RELAYTST

IDENTIFICATION

Product Code:	Maindec 12-D8AB-D(P)
Product Name:	PDP-12 Relay Register Test
Date Created:	August 1, 1969
Maintainer:	Diagnostics Group
Author:	J. Kelly

1. ABSTRACT

The relay register diagnostic and exerciser consists of three (3) separate programs. The first, and major, program thoroughly diagnoses and exercises the relay flip flop register on a bit-by-bit basis. The second routine is a three instruction loop which allows the service engineer to transfer the contents of the right switches RSW bits 6 through 11 into the relay register. This is useful for signal tracing and setting specific number patterns into the relays. The third and last routine alternately sets and clears the entire relay register at a 100 millisecond rate, as determined by the teletype logic. This program allows the service engineer to examine the electromechanical characteristics of the actual relays themselves.

2. REQUIREMENTS

2.1 Equipment

a. A standard basic PDP-12 computer
b. A DR-12 relay register option
c. ASR-33 teletype
d. An oscilloscope (needed only if you wish to examine the relay characteristics.)

2.3 Preliminary Programs

All basic PDP-12 instruction diagnostic programs must have been successfully run prior to attempting to test the relay register.

3. LOADING PROCEDURES

3.1 Method

This program must be loaded with the binary loader. If you are unfamiliar with the proper binary loading procedures refer to "Appendix A" of this program, otherwise procede with the following:

a. Set the teletype reader switch to FREE.
b. Open the teletype reader and insert the program tape so that the arrows on the tape are visible to, and pointing toward the operator.
c. Close the reader and set the reader switch to START.
d. Set the teletype front panel switch to ON LINE.
e. Set the LEFT switch to 7777.
f. Set the RIGHT switch to 4000.
g. Set the MODE switch to 8 mode.
h. Depress I/O preset.
i. Depress START LS.
j. When the program tape has been read in the computer will halt.
k. The ACCUMULATOR must be = 0000, if it is not, a read in error has occurred and one might try reloading the binary loader.
l. Remove the program tape from the reader.

4. STARTING PROCEDURE

4.1 Starting Address "RELAY FLIP FLOP REGISTER TEST"

The major diagnostic and exerciser "Relay Flip Flop Register Test" starts at address 20 to run this test procede as follows:

a. Set the MODE switch to 8 mode.
b. Set IF = 0, DF = 0.
c. Depress I/O preset.
d. Depress START 20.
e. The LSW and RSW have no effect on this test.

The state of all other switches, i.e. LEFT, RIGHT and SENSE switches, have no effect on this routine. This test, once started will run continuously with no halts. If it should halt, indicating an error, consult section 5 of this write-up along with the program listing. This test must be allowed to run for at least 2 minutes.

"RSW TO RELAY TEST"

The second test "RSW To Relay Test" starts at address 1000 and once running transfers the contents of RSW bits 6 through 11 into the relay register. This program does not perform any error checking and is intended solely as a visual display and signal tracing aide. To start it, as follows:

a. Set the Mode switch to LINC.
b. Depress I/O preset.
c. Set 1000 into the LEFT switches.
d. Depress START LS.
e. Set RSW - 0011.
f. Set any combination of numbers into the right most 6 switches bits 6 through 11 in RSW and observe that the same data appears in both the RELAY REGISTER indicator lamps and the accumulator.
g. It should be noted that RSW bits 0 through 5 also appear in the AC but have no effect on the relay register.

"RELAY TEST"

The third and final test is designed to allow the service engineer to observe the relay switching action. By applying a small DC voltage through the relay contacts being tested thence to the oscilloscope, one may observe the make-break action of each relay contact. Normally, this test need not be run unless a specific relay problem is suspected. To run this test proceed as follows:

a. Set the MODE switch to LINC mode.
b. Depress I/O preset.
c. Set LEFT switches to 1003.
d. Depress START LS.

All relay indicaters along with the entire accumulator will alternately set and clear at a millisecond rate. 100

5. ERRORS

Any errors which occur while running the RELAY Flip-Flop register will cause the computer to halt at a predesignated address. This address which appears in the (MA) MEMORY ADDRESS register along with the data appearing in the ACCUMULATOR and the RELAY REGISTER indicators allows us to ascertain the nature of the failure. All errors are listed below:

C(MA)	C(AC)	C(RELAY)	EXPLANATION
0025	0000	00	Any bit set in either the AC or Relay register was not cleared by I/O preset.
0033	0000	00	RTA from a cleared relay register failed to clear the entire AC.
0041	7777	77	ATR modified the AC. The AC was set to 7777, ATR was issued, it should have left the AC as 7777. The state of the relay register is not checked at this time.
0047	0000	00	ATR modified the AC. The AC was set to 0000, ATR was issued; it should have left the AC as 0000. The state of the relay register was not checked at this time.
0056	0001	01	AC11 transfer to and from relay 5 failed.
0065	0002	02	AC10 transfer to and from relay 4 failed.
0074	0004	04	AC9 transfer to and from relay 3 failed.
0103	0010	10	AC8 transfer to and from relay 2 failed.
0112	0020	20	AC7 transfer to and from relay 1 failed.
0121	0040	40	AC6 transfer to and from relay 0 failed.

0130	0077	77	ATR RTA 77 failed.
0137	0076	76	ATR RTA 76 failed.
0146	0075	75	ATR RTA 75 failed.
0155	0073	73	ATR RTA 73 failed.
0164	0067	67	ATR RTA 67 failed.
0173	0057	57	ATR RTA 57 failed.
0202	0037	37	ATR RTA 37 failed.
0260	0052	52	The number 52 was loaded into the relay register and read back 20 consecutive times before testing. The AC and relay register should be identical, if any differences occur that relay flop is bad.
0344	0025	25	Same as previous test.
0417	0077	77	The relay register was loaded with with 77, read back complemented Loaded again, etc., 12 times. The Accumulator and the relay register should both equal 77. Any differences indicate the failing bit.
0456	XXXX	XX	This test is a random number test wherein random numbers are loaded into and read out of the relay register. The AC bits 6 through 11 contain the data which was sent to the relay register. The relay register contains the actual data received.
0471	0077	00	The AC was distrubed while trying to load the relay register.
0475	0077	00	The relay register was disturbed. A test was performed on M115 L08 of the relay register gating. The test caused at least one of the inputs of the "AND" gate to be disqualified inhibiting the ATR command.

0550	0052	52	The relay register was loaded with 52, read back complemented loaded again, etc., 12 times. The accumulator and the relay register should both equal 52, any differences indicate the failing bit.

APPENDIX A

PDP-8 MODE PERFORATED - TAPE LOADER

READIN MODE LOADER

The readin mode (RIM) loader is a minimum length, basic, perforated-tape program for the 33 ASR. It is initially stored in memory by manual use of the operator console keys and switches. The loader is permanently stored in 18 locations of page 37.

The RIM loader can only be used in conjunction with the 33ASR reader (not the high-speed perforated-tape reader). Because a tape in RIM format is, in effect, twice as long as it need be, it is suggested that the RIM loader be used only to read the binary loader when using the 33 ASR. (NOTE: Some PDP-12 diagnostic program tapes are in RIM format).

The complete PDP-12 RIM loader (SA = 7756 is as follows:

Absolute Address	Octal Content	Tag	Instruction I Z	Comments
7756	6032	BEG,	KCC	/CLEAR AC AND FLAG
7757,	6031		KSF	/SKIP IF FLAG = 1
7760	5357		JMP -1	/LOOKING FOR CHARACTER
7761,	6036		KRB	/READ BUFFER
7762,	7106		CLL RTL	
7763,	7006		RTL	/CHANNEL 8 IN ACO
7764,	7510		SPA	/CHECKING FOR LEADER
7765,	5357		JMP BEG +1	/FOUND LEADER
7766,	7006		RTL	/OK, CHANNEL 7 IN LINK
7767	6031		KSF	
7770,	5367		JMP -1	
7771,	6034		KRS	/READ, DO NOT CLEAR
7772,	7420		SNL	/CHECKING FOR ADDRESS
7773,	3776		DCA I TEMP	/STORE CONTENT
7774,	3376		DCA TEMP	/STORE ADDRESS
7775,	5356		JMP BEG	/NEXT WORD
7776,	0	TEMP,	0	/TEMP STORAGE
7777,	5XXX		JMP X	/JMP START OF BIN LOADER

Placing the RIM loader in core memory by way of the operator console keys and switches is accomplished as follows:

a. Set the starting address 7756 in the LEFT switches.
b. Set the first instruction (6032) in the RIGHT switches.
c. Press the FILL switch.
d. Set the next instruction (6031) in the RIGHT switches.
e. Press the FILL STEP switch.
f. Repeat steps d and e until all 16 instructions have been deposited.

To lead a tape in RIM format, place the tape in the reader, set the LEFT switches to the starting address 7756 of the RIM loader (not of the program being read), press the START LS key, and start the Teletype reader.

```
                        EXPUNGE
                1000    LDA=1000
                0004    AOM=0004
                0011    CLR=0011
                0015    RTA=0015
                0014    ATR=0014
                0002    PDP=0002
                7004    RAL=7004
                7041    CIA=7041
                7640    SZA=7640                /ALSO CLEARS
                0016    NOPL=0016
                0000    HLT=0000
                1440    SAE=1440
                0017    COM=0017
                6000    JMP=6000
                0516    RSW=0516
                0500    IOB=0500
                6141    LINC=6141
                6046    TLS=6046
                6041    TSF=6041
                0001    *1
        0001    7601    RNA,    7601
        0002    3452    RNB,    3452
        0003    0000    RNC,    0000
        0004    0007    K0007,  0007
        0005    0077    K0077,  0077
        0006    0000    TEMP,   0

                0020    *20

        0020    6141    BEGIN,  LINC
        0021    0011    TST01,  CLR
        0022    0015            RTA
        0023    1460            SAE+20
        0024    0000            0000
        0025    0000            HLT             /IO PRESET FAILED TO CLEAR RELAYS AC=00

        0026    1020    TST02,  LDA+20
        0027    7777            7777
        0030    0015            RTA
        0031    1460            SAE+20
        0032    0000            0000
        0033    0000            HLT             /RTA FAILED TO CLEAR AC

        0034    1020    TST03,  LDA+20
        0035    7777            7777
        0036    0014            ATR
        0037    1460            SAE+20
        0040    7777            7777
        0041    0000            HLT             /ATR CHANGED AC AC=7777

        0042    1020    TST04,  LDA+20
        0043    0000            0000
        0044    0014            ATR
        0045    1460            SAE+20
```

```
0046  0000          0000
0047  0000          HLT             /ATR CHANGED AC AC=0000
```

```
                        /
                        /DATA HANDLING TESTS
                        /
0050  1020     TST05,   LDA+20
0051  5201              5201
0052  0014              ATR
0053  0015              RTA
0054  1460              SAE+20
0055  0001              0001
0056  0000              HLT             /RTA AC11 FAILED AC=0001

0057  1020     TST06,   LDA+20
0060  2502              2502
0061  0014              ATR
0062  0015              RTA
0063  1460              SAE+20
0064  0002              0002
0065  0000              HLT             /RTA AC10 FAILED AC=0002

0066  1020     TST07,   LDA+20
0067  5204              5204
0070  0014              ATR
0071  0015              RTA
0072  1460              SAE+20
0073  0004              0004
0074  0000              HLT             /RTA AC09 FAILED AC=0004

0075  1020     TST08,   LDA+20
0076  2510              2510
0077  0014              ATR
0100  0015              RTA
0101  1460              SAE+20
0102  0010              0010
0103  0000              HLT             /RTA AC08 FAILED AC=0010

0104  1020     TST09,   LDA+20
0105  5220              5220
0106  0014              ATR
0107  0015              RTA
0110  1460              SAE+20
0111  0020              0020
0112  0000              HLT             /RTA AC07 FAILED AC=0020

0113  1020     TST10,   LDA+20
0114  2540              2540
0115  0014              ATR
0116  0015              RTA
0117  1460              SAE+20
0120  0040              0040
0121  0000              HLT             /RTA AC06 FAILED AC=0040
```

```
                        /DATA TEST FLOAT A SINGLE 0
                        /
0122  1020    TST11,    LDA+20
0123  5277              5277
0124  0014              ATR
0125  0015              RTA
0126  1460              SAE+20
0127  0077              0077
0130  0000              HLT             /ATR RTA FAILED AC=0077

0131  1020    TST12,    LDA+20
0132  2576              2576
0133  0014              ATR
0134  0015              RTA
0135  1460              SAE+20
0136  0076              0076
0137  0000              HLT             /ATR RTA FAILED AC=0076

0140  1020    TST13,    LDA+20
0141  5275              5275
0142  0014              ATR
0143  0015              RTA
0144  1460              SAE+20
0145  0075              0075
0146  0000              HLT             /ATR RTA FAILED AC=0075

0147  1020    TST14,    LDA+20
0150  2573              2573
0151  0014              ATR
0152  0015              RTA
0153  1460              SAE+20
0154  0073              0073
0155  0000              HLT             /ATR RTA FAILED AC=0073

0156  1020    TST15,    LDA+20
0157  5267              5267
0160  0014              ATR
0161  0015              RTA
0162  1460              SAE+20
0163  0067              0067
0164  0000              HLT             /ATR RTA FAILED AC=0067

0165  1020    TST16,    LDA+20
0166  2557              2557
0167  0014              ATR
0170  0015              RTA
0171  1460              SAE+20
0172  0057              0057
0173  0000              HLT             /ATR RTA FAILED AC=0057
```

```
0174  1020    TST17,  LDA+20
0175  5237            5237
0176  0014            ATR
0177  0015            RTA
0200  1460            SAE+20
0201  0037            0037
0202  0000            HLT             /ATR RTA FAILED AC=0037

                      /
                      /CHECKERBOARD RELAY TEST AT HIGH SPEED
                      /
0203  1020    TST19,  LDA+20
0204  0052            0052
0205  0014            ATR
0206  0011            CLR
0207  0015            RTA
0210  0014            ATR
0211  0015            RTA
0212  0014            ATR
0213  0015            RTA
0214  0014            ATR
0215  0015            RTA
0216  0014            ATR
0217  0015            RTA
0220  0014            ATR
0221  0015            RTA
0222  0014            ATR

0223  0015            RTA
0224  0014            ATR
0225  0015            RTA
0226  0014            ATR
0227  0015            RTA
0230  0014            ATR
0231  0015            RTA
0232  0014            ATR
0233  0015            RTA
0234  0014            ATR
0235  0015            RTA
0236  0014            ATR
0237  0015            RTA
0240  0014            ATR
0241  0015            RTA
0242  0014            ATR
0243  0015            RTA
0244  0014            ATR
0245  0015            RTA
0246  0014            ATR
0247  0015            RTA
0250  0014            ATR
0251  0015            RTA
0252  0014            ATR
0253  0015            RTA
```

```
0254  0014            ATR
0255  0015            RTA
0256  1460            SAE+20
0257  0052            0052
0260  0000            HLT             /RELAY REGISTER CHECKERBOARD TEST FAILED AC=0052
                /
                /
0261  1020    TST20,  LDA+20
0262  0025            0025
0263  0014            ATR
0264  0011            CLR
0265  0015            RTA
0266  0014            ATR
0267  0015            RTA
0270  0014            ATR
0271  0015            RTA
0272  0014            ATR
0273  0015            RTA
0274  0014            ATR
0275  0015            RTA
0276  0014            ATR
0277  0015            RTA
0300  0014            ATR
0301  0015            RTA
0302  0014            ATR
0303  0015            RTA
0304  0014            ATR
0305  0015            RTA
0306  0014            ATR
0307  0015            RTA
0310  0014            ATR
0311  0015            RTA
0312  0014            ATR
0313  0015            RTA
0314  0014            ATR
0315  0015            RTA
0316  0014            ATR
0317  0015            RTA
0320  0014            ATR
0321  0015            RTA
0322  0014            ATR

0323  0015            RTA
0324  0014            ATR
0325  0015            RTA
0326  0014            ATR
0327  0015            RTA
0330  0014            ATR
0331  0015            RTA
0332  0014            ATR
0333  0015            RTA
0334  0014            ATR
0335  0015            RTA
0336  0014            ATR
0337  0015            RTA
```

```
0340  0014          ATR
0341  0015          RTA
0342  1460          SAE+20
0343  0025          0025
0344  0000          HLT             /RELAY REGISTER CHECKERBOARD TEST FAILED AC=0025

0345  1020    TST20A, LDA+20
0346  0077          0077
0347  0014          ATR
0350  0015          RTA
0351  0017          COM
0352  0014          ATR
0353  0015          RTA
0354  0017          COM
0355  0014          ATR
0356  0015          RTA
0357  0017          COM
0360  0014          ATR
0361  0015          RTA
0362  0017          COM
0363  0014          ATR
0364  0015          RTA
0365  0017          COM
0366  0014          ATR
0367  0015          RTA
0370  0017          COM
0371  0014          ATR

0372  0015          RTA
0373  0017          COM
0374  0014          ATR
0375  0015          RTA
0376  0017          COM
0377  0014          ATR
0400  0015          RTA
0401  0017          COM
0402  0014          ATR
0403  0015          RTA
0404  0017          COM
0405  0014          ATR
0406  0015          RTA
0407  0017          COM
0410  0014          ATR
0411  0015          RTA
0412  0017          COM
0413  0014          ATR
0414  0015          RTA
0415  1460          SAE+20
0416  0077          0077
0417  0000          HLT             /ALL ONES COMPLEMENT TEST FAILED
```

```
0420  0002  TST21,  PDP
0421  1001          TAD     RNA
0422  1002          TAD     RNB
0423  1003          TAD     RNC
0424  3001          DCA     RNA
0425  7004          RAL
0426  1001          TAD     RNA
0427  1002          TAD     RNB
0430  1003          TAD     RNC
0431  3002          DCA     RNB
0432  7004          RAL
0433  1001          TAD     RNA
0434  1002          TAD     RNB
0435  1003          TAD     RNC
0436  3003          DCA     RNC
0437  7004          RAL
0440  1001          TAD     RNA
0441  3001          DCA     RNA
0442  1002          TAD     RNB
0443  0005          K0077
0444  3006          DCA     TEMP
0445  1006          TAD     TEMP
0446  6141          LINC
0447  0014          ATR
0450  0011          CLR
0451  0015          RTA
0452  0002          PDP
0453  7041          CIA
0454  1006          TAD     TEMP
0455  7640          SZA
0456  0000          HLT             /RANDOM RELAY TEST FAILED NUMBER RECEIVED IS IN RELAY REGISTERL
0457  6141          LINC            /NUMBER SENT FROM RELAYS IS IN AC
                    /
                    /RELAY REGISTER NON DISTURB: TEST M115 L08
                    /
0460  0011  TST22,  CLR
0461  0014          ATR             /CLEAR RELAY REGISTER
0462  1020          LDA+20
0463  0077          0077            /SET DATA TO RELAY REGISTER
0464  0414          0414            /GENERATE INS MSC NOT

0465  0016          NOPL            /IN CASE IT SKIPS
0466  0016          NOPL            /GENERATE EQ14 NOT
0467  1460          SAE+20
0470  0077          0077
0471  0000          HLT             /ILLEGAL CHANGE AC
0472  0015          RTA             /READ RELAYS TO SEE IF THEY WERE DISTURBED
0473  1460          SAE+20
0474  0000          0000
0475  0000          HLT             /RELAYS WERE DISTURBED BY NOT ATR INSTRUCTION
```

```
0476  1020          LDA+20          /RELAY REGISTER TEST COMPLEMENT TEST
0477  0052          0052
0500  0014          ATR
0501  0015          RTA
0502  0017          COM
0503  0014          ATR
0504  0015          RTA
0505  0017          COM
0506  0014          ATR
0507  0015          RTA
0510  0017          COM
0511  0014          ATR
0512  0015          RTA
0513  0017          COM
0514  0014          ATR
0515  0015          RTA
0516  0017          COM
0517  0014          ATR
0520  0015          RTA
0521  0017          COM
0522  0014          ATR
0523  0015          RTA
0524  0017          COM
0525  0014          ATR
0526  0015          RTA
0527  0017          COM
0530  0014          ATR

0531  0015          RTA
0532  0017          COM
0533  0014          ATR
0534  0015          RTA
0535  0017          COM
0536  0014          ATR
0537  0015          RTA
0540  0017          COM
0541  0014          ATR
0542  0015          RTA
0543  0017          COM
0544  0014          ATR
0545  0015          RTA
0546  1460          SAE+20
0547  0052          0052
0550  0000          HLT             /RELAY REGISTER COMPLEMENT TEST FAILED
0551  0011          CLR
0552  0014          ATR             /CLEAR RELAYS
0553  6021          JMP     BEGIN+1
      1000    *1000
1000  0016          RSW
1001  0014          ATR
1002  7000          JMP     .-2

1003  0011  SCOPE,  CLR             /CLEAR
1004  0014          ATR             /TO RELAYS
1005  0500          IOB
```

```
1006  6046          TLS

1007  6500          IOB
1010  6041          TSF
1011  7207          JMP     .-2

1012  0017          COM
1013  7004          JMP     SCOPE+1
                $
```