

IDENTIFICATION

Product Code: MAINDEC-8I-D6AB-D

Product Name: AX08 Diagnostic

Date Created: October 8, 1968

Maintainer: Diagnostic Group

Author(s): J. Kelly
J. Hittell

1. ABSTRACT

This unit is tested in three sections: (a) an instruction test of the logic; (b) a display test for the scope; (c) a calibration section for the A/D Converter.

2. REQUIREMENTS

2.1 Equipment

PDP-8, 8L or 8I Standard Computer

AX08 option

Adjustable Voltage Source (0.01% or better, Z out < 1.0 ohm)

2.2 Storage

2.2.1 Program Storage - The routine uses memory from address 0 to 4500.

3. LOADING PROCEDURE

3.1 Methods

Procedure for normal binary tape is followed.

4. STARTING PROCEDURE

For normal starting operation all switches should be down. Starting address is 200.

4.1 Program and/or Operator Action

Connect non-zero voltage source to input connector for channel zero.

Set "Timing Control" minimum (C.C.W.)

Load the program into memory.

Set switch register to starting address - SA = 0200

Load Address.

Press Start.

4.1.1 The program will loop in the first section of the test, and the display, if on, will read

"DIAGNOSTIC RUNNING"

"SAME VALUE IN XX ICMX"

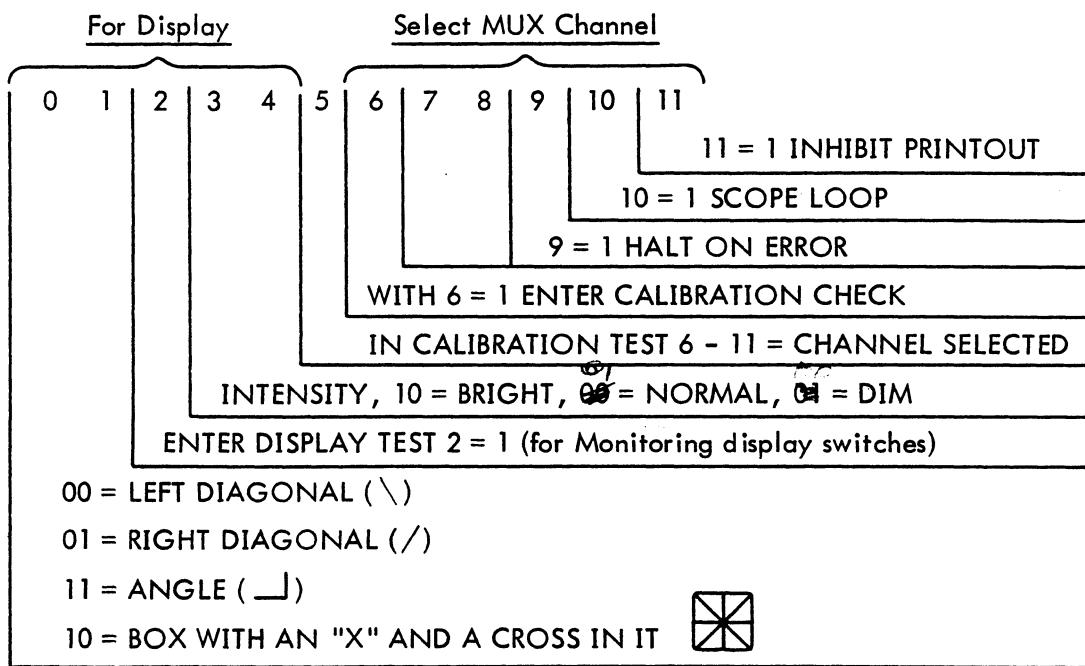
If there is an error, the teleprinter will print out the error and continue on in section test. (XX = the multiplexer channel + 1 where overflow occurs)

5. OPERATING PROCEDURE

5.1 Operational Switch Settings

With all switches down (Logical zero), the test will stay in the instruction section. With switch 2 up the test will enter the display section, from the instruction section. With switch 6 up the test will enter the A/D calibration section, from the display section.

5.1.1 Switches -



5.2 Subroutine Abstract

5.2.1 BEGIN - This is AX08 instruction test of the logic which tests that all registers and flip-flops initiated by start key are in the correct state. Also tested is the ability to set and clear the (Y) register, the skip on flag and interrupt logic for--the A/D timing, the RC clock and the crystal clock. Other logic functions of the display and the A/D converter are also tested.

5.2.2 CHTST - This is an increment test of multiplexer and assumes that (1) the display is operating; (2) the A/D is calibrated; (3) the channel zero of the multiplexer has a non-zero voltage applied to it,

and that all other channels have no voltage applied to them. This routine records the voltage it sees on channel zero, counts increments of the multiplexer until the same voltage (+/-1/2 LSB) is found again. Then uses the display for the message "SAME VALUE IN XX ICMX" (ICMX is the increment instruction).

5.2.3 Display - There are four basic patterns which can be displayed: (1) a right diagonal from the lower left corner to the upper right; (2) a left diagonal from the upper left corner to the lower right corner; (3) an angle from the middle to the left edge of the screen to the center then to the top; (4) a box with an "X" and a cross in it. These tests are designed to show inverted bit transfers from accumulator to the deflection registers, malfunctions in the deflection logic and deflection amplifier faults.

5.2.4 INIT3 - This routine is the A/D Converter calibration check. Bits 6-11 of the switch register selects the multiplexer channel, then 1000 octal conversions are made on this channel and stored in a buffer. The first word of the buffer, which is the binary value of the analog voltage is displayed in the upper left of the scope. A horizontal line is now drawn on the scope. A deviation in the amplitude of the horizontal sweep from its point of origin represents a change in the A/D Converter output for a fixed voltage in. A voltage at the converter switching point will give two levels in the horizontal sweep. A noisy converter, or voltage source may give a staircase pattern which indicates excessive noise in the system. The refresh rate of the sweep is controlled by the RC (timing control) clock adjustment on the front panel.

5.2.5 SCOPE - This subroutine call, is placed between each subtest in the instruction section and records the starting address of each subtest as it is being entered. If a scope loop is requested, it will jump to the start of the subtest that the scope loop is requested for.

5.2.6 HALT - This routine printouts an address that tags the failing subtest and the contents of the AC at the time of the failure.

5.3 Program and/or Operator Action

Loading and starting at 200 with all switches down is the start of the IOT instruction test. If an error is detected here, there will be a printout in this section. When an error is detected, and it is necessary to scope on it, place SW9 UP to halt on error, then SW10 UP to loop on it, then SW11 to DELETE printouts.

When errors in the instruction section have been corrected SW2 UP will advance the program to the display test.

SR 0 and 1 select which of the four figures are to be displayed. SR 3 and 4 control the display intensity. SR2 UP allows the program to monitor SW 0, 1, 3 and 4.

When the display is operating correctly SW6 UP will advance the program to the A/D calibration section.

Bits 6 - 11 of the switch register select the multiplexer channel which has a maximum of 27 plus 34, 35, 36 and 37 octal channels.

6. ERRORS

6.1 Error Halt and Description

<u>Halt (PC)</u>	<u>FUNCTION TESTED</u>
0205	DOES START KEY CLEAR SYNC PULSE CHANNEL?
0211	DOES START KEY CLEAR ERROR FLAG?
0221	DOES START KEY CLEAR ALL INTERRUPT ENABLES?
0231	DOES START KEY CLEAR THE RC CLOCK FLAG?
0241	NO RC CLOCK INTERRUPT UP?
0253	(Y) REGISTER EQUAL ZERO (0000)?
0264	(Y) REGISTER EQUAL SEVENS (7777)?
0275	(RADC) INSTRUCTION CLEARS (Y) REGISTER?
0304	CONTINGENCY AND PULSE CHANNEL EQUAL ZERO (0000)?
0313	WILL (ADCV) CONVERT INSTRUCTION SET A/D DONE FLAG?
0324	WILL (RADC) READ BUFFER INSTRUCTION CLEAR A/D DONE FLAG?
0334	WILL (CLER) INSTRUCTION CLEAR A/D DONE FLAG?
0341	DOES (OTEN) INSTRUCTION CLEAR THE AC?
0354	THAT (ICMX) INC MUX DOES NOT SET A/D DONE
0361	THAT (ICMX) DOES NOT CHANGE THE AC
0365	THAT (ICMX) DOES NOT CHANGE THE AC
0375	(Y) REGISTER EQUAL ZERO (0000)
0410	(Y) REGISTER EQUAL SEVENS (7777)

6.1.1 Module Callout For The AX08 - Program cannot be loaded due to bits in AC,

- a. if bits 0 to 5 B07, B05
- b. if bits 6 to 11 B08, B06

<u>Address</u>	<u>Good (AC)</u>	<u>Bad (AC)</u>	<u>Corrective Action</u>
0205	0000	XX00	A13, A15
	0000	Bit 0	C08
	0000	Bit 1, 2	C07
	0000	Bit 3	C06
0211	0000	NA	D19, C13, A13, A15

<u>Address</u>	<u>Good (AC)</u>	<u>Bad (AC)</u>	<u>Corrective Action</u>
0221	0000	NA	C13, B14, C03, B13
0231	0000	NA	C12, C13
0241	0000	NA	C13
0253	0000	XXXX	D17, D15, A11, A10, A9, D19
	0000	7400	C20, B7
	0000	0200	C20, B7
	0000	0100	C19, B7
	0000	0040	C19, B8
	0000	Bit 7 or 8	C18, B8
	0000	Bit 9 or 10	C17, B8
	0000	0001	C16, B8
0264	0000	7777	A17, B14, A10, A8
0275	7777	0000	A17, A13, A12, A16, B16
	7777	0377	C20, C14, B02, B07
	7777	7577	C20, B07, C14, B02
	7777	7677	C19, B07, C14, B03
	7777	7737	C19, B08, C14, B03
(0275)	7777	7757	C18, B08, C15, B03
	7777	7767	C18, B08, C15, B04, B03
	7777	7773	C17, B08, C15, B04
	7777	7775	C17, B08, C15, B04
	7777	7776	C16, B08, C15, B04
0304	0000	0XXX	B12
	0000	Bit 10, 11	B11
	0000	Bit 7, 8, 9	B10
	0000	Bit 4, 5, 6	B9
0313	0000	NA	B14, B17, A08, D23, D22, D15, D21, B21, B18, B19, B20, A11, A12, A13, D13
0324	NA	NA	B17, D18
0334	NA	NA	A11, A14, D18
0341	0000	7777	A14, A11
0354	NA	NA	A7
0361	0000	XXXX	B14, A10
0365	7777	XXXX	B14, A10

<u>Address</u>	<u>Good (AC)</u>	<u>Bad (AC)</u>	<u>Corrective Action</u>
0375	0000	7777	A08, A07
0410	0000	7777	A08, A07
0421	7777	0000	A08, A07
0430	0000	0000	A08
0440	NA	NA	A08, A10
0445	NA	NA	C13, C19, A18, D15, B13, A12
0463	0000	0000	D19, D18
0470	0000	0000	D19, D18
0475	0000	0000	D13, D15, D18
0504	0000	0000	D18, A14, A11
0520	0000	0000	D18, D19
0533	0000	0000	B14, C03
0550	0000	0000	C13, C03
0570	0000	0000	B14, C03, A15
0612	0000	0000	C13, C03
0625	NA	NA	A08
0635	NA	NA	A07
0637	NA	NA	A07
0646	NA	NA	A07
0656	NA	NA	A07
0660	NA	NA	A07
0670	0000	0000	C4, F28, C10, A16, C12, C13, B16
0702	0000	0000	B16, D17
0712	0000	0000	C12, A14
0725	0000	0000	C02, C13
0743	0000	0000	B16, D17
0754	0000	0000	A15, C01
0764	0000	0000	A16
0770	0000	0000	A16, C9, C8
1014	0000	0000	C13
1025	0000	0000	C11, C12, C13, B13
1040	0000	0000	B12, C12
1053	0000	0000	C11

<u>Address</u>	<u>Good (AC)</u>	<u>Bad (AC)</u>	<u>Corrective Action</u>
0066	0000	0000	C11
1102	0000	0000	C13, C02
1112	4000	0000	C08, A13, A12, B01, B05
1122	0000	0000	C13
1137	NA	NA	D17, D15/CH 34 SHOULD HAVE NON-ZERO VOLTAGE APPLIED
1151	XXXX	7777	A16, B16/CH 34 SHOULD HAVE NON-ZERO VOLTAGE
1160	7777	NA	A16, B16
1167	0000	0000	D17, D15
1241	0000		F28
1303	0000		F28
1324			C8, C9, C10
1461	0000	0000	C14, B13, A24/EXTERNAL INTERRUPT
1503	0000	X000	E27, E28, C07/EXTERNAL STIMULUS
	0000	0X00	E26, 06/EXTERNAL STIMULUS
1524	NA	NA	D17

6.1.2 Display section of list

- a. if no Intensity , A21, A18, A16, A24
- b. cannot vary Intensity , A19, A20, B16, A24
- c. if Alphanumeric is displayed as a series of dots, Intensity duration is too long or not applied to scope.

0421 (RADC + 10) INSTRUCTION CLEARS THE (Y) REGISTER
 0430 WILL (ADCV + 10) CONVERT INSTRUCTION SET A/D DONE FLAG ?
 0440 WILL (RADC + 10) READ BUFFER INSTRUCTION CLEAR A/D DONE FLAG ?
 0445 WILL TWO (ADCV) RAISE ERROR CONDITION ?
 0463 DOES (CLER), CLEAR THE ADCIP "FF" ?
 0470 TEST FOR NO ADC TIMING ERROR
 0475 SET ERROR CONDITION
 0504 DOES (CLER) CLEAR ERROR FLAG ?
 0520 DOES (CLER) CLEAR THE (ADCIF) "FF" ?
 0533 TEST A/D DONE INTERRUPT ENABLE
 0550 TEST ERROR INTERRUPT ENABLE
 0570 TEST A/D DONE INTERRUPT ENABLE
 0612 TEST ERROR INTERRUPT ENABLE
 0625 TEST A/D DONE WITH MICRO PROGRAMMED IOT'S

0635	WILL (ICMX AND ADCV) SET A/D DONE?
0637	WILL MICRO PROGRAMMED IOT RAISE ERROR FLAG "
0646	SET A/D DONE WITH (ACMX, RADC, AND ADCV)
0656	SET A/D DONE WITH MICRO PROGRAMMED IOT'S
0660	RAISE ERROR CONDITION WITH MICRO PROGRAMMED IOT'S
0670	SET RC CLOCK FLAG
0702	RAISE ERROR WITH RC CLOCK
0712	CLEAR RC CLOCK FLAG
0725	RAISE INTERRUPT WITH RC CLOCK
0743	SET A/D DONE FLAG WITH RC CLOCK
0754	CLEAR RC CLOCK AND TEST FOR NO SKIP
0764	RC CLOCK (SLOW) SET TOO SOON
0770	RC CLOCK (SLOW) NOT SET
1014	RAISE AN INTERRUPT WITH RC CLOCK
1025	RAISE CRYSTAL CLOCK FLAG
1040	CLEAR CRYSTAL CLOCK FLAG
1053	TEST CRYSTAL CLOCK DOES NOT SET FLAG TOO SOON
1066	TEST CRYSTAL CLOCK DOES NOT SET FLAG TOO SLOW
1102	INTERRUPT ON CRYSTAL CLOCK
1112	SET CHANNEL FLAG
1122	TEST CRYSTAL INTERRUPT ENABLE
1137	(DYC) INHIBITED BY CONVERT COMMAND
1151	(DYL) INHIBITED BY CONVERT COMMAND
1160	(DXL) INHIBITED BY CONVERT COMMAND
1167	(DXC) INHIBITED BY CONVERT COMMAND
1241	TEST RC CLOCK STABILITY AT ONE EIGHTH SPEED
1303	TEST RC CLOCK STABILITY NORMAL SPEED
1324	TEST RC CLOCK FAST/SLOW RATIO
1461	TEST FOR ABSENCE OF EXTERNAL INTERRUPT
1503	TEST FOR ABSENCE OF EXTERNAL STIMULUS
1524	TEST THAT RC CLOCK DOES NOT INHIBIT ADCV

6.2 Error Recovery

Depress Continue or Restart at 200

7. RESTRICTIONS

Starting restrictions always starts at 200. There are no operation restrictions.

8. MISCELLANEOUS

Execution time for section 1 is about .1 sec.

9. PROGRAM DESCRIPTION

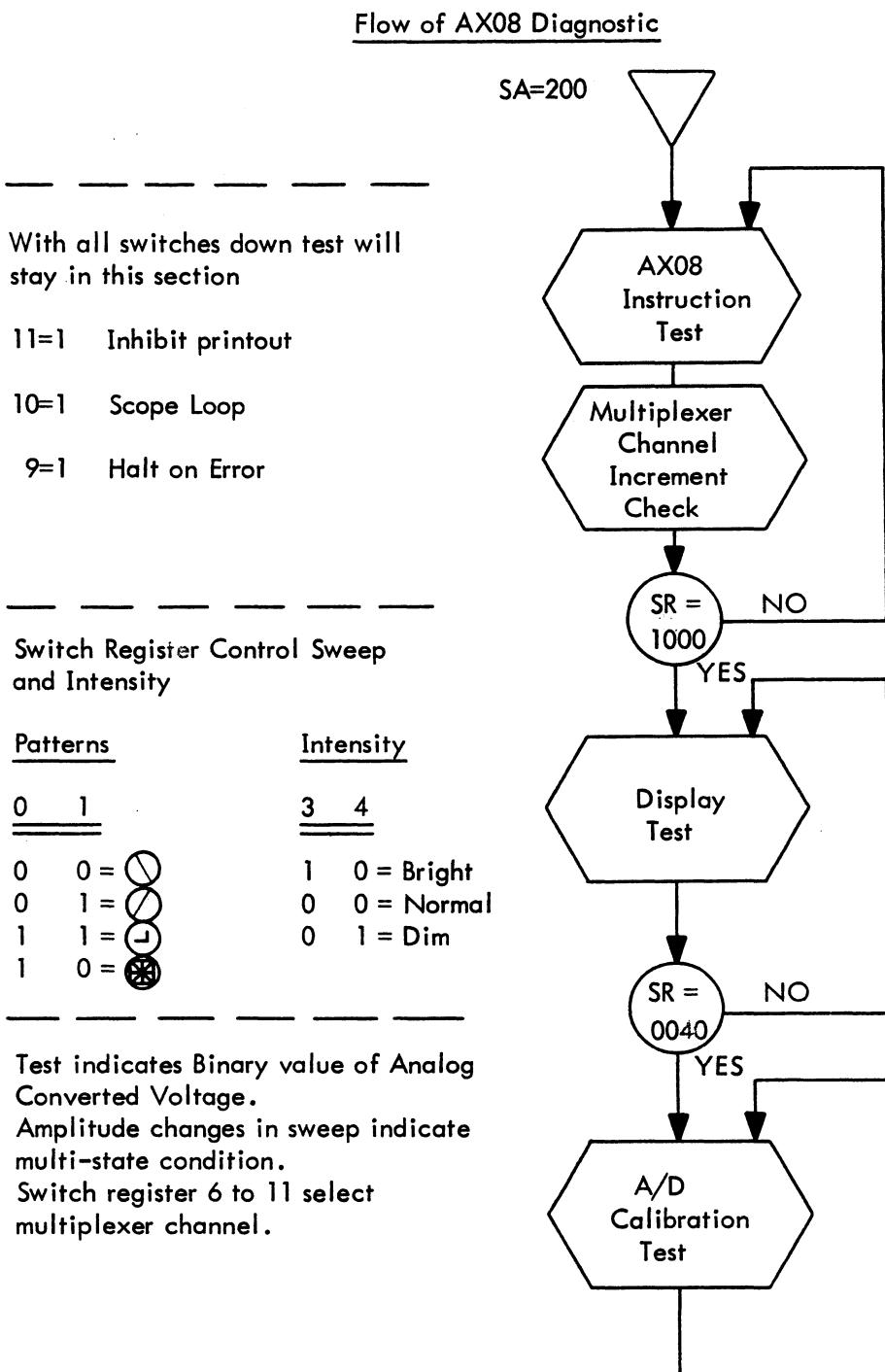
The three sections of this program are designed to be an increment test of the system. The first section which is a test of hardware's logic, checks that start key initiated the system correctly.

The following are tested automatically by the computer: flags, interrupts, crystal and RC clocks, Y register, timing error conditions, external registers, and other integrated logic functions that are associated with the display and analog digital converter.

The second section uses the display logic and the scope to validate the display. The switch register is used in the test to control the generation of intensity and pattern selection. At this stage of the test, the operator must determine if the display responds correctly in relation to the switch register.

The third section of the test is a check on the calibration and repetition of the A/D Converter and its respective multiplexer channel. The switch register selects the multiplexer channels; conversions on that channel are made and stored into a buffer. The buffer is then displayed on the scope. The first buffer voltage is displayed as an octal value; a deviation in horizontal sweep indicates noise in the system, measuring monotonicity, repeatability and drift. Using this routine is a subjective check on the A/D portions and the environment in which the system is installed; the quality of analog input must be considered in evaluating this display.

11.

FLOW CHART

/INSTRUCTIONS FOR THE AX08

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0301	/CLEAR X REGISTER
0302	/LOAD X REGISTER (1) SIDE
0304	/DISPLAY
0311	/CLEAR Y REGISTER
0312	/LOAD Y REGISTER (1) SIDE
0321	/SKIP ON CRYSTAL CLOCK
0322	/SKIP ON ADC TIMING ERROR
0324	/SET BRIGHTNESS
0331	/OR EXTERNAL SENSE REGISTER INTO AC
0332	/SKIP ON A/D DONE
0334	/CLEAR SENSE BIT WITH ONE IN AC
0341	/SKIP ON RC TIMING CLOCK
0342	/ZERO IN AC INHIBIT INTERRUPT REGISTER
0344	/ONES IN AC ENABLE INTERRUPT
0351	/CLEAR ADC TIMING ERROR CONDITION
0352	/CLEAR CRYSTAL CLOCK FLAG
0354	/CLEAR RC CLOCK AND FLAG
0361	/INCREMENT MULTIPLEXER
0362	/CLEAR AC, READ A/D BUFFER
0364	/START CONVERSION
0371	/JAM SET MULTIPLEXER
1344	M1=CLA CLL CMA RAL
0020	*20
0021	M1400, -1400
0022	K1400, 1400
0023	KM1043, -0043
0024	K0400, 0400
0025	Km177, -0117
0026	SL1, 0
0027	F11, 2
0028	Mn377, -0317
0029	K034, 0034
0030	K4100, 0100
0031	K1,00, 1000
0032	K0002, 0002
0033	K2,02, 2002
0034	K3,02, 3002
0035	K004, 0004
0036	C0010, 0010
0037	K0200, 0200
0038	K1,04, 1004
0039	K0340, 0340
0040	K4,02, 4002
0041	K0015, 0015
0042	K1700, 1100
0043	K0077, 0017
0044	KM1000, -1000
0045	KM1020, -20
0046	K1V02, 1002
0047	K1176, 1116

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K003	/ / / /	K / / / , / / / /
K004	4203	MSSG, MESG
K005	3500	CHUSCI, CHUSC
K006	3755	AUSTBL, USCTRL
K007	0260	MAXNUM, 0
K008	0213	K2103, 0003

0061	1112	KMJD000, -0
0062	0300	CITEMA, 0
0063	0000	CTEMB, 0
0064	0000	CTEMC, 0
0065	0000	COUNTA, 0
0066	0000	COUNTB, 0
0067	0000	COUNTC, 0
0070	0000	HAD, 0
0071	4000	INLL, 4000
0072	0000	JUMP, 0
0073	0000	0
0074	0000	XER, 0
0075	0000	TEMP01, 0
0076	0000	TEMP02, 0
0077	0000	TEMP03, 0
0100	0000	TEMP04, 0
0101	0000	TEMP05, 0
0102	0000	TEMP06, 0
0103	0000	MSRHT, 0
0104	0000	CHXL, 0
0105	0000	CHYL, 0
	4454	L0H=JMS I MSSG
0106	0000	STALL, 0
0107	0040	KEN40, 0040
0110	2400	XINTS, INIT
0111	4223	XSCOPE, SCOPEA
	4211	SCOPE=JMS I XSCOPE
0112	4201	XERADD, ERAUD
0113	4320	XTYPE, MESSAGE
0114	4235	XIPRIN, IPHINT
0115	1642	XSIXTY, SIXTY
0116	4202	XCRLF, CRLF
0117	1500	XTEXTB, TEXTB
0120	0000	AC, 0
0121	2000	XSWTCH, SWITCH
	7000	OFR=7000
	7402	XX=/402
	4512	HALT=JMS I XERADD

0122	214/	STURA, STURS
0123	223/	UDULA, UDULS
0124	2256	UDULA, UDULS
0125	2100	UVLTA, UVLTS
0126	2260	UVLBA, UVLBS
0127	2212	UHLRA, UHLRS
0130	2224	UHLLA, UHLLS
0131	0500	K6000, 600
0132	6324	K6324, 6324
0133	0317	K37/, 317
0134	0000	XPOSR, 0
0135	0000	YPOSR, 0
0136	0400	K400, 400
0137	0111	K111, 111
0140	0002	P2, 2
0141	1400	M400, -400
0142	7600	M200, -200
0143	0000	COUNT, 0
4522		STUR=JMS I STURA
4525		DVL T=JMS I DVLTA
4526		DVL B=JMS I UVLBA
4527		UHL R=JMS I UHLRA
4530		UHLL=JMS I UHLLA
4523		UDUL=JMS I UDULA
4524		UDUL=JMS I UDULA
		/SR
		/61

		BRIGHTNESS
/0=LEFT DIAGONAL	0=REPEAT	
/01=RIGHT DIAGONAL		
/1=ANGLE	1=NEW TEST	
/11=XBOX		
*	, 17/+1	

0200

/START KEY SHOULD CLEAR SYNC PULSE CHANNEL

```

W200 7200
W201 6351
W202 4021
W203 7440
W204 4512
W207 4511
W215 6322
W217 7410
W218 4512
W219 4511
W212 1223
W213 3001
W214 1224
W215 3002
W216 6001
W217 7410
W220 4512
W221 6002
W222 5222
W223 5402
W224 0220
W227 4511
W226 6341
W227 7410
W230 4512
W231 4511
W232 1032
W233 6340
W234 1243
W235 3002
W236 6001
W237 7410
W240 4512
W241 6002
W242 7410
W243 0240
W244 4511
W245 6311
W246 6362
W247 1650
W250 5253
W251 6302
W252 4512
W253 4511
W254 1240
W255 6311

BEGIN, CLA
          XRIN           /READ PULSE REGISTER
          AND K7400      /BIT 0 TO 3
          SZA
          HALT          /NOT CLEARED BY START KEY
          SCOPE

/JDLS START KEY CLEAR ERROR FLAG?
SKER           /SKIP ON ERROR FLAG
SKP
HALT          /ERROR FLAG SKIPEU
SCOPE

/TI, ST FOR NO INTERRUPT /START KEY SHOULD CLEAR ALL INTERRUPT ENABLES
TAU .+11
JCA 1
IAU .+10
JCA 2
ION
SKP
HALT          /INTERRUPT UP, START KEY
IOP             /SHOULD CLEAR ALL INTERRUPT ENABLES
JMP ,+3
JMP I 2        /GO TO MEMORY LOCATION ONE
,-4            /GO TO MEMORY LOCATION TWO
SCOPE

/JDLS START KEY CLEAR RC CLOCK FLAG
SKRK           /SKIP ON RC CLOCK
SKP
HALT          /START KEY DID NOT CLEAR FLAG
SCOPE

/TIEST FOR NO RC CLOCK INTERRUPT
IAU <1000      /SET RC INTERRUPT ENABLE
ZEN UTEN
IAU ,+7
JCA 2
ION           /THERE SHOULD BE NO INTERRUPT
SKP
HALT          /RC CLOCK INTERRUPT UP
IOP
SKP
,-3
SCOPE

/TIEST READ BUFFER (Y REGISTER) AC=ZERO
LJUPA, JYC      /CLEAR Y REGISTER
RAUC           /READ BUFFER
SNA CLA        /TEST
JMP ,+3        /GOOD
RAUC           /BAU
HALT          /AC SHOULD EQUAL 0000
SCOPE

/TIEST READ BUFFER (Y REGISTER) AC=SEVEN
CLA CMA       /SET AC TO SEVENS
UYC           /CLEAR Y REGISTER

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V206	6362	RADC	/READ BUFFER
V207	7450	SNA	/TEST
V208	5264	JMP ,+4	/GOOD
V209	1240	CLA CMA	/BAD
V202	6362	RADC	/AC SHOULD EQUAL 0000
V203	4512	HALT	/BAD AC CLEAR PULSE
V204	4011	SCOPE	


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/TEST READ BUFFER (Y REGISTER)
0265 7240          CLA CMA      /AC EQUAL SEVENS
0266 6312          DYL          /SET Y REGISTER
0267 6302          RAUC         /READ BUFFER
0270 7201          IAC
0271 7650          SNA CLA     /TEST
0272 5270          JMP ,+3     /GOOD
0273 6362          RAUC         /BAD
0274 4512          HALT        /AC SHOULD EQUAL 7777
0275 4511          SCOPE

/TTEST CONTINGENCY AND PULSE CHANNEL FOR ZERO
0276 7240          CLA CMA      /AC=SEVENS
0277 6334          XHCL         /CLEAR CHANNEL
0300 7200          CLA
0301 6331          XRIN         /READ CHANNELS
0302 7440          SZA          /TEST FOR ZERO
0303 4512          HALT        /FAILED TO CLEAR
0304 4511          SCOPE

/WILL CONVERT INSTRUCTION SET THE FLAG?
0305 6364          ADCV         /START
0306 3106          UCA STALL
0307 2106          ISZ STALL    /TIME FOR FLAG TO SET
0310 5301          JMP ,-1
0311 6332          SKAU         /SKIP ON DONE FLAG
0312 4512          HALT        /DONE FLAG NOT SET OR SKIP FAILED
0313 6362          RAUC         /CLEAR FOR SCOPE
0314 4511          SCOPE

/TTEST THAT (RAUC) CLEARS DONE FLAG
0315 6364          ADCV         /START CONVERT TO SET FLAG
0316 6332          SKAU
0317 5316          JMP ,-1      /WAIT FOR FLAG
0320 6362          RAUC         /CLEAR FLAG
0321 6332          SKAU         /IS FLAG CLEARED
0322 7410          SKP          /YES
0323 4512          HALT        /NO, FLAG IS SET OR SKIP FAILED
0324 4511          SCOPE

/TTEST THAT (CLER) CLEARS THE DONE FLAG
0325 6364          ADCV         /START CONVERT TO SET FLAG
0326 6332          SKAU         /SKIP ON DONE
0327 5326          JMP ,-1      /WAIT FOR FLAG
0330 6351          CLER         /CLEAR DONE FLAG
0331 6332          SKAU         /TEST THAT FLAG IS CLEARED
0332 7410          SKP
0333 4512          HALT        /CLER DID NOT CLEAR DONE FLAG
0334 4511          SCOPE

/TTEST THAT (OTEN) CLEARS THE AC
0335 7240          CLA CMA      /AC=SEVENS
0336 6344          OTEN         /CLEAR AC
0337 7440          SZA          /TEST
0340 4512          HALT        /OTEN DID NOT CLEAR AC
0341 4511          SCOPE
0342 6342          ETEN         /CLEAR ALL INTERRUPT ENABLES
0343 2106          ISZ STALL   /WILL INC MUX SET DONE FLAG

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6544	5545	JMP .-1
6545	6351	ULER
6546	6361	ICMX
6547	2106	ISZ STALL
6548	5347	JMP .-1
6549	0352	SKAU
6550	1410	SKP
6551	4212	HALT
6552	0302	/ICMX SET DONE FLAG
6553	4211	RAUC
		SCOPE

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/WILL MULTIPLEXER INSTRUCTION CHANGE AC
  6356 6361      ICMX          /INCREMENT MUX
  6357 7440      SZA
  6360 4512      HALT          /ICMX, SET AC
  6361 7240      CLA CMA
  6362 6361      ICMX          /INCREMENT MUX
  6363 7450      SNA
  6364 4512      HALT          /ICMX+10, SET AC
  6365 6362      RAUC
  6366 4511      SCOPE

/ROUTINES USING IOT 637X
/TEST READ BUFFER (Y REGISTER) AC=ZERO
  6367 6311      DYC           /CLEAR Y REGISTER
  6370 6372      RAUC+10     /READ BUFFER
  6371 7650      SNA CLA      /TEST
  6372 5370      JMP ,+3      /GOOD
  6373 6372      RAUC+10     /BAD
  6374 4512      HALT          /AC SHOULD EQUAL 0000
  6375 4511      SCOPE
  6376 5777      JMP I ,+1
  6377 6400      , 177+1

/TEST READ BUFFER (Y REGISTER) AC=SEVEN
  6400 7240      CLA CMA      /SET AC TO SEVENS
  6401 6311      DYC           /CLEAR Y REGISTER
  6402 6372      RAUC+10     /READ BUFFER
  6403 7450      SNA
  6404 5210      JMP ,+4      /GOOD
  6405 7240      CLA CMA
  6406 6372      RAUC+10     /AC SHOULD EQUAL 0000
  6407 4512      HALT          /BAD AC CLEAR PULSE
  6408 4511      SCOPE

/TEST READ BUFFER (Y REGISTER)
  6411 7240      CLA CMA      /AC EQUAL SEVENS
  6412 6312      DYL           /SET Y REGISTER
  6413 6372      RAUC+10     /READ BUFFER
  6414 7001      IAC
  6415 7650      SNA CLA      /TEST
  6416 5221      JMP ,+3      /GOOD
  6417 6372      RAUC+10     /BAD
  6418 4512      HALT          /AC SHOULD EQUAL 7777
  6419 4511      SCOPE

/WILL CONVERT INSTRUCTION SETS THE FLAG
  6422 6374      AUCV+10     /START
  6423 3106      UCA STALL
  6424 2106      ISZ STALL    /TIME FOR FLAG TO SET
  6425 5224      JMP ,-1
  6426 6332      SKAD          /SKIP ON DONE FLAG
  6427 4512      HALT          /DONE FLAG NOT SET OR SKIP FAILED
  6428 4511      SCOPE

```



```

/TEST THAT (RADC) CLEARS DONE FLAG
W431 63/4          ADCV+10      /START CONVERT TO SET FLAG
W432 6332         SKAD
W433 5232         JMP , -1     /WAIT FOR FLAG
W434 6372         RADC+10    /CLEAR FLAG
W435 6332         SKAD
W436 7410         SKP        /IS FLAG CLEARED
W437 4512         HALT       /YES
W440 4511         SCOPE      /NO, FLAG IS SET OR SKIP FAILED

/GENERATE TIMING ERROR CONDITION
W441 6374          ADCV+10    /CONVERT
W442 63/4           ADCV+10    /TWO ADCV SET ERROR CONDITION
W443 6322         SKER
W444 4512         HALT       /ERROR NOT UP
W445 6332         SKAD
W446 5245         JMP , -1
W447 4511         SCOPE      /DUES (CLER) CLEAR ADCIP "FF"

W450 63/4          ADCV+10    /SET ERROR CONDITION
W451 63/4          ADCV+10    /CLEAR ADCIP "FF"
W452 6332         SKAD
W453 5252         JMP , -1     /WAIT FOR FLAG
W454 6351         CLER
W455 63/4          ADCV+10    /CONVERT
W456 6332         SKAD
W457 5256         JMP , -1     /WAIT FOR FLAG
W460 6322         SKER       /SKIP ON ERROR
W461 7410         SKP        /NO ERROR
W462 4512         HALT       /(CLER) DID NOT CLEAR ADCIP FF
W463 4511         SCOPE

```

```

/TEST FOR ADC TIMING ERROR
W404 6351      CLER      /CLEAR ERROR CONDITION
W405 6322      SKER      /SKIP ON ERROR
W406 7410      SKP
W407 4512      HALT     /ERROR CONDITION UP
W408 4511      SCOPE

/GENERATE TIMING ERROR CONDITION
W411 6364      ADCV     /CONVERT
W412 6364      ADCV     /TWOADCV SET ERROR CONDITION
W413 6322      SKER     /SKIP ON ERROR
W414 4512      HALT     /ERROR NOT UP
W415 6332      SKAD
W416 5210      JMP , -1
W417 4511      SCOPE

/DIRES (CLER) CLEAR ERROR FLAG
W500 6351      CLER      /CLEAR ERROR
W501 6322      SKER      /SKIP ON ERROR
W502 7410      SKP       /NO ERROR
W503 4512      HALT     /ERROR FLAG NOT CLEARED
W504 4511      SCOPE

/DIRES (CLER) CLEAR ADCIP "FF"
W505 6364      ADCV     /SET ERROR CONDITION
W506 6332      SKAD
W507 5367      JMP , -1   /WAIT FOR FLAG
W508 6351      CLER      /CLEAR ADCIP "FF"
W509 6364      ADCV     /CONVERT
W510 6332      SKAD     /SKIP ON FLAG
W511 5313      JMP , -1   /WAIT FOR FLAG
W512 6322      SKER     /SKIP ON ERROR
W513 7410      SKP      /NO ERROR
W514 4512      HALT     /(CLER) DID NOT CLEAR ADCIP FF
W515 4511      SCOPE

```

```

/SET DONE AND TEST FOR INTERRUPT WITH NO INTERRUPT ENABLES
 0221 6364      ADCV           /START CONVERT
 0222 6332      SKAU
 0223 5322      JMP , -1      /WAIT FOR DONE FLAG
 0224 7200      CLA
 0225 6342      ZTEN           /INHIBIT INTERRUPTS
 0226 1330      IAU , +7
 0227 3002      JCA 2
 0230 0001      ION
 0231 1410      SKP
 0232 4512      HALT          /INTERRUPT UP
 0233 6002      IOP
 0234 7410      SKP
 0235 0732      .-3
 0236 4511      SCUPE

/SET ERRL FLAG AND TEST FOR INTERRUPT WITH NO INTERRUPT ENABLE
 0237 6364      ADCV           /GENERATE ERROR FLAG
 0240 6364      ADCV
 0241 6332      SKAU
 0242 5341      JMP , -1
 0243 1302      IAU , +7
 0244 3002      JCA 2
 0245 6001      ION
 0246 1410      SKP
 0247 4512      HALT          /INTERRUPT UP
 0250 6002      IOP
 0251 7410      SKP
 0252 074/      .-3
 0253 4511      SCUPE

/WILL DONE FLAG RAISE AN INTERRUPT
 0254 7200      CLA
 0255 1031      IAU K0100
 0256 0346      ZTEN UTEN      /ENABLE ADC INTERRUPT
 0257 0364      ADCV          /START CONVERT
 0261 6332      SKAU
 0261 5360      JMP , -1      /WAIT FOR FLAG
 0262 1371      IAU , +7
 0263 3002      JCA 2
 0264 6001      ION
 0265 1000      NOP
 0266 6002      IOP
 0267 4512      HALT          /DONE FLAG DID NOT RAISE INTERRUPT
 0270 7410      SKP
 0271 0572      .+1
 0272 4511      SCUPE
 0273 5714      JMP I , +1
 0274 0600      , 1/7+1

```

/WILL TIMING ERROR RAISE AN INTERRUPT

6270	7200	CLA
6275	1A40	IAU K0200
6277	6340	ZIEN UTEN
6278	6364	AUDCV
6279	6364	AUDCV
6282	6332	SKAU
6283	92ed	JMP .-1
6284	1213	IAU .+7
6285	53e2	JCA 2
6286	6d31	IUN
6287	7Ae0	NOP
6288	6d12	10F
6289	4d12	HALT
6290	7410	SKP
6293	5642	.-1
6294	6351	CLEAR
6295	4d11	SCOPE

/MICRO PROGRAMMED IUT

6515	6362	RAUC	/CLEAR DONE
6517	7242	CLA CMA	
6520	6367	ICMX RAUC ADCV	/INC MUX, READ BUFFER, CONVERT
6521	2125	1SE STALL	
6522	5221	JMP .-1	
6523	6332	SKAU	/SKIP ON
6524	4d12	HALT	/DONE FLAG NOT SET
6525	4d11	SCOPE	DONE

/SET TIMING ERROR FLAG

6526	6351	CLEAR	
6527	6362	ICMX ADCV	
6530	6365	ICMX ADCV	
6531	2165	1SE STALL	
6532	5231	JMP .-1	
6533	6332	SKAU	
6534	4d12	HALT	/DONE FLAG NOT SET
6535	6322	SKER	
6536	4d12	HALT	/NO TIMING ERROR FLAG
6537	4d11	SCOPE	
6540	6362	RAUC	
6541	6371	ACMX RAUC ADCV	/SET MUX, READ BUFFER, CONVERT
6542	2160	1SE STALL	
6543	5242	JMP .-1	
6544	6332	SKAU	
6545	4d12	HALT	/DONE FLAG NOT SET
6546	4d11	SCOPE	

/SET TIMING ERROR FLAG

0647	6351	CLEAR
0650	6377	ACMX RAUC ADCV /SET MUX, READ BUFFER, CONVERT
0651	6372	ACMX ADCV
0652	2106	ISZ STALL
0653	5252	JMP , -1
0654	6332	SKAD /SKIP ON DONE
0655	4512	HALT /DONE NO SET
0656	6322	SKER /SKIP ON ERROR
0657	4512	HALT /ERROR SHOULD BE UP
0660	4511	SCOPE

/TEST USING RC CLOCK CONVERTING + INTERRUPT

/TEST RC CLOCK

/ENABLE RC CLOCK AND SKIP ON FLAG

0501	7200	CLA	
0502	1433	IAU K2002	
0503	6346	ZTEN OTEN	/TURN ON RC CLOCK
0504	2125	ISZ STALL	
0505	2664	JMP .-1	
0506	0341	SKRK	/RC CLOCK FLAG SHOULD BE SET
0507	4212	HALT	/DID NOT SKIP ON RC CLOCK FLAG
0508	6354	CLRK	/CLR RC CLOCK AND FLAG
0509	4211	SCOPE	
/TEST FOR ADC TIMING ERROR			
0510	0351	CLER	
0511	7200	LLA	
0512	1334	IAU K2002	
0513	0345	ZTEN OTEN	
0514	2100	ISZ STALL	
0515	5216	JMP .-1	
0516	6322	SKER	/SKIP ON ADC TIMING ERROR
0517	4212	HALT	/ERROR SHOULD BE SET
0518	4211	SCOPE	/RC TIME ADJ SET FOR MIN
/TEST CLEAR RC CLOCK INSTRUCTION			
0519	6354	CLRK	/CLEAR RC CLOCK AND FLAG
0520	6341	SKRK	
0521	2344	JMP .-1	/SYNC ON CLOCK
0522	6354	CLRK	
0523	6341	SKRK	/SKIP ON RC CLOCK
0524	7410	SKP	
0525	4212	HALT	/CLEAR DID NOT WORK
0526	4211	SCOPE	
/TEST RC CLOCK RAISE AN INTERRUPT			
0527	6341	SKRK	
0528	2313	JMP .-1	/WAIT FOR RC CLOCK FLAG
0529	1433	IAU K3002	
0530	6346	ZTEN OTEN	/RC CLOCK INTERRUPT ENABLE ON
0531	1326	IAU .+1	
0532	3062	UCA 2	
0533	6341	ION	
0534	7200	VOP	/SHOULD INTERRUPT HERE
0535	6302	IUF	
0536	4212	HALT	/NO INTERRUPT
0537	7410	SKP	
0538	6725	.-1	
0539	6354	CLRK	
0540	4211	SCOPE	

/* WILL RC CLOCK SET ADC DONE FLAG

```

0/31 0354
0/32 0341
0/33 5332
0/34 6354
0/35 0341
0/36 5352
0/37 2106
0/38 5337
0/39 6332
0/40 4512
0/41 4511
0/42 4512
0/43 4511
0/44 1200
0/45 6342
0/46 6354
0/47 2106
0/48 5347
0/49 6341
0/50 7410
0/51 4512
0/52 4511
0/53 4512
0/54 4511

```

CLRK
SKRK
JMP .-1
CLRK
SKRK /SKIP ON RC FLAG
JMP .-1 /WAIT FOR RC FLAG
ISE STALL
JMP .-1 /ADC DONE SHOULD BE SET
SKAD /SKIP ON ADC DONE
HALT /ADC DONE NOT SET
SCOPE

/* CLEAR RC CLOCK AND TEST FOR NO SKIP

```

0/55 7200
0/56 1043
0/57 6346
0/58 6354
0/59 6341
0/60 7410
0/61 4512
0/62 4511
0/63 4512
0/64 2106
0/65 5364
0/66 6341
0/67 4512
0/68 4511
0/69 5712
0/70 1000
0/71 1000

```

CLA
ZTEN /TURN CLOCK OFF
CLRK /CL CLOCK FLAG
ISE STALL
JMP .-1 /SKIP ON RC CLOCK
SKRK
SKP
HALT /CLOCK SHOULD BE OFF
SCOPE

/* TEST RC CLOCK (ONE EIGHT SPEED)

```

0/72 7200
0/73 1043
0/74 6346
0/75 6354
0/76 6341
0/77 7410
0/78 4512
0/79 4511
0/80 5712
0/81 1000
0/82 1000
0/83 1000
0/84 1000
0/85 1000
0/86 1000
0/87 1000
0/88 1000
0/89 1000
0/90 1000
0/91 1000
0/92 1000
0/93 1000
0/94 1000
0/95 1000
0/96 1000
0/97 1000
0/98 1000
0/99 1000

```

CLA
TAU K4002 /SLOW SPEED RC CLOCK ENABLE
ZTEN UTEN /CLEAR RC CLOCK FLAG
CLRK
SKRK /SKIP ON RC FLAG
SKP
HALT /RC FLAG SET TOO SOON
ISE STALL
JMP .-1 /WAIT FOR FLAG TO SET
SKRK /SKIP ON RC FLAG
HALT /FLAG NOT SET
SCOPE
JMP I .+1
* 177+1

/* TEST THAT RC CLOCK GENERATES INTERRUPTS

```

1000 7000
1001 7200
1002 1051
1003 6346
1004 2106
1005 5204
1006 1215
1007 3002
1010 6001
1011 7000
1012 6002
1013 4512
1014 7410
1015 1014
1016 6351

```

UPR
CLA
TAU K1002 /RC INTERRUPTS AND RC TIMING
ZTEN UTEN
ISE STALL
JMP .-1
TAU .+7
UCA 2
ION
UPR
IOP
HALT /NO INTERRUPT
SKP
.+1
CLEAR

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101/ 6354
1028 4511

ULRK
SCOPE

/TEST USING CRYSTAL CLOCK TO SET FLAG
1021 5100 UCA STALL /FLAG SHOULD BE SET 150 USEC
1022 2106 ISZ STALL
1023 5226 JMP ,+3
1024 4212 HALT /CRYSTAL CLOCK FLAG NOT SET
1025 5230 JMP ,+3
1026 0321 SKXK /SKIP ON CRYSTAL FLAG
1027 5222 JMP ,-5 /NOT SET
1028 4211 SCOPE
PAUSE


```

/TAPE 2
/CLEAR CRYSTAL CLOCK FLAG WITH "IOT"
1031 0322 CLXK
1032 0321 SKXX
1033 5232 JMP .-1
1034 0352 CLXK
1035 0321 SKXX
1036 7410 SKP
1037 4512 HALT
1040 4511 SCOPE

/TEST THAT FLAG DOES NOT SET TOO SOON
1041 0352 CLXK
1042 6321 SKXX
1043 5242 JMP .-1           /SYNC ON CLOCK
1044 6352 CLXK
1045 2106 ISZ STALL
1046 2106 ISZ STALL
1047 2106 ISZ STALL
1050 6321 SKXX
1051 7410 SKP
1052 4512 HALT           /FLAG SET TOO SOON
1053 4511 SCOPE

/TEST THAT FLAG DOES NOT TAKE TOO LONG TO SET
1054 6352 CLXK
1055 6321 SKXX
1056 5255 JMP .-1           /SYNC ON CLOCK
1057 6352 CLXK           /CLEAR XTAL CLOCK FLAG
1060 1022 IAU KM0043
1061 3106 UCA STALL
1062 2106 ISZ STALL       /150 MICRO SEC
1063 5262 JMP .-1
1064 6321 SKXX           /SKIP ON XTAL CLOCK FLAG
1065 4512 HALT           /XTAL CLOCK FL TAKES TOO LONG
1066 4511 SCOPE

/WILL CRYSTAL CLOCK GENERATE AN INTERRUPT
1067 7200 CLA
1070 1023 IAU K0400           /ENABLE XTAL CLOCK INTERRUPT
1071 6346 ZTEN OTEN
1072 2106 ISZ STALL         /XTAL CLOCK FLAG SHOULD BE SET
1073 5272 JMP .-1
1074 1303 IAU .+7
1075 3002 UCA 2
1076 6001 ION               /INTERRUPT ON
1077 7000 NOP               /SHOULD INTERRUPT HERE
1100 6002 IOP
1101 4512 HALT             /NO XTAL INTERRUPT UP
1102 7410 SKP
1103 1104 ,+1
1104 4511 SCOPE

/SET CHANNEL FLAG
1105 7124 STL RAL           /0001 TO AC
1106 6346 OTEN ZTEN         /SET CHANNEL FLAG
1107 6351 XRIN             /SENSE REGISTER TO AC

```

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1110 1500
1111 4012
1112 1200
1113 4011

SMA /AC SHOULD=400W
HALT /B11 0 NOT SET
CLA
SCOPE

/CLEAR XTAL FLAG AND TEST FOR NO INTERRUPT WITH ENABLE UP
 1114 6352 CLXK /CLEAR CRYSTAL CLOCK FLAG
 1115 1324 TAU ,+7
 1116 3002 UCA 2
 1117 0001 ION
 1120 7410 SKP
 1121 4512 HALT /INTERRUPT UP
 1122 6002 IOP
 1123 7410 SKP
 1124 1121 ,+3
 1125 4511 SCOPE
 1126 1030 TAU K0034
 1127 6371 ACMX /MULTIPLEXER CHANNEL 34

/TEST THAT DISPLAY COMMANDS DO NOT INTERFERE WITH A/D CONVERSIONS
 /THIS TEST ASSUMES THAT CHANNEL 34 IS SELECTED AND THAT
 /AND THAT A FIXED NON ZERO VOLTAGE IS SUPPLIED TO CHANNEL 34

1130 6364 ADCV /START CONVERSION
 1131 7000 NOP
 1132 7000 NOP
 1133 6311 DYC /CONVERSION IN PROGRESS
 1134 6362 RADC /THIS INSTRUCTION SHOULD BE INHIBITED
 1135 7450 /IF ZERO (DYC) NOT INHIBITED
 1136 4512 SNA /TEST
 1137 4511 HALT /DYC WAS NOT INHIBITED AND CLEARED CONVERTER
 SCOPE


```

1— 6364
11 1 6332
11 2 5341
1143 7240
1144 6312
1: 3 6362
1: 6 7001
1147 7450
1150 4512
1: 1 4511

/TEST DYL IS INHIBITED DURING A/D CONVERSIONS-CH 34 SET TO HALF POSITIVE SCAL
    ADCV           /START CONVERSION
    SKAU
    JMP , -1       /WAIT FOR FLAG .
    CLA CMA       /AC=7777
    DYL           /(DYL) SHOULD BE INHIBITED UNTILL RADC
    RADC           /IF AC=7777 DYL NOT INHIBITED
    TAU
    SNA           /TEST AC NOT EQUAL 7777
    HALT          /DYL NOT INHIBITED
    SCOPE         /CHANNEL 34 SHOULD HAVE A NON ZERO VOLTAGE

/TEST THAT (DXL) IS INHIBITED DURING A/D CONVERSION
    CLA CMA       /AC=SEVEN
    ADCV           /START CONVERSION
    DXL            /SHOULD BE INHIBITED AN NOT LOAD "X" WITH SEVENS
    SKAU           /IF "X" IS LOADED, DONE WILL SET TOO SOON
    SKP
    HALT          /DONE SET TOO SOON
    SCOPE

/TEST THAT DXC IS INHIBITED BETWEEN (ADCV) AND (RADC)
    ADCV           /START CONVERSION
    SKAU
    JMP , -1       /WAIT FOR FLAG
    DXC            /"DXC" SHOULD BE INHIBITED
    SKAU           /IF NOT INHIBITED WILL CLEAR ADC FLAG
    HALT          /DXC CLEARED DONE
    SCOPE

/THIS ROUTINE IS FOR SCOPING RELAY ENABLES R1, R2 AND R4
    TAU STALL
    AND C0070
    ZTEN UTEN
    ISZ STALL
    JMP , -4
    JMP I , +1
    , 17/+1
*, 17/+1

```

/TEST RC CLOCK SLOW (ONE EIGHT SPEED)

1200	1200	RCX, CLA
1201	1043	TAU K4002
1202	6345	ZLEN UTEN
1203	3106	UCA STALL
1204	6354	CLRK
1205	6341	SKRK
1206	5207	JMP .-1
1207	6354	CLRK
1208	2105	ISZ STALL
1209	6341	SARK
1210	5210	JMP .-2
1211	1106	TAU STALL
1212	6354	UCA SL1
1213	3020	UCA STALL
1214	3106	CLRK
1215	6354	SKRK
1216	6341	JMP .-1
1217	5217	CLRK
1218	6354	ISZ STALL
1219	2106	SKRK
1220	6341	JMP .-2
1221	5222	TAU STALL
1222	1106	UIA
1223	6341	TAU SL1
1224	5222	SNA
1225	1041	JMP RCX1 /EQUAL
1226	1020	CMA
1227	1040	SNA
1228	7450	JMP RCX1 /MINUS ONE
1229	5241	TAU
1230	1001	CMA
1231	1040	SZA
1232	7450	HALT
1233	5241	/PLUS ONE
1234	1001	SCUPE
1235	1040	/TEST RC CLOCK FAST
1236	7450	CLA
1237	5241	TAU K4002
1238	1001	ZLEN UTEN
1239	1040	UCA STALL
1240	6354	CLRK
1241	6341	SKRK
1242	1200	JMP .-1
1243	1033	CLRK
1244	6346	SKRK
1245	3106	JMP .-2
1246	6354	TAU STALL
1247	6341	UCA FT1
1248	5247	UCA STALL
1249	6354	CLRK
1250	2106	SKRK
1251	6341	JMP .-1
1252	5252	CLRK
1253	1106	SKRK
1254	3026	JMP .-2
1255	6341	TAU STALL
1256	6354	UCA FT1
1257	3106	UCA STALL
1258	6354	CLRK
1259	6341	SKRK
1260	5261	JMP .-1
1261	6354	CLRK
1262	2106	ISZ STALL

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1265	6341	SKRK
1266	5264	JMP .-2
1267	1106	TAU STALL
1270	7041	CIA
1271	1026	IAU FT1
1272	7450	SNA
1273	5303	JMP RCX2 /EQUAL
1274	7040	CMA
1275	1450	SNA
1276	5303	JMP RCX2 /MINUS ONE
1277	7001	IAC
1300	7040	CMA
1301	1440	SZA /PLUS ONE
1302	4512	HALT
1303	4511	RCX2, SCUPE /TEST FAST-SLOW RATIO OF RC CLOCK
1304	7300	CLA CLL /IF THIS TEST FAILS
1305	1025	TAU SL1 /RATIO OF CLOCK IS
1306	7110	RAR CLL /NOT 8 TO 1
1307	7110	RAR CLL
1310	7110	RAR CLL
1311	7041	CIA
1312	1026	IAU FT1
1313	7450	SNA
1314	5324	JMP RCX3
1315	7240	CMA
1316	7450	SNA
1317	5324	JMP RCX3
1320	7001	IAC
1321	7040	CMA
1322	7440	SZA
1323	4512	HALT /RATIO NOT 8 TO 1
1324	4511	RCX3, SCUPE /THIS IS NOT TRUE
1325	6342	ZTEN /CLEAR ENABLES
1326	6354	CLRK /CLEAR RC FLAG
1327	5750	JMP I ,+1 /USES DISPLAY TO CHECK ICMX
1330	1400	CHIST /INSTRUCTION

```

/SELECT MUX WITH SWITCHES, DISPLAY CONVERTED VALUE IN AC
1331 4340
1332 4353
1333 5331
1334 4340
1335 5334
1336 4353
1337 5336

CUN3,    JMS CON1
          JMS CON2
          JMP , -2
          JMS CON1           /USE ACMX, RADC, ADCV
          JMP , -1
          JMS CON2           /USE ICMX RADXC ADCV
          JMP , -1

/DISPLAY CONVERTER VALUE IN AC, SW REGISTER 7-11 SELECT MUX
1340 7000
1341 7504
1342 5375
1343 6362
1344 6332
1345 5344
1346 2100
1347 5346
1348 2106
1349 5350
1350 5352
1351 5354
1352 5355
1353 7000
1354 7604
1355 1003
1356 6371
1357 6361
1358 6364
1359 6362
1360 6332
1361 5362
1362 2106
1363 5364
1364 2106
1365 5366
1366 5753
1367 5772
1368 1400

CUN1,    NOP
          LAS
          ACMX ADCV
          RADC
          SKAD
          JMP , -1
          ISZ STALL
          JMP , -1
          ISZ STALL
          JMP , -1
          JMP I CUN1
          NOP
          LAS
          IAU K7777      /MINUS ONE
          ACMX
          ICMX
          ADCV
          RADC
          SKAD
          JMP , -1
          ISZ STALL
          JMP , -1
          ISZ STALL
          JMP , -1
          JMP I CUN2
          JMP I , +1
          . 1/7+1

```

1400 *., 17/+1
 /TEST FOR NUMBER OF CHANNELS ON MULTIPLEXER
 1401 7200 CHTST, CLA
 1402 5057 DCA MUXNUM /CHANNEL ZERO
 1403 6371 ACMX
 1404 6364 ADCV /FIRST CONVERT
 1405 6332 SKAD
 1406 5204 JMP , -1
 1407 6367 ICMX RAUC ADCV /SECOND CONVERT FIRST READ
 1408 3062 DCA CTEMA
 1409 6332 CHTST2, SKAD
 1410 5210 JMP , -1
 1411 6367 ICMX RAUC ADCV /3RD CONVERT 2ND READ
 1412 2057 ISZ MUXNUM
 1413 3070 DCA BAD
 1414 1070 TAU BAD
 1415 7041 CIA
 1416 1062 TAU CTEMA /FIRST READ
 1417 1650 SNA CLA
 1418 5241 JMP CHTST1
 1419 1071 TAU BAD
 1420 7040 CIA
 1421 1062 TAU CTEMA /FIRST READ
 1422 1650 SNA CLA
 1423 5241 JMP CHTST1
 1424 1062 TAU CTEMA
 1425 1650 SNA CLA
 1426 5241 CMA /
 1427 1062 TAU BAD /TEST THE REST
 1428 7040 CIA /NOT EQUAL +/- 1/2 LSB
 1429 1057 TAU MUXNUM /CHANNEL
 1430 7041 ISZ MUXNUM /EQUAL TO MAXIMUM
 1431 1070 TAU BAD /NO--NOT 40
 1432 1650 SNA CLA
 1433 5210 JMP CHTST2
 1434 1057 TAU K0040
 1435 7041 CIA
 1436 1107 TAU K0040
 1437 7540 SZA CLA
 1438 5210 JMP CHTST2
 1439 1050 TAU KM0020
 1440 3106 DCA STALL
 1441 4517 JMS I XTEXTB /SAME VALUE IN X ICMX
 1442 2106 ISZ STALL
 1443 5243 JMP , -2
 1444 4511 SCOPE

/TEST CONTINGENCY REGISTER WAIT 36 MILL SEC

1447	7240	CLA CMA	
1450	6334	XRCL	/CLEAR CONTINGENCY CHANNEL
1451	7200	CLA	
1452	2106	ISZ STALL	/WAIT 36 MSEC FOR
1453	5252	JMP .-1	/EXTERNAL STIMULUS
1454	2106	ISZ STALL	
1455	5254	JMP .-1	
1456	6331	XRIN	/READ CHANNELS
1457	7440	SEA	/TEST FOR ZERO
1460	4512	HALT	/EXTERNAL STIMULUS WAS APPLIED
1461	7240	CLA CMA	
1462	6334	XRCL	/CLEAR CHANNELS
1463	4511	SCOPE	
1464	6354	CLRK	

/LET S1, S2, OR S3 TRIGGER EXTERNAL INTERRUPT

/VALUE OF Y REGISTER CONSTANTLY INCREASING

/VALUE OF Y REGISTER IN AC IF INTERRUPT OCCUR

1465	1041	TAU K1004	/EXTERNAL INTERRUPT ENABLE
1466	6346	ZTEN OTEN	/SELECT ENABLES
1467	1305	TAU VAL1	/INTERRUPT RETURN
1468	3002	UCA 2	
1469	3106	UCA STALL	/EQUAL (Y REGISTER)
1470	6001	ION	/INTERRUPT ON
1471	6313	UYC DYL	/LOAD Y REGISTER
1472	7000	NOP	
1473	7000	NOP	
1474	7001	IAC	/TIME FOR INTERRUPT
1475	2106	ISZ STALL	/INCREMENT (Y VALUE)
1476	5273	JMP .-5	/DONE ALL VALUES
1477	5303	JMP .+2	
1478	5303	JMP .+2	/YES -- TURN INTERRUPT OFF
1479	4512	HALT	/INTERRUPT OCCURED, AC=(Y-REGISTER)
1480	6002	IUP	
1481	7410	SKP	
1482	1502	VAL1, .-3	
1483	6342	ZTEN	
1484	7240	CLA CMA	
1485	6334	XRCL	/CLEAR CONTINGENCY CHANNEL
1486	4511	SCOPE	

/TEST THAT RC CLOCK DOES NOT INHIBIT ADCV

/ECO SEP 11, 1968

1487	6354	CLRK	
1488	6351	CLER	
1489	1034	TAU K2002	/CLER CV AND CM
1490	6346	ZTEN OTEN	/RC CLOCK INITIATE CONVERT
1491	6341	SKRK	
1492	5316	JMP .-1	/WAIT FOR FLAG
1493	6364	ADCV	/NOW DO A ADCV, GENERATE ERROR
1494	6354	CLRK	/CLEAR CLOCK FLAG
1495	6322	SKER	/SKIP ON ERROR
1496	4512	HALT	/ERROR NOT UP
1497	6342	ZTEN	
1498	6332	SKAD	

1226	5325	JMP .,-1	/WAIT FOR FLAG
1227	6354	CLRK	
1230	6362	RAUC	/CLEAR A/D FLAG
1231	4511	SCOPE	
1232	6351	CLER	
1233	6342	ZEN	
/CR,LF AT END OF PASS IF ERROR			
1234	7260	CLA	
1235	1213	TAD I XTYPE	/TEST FLAG
1236	7440	SZA	
1237	4516	JMS I XCRLF	/CRLF TO TTY
1240	3513	UCA I XTYPE.	/CLEAR FLAG
1241	1504	LAS	
1242	7006	RTL	
1243	1710	SPA CLA	
1244	5521	JMP I XSWTCH	/TO DISPLAY TEST
1245	5746	JMP I ,+1	/LOOP ON INSTRUCTION TEST
1246	0245	LOUPA	

1600	1600	*	17/+1
1600	7402	TEXTB,	XX
1601	6351		CLER
1602	1060		TAU K0003
1603	3104		DCA CHXL
1604	1044		TAU K0015
1605	3107		DCA CHYL
1606	4510		JMS I XSIXTY
1607	0057		MUXNUM
1610	1630		TEXTB1
1611	1630		TEXTB1
1612	4454	JMS I MSSG	/DISPLAY OUTPUT
1613	4543	4543	/DIAGNOSTIC RUNNING
1614	0411	0411	
1615	0107	0107	
1616	1617	1617	
1617	2324	2324	
1620	1103	1103	
1621	4022	4022	
1622	2516	2516	
1623	1611	1611	
1624	1507	1607	
1625	4543	4543	
1626	2301	2301	/SA
1627	1505	1505	/ME
1630	4026	4026	/SPACE V
1631	0114	0114	/AL
1632	2505	2505	/UE
1633	4011	4011	/SPACE I
1634	1640	1640	/N SPACE
1635	3030	3030	/XX
1636	4011	4011	/IC
1637	0315	0315	/MX
1640	3000	3000	
1641	5600	JMP I TEXTB	

1542	1402	SIXTY, HLI	
1543	1000	NOP	
1544	7000	NOP	/STORE INIT NEXT TIME
1545	1200	CLA	
1546	1542	TAU I , -4	/ADDRESS OF OPERAND
1547	3251	UCA .+2	
1550	5652	JMP I .+2	
1551	0000	0	/ADDRESS OPERAND
1552	1654	SIXTY+12	/CHANGING REFERENCE (P)
1553	5245	JMP SIXTY+3	
1554	1651	TAU I SIXTY+7	/AC (OPERAND)
1555	0327	ANU K0007	
1556	3322	UCA, MASKA	/000X
1557	1651	TAU I SIXTY+7	/AC (OPERAND)
1560	0330	ANU K00/0	
1561	3323	UCA MASKB	/00X0
1562	1651	TAU I SIXTY+7	/AC (OPERAND)
1563	0331	ANU K0700	
1564	3324	UCA MASKC	/0X00
1565	1651	TAU I SIXTY+7	/AC (OPERAND)
1566	0332	ANU K7000	
1567	3325	UCA MASKD	/X000
1570	1324	TAU MASKC	/0X00
16/1	7112	RTH CLL	
16/2	7010	RAR	/0X00 RSS 00X0
16/3	1325	IAU MASKD	/X0X0
16/4	7012	RTH	
16/5	7010	RAR	
16/6	1326	TAU MASKD+1	/X0X0 RS3 0X0X
15/7	3324	UCA MASKC	/TEMP STORAGE
1/00	2242	ISZ SIXTY	/INCREMENT FOR STORAGE
1/01	4252	JMS SIXTY+10	/FIND STORAGE ADDRESS
1/02	1324	TAU MASKC	/6X6X
1/03	3651	UCA I SIXTY+7	/STORE OPERAND AS SPECIFIED
1/04	1323	TAU MASKB	/00X0
1/05	7004	HAL	
17/06	7006	RTL	/00X0 SL3 0X00
1/07	1322	TAU MASKA	/0X00+000X=0X0X
1/10	1326	TAU MASKD+1	/0X0X+6060=6X6X
1/11	3325	UCA MASKD	/TEMP STORAGE ADDRESS
1/12	2242	ISZ SIXTY	/INCREMENT FOR STORAGE
1/13	4252	JMS SIXTY+10	/FIND STORAGE ADDRESS
1/14	1325	TAU MASKD	/6X6X
1/15	3651	UCA I SIXTY+7	/STORE OPERAND AS SECIFIED
1/16	1333	IAU SIX12	/HOUSE KEEPING
1/17	3252	UCA SIXTY+10	
1/20	2242	ISZ SIXTY	/INCREMENT FOR RETURN
1/21	5642	JMP I SIXTY	/RETURN

1/22	0000	MASKA,	0
1/23	0000	MASKB,	0
1/24	0000	MASKC,	0
1/25	0000	MASKD,	0
1/26	6000		0000
1/27	0007	K0007,	0007
1/30	0070	K0070,	0070
1/31	0700	K0700,	0700
1/32	7000	K7000,	7000
1/33	1654	SIX12,	SIXTY+12

*. 17/+1

2000	2000		
2000	7604	SWTCH, LAS	/DISCOVER WHAT TEST OPERATOR WANTS
2001	7104	CLL RAL	/MOVE SR0,1 INTO LINK AC FOR TEST
2002	7530	SZL SPA	
2003	7410	SKP	
2004	5237	JMP LDIAG	/HE WANTS LEFT DIAGONAL
2005	7040	CMA	
2006	7530	SZL SPA	
2007	7410	SKP	
2010	5243	JMP RDIAG	/HE WANTS RIGHT DIAGONAL
2011	7060	CMA CML	
2012	7730	SZL SPA CLA	
2013	5247	JMP ANGLE	/HE WANTS THE ANGLE
2014	5271	JMP XBOX	
2015	0000	KEYS, 0	
2016	7604	LAS	
2017	0131	AND K0600	/SAVE INTENSITY BITS
2020	7106	CLL RTL	/MOVE TO AC 10, 11
2021	7006	RTL	
2022	7006	RTL	
2023	1132	TAD K6324	
2024	3229	UCA EXECUT	/ADD BASIC IOT TO BITS
2025	0000	EXECUT, 0	/STORE
2026	7604	LAS	
2027	7106	CLL RTL	/GET SWITCHES
2030	7710	SPA CLA	
2031	5200	JMP SWTCH	/SHALL WE REPEAT
2032	7604	LAS	/NO
2033	0107	AND K0040	
2034	7640	SZA CLA	
2035	5510	JMP I XINT3	
2036	5610	JMP I KEYS	/YES
2037	4326	LUIAG, STUL	/LEFT DIAGONAL SUBROUTINE
2040	4523	UDUL	/SET TOO UPPER LEFT
2041	4215	JMS KEYS	/DRAW LEFT DIAGONAL LINE
2042	5237	JMP LDIAG	/CHECK THE KEYS
2042	5237		/REDRAW
2043	4522	RUIAG, STUR	
2044	4524	DRUL	/SET TOO UPPER RIGHT
2045	4215	JMS KEYS	/DRAW RIGHT DIAGONAL LINE
2046	5243	JMP RDIAG	/CHECK THE KEYS
2046	5243		/REDRAW
2047	7300	ANGLE, CLA CLL	
2050	6343	DXC DXL	/CLEAR X
2051	6313	DYC DYL	/CLEAR Y
2052	1142	TAD M200	
2053	3143	UCA COUNT	/SET COUNTER
2054	1140	TAD P2	
2055	6307	DXC DXL DIS	
2056	2143	ISZ COUNT	/DRAW
2057	5254	JMP , -3	/DONE YET
2057	5254		/NO

2060	7300	CLA CLL	
2061	1142	TAU M200	/SET UP COUNTER
2062	3143	UCA COUNT	
2063	1140	TAU P2	
2064	6317	UYC DYL DIS	/DRAW
2065	2143	ISZ COUNT	
2066	5263	JMP .-3	/DONE YET
2067	4215	JMS KEYS	/EXIT
2070	5247	JMP ANGLE	/REDRAW
 2071	 4316	XBOX,	STLL
2072	4525		DVLT
2073	1133		TAD K37/
2074	6303		UXC DXL
2075	3134		UCA XPOSR
2076	4526		DVLB
2077	4336		S1LR
2100	4525		DVLT
2101	6313		UYC DYL
2102	3135		UCA YPOSR
2103	4530		UHLL
2104	4326		STUL
2105	4523		DLUL
2106	4522		STUR
2107	4524		DRUL
2110	4326		STUL
2111	4527		UHLR
2112	4336		STLR
2113	4530		UHLL
 2114	 4217		JMS KEYS
2115	5271		JMP XBOX

2116	0000	SILLS, 0	CLA CLL UXC DXL UCA XPOSR IAD K400 UYC DYL UCA YPOSR JMP I STLLS
2117	7300		
2120	6303		
2121	3134		
2122	1136		
2123	6313		
2124	3135		
2125	5716		
2126	0000	STULS, 0	/SET TO 0400
2127	7300		CLA CLL UXC UCA XPOSR IAD K377 UYC DYL UCA YPOSR JMP I STULS
2130	6301		
2131	3134		
2132	1133		
2133	6313		
2134	3135		
2135	5726		
2136	0000	STLRS, 0	CLA CLL IAD K400 UYC DYL UCA YPOSR IAD K777 UXC DXL UCA XPOSR JMP I STLRS
2137	7300		
2140	1136		
2141	6313		
2142	3135		
2143	1137		
2144	6303		
2145	3134		
2146	5736		
2147	0000	STURS, 0	CLA CLL IAD K777 UXC DXL UCA XPOSR IAD K377 UYC DYL UCA YPOSR JMP I STURS
2150	7300		
2151	1137		
2152	6303		
2153	3134		
2154	1133		
2155	6313		
2156	3135		
2157	5747		
2160	0000	DVLTS, 0	JMP I STURS TAU M400 UCA COUNT TAU YPOSR
2161	1141		
2162	3143		
2163	1135		

2164	1140	IAD P2	
2165	6317	UYC DYL DIS	
2166	2143	ISZ COUNT	
2167	5364	JMP , -3	
2170	7300	CLA CLL	
2171	5760	JMP I DVLTS	
	4316	STLL=JMS SILLS	
	4326	STUL=JMS SIULS	
	4336	STLR=JMS SILRS	
	2200	* , 17/+1	
2200	0000	DVLTS, 0	
2201	1141	TAO M400	
2202	3143	OCA COUNT	
2203	1155	IAD YPOSR	
2204	1052	TAO K7776	/MINUS 2
2205	6317	UYC DYL DIS	
2206	2143	ISZ COUNT	
2207	5204	JMP , -3	
2210	7300	CLA CLL	
2211	5600	JMP I DVLTS	
2212	0000	DHLRS, 0	
2213	1141	IAD M400	
2214	3143	OCA COUNT	
2215	1154	IAD XPOSR	
2216	1140	TAO P2	
2217	6307	UXC DXL DIS	
2220	2143	ISZ COUNT	
2221	5216	JMP , -3	
2222	7300	CLA CLL	
2223	5612	JMP I DHLRS	

2224	0000	DHLLS,	0
2225	7300		CLA CLL
2226	1141		IAD M400
2227	3143		DCA COUNT
2230	1134		TAD XPOSR
2231	1052		TAU K7776
2232	6307		UXC DXL DIS
2233	2143		ISZ COUNT
2234	5231		JMP , -3
2235	7300		CLA CLL
2236	5624		JMP I DHLLS
2237	0000	DLDLS,	0
2240	7300		CLA CLL
2241	1141		TAU M400
2242	3143		DCA COUNT
2243	1134	MYPX,	TAU XPOSR
2244	1140		IAD P2
2245	6303		UXC DXL
2246	3134		UCA XPOSR
2247	1135		TAD YPOSR
2250	1052		TAU K77/6
2251	6317		UYC DYL DIS
2252	3135		DCA YPOSR
2253	2143		ISZ COUNT
2254	5243		JMP MYPX
2255	5637		JMP I DLDLS
2256	0000	DRDLS,	0
2257	7300		CLA CLL
2260	1141		TAU M400
2261	3143		DCA COUNT
2262	4522		STUR
2263	1134	MYMX,	TAU XPOSR
2264	1052		TAU K7776
2265	6303		UXC DXL
2266	3134		UCA XPOSR
2267	1135		TAD YPOSR
2270	1052		TAU K7776
2271	6317		UYC DYL DIS
2272	3135		UCA YPOSR
2273	2143		ISZ COUNT
2274	5263		JMP MYMX
2275	5656		JMP I DRDLS

	2400	*	, 17/+1
2400	5205		JMP INIT3
	0010		PNTR=10
2401	0000		X, 0
2402	0000		Y, 0
2403	0000		RCNT, 0
2404	2514		ADBUFR, ADBUF=1
			PAUSE

/TAPE 3
 /THREE STATE SCOPE DISPLAY
 2405 7326 INIT3, CLA STL RTL /POSITIVE TWO
 2406 6346 ETEN OTEN
 2407 6354 CLK
 2410 1047 INISAM, TAU KM1000
 2411 3143 UCA COUNT
 2412 1204 TAU ADBUFR
 2413 3010 UCA PNTR
 2414 7604 SAMLOP, LAS
 2415 6375 ACMX ADCV /LOAD MUX WITH SWITCHES, CONVERT
 2416 6332 SKAD
 2417 5216 JMP , -1 /WAIT FOR FLAG
 2420 6362 RAUC /READ BUFFER
 2421 3410 UCA I PNTR /STORE SKP
 /FOR SCOPING WITHOUT INDEXING MUX REPLACE A WITH A NOP
 2422 5235 JMP SAM1
 2423 7604 LAS /READ SWITCHES, SUBTRACT ONE
 2424 1053 TAU K7777 /LOAD MUX, INCREMENT MVX
 2425 6371 ACMX
 2426 6361 ICMX /CONVERT
 2427 6364 ADCV
 2430 6332 SKAD
 2431 5230 JMP , -1 /WAIT FOR FLAG
 2432 6362 RAUC /READ BUFFER
 2433 3410 UCA I PNTR /STORE
 2434 2143 ISZ COUNT
 2435 2143 SAM1, ISZ COUNT
 2436 5214 JMP SAMLOP /MORE SAMPLES
 2437 1050 TAU KM0020
 2440 3203 UCA RCNT
 2441 1204 INIT3, TAU ADBUFR /BUFFER
 2442 3010 UCA PNTR
 2443 1024 TAU KM0/77
 2444 3143 UCA COUNT
 2445 3201 UCA X /X REFERENCE SETUP
 2446 1410 TAU I PNTR
 2447 1041 UCA IAC
 2450 3202 UCA Y /Y REFERENCE SETUP

2451	4276	JMS STATE	/VALUE OF CONVERTED WORD
2452	1410	DISLOP, TAD I PNTR	/NEXT WORD
2453	1202	TAD Y	/REFERENCE IT
2454	7006	RTL	
2455	7006	RTL	
2456	7006	RTL	
2457	0045	AND K7700	
2460	0313	JYC DYL	/LOAD Y
2461	7200	CLA	
2462	1201	TAD X	
2463	6301	UXC DXL DIS	/LOAD X
2464	1001	IAC	
2465	3201	UCA X	/RESTORE X INCREMENTED
2466	2143	ISZ COUNT	/DONE
2467	5252	JMP DISLOP	/NO
2470	6341	SKRK	/SKIP ON RC CLOCK
2471	5241	JMP INIUDS	/RC CLOCK IS REFRESH RATE
2472	6354	CLRK	/CLEAR CLOCK
2473	2203	ISZ RCNT	/BASIC TIME COUNT
2474	5241	JMP INIUDS	/REFRESH DISPLAY
2475	5210	JMP INISAM	/FILL BUFFER WITH NEW
2476	7402	STATE, XX	
2477	6351	CLER	
2500	1060	TAD K0003	
2501	3104	UCA CHXL	
2502	1042	TAD K0340	
2503	3105	UCA CHYL	
2504	4515	JMS I XSIXTY	
2505	2515	AUBUF	
2506	2511	,+3	
2507	2512	,+3	
2510	4454	JMS I MSSG	
2511	6060	6060	
2512	6060	6060	
2513	0000	0	
2514	5676	JMP I STATE	
2515	0000	AUBUF, 0	
		*AUBUF +1000	

3600 *.. 17/*1 /FILE NAME: DSCPAK

/DISPLAY STRIPPED ASCII CHAR IN AC: DSC
 /SAMPLE CALLING SEQUENCE -
 / LUH /GET HALFWORD
 / USC /DISPLAY IF NON ZERO
 / JMP , -2 /DISPLAY THE NEXT HALFWORD

4455 USC=JMS I CHDSCI

/TEMPORARY STORAGE:
 00/6 CHCNT3=TEMP02
 00/7 CHCNT2=TEMP03
 0100 CHCNT1=TEMP04
 0141 CHRUT=TEMP05
 00/5 CHFAC=TEMP01
 0102 CHPNT=TEMP06
 00/5 CHYS=TEMP01

/DISPLAY TABLE EXCEPTIONS
 7777 SPACE=-1
 0005 ENDIS=5
 0001 BKSPC=1
 0002 RESET=2
 0003 LFED=3
 0004 CRETN=4
 0000 IGNOR=0

500	0000	CHUSC, 0	
501	7104	CLL RAL	
502	1056	TAU ADSTBL	
503	5102	UCA CHPNT	
504	1502	TAU I CHPNT	
505	2102	ISE CHPNT	
506	7440	SZA	
507	5223	JMP CHSET1	/NOT SPECIAL CHARACTER
510	1502	TAU I CHPNT	
511	1360	TAU CHJMP	
512	3213	UCA ,+1	
513	5600	JMP I CHUSC	
 /DISPATCH TABLE FOR ABOVE JMP			
614	3676	CHJMPL, CHSPA	/JUMP TABLE: SPACE
615	3671	CHEND+1	/IGNORE
616	3700	CHBSK	/BACKSPACE
617	3715	CHREST	/NEXT 4 CHARACTERS RESET X, Y, DELTA, INTENSIIY
620	3751	CHLF	/DO A LINE FEED
621	3747	CHCR	/DO A CARRIAGE RETURN
622	3670	CHEND	/END OF TEXT
 623 3101 CHSET1, UCA CHROT			
624	1104	TAU CHXL	
625	6303	UXC DXL	
626	7344	MTW	
627	3076	UCA CHCNT3	/NUMBER OF WORDS IS TWO
630	7344	CHSET2, MTW	/NUMBER OF LINES IS TWO
631	3077	UCA CHCNT2	
632	1061	CHSETS, TAU KM0006	/NUMBER OF POINTS IN A LINE IS SIX
633	3100	UCA CHCNT1	
634	1105	TAU CHYL	/REPOSITION Y AT BOTTOM OF CHARACTER
635	3075	UCA CHYS	/RECORD PRESENT Y POSITION
636	1101	CHDIS, TAU CHROT	
637	7104	CLL RAL	/NO, GET FIRST BIT INTO LINK
640	3101	UCA CHROT	/STORE CODE WORD FOR NEXT BIT
641	1075	TAU CHYS	/INTENSIFICATION POSITION
642	6313	UYC DYL	
643	7430	SEL	/DISPLAYS IF LINK=1
644	6304	DIS	
645	1361	TAU CHSIZ	/GO NEXT POSSIBLE DOT-
646	3075	UCA CHYS	/KEEP RECORD OF PRESENT POSITION
647	2102	ISE CHCNT1	/DO ALL THIS SIX TIMES
650	5236	JMP CHDIS	
651	1104	TAU CHXL	
652	1361	TAU CHSIZ	
653	6303	UXC DXL	
654	3104	UCA CHXL	
655	2077	ISE CHCNT2	/HAS SECOND HALF BEEN DONE?
656	5232	JMP CHSET3	/NO, DO IT
657	1502	TAU I CHPNT	/GET SECOND WORD
660	3101	UCA CHROT	
661	2076	ISE CHCNT3	
662	5230	JMP CHSET2	

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3663	1361	TAD CHSIZ	/BOTH DONE
3664	7104	CLL RAL	
3665	1104	TAD CHXL	
3666	3104	UCA CHXL	/SPACE 2 INCREMENTS
3667	5600	JMP I CHDSC	

S/0/0 2200 CHEND, ISZ CHOSC
 S/0/1 6303 DXC DXL
 S/0/2 1364 TAU K0401
 S/0/3 6313 DYC DYL
 S/0/4 7200 CLA
 S/0/5 5600 JMP I CHOSC
 /SPACE: MOVE X RIGHT 6 INCREMENTS
 S/0/6 4305 CHSPA, JMS GET6 /GET X FOR WHOLE CHARACTER
 S/0/7 5302 JMP CHBS+2

S/W/0 4305 /BACKSPACE: MOVE X LEFT ONE CHARACTER
 CHBS, JMS GET6
 S/W/1 7041 CMA IAC
 S/W/2 1104 TAU CHXL /MOVE X POINTER LEFT
 S/W/3 3104 UCA CHXL /ONE CHARACTER
 S/W/4 5600 JMP I CHOSC

/GETS SIX TIMES CHAR SIZE
 S/W/5 0000 GET6, 0
 S/W/6 1361 TAU CHSIZ
 S/W/7 7106 CLL RTL ,4 TIMES SIZE
 S/W/8 3075 UCA CHFAC
 S/W/9 1301 TAU CHSIZ
 S/W/10 7104 CLL RAL /PLUS 2 TIMES SIZE
 S/W/11 1015 TAU CHFAC /IS SIX TIMES SIZE
 S/W/12 5700 JMP I GET6

/SELECT NEW X POSITION
 CHREST, LUH
 S/W/13 4454 TAU KM0001
 S/W/14 0303 AND K0017
 S/W/15 7106 CLL RTL
 S/W/16 7006 RTL
 S/W/17 7004 RAL
 S/W/18 3104 UCA CHXL

/SELECT NEW Y POSITION
 CHYPOS, LUH
 S/W/19 4454 AND K0017
 S/W/20 0303 CLL RTL
 S/W/21 7106 RTL
 S/W/22 7006 RAL
 S/W/23 7041 CMA IAC
 S/W/24 1364 TAU K0401
 S/W/25 3105 UCA CHYL

/CHARACTER SIZE SELECTION

3/34	4454	CHOSZ, LDH
3/35	0363	AND K0017
3/36	7104	CLL RAL
3/37	3361	UCA CHSIZ

/ELIMINATE ALL BUT BITS 8-11
/STORE DESIRED CHARACTER SIZE

/INTENSIFICATION SELECTION

3/40	4454	CHINT, LDH
3/41	0260	AND K0003
3/42	1365	IAD KDSB
3/43	3344	UCA ,+1
3/44	6324	USB
3/45	5600	JMP I CHOSC
3/46	5600	JMP I CHOSC

/CARRIAGE RETURN: RETURN X TO LEFT MARGIN

3/47	3104	CHCR, UCA CHXL
3/50	5600	JMP I CHOSC

/LINE FEED: MOVE Y DOWN 8 INCREMENTS

3/51	1361	CHLF, IAD CHSIZ
3/52	7106	/8 TIMES CHAR SIZE
3/53	7204	CLL RTL
3/54	7241	RAL
3/55	1105	CMA IAC
3/56	3105	IAD CHYL
3/57	5600	UCA CHYL
		/NEW Y POSITION
		JMP I CHOSC

/CONSTANTS USED THIS PAGE ONLY

3/60	5015	CHJMP, JMP I CHJMP+1
------	------	----------------------

/VARIABLES FOR THIS PAGE

3/61	0004	CHSIZ, 4
------	------	----------

/CHARACTER SIZE CONSTANT

3/62	7717	KM4001, -1
3/63	0017	K0017, 1/
3/64	0401	K0401, 401

3/65	6324	KUSB, USB
------	------	-----------

S/66 S/67	0000 0005	DSCTBL, & ENVIS	/@ SPECIAL, MEANS END OF TEXT
S/10 S/11	7711 1177	1111 1177	/A
S/12 S/13	7740 4532	1145 4532	/B
S/14 S/15	3641 4122	3641 4122	/C
S/16 S/17	7741 4136	1141 4136	/D
4000 4001	7751 5141	1151 5141	/E
4002 4003	1111 1101	1111 1101	/F
4004 4005	3641 5132	3641 5132	/G
4006 4007	7710 1017	1110 1017	/H
4010 4011	0077 0000	0017 0000	/I
4012 4013	2040 4037	2040 4037	/J
4014 4015	1714 2241	1714 2241	/K
4016 4017	7740 4040	1140 4040	/L
4020 4021	7706 0611	1106 0611	/M
4022 4023	7704 1017	1104 1017	/N
4024 4025	7741 4177	1741 4177	/O
4026 4027	7711 1106	1111 1106	/P
4030 4031	1621 3156	1621 3156	/Q

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131	/11	
13	3146	/R
134	2245	/S
135	4531	
136	0101	/T
137	1101	
14	7740	/U
14	4011	
142	3140	/V
143	2011	
14	1730	/W
145	4011	
14	6314	/X
14	1463	
050	0710	/Y
0:	1007	
052	6151	/Z
053	4543	
01	0611	/L DISPLAYED AS #
02	1706	
054	1051	/\ DISPLAYED AS DOWN ARROW
0	1000	
060	2313	/] DISPLAYED AS %
061	6462	
02	0410	/+
063	0400	
 /SPECIAL, DOES BACKSPACE		
04	0000	\
005	0001	BKSPC
05	0000	
07	1111	SPACE /SPACE IS A SPECIAL CHARACTER
010	0057	/!
011	0000	
02	0000	
073	0000	0 /* SPECIAL, MARKS PROG INPUT TO TEXT BUFFER, NOT DISPL
04	0000	
05	0003	0 /* SPECIAL, DOES LINE FEED

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	0	/\$ SPECIAL, DISPLAY RESET FOLLOWS
	RESET	
1	0000	
01	0004	
		/%
	CRETN	SPECIAL, DOES CARRIAGE RETURN
	0/17	
	/010	
		/8
04	0008	
	0000	
	IGNUR	'/ SPECIAL, MARKS KBD INPUT TO TEXT BUFFER, NOT DISPLAYED
00	1/41	
01	4100	
		/(* DISPLAYED AS [
1	0041	
	41//	
		/) DISPLAYED AS]
12	2214	
	1422	
		/* DISPLAYED AS LITTLE X
14	0416	
	0400	
		/+
15	0050	
17	3000	
		/0
1	0404	
	0400	
		/-
22	0040	
	0000	
		/0
23	010	
25	0402	
		//
3	3641	
7	4130	
		/0
30	0042	
L	1140	
		/1
32	6251	
33	5146	
		/2
4	2241	
03	4532	
		/3
45	1412	
7	7710	
		/4
40	2745	
41	4531	
		/5

4142	3645	3645	/6
4143	4030	4030	
4144	6111	6111	/7
4145	0503	0503	
4146	3245	3245	/8
4147	4032	4032	
4150	0651	0651	/9
4151	5136	5136	
4152	0033	0033	/:
4153	0000	0000	
4154	0053	0053	/;
4155	3200	3200	
4156	1422	1422	/<
4157	4100	4100	
4160	0012	0012	/=
4161	1212	1212	
4162	4122	4122	/>
4163	1400	1400	
4164	0251	0251	/?
4165	0502	0502	
4200		*	17/+1

/LOAD HALF WORD AND DISPLAY

4200	1402	MSG,	XX
4201	7240		CLA CMA
4202	1200		TAU MSG
4203	3010		UCA 10
4204	1410		TAU I 10
4205	3103		UCA MSRHT
4206	1103		TAU MSRHT
4207	7012		RTR
4210	7012		RTR
4211	7012		RTR
4212	0046		AND K0077
4213	4455		USC
4214	7610		SKP CLA
4215	5410		JMP I 10
4216	1103		TAU MSRHT
4217	0046		AND K0077
4220	4455		USC
4221	5204		JMP MMSG+4
4222	5410		JMP I 10

```

/SCOPE LOOP CHECK
/SCOPE WITH SWITCH BIT 10=1
SCOPEA, XX
  LAS
  AND K0002
  SZA CLA
  JMP I RETURN
  IAU SCOPEA
  JCA RETURN
  JMP I SCOPEA

4223 7402
4224 7604
4225 0033
4226 1540
4227 0533
4230 1223
4231 0233
4232 0623

4233 0200
4234 0633

RETURN, BEGIN
  JMP I RETURN

/INITIAL PRINT OUT WHEN BIT 11=1

IPRINT, XX
  UCA AC           /SAVE AC
  LAS
  RAR
  SNL CLA
  JMP ,+6
  IAU IPRINT
  IAU K/7/6         /MINUS 2
  UCA IPRINT
  IAU I IPRINT
  UCA IPRINT
  IAU AC           /RESTORE AC
  JMP I IPRINT
/GENERATE CR,LF
CRLF, XX
  JMS I XIYPE
  4543
  0000
  KCC
  ICF
  JMP I CRLF

```

/PRINTOUT CONTENTS OF AC AND ERROR ADDRESS
ERAUD, XX
JMS I XIPRIN /TEST FOR INHIBIT PRINT
10F
JMS I XSIXTY
ERAUD
,+4
,+4
JMS I XTYPE /TYPE ERROR ADDRESS
4543
6060
6060
6060
9000
4515 JMS I XSIXTY
0120 AC
4303 ,+4
4304 ,+4
4501 4515 JMS I XTYPE /TYPE AC
4502 4040 4040
4503 6060 0000
4504 6060 0000
4505 0000 0000
4506 6042 10F
4507 6032 KCU
4510 7604 LAS /TEST FOR HALT
4511 7012 RTR /BIT 9=1, (0004)
4512 7010 RAK
4513 7620 SNL CLA
4514 5661 JMP I ERAUD
4515 1120 IAD AC
4516 7402 HLT
4517 5601 JMP I ERAUD

PAUSE

/TAPE 4
 /DIGITAL 8-18-U
 /MESSAGE TYPE-OUT
 /CALL WITH A JMS MESSAGE
 /WITH DATA FOLLOWING
 /RETURN FOLLOWING END OF MESSAGE
 /CODE(00)

4320	0000	MESSAGE,	0	
4321	1240		CLA CMA	/SET C(AC)=-1
4322	1320		IAD MESSAGE	/ADD LOCATION
4323	3010		JCA 10	/AUTO-INDEX REGISTER
4324	1410		IAD I 10	/FETCH FIRST WORD
4325	3336		JCA MSRHT	/SAVE IT
4326	1336		IAD MSRHT	
4327	7312		RTR	
4330	7012		RTR	/ROTATE 6 BITS RIGHT
4331	7012		RTR	
4332	4331		JMS TYPECH	/TYPE IT
4333	1336		IAD MSRHT	/GET DATA AGAIN
4334	4331		JMS TYPECH	/TYPE RIGHT HALF
4335	5324		JMP MESSAGE+4	/CONTINUE
4336	0000	MSRHT,	0	/TEMPORARY STORAGE
4337	0000	TYPECH,	0	/TYPE CHARACTER IN C(AC)6-11
4340	0310		AND MASK77	
4341	1400		SNA	
4342	5410		JMP I 10	/IS IT END OF MESSAGE?
4343	1311		IAD M40	/YES: EXIT
4344	7000		SMA	/SUBTRACT 40
4345	5350		JMP .+3	/<40?
4346	1312		IAD C340	/NO
4347	5360		JMP MTP	/YES: ADD 300
4350	1313		IAD M3	/TO CODES <40
4351	7440		SZA	/SUBTRACT 3
4352	5352		JMP .+3	/IS IT ZERO?
4353	1314		IAD C212	/NO
4354	5363		JMP MTP	/YES: CODE 43 IS
4355	1315		IAD M2	/LINE-FEED (212)
4356	7440		SZA	/SUBTRACT 2
4357	5362		JMP .+3	/IS IT ZERO?
4360	1316		IAD C215	/NO
4361	5363		JMP MTP	/YES: CODE 45 IS
4362	1377		IAD C245	/CARRIAGE-RETURN (215)
4363	6046	MTP,	ILS	/ADD 200 TO OTHERS >40
4364	6041		ISF	/TRANSMIT CHARACTER
4365	5364		JMP .-1	/WAIT FOR FLAG
4366	7200		CLA	/NOT SET YET
4367	5737		JMP I TYPECH	/SET: CLEAR C(AC)
				/RETURN

/CONSTANTS
4310 0077
4311 7740
4312 0340
4313 7770
4314 0212
4315 7716
4316 0210
4317 0245

\$

THERE ARE NO ERRORS

SYMBOL TAB_E

AU	4120
AUMA	6371
AUHUF	2515
AUHUF.R	2404
AUCV	6364
AUSTBL	0056
ANGLE	2041
BAL	0070
BEGIV	0200
BKSPC	0001
CCONTA	0055
CCONTB	0056
CCONTC	0057
CHHS	3100
CHCN11	0100
CHCN12	0071
CHCN13	0076
CHCR	3141
CHCS?	3134
CHDIS	3636
CHDSC	3600
CHDSCI	0055
CHEND	3670
CHFAC	0075
CHINT	3140
CHJMP	3150
CHJMP.L	5014
CHLF	3171
CHPNT	0102
CHRESI	3115
CHR01	0101
CHSET1	3023
CHSET2	3630
CHSET3	3632
CHSI%	3151
CHSPA	3076
CHTST	1400
CHTST1	1441
CHTST2	1410
CHXL	0104
CHYL	0105
CHYPOS	3124
CHYS	0075
CLER	6351
CLRK	6354
CLXK	6352
CUN1	1340
CUN2	1353
CUNS	1331
COUNT	0143
CRETN	0004
CRLF	4202
CIEMA	0052

SYMBOL TABLE

UITEMB	0063
UITEMC	0064
U0070	0037
UC112	4374
UC115	4376
UC45	4377
US4W	4372
UHLL	4530
UHLLA	0130
UHLLS	2224
UHLR	4527
UHLRA	0127
UHLRS	2212
UIS	5324
UISL0P	2452
UL0L	4523
UL0LA	0123
UL0LS	2231
UR0L	4524
UR0LA	0124
UR0LS	2256
USH	6324
USC	4455
USC1BL	3166
UVLB	4526
UVLRA	0126
UVLBS	2200
UVLI	4525
UVLIA	0125
UVLIS	2160
UXC	6301
UXL	5302
UYC	6311
UYL	6312
EN01S	0005
ERADD	4261
EXECUI	2025
F11	0026
GETG	3705
HAL1	4512
IUMX	6361
IGNOR	0000
INIDIS	2441
INISAM	2410
INIT3	2405
INLL	0071
IPRIVI	4235
KUSB	3165
KEYS	2015
KM0001	3762
KM0006	0061
KM0020	0050
KM0043	0022

SYMBOL TABLE

KM#1//	0024
KM1#3#	0047
KU#2	0033
KU#3	0050
KU#4	0056
KU#7	1721
KU#15	0044
KU#17	3163
KU#34	0054
KU#43	0107
KU#75	1730
KU#11	0046
KU1#3	0031
KU2#3	0040
KU3#3	0042
KU4#3	0023
KU4#1	3154
KU6#0	0131
KU7#0	1731
K1#W#J	0032
K1#W#2	0051
K1#W#4	0041
K2#W#2	0034
K3#W#2	0035
K5#7	0133
K4#W	0136
K4#W#2	0043
K6#24	0132
K7#W#0	1732
K7#W#0	0021
K7#W#3	0045
K7#7	0137
K7#7#6	0052
K7#7#7	0053
LUM	4454
LUIAG	2637
LFED	0003
LOOP	0072
LUOPA	0245
MASKA	1722
MASKB	1723
MASKC	1724
MASKD	1725
MASK#	4370
MESSAGE	4320
MESG	4200
MSRGH1	4330
MSRHT	0103
MSG	0054
MIP	4363
MIW	7344
MUXNUM	0057
MYMX	2263

SYMBOL TABLE

MYPX	2243
MW3/7	0027
MZ	4375
MZBW	0142
MJ	4373
M40	4371
M40W	0141
M/4W0	0020
UPR	1000
ULEN	6344
PNTK	0010
PC	0140
RADC	6352
RUNI	2403
RUX	1200
RUX1	1241
RUX2	1303
RUX3	1324
HUIAG	2043
RESET	0002
RETURN	4233
SAMLOP	2414
SAM1	2435
SLOPE	4511
SLOPEA	4223
SIX1Y	1642
SIX12	1733
SKAU	6332
SKER	6322
SKRK	6341
SKXK	6321
SL1	0025
SPACE	1177
SIAL	0106
SIALE	2476
SILL	4316
SILLS	2116
SILR	4336
SILRS	2136
SILUL	4326
SILULS	2126
SIUR	4522
SIURA	0122
SIURS	2147
SWTCH	2000
TEMP01	0075
TEMP02	0076
TEMP03	0077
TEMP04	0100
TEMP05	0101
TEMP06	0102
TEXT8	1600
TEXT31	1635

SYMBOL TABLE

TYPECH	4337
VAL1	1505
X	2401
XDX	2071
XURL	0116
XCR	0074
XERASU	0112
XIN13	0110
XIPRIN	0114
XPOSY	0134
XCOL	6334
XIN	6331
XSCOPE	0111
XIXIY	0115
XSWICH	0121
XLEXIB	0117
XIYPE	0113
XX	1402
Y	2402
YPOSY	0135
ZEN	6342

SYMBOL TABLE

LUNDR	0000
RASPC	0001
RESET	0002
LFELD	0003
CREIN	0004
ENVIS	0005
PNTK	0010
M/400	0020
N/400	0021
KM0043	0022
K0403	0023
K10111	0024
SL1	0025
F11	0026
M0317	0027
KW034	0030
K0100	0031
K1000	0032
KW002	0033
K2002	0034
K3002	0035
K0004	0036
C0010	0037
KW200	0040
K1004	0041
KW340	0042
K4002	0043
KW015	0044
K1700	0045
KW017	0046
KM1000	0047
K10020	0050
K1002	0051
K1716	0052
K1717	0053
MSSG	0054
CHDSCI	0055
AUSTBL	0056
MUXNUM	0057
KW003	0060
KM0006	0061
CIEMA	0062
CIEMB	0063
CIEMC	0064
CICONTA	0065
CICONTB	0066
CICONTC	0067
BAD	0070
INLL	0071
LUOP	0072
XER	0074
CHYS	0075
TEMP01	0075

SYMBOL TABLE

UMFAU	0015
UMC113	0076
UMPH2	0076
UMCH12	0077
UMPH3	0077
UMCN11	0100
UMPH04	0100
UMPH20	0101
UMR01	0101
UMPN1	0102
UMPH06	0102
MSRM1	0103
UMXL	0104
UMYL	0105
SIAL-	0106
KW042	0107
XINTS	0110
XSCDPE	0111
XERALD	0112
XIYFE	0113
XIPRIN	0114
XSIXY	0115
XURLF	0116
XIEXIB	0117
AU	0120
XSWICH	0121
SIURA	0122
ULOLA	0123
UROLA	0124
UVLIA	0125
UVLBA	0126
UMLKA	0127
UMLLA	0130
KW6K2	0131
K6324	0132
K377	0133
XPOSR	0134
YPOSR	0135
K40W	0136
K171	0137
PZ	0140
M40W	0141
M200	0142
LUON1	0143
REG1N	0200
LUOPA	0245
RUX	1200
RUX1	1241
RUX2	1303
RUX3	1324
UN3	1331
UN1	1340
UN2	1353

SYMBOL TABLE

CHTST	1400
CHTST2	1410
CHTST1	1441
VAL1	1505
TEXTR	1600
TEXTR1	1635
STXTY	1642
MASKA	1722
MASKB	1723
MASKC	1724
MASKD	1725
KWDW7	1727
KWDW8	1730
KWDW9	1731
KWDW0	1732
STX12	1733
SWTCH	2000
KEYS	2015
EXECUT	2025
LUDAG	2037
KUJAG	2043
ANGLE	2047
XBOX	2071
SILLS	2116
SILULS	2126
SILRS	2136
SILRS	2147
UVLIS	2150
UVLBS	2200
UMLRS	2212
UMLLS	2224
ULDLs	2237
MTPX	2243
URDLS	2256
MTMX	2263
X	2401
Y	2402
RUN1	2403
AUBUFK	2404
INIT3	2405
INISAM	2410
SAMLOP	2414
SAM1	2435
INIUIS	2441
DISL0P	2452
STATE	2476
AUBUF	2515
CHDSC	3600
CHJMPL	3614
CHSET1	3623
CHSET2	3630
CHSETS	3632
CHDIS	3636

SYMBOL TABLE

CHEND	5070
CHSPA	5076
CHBK5	5100
GET6	5105
CHRES1	5115
CHYRJS	5124
CHCSE	5134
CHINT	5144
CHCR	5147
CHLT	5151
CHJNP	5150
CHS1%	5151
KM0U21	5152
K0017	5153
K0401	5154
KUSB	5155
USC13L	5156
MESG	4200
SLOPEA	4223
RETURN	4233
IPRIVI	4235
URLF	4252
ERAOJ	4251
STLL	4316
MESSAGE	4320
STUL	4326
STLR	4330
MORGHI	4336
TYPECH	4337
MIP	4363
MASK//	4370
140	4371
LS40	4372
MS	4373
UZ12	4374
MC	4375
UZ19	4376
UZ45	4377
LUH	4404
USC	4455
SLOPE	4511
HALT	4512
SIUR	4522
ULDL	4523
URDL	4524
UVLT	4525
UVLB	4526
UMLR	4527
UMLL	4530
UXC	6301
UXL	6302
UIS	6304
UYC	6311

SYMBOL TABLE

UYL	6312
SNXK	6321
SNEK	6322
JSB	6324
XRIW	6331
SKAU	6332
XKCL	6334
SKRK	6341
ZIEN	6342
UIEN	6344
ULER	6351
ULXK	6352
ULRK	6354
IUMX	6361
RADU	6362
AUCV	6364
AUMX	6371
JPR	7000
MIW	1344
XX	1402
SPACE	1717

