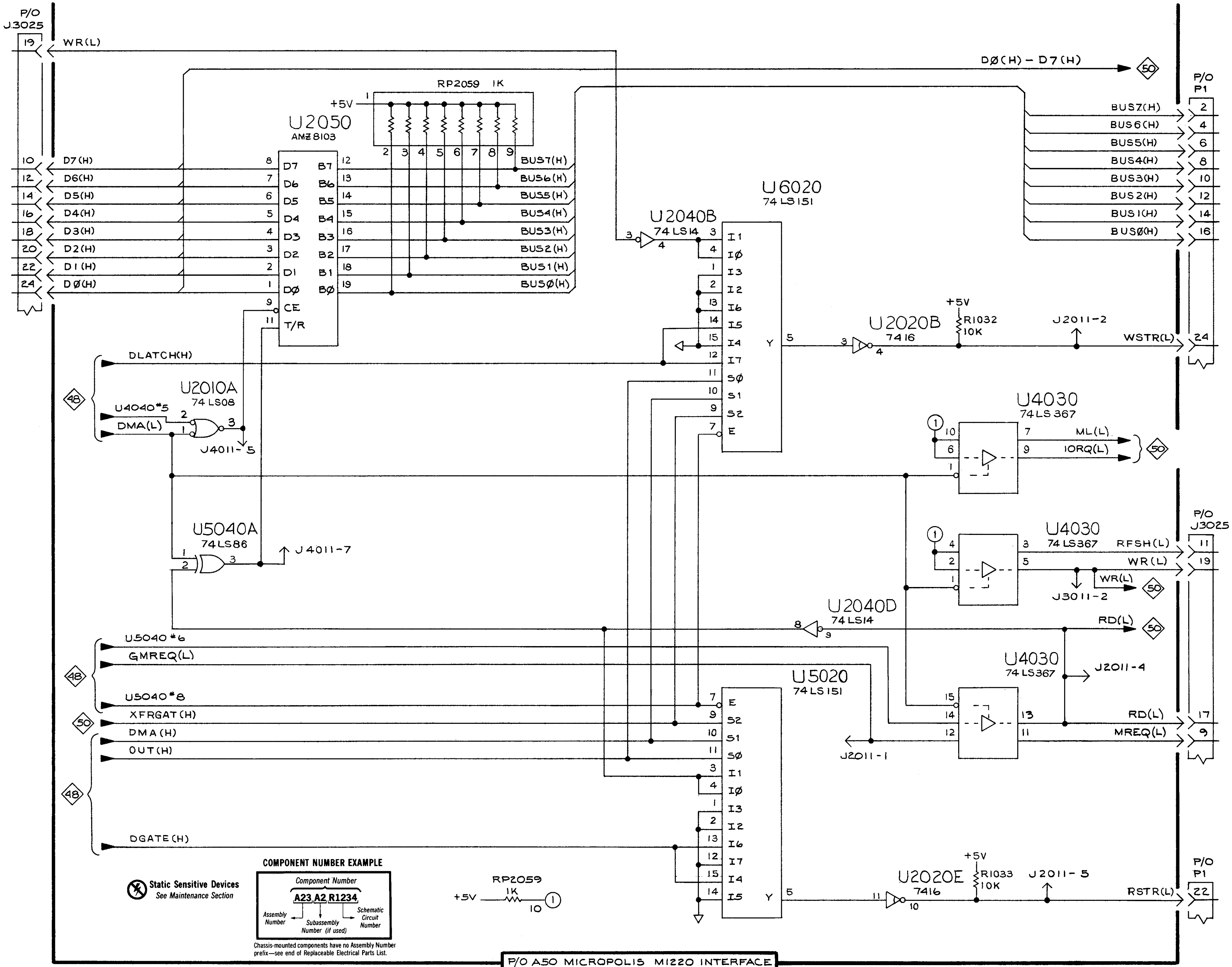
12581-133

Table 21-5
Twelve 0.1 µF
Decoupling Capacitors

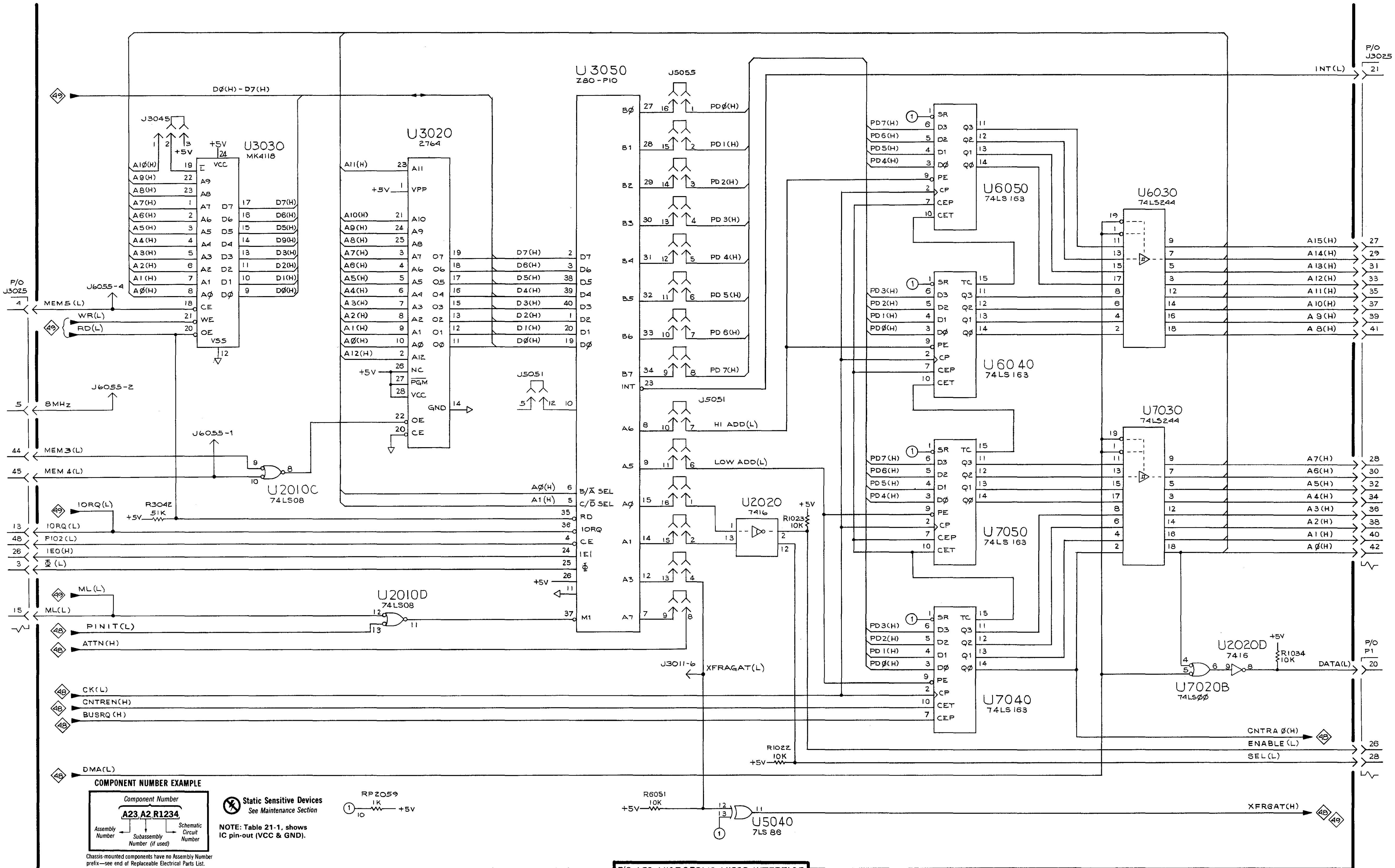
C1044
C2019
C2029
C2059
C3019
C4031
C4029
C6019
C6029
C6039
C6049
C6059



@ 12581-48

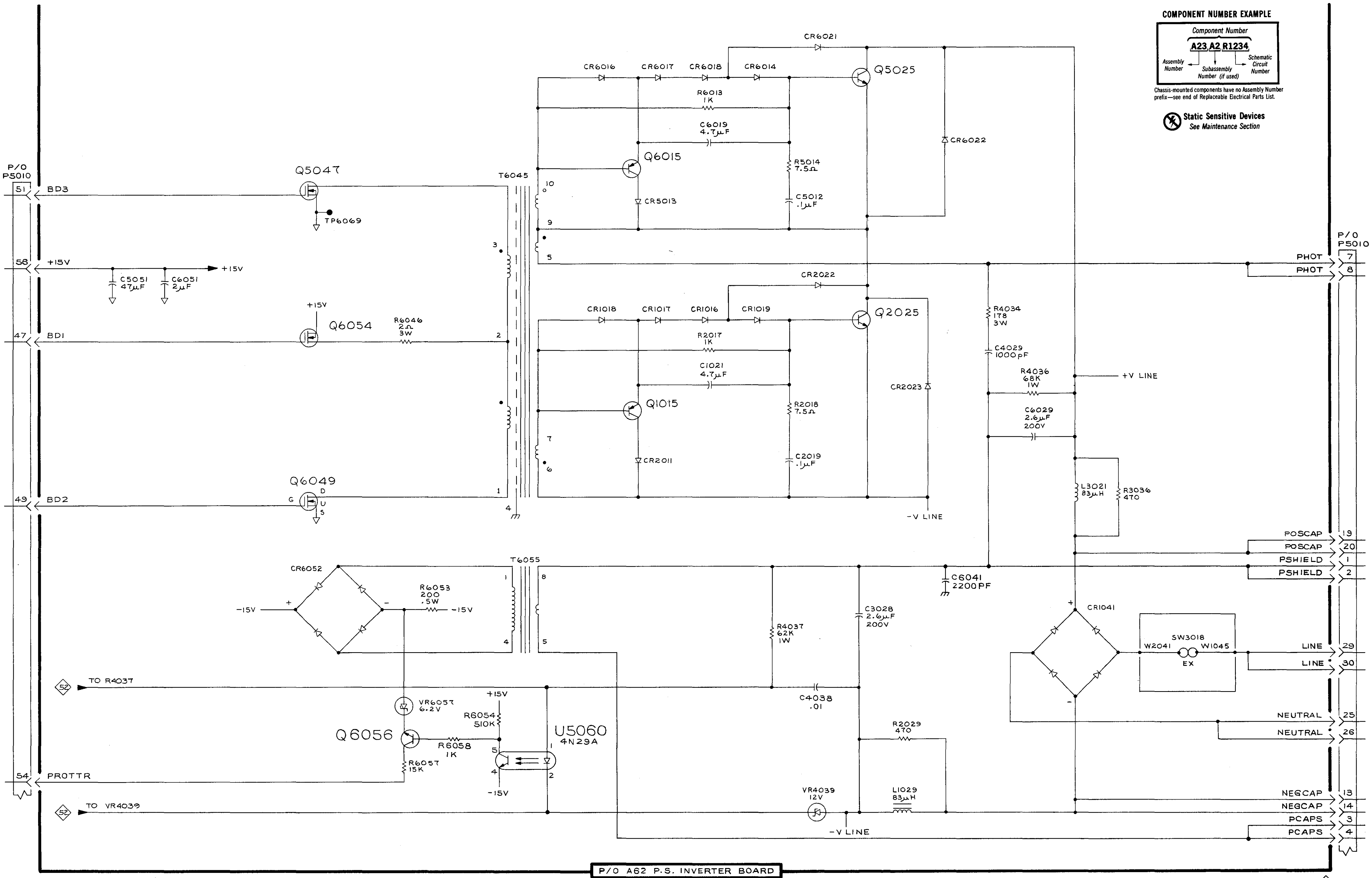


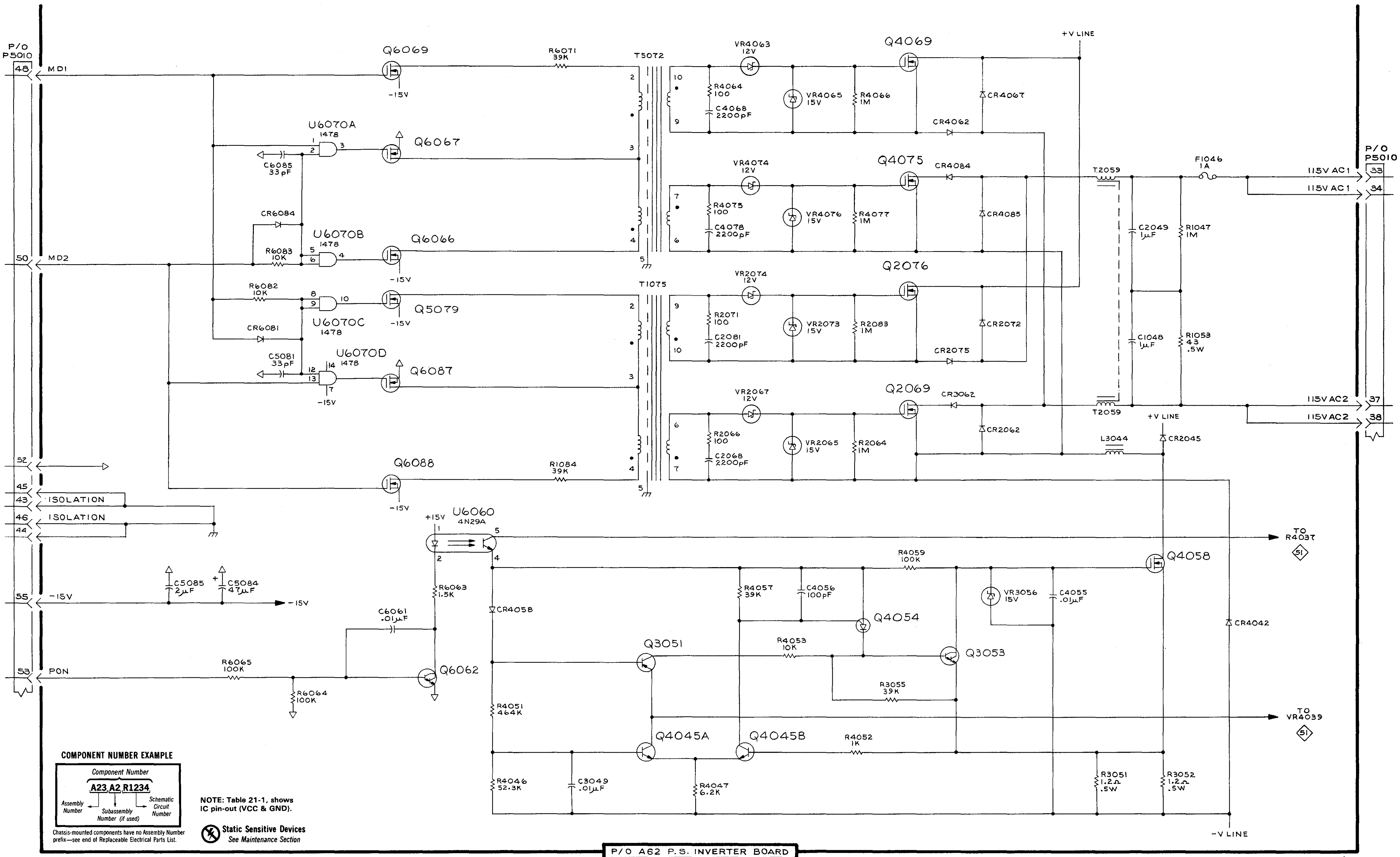
BUS TRANSCEIVERS AND 49
DMA OUTPUT CIRCUIT



DMA ADDRESS COUNTER 50

@ 12581-50


COMPONENT NUMBER EXAMPLE
Component Number
A23 A2 R1234
Assembly Number
Subassembly Number (if used)
Schematic Circuit Number
Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List.
Static Sensitive Devices
See Maintenance Section
P/O P5010
BD3
+15V
BD1
BD2
PROTTR
Q5047
TP6069
C5051 47µF
C6051 2µF
+15V
Q6054
R6046 2Ω 3W
Q6049
T6045
CR6016
CR6017
CR6018
CR6014
CR6021
Q5025
R6013 1K
C6019 4.7µF
Q6015
R5014 7.5Ω
CR5013
C5012 .1µF
CR6022
CR2022
CR1018
CR1017
CR1016
CR1019
Q2025
R2017 1K
C1021 4.7µF
Q1015
R2018 7.5Ω
CR2011
C2019 .1µF
CR2023
-V LINE
R4034 178 3W
C4029 1000pF
R4036 68K 1W
+V LINE
C6029 2.6µF 200V
L3021 83µH
R3036 470
PHOT
PHOT
POSCAP
POSCAP
PSHIELD
PSHIELD
CR6052
T6055
R6053 200 .5W
-15V
C6041 2200PF
R4037 62K 1W
C3028 2.6µF 200V
CR1041
SW3018
W2041
W1045
EX
LINE
LINE
NEUTRAL
NEUTRAL
TO R4037
VR6057 6.2V
R6054 510K
Q6056
R6058 1K
R6057 15K
U5060 4N29A
C4038 .01
R2029 470
TO VR4039
VR4039 12V
L1029 83µH
-V LINE
NEGCAP
NEGCAP
PCAPS
PCAPS
P/O A62 P.S. INVERTER BOARD


P/O P5010
48 MD1
50 MD2
52
45
43 ISOLATION
46 ISOLATION
44
55 -15V
53 PON
Q6069
-15V
R6071 39K
T5072
U6070A 1478
Q6067
C6085 33pF
CR6084
U6070B 1478
Q6066
R6083 10K
R6082 10K
U6070C 1478
Q5079
CR6081
C5081 33pF
U6070D 1478
Q6087
Q6088
R1084 39K
T1075
VR4063 12V
R4064 100
C4068 2200pF
VR4065 15V
R4066 1M
Q4069
CR4067
CR4062
+V LINE
VR4074 12V
R4075 100
C4078 2200pF
VR4076 15V
R4077 1M
Q4075
CR4084
CR4085
VR2074 12V
R2071 100
C2081 2200pF
VR2073 15V
R2083 1M
Q2076
CR2072
CR2075
VR2067 12V
R2066 100
C2068 2200pF
VR2065 15V
R2064 1M
Q2069
CR3062
CR2062
T2059
C2049 1µF
R1047 1M
C1048 1µF
R1053 43 .5W
F1046 1A
115V AC1
115V AC2
P/O P5010
33
34
37
38
+V LINE
CR2045
L3044
U6060 4N29A
+15V
TO R4037 51
R4059 100K
Q4058
R4057 39K
C4056 100pF
VR3056 15V
C4055 .01µF
Q4054
CR4042
CR4058
R6063 1.5K
C6061 .01µF
C5085 2µF
C5084 47µF
-15V
R6065 100K
R6064 100K
Q6062
Q3051
R4053 10K
Q3053
R3055 39K
TO VR4039 51
R4051 464K
Q4045A
Q4045B
R4052 1K
R4046 52.3K
C3049 .01µF
R4047 6.2K
R3051 1.2Ω .5W
R3052 1.2Ω .5W
-V LINE
COMPONENT NUMBER EXAMPLE
Component Number
A23 A2 R1234
Assembly Number
Subassembly Number (if used)
Schematic Circuit Number
Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List.
NOTE: Table 21-1, shows IC pin-out (VCC & GND).
Static Sensitive Devices
See Maintenance Section
P/O A62 P.S. INVERTER BOARD

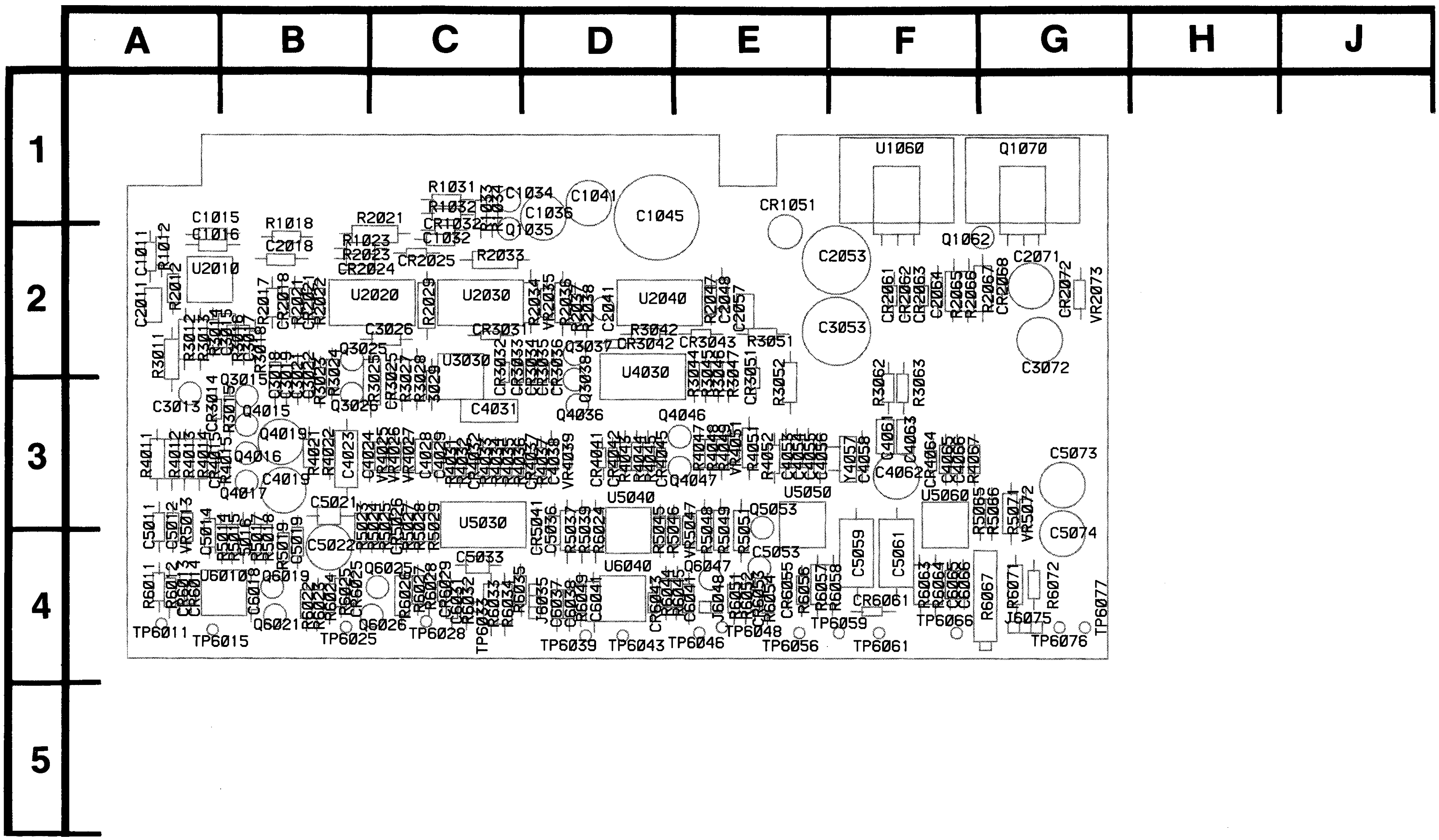


Fig. 21-9. A64—Regulator Board.

COMPONENT NUMBER EXAMPLE

Component Number

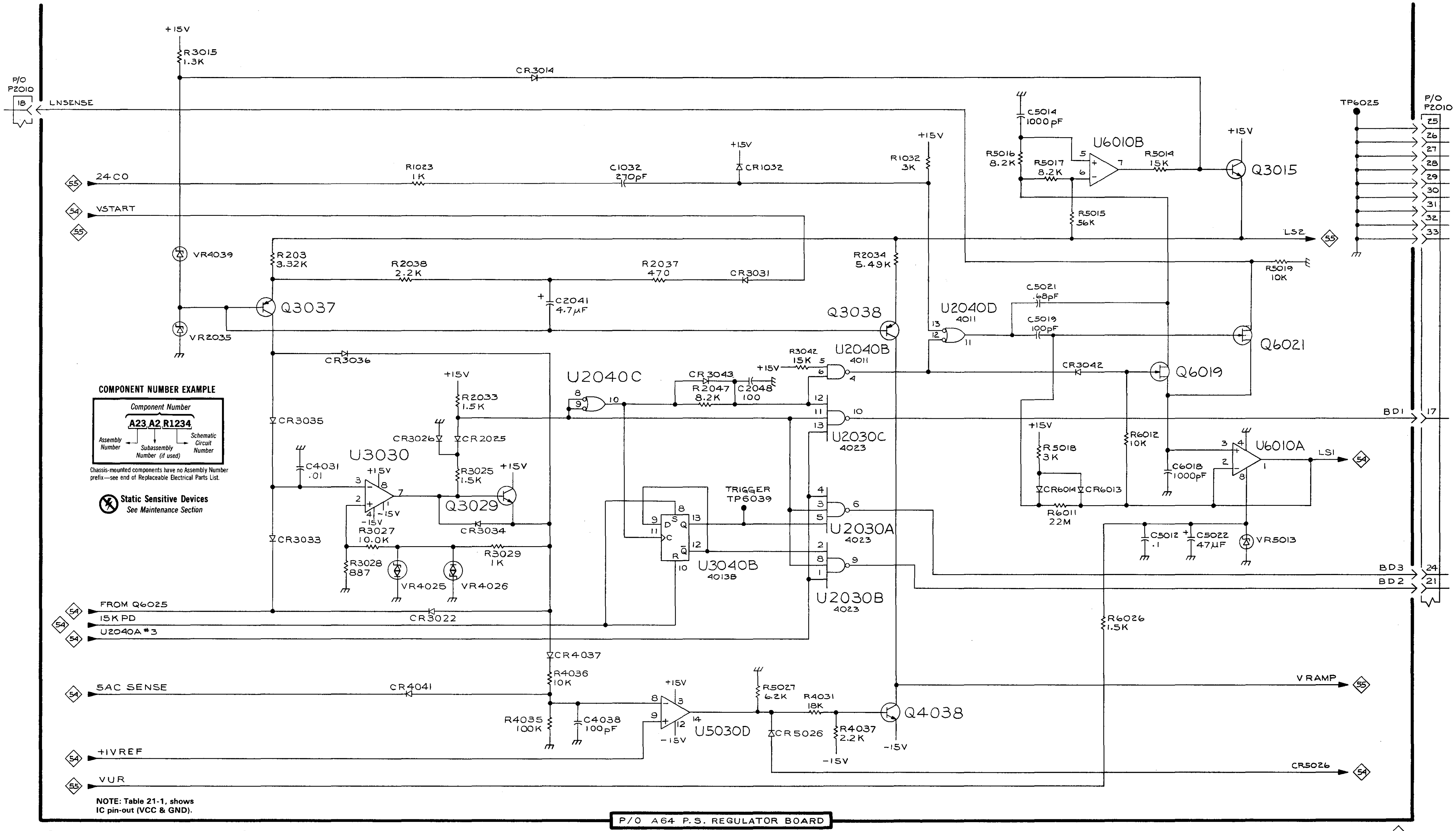
A23 A2 R1234

Assembly Number — Subassembly Number (if used) — Schematic Circuit Number

Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List.

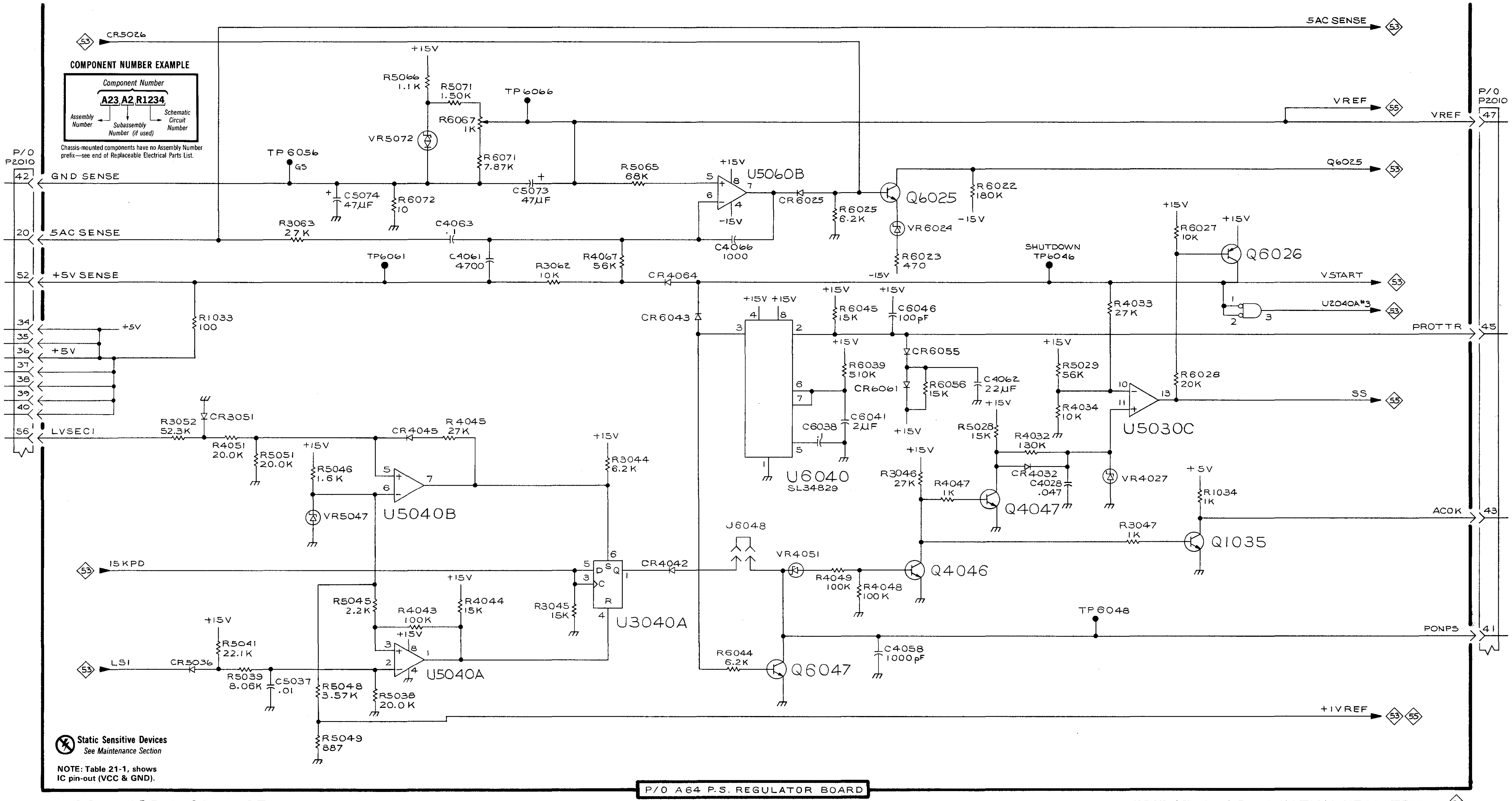
Static Sensitive Devices
See Maintenance Section

12581-135



P.S. MAIN INVERTER CONTROL

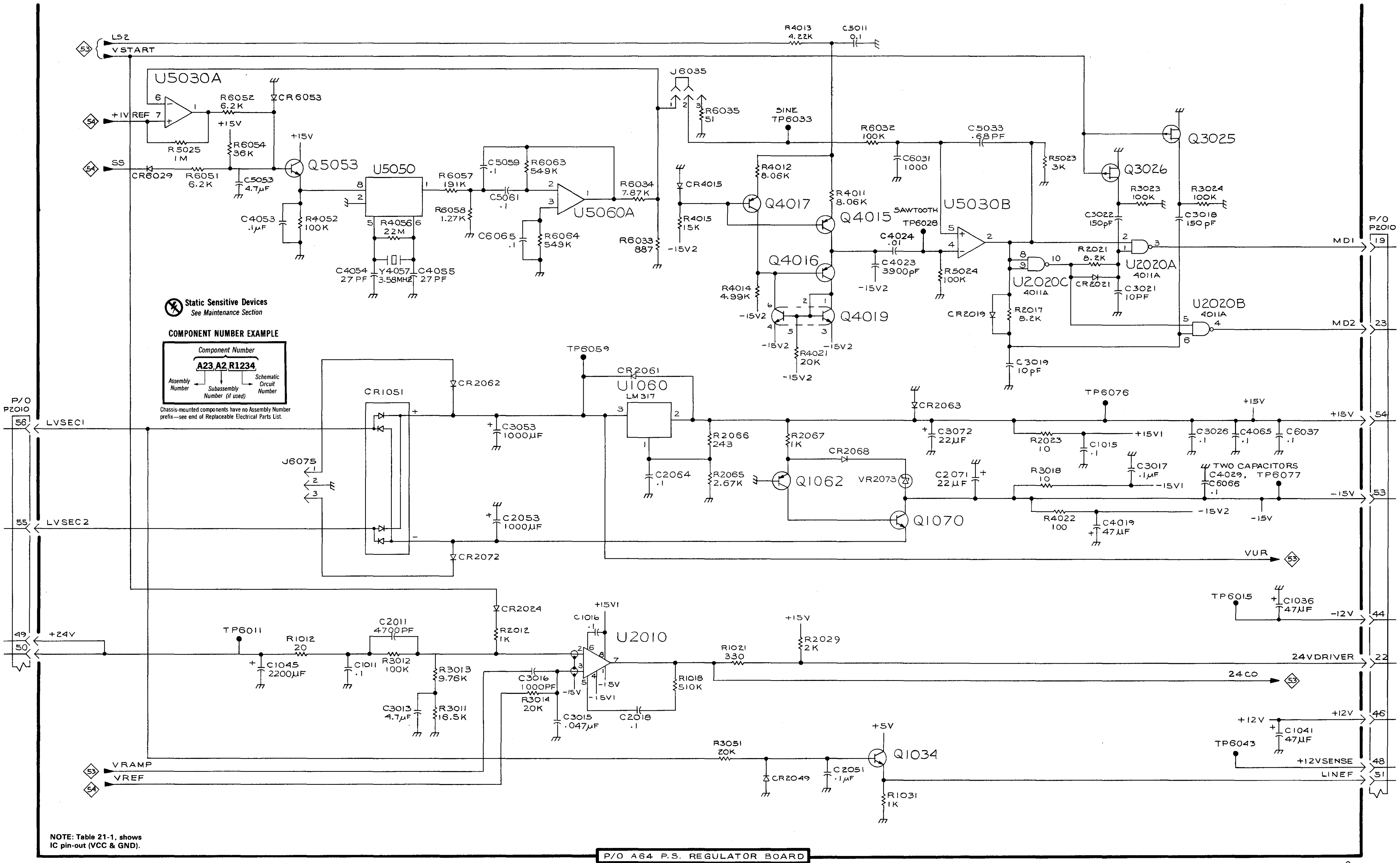
53



@ 12581-54

5V REFERENCE & PROTECTION CIRCUITRY 54

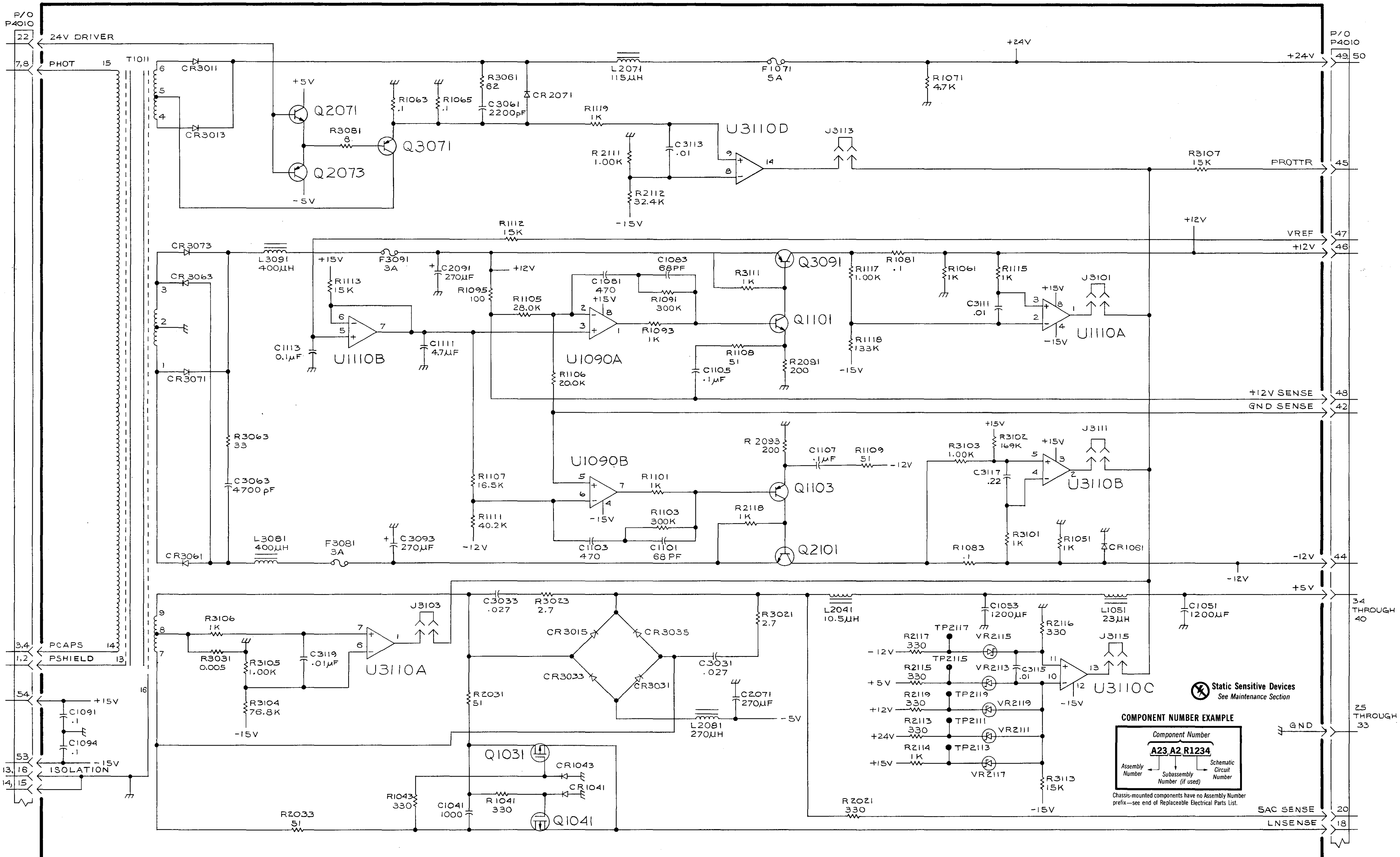
P.S. REFERENCE AND PROTECTION
54



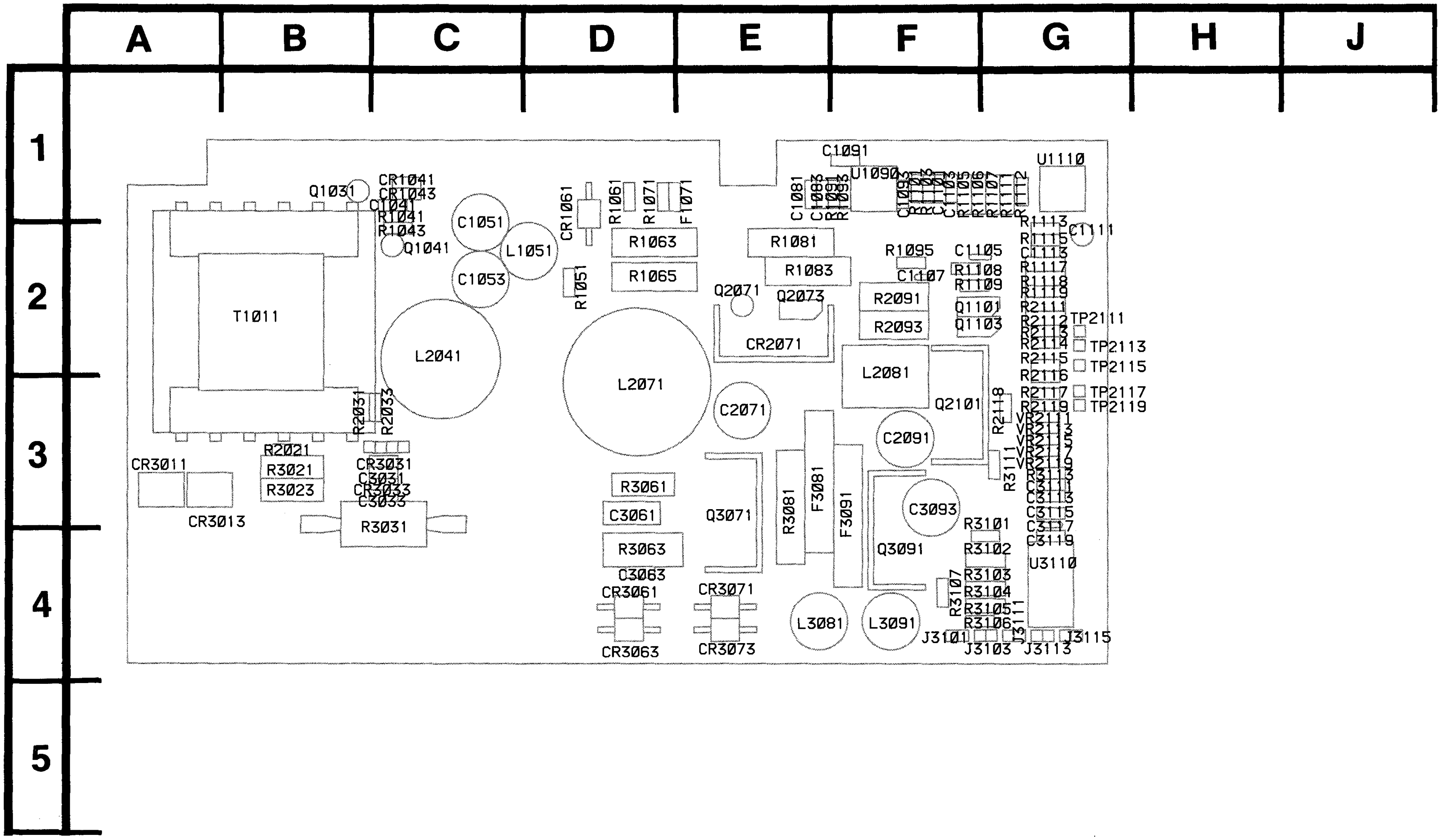
@ 12581-55

P.S. ±15V SUPPLY AND CONTROL

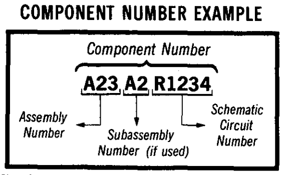
55



A66 P.S. SECONDARY BOARD



COMPONENT NUMBER EXAMPLE

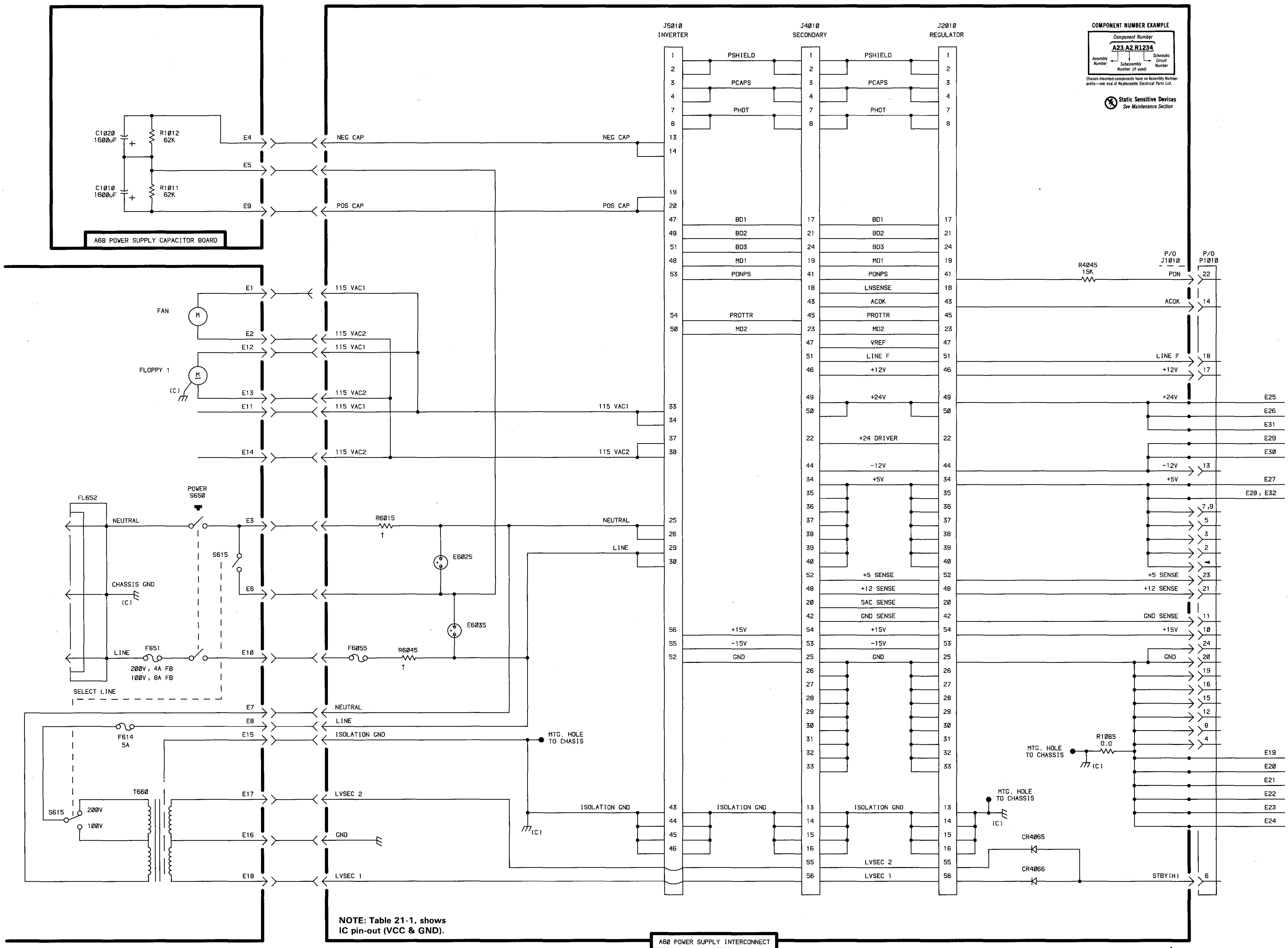


Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List.

Fig. 21-10. A66—Secondary Board.

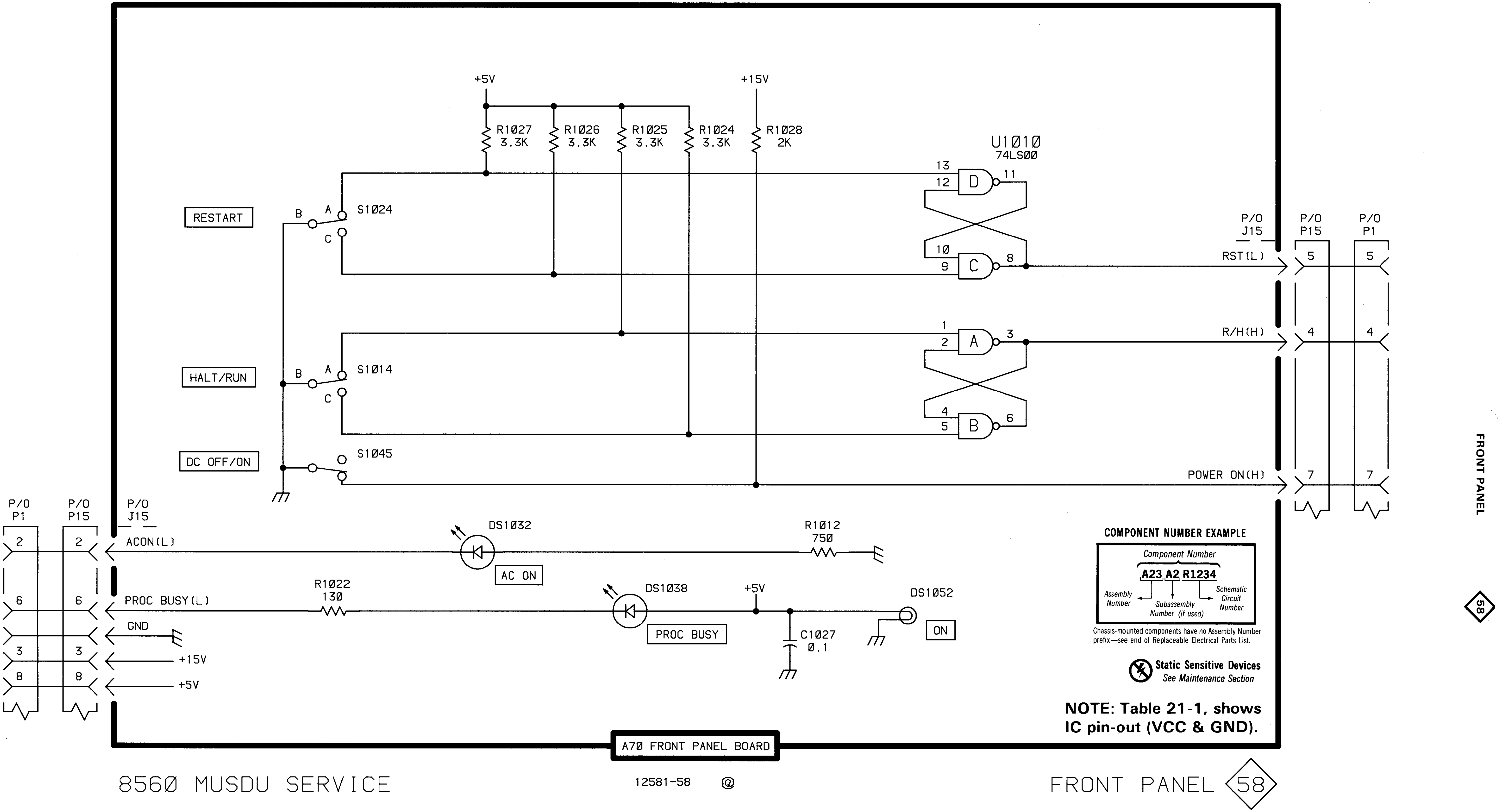
Static Sensitive Devices
See Maintenance Section

12581-136



P.S. INTERCONNECT BOARD

57


+5V
+15V
R1Ø27 3.3K
R1Ø26 3.3K
R1Ø25 3.3K
R1Ø24 3.3K
R1Ø28 2K
U1Ø1Ø 74LSØØ
RESTART
S1Ø24
HALT/RUN
S1Ø14
DC OFF/ON
S1Ø45
P/O J15
P/O P15
P/O P1
RST(L)
R/H(H)
POWER ON(H)
ACON(L)
DS1Ø32
AC ON
R1Ø12 75Ø
PROC BUSY(L)
R1Ø22 13Ø
DS1Ø38
PROC BUSY
DS1Ø52
ON
C1Ø27 Ø.1
GND
+15V
+5V
COMPONENT NUMBER EXAMPLE
Component Number
A23 A2 R1234
Assembly Number
Subassembly Number (if used)
Schematic Circuit Number
Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List.
Static Sensitive Devices
See Maintenance Section
NOTE: Table 21-1, shows IC pin-out (VCC & GND).
A7Ø FRONT PANEL BOARD
FRONT PANEL 58

SECTION 22
REPLACEABLE MECHANICAL PARTS

PARTS ORDERING INFORMATION

Replacement parts are available from or through your local ronix, Inc. Field Office or representative.

Changes to Tektronix instruments are sometimes made to mmodate improved components as they become available, to give you the benefit of the latest circuit improvements loped in our engineering department. It is therefore rtant, when ordering parts, to include the following mation in your order: Part number, instrument type or ɔer, serial number, and modification number if applicable.

If a part you have ordered has been replaced with a new or ɔved part, your local Tektronix, Inc. Field Office or sentative will contact you concerning any change in part ɔer.

Change information, if any, is located at the rear of this ıal.

SPECIAL NOTES AND SYMBOLS

X000 Part first added at this serial number

00X Part removed after this serial number

FIGURE AND INDEX NUMBERS

Items in this section are referenced by figure and index ɪers to the illustrations.

INDENTATION SYSTEM

This mechanical parts list is indented to indicate item relationships. Following is an example of the indentation system used in the description column.

1 2 3 4 5 Name & Description

Assembly and/or Component
Attaching parts for Assembly and/or Component
--- * ---
Detail Part of Assembly and/or Component
Attaching parts for Detail Part
--- * ---
Parts of Detail Part
Attaching parts for Parts of Detail Part
--- * ---

Attaching Parts always appear in the same indentation as the item it mounts, while the detail parts are indented to the right. Indented items are part of, and included with, the next higher indentation. The separation symbol --- * --- indicates the end of attaching parts.

Attaching parts must be purchased separately, unless otherwise specified.

ITEM NAME

In the Parts List, an Item Name is separated from the description by a colon (:). Because of space limitations, an Item Name may sometimes appear as incomplete. For further Item Name identification, the U.S. Federal Cataloging Handbook H6-1 can be utilized where possible.

ABBREVIATIONS

INCH	ELCTRN	ELECTRON	IN	INCH	SE	SINGLE END
NUMBER SIZE	ELEC	ELECTRICAL	INCAND	INCANDESCENT	SECT	SECTION
ACTUATOR	ELCTLT	ELECTROLYTIC	INSUL	INSULATOR	SEMICOND	SEMICONDUCTOR
ADAPTER	ELEM	ELEMENT	INTL	INTERNAL	SHLD	SHIELD
ALIGNMENT	EPL	ELECTRICAL PARTS LIST	LPHLDR	LAMPHOLDER	SHLDR	SHOULDERED
ALUMINUM	EQPT	EQUIPMENT	MACH	MACHINE	SKT	SOCKET
ASSEMBLED	EXT	EXTERNAL	MECH	MECHANICAL	SL	SLIDE
ASSEMBLY	FIL	FILLISTER HEAD	MTG	MOUNTING	SLFLKG	SELF-LOCKING
ATTENUATOR	FLEX	FLEXIBLE	NIP	NIPPLE	SLVG	SLEEVING
AMERICAN WIRE GAGE	FLH	FLAT HEAD	NON WIRE	NOT WIRE WOUND	SPR	SPRING
BOARD	FLTR	FILTER	OBD	ORDER BY DESCRIPTION	SQ	SQUARE
BRACKET	FR	FRAME or FRONT	OD	OUTSIDE DIAMETER	SST	STAINLESS STEEL
BRASS	FSTNR	FASTENER	OVH	OVAL HEAD	STL	STEEL
BRONZE	FT	FOOT	PH BRZ	PHOSPHOR BRONZE	SW	SWITCH
BUSHING	FXD	FIXED	PL	PLAIN or PLATE	T	TUBE
CABINET	GSKT	GASKET	PLSTC	PLASTIC	TERM	TERMINAL
CAPACITOR	HDL	HANDLE	PN	PART NUMBER	THD	THREAD
CERAMIC	HEX	HEXAGON	PNH	PAN HEAD	THK	THICK
CHASSIS	HEX HD	HEXAGONAL HEAD	PWR	POWER	TNSN	TENSION
CIRCUIT	HEX SOC	HEXAGONAL SOCKET	RCPT	RECEPTACLE	TPG	TAPPING
COMPOSITION	HLCPS	HELICAL COMPRESSION	RES	RESISTOR	TRH	TRUSS HEAD
CONNECTOR	HLEXT	HELICAL EXTENSION	RGD	RIGID	V	VOLTAGE
COVER	HV	HIGH VOLTAGE	RLF	RELIEF	VAR	VARIABLE
COUPLING	IC	INTEGRATED CIRCUIT	RTNR	RETAINER	W/	WITH
CATHODE RAY TUBE	ID	INSIDE DIAMETER	SCH	SOCKET HEAD	WSHR	WASHER
DEGREE	IDENT	IDENTIFICATION	SCOPE	OSCILLOSCOPE	XFMR	TRANSFORMER
DRAWER	IMPLR	IMPELLER	SCR	SCREW	XSTR	TRANSISTOR

CROSS INDEX—MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip
S3109	C/O PANEL COMPONENTS CORP.	P.O. BOX 6626	SANTA ROSA, CA 95406
S3629	PANEL COMPONENTS CORP.	2015 SECOND ST.	BERKELEY, CA 94170
000BH	FAB-TEK	17 SUGAR HALLOW ROAD	DANBURY, CT 06810
000JA	J. PHILLIP INDUSTRIES INC.	5713 NORTHWEST HIGHWAY	CHICAGO, ILL 60646
00779	AMP, INC.	P O BOX 3608	HARRISBURG, PA 17105
05574	VIKING INDUSTRIES, INC.	21001 NORDHOFF STREET	CHATSWORTH, CA 91311
06383	PANDUIT CORPORATION	17301 RIDGELAND	TINLEY PARK, IL 60477
06776	ROBINSON NUGENT INC.	800 E. 8TH ST., BOX 470	NEW ALBANY, IN 47150
09922	BURNDY CORPORATION	RICHARDS AVENUE	NORWALK, CT 06852
12327	FREEWAY CORPORATION	9301 ALLEN DRIVE	CLEVELAND, OH 44125
13103	THERMALLOY COMPANY, INC.	2021 W VALLEY VIEW LANE P O BOX 34829	DALLAS, TX 75234
15476	DIGITAL EQUIPMENT CORP.	146 MAIN ST.	MAYNARD, MA 01754
16428	BELDEN CORP.	P. O. BOX 1331	RICHMOND, IN 47374
22526	BERG ELECTRONICS, INC.	YOUK EXPRESSWAY	NEW CUMBERLAND, PA 17
23880	STANFORD APPLIED ENGINEERING, INC.	340 MARTIN AVE.	SANTA CLARA, CA 95050
26365	GRIES REPRODUCER CO., DIV. OF COATS AND CLARK, INC.	125 BEECHWOOD AVE.	NEW ROCHELLE, NY 108C
28520	HEYMAN MFG. CO.	147 N. MICHIGAN AVE.	KENILWORTH, NJ 07033
53387	MINNESOTA MINING AND MFG. CO., ELECTRO PRODUCTS DIVISION	3M CENTER	ST. PAUL, MN 55101
59730	THOMAS AND BETTS COMPANY	36 BUTLER ST.	ELIZABETH, NJ 07207
70485	ATLANTIC INDIA RUBBER WORKS, INC.	571 W. POLK ST.	CHICAGO, IL 60607
71400	BUSSMAN MFG., DIVISION OF MCGRAW-EDISON CO.	2536 W. UNIVERSITY ST.	ST. LOUIS, MO 63107
73743	FISCHER SPECIAL MFG. CO.	446 MORGAN ST.	CINCINNATI, OH 45206
75037	MINNESOTA MINING & MFG CO. ELECTRO PRODUCTS DIV.	3M CENTER	ST. PAUL, MN 55101
76381	MINNESOTA MINING AND MFG. CO.	3M CENTER	ST. PAUL, MN 55101
78189	ILLINOIS TOOL WORKS, INC. SHAKEPROOF DIVISION	ST. CHARLES ROAD	ELGIN, IL 60120
80009	TEKTRONIX, INC.	P O BOX 500	BEAVERTON, OR 97077
80126	PACIFIC ELECTRICORD CO.	747 W. REDONDO BEACH,P O BOX 10	GARDENA, CA 90247
83385	CENTRAL SCREW CO.	2530 CRESCENT DR.	BROADVIEW, IL 60153
86445	PENN FIBRE AND SPECIALTY CO., INC.	2032 E. WESTMORELAND ST.	PHILADELPHIA, PA 191
86928	SEASTROM MFG. COMPANY, INC.	701 SONORA AVENUE	GLENDALE, CA 91201
87308	N. L. INDUSTRIES, INC., SOUTHERN SCREW DIV.	P. O. BOX 1360	STATESVILLE, NC 2867
93907	TEXTRON INC. CAMCAR DIV	600 18TH AVE	ROCKFORD, IL 61101
95238	CONTINENTAL CONNECTOR CORP.	34-63 56TH ST.	WOODSIDE, NY 11377
95987	WECKESSER CO., INC.	4444 WEST IRVING PARK RD.	CHICAGO, IL 60641
98159	RUBBER TECK, INC.	19115 HAMILTON AVE., P O BOX 389	GARDENA, CA 90247

	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5 Name & Description	Mfr Code	Mfr Part Number
	672-1028-00			1	CKT BOARD ASSY:SD FRONT PANEL	80009	672-1028-00
	333-2890-00			1	. PANEL,FRONT:	80009	333-2890-00
	----- -----			1	. SWITCH,ROCKER:(SEE S1045 REPL)		
	----- -----			2	. SWITCH,TOGGLE:(SEE S1014 & S1024 REPL)		
	352-0157-00			3	. LAMPHOLDER:WHITE PLASTIC	80009	352-0157-00
	378-0602-00			1	. LENS,LIGHT:GREEN	80009	378-0602-00
	378-0602-01			2	. LENS,LIGHT:AMBER	80009	378-0602-01
	----- -----			3	. LT EMITTING DIO:(SEE DS1032,1038 & 1052 REPL)		
	200-0935-00			1	. BASE,LAMPHOLDER:0.29 OD X 0.19 CASE	80009	200-0935-00
	214-2964-00			2	. SPRING,PANEL:COPPER-BERYLLIUM	80009	214-2964-00
					(ATTACHING PARTS)		
	210-0586-00			4	. NUT,PL,ASSEM WA:4-40 X 0.25,STL CD PL	83385	OBD
0	343-0831-00			2	. RETAINER,SPR:ALUMINUM	80009	343-0831-00
					- - - * - - -		
1	----- -----			1	. CKT BOARD ASSY:FRONT PANEL(SEE A70 REPL)		
					(ATTACHING PARTS)		
2	211-0116-00			2	. SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH BRS	83385	OBD
					- - - * - - -		
	----- -----			-	. . CKT BOARD ASSY INCLUDES:		
3	131-0608-00			8	. . TERMINAL,PIN:0.365 L X 0.025 PH BRZ GOLD	22526	47357
	334-4471-00			1	. . MARKER,IDENT:MKD 670-7474-XX	80009	334-4471-00
4	386-4226-00			1	. SUBPANEL,FRONT:CONTROL	80009	386-4226-00
5	129-0851-00			3	SPACER,POST:0.709 L W/6-32 INT THD	80009	129-0851-00
6	210-0006-00			3	WASHER,LOCK:#6 INTL,0.018THK,STL CD PL	78189	1206-00-00-0541C
7	210-0802-00			3	WASHER,FLAT:0.15 ID X 0.312 INCH OD	12327	OBD
8	378-0197-00			2	GRILL,PLASTIC:5.62 L X 3.12 W	80009	378-0197-00
	101-0079-00			1	TRIM,DECORATIVE:SILVER GRAY	80009	101-0079-00
9	101-0083-00			1	TRIM,DECORATIVE:FACADE	80009	101-0083-00
					(ATTACHING PARTS)		
0	211-0507-00			3	SCREW,MACHINE:6-32 X 0.312 INCH,PNH STL	83385	OBD
1	211-0511-00			4	SCREW,MACHINE:6-32 X 0.500,PNH,STL,CD PL	83385	OBD
					- - - * - - -		
2	220-0884-00			4	NUT,BAR:0.312 SQ X 3.234 L	80009	220-0884-00
					(ATTACHING PARTS)		
3	211-0512-00			8	SCREW,MACHINE:6-32 X 0.50" 100 DEG,FLH STL	83385	OBD
					- - - * - - -		
	334-4228-00			1	MARKER,IDENT:MKD 8560 SOFTWARE DEV UNIT	80009	334-4228-00
4	426-1888-00			1	FRAME,CABINET:OPEN FRONT	80009	426-1888-00
5	390-0749-03			1	CABINET BOTTOM:EARTH BROWN	80009	390-0749-03
	390-0752-03			1	CABINET TOP:EARTH BROWN	80009	390-0752-03
6	390-0750-03			2	CABINET SIDE:EARTH BROWN	80009	390-0750-03
7	124-0367-03			1	STRIP,TRIM:CORNER,TOP,PVC,EARTH BROWN	80009	124-0367-03
8	124-0366-03			1	STRIP,TRIM:CORNER,BOT,PVC,EARTH BROWN	80009	124-0366-03
9	426-1886-00			1	FR SECT,CORNER:UPPER LEFT/LOWER RIGHT	80009	426-1886-00
					(ATTACHING PARTS)		
0	211-0507-00			4	SCREW,MACHINE:6-32 X 0.312 INCH,PNH STL	83385	OBD
1	213-0801-00			2	SCREW,TPG,TF:8-32 X 0.312,TAPTITE,PNH	93907	OBD
2	348-0617-04			2	FOOT,CABINET:BOT,EARTH BROWN	80009	348-0617-04
3	348-0596-00			2	PAD,CAB.FOOT:0.69 X 0.255 X 0.06,PU	80009	348-0596-00
4	426-1887-00			1	FR SECT,DEV UN:UPPER RIGHT/LOWER LEFT	80009	426-1887-00
					(ATTACHING PARTS)		
5	211-0507-00			4	SCREW,MACHINE:6-32 X 0.312 INCH,PNH STL	83385	OBD
	213-0801-00			2	SCREW,TPG,TF:8-32 X 0.312,TAPTITE,PNH	93907	OBD
					- - - * - - -		
6	441-1617-00			1	CHASSIS,FLEX DR:	80009	441-1617-00
					(ATTACHING PARTS)		
7	212-0023-00			6	SCREW,MACHINE:8-32 X 0.375 INCH,PNH STL	83385	OBD
8	211-0559-00			4	SCREW,MACHINE:6-32 X 0.375"100 DEG,FLH STL	83385	OBD
					- - - * - - -		
9	426-1652-00			1	FR SECT,DEV UN:SIDE RAIL	80009	426-1652-00
					(ATTACHING PARTS)		
0	213-0863-00			4	SCREW,TPG,TF:8-32 X 1.375,TAPTITE,FILH	93907	OBD
					- - - * - - -		

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5 Name & Description	Mfr Code	Mfr Part Number
2-1	175-2588-00			1	CA ASSY,SP,ELEC:8,22 AWG,9.0 L	80009	175-2588-00
	352-0166-00			2	. CONN BODY,PL,EL:8 WIRE BLACK	80009	352-0166-00
-2	175-4168-00			1	CA ASSY,SP,ELEC:50,28 AWG,24.0 L,RIBBON	80009	175-4168-00
-3	175-4538-00			1	CA ASSY,SP,ELEC:50,28 AWG,5.0 L,RIBBON	80009	175-4538-00
-4	175-4541-00			1	CA ASSY,SP,ELEC:34 AWG,7.625 L,RIBBON	80009	175-4541-00
-5	----- -----			1	CKT BOARD ASSY:BACKPLANE(SEE A10 REPL)		
					(ATTACHING PARTS)		
-6	211-0601-00			5	SCR,ASSEM WSHR:6-32 X 0.312,DOUBLE SEMS	83385	OBD
-7	211-0016-00			2	SCREW,MACHINE:4-40 X 0.625 INCH,PNH STL	83385	OBD
-8	210-0586-00			2	NUT,PL,ASSEM WA:4-40 X 0.25,STL CD PL	83385	OBD
					- - - * - - -		
	----- -----			-	. CKT BOARD ASSY INCLUDES:		
-9	131-1973-00			2	. CONN,RCPT,ELEC:CKT BD,36 CONT W/O MTG TABS	15476	H807
-10	131-0993-00			14	. BUS,CONDUCTOR:2 WIRE BLACK	00779	530153-2
-11	131-1343-00			1	. TERM. SET,PIN:36-0.525 L X 0.025 SQ	22526	65501-136
-12	131-2409-00			1	. CONN,RCPT,ELEC:CKT BD,2 X 25,MALE	75037	3496-2003
-13	131-1939-00			2	. TERM. SET,PIN:1 X 14,0.15 SPACING	22526	65561-114
-14	131-2727-00			1	. CONN,RCPT,ELEC:HEADER,2 X 20,0.100 CTR	53387	3495-2003
-15	131-2410-00			1	. CONN,RCPT,ELEC:CKT BD,2 X 25,MALE RTANG	75037	3494-2003
-16	131-2406-00			1	. CONN,RCPT,ELEC:CKT BD,2 X 17,MALE RTANG	75037	3494-2003
-17	131-2240-00			8	. CONN,RCPT,ELEC:CKT BD,50/100CONT	05574	000201-5256
-18	131-1425-00			1	. CONTACT SET,ELE:R ANGLE,0.150" L,STR OF 36	22526	65521-136
-19	348-0596-00			2	PAD,CAB.FOOT:0.69 X 0.255 X 0.06,PU	80009	348-0596-00
-20	348-0617-04			2	FOOT,CABINET:BOT,EARTH BROWN	80009	348-0617-04
-21	124-0366-03			1	STRIP,TRIM:CORNER,BOTTOM,PVC,EARTH BRN	80009	124-0366-03
-22	124-0367-03			1	STRIP,TRIM:CORNER,TOP,PVC,EARTH BRN	80009	124-0367-03
-23	426-1886-00			1	FR SECT,CORNER:UPPER LEFT/LOWER RIGHT	80009	426-1886-00
					(ATTACHING PARTS)		
-24	211-0510-00			4	SCREW,MACHINE:6-32 X 0.375,PNH,STL,CD PL	83385	OBD
	213-0863-00			2	SCREW,TPG,TF:8-32 X 1.375,TAPTITE,FILH	93907	OBD
					- - - * - - -		
-25	426-1887-00			1	FR SECT,DEV UN:UPPER RIGHT/LOWER LEFT	80009	426-1887-00
					(ATTACHING PARTS)		
-26	211-0510-00			5	SCREW,MACHINE:6-32 X 0.375,PNH,STL,CD PL	83385	OBD
	213-0863-00			2	SCREW,TPG,TF:8-32 X 1.375,TAPTITE,FILH	93907	OBD
					- - - * - - -		
-27	361-0982-00			2	SPACER,PLATE:0.062 THK X 12.087 L X 0.6 W	80009	361-0982-00
-28	426-1652-00			1	FR SECT,DEV UN:SIDE RAIL	80009	426-1652-00
					(ATTACHING PARTS)		
-29	211-0511-00			5	SCREW,MACHINE:6-32 X 0.500,PNH,STL,CD PL	83385	OBD
	213-0863-00			4	SCREW,TPG,TF:8-32 X 1.375,TAPTITE,FILH	93907	OBD
					- - - * - - -		
-30	361-1018-00			4	SPACER,POST:0.518 L,W/6-32 THD THRU,AL	80009	361-1018-00
	385-0080-00			2	SPACER,POST:0.437 L W/6-32 THD THRU,AL	80009	385-0080-00
					(ATTACHING PARTS)		
-31	211-0507-00			6	SCREW,MACHINE:6-32 X 0.312 INCH,PNH STL	83385	OBD
					- - - * - - -		
-32	----- -----			1	CKT BOARD ASSY:I/O ADAPTER(SEE A35 REPL)		
					(ATTACHING PARTS)		
-33	211-0601-00			6	SCR,ASSEM WSHR:6-32 X 0.312,DOUBLE SEMS	83385	OBD
					- - - * - - -		
	----- -----			-	. CKT BOARD ASSY INCLUDES:		
-34	198-4498-00			8	. WIRE SET,ELEC:	80009	198-4498-00
-35	131-0608-00			196	. TERMINAL,PIN:0.365 L X 0.025 PH BRZ GOLD	22526	47357
-36	136-0729-00			15	. SKT,PL-IN ELEK:MICROCKT,16 CONTACT	09922	DILB16P-108
-37	214-2518-00			1	. HEAT SINK,XSTR:TO-220 OR TO-202	000BH	106B-B-HT
-38	131-2406-00			1	. CONN,RCPT,ELEC:CKT BD,2 X 17,MALE	75037	3494-2003
-39	131-2409-00			1	. CONN,RCPT,ELEC:CKT BD,2 X 25,MALE	75037	3496-2003
-40	386-4227-00			1	SUBPANEL,FRONT:	80009	386-4227-00
					(ATTACHING PARTS)		
-41	211-0507-00			4	SCREW,MACHINE:6-32 X 0.312 INCH,PNH STL	83385	OBD
					- - - * - - -		
-42	334-4230-00			1	PLATE,IDENT:CARD CAGE	80009	334-4230-00
-43	386-4710-00			1	CAGE,CKT BD:	80009	386-4710-00
					(ATTACHING PARTS)		
-44	212-0023-00			6	SCREW,MACHINE:8-32 X 0.375 INCH,PNH STL	83385	OBD
					- - - * - - -		

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5 Name & Description	Mfr Code	Mfr Part Number
2-45	386-4706-00			1	SUPPORT,CHASSIS:ALUMINUM	80009	386-4706-00
					(ATTACHING PARTS)		
-46	211-0507-00			3	SCREW,MACHINE:6-32 X 0.312 INCH,PNH STL	83385	OBD
					- - - * - - -		
-47	441-1626-00			1	CHAS,CARD CAGE:REAR	80009	441-1626-00
					(ATTACHING PARTS)		
-48	211-0507-00			3	SCREW,MACHINE:6-32 X 0.312 INCH,PNH STL	83385	OBD
					- - - * - - -		
	----- -----			-	. CARD CAGE INCLUDES:		
-49	351-0303-00			8	. GUIDE,CKT CARD:3 INCH LONG,PLASTIC	80009	351-0303-00
	351-0087-00			10	. GUIDE,CKT BOARD:4.75 INCH LONG,PLASTIC	80009	351-0087-00

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5 Name & Description	Mfr Code	Mfr Part Number
3-1	----- -----			1	CKT BOARD ASSY:UTILITY(SEE A20 REPL)		
-2	105-0792-00			2	. EJECTOR,CKT BD:PLASTIC	80009	105-0792-00
-3	214-1337-00			2	. . PIN,SPRING:0.10 OD X 0.25 INCH L,STL	80009	214-1337-00
-4	131-0608-00			98	. TERMINAL,PIN:0.365 L X 0.025 PH BRZ GOLD	22526	47357
	131-0589-00			2	. TERMINAL,PIN:0.46 L X 0.025 SQ	80009	131-0589-00
-5	131-0993-00			32	. BUS,CONDUCTOR:2 WIRE BLACK	00779	530153-2
-6	136-0751-00			2	. SKT,PL-IN ELEK:MICROCKT,24 PIN,LOW PROFILE	09922	DILB24P108
-7	----- -----			16	. BUS CONDUCTOR:(SEE A20W1098,2094,2095,3091,		
	----- -----			-	. 4016,4018,4031,4041,4043,4045,5061,		
	----- -----			-	. 6101,7012,7013,7016,7017 REPL)		
-8	----- -----			1	CKT BOARD ASSY:I/O PROCESSOR(SEE A30 REPL)		
-9	105-0792-00			2	. EJECTOR,CKT BD:PLASTIC	80009	105-0792-00
-10	214-1337-00			2	. . PIN,SPRING:0.10 OD X 0.25 INCH L,STL	80009	214-1337-00
-11	131-0608-00			110	. TERMINAL,PIN:0.365 L X 0.025 PH BRZ GOLD	22526	47357
-12	131-0993-00			22	. BUS,CONDUCTOR:2 WIRE BLACK	00779	530153-2
-13	131-0993-07			7	. LINK,TERM.CONNE:2 WIRE VIOLET	00779	530153-7
-14	136-0755-00			10	. SKT,PL-IN ELEK:MICROCIRCUIT,28 DIP	09922	DILB28P-108
-15	136-0757-00			4	. SKT,PL-IN ELEK:MICROCIRCUIT,40 DIP	09922	DILB40P-108
-16	----- -----			1	CKT BOARD ASSY:64K MEMORY(SEE A25 REPL)		
-17	105-0792-00			2	. EJECTOR,CKT BD:PLASTIC	80009	105-0792-00
-18	214-1337-00			2	. . PIN,SPRING:0.10 OD X 0.25 INCH L,STL	80009	214-1337-00
-19	131-0608-00			55	. TERMINAL,PIN:0.365 L X 0.025 PH BRZ GOLD	22526	47357
-20	131-0993-00			15	. BUS,CONDUCTOR:2 WIRE BLACK	00779	530153-2
-21	----- -----			2	. BUS CONDUCTOR:(SEE A25W7108,7109 REPL)		
-22	----- -----			1	CKT BOARD ASSY:PMS CONTROLLER(SEE A45 REPL)		
-23	105-0792-00			2	. EJECTOR,CKT BD:PLASTIC	80009	105-0792-00
-24	214-1337-00			2	. . PIN,SPRING:0.10 OD X 0.25 INCH L,STL	80009	214-1337-00
-25	136-0691-00			1	. SKT,PL-IN ELEK:MICROCKT,12 CONT LOW	23880	C5A-3200-12B
-26	136-0449-00			2	. SKT,PL-IN ELEK:MICROCIRCUIT,25 CONTACT	06776	SB-25-G
-27	136-0751-00			1	. SKT,PL-IN ELEK:MICROCKT,24 PIN,LOW PROFILE	09922	DILB24P108
-28	136-0755-00			2	. SKT,PL-IN ELEK:MICROCIRCUIT,28 DIP	09922	DILB28-108
-29	136-0757-00			3	. SKT,PL-IN ELEK:MICROCIRCUIT,40 DIP	09922	DILB40P-108
-30	131-0608-00			261	. TERMINAL,PIN:0.365 L X 0.025 PH BRZ GOLD	22526	47357
-31	131-0993-00			62	. BUS,CONDUCTOR:2 WIRE BLACK	00779	530153-2
-32	175-4093-00			1	CA ASSY,SP,ELEC:34,28 AWG,18.0 L,RIBBON	80009	175-4093-00
-33	----- -----			1	CKT BOARD ASSY:M1220(SEE A50 REPL)		
-34	131-0608-00			146	. TERMINAL,PIN:0.365 L X 0.025 PH BRZ GOLD	22526	47357
-35	131-0993-00			21	. BUS,CONDUCTOR:2 WIRE BLACK	00779	530153-2
-36	136-0755-00			1	. SKT,PL-IN ELEK:MICROCIRCUIT,28 DIP	09922	DILB28P-108
-37	136-0751-00			1	. SKT,PL-IN ELEK:MICROCKT,24 PIN,LOW PROFILE	09922	DILB24P108
-38	136-0757-00			1	. SKT,PL-IN ELEK:MICROCIRCUIT,40 DIP	09922	DILB40P-108
-39	351-0213-00			4	. GUIDE-POST,LOCK:0.285 INCH LONG	71400	2839
-40	211-0121-00			4	. SCR,ASSEM WSHR:4-40 X 0.438 INCH,PNH BRS	83385	OBD
-41	----- -----			1	CKT BOARD ASSY:CPU(SEE A15 REPL)		
-42	367-0183-00			2	. PULL,CKT CARD:	15476	0937
-43	131-0623-00			4	. CONN,RCPT,ELEC:EDGE CARD,50/100 CONT	05574	600201-3221
-44	131-1343-00			1	. TERM. SET,PIN:36-0.525 L X 0.025 SQ	22526	65501-136
	----- -----			1	. BUS,CONDUCTOR:(SEE A15W3 REPL)		

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5 Name & Description	Mfr Code	Mfr Part Number
4-1	337-2977-00			1	SHIELD,ELEC:TOP	80009	337-2977-00
					(ATTACHING PARTS)		
-2	211-0097-00			1	SCREW,MACHINE:4-40 X 0.312 INCH,PNH STL	83385	OBD
					- - - * - - -		
-3	337-2976-00			2	SHIELD,ELEC:SIDE	80009	337-2976-00
-4	211-0507-00			6	SCREW,MACHINE:6-32 X 0.312 INCH,PNH STL	83385	OBD
					- - - * - - -		
-5	129-0223-00			1	SPACER,POST:0.80 L,W/6-32THD EA END	80009	129-0223-00
					(ATTACHING PARTS)		
-6	211-0510-00			1	SCREW,MACHINE:6-32 X 0.375,PNH,STL,CD PL	83385	OBD
-7	210-0006-00			1	WASHER,LOCK:#6 INTL,0.018THK,STL CD PL	78189	1206-00-00-0541C
					- - - * - - -		
-8	407-2366-00			1	BRKT,CKT BD GUI:POWER SUPPLY	80009	407-2366-00
					(ATTACHING PARTS)		
-9	211-0510-00			4	SCREW,MACHINE:6-32 X 0.375,PNH,STL,CD PL	83385	OBD
					- - - * - - -		
	----- -----			-	. CKT BOARD BRACKET INCLUDES:		
-10	351-0103-00			3	. SLIDE,STRAP:12.6 X 0.063,AL	80009	351-0103-00
-11	----- -----			1	TRANSFORMER:(SEE T660 REPL)		
					(ATTACHING PARTS)		
-12	211-0507-00			2	SCREW,MACHINE:6-32 X 0.312 INCH,PNH STL	83385	OBD
-13	210-0005-00			2	WASHER,LOCK:#6 EXT,0.02 THK,STL	78189	1106-00
					- - - * - - -		
	195-0439-00			1	LEAD,ELECTRICAL:18 AWG,10.0 L,8-01	80009	195-0439-00
	195-0440-00			1	LEAD,ELECTRICAL:18 AWG,13.0 L,8-16	80009	195-0440-00
	195-0441-00			1	LEAD,ELECTRICAL:18 AWG,11.0 L,8-26	80009	195-0441-00
	195-0442-00			1	LEAD,ELECTRICAL:18 AWG,6.0 L,8-26	80009	195-0442-00
	195-0443-00			1	LEAD,ELECTRICAL:18 AWG,5.0 L,8-0	80009	195-0443-00
	195-0444-00			1	LEAD,ELECTRICAL:18 AWG,6.0 L,8-2	80009	195-0444-00
	195-1600-00			1	LEAD,ELECTRICAL:18 AWG,17.0 L,8-03	80009	195-1600-00
	195-1601-00			1	LEAD,ELECTRICAL:18 AWG,6.0L,8-01	80009	195-1601-00
	198-4240-00			1	WIRE SET,ELEC:	80009	198-4240-00
	198-4241-00			1	WIRE SET,ELEC:	80009	198-4241-00
	198-4486-00			1	WIRE SET,ELEC:	80009	198-4486-00
	348-0003-00			1	. GROMMET,RUBBER:0.312 INCH DIAMETER	70485	1411B6040
	198-4509-00			1	WIRE SET,ELEC:	80009	198-4509-00
	352-0467-00			1	. HOLDER,BEARING:ALUMINUM	80009	352-0467-00
-14	343-0844-00			1	RETAINER,CAP:PLASTIC	80009	343-0844-00
					(ATTACHING PARTS)		
-15	211-0513-00			1	SCREW,MACHINE:6-32 X 0.625 INCH,PNH STL	83385	OBD
-16	210-0005-00			1	WASHER,LOCK:#6 EXT,0.02 THK,STL	78189	1106-00
-17	210-0802-00			1	WASHER,FLAT:0.15 ID X 0.312 INCH OD	12327	OBD
					- - - * - - -		
-18	----- -----			1	CKT BOARD ASSY:PS CAP(SEE A68 REPL)		
-19	----- -----			2	. CAP.,FXD,ELCTLT:(SEE A68C1010,1020 REPL)		
					(ATTACHING PARTS)		
-20	212-0518-00			4	. SCREW,MACHINE:10-32 X 0.312 INCH,PNH STL	83385	OBD
-21	210-0010-00			4	. WASHER,LOCK:INT,0.20 ID X0.376" OD,STL	78189	1210-00-00-0541C
-22	210-0805-00			4	. WASHER,FLAT:0.204 ID X 0.438 INCH OD,STL	12327	OBD
-23	129-0089-00			1	POST,ELEC-MECH:6-32 X 0.25 X0.83 INCH L	80009	129-0089-00
-24	210-0005-00			1	WASHER,LOCK:#6 EXT,0.02 THK,STL	78189	1106-00
-25	----- -----			1	CKT BOARD ASSY:PS INTERCONNECT(SEE A60 REPL)		
					(ATTACHING PARTS)		
-26	211-0601-00			4	SCR,ASSEM WSHR:6-32 X 0.312,DOUBLE SEMS	83385	OBD
					- - - * - - -		
	----- -----			-	. CKT BOARD ASSY INCLUDES:		
-27	----- -----			1	. RESISTOR:(SEE A60W1065 REPL)		
-28	131-0589-00			2	. TERMINAL,PIN:0.46 L X 0.025 SQ	80009	131-0589-00
-29	131-2194-01			1	. CONN,RCPT,ELEC:CKT BD,12/24 MALE,R ANGLE	00779	1-87229-2
-30	131-1078-00			3	. CONNECTOR,RCPT,:28/56 CONTACT	95238	600-1156Y25GDF30
-31	352-0482-00			1	HOLDER,CA,TIE:0.75 SQ,STICKY BACK,PLASTIC	06383	ABMM-A
-32	343-0549-00			4	STRAP,TIEDOWN:0.091 W X 3.62 INCH LONG	59730	TY100
-33	210-0202-00			2	TERMINAL,LUG:0.146 ID,LOCKING,BRZ TINNED	78189	2104-06-00-2520N
					(ATTACHING PARTS)		
-34	210-0407-00			2	NUT,PLAIN,HEX.:6-32 X 0.25 INCH,BRS	73743	3038-0228-402
					- - - * - - -		

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5 Name & Description	Mfr Code	Mfr Part Number
4-35	334-3379-02			1	MARKER,IDENT:MARKED GROUND SYMBOL	80009	334-3379-02
-36	348-0442-00			2	GROMMET,PLASTIC:BLACK,ROUND,0.375" ID	28520	SB-500-6
-37	441-1497-00			1	CHAS,PWR SUPPLY:REAR,ALUMINUM	80009	441-1497-00
-38	343-0775-00			3	CLIP,SPR TNSN:	76381	3484-1000
	343-0549-00			2	STRAP,TIEDOWN:0.091 W X 3.62 INCH LONG	59730	TY100
-39	352-0515-00			1	FUSEHOLDER:(1)3AG,15A,250V,CHASSIS MTG	71400	2839
					(ATTACHING PARTS)		
-40	211-0510-00			1	SCREW,MACHINE:6-32 X 0.375,PNH,STL,CD PL	83385	OBD
-41	210-0457-00			1	NUT,PL,ASSEM WA:6-32 X 0.312 INCH,STL	83385	OBD
					- - - * - - -		
-42	441-1499-00			1	CHAS,PWR SUPPLY:ALUMINUM	80009	441-1499-00
					(ATTACHING PARTS)		
-43	210-0507-00			10	RING,EXT THD:0.437-28 X 0.437 OD,BRS CD	80009	210-0507-00
					- - - * - - -		
	----- -----			-	. BRACKET INCLUDES:		
-44	351-0303-00			3	. GUIDE,CKT CARD:3 INCH LONG,PLASTIC	80009	351-0303-00
-45	----- -----			1	CKT BOARD ASSY:PS INVERTER(SEE A62 REPL)		
-46	----- -----			2	. TRANSISTOR:(SEE A62Q2025,Q5025 REPL)		
					(ATTACHING PARTS)		
-47	211-0511-00			2	. SCREW,MACHINE:6-32 X 0.500,PNH,STL,CD PL	83385	OBD
-48	210-0457-00			2	. NUT,PL,ASSEM WA:6-32 X 0.312 INCH,STL	83385	OBD
					- - - * - - -		
-49	342-0420-00			2	. INSULATOR,PLATE:TRANSISTOR,PORCELAIN	80009	342-0420-00
-50	342-0577-00			2	. INSULATOR,XSTR:PLASTIC	80009	342-0577-00
-51	----- -----			1	. SWITCH:(SEE A62SW3018 REPL)		
					(ATTACHING PARTS)		
-52	211-0116-00			2	. SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH BRS	83385	OBD
					- - - * - - -		
-53	214-3315-00			1	. HT SK,MICROCKT:ALUMINUM	13103	OBD
-54	----- -----			1	. TEST POINT:(SEE A62TP6069 REPL)		
-55	136-0252-07			6	. SOCKET,PIN CONN:W/O DIMPLE	22526	75060-012
-56	----- -----			1	. COIL,RF:(SEE A62L3044 REPL)		
-57	346-0032-00			1	. STRAP,RETAINING:0.075 DIA X 4.0 L,MLD RBR	98159	2859-75-4
-58	210-0917-00			1	. WASHER,NONMETAL:0.191 ID X 0.625 INCH OD	86445	OBD
-59	----- -----			1	. SEMICOND DEVICE:(SEE A62CR1041 REPL)		
					(ATTACHING PARTS)		
-60	211-0513-00			1	. SCREW,MACHINE:6-32 X 0.625 INCH,PNH STL	83385	OBD
-61	210-0457-00			1	. NUT,PL,ASSEM WA:6-32 X 0.312 INCH,STL	83385	OBD
					- - - * - - -		
-62	214-3258-00			1	. HEAT SINK,XSTR:ALUMINUM	80009	214-3258-00
-63	342-0577-00			1	. INSULATOR,XSTR:PLASTIC	80009	342-0577-00
-64	----- -----			2	. TRANSISTOR:(SEE A62Q2069,2076 REPL)		
					(ATTACHING PARTS)		
-65	211-0558-00			2	. SCREW,MACHINE:6-32 X 0.250 BDGH,NYL,SLOT	26365	921-1150-0014
					- - - * - - -		
-66	342-0420-00			2	. INSULATOR,PLATE:TRANSISTOR,PORCELAIN	80009	342-0420-00
-67	214-3313-00			1	. HEAT SINK,XSTR:TO-220,AL	80009	214-3313-00
-68	----- -----			3	. TRANSISTOR:(SEE A62Q4058,4069,4075 REPL)		
					(ATTACHING PARTS)		
-69	211-0558-00			3	. SCREW,MACHINE:6-32 X 0.250 BDGH,NYL,SLOT	26365	921-1150-0014
					- - - * - - -		
-70	342-0420-00			3	. INSULATOR,PLATE:TRANSISTOR,PORCELAIN	80009	342-0420-00
-71	214-3300-00			1	. HEAT SINK,XSTR:TO-220,AL	80009	214-3300-00
-72	----- -----			1	CKT BOARD ASSY:PS SECONDARY(SEE A66 REPL)		
-73	342-0597-00			1	. INSULATOR,DIODE:1.625 X 0.8 X 0.16,CERAMIC	80009	342-0597-00
					(ATTACHING PARTS)		
-74	212-0066-00			2	. SCREW,MACHINE:8-32 X 0.500,RDH,NYL,SLOT	95987	OBD
					- - - * - - -		
-75	----- -----			2	. SEMICOND DEVICE:(SEE A66CR3015,CR3035 REPL)		
	175-4700-00			1	. CA ASSY,SP,ELEC:4,26 AWG,3.0 L,RIBBON	80009	175-4700-00
-76	214-3257-00			1	. HEAT SINK,DIODE:ALUMINUM	80009	214-3257-00
					(ATTACHING PARTS)		
-77	211-0507-00			2	. SCREW,MACHINE:6-32 X 0.312 INCH,PNH STL	83385	OBD
-78	210-0005-00			2	. WASHER,LOCK:#6 EXT,0.02 THK,STL	78189	1106-00
					- - - * - - -		

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5 Name & Description	Mfr Code	Mfr Part Number
4-79	----- -----			1	. RESISTOR:(SEE A66R3031 REPL)		
					(ATTACHING PARTS)		
-80	211-0001-00			2	. SCREW,MACHINE:2-56 X 0.25 INCH,PNH STL	87308	OBD
					- - - * - - -		
-81	----- -----			1	. COIL,RF:(SEE A66L2071 REPL)		
					(ATTACHING PARTS)		
-82	211-0019-00			1	. SCREW,MACHINE:4-40 X 1.0 INCH,PNH STL	83385	OBD
-83	210-0586-00			1	. NUT,PL,ASSEM WA:4-40 X 0.25,STL CD PL	83385	OBD
-84	210-1275-00			1	. WASHER,FLAT:0.128 ID X 0.32 THK,FIBRE	86928	5602-62-32
					- - - * - - -		
-85	----- -----			2	. COIL,RF:(SEE A66L3081,L3091 REPL)		
					(ATTACHING PARTS)		
-86	211-0019-00			2	. SCREW,MACHINE:4-40 X 1.0 INCH,PNH STL	83385	OBD
-87	210-0586-00			2	. NUT,PL,ASSEM WA:4-40 X 0.25,STL CD PL	83385	OBD
-88	210-0917-00			2	. WASHER,NONMETAL:0.191 ID X 0.625 INCH OD	86445	OBD
					- - - * - - -		
-89	----- -----			5	. TEST POINT:(SEE A66TP2111 THRU TP2119 REPL)		
-90	131-0993-00			5	. BUS,CONDUCTOR:2 WIRE BLACK	00779	530153-2
-91	131-0608-00			10	. TERMINAL,PIN:0.365 L X 0.025 PH BRZ GOLD	22526	47357
-92	----- -----			4	. TRANSISTOR:(SEE A66CR2071,Q2101,Q3071,		
	----- -----			-	. Q3091 REPL)		
					(ATTACHING PARTS)		
-93	211-0507-00			4	. SCREW,MACHINE:6-32 X 0.312 INCH,PNH STL	83385	OBD
-94	210-0457-00			4	. NUT,PL,ASSEM WA:6-32 X 0.312 INCH,STL	83385	OBD
					- - - * - - -		
-95	214-2953-00			4	. HEAT SINK,XSTR:TO-220,AL	13103	OBD
-96	407-2787-00			1	BRACKET,HT SINK:ALUMINUM	80009	407-2787-00
					(ATTACHING PARTS)		
-97	211-0507-00			2	SCREW,MACHINE:6-32 X 0.312 INCH,PNH STL	83385	OBD
					- - - * - - -		
-98	----- -----			1	CKT BOARD ASSY:PS REGULATOR(SEE A64 REPL)		
-99	214-2518-00			2	. HEAT SINK,XSTR:TO-220 OR TO-202	000BH	106B-B-HT
-100	----- -----			15	. TERM,TEST PT:(SEE A64TP6011 THRU TP6077 REPL)		
-101	131-0993-00			2	. BUS,CONDUCTOR:2 WIRE BLACK	00779	530153-2
-102	131-0608-00			8	. TERMINAL,PIN:0.365 L X 0.025 PH BRZ GOLD	22526	47357
-103	136-0252-07			3	. SOCKET,PIN CONN:W/O DIMPLE	22526	75060-012
-104	175-4540-00			1	CA ASSY,SP,ELEC:20,28 AWG,10.875 L,RIBBON	80009	175-4540-00
	----- -----			-	(OPTION 03 ONLY)		
-105	----- -----			1	CKT BOARD ASSY:I/O CONNECTOR(SEE A40 REPL)		
					(ATTACHING PARTS)		
-106	214-3106-00			12	HARDWARE KIT:JACK SOCKET	53387	3341-1S
					- - - * - - -		
	----- -----			-	. CKT BOARD ASSY INCLUDES:		
-107	----- -----			1	. CONN,RCPT,ELEC:(SEE A40J8001 REPL)		
-108	----- -----			6	. CONN,RCPT,ELEC:(SEE A40J8011,8021,8031,		
	----- -----			-	. 8041,8051,8101 REPL)		
	129-0232-00			20	. SPACER,POST:0.344L,W/4-40THD THRU,BRASS	80009	129-0232-00
	200-2707-00			4	. COVER,HOLE:CONNECTOR	80009	200-2707-00
-109	----- -----			1	FILTER:9SEE FL652 REPL)		
					(ATTACHING PARTS)		
-110	210-0586-00			2	NUT,PL,ASSEM WA:4-40 X 0.25,STL CD PL	83385	OBD
					- - - * - - -		
	195-0445-00			1	LEAD,ELECTRICAL:18 AWG,3.5 L,8-16	80009	195-0445-00
	195-0447-00			2	LEAD,ELECTRICAL:18 AWG,3.0 L,8-1	80009	195-0447-00
	195-0448-00			1	LEAD,ELECTRICAL:18 AWG,3.5 L,5-4	80009	195-0448-00
-111	----- -----			1	SWITCH,SLIDE:(SEE S615 REPL)		
					(ATTACHING PARTS)		
-112	210-0586-00			2	NUT,PL,ASSEM WA:4-40 X 0.25,STL CD PL	83385	OBD
					- - - * - - -		
-113	204-0832-00			1	BODY,FUSEHOLDER:3AG,5 X 20MM FUSES	S3629	031.1673(MDLFEU)
-114	200-2264-00			1	CAP.,FUSEHOLDER:3AG FUSES	S3629	FEK 031 1666
-115	----- -----			1	SWITCH,ROCKER:(SEE S650 REPL)		
-116	333-2813-00			1	PANEL,REAR:	80009	333-2813-00
					(ATTACHING PARTS)		
-117	213-0801-00			4	SCREW,TPG,TF:8-32 X 0.312,TAPTITE,PNH	93907	OBD
					- - - * - - -		

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5 Name & Description	Mfr Code	Mfr Part Number
4-118	386-4718-00			1	PLATE,CONN MTG:BLANK	80009	386-4718-00
					(ATTACHING PARTS)		
-119	211-0008-00			2	SCREW,MACHINE:4-40 X 0.25 INCH,PNH STL	83385	OBD
					- - - * - - -		
-120	386-4719-00			1	PLATE,CONN MTG:BLANK	80009	386-4719-00
					(ATTACHING PARTS)		
-121	211-0008-00			4	SCREW,MACHINE:4-40 X 0.25 INCH,PNH STL	83385	OBD
					- - - * - - -		
-122	200-2729-02			1	COVER,PROT:	80009	200-2729-02
					(ATTACHING PARTS)		
-123	211-0008-00			1	SCREW,MACHINE:4-40 X 0.25 INCH,PNH STL	83385	OBD
-124	175-4161-00			1	CA ASSY,SP,ELEC:50,28 AWG,17.5 L,RIBBON	80009	175-4161-00
					(ATTACHING PARTS)		
-125	211-0008-00			2	SCREW,MACHINE:4-40 X 0.25 INCH,PNH STL	83385	OBD
					- - - * - - -		
-126	348-0544-05			4	RTNR,CAB. COVER:CORNER,EARTH BROWN,PC	80009	348-0544-05
					(ATTACHING PARTS)		
-127	213-0801-00			4	SCREW,TPG,TF:8-32 X 0.312,TAPTITE,PNH	93907	OBD
					- - - * - - -		
-128	426-1891-00			1	FRAME,CABINET:REAR	80009	426-1891-00
-129	334-4453-00			1	MARKER,IDENT:MKD 1.2A,250V,SLOW	80009	334-4453-00
	334-3972-00			1	MARKER,IDENT:MKD 115V-60HZ	80009	334-3972-00
	334-4452-00			1	MARKER,IDENT:0.5A,250V,FAST	80009	334-4452-00
-130	200-2682-00			1	COVER,FAN:ALUMINUM	80009	200-2682-00
					(ATTACHING PARTS)		
-131	211-0507-00			6	SCREW,MACHINE:6-32 X 0.312 INCH,PNH STL	83385	OBD
					- - - * - - -		
-132	407-2788-00			1	BRKT,FAN MTG:ALUMINUM	80009	407-2788-00
					(ATTACHING PARTS)		
-133	211-0534-00			8	SCR,ASSEM,WSHR:6-32 X 0.312 INCH,PNH STL	83385	OBD
					- - - * - - -		
-134	----- -----			1	FAN:(SEE B610 REPL)		
					(ATTACHING PARTS)		
-135	211-0513-00			2	SCREW,MACHINE:6-32 X 0.625 INCH,PNH STL	83385	OBD
-136	210-0457-00			2	NUT,PL,ASSEM WA:6-32 X 0.312 INCH,STL	83385	OBD
					- - - * - - -		
-137	343-1066-00			1	RTNR,CIRCUIT BD:5.0 L X 0.875 W X 0.125 THK	80009	343-1066-00
					(ATTACHING PARTS)		
-138	211-0513-00			2	SCREW,MACHINE:6-32 X 0.625 INCH,PNH STL	83385	OBD
-139	210-0457-00			2	NUT,PL,ASSEM WA:6-32 X 0.312 INCH,STL	83385	OBD
					- - - * - - -		
	198-4462-00			1	WIRE SET,ELEC:	80009	198-4462-00
	198-4523-00			1	WIRE SET,ELEC:	80009	198-4523-00

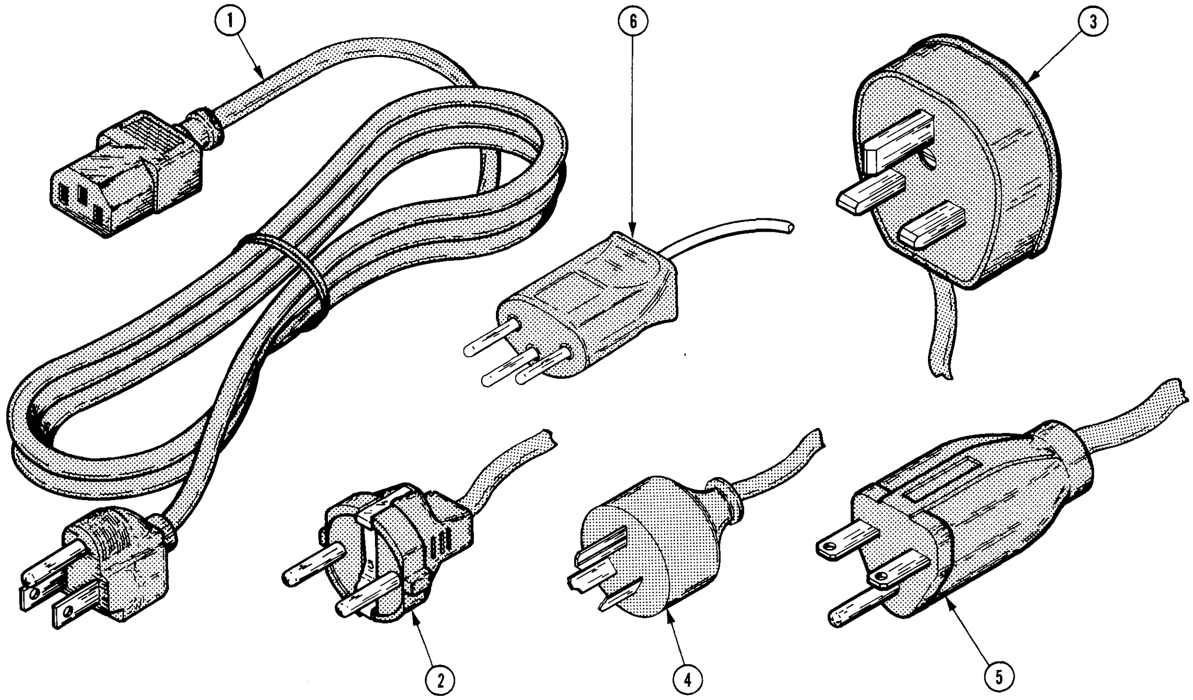
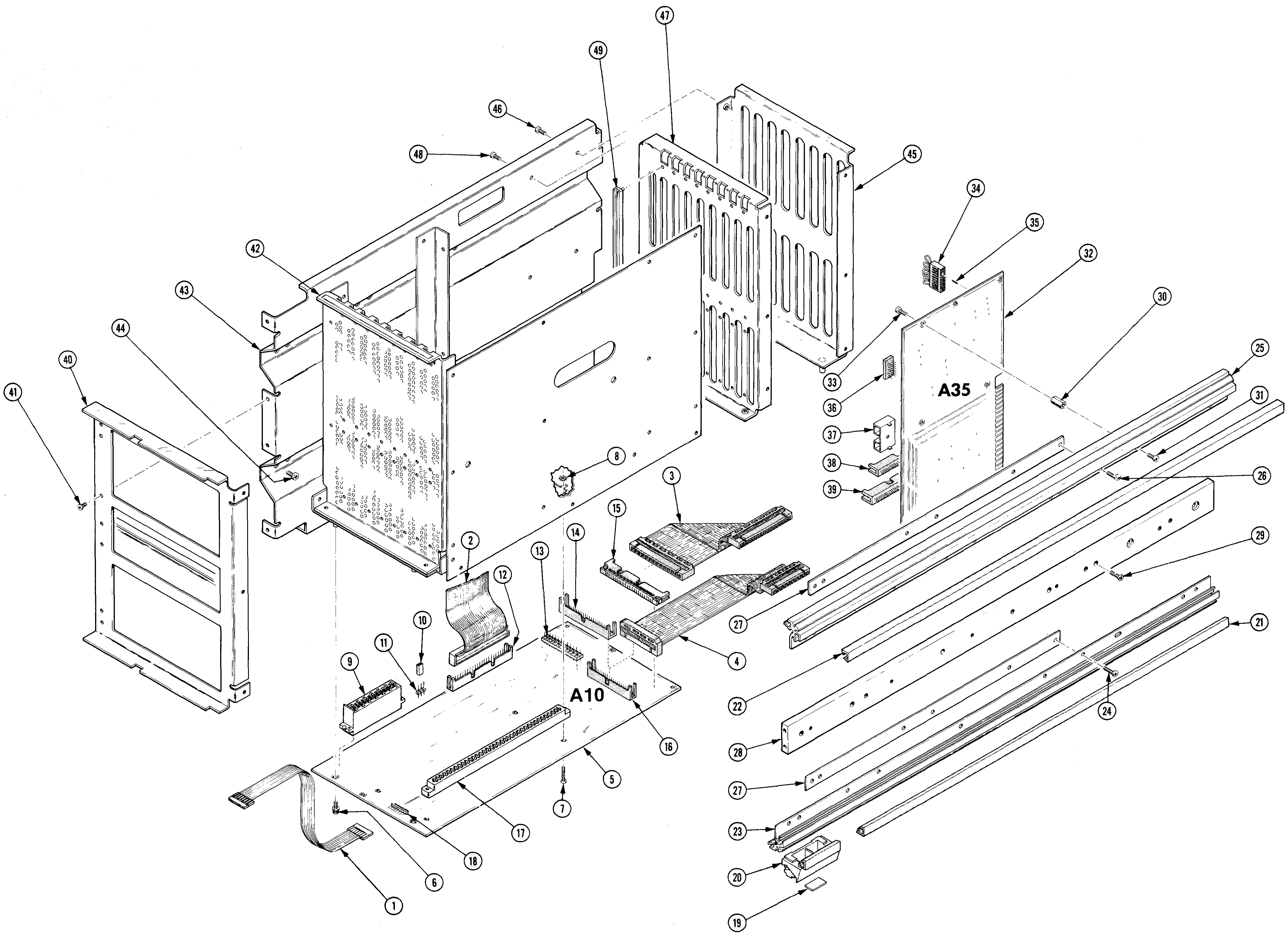


Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5 Name & Description	Mfr Code	Mfr Part Number
					STANDARD ACCESSORIES		
	062-5840-00			1	SOFTWARE PKG:8560 DIAGNOSTIC	80009	062-5840-00
	062-5882-00			1	SOFTWARE PKG:OPERATING SYSTEMS	80009	062-5882-00
	070-3899-00			1	MANUAL,TECH:INSTALLATION GUIDE	80009	070-3899-00
	070-3940-00			1	MANUAL,TECH:USERS	80009	070-3940-00
	070-3941-00			1	MANUAL,TECH:REFERENCE	80009	070-3941-00
	070-3942-00			1	CARD,INFO:REFERENCE	80009	070-3942-00
	119-1182-00			2	FLOPPY DISKETTE:DOUBLE SIDED	80009	119-1182-00
5-1	161-0066-00			1	CABLE ASSY,PWR,:3,18 AWG,115V,98.0 L	16428	KH8481
-2	161-0066-09			1	CABLE ASSY,PWR:3,0.75MM SQ,220V,96.0 L	80126	OBD
	----- -----			-	(EUROPEAN-OPTION A1)		
-3	161-0066-10			1	CABLE ASSY,PWR:3,0.75MM SQ,240V,96.0 L	80126	OBD
	----- -----			-	(UNITED KINGDOM-OPTION A2)		
-4	161-0066-11			1	CABLE ASSY,PWR:3,0.75MM,240V,96.0L	S3109	OBD
	----- -----			-	(AUSTRALIAN-OPTION A3)		
-5	161-0066-12			1	CABLE ASSY,PWR:3,18 AWG,240V,96.0 L	80126	OBD
	----- -----			-	(NORTH AMERICAN-OPTION A4)		
-6	161-0154-00			1	CABLE ASSY,PWR:3,0.75MM SQ,240V,6A,2.5M L	000JA	OBD
	----- -----			-	(SWITZERLAND-OPTION A5)		
	200-2265-00			1	CAP,FUSEHOLDER:5 X 20MM FUSES	S3629	FEK 031.1663
	----- -----			-	(OPTIONS A1 AND A5 ONLY)		
					OPTIONAL ACCESSORIES		
	061-2521-00			1	MANUAL,TECH:INTERIM,SERVICE	80009	061-2521-00
	061-2383-01			**1**	**MANUAL,TECH:SERVICE,QUME**	**80009**	**061-2383-01**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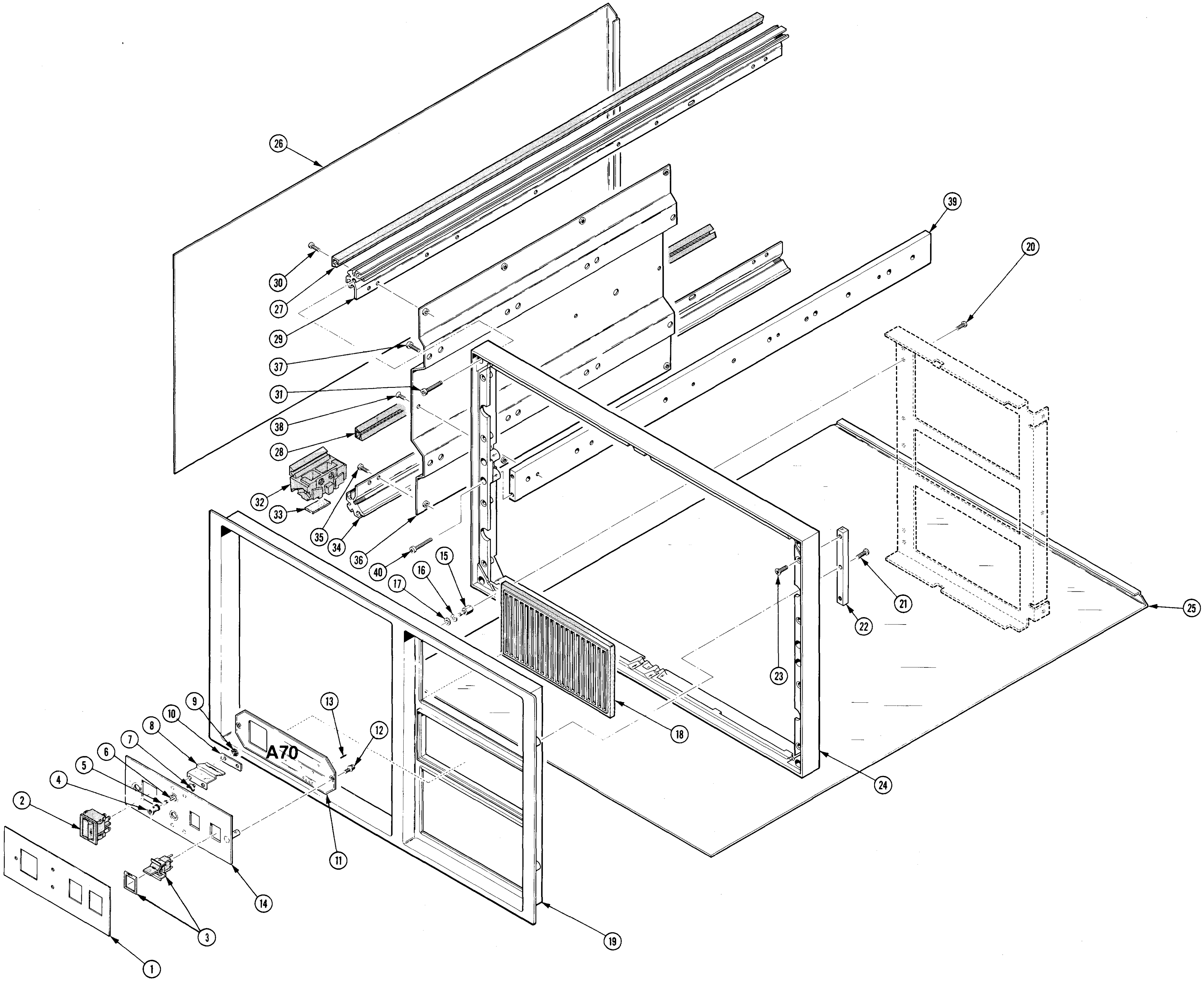

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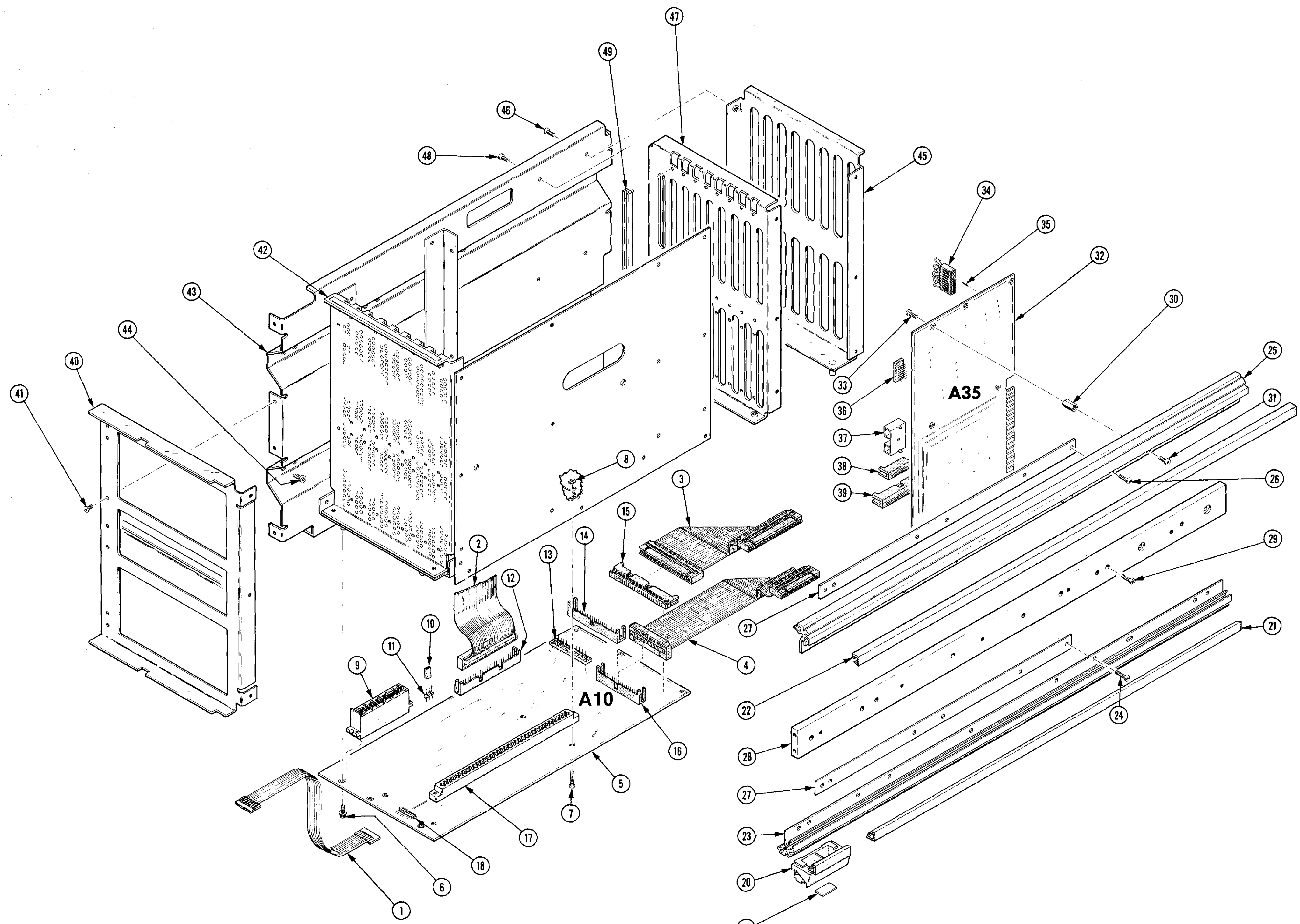

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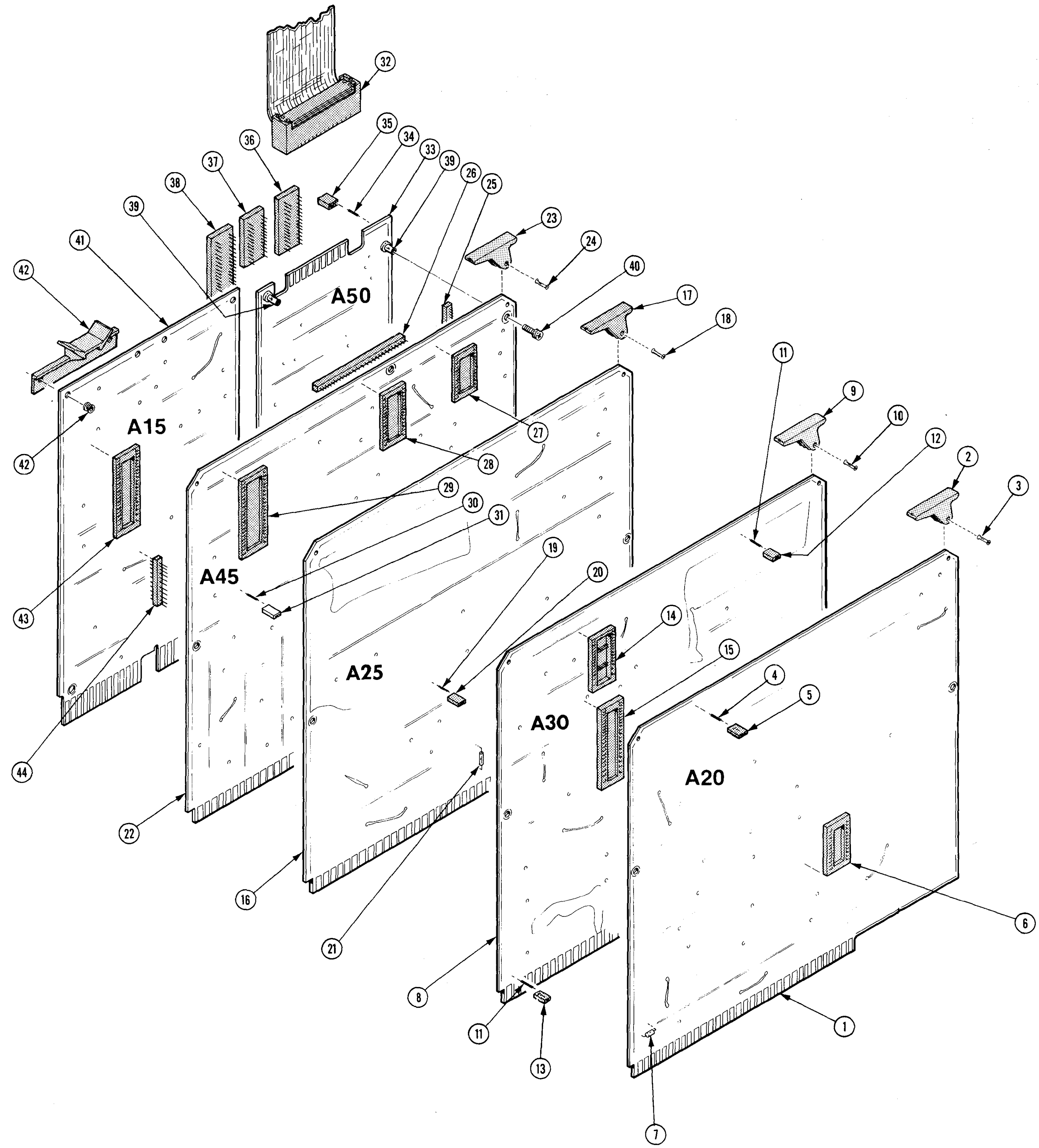

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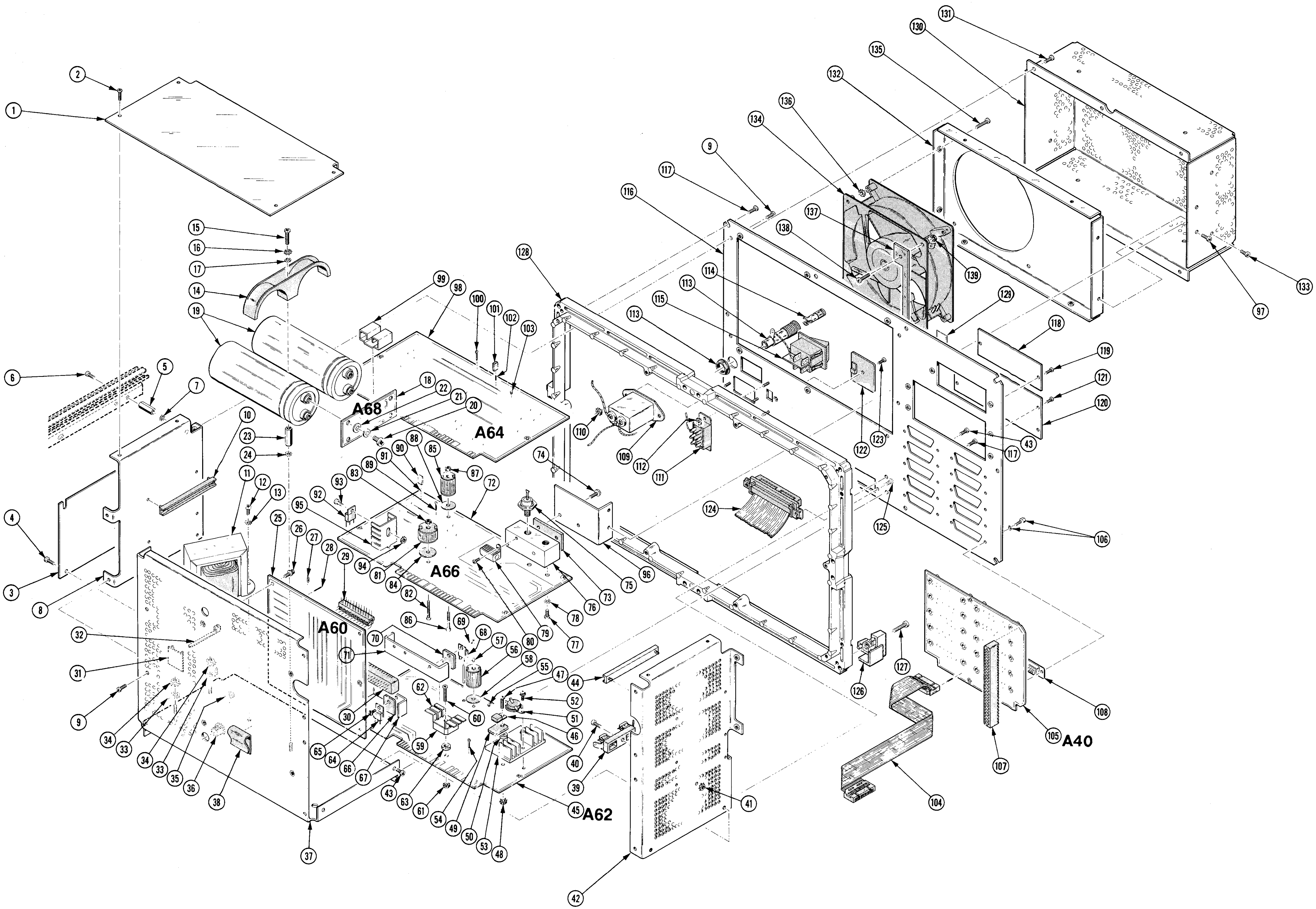
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MANUAL CHANGE INFORMATION

At Tektronix, we continually strive to keep up with latest electronic developments by adding circuit and component improvements to our instruments as soon as they are developed and tested.

Sometimes, due to printing and shipping requirements, we can't get these changes immediately into printed manuals. Hence, your manual may contain new change information on following pages.

A single change may affect several sections. Since the change information sheets are carried in the manual until all changes are permanently entered, some duplication may occur. If no such change pages appear following this page, your manual is correct as printed.

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MANUAL CHANGE INFORMATION

Date: 12-7-81 Change Reference: C1/1281

Product: 8560 MUSDU Service Manual Part No.: 061-2581-00

DESCRIPTION

TEXT CORRECTIONS

Page 3-42 Change title of Table 3-22 from "Regulator Board Jumpers" to "Secondary Board Jumpers"

Page 3-43 Change title of Table 3-23 from "Secondary Board Jumpers" to "Regulator Board Jumpers"

Page 3-44 Change strap numbers as shown in the figure below

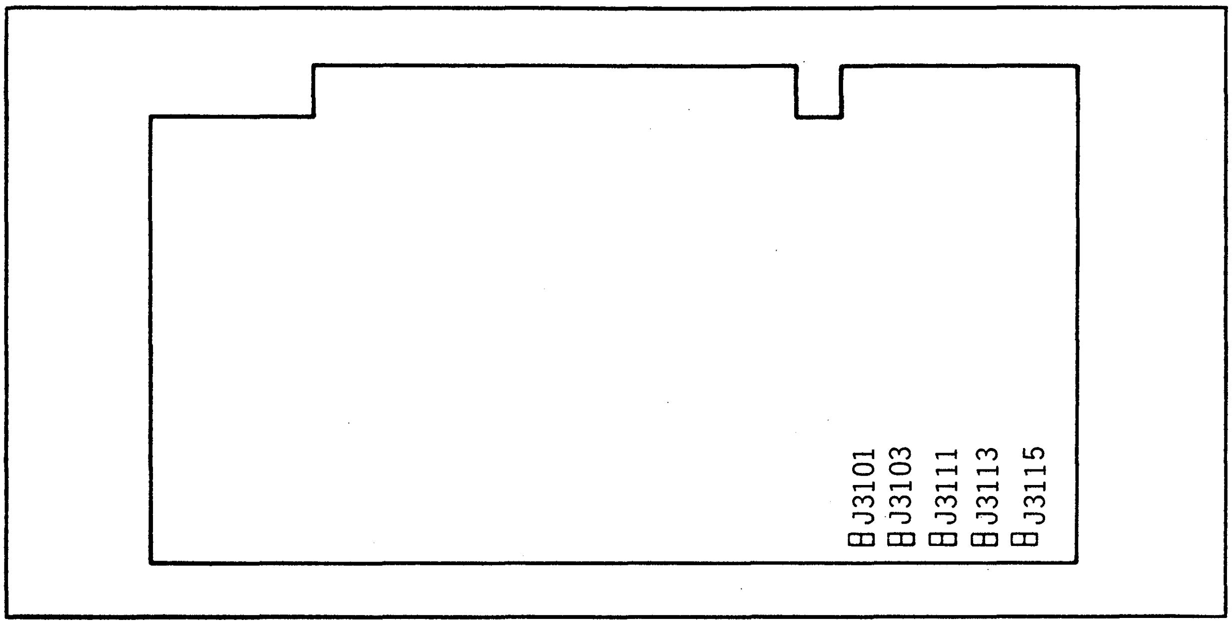

Fig. 3-20. Secondary board jumper strap locations.

Page 16-39 Insert the following paragraph after item d.

e. If the IOP selftest is in progress, the 7-segment IOP display shows three horizontal bars. (This is not shown in Fig. 16-3).

Page 16-40 Insert the following information after the 5th paragraph from the top:

IOP error codes are as follows:

000017 - SIO chip U4100 has failed
000360 - SIO chip U4080 has failed
000377 - both SIO chips failed

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MANUAL CHANGE INFORMATION

Date: 2-3-82 Change Reference: C2/282

Product: 8560 MUSDU Service Manual Manual Part No.: 061-2581-00

DESCRIPTION

TEXT CORRECTIONS

Page 18-6, under the heading "UNLOCKING THE HARD-DISC HEAD LOCKING DEVICE"

ADD THE FOLLOWING INFORMATION:

NOTE

The installation procedure in the Section 18 of the 8560 Multi-User Software Development Unit Service Manual requires that the hard disc drive read/write head shipping lock be released prior to 8560 operation.

Some early versions of the Micropolis drive do not contain a shipping lock.

If, during installation, you find the label "Head Lock is not functional " across the shipping lock access hole, the shipping lock is not connected, and need not be released. If no label is present, release the shipping lock as outlined.

Page 17-1, under the heading "STANDARD ACCESSORIES", the two references to Shipping Restrainer have wrong part numbers

CHANGE THE PART NUMBERS TO:

(361-1073-00)

(361-1074-00)

Under the heading "OPTIONAL ACCESSORIES", the part number for Service Manual

CHANGE TO:

061-2581-00

Just below, find the part number for Qume Drive Service Manual

CHANGE TO:

070-4253-00

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MANUAL CHANGE INFORMATION

Date: 2-9-82 Change Reference: C3/282

Product: 8560 MUSDU Service Manual Manual Part No.: 061-2581-00

DESCRIPTION

TEXT CORRECTIONS

SECTION 18 INSTALLATION

Page 18-10 Delete all of the text and the heading pertaining to the subject, "REMOVING THE HARD-DISC ROTOR RESTRAINT"

Page 18-11 Delete the illustration and caption for Figure 18-6

Page 18-12 Delete the illustration and caption for Figure 18-7

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MANUAL CHANGE INFORMATION

Date: 3-11-82 Change Reference: C4/382

Product: 8560 MUSDU Service Manual Manual Part No.: 061-2581-00

DESCRIPTION

ALTERNATE INSTRUCTIONS FOR UNLOCKING THE HARD-DISC HEAD LOCKING DEVICE

The installation procedure in Section 18 requires that the Micropolis disc drive read/write shipping lock be released prior to 8560 operation. For this operation you need a special tool that is included with your packaging material. A wide-bladed screw driver that has a blade length of at least 10 inches could be used if the special tool is mislaid. In that case, however, extreme care must be taken not to damage the locking mechanism since it is made from soft material.

Remove the shipping lock as follows:

1. Remove the 8560 cabinet bottom cover (See instructions in Section 15 of this manual.)

2. Turn the 8560 on its side.

3. Locate the 1/2 inch round hole in the bottom of the Qume flexible disc drive. (Facing the bottom of the box, the hole is located near the right front corner).

4. Insert the tool through the hole in the Qume drive into the unlocking screw located at the bottom of the Micropolis drive.

5. Unlock the heads of the Micropolis drive by turning the unlocking screw 90 degrees clockwise to the UNLOCK position.

6. Re-install the bottom cover.