IDENTIFICATION

Product Code:	MAINDEC 08-D02B-D
Product Name:	PDP-8 Instruction Test Part 2B
Date Created:	January 12, 1968
Maintainer:	Diagnostic Group

1. ABSTRACT

This program is a test of the 2s complement add (TAD) and rotate logic (RAL, RTL, RAR, RTR). Random numbers are used in the Twos Add portion of the test and sequential numbers are used in the Rotate portion. Program control depends on operator manipulation of four switches in the SWITCH REGISTER (bits 0, 1, 2, 3). Error information is normally printed out on the keyboard printer.

2. REQUIREMENTS

Storage

Memory locations 20_8-4177_8.

Subprograms and/or Subroutines

High RIM Loader, High Binary Loader.

Equipment

PDP-8 Processor-Keyboard Reader

3. USAGE

3.1 Loading

If the Binary Loader beginning at 7777_8 is in memory, load the Instruction Test - Part 2b. Otherwise, the RIM Loader beginning at 7756_8 and/or the Binary Loader must be loaded into memory.

PDP-8 Instruction Test - Part 2B (Maindec 801-2B) may now be loaded as follows:

Set 7777_8 in the SWITCH REGISTER.

Press LOAD ADDRESS key.

Place Instruction Test-Part 2B in the keyboard reader.

Press START key on the operator console.

Engage the keyboard reader.

3.2 Switch Settings

When starting at the TAD portion (200_8) of the test, set switches 0 and 2 to the 1 state. This switch configuration allows the program to print any error message and halt on the error condition. After the TAD portion has run for a minimum of 10 minutes, set switch 3 to a 1 to enter the Rotate Test.

When starting at the rotate portion (2000_8) set switches 0 and 2 to the 1 state as above. This switch configuration allows the program to print any error message and halt on the error condition.

Switch 0	Stop on error (406_8 for TAD or 2433_8 for Rotate Test).
Switch 1	Scope mode (repeat loop causing the error).
Switch 2	Print error.
Switch 3	Leave the Twos Add test and start the Rotate Test.

Switch 0 and 1	Scope mode and stop on error.
Switch 0 and 2	Print error and halt.
Switch 1 and 2	Scope and print error.

3.3 Start-Up and/or Entry

The starting address of the TAD portion of the test is 0200_8. The starting address of the Rotate portion of the test is 2000_8. If bit 3 of the SWITCH REGISTER is set, it automatically causes an exit from the Twos Add portion of the test to the Rotate portion of the test.

Set either 0200_8 in the SWITCH REGISTER to start at the Twos Add portion of the test, or set 2000_8 in the SWITCH REGISTER to start at the Rotate portion of the test.

Press the LOAD ADDRESS key.

Press the START key.

3.4 Errors in Usage

The error halt for TAD Test is 406_8.

The error halt for Rotate Test is 2433_8.

Error printouts from both tests would appear as follows:

TWOS ADD ERROR PRINTOUT:

Good	Bad	X ARG	Y ARG
0 000000000001	0 00000000000 0	000000000000	000000000001

Indicating loss of a 1 bit in AC bit 11.

ROTATE ERROR PRINTOUTS:

PAT 0	000000000001	(original pattern)
RAL 0	000000000010	(pattern after RAL inst.)
RAR 0	000000000000	(pattern after RAR inst.)

Indicating loss of a 1 bit in AC bit 11 as a result of an RAR.

PAT 0	000000100000
RTR 0	000000000000
RTL 0	000000000000

Indicating loss of a 1 bit in AC bit 8 as a result of an RTR.

3.5 Recovery from such Errors

The program may be continued after it halts on an error, by pressing the CONTINUE key. The program continues to the next test, unless scope mode (bit 1) is requested.

Set the state of AC switch 1 to 1 to repeat the loop causing the error (scope mode).

Reference 4.3 for other switch variations.

4. RESTRICTIONS

This test should be run only after a successful run of the Instruction Test 2A to provide maximum reliability of the module repair table.

5. DESCRIPTION

5.1 Discussion

The PDP-8 Instruction Test-Part 2B tests the 2s ADD and ROTATE logic.

The 2s ADD logic is tested by the addition of pseudo random numbers. Two pseudo random numbers are generated and 2s added by a logical (simulated) adder. The same two numbers are added by the 2s add logic (TAD). The results are compared, and if an equality exists, two new random numbers are generated and the sequence is re-executed. If an inequality exists, the computer halts and/or types the error condition depending on the switch settings.

5.2 Examples and/or Applications

The error printout will contain the correct answer, the incorrect answer, and the two random numbers used.

Visual inspection of these patterns will determine the cause of the error. A lookup table is provided for rapid repair which will give all of the information shown in section 4.6.

Exit from TAD Test to the Rotate portion is accomplished by setting bit 3 in the SWITCH REGISTER. This switch also causes the program to print "ADD OK."

The Rotate Test generates 8192 patterns to be tested on two pairs of rotate instructions. The first pair of rotate instructions to be tested is RAL and RAR. The test pattern is rotated left once, then the result is rotated right once. The following items are compared:

The result of the RAR should equal the test pattern and original link.

The result of the link after the RAL should equal bit 0 of the test pattern.

If the RAR results and link equals the test pattern and link, the RAL and RAR instructions have operated correctly.

If an error occurs and an error printout is requested, the test pattern and the results of both the RAL and RAR instructions are printed. Visual inspection of these patterns will determine the probable cause of the error.

The second pair of rotate instructions to be tested is RTR and RTL. The test pattern is rotated right twice, then the result is rotated left twice. The following items are compared:

The result of the RTL should equal the test pattern and original link.

The result of the link after the RTR should equal pattern bit 1 of the test pattern.

If the RTL results and link equal the test pattern and link, the RTR and RTL, instructions have operated correctly.

If an error occurs and an error printout is requested, the test pattern and the results of both the RTR and RTL instructions are printed. Visual inspection of these patterns will determine the probable cause of the error.

After a complete pass through the Rotate Test, the computer will print ROT.

A printout of "2B" indicates the completion os a complete pass through the entire set of tests, after which the test begins again.

6. METHODS

See description section 5.

7. EXECUTION TIME

The TAD section takes 1 second for one complete pass; it will cycle continuously unless AC switch 3 is set. The Rotate portion takes 3 seconds for one complete pass.

8. PROGRAM LISTING

```
                        /PDP-8 INSTRUCTION TEST PART 2B ADD-ROTATE
      0000              *0
0000  0000                      0000
0001  5001                      JMP 1
0002  0002                      2
0003  0003                      3

      0020              *0020
0020  0000              PRXLOP, 0                   /PRINT LOOP
0021  6046                      TLS
0022  6041              LPXX,   TSF
0023  5022                      JMP LPXX
0024  7200                      CLA
0025  5420                      JMP I PRXLOP

0026  0000              CRLFLF, 0
0027  7240                      CLA CMA
0030  0104                      AND CR              /CR
0031  4020                      JMS PRXLOP
0032  7240                      CLA CMA
0033  0103                      AND LF              /LF
0034  4020                      JMS PRXLOP
0035  7240                      CLA CMA
0036  0103                      AND LF              /LF
0037  4020                      JMS PRXLOP
0040  5426                      JMP I CRLFLF

0041  0000              CRLF,   0
0042  7240                      CLA CMA
0043  0104                      AND CR              /CR
0044  4020                      JMS PRXLOP
0045  7240                      CLA CMA
0046  0103                      AND LF              /LF
0047  4020                      JMS PRXLOP
0050  5441                      JMP I CRLF

0051  0000              PAT,    0                   /GENERATOR PATTERN
0052  0000              RALRTL, 0                   /ROTATE LEFT PATTERNS
0053  0000              LFTLNK, 0                   /ROTATE LEFT LINK PATTERNS
0054  0000              RARRTR, 0                   /ROTATE RIGHT PATTERNS
0055  0000              RITLNK, 0                   /ROTATE RIGHT LINK PATTERNS
0056  0000              TST1,   0                   /TEST FLAG
```

```
0057  0000          PROUT,  0               /PRINT OUT LOCATION
0060  4000          K4000,  4000            /MASK LIST
0061  2000          K2000,  2000
0062  1000          K1000,  1000
0063  0400          K0400,  0400
0064  0200          K0200,  0200
0065  0100          K0100,  0100
0066  0040          K0040,  0040
0067  0020          K0020,  0020
0070  0010          K0010,  0010
0071  0004          K0004,  0004
0072  0002          K0002,  0002
0073  0001          K0001,  0001
0074  0057          XPROUT, PROUT
0075  0322          R,      0322            /R
0076  0301          A,      0301            /A
0077  0314          L,      0314            /L
0100  0324          T,      0324            /T
0101  0320          P,      0320            /P
0102  0240          SP,     0240            /SP
0103  0212          LF,     0212            /LF
0104  0215          CR,     0215            /CR
0105  0060          ZERO,   0060            /ZERO
0106  0061          ONE,    0061            /ONE
0107  0317          O,      0317            /O ALPHA
0110  0313          K,      0313            /K
0111  7764          COUNT,  7764            /MINUS 11
0112  0000          STRCNT, 0
0113  0262          TWO,    0262            /2
0114  0302          B,      0302            /B
0115  0000          WD1,    0
0116  0000          WD2,    0
0117  0000          BW1,    0
0120  0000          CRY,    0
0121  0000          TOTAL,  0
0122  0000          SUM,    0
0123  0000          CNTR,   0
0124  0000          HEADER, 0
0125  0000          BITSTR, 0
0126  7776          SPACO6, 7776            /MINUS 1
0127  0000          SPACST, 0
0130  0307          G,      0307            /G
0131  0304          D,      0304            /D
0132  0330          X,      0330            /X
0133  0331          Y,      0331            /Y
0134  0000          LINK,   0               /LINK
0135  0000          XARG,   0               /XARG
0136  0000          YARG,   0               /YARG
0137  7763          COUNTX, 7763
0140  0000          LNKSTR, 0
0141  7377          K7377,  7377
```

```
0357  1125        TAD TW6
0360  5741        JMP I SLOC
```

```
39<2   0000  0
0143   7240    CLA CMA
0144   0140    AND Z LNKSTR
0145   7440    SZA
0146   5150    JMP SL
0147   5152    JMP CL
0150   7360  SL,         CLA CMA STL
0151   5542    JMP I CX
0152   7340  CL,         CLL CLA CMA
0153   5542    JMP I CX
```

```
                *4000

4000  7200  RAND2,      CLA
4001  1417    TAD I 0017
4002  3135    DCA XARG                    /STORE FIXED PAT
4003  1417    TAD I 0017
4004  3136    DCA YARG                    /STORE FIXED PAT
4005  2216    ISZ RCNT
4006  5647    JMP I XSTRXY          /EXIT TO TEST
4007  1215    TAD LISTX
4010  3017    DCA 0017
4011  1214    TAD M144
4012  3216    DCA RCNT
4013  5647    JMP I XSTRXY          /EXIT TO TEST

4014  7634  M144,       -144
4015  4177  LISTX,      LIST-1
4016  0000  RCNT,       0000
4017  0000  ODEVEN,     0000

4020  7300  RAND,       CLL CLA                 /FIXED PATTERN
4021  2217    ISZ ODEVEN                  /RANDOM PATTERN
4022  7000    NOP
4023  1217    TAD ODEVEN
4024  7010    RAR
4025  7630    SZL CLA
4026  5230    JMP RAND1
4027  5200    JMP RAND2

4030  7604  RAND1,      CLA OSR
4031  0063    AND Z K0400
4032  7000    NOP
4033  7440    SZA
4034  5650    JMP I ADDX                  /SW 3 EQUALS A ONE TO EXIT
4035  7240    CLA CMA
4036  0121    AND Z TOTAL
4037  7000  NOP
4040  3135    DCA Z XARG
4041  7040    CMA
4042  0121    AND Z TOTAL
4043  7001    IAC
4044  1410    TAD I Z 10
4045  3136    DCA Z YARG
4046  5647    JMP I XSTRXY
4047  0225  XSTRXY,     STRXY
4050  0312  ADDX,       PADDOK
```

```
                *0017
0017  4177        LIST-1

                *4051
4051  7240  FCOMP,       CLA CMA                    /COMPARE SUM AND TOTAL
4052  0121        AND Z TOTAL
4053  7040        CMA
4054  0122        AND Z SUM
4055  3275        DCA CXM
4056  7240        CLA CMA
4057  0122        AND Z SUM
4060  7040        CMA
4061  0121        AND Z TOTAL
4062  3274        DCA CXN
4063  7240        CLA CMA
4064  0275        AND CXM
4065  7440        SZA
4066  5676        JMP I ERX                          /ERROR
4067  7240        CLA CMA
4070  0274        AND CXN
4071  7440        SZA
4072  5676        JMP I ERX                          /ERROR
4073  5277        JMP LCOMP
4074  0000  CXN,         0
4075  0000  CXM,         0
4076  0400  ERX,         ERROR
4077  7240  LCOMP,      CLA CMA                      /COMPARE CRY AND LINK
4100  0134        AND Z LINK              /LINK BIT IN BIT 11
4101  7040        CMA
4102  0120        AND Z CRY
4103  3322        DCA LRX
4104  7240        CLA CMA
4105  0120        AND Z CRY
4106  7040        CMA
4107  0134        AND Z LINK
4110  3323        DCA LRY
4111  7240        CLA CMA
4112  0322        AND LRX
4113  7440        SZA
4114  5676        JMP I ERX                          /ERROR
4115  7240        CLA CMA
4116  0323        AND LRY
4117  7440        SZA
4120  5676        JMP I ERX                          /ERRROR
4121  5724        JMP I NOERX
4122  0000  LRX,         0
4123  0000  LRY,         0
4124  0407  NOERX,      NOERR
```

```
*4200

4200  7777  LIST,     7777
4201  7777    7777
4202  7776    7776
4203  7777    7777
4204  7775    7775
4205  7777    7777
4206  7773    7773
4207  7777    7777
4210  7767    7767
4211  7777    7777
4212  7757    7757
4213  7777    7777
4214  7737    7737
4215  7777    7777
4216  7677    7677
4217  7777    7777
4220  7577    7577
4221  7777    7777
4222  7377    7377
4223  7777    7777
4224  6777    6777
4225  7777    7777
4226  5777    5777
4227  7777    7777
4230  3777    3777
4231  7777    7777
4232  7777    7777
4233  7777    7777
4234  7776    7776
4235  7777    7777
4236  7775    7775
4237  7777    7777
4240  7773    7773
4241  7777    7777
4242  7767    7767
4243  7777    7777
4244  7757    7757
4245  7777    7777
4246  7737    7737
4247  7777    7777
4250  7677    7677
4251  7777    7777
4252  7577    7577
4253  7777    7777
4254  7377    7377
4255  6777    6777
4256  7777    7777
4257  5777    5777
4260  7777    7777
4261  3777    3777
4262  7777    7777
4263  0001    0001
4264  7777    7777
4265  0002    0002
4266  7777    7777
4267  0004    0004
4270  7777    7777
4271  0010    0010
4272  7777    7777
4273  0020    0020
4274  7777    7777
4275  0040    0040
4276  7777    7777
4277  0100    0100
4300  7777    7777
4301  0200    0200
4302  7777    7777
4303  0400    0400
4304  7777    7777
4305  1000    1000
4306  7777    7777
4307  2000    2000
4310  7777    7777
4311  4000    4000
4312  0001    0001
4313  7777    7777
4314  0002    0002
4315  7777    7777
4316  0004    0004
4317  7777    7777
4320  0010    0010
4321  7777    7777
4322  0200    0200
4323  7777    7777
4324  0400    0400
4325  7777    7777
4326  0100    0100
4327  7777    7777
4330  0200    0200
4331  7777    7777
4332  0400    0400
4333  7777    7777
4334  1000    1000
4335  7777    7777
4336  2000    2000
4337  7777    7777
4340  4000    4000
4341  7777    7777
```

```
          *0200
0200  7240  ARITHT,     CLA CMA
0201  3124    DCA Z HEADER
0202  7240    CLA CMA
0203  3135    DCA XARG
0204  7240    CLA CMA
0205  3136    DCA YARG
0206  7240    CLA CMA
0207  3121    DCA TOTAL
0210  3134    DCA Z LINK
0211  3115    DCA Z WD1
0212  5223    JMP INCR
0213  3120    DCA Z CRY

0214  7340  ADD,         CLA CMA CLL
0215  0135    AND Z XARG
0216  1136    TAD Z YARG
0217  3122    DCA Z SUM                          /STORE SUM OF REAL ADD
0220  7004    RAL
0221  3134    DCA Z LINK                /STORE LINK OF REAL ADD AT BIT 11
0222  5737    JMP I XFCOMP          /COMPARE SUM AND TOTAL

0223  5624  INCR,       JMP I INCRX
0224  4020  INCRX,      RAND

0225  7240  STRXY,      CLA CMA
0226  0135    AND Z XARG
0227  3115    DCA Z WD1                          /XARG EQUALS WD2
0230  7240    CLA CMA
0231  0136    AND Z YARG
0232  3116    DCA Z WD2                          /YARG EQUALS WD2
0233  4235    JMS ADDISM                /JMS TO FAKE ADD
0234  5214    JMP ADD
```

```
0235  0000  ADDISM,     0                          /FAKE ADD
0236  7300    CLA CLL
0237  3121    DCA Z TOTAL
0240  3120    DCA Z CRY
0241  7040    CMA
0242  0111    AND Z COUNT          /MINUS 11
0243  3123    DCA Z CNTR

0244  7040  AISM,        CMA
0245  0115    AND Z WD1
0246  7010    RAR
0247  3115    DCA Z WD1
0250  7004    RAL
0251  3117    DCA Z BW1
0252  7040    CMA
0253  0116    AND Z WD2
0254  7010    RAR
0255  3116    DCA Z WD2
0256  7040    CMA
0257  0117    AND BW1

0260  7420    SNL
0261  5302    JMP DISM
0262  7450    SNA
0263  5305    JMP CISM
0264  7300    CLL CLA
0265  7040  AXISM,       CMA
0266  0120    AND Z CRY
0267  7010    RAR
0270  7040    CMA
0271  0117    AND Z BW1
0272  3120  BISM,        DCA Z CRY
0273  7040    CMA
0274  0121    AND Z TOTAL
0275  7010    RAR
0276  3121    DCA Z TOTAL
0277  2123    ISZ Z CNTR
0300  5244    JMP AISM
0301  5635    JMP I ADDISM
0302  7450  DISM,        SNA
0303  5265    JMP AXISM
0304  7220    CML CLA
0305  7040  CISM,        CMA
0306  0120    AND Z CRY
0307  7440    SZA
0310  7100    CLL
0311  5272    JMP BISM
```

```
0312  4041  PADDOK,     JMS Z CRLF                /CR LF
0313  7240    CLA CMA
0314  0076    AND Z A                   /A
0315  4020    JMS Z PRXLOP
0316  7240    CLA CMA
0317  0131    AND Z D                   /D
0320  4020    JMS Z PRXLOP
0321  7240    CLA CMA
0322  0131    AND Z D                   /D
0323  4020    JMS Z PRXLOP

0324  7240    CLA CMA
0325  0102    AND Z SP                  /SP
0326  4020    JMS Z PRXLOP
0327  7240    CLA CMA
0330  0107    AND Z O                   /O
0331  4020    JMS Z PRXLOP
0332  7240    CLA CMA
0333  0110    AND Z K                   /K
0334  4020    JMS Z PRXLOP
0335  5736    JMP I ROTATE          /EXIT ADD TEST
0336  2000  ROTATE,     GEN1
0337  4051  XFCOMP,     FCOMP
```

```
                *0400
0400   7604  ERROR,      CLA OSR                  /READ IN SR
0401   7106    CLL RTL
0402   7510    SPA                          /SW2 EQUALS A ONE TO PRINT
0403   4216    JMS PRINT                            /JMS TO PRINT ROUTINE
0404   7604    CLA OSR
0405   7510    SPA                          /SW0 EQUALS A ONE TO HALT
0406   7402    HLT                          /HALT ON ERROR
0407   7604  NOERR,      CLA OSR
0410   7104    CLL RAL
0411   7510    SPA                          /SW1 EQUALS A ONE TO SCOPE MODE
0412   5614    JMP I SXY                            /SCOPE MODE
0413   5615    JMP I INCRT            /CONTINUE MODE
0414   0225  SXY,        STRXY
0415   0223  INCRT,      INCR

0416   0000  PRINT,      0
0417   7240    CLA CMA
0420   0124    AND Z HEADER           /HEADER FLAG
0421   7440    SZA
0422   4321    JMS PRHEAD                   /JMS TO PRINT HEADER ROUTINE
0423   7000  PRERR,      NOP
0424   4041    JMS Z CRLF                   /CR LF
0425   4020    JMS Z PRXLOP
0426   7240    CLA CMA
0427   0120    AND Z CRY
0430   4635    JMS I XONZER           /TEST FAKE LINK FOR SEX AND
                                       /PRINT A ONE OR ZERO

0431   7240    CLA CMA
0432   0102    AND Z SP                     /PRINT SP
0433   4020    JMS Z PRXLOP
0434   5236    JMP PTOTAL                   /PRINT CONTENTS OF FAKE ADD
0435   2637  XONZER,     ONZER
```

```
0436  7240  PTOTAL,     CLA CMA
0437  0121    AND Ž TOTAL          /STORE CONTENTS OF FAKE ADD
0440  3125    DCA Ž BITSTR
0441  4266    JMS MESSG
0442  7240    CLA CMA
0443  0134    AND Ž LINK                /TEST REAL LINK FOR SEX AND
0444  4635    JMS I XONŽER         /PRINT A ONE OR ŽERO

0445  7240    CLA CMA
0446  0102    AND Ž SP                  / PRINT SP
0447  4020    JMS Ž PRXLOP
0450  5251    JMP XTOTAL

0451  7240  XTOTAL,     CLA CMA
0452  0122    AND Ž SUM
0453  3125    DCA Ž BITSTR         /STORE CONTENTS OF REAL ADD
0454  4266    JMS MESSG
0455  7240    CLA CMA
0456  0135    AND Ž XARG
0457  3125    DCA Ž BITSTR         /STORE XARG
0460  4266    JMS MESSG
0461  7240    CLA CMA
0462  0136    AND Ž YARG
0463  3125    DCA Ž BITSTR         /STORE Y ARG
0464  4266    JMS MESSG
0465  5616    JMP I PRINT          /EXIT TO SWITCH ROUTINE
```

```
0466  0000  MESSG,      0
0467  7240    CLA CMA
0470  0137    AND Z COUNTX
0471  3112    DCA Z STRCNT
0472  2112  NBIT,       ISZ Z STRCNT
0473  7410    SKP
0474  5312    JMP PRSPAC              /12 COUNTS FINISHED
0475  7240    CLA CMA
0476  0125    AND Z BITSTR
0477  7100    CLL
0500  7004    RAL
0501  3125    DCA Z BITSTR          /STORE ROTATED WORD
0502  7430    SZL
0503  5306    JMP PRONE
0504  4764  PRZERO,     JMS I XZEROR         /PRINT ZERO
0505  5272    JMP NBIT
0506  7240  PRONE,      CLA CMA
0507  0106    AND Z ONE
0510  4020    JMS Z PRXLOP          /PRINT ONE
0511  5272    JMP NBIT
0512  7240  PRSPAC,     CLA CMA
0513  0102    AND Z SP
0514  4020    JMS Z PRXLOP          /SP
0515  7240    CLA CMA
0516  0102    AND Z SP                    /SP
0517  4020    JMS Z PRXLOP
0520  5666    JMP I MESSG

0521  0000  PRHEAD,     0
0522  7200    CLA
0523  3124    DCA Z HEADER          /CLEAR HEADER FLAG
0524  7240    CLA CMA
0525  0126    AND Z SPACO6
0526  3127    DCA Z SPACST          /STORE SPACE COUNT
0527  4041    JMS Z CRLF                  /PRINT CR LF
```

```
0530  7240  SPA06,      CLA CMA
0531  0102    AND Z SP
0532  4020    JMS Z PRXLOP          /PRINT 6 SPACES
0533  2127    ISZ Z SPACST
0534  5330    JMP SPA06
0535  7240    CLA CMA
0536  0130    AND Z G                     /G
0537  4020    JMS Z PRXLOP
0540  7240    CLA CMA
0541  0107    AND Z O                     /O ALPHA
0542  4020    JMS Z PRXLOP
0543  7240    CLA CMA
0544  0107    AND Z O                     /O ALPHA
0545  4020    JMS Z PRXLOP
0546  7240    CLA CMA
0547  0131    AND Z D                     /D
0550  4020    JMS Z PRXLOP
0551  4762    JMS I MANYSP          /JMP TO PRINT 12 SPACES
0552  7240    CLA CMA
0553  0114    AND Z B                     /B
0554  4020    JMS Z PRXLOP
0555  7240    CLA CMA
0556  0076    AND Z A                     /A
0557  4020    JMS Z PRXLOP
0560  5761    JMP I CONHED
0561  0600  CONHED,     HEDCON
0562  0626  MANYSP,     TWELVE
0563  5721  HEDRJ,      JMP I PRHEAD          /EXIT HEADER ROUTINE
0564  2702  XZEROR,     ZEROR
```

```
                *0600
0600   7240   HEDCON,     CLA CMA
0601   0131     AND Z D                    /D
0602   4020     JMS Z PRXLOP
0603   4226     JMS TWELVE                 /12 SPACES
0604   7240     CLA CMA
0605   0132     AND Z X                    /X
0606   4020     JMS Z PRXLOP
0607   7240     CLA CMA
0610   0102     AND Z SP                   /SP
0611   4020     JMS Z PRXLOP
0612   4240     JMS ARGXXX                 /ARG
0613   4226     JMS TWELVE                 /12 SPACES
0614   7240     CLA CMA
0615   0133     AND Z Y                    /Y
0616   4020     JMS Z PRXLOP
0617   7240     CLA CMA
0620   0102     AND Z SP                   /SP
0621   4020     JMS Z PRXLOP
0622   4240     JMS ARGXXX                 /ARG
0623   4041     JMS Z CRLF                 /CR LF
0624   5625     JMP I RJHED              /JUMP TO EXIT HEADER ROUTINE
0625   0563   RJHED,      HEDRJ
0626   0000   TWELVE,     0
0627   7240     CLA CMA
0630   0111     AND Z COUNT
0631   3127     DCA Z SPACST             /STORE MINUS 12
0632   7240   SPA12,      CLA CMA
0633   0102     AND Z SP                   /SP
0634   4020     JMS Z PRXLOP             /PRINT 12 SPACES
0635   2127     ISZ Z SPACST
0636   5232     JMP SPA12
0637   5626     JMP I TWELVE

0640   0000   ARGXXX,     0
0641   7240     CLA CMA
0642   0076     AND Z A                    /A
0643   4020     JMS Z PRXLOP
0644   7240     CLA CMA
0645   0075     AND Z R                    /R
0646   4020     JMS Z PRXLOP
0647   7240     CLA CMA
0650   0130     AND Z G                    /G
0651   4020     JMS Z PRXLOP
0652   5640     JMP I ARGXXX
```

```
          *2000
2000  4316  GEN1,       JMS HSEKP
2001  4142  CONT1,      JMS Z CX
2002  0051    AND Z PAT
2003  7001    IAC
2004  3051    DCA Z PAT                          /STORE INCREMENTED PATTERN
2005  7420    SNL
2006  5215    JMP CLRLNK              /JMP TO CLEAR LNKSTR
2007  1060    TAD K4000
2010  3140    DCA Z LNKSTR        /SET LNKSTR TO 4000
2011  4352  PT1EX,      JMS EX
2012  7440    SZA
2013  5220    JMP ROT1
2014  5274    JMP GEN2                /EXIT ROT1
2015  7200  CLRLNK,     CLA
2016  3140    DCA Z LNKSTR
2017  5211    JMP PT1EX

2020  7240  ROT1,       CLA CMA
2021  3056    DCA Z TST1              /SET TST1 FLAG
2022  7340    CLL CLA CMA
2023  0140    AND Z LNKSTR
2024  7440    SZA
2025  5272    JMP SETLNK
2026  7140    CLL CMA                 /CLEAR LINK
2027  0051  REROT1,     AND Z PAT                          /BRING UP PATTERN
2030  7004    RAL
2031  3052    DCA Z RALRTL        /STORE RAL PATTERN
2032  7430    SZL                     /SKIP IF LINK EQUALS A ZERO
2033  1060    TAD Z K4000         /SET RAL LINK STORE
2034  3053    DCA Z LFTLNK        /CLEAR RAL LINK STORE
2035  7240    CLA CMA
2036  0052    AND Z RALRTL
2037  7010    RAR
2040  3054    DCA Z RARRTR        /STORE RAR PATTERN
2041  7430    SZL                     /SKIP IF LINK EQUALS A ZERO
2042  1060    TAD Z K4000         /SET RAR LINK STORE
2043  3055    DCA Z RITLNK        /CLEAR RAR LINK STORE
```

```
2044  7340    CLL CLA CMA
2045  0054    AND Z RARRTR          /RARRTR SHOULD EQUAL PAT
2046  7040    CMA
2047  1051    TAD Z PAT                             /COMPARE RARTR WITH PAT
2050  7040    CMA                         /AC SHOULD EQUAL ZERO
2051  7450    SNA
2052  7430    SZL
2053  5715    JMP I ERSWIX          /JUMP TO ERROR SWITCHES
2054  1060    TAD K4000
2055  0051    AND Z PAT                             /MASK BIT 0 OF PAT
2056  7040    CMA
2057  1053    TAD Z LFTLNK          /COMPARE LFTLNK WITH PAT
2060  7040    CMA                         /BIT 0
2061  7440    SZA
2062  5715    JMP I ERSWIX          /JUMP TO ERROR SWITCHES
2063  1055    TAD Z RITLNK
2064  7040    CMA
2065  1140    TAD Z LNKSTR          /COMPARE PAT LINK WITH RITLNK
2066  7040    CMA
2067  7440    SZA
2070  5715    JMP I ERSWIX
2071  5751    JMP I SXOKX1
2072  7360  SETLNK,     CLA CMA STL          /SET LINK
2073  5227    JMP REROT1
2074  4316  GEN2,       JMS HSEKP
2075  4142  CONT2,      JMS Z CX
2076  0051    AND Z PAT
2077  7001    IAC
2100  3051    DCA Z PAT                             /STORE INCREMENTED PATTERN
2101  7420    SNL
2102  5311    JMP CLLINK                  /JUMP TO CLEAR LNKSTR
2103  1060    TAD K4000
2104  3140    DCA Z LNKSTR          /SET LNKSTR TO 4000
2105  4363  PT1EXX,     JMS EX1
2106  7440    SZA
2107  5714    JMP I ROT2X
2110  5332    JMP ROTOK                             /EXIT ROTATE TESTS
```

```
2111  7200  CLLINK,     CLA
2112  3140    DCA Z LNKSTR
2113  5305    JMP PT1EXX

2114  2200  ROT2X,      ROT2
2115  2400  ERSWIX,     ERRSW1
2116  0000  HSEKP,      0
2117  7300    CLA CLL
2120  3051    DCA Z PAT
2121  3052    DCA Z RALRTL
2122  3054    DCA Z RARRTR
2123  3053    DCA Z LFTLNK
2124  3055    DCA Z RITLNK
2125  3140    DCA Z LNKSTR
2126  7000    NOP
2127  7000    NOP
2130  7000    NOP
2131  5716    JMP I HSEKP
2132  7200  ROTOK,      CLA
2133  4041    JMS Z CRLF                /CRLF
2134  1075    TAD Z R                   /R
2135  4020    JMS Z PRXLOP
2136  1107    TAD Z O                   /O
2137  4020    JMS Z PRXLOP
2140  1100    TAD Z T                   /T
2141  4020    JMS Z PRXLOP
2142  4041    JMS Z CRLF                /CRLF
2143  1113    TAD Z TWO                           /2
2144  4020    JMS Z PRXLOP
2145  1114    TAD Z B                   /B
2146  4020    JMS Z PRXLOP
2147  5750    JMP I ARITH
2150  0200  ARITH,      ARITHT
2151  2521  SXOKX1,     SWOKX1
2152  0000  EX,         0
2153  1140    TAD Z LNKSTR
2154  7440    SZA
2155  7410    SKP
2156  5220    JMP ROT1
2157  7240    CLA CMA
2160  0051    AND Z PAT
2161  7040    CMA
2162  5752    JMP I EX
2163  0000  EX1,        0
2164  1140    TAD Z LNKSTR
2165  7440    SZA
2166  7410    SKP
2167  5714    JMP I ROT2X
2170  7240    CLA CMA
2171  0051    AND Z PAT
2172  7040    CMA
2173  5763    JMP I EX1
```

```
                *2200

2200  7300  ROT2,       CLA CLL
2201  3056    DCA Z TST1              /CLEAR TEST FLAG
2202  7340    CLL CLA CMA
2203  0140    AND Z LNKSTR
2204  7440    SZA
2205  5250    JMP STLNK
2206  7140    CLL CMA
2207  0051  REROT2,     AND Z PAT                           /BRING UP PATTERN
2210  7012    RTR
2211  3054    DCA Z RARRTR        /STORE RTR PATTERN
2212  7430    SZL                      /SKIP IF LINK EQUALS A ZERO
2213  1072    TAD Z K0002         /SET RTR LINK STORE
2214  3055    DCA Z RITLNK        /CLEAR RTR LINK STORE
2215  1054    TAD Z RARRTR
2216  7006    RTL
2217  3052    DCA Z RALRTL        /STORE RTL PATTERN
2220  7430    SZL
2221  1060    TAD Z K4000         /SET RTL LINK STORE
2222  3053    DCA Z LFTLNK        /CLEAR RTL LINK STORE
2223  7100    CLL
2224  1052    TAD Z RALRTL        /RALRTL SHOULD EQUAL PAT
2225  7040    CMA
2226  1051    TAD Z PAT                       /COMPARE RALRTL WITH PAT
2227  7040    CMA
2230  7440    SZA
2231  5652    JMP I ERSW2X        /JMP TO ERROR SWITCHES
2232  1072    TAD Z K0002         /COMPARE ROTLNK WITH PAT BIT 10
2233  0051    AND Z PAT                       /MASK BIT 10 OF PAT
2234  7040    CMA
2235  1055    TAD Z RITLNK
2236  7040    CMA
2237  7440    SZA
2240  5652    JMP I ERSW2X
2241  1053    TAD Z LFTLNK        /LFT LINK SHOULD EQUAL LNKSTR
2242  7040    CMA
2243  1140    TAD Z LNKSTR        /COMPARE LFTLNK WITH LNKSTR
2244  7040    CMA
2245  7440    SZA
2246  5652    JMP I ERSW2X        /JUMP TO ERROR SWITCHES
2247  5653    JMP I SXOKX2

2250  7360  STLNK,      CLA CMA STL
2251  5207    JMP REROT2

2252  2406  ERSW2X,     ERRSW2
2253  2525  SXOKX2,     SWOKX2
```

```
          *2400
2400  7200  ERRSW1,     CLA
2401  1244    TAD ROTX1
2402  3215    DCA ERIN                  /SCOPE MODE RJMP ADDRESS
2403  1245    TAD CONTX1
2404  3214    DCA CONTX                           /CONTINUE MODE RJMP ADDRESS
2405  5216    JMP ERSW
2406  7200  ERRSW2,     CLA
2407  1250    TAD ROTX2
2410  3215    DCA ERIN                  /SCOPE MODE RJMP ADDRESS
2411  1251    TAD CONTX2
2412  3214    DCA CONTX                           /CONTINUE MODE RJMP ADDRESS
2413  5216    JMP ERSW

2414  0000  CONTX,       0
2415  0000  ERIN,        0
2416  7604  ERSW,       CLA OSR                   /READ IN SWITCHES
2417  0062    AND Z K1000           /MASK BIT 2
2420  7040    CMA
2421  1062    TAD Z K1000
2422  7040    CMA
2423  7450    SNA                         /TEST BIT 2 SWITCH
2424  4255    JMS ROPR
2425  7604    CLA OSR
2426  0060    AND Z K4000           /MASK BIT 0
2427  7040    CMA
2430  1060    TAD Z K4000
2431  7040    CMA
2432  7450    SNA                         /TEST BIT 0 SWITCH
2433  7402    HLT                         /ERROR HALT
2434  7604  SWOK,       CLA OSR
2435  0061    AND Z K2000           /MASK BIT 1
2436  7040    CMA
2437  1061    TAD Z K2000
2440  7040    CMA
2441  7450    SNA                         /TEST BIT 1 SWITCH
2442  5615    JMP I ERIN                  /JMP TO SCOPE MOD
2443  5614    JMP I CONTX           /JMP TO CONTINUE MODE
```

```
2444  2020  ROTX1,      ROT1
2445  2001  CONTX1,     CONT1
2446  2000  GEN1X1,     GEN1
2447  2074  GEN2X2,     GEN2
2450  2200  ROTX2,      ROT2
2451  2075  CONTX2,     CONT2
2452  2464  TWOROX,     TWORO
2453  2465  FINPRX,     FINPR
2454  2650  RARPRX,     RARPR

2455  0000  ROPR,       0                          /RJMP TO SWITCH ROUTINE
2456  4026    JMS Z CRLFLF          /PRINT CR LF LF
2457  4714    JMS I PATPRX          /PRINT PAT
2460  7200    CLA
2461  1056    TAD Z TST1
2462  7440    SZA
2463  5266    JMP ROT1PR                /PRINT ROTATE ONE PATTERN
2464  4715  TWORO,      JMS I ROT2PX        /PRINT ROTATE TWO PATTERN
2465  5655  FINPR,      JMP I ROPR
2466  7200  ROT1PR,     CLA
2467  1254    TAD RARPRX
2470  3714    DCA I PATPRX
2471  4041    JMS Z CRLF                /PRINT CR LF
2472  7200    CLA
2473  1075    TAD Z R                   /R
2474  4020    JMS Z PRXLOP
2475  1076    TAD Z A                   /A
2476  4020    JMS Z PRXLOP
2477  1077    TAD Z L                   /L
2500  4020    JMS Z PRXLOP
2501  1102    TAD Z SP                  /SP
2502  4020    JMS Z PRXLOP
2503  1053    TAD Z LFTLNK
2504  7440    SZA
2505  5716    JMP I LNONER          /LEFT LINK PRINT ONE
2506  4717    JMS I ZERORX          /LEFT LINK PRINT ZERO
2507  1102  RO1X,       TAD Z SP
2510  4020    JMS Z PRXLOP          /SP
2511  1052    TAD Z RALRTL
2512  3057    DCA Z PROUT
2513  5720    JMP I COUNXX          /PRINT RALRTL CONTENTS

2514  2600  PATPRX,     PATPR
2515  2732  ROT2PX,     ROT2PR
2516  2676  LNONER,     LNONE
2517  2702  ZERORX,     ZERO
2520  2616  COUNXX,     COUNPR
2521  7200  SWOKX1,     CLA
2522  1245    TAD CONTX1
2523  3214    DCA CONTX
2524  5234    JMP SWOK
2525  7200  SWOKX2,     CLA
2526  1251    TAD CONTX2
2527  3214    DCA CONTX
2530  5234    JMP SWOK
```

```
          *2600
2600  0000  PATPR,      0
2601  1101    TAD Z P                 /P
2602  4020    JMS Z PRXLOP
2603  1076    TAD Z A                 /A
2604  4020    JMS Z PRXLOP
2605  1100    TAD Z T                 /T
2606  4020    JMS Z PRXLOP
2607  1102    TAD Z SP                /SP
2610  4020    JMS Z PRXLOP
2611  4361    JMS PLINK
2612  1102    TAD Z SP
2613  4020    JMS Z PRXLOP        /SP
2614  1051    TAD Z PAT
2615  3057    DCA Z PROUT         /STORE GENERATED PATTERN

2616  4231  COUNPR,     JMS MINDEX              /JMS TO MASK INDEX ROUTINE
2617  0137    AND Z COUNTX
2620  3112    DCA Z STRCNT
2621  2112  LSTBIT,     ISZ Z STRCNT
2622  7410    SKP
2623  5600    JMP I PATPR         /12 COUNTS FINISHED
2624  7200    CLA
2625  1057    TAD Z PROUT
2626  0410    AND I Z 10
2627  4237    JMS ONZER
2630  5221    JMP LSTBIT

2631  0000  MINDEX,     0
2632  7200    CLA
2633  1074    TAD Z XPROUT        /INDEX STARTING ADDRESS
2634  3010    DCA Z 10                /STORE INDEX ADDRESS
2635  7240    CLA CMA
2636  5631    JMP I MINDEX
```

```
2637  0000  ONZER,      0
2640  7440    SZA
2641  5244    JMP ONEP                    /JMP TO PRINT ONE
2642  4302    JMS ZEROR
2643  5637    JMP I ONZER
2644  7240  ONEP,       CLA CMA
2645  0106    AND Z ONE
2646  4020    JMS Z PRXLOP          /PRINT ONE
2647  5637    JMP I ONZER

2650  7200  RARPR,      CLA
2651  1273    TAD FINPRN
2652  3200    DCA PATPR
2653  4041    JMS Z CRLF                  /CR LF
2654  7200    CLA
2655  1075    TAD Z R                     /R
2656  4020    JMS Z PRXLOP
2657  1076    TAD Z A                     /A
2660  4020    JMS Z PRXLOP
2661  4323    JMS RSPACE                  /R SP
2662  1055    TAD Z RITLNK
2663  7440    SZA
2664  5307    JMP LNONEX                  /RIT LINK EQUALS A ONE
2665  4302    JMS ZEROR
2666  1102  R01XX,      TAD Z SP                    /SP
2667  4020    JMS Z PRXLOP
2670  1054    TAD Z RARRTR
2671  3057    DCA Z PROUT
2672  5216    JMP COUNPR                  /PRINT RARR TR CONTENTS

2673  2465  FINPRN,     FINPR
2674  2507  R01XR,      R01X
2675  2744  RTLPRX,     RTLPR
```

```
2676  7240  LNONE,      CLA CMA
2677  0106    AND Z ONE
2700  4020    JMS Z PRXLOP          /PRINT LINK
2701  5674    JMP I RO1XR

2702  0000  ZEROR,       0
2703  7240    CLA CMA
2704  0105    AND Z ZERO
2705  4020    JMS Z PRXLOP          /PRINT 0 LINK
2706  5702    JMP I ZEROR

2707  7200  LNONEX,     CLA
2710  1106    TAD Z ONE
2711  4020    JMS Z PRXLOP
2712  5266    JMP RO1XX

2713  0000  RTCRLF,     0
2714  7200    CLA
2715  4041    JMS Z CRLF                  /CR LF
2716  1075    TAD Z R                     /R
2717  4020    JMS Z PRXLOP
2720  1100    TAD Z T                     /T
2721  4020    JMS Z PRXLOP
2722  5713    JMP I RTCRLF

2723  0000  RSPACE,     0
2724  7200    CLA
2725  1075    TAD Z R                     /R
2726  4020    JMS Z PRXLOP
2727  1102    TAD Z SP                    /SP
2730  4020    JMS Z PRXLOP
2731  5723    JMP I RSPACE
```

```
2732  7200  ROT2PR,     CLA
2733  1275    TAD RTLPRX
2734  3200    DCA PATPR
2735  4313    JMS RTCRLF              /CR LF RT
2736  4323    JMS RSPACE              /R SP
2737  1055    TAD Z RITLNK
2740  7440    SZA
2741  5307    JMP LNONEX              /RIGHT LINK EQUALS A ONE
2742  4302    JMS ZEROR                       /PRINT 0 LINK
2743  5266    JMP RO1XX                       /PRINT SP AND RARRTR CONTENTS

2744  7200  RTLPR,      CLA
2745  1273    TAD FINPRN
2746  3200    DCA PATPR
2747  4313    JMS RTCRLF              /CR LF RT
2750  1077    TAD Z L                 /L
2751  4020    JMS Z PRXLOP
2752  1102    TAD Z SP                /SP
2753  4020    JMS Z PRXLOP
2754  1053    TAD Z LFTLNK
2755  7440    SZA
2756  5276    JMP LNONE                       /PRINT 1 LINK
2757  4302    JMS ZEROR                       /PRINT 0 LINK
2760  5674    JMP I RO1XR

2761  0000  PLINK,      0
2762  1140    TAD Z LNKSTR        /PRINT PAT LINK
2763  4237    JMS ONZER
2764  5761    JMP I PLINK
```

```
@A        0076
ADD       0214
ADDISM    0235
ADDX      4050
AISM      0244
ARGXXX    0640
ARITH     2150
ARITHT    0200
AXISM     0265
B         0114
BISM      0272
BITSTR    0125
BW1       0117
CISM      0305
CL        0152
CLLINK    2111
CLRLNK    2015
CNTR      0123
CONHFD    0561
CONTX     2414
CONTX1    2445
CONTX2    2451
CONT1     2001
CONT2     2075
COUNPR    2616
COUNT     0111
COUNTX    0137
COUNXX    2520
CR        0104
CRLF      0041
CRLFLF    0026
CRY       0120
CX        0142

CXM       4075
CXN       4074
D         0131
DISM      0302
ERIN      2415
ERROR     0400
ERRSW1    2400
ERRSW2    2406
ERSW      2416
ERSWIX    2115
ERSW2X    2252
ERX       4076
EX        2152
EX1       2163
FCOMP     4051
FINPR     2465
FINPRN    2673
FINPRX    2453
G         0130
GEN1      2000
GEN1X1    2446
GEN2      2074
GEN2X2    2447
HEADFR    0124
HEDCON    0600
HEDRJ     0563
HSEKP     2116
INCR      0223
INCRT     0415
INCRX     0224
K         0110
K0001     0073
K0002     0072
K0004     0071
K0010     0070
K0020     0067
K0040     0066
K0100     0065
K0200     0064
K0400     0063
K1000     0062
K2000     0061
K4000     0060
K7377     0141
L         0077
LCOMP     4077
LF        0103
LFTLNK    0053
LINK      0134
LIST      4200
LISTX     4015
LNKSTR    0140
LNONF     2676
LNONFR    2516
LNONFX    2707
LPXX      0022
LRX       4122
LRY       4123
LSTBIT    2621
MANYSP    0562
MESSG     0466
MINDFX    2631
M144      4014
NBIT      0472
NOERR     0407

NOERX     4124
O         0107
ODEVFN    4017
ONE       0106
ONEP      2644
ONZER     2637
P         0101
PADDOK    0312
PAT       0051
PATPR     2600
PATPRX    2514
PLINK     2761
PRERR     0423
PRHEAD    0521
PRINT     0416
PRONF     0506
PROUT     0057
PRSPAC    0512
PRXLOP    0020
PRZERO    0504
PTOTAL    0436
PT1EX     2011
PT1EXX    2105
R         0075
RALRTL    0052
RAND      4020
RAND1     4030
RAND2     4000
```

```
RARPR   2650
RARPRX  2454
RARRTR  0054
RCNT    4016
REROT1  2027
REROT2  2207
RITLNK  0055
RJHED   0625
ROPR    2455
ROTATE  0336
ROTOK   2132
ROTX1   2444
ROTX2   2450
ROT1    2020
ROT1PR  2466
ROT2    2200
ROT2PR  2732
ROT2PX  2515
ROT2X   2114
RO1X    2507
RO1XR   2674
RO1XX   2666
RSPACE  2723
RTCRLF  2713
RTLPR   2744
RTLPRX  2675
SETLNK  2072
SL      0150
SP      0102
SPAC06  0126
SPACST  0127
SPA06   0530
SPA12   0632
STLNK   2250
STRCNT  0112
STRXY   0225
SUM     0122
SWOK    2434
SWOKX1  2521
SWOKX2  2525
SXOKX1  2151
SXOKX2  2253
SXY     0414
T       0100
TOTAL   0121
TST1    0056
TWELVE  0626
TWO     0113
TWORO   2464
TWOROX  2452
WD1     0115
WD2     0116
X       0132
XARG    0135
XFCOMP  0337
XONEFR  0435
XPROUT  0074
XSTRXY  4047
XTOTAL  0451
XZEROR  0564
Y       0133
YARG    0136
ZERO    0105
ZEROR   2702
ZERORX  2517
0
```