

RELAY TST

IDENTIFICATION

Product Code: Maindec I2-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 milli-second 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 indicators 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 disturbed 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 load 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
0010 NOPL=0016
0000 HLT=0000
1440 SAE=1440
0017 COM=0017
6000 JMP=6000
0516 RSW=0516
0500 JOB=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

0026 1020 TST02, LDA+20
0027 7777 7777
0030 0015 RTA
0031 1460 SAE+20
0032 0000 0000
0033 0200 HLT

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

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

/ALSO CLEARS

/IO PRESET FAILED TO CLEAR RELAYS AC=00

/RTA FAILED TO CLEAR AC

/ATR CHANGED AC AC=7777

0046 0000
0047 0000
0000
HLT

/ATR CHANGED AC AC0000

/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	
0457	6141		LINC	

/RANDOM RELAY TEST FAILED NUMBER RECEIVED IS IN RELAY REGISTERL
/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	
0521	0015		RTA	
0522	0017		COM	
0523	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	TL5	
1007	0500	IOB	
1010	6041	TSF	
1011	7207	JMP	.-2
1012	2017	COM	
1013	7004	JMP	SCOPE+1

S