

RELAYTST

IDENTIFICATION

Product Code:	Maindec 12-D8AB-D(P)
Product Name:	PDP-12 Relay Register Test
Date Created:	August 1, 1969
Maintainer:	Diagnostics Group
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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 proceed 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 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 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
LDA=1000
AOM=0004
CLR=0011
RTA=0015
ATR=0014
PDP=0002
RAL=7004
CIA=7041
SZA=7640
NOPL=0016
HLT=0000
SAE=1440
COM=0017
JMP=0000
RSH=0516
IOB=0500
6141 LINC=6141
6046 TLS=6046
6041 TSF=6041
*1
0001 RNA, 7601
0002 RNB, 3452
0003 RNC, 0000
0004 K0001, 0007
0005 K0077, 0077
0006 TEMP, 0
*20
0020
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 0000 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 AC000

/RTA FAILED TO CLEAR AC

/ATR CHANGED AC AC07777

EXPUNGE PAL10 V141 11-SEP-69 4156 PAGE 1-1
0046 0000
0047 0000
0000
HLT
/ATR CHANGED AC AC0000

/ DATA HANDLING TESTS

0050 1020
0051 5201
0052 0014
0053 0015
0054 1460
0055 0001
0056 0000

TST05, LDA+20
5201
ATR
RTA
SAE+20
0001
HLT

/RTA AC11 FAILED AC=0001

0057 1020
0058 2502
0059 0014
0060 0015
0061 1460
0062 0002
0063 0000
0064 0000
0065 0000

TST06, LDA+20
2502
ATR
RTA
SAE+20
0002
HLT

/RTA AC10 FAILED AC=0002

0066 1020
0067 5204
0068 0014
0069 0015
0070 1460
0071 0004
0072 0004
0073 0000
0074 0000

TST07, LDA+20
5204
ATR
RTA
SAE+20
0004
HLT

/RTA AC09 FAILED AC=0004

0075 1020
0076 2510
0077 0014
0078 0015
0079 1460
0080 0010
0081 0000
0082 0000

TST08, LDA+20
2510
ATR
RTA
SAE+20
0010
HLT

/RTA AC08 FAILED AC=0010

0104 1020
0105 5220
0106 0014
0107 0015
0108 1460
0109 0020
0110 0000
0111 0000
0112 0000

TST09, LDA+20
5220
ATR
RTA
SAE+20
0020
HLT

/RTA AC07 FAILED AC=0020

0113 1020
0114 2540
0115 0014
0116 0015
0117 1460
0118 0040
0119 0000
0120 0000
0121 0000

TST10, LDA+20
2540
ATR
RTA
SAE+20
0040
HLT

/RTA AC06 FAILED AC=0040

/DATA TEST FLOAT A SINGLE 0

0122 1020
0123 5277
0124 0014
0125 0015
0126 1460
0127 0077
0130 0000

TST11, LDA+20
5277
ATR
RTA
SAE+20
0077
HLT

/ATR RTA FAILED AC=0077

0131 1020
0132 2576
0133 0014
0134 0015
0135 1460
0136 0076
0137 0000

TST12, LDA+20
2576
ATR
RTA
SAE+20
0076
HLT

/ATR RTA FAILED AC=0076

0140 1020
0141 5275
0142 0014
0143 0015
0144 1460
0145 0075
0146 0000

TST13, LDA+20
5275
ATR
RTA
SAE+20
0075
HLT

/ATR RTA FAILED AC=0075

0147 1020
0150 2573
0151 0014
0152 0015
0153 1460
0154 0073
0155 0000

TST14, LDA+20
2573
ATR
RTA
SAE+20
0073
HLT

/ATR RTA FAILED AC=0073

0156 1020
0157 5267
0160 0014
0161 0015
0162 1460
0163 0067
0164 0000

TST15, LDA+20
5267
ATR
RTA
SAE+20
0067
HLT

/ATR RTA FAILED AC=0067

0165 1020
0166 2557
0167 0014
0170 0015
0171 1460
0172 0057
0173 0000

TST16, LDA+20
2557
ATR
RTA
SAE+20
0057
HLT

/ATR RTA FAILED AC=0057

/ATR RTA FAILED AC00037

00223	0015	RTA
00224	0014	ATR
00225	0015	RTA
00226	0014	ATR
00227	0015	RTA
00230	0014	ATR
00231	0015	RTA
00232	0014	ATR
00233	0015	RTA
00234	0014	ATR
00235	0015	RTA
00236	0014	ATR
00237	0015	RTA
00240	0014	ATR
00241	0015	RTA
00242	0014	ATR
00243	0015	RTA
00244	0014	ATR
00245	0015	RTA
00246	0014	ATR
00247	0015	RTA
00250	0014	ATR
00251	0015	RTA
00252	0014	ATR
00253	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
2416 0077 0077
2417 0000 HLT

/ALL ONES COMPLEMENT TEST FAILED

0420	0002	TST21,	PDP	RNA
0421	1001	TAD	TAD	RNB
0422	1002	TAD	TAD	RNC
0423	1003	TAD	TAD	RNA
0424	3001	DCA	DCA	RNA
0425	7004	RAL	RAL	RNA
0426	1001	TAD	TAD	RNB
0427	1002	TAD	TAD	RNC
0430	1003	TAD	TAD	RNB
0431	3002	DCA	DCA	RNA
0432	7004	RAL	RAL	RNB
0433	1001	TAD	TAD	RNC
0434	1002	TAD	TAD	RNC
0435	1003	TAD	TAD	RNC
0436	3003	DCA	DCA	RNA
0437	7004	RAL	RAL	RNA
0440	1001	TAD	TAD	RNA
0441	3001	DCA	DCA	RNA
0442	1002	TAD	TAD	RNB
0443	0005			K0077
0444	3006			TEMP
0445	1006			TEMP
0446	6141			
0447	0014	LING		
0450	0011	ATR		
0451	0015	CLR		
0452	0002	RTA		
0453	7041	PDP		
0454	1006	CIA		
0455	7040	TAD		
0456	0000	SZA		
0457	6141	HLT		
		LING		

/RANDOM RELAY TEST FAILED NUMBER RECEIVED IS IN RELAY REGISTER
/NUMBER SENT FROM RELAYS IS IN AC

TEMP

/RELAY REGISTER NON DISTURB: TEST M115 L08

0460	0011	CLR		/CLEAR RELAY REGISTER
0461	0014	ATR		
0462	1020	LDA+20		/SET DATA TO RELAY REGISTER
0463	0077	0077		/GENERATE INS NSC NOT
0464	0414	0414		
0465	0016	NOPL		/IN CASE IT SKIPS
0466	0016	NOPL		/GENERATE 0014 NOT
0467	1460	SAE+20		
0470	0077	0077		/ILLEGAL CHANGE AC
0471	0000	HLT		/READ RELAYS TO SEE IF THEY WERE DISTURBED
0472	0015	RTA		
0473	1460	SAE+20		
0474	0000	0000		/RELAYS WERE DISTURBED BY NOT ATR INSTRUCTION
0475	0000	HLT		

/RELAY REGISTER TEST COMPLEMENT TEST

0476	1020	LDA#20
0477	0052	0052
0500	0014	ATR
0501	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

2531	0015	RTA	SAE+20
0532	0017	COM	0052
0533	0014	ATA	HLT
0534	0015	RTA	CLR
0535	0017	COM	ATR
0536	0014	ATA	JMP
0537	0015	RTA	RSW
0540	0017	COM	ATR
0541	0014	ATA	JMP
0542	0015	RTA	CLR
0543	0017	COM	ATR
0544	0014	ATA	JMP
0545	0015	RTA	RSW
0546	1460	SAE+20	ATR
0547	0052	0052	JMP
0550	0000	HLT	RSW
0551	0011	CLR	ATR
0552	0014	ATR	JMP
0553	6021	JMP	CLR
	1000		ATR
1000	0016	RSW	JMP
1021	0014	ATR	CLR
1002	7000	JMP	ATR
			IOB
1003	0011	CLR	SCOPE,
1004	0014	ATR	
1005	0500	IOB	

1006	6046	TLS	
1007	0500	IOB	
1010	6041	TSF	
1011	7207	JMP	.-2
1012	0017	COM	
1013	7004	JMP	SCOPE+1

S