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TM 1003 010 00

Milestone 11

160A Computer Program Description

TM-1003/010/00

TECHNICAL MEMORANDUM

(TM Series)

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Milestone 11

160A Computer Program Description

By

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26 March 1963

Approved

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PROGRAM IDENTIFICATION

A. Title: CCC Simulator Program (CCC SIM) - Ident 22C, Mod 00

B. Programmed: 11 January 1963

N. D. Babic, Control Data Corporation

C. Documented: 26 March 1963

N. D. Babic, CDC and V. J. Gergen, SDC

PURPOSE

The CCC Simulator provides a simulated intercommunication link between the Bird Buffer (BB) computer and the Tracking Station (TS) computer that is normally performed by the Computer Communication Converter (CCC) and associated equipment.

USAGE

A. Operating Instructions

Step 1 Master Clear all three computers before uncabling and recabling.

Step 2 Use machine load of computer No. 1 to read the paper tape containing the CCC Simulation program into core. Starting location is "0000" Bank "0".

Step 3 Set Selective Stop Switches 1 and 2 (SLS 1 & SLS 2) on the CCC Simulation computer for error stop indications desired. (See Error Stops below.)

Step 4 Load interfacing programs into TS & BB computers and put them into the programmed "wait loop" (see Restrictions D, Computer No. 2 = TS, Computer No. 3 = BB).

Step 5 Set the CCC Simulation computer Program Register (P) = 0000, and set Run/Step switch to "RUN".

Step 6 Execute a Manual Interrupt on the CCC Simulation computer, e.g., depress a Jump and a Stop key, simultaneously, to start programs into the transmission cycle.

B. Error Stops:

P = 1270 A tracking station computer has failed to take the status code word, if SLS 1 is set.

P = 1273 A tracking station computer has failed to take the data word, if SLS 2 is set.

P = 0414 A tracking station computer has attempted to send or receive out of turn.

P = 1567 A Bird Buffer computer has failed to take a status code work, if SLS 1 is set.

P = 1572 A Bird Buffer computer has failed to take a data word, if SLS 2 is set.

P = 0114 A Bird Buffer computer has attempted to send or receive out of turn.

C. I/O Format

1. Inputs

Select Codes - The following select codes can be issued by the BB and TS computers. These select codes will be interpreted by the CCC Simulator program as indicated below:

EFC	ACTION
5500	Transfer a word from the CCC Simulator to the BB (or TS) computer.
5501	Transfer a word from the BB (or TS) computer to the CCC Simulator for relay to TS_1 (or BB_1) computer.
5502	Transfer a word from BB (or TS) computer to the CCC Simulator for relay to TS_2 (or BB_2) computer.
5503	The BB (or TS) requests the present status of the CCC Simulator.
5504 through 5511	No action required of CCC Simulator.

Data Words - The input data word uses the standard 12 bit computer word.

Interrupt 10 - Interrupt 10 is a one time input, when the operator wishes to start the transmission cycles between the computers.

Interrupt 20 - Interrupt 20 is programmed internal to the CCC Simulator. It indicates when the TS computer has an input word for the CCC Simulator on the Internal Buffer channel.

Interrupt 30 - Interrupt 30 is programmed internal to the CCC Simulator. It indicates when the BB computer has an input word for the CCC Simulator on the External Buffer channel.

Interrupt 40 - Interrupt 40 is generated by the CCC adaptor to indicate to the CCC Simulator that the BB computer has requested status from the CCC Simulator. The input is via the CCC Simulator computer's Normal channel.

2. Outputs

CCC Status Words - The CCC Simulation computer outputs a 12 bit status word when requested by the BB or TS computer. The following is the bit interpretation of the Status Code word:

Bit No. (from left to right)	Interpretation
2^0	CCC Simulator has a valid input word for the BB (or TS) computer.
2^2	CCC Simulator is ready to receive a word from the BB (or TS) computer.
2^8	The source of the input word is from the remote number one computer.
2^9	The source of the input word is from the remote number two computer.

The remaining bits are unused and are set to zero.

Interrupt 40 - The Interrupt 40 is generated as a timed output and alternately transmitted to the BB and TS computers.

Data Word - The data word is transferred as the standard 12 bit computer word.

METHOD

A. General

The CCC simulation program, in a single 160-A computer, assumes the role of two CCC's, the interstation communication equipment, and their associated telephone lines. It provides a method for apparent multiplexing of data as a sending device, and separating and distributing the data to the appropriate computer as a receiving device. It is capable of interfacing with programs, in other 160-A computer, which are programmed such that their 160-A normal channel appears as two computers. The simulation program performs the following functions of the CCC.

1. Within each transmission word time of 13.3 milliseconds, it selects the simulator adaptor to interrupt each apparent computer in the link if a data word directed to that computer is available. The receiving computer is allowed approximately 1.8 milliseconds to service the interrupt and select the word.

2. Within each 13.3 milliseconds interval, it selects the simulator adaptor to interrupt each apparent computer in the link, subject to the priority of 3. whose interrupt is enabled to allow that computer to send a word of data. It maintains a status by means of select codes from the individual computers.

3. It controls the interrupt procedure of 2. such that each apparent 160-A is allowed to send data on a word-by-word priority basis, where the lowest priority is assigned to the computer that sent last.

4. It provides unique sets of status codes to each of the apparent interfacing 160-A computers.

B. Specific

The CCC Simulator program cycles through the following steps.

1. Signal the target computer with an Interrupt 40.

2. Wait for the target computer to issue a request for the CCC Simulator status (EFC 5503). This activates the Interrupt 20 or 30 line. The receipt of this interrupt at this time in the quarter cycle indicates to the CCC Simulator that the target computer has requested status.

3. Reactivate the appropriate output buffer with the status code as a data word.

4. Reactivate the appropriate input buffer for the EFC word, and wait for a 20 or 30 Interrupt. The interrupt at this point in the quarter cycle indicates that the target computer has transmitted the EFC to the CCC Simulator as indicated by the status word to the BB (or TS) computer.

5. Execute the appropriate subroutine.

   For EFC 5500:

   a. Reactivate the output buffer with the data word.

   b. Reactivate the input buffer controls.

   c. Wait for an interrupt 20 or 30. Return to 1. if the quarter cycle time runs out. Return to 5. if the interrupt arrives.

   For EFC 5501 or 5502:

   a. Reactivate the input buffer and wait for the Interrupt 20 or 30.

   b. After receipt of the interrupt again reactivate the input buffer.

   c. Wait for an interrupt 20 or 30. Return to 1. if the quarter cycle time runs out. Return to 5. if the interrupts arrives.

RESTRICTIONS

A. The target computer must service the Interrupt 40 in the time alloted (approximately 1.8 milliseconds for the BB and 1.85 milliseconds for the TS). Failure to service the interrupt in time will cause the CCC Simulator program to HALT (See Error Stops, page No. 1).

B. No other external device can be operated on the normal channel of the TS computer.

C. The CCC Simulator program is designed to ignore the following EFC's:

EFC	FUNCTION	EFC	FUNCTION
5504	Disable Transmit Interrupt	5508	Not Used
5505	Initiate Resign	5509	Not Used
5506	Enable transmit Interrupt	5510	Enable Test Mode
5507	Not Used	5511	Disable Test Mode

D. The interfacing TS and BB programs should be programmed with a "Wait" loop as a starting point to allow the CCC Simulator program to start the cycling routine.

E. CPDC System Configuration

The CCC Simulation System is composed of three 160A's: 160A 1 = the CCC Simulator Computer, 160A 2 = the Remote Tracking Station Simulator, and 160A 3 = Bird Buffer Computer; two 169 auxiliary memories: 169 2 is associated with 160A 3, and 169 1 is associated with 160A 1 and the Simulator Adaptor; and various peripheral devices as needed by the BB & TS programs.

The system layout is shown in Figure 1. Note that the Normal Channel of 160A 2 computer is connected to the Internal Buffer Channel of 160A 1, while the 160A 3 computer's Normal Channel is connected to the External Buffer Channel of 160A 1 computer. The Normal Channel of 160A 1 is used, via the CCC Simulator Adaptor, to provide interrupts to 160A's and No. 2 and No. 3.

F. Cabling Instructions for the CPDC Installation

The following cabling connections must be made in order to utilize the CCC Simulator:

1. Remove the cables in the 161 cabinet that jumper to the 1610 and connect to the cables that are marked with black tape, "IN" and "OUT", to the jacks marked "IN" and "OUT", respectively. These are the jacks from which the 1610 cables were removed.

2. Remove the cables from J02 and J04 of 169 1 and connect the cable with the black tag marked J04 to J04.

3. Attach connectors J01 thru J09 to CCC Simulator adaptor in 169 1.

4. Be sure the cables with the black tags marked J02 and J04 in 169 2 are connected to J02 and J04 jacks.

5. A cable diagram is given in Figure 2 which will indicate all other connections that are normal to the CPDC.

TIMING

The CCC Simulation cycle time for the 40 Interrupt is 13.3 milliseconds. Because the 160A computer I/O is not full duplex, this cycle time is broken into four quarter cycles. Each quarter is assigned to an apparent computer (TS_1, TS_2, BB_1, or BB_2). The CCC Simulation Program has a 40 Interrupt schedule where it interleaves the 40 interrupts as follows, TS_1, BB_1, TS_2, BB_2, TS_1, etc. Each of these apparent computers must service the 40 Interrupt within a preset time. It is approximately 1.80 milliseconds for the BB and 1.85 milliseconds for the TS. If no datum is being transmitted between the BB computer and the CCC Simulation computer, the cycle time is 6.7 milliseconds, and 13.3 whenever a datum transfer is required. This is the same for the interface between the CCC Simulator computer and the TS Computer. These 40 interrupts are independent of one another, such that the BB could be on a 6.7 millisecond cycle while the TS is on a 13.3 millisecond cycle time.

STORAGE

Load Start Address	"0000"	Bank 0
END Address	1625_8	

VALIDATION TESTS

Two types of validation tests were used, one called the "Test Transmission" program and the second referred to as "BB & TS operational check."

The BB & TS operational check is loaded into both the TS & BB computers. if the cabling and computer Jump switches are set correctly, the CCC Simulator program will cycle with the TS & BB programs, and the three computers will halt at some predetermined point in their respective programs. The P stop number is varied if the cycle time is varied. If the computers fail to cycle, a CDC, CE should be asked to assist in determining the fault. (This program is the second tape in the box that stores the CCC Simulator tape in the CPDC.)

The Test Transmission program (Appendix C) is designed to use the typewriter to print out a "go" condition. If the printout fails and the Jump switches are set correctly, a CDC, CE should be asked to assist in determining the fault. Programs are available with cycle times of 12.1, 13.5 and 13.3 milliseconds or adjust locations 1222 & 1521 as desired.

REFERENCES

SDC Library Document No. 30129, "Report on CCC Simulation", 25 January 1963.

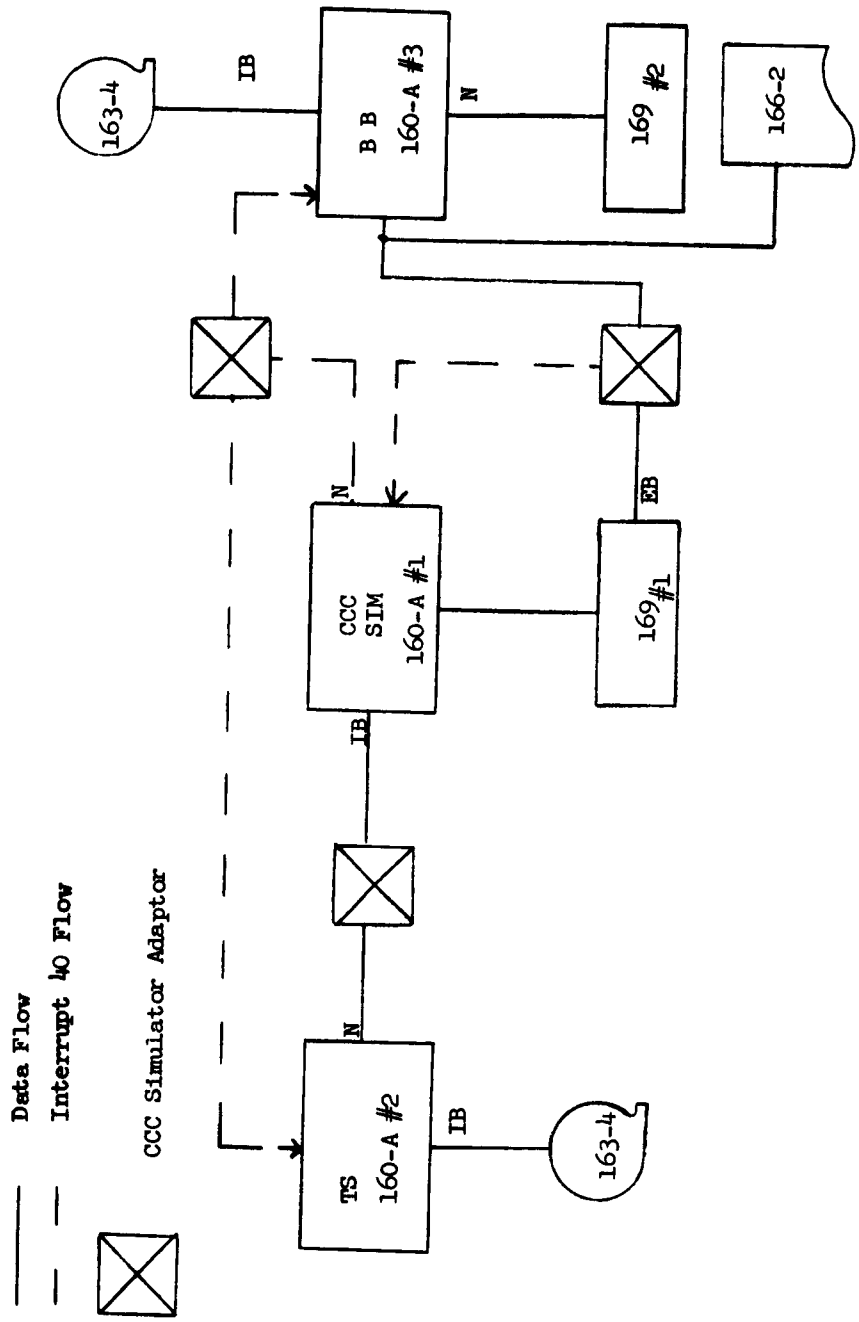

Figure 1: CCC Simulation System

(Page 10 Blank)

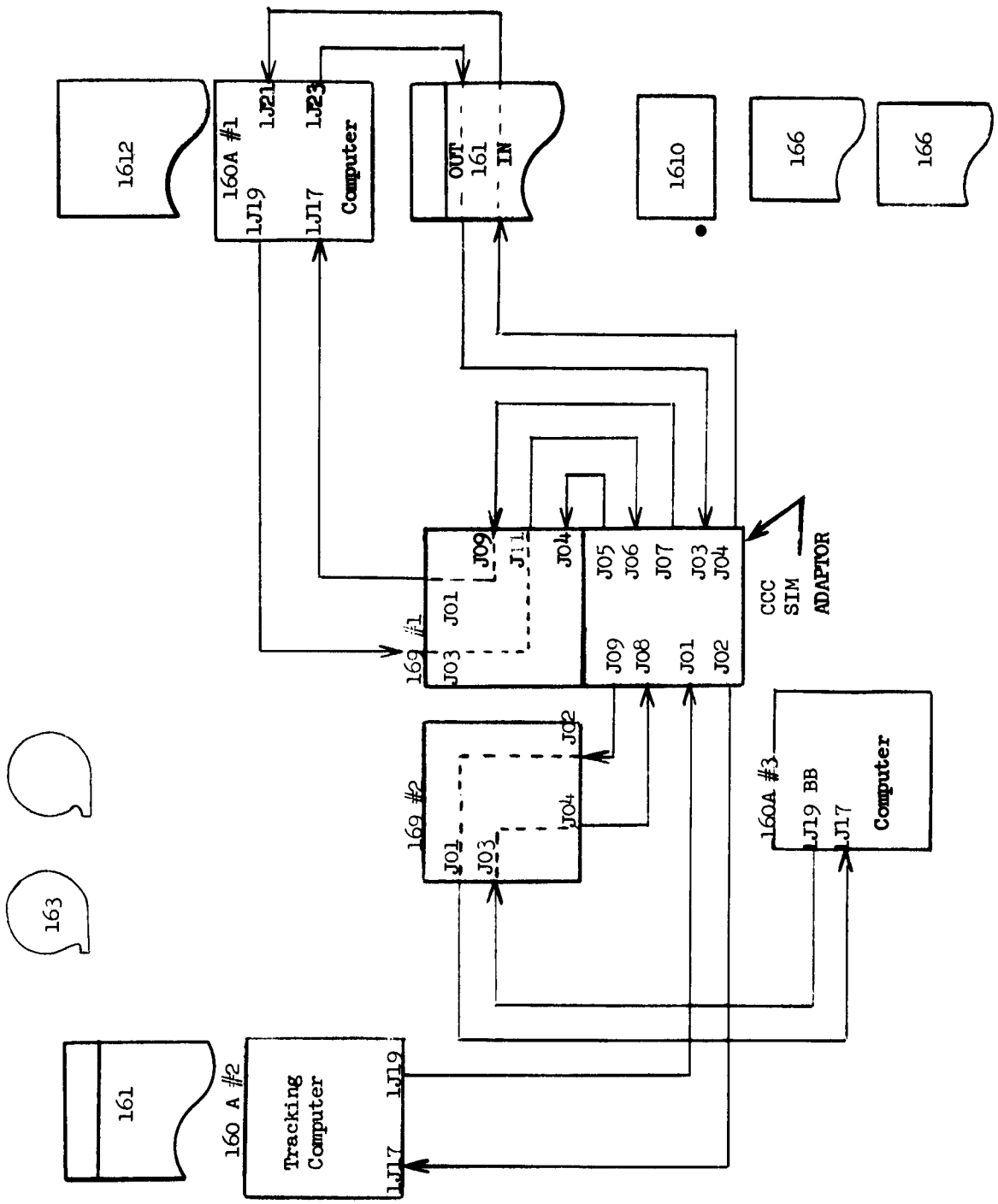

Figure 2: CCC Simulator Cabling

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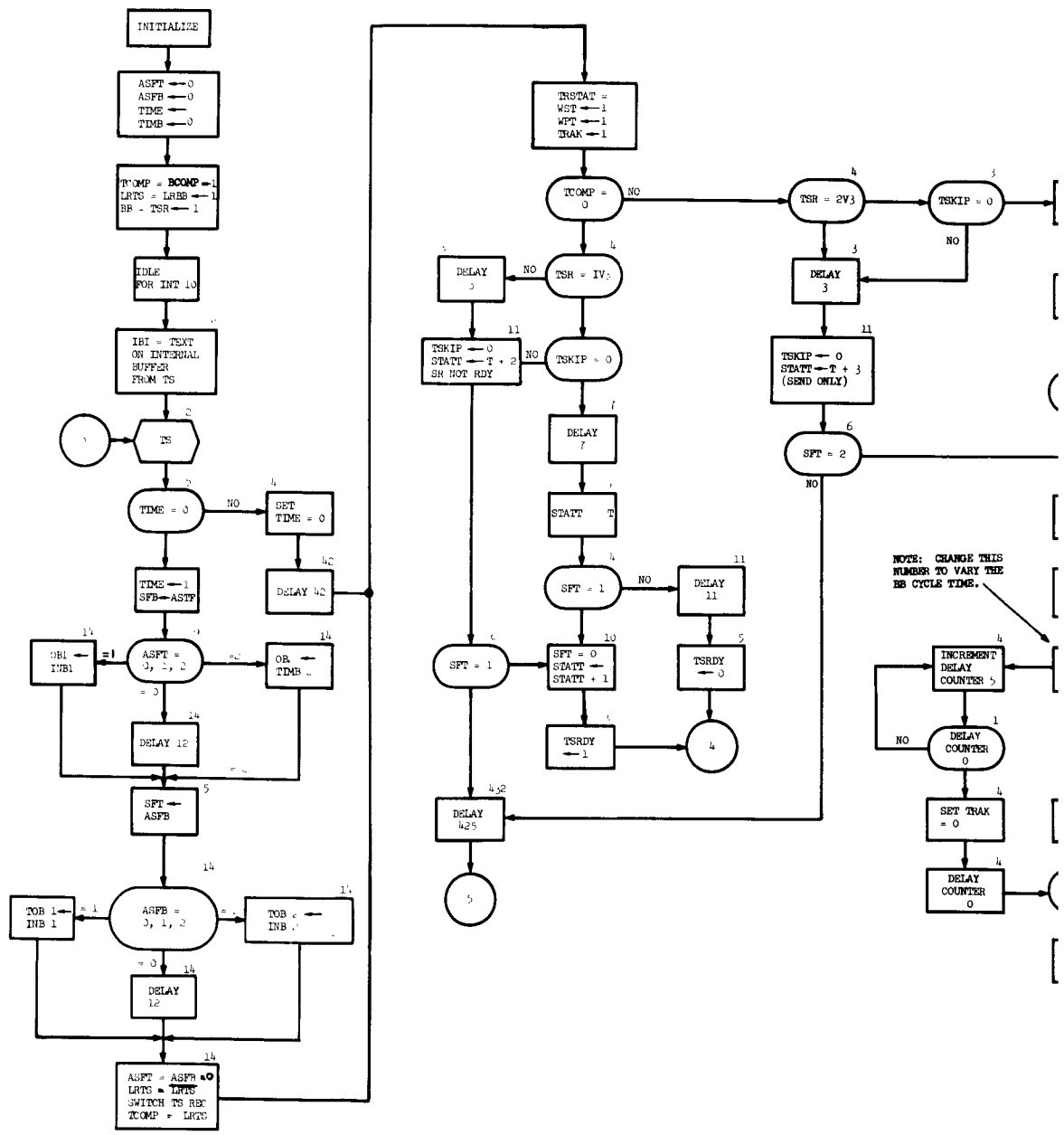
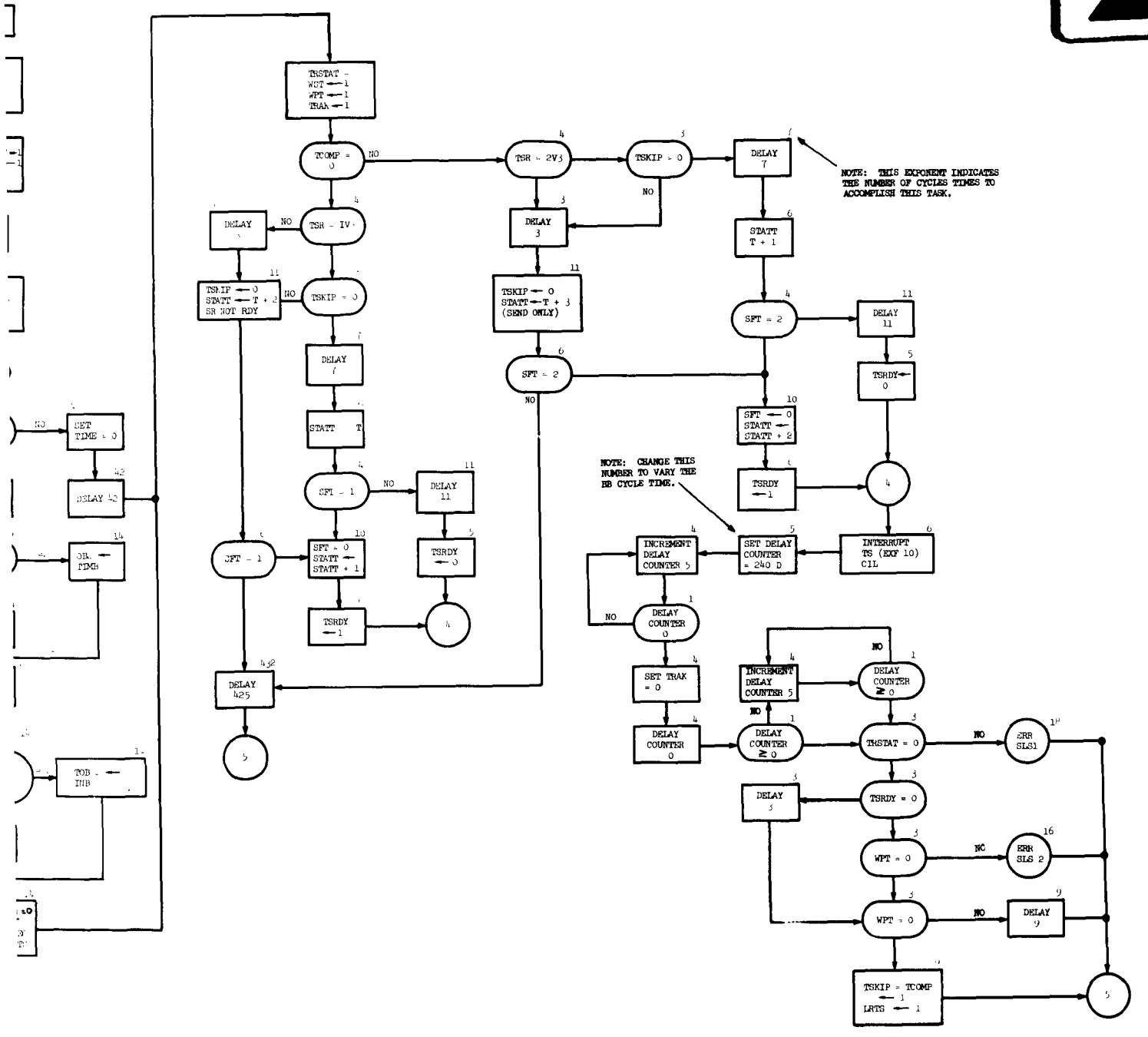
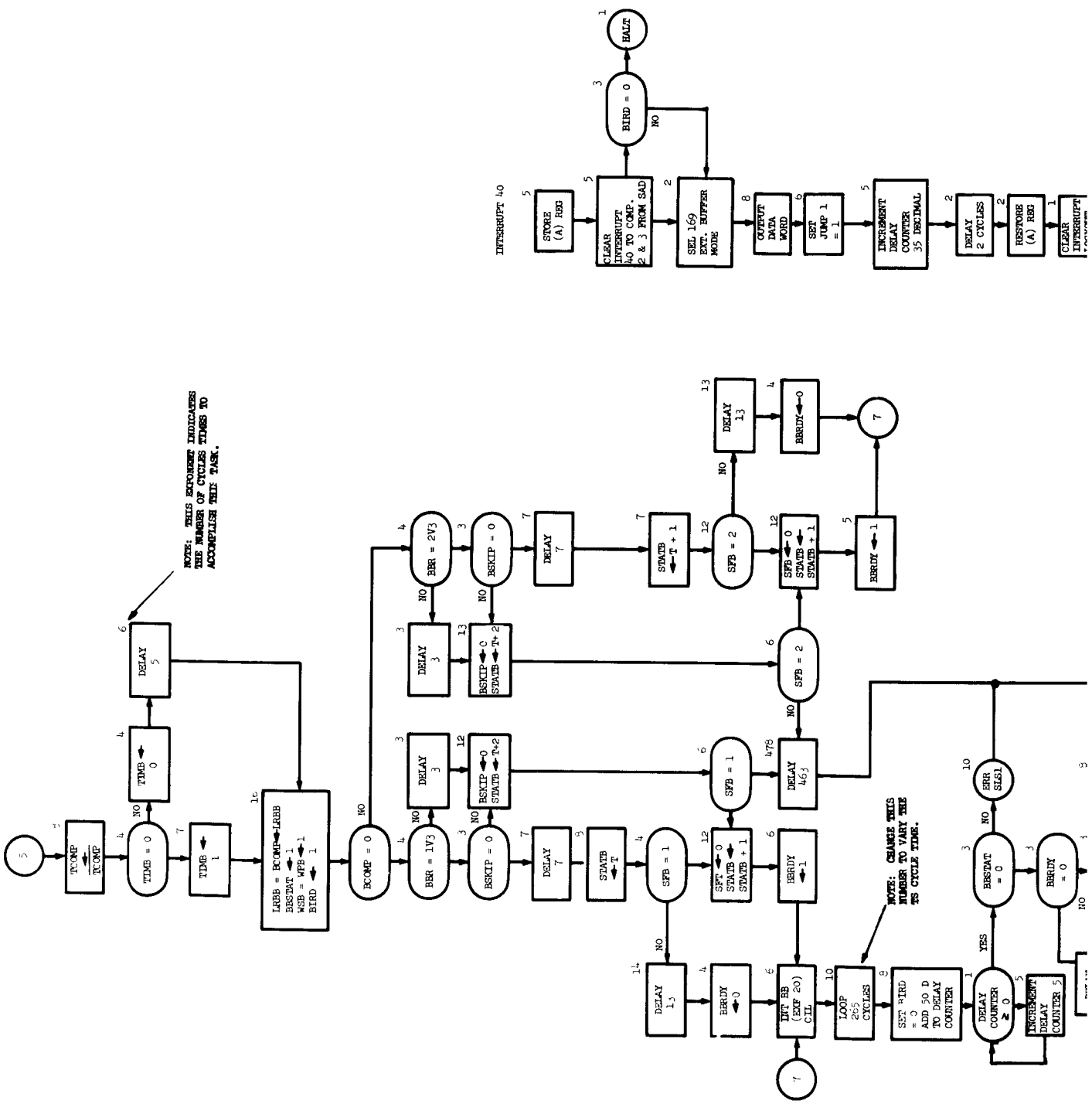
APPENDIX A



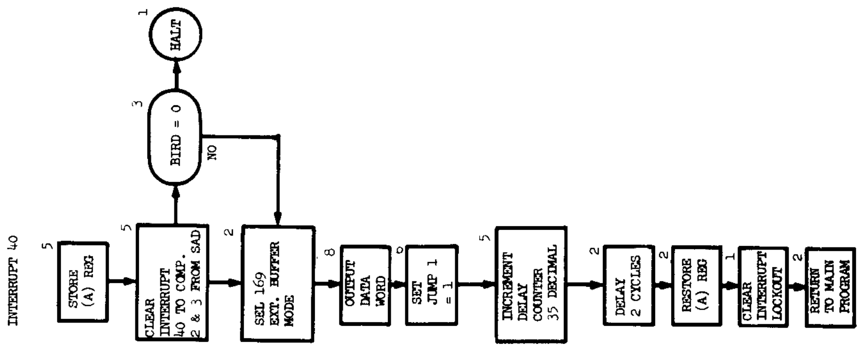
2

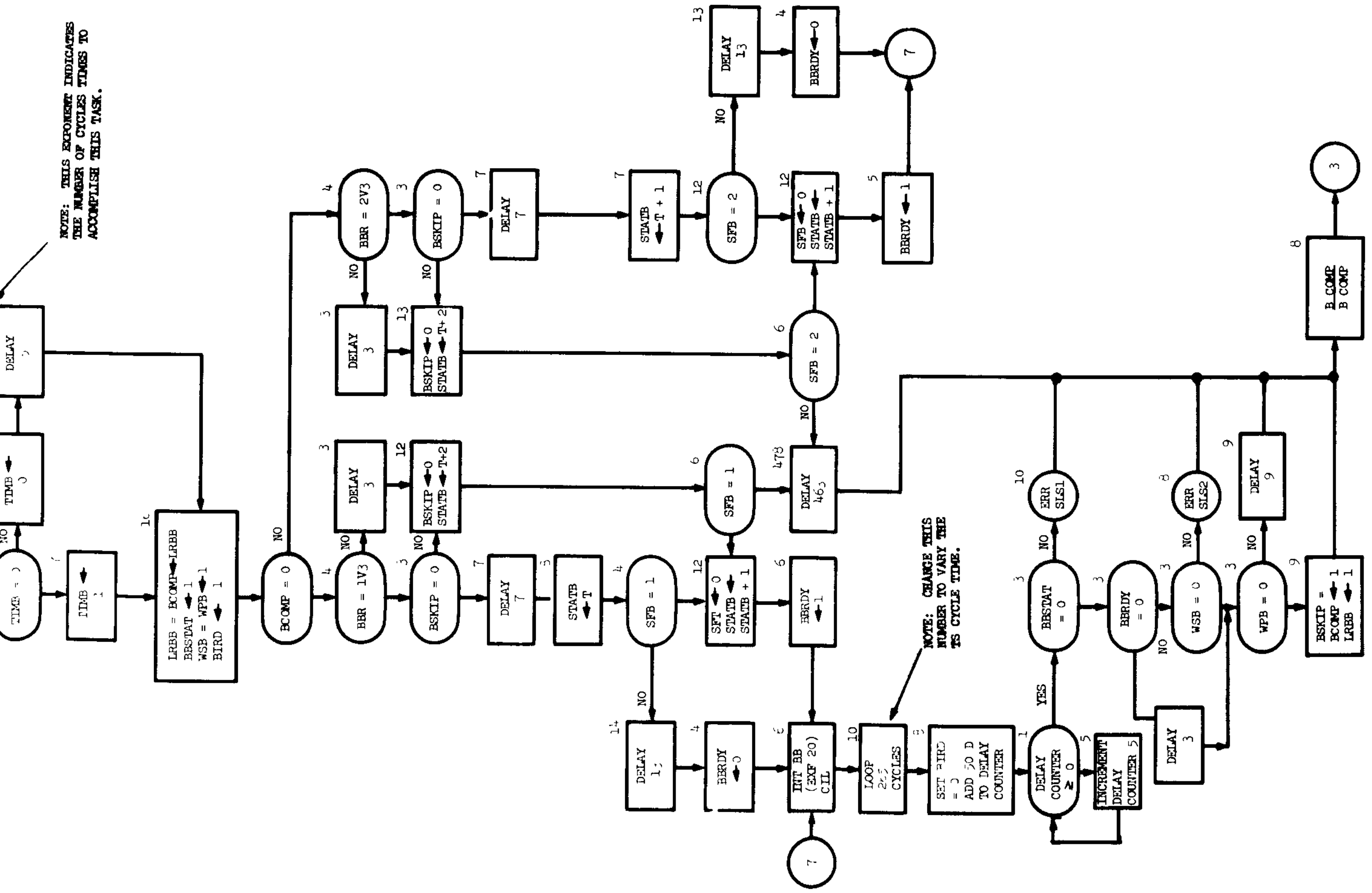
APPENDIX A

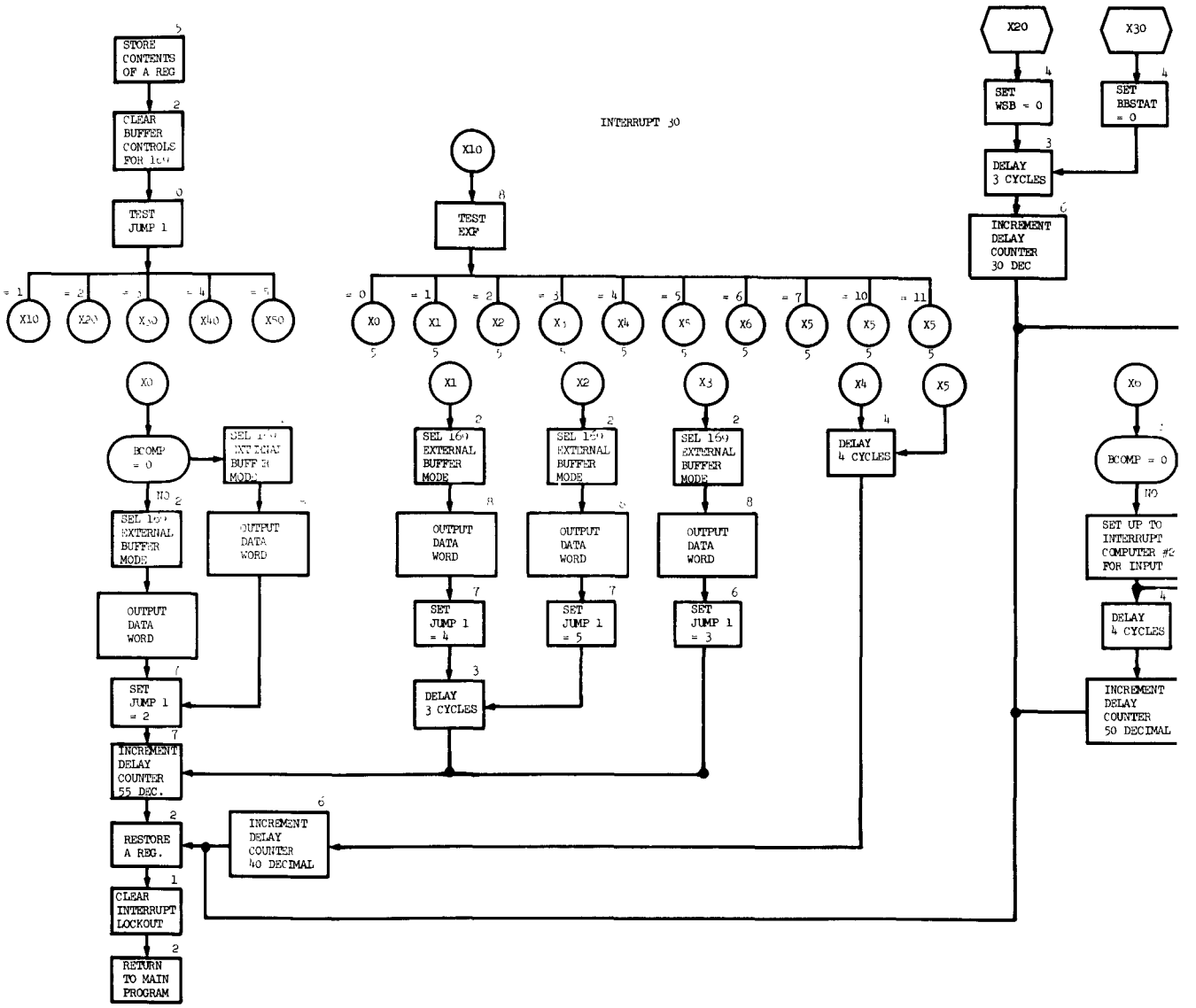

TRSTAT = WGT ← 1 WPT ← 1 TRAK ← 1
TCOMP = 0
NO
TSR = 2V3
TSKIP = 0
DELAY 7
NOTE: THIS EXPONENT INDICATES THE NUMBER OF CYCLES TIMES TO ACCOMPLISH THIS TASK.
DELAY
TSR = IV
DELAY 3
STATT T + 1
TSKIP ← 0 STATT ← T + 2 SR NOT RDY
TSKIP = 0
TSKIP ← 0 STATT ← T + 3 (SEND ONLY)
SFT = 2
DELAY 11
DELAY 7
TSRDY ← 0
STATT T
SFT = 1
DELAY 11
SFT ← 0 STATT ← STATT + 2
NOTE: CHANGE THIS NUMBER TO VARY THE BB CYCLE TIME.
TSRDY ← 1
SFT = 1
SFT ← 0 STATT ← STATT + 1
TSRDY ← 0
INCREMENT DELAY COUNTER 5
SET DELAY COUNTER = 240 D
INTERRUPT TS (EXF 10) CIL
DELAY 425
DELAY COUNTER ≠ 0
SET TRAK = 0
TRSTAT = 0
ERR SLS1
TSRDY = 0
DELAY 5
WPT = 0
ERR SLS 2
DELAY 9
TSKIP = TCOMP ← 1 LRTS ← 1
SET TIME = 0
DELAY 42
OR TIMB
TOB ← INB

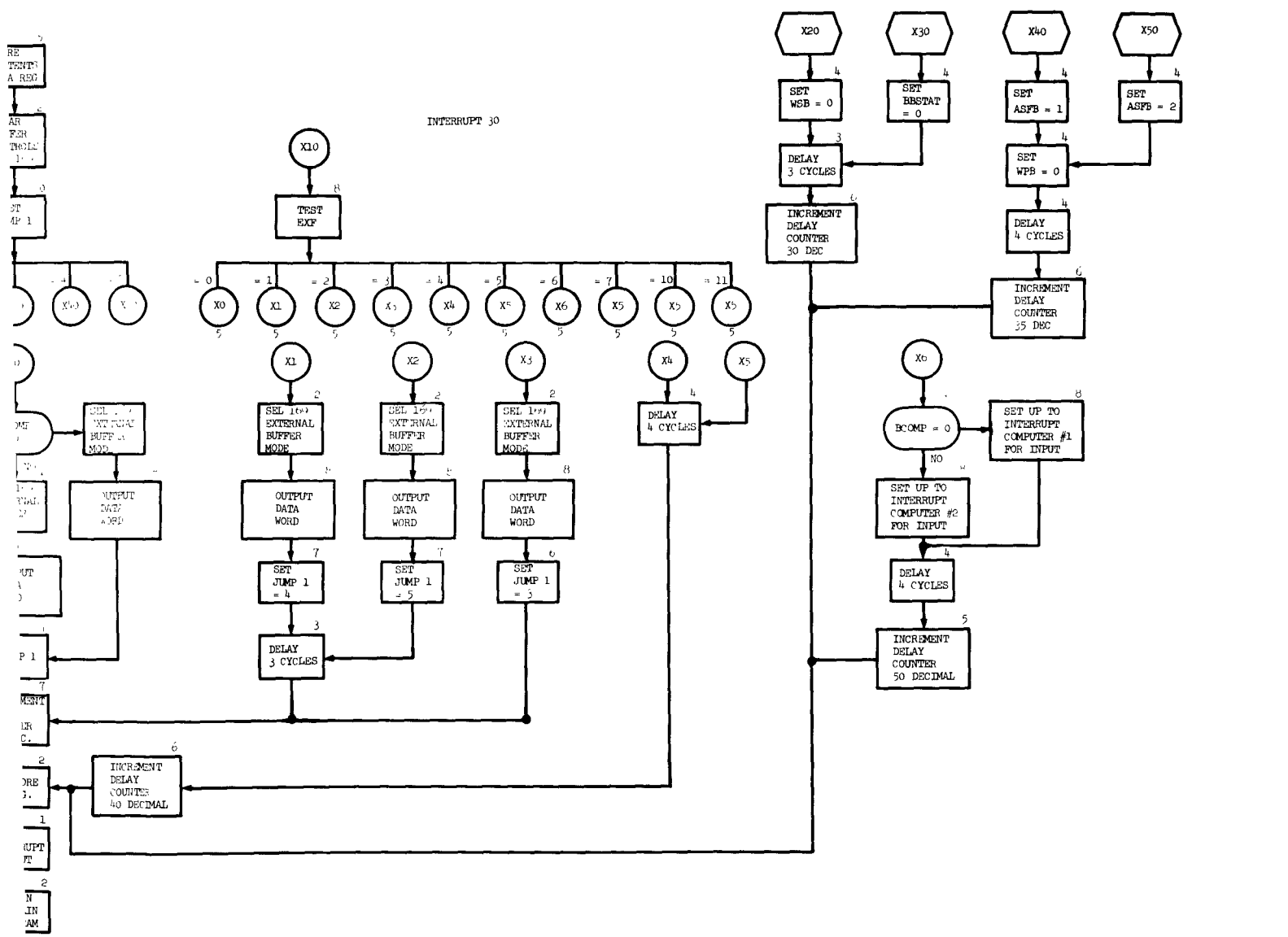

INTERRUPT 40
STORE (A) REG
CLEAR INTERRUPT 40 TO COMP. 2 & 3 FROM SAD
BIRD = 0
NO
HALT
SEL 169 EXT. BUFFER MODE
OUTPUT DATA WORD
SET JUMP 1 = 1
INCREMENT DELAY COUNTER 35 DECIMAL
DELAY 2 CYCLES
RESTORE (A) REG
CLEAR INTERRUPT
NOTE: THIS EXPONENT INDICATES THE NUMBER OF CYCLES TIMES TO ACCOMPLISH THIS TASK.
TCOMP ⇌ TCOMP
TIMB = 0
TIMB ↓ 0
DELAY 5
TIMB ↓ 1
LRBB = BCOMP → LRBB
BRSTAT ↓ 1
WSB = WFB ↓ 1
BIRD ↓ 1
BCOMP = 0
BBR = 2V3
BSKIP = 0
DELAY 7
STATB ↓ T + 1
SFB = 2
SFB ↓ 0
STATB ↓ STATB + 1
BBRDY ↓ 1
DELAY 13
BBRDY ↓ 0
DELAY 3
BSKIP ↓ 0
STATB ↓ T+2
SFB = 2
BBR = 1V3
BSKIP = 0
DELAY 7
STATB ↓ T
SFB = 1
SFT ↓ 0
STATB ↓ STATB + 1
BBRDY ↓ 1
DELAY 3
BSKIP ↓ 0
STATB ↓ T+2
SFB = 1
DELAY 463
DELAY 13
BBRDY ↓ 0
INT BB (EXP 20) CIL
LOOP 255 CYCLES
SET BIRD = 0 ADD 50 D TO DELAY COUNTER
DELAY COUNTER ≥ 0
INCREMENT DELAY COUNTER 5
ERR SIG1
BBRSTAT = 0
BBRDY = 0
NOTE: CHANGE THIS NUMBER TO VARY THE TS CYCLE TIME.
YES
NO

2


INTERRUPT 40
STORE (A) REG
CLEAR INTERRUPT 40 TO COMP. 2 & 3 FROM SAD
BIRD = 0
NO
HALT
SEL 169 EXT. BUFFER MODE
OUTPUT DATA WORD
SET JUMP 1 = 1
INCREMENT DELAY COUNTER 35 DECIMAL
DELAY 2 CYCLES
RESTORE (A) REG
CLEAR INTERRUPT LOCKOUT
RETURN TO MAIN PROGRAM


NOTE: THIS EXPONENT INDICATES THE NUMBER OF CYCLES TIMES TO ACCOMPLISH THIS TASK.
NOTE: CHANGE THIS NUMBER TO VARY THE TS CYCLE TIME.
BCOMP = 0
BBR = 2V3
BBR = 1V3
BSKIP = 0
DELAY 7
DELAY 3
SFB = 2
SFB = 1
DELAY 13
DELAY 9
DELAY 465
BBRDY
B COMP
BBSTAT = 0
BBRDY = 0
WSB = 0
WFB = 0
ERR SLS1
ERR SLS2
DELAY COUNTER ≥ 0
INCREMENT DELAY COUNTER 5
YES
NO


INTERRUPT 30
STORE CONTENTS OF A REG
CLEAR BUFFER CONTROLS FOR 1
TEST JUMP 1
X10
X20
X30
X40
X50
TEST EXF
X0
X1
X2
X3
X4
X5
X6
X7
X10
X11
BCOMP = 0
NO
SEL 160 EXTERNAL BUFFER MODE
OUTPUT DATA WORD
SET JUMP 1 = 2
INCREMENT DELAY COUNTER 55 DEC.
RESTORE A REG.
CLEAR INTERRUPT LOCKOUT
RETURN TO MAIN PROGRAM
INCREMENT DELAY COUNTER 40 DECIMAL
SET JUMP 1 = 4
SET JUMP 1 = 5
SET JUMP 1 = 3
DELAY 3 CYCLES
DELAY 4 CYCLES
SET WSB = 0
SET BBSTAT = 0
INCREMENT DELAY COUNTER 30 DEC
SET UP TO INTERRUPT COMPUTER #2 FOR INPUT
INCREMENT DELAY COUNTER 50 DECIMAL


INTERRUPT 30
X10
TEST EXF
= 0
= 1
= 2
= 3
= 4
= 5
= 6
= 7
= 10
= 11
X0
X1
X2
X3
X4
X5
X6
X5
X5
X20
X30
X40
X50
SET WSB = 0
SET BBSTAT = 0
SET ASFB = 1
SET ASFB = 2
DELAY 3 CYCLES
SET WPB = 0
INCREMENT DELAY COUNTER 30 DEC
DELAY 4 CYCLES
INCREMENT DELAY COUNTER 35 DEC
SEL 16? EXTERNAL BUFFER MODE
OUTPUT DATA WORD
SET JUMP 1 = 4
SET JUMP 1 = 5
SET JUMP 1 = 3
DELAY 3 CYCLES
DELAY 4 CYCLES
BCOMP = 0
NO
SET UP TO INTERRUPT COMPUTER #1 FOR INPUT
SET UP TO INTERRUPT COMPUTER #2 FOR INPUT
DELAY 4 CYCLES
INCREMENT DELAY COUNTER 50 DECIMAL
INCREMENT DELAY COUNTER 40 DECIMAL

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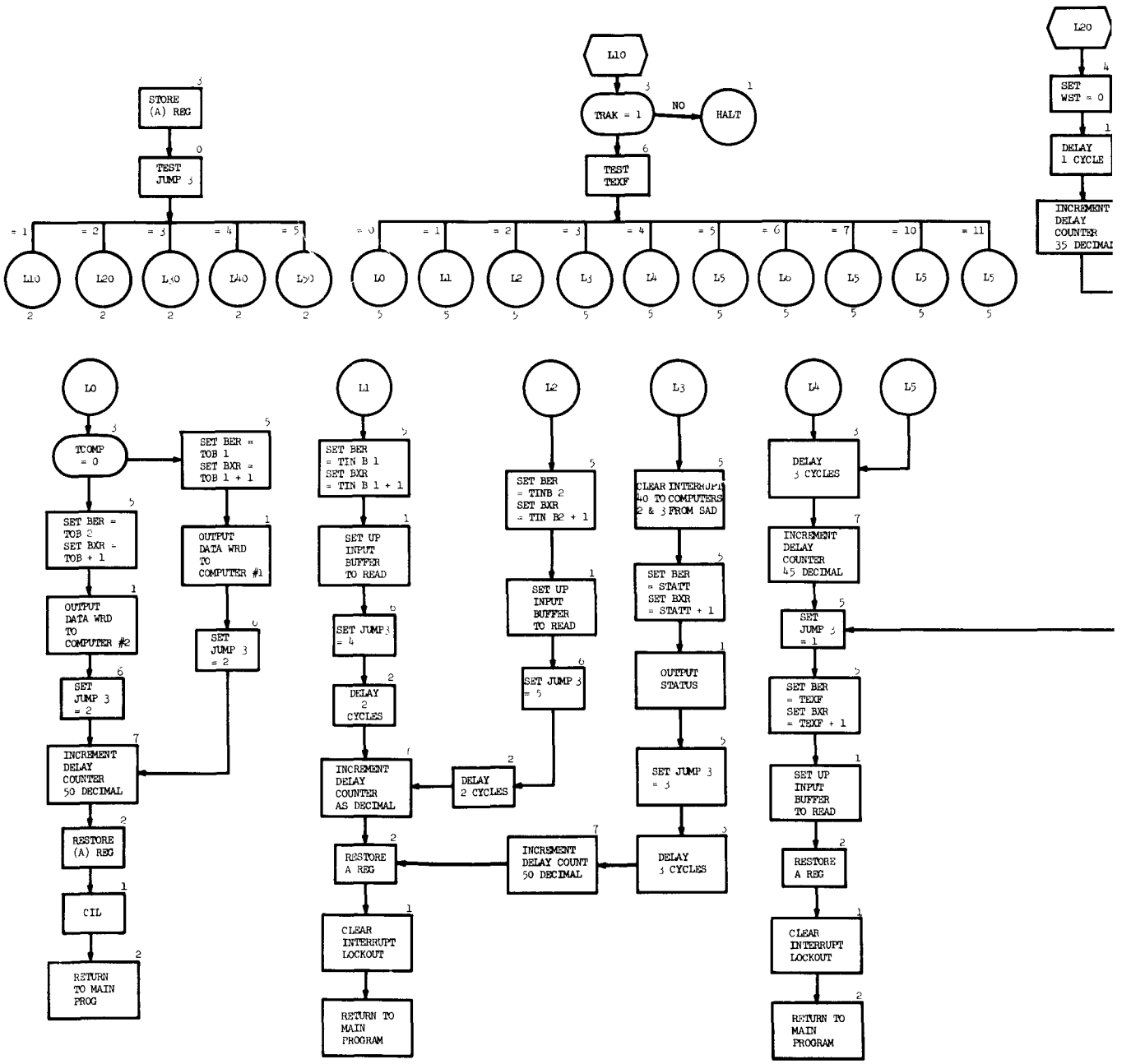

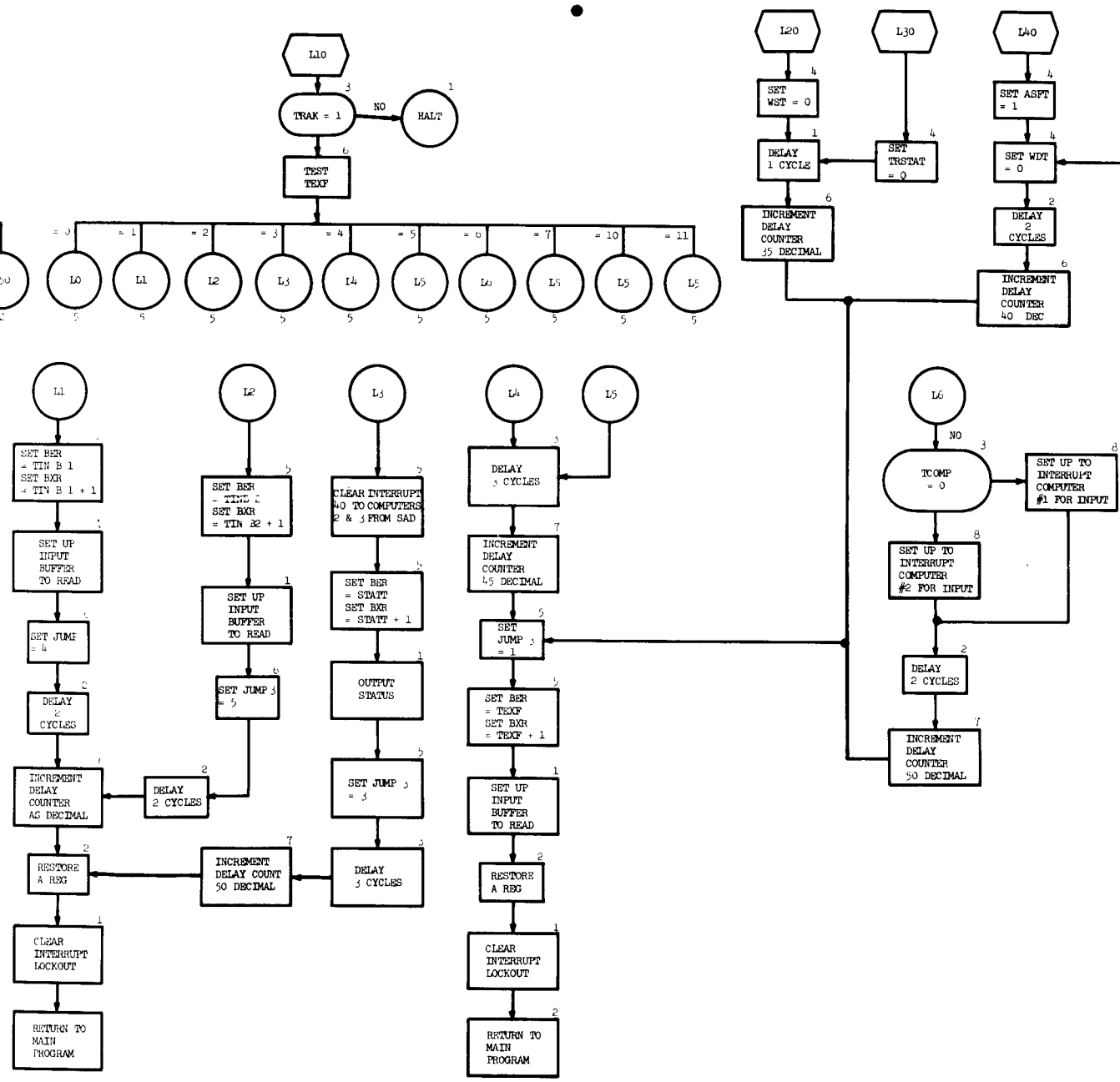
L10
TRAK = 1
NO
HALT
TEST TEXF
= 0
= 1
= 2
= 3
= 4
= 5
= 6
= 7
= 10
= 11
L0
L1
L2
L3
L4
L5
L6
L7
L5
L5
L20
L30
L40
L50
SET WST = 0
DELAY 1 CYCLE
SET TRSTAT = 0
SET ASFT = 1
SET ASFT = 2
SET WDT = 0
DELAY 2 CYCLES
INCREMENT DELAY COUNTER 35 DECIMAL
INCREMENT DELAY COUNTER 40 DEC
L1
SET BER = TIN B 1 SET BXR = TIN B 1 + 1
SET UP INPUT BUFFER TO READ
SET JUMP = 4
DELAY 2 CYCLES
INCREMENT DELAY COUNTER 45 DECIMAL
DELAY 2 CYCLES
RESTORE A REG
CLEAR INTERRUPT LOCKOUT
RETURN TO MAIN PROGRAM
L2
SET BER = TIN 2 SET BXR = TIN 32 + 1
SET UP INPUT BUFFER TO READ
SET JUMP 3 = 5
INCREMENT DELAY COUNT 50 DECIMAL
L3
CLEAR INTERRUPT 40 TO COMPUTERS 2 & 3 FROM SAD
SET BER = STATT SET BXR = STATT + 1
OUTPUT STATUS
SET JUMP 3 = 3
DELAY 3 CYCLES
L4
L5
DELAY 3 CYCLES
INCREMENT DELAY COUNTER 45 DECIMAL
SET JUMP 3 = 1
SET BER = TEXF SET BXR = TEXF + 1
SET UP INPUT BUFFER TO READ
RESTORE A REG
CLEAR INTERRUPT LOCKOUT
RETURN TO MAIN PROGRAM
L6
NO
TCOMP = 0
SET UP TO INTERRUPT COMPUTER #1 FOR INPUT
SET UP TO INTERRUPT COMPUTER #2 FOR INPUT
DELAY 2 CYCLES
INCREMENT DELAY COUNTER 50 DECIMAL

APPENDIX B

```
      0000          CON   0
0000  0060          SIDO
0001  7101          JFI   1                 SET I AND D BANKS TO ZERO
0002  0712                START
0003  0000    ASFT                          AUXIL SEND FLAG TS
0004  0000    ASFB                          AUXIL SEND FLAG BB
0005  0000    TIME
0006  0000    TCOMP                         TS COMPUTER
0007  0000    BCOMP                         BB COMPUTER
0010  0000    INT10
0011  7101          JFI   1
0012  1613                UPBUF
0013  0000    LRTS                          LAST REC TS
0014  0000    LRBB                          LAST REC BB
0015  0000    SFT                           SEND FLAG TS
0016  0000    SFB                           SEND FLAG BB
0017  0000    AREG                          A REGISTER
0020  0000    INT20               0
0021  4017          STD   AREG
0022  7101    JUMPJ JFI   1
0023  0412                L10
0024  0616                L20
0025  0624                L30
0026  0632                L40
0027  0643                L50
0030  0000    INTJU               0
0031  4017          STD   AREG
0032  7101          JFI   1
0033  0100                R30
      0040          CON   40
0040  0000    INT40               0
0041  4017          STD   AREG
0042  7101          JFI   1
0043  0110                R40
      0050          CON   50
0050  0000    TRSTAT                        STATUS ASKED TS
0051  0000    WST                           WORD PU
0052  0000    WPT                           WORD SENT
0053  0000    TSRDY                         RDY TO SEND FLAG
0054  0000    TSR                           TS REC FLAG
0055  0000    TSKIP                         TS SKIP REC FLAG
0056  0000    BBSTAT
0057  0000    WSB
0060  0000    WPB
0061  0000    BBR
0062  0000    BSKIP
0063  0000    BWRDY
0064  0000    STATW                         BB STATUS WORD
0065  0000    STATT                         TS
0066  0000    TIMB
0067  0000    JUNK
0070  0000    BIRD
0071  0000    TRAK
      0100          PRG   100
0100  7500    R30   EXC   4702
0101  4702
0102  7101    JUMP1 JFI   1
0103  0143                X10
0104  0350                X20
0105  0356                X30
```

```
0106  0364                    X40
0107  0375                    X50
0110  7500   X40      EXC     30
0111  0030
0112  2070            LDD     BIRD
0113  6104            NZF     4
0114  7700            HLT                       B6 NOT IN TIME
0115  7101            JFI     1
0116  0712                    START
0117  7500            EXC     4701
0120  4701
0121  7315            OUT     15
0122  0143                    R        +4
0123  2200            LDC     7101
0124  7101
0125  4100            STM     JUMP1
0126  0102
0127  2200            LDC     40D
0130  0050
0131  5067            RAD     JUNK
0132  2010            LDD     INT10
0133  2017            LDD     AREG
0134  0120            CIL
0135  7040            JPI     INT40
0136  0137                    R
0137  4012   R                4012
0140  0700                    EXF
0141  0701                    EXF      +1
0142  0000                    0
                      REM                       ANAL EXF 30 INT
0143  0022   X10      SIC2
0144  2100            LDM     EXF
0145  0700
0146  0020            SIC0
0147  0277            LPN     77
0150  3200            ADC     7101
0151  7101
0152  4201            STF     1
0153  0000                    0
0154  0166                    X0                5500
0155  0230                    X1                01
0156  0246                    X2                02
0157  0271                    X3                03
0160  0312                    X4                04
0161  0317                    X5                05
0162  0324                    X6                06
0163  0317                    X5                07
0164  0317                    X5                10
0165  0317                    X5                11
0166  2007   X0       LDD     WCOMP
0167  6013            ZJF     X0,1
0170  7500            EXC     4701              COMP 2
0171  4701
0172  7307            OUT     7
0173  0224                    X0,5     +4
0174  2200            LDC     7102
0175  7102
0176  4100            STM     JUMP1
0177  0102
0200  6314            NJF     X0,4
```

```
0201  0220                        X0,5
0202  7500  X0,1   EXC   4701          COMP 1
0203  4701
0204  7307        OUT   7
0205  0230                        X0,6    +4
0206  2200        LDC   7102
0207  7102
0210  4100        STM   JUMP1
0211  0102
0212  6302        NJF   X0,4
0213  0224                        X0,6
0214  2200  X0,4  LDC   55D           NO CYCLES=5500
0215  0067
0216  7101        JFI   1
0217  0344                        X8
0220  4002  X0,5        4002
0221  0704                        OB2
0222  0705                        OB2     +1
0223  0000                        0
0224  4002  X0,6        4002
0225  0703                        OB1
0226  0704                        OB1     +1
0227  0000                        0
0230  7500  X1    EXC   4701
0231  4701
0232  7307        OUT   7
0233  0246                        X1,5    +4
0234  2200        LDC   7104
0235  7104

0236  4100        STM   JUMP1
0237  0102
0240  6324        NJF   X2,6
0241  0242                        X1,5
0242  4012  X1,5        4012
0243  0701                        INB1
0244  0702                        INB1    +1
0245  0000                        0
0246  7500  X2    EXC   4701
0247  4701
0250  7307        OUT   7
0251  0264                        X2,5    +4
0252  2200        LDC   7105
0253  7105
0254  4100        STM   JUMP1
0255  0102
0256  6306        NJF   X2,6
0257  0260                        X2,5
0260  4012  X2,5        4012
0261  0702                        INB2
0262  0703                        INB2    +1
0263  0000                        0
0264  2200  X2,6  LDC   55D           NO CYCLES =2
0265  0067
0266  4020        STO   INT20
0267  7101        JFI   1
0270  0344                        X8
0271  7500  X3    EXC   4701
0272  4701
0273  7312        OUT   12
```

```
0274  0312                    X3,5   +4
0275  2200          LDC       7103
0276  7103
0277  4100          STM       JUMP1
0300  0102
0301  2200          LDC       55D          NO CYC. 03
0302  0067
0303  7101          JPI       1
0304  0344                    X8
0305  0306                    X3,5
0306  4002  X3.5               4002
0307  0064                    STATW
0310  0065                    STATW  +1
0311  0000                    0
0312  2200  X4      LDC       40D          NO CYC 04
0313  0050
0314  4100          STM       INT10
0315  0010
0316  6226          PJF       X8
0317  2200  X5      LDC       40D          DISREGARD 05
0320  0050
0321  4100          STM       INT10
0322  0010
0323  6221          PJF       X8
0324  2007  X6      LDD       RCOMP
0325  6006          ZJF       X6,0
0326  2061          LDD       BBR          COMP 2
0327  0201          LPN       1
0330  0602          ADN       2
0331  4061          STD       BBR
0332  6206          PJF       X6,1
0333  2061  X6.0     LDD       BBR          COMP 1
0334  0202          LPN       2
0335  0601          ADN       1
0336  4061          STD       BBR
0337  6201          PJF       X6,1
0340  2200  X6.1     LDC       50D          NO CYC 06
0341  0062
0342  4100          STM       INT10
0343  0010
0344  5067  X8      RAD       JUNK
0345  2017          LDD       AREG
0346  0120          CIL
0347  7030          JPI       INT30
0350  0400  X20     LDN       0
0351  4057          STD       WSB
0352  2200          LDC       30D          NO CYC AFTER 5500
0353  0036
0354  4010          STD       INT10
0355  6231          PJF       X55
0356  0400  X30     LDN       0
0357  4056          STD       WBSTAT
0360  2200          LDC       30D          NO CYC AFTER 5503
0361  0036
0362  4010          STD       INT10
0363  6223          PJF       X55
0364  0400  X40     LDN       0
0365  4060          STD       WPR
0366  0401          LDN       1
0367  4004          STD       ASFR
```

```
0370  2200          LDC   35D          NO CYC AFTER 5501
0371  0043
0372  4100          STM   INT10
0373  0010
0374  6212          PJF   X55
0375  0400  X50      LDN   0
0376  4060          STD   WPB
0377  0402          LDN   2
0400  4004          STD   ASFR
0401  2200          LDC   35D          NO CYCLES AFTER 5502
0402  0043
0403  4100          STM   INT10
0404  0010
0405  6201          PJF   X55
0406  5067  X55      HAC   JUNK
0407  2017          LDD   AREG
0410  0120          CIL
0411  7030          JPI   INT30
0412  2071  L10      LDD   TRAK
0413  6104          NZF   4
0414  7700          HLT
0415  7101          JFI   1
0416  0712          START
0417  2100          LDM   TEXF
0420  0705
0421  0277          LPA   77
0422  3200          ADC   7101
0423  7101
0424  4201          STF   1
0425  0000          0
0426  0440          L0                 5500
0427  0500          L1                 01
0430  0515          L2                 02
0431  0540          L3                 03
0432  0562          L4                 04
0433  0566          L5                 05
0434  0572          L6                 06
0435  0566          L5                 07
0436  0566          L5                 10
0437  0566          L5                 11
0440  2006  L0      LDD   TCOMP
0441  6016          ZJF   L0,1
0442  2200          LDC   TOB2         COMP2
0443  0711
0444  0105  L00,1    ATE   L00,1
0445  0444
0446  0601          ADN   1
0447  0106          ATX   L00,1  +3
0450  0447
0451  7300          IBO   L00,1  +5
0452  0451
0453  2200          LDC   7102
0454  7102
0455  4022          STD   JUMP3
0456  6316          NJF   L0,4
0457  2200  L0,1     LDC   TOB1
0460  0710
0461  0105  L00,2    ATE   L00,2
0462  0461
0463  0601          ADN   1
```

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0464  0106          ATX   L00,2  +3
0465  0464
0466  7300          IBO   L00,2  +5
0467  0466
0470  2200          LDC   7102
0471  7102
0472  4022          STD   JUMP3
0473  6301          NJF   L0,4
0474  2200  L0,4     LDC   50D
0475  0062
0476  7101          JFI   1
0477  0612                L8
0500  2200  L1      LDC   TIN81
0501  0706
0502  0105  L11,1    ATE   L11,1
0503  0502
0504  0601          ADN   1
0505  0106          ATX   L11,1  +3
0506  0505
0507  7200          IBI   L11,1  +5
0510  0507
0511  2200          LDC   7104
0512  7104
0513  4022          STD   JUMP3
0514  6316          NJF   L2,5
0515  2200  L2      LDC   TIN82
0516  0707
0517  0105  L22,1    ATE   L22,1
0520  0517
0521  0601          ADN   1
0522  0106          ATX   L22,1  +3
0523  0522
0524  7200          IBI   L22,1  +5
0525  0524
0526  2200          LDC   7105
0527  7105
0530  4022          STD   JUMP3
0531  6301          NJF   L2,6
0532  2200  L2,6     LDC   50D          NO CYC 01-2
0533  0062
0534  0277          LPN   77
0535  0277          LPN   77
0536  7101          JFI   1
0537  0612                L8
0540  7500  L3      EXC   30
0541  0030
0542  2200          LDC   STATT
0543  0065
0544  0105  L33,1    ATE   L33,1
0545  0544
0546  0601          ADN   1
0547  0106          ATX   L33,1  +3
0550  0547
0551  7300          IBO   L33,1  +5
0552  0551
0553  2200          LDC   7103
0554  7103
0555  4022          STD   JUMP3
0556  2200          LDC   50D          NO CYC 5503
0557  0062
```

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0560  7101          JFI   1
0561  0612                L8
0562  2200  L4      LDC   45D          NO CYCLES 5504
0563  0055
0564  7101          JFI   1
0565  0654                L55
0566  2200  L5      LDC   45D
0567  0055
0570  7101          JFI   1
0571  0654                L55
0572  2006  L6      LDD   TCOMP
0573  6006          ZJF   L6,0
0574  2054          LDD   TSR          COMP2
0575  0201          LPN   1
0576  0602          ADN   2
0577  4054          STD   TSR
0600  6206          PJF   L6,1
0601  2054  L6,0    LDD   TSR          COMP1
0602  0202          LPN   2
0603  0601          ADN   1
0604  4054          STD   TSR
0605  6201          PJF   L6,1
0606  2200  L6,1    LDC   50D
0607  0062
0610  7101          JFI   1
0611  0654                L55
0612  5067  L8      RAD   JUNK
0613  2017          LDD   AREG
0614  0120          CIL
0615  7020          JPI   INT20
0616  0400  L20     LDN   0
0617  4051          STD   MST
0620  2200          LDC   35D          NO CYCLE AFTER 5500
0621  0043
0622  0277          LPN   77
0623  6231          PJF   L55
0624  0400  L30     LDN   0
0625  4050          STD   TRSTAT
0626  2200          LDC   35D          NO CYCLE AFTER 5503
0627  0043
0630  0277          LPN   77
0631  6223          PJF   L55
0632  0400  L40     LDN   0
0633  4052          STD   MPT
0634  0401          LDN   1
0635  4003          STD   ASFT
0636  2200          LDC   40D          NO CYCLE AFTER 5501
0637  0050
0640  0277          LPN   77
0641  0277          LPN   77
0642  6212          PJF   L55
0643  0400  L50     LDN   0
0644  4052          STD   MPT
0645  0402          LDN   2
0646  4003          STD   ASFT
0647  2200          LDC   40D          NO CYCLE AFTER 5502
0650  0050
0651  0277          LPN   77
0652  0277          LPN   77
0653  6201          PJF   L55
```

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0654  5067  L55     RAD   JUNK
0655  2200          LDC   7101
0656  7101
0657  4022          STD   JUMPJ
0660  2200          LDC   TEXF
0661  0705
0662  0105  L55,5    ATE   L55,5
0663  0662
0664  0601          ADN   1
0665  0106          ATX   L55,5   +J
0666  0665
0667  7200          IBI   L55,5   +5
0670  0667
0671  2017          LDD   AREG
0672  0120          CIL
0673  7020          JPI   INT20
0674  0404  T               404           1 RDY TO REC
0675  1004                  1004          2
0676  0400                  400           U NOT RDY REC
0677  1000                  1000          2
0700  0000  EXF
0701  0000  INB1
0702  0000  INB2
0703  0000  OB1
0704  0000  OB2
0705  0000  TEXF
0706  0000  TINB1
0707  0000  TINB2
0710  0000  TOH1
0711  0000  TOH2
0712  0400  START   LDN   0             INITIALIZE
0713  4003          STD   ASFT
0714  4004          STD   ASFB
0715  4005          STD   TIME
0716  4006          STD   TIMR
0717  4055          STD   TSKIP
0720  4062          STD   BSKIP
0721  0140          SBUO
0722  0401          LDN   1
0723  4006          STD   TCOMP
0724  4007          STD   BCOMP
0725  4013          STD   LRTS
0726  4014          STD   LRBB
0727  0403          LDN   3
0730  4061          STD   BBR
0731  4054          STD   TBR
0732  7500          EXC   4702
0733  4702
0734  0120          CIL
0735  2200          LDC   7101
0736  7101
0737  4022          STD   JUMPJ
0740  0400          LDN   0             IDLE
0741  6601          PJB   1
                    HEM                 TB CYCLE
0742  2005  TB      LDD   TIME
0743  6003          ZJF   3
0744  7101          JFI   1
0745  1045                AD,8
0746  0401          LDN   1             1ST TIME
```

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0747  4005          STD   TIME
0750  2003          LDD   ASFT
0751  4016          STD   SFB
0752  0701          SBN   1
0753  6322          NJF   A0,2
0754  6111          NZF   A0,1
0755  2100          LDM   TIN91          COMP 1
0756  0706
0757  0022          SIC2
0760  4100          STM   OB1
0761  0703
0762  0020          SIC0
0763  7101          JFI   1
0764  1003                A0,3
0765  2100    A0,1  LDM   TIN82          COMP 2
0766  0707
0767  0022          SIC2
0770  4100          STM   OB2
0771  0704
0772  0020          SIC0
0773  7101          JFI   1
0774  1003                A0,3
0775  2100    A0,2  LDM   INT10          NEITHER 12 DELAY
0776  0010
0777  4100          STM   INT10
1000  0010
1001  4010          STD   INT10
1002  4010          STD   INT10
1003  2004    A0,3  LDD   ASFB
1004  4015          STD   SFT
1005  0701          SBN   1
1006  6322          NJF   A0,6
1007  6111          NZF   A0,5
1010  0022          SIC2
1011  2100          LDM   INB1           COMP 1
1012  0701
1013  0020          SIC0
1014  4100          STM   TOB1
1015  0710
1016  7101          JFI   1
1017  1037                A0,7
1020  0022    A0,5  SIC2                 COMP 2
1021  2100          LDM   INB2
1022  0702
1023  0020          SIC0
1024  4100          STM   TOB2
1025  0711
1026  7101          JFI   1
1027  1037                A0,7
1030  2100    A0,6  LDM   INT10          NEITHER 12 DELAY
1031  0010
1032  4100          STM   INT10
1033  0010
1034  2010          LDD   INT10
1035  4004          STD   ASFB
1036  4003          STD   ASFT
1037  0400    A0,7  LDN   0
1040  4010          STD   INT10
1041  2013          LDD   LRTS           COMP=OPPOS LRTS
1042  0301          SCN   1
```

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1043  4006          STD   TCOMP
1044  6215          PJF   A1
1045  0400  A0,8    LDN   0              DELAY 42 TOTAL
1046  4005          STD   TIME
1047  0503          LCN   3
1050  4067          STD   JUNK
1051  2100  A0,9    LDM   INT10
1052  0010
1053  4100          STM   INT10
1054  0010
1055  0501          LCN   1
1056  5467          AOD   JUNK
1057  6706          NJB   A0,9
1060  2010          LDD   INT10
1061  0401  A1      LDN   1
1062  4050          STD   THSTAT
1063  4051          STD   WST
1064  4052          STD   WPT
1065  4071          STD   TRAK
1066  2006  A10     LDD   TCOMP
1067  6154          NZF   A25            IF COMP 2
1070  2054          LDD   TSR            COMP 1
1071  0201          LPN   1
1072  6034          ZJF   A11
1073  2055          LDD   TSKIP
1074  6134          NZF   A11    +2
1075  2100          LDM   INT10          DELAY 7
1076  0010
1077  4100          STM   INT10
1100  0010

1101  2100          LDM   T
1102  0674
1103  4065          STD   STATT
1104  2015          LDD   SFT
1105  0201          LPN   1
1106  6011          ZJF   A20
1107  0400  A19     LDN   0
1110  4015          STD   SFT
1111  2065          LDD   STATT
1112  0601          ADN   1
1113  4065          STD   STATT
1114  0401          LDN   1
1115  4053  A19,9    STD   TSRDY
1116  6253          PJF   A39,9  +1
1117  0400  A20     LDN   0              DELAY 11
1120  4100          STM   INT10
1121  0010
1122  4100          STM   INT10
1123  0010
1124  0400          LDN   0
1125  6610          PJB   A19,9
1126  2100  A11     LDM   INT10
1127  0010
1130  0400          LDN   0
1131  4055          STD   TSKIP
1132  2100          LDM   T      +2
1133  0676
1134  4100          STM   STATT
1135  0065
```

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1136  2015          LDD   SFT
1137  0201          LPN   1
1140  6531          NZB   A19
1141  7101          JFI   1
1142  1313                A99
1143  2054    A25   LDD   TSR
1144  0202          LPN   2
1145  6034          ZJF   A31
1146  2055          LDD   TSKIP
1147  6134          NZF   A31     +2
1150  2100          LDM   INT10             DELAY 7
1151  0010
1152  4100          STM   INT10
1153  0010
1154  2100          LDM   T       +1
1155  0675
1156  4065          STD   STATT
1157  2015          LDD   SFT
1160  0202          LPN   2
1161  6011          ZJF   A40
1162  0400    A39   LDN   0
1163  4015          STD   SFT
1164  2065          LDD   STATT
1165  0601          ADN   1
1166  4065          STD   STATT
1167  0401          LDN   1
1170  4053    A39,9 STD   TSRDY
1171  6225          PJF   A50
1172  0400    A40   LDN   0               DELAY 11
1173  4100          STM   INT10
1174  0010
1175  4100          STM   INT10
1176  0010
1177  0400          LDN   0
1200  6610          PJB   A39,9
1201  2100    A31   LDM   INT10
1202  0010
1203  0400          LDN   0
1204  4055          STD   TSKIP
1205  2100          LDM   T       +5
1206  0677
1207  4100          STM   STATT
1210  0065
1211  2015          LDD   SFT
1212  0202          LPN   2
1213  6531          NZB   A39
1214  7101          JFI   1
1215  1313                A99
1216  7500    A50   EXC   10              INTERRUPT TS
1217  0010
1220  0120          CIL
1221  2600          LCC   2900
1222  0442
1223  4067          STD   JUNK
1224  0405          LDN   5
1225  5067          RAD   JUNK
1226  6702          NJB   2
1227  0400          LDN   0
1230  4071          STD   TRAK
1231  0562          LCN   90D
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1232  5067          MAD   JUNK
1233  6204          MJP   4
1234  0405          LDN   5
1235  5067          MAD   JUNK
1236  6702          NJM   2
1237  2050          LDD   TRSTAT
1240  6130          NZF   A90
1241  2053          LDD   TSRDY
1242  6016          ZJF   A85
1243  2051          LDD   WST             WAS ABLE SEND
1244  6127          NZF   A91
1245  2052    A80   LDD   WPT
1246  6114          NZF   A87
1247  0401          LDN   1               WORD REC
1250  4055          STD   TSKIP
1251  2006          LDD   TCOMP
1252  4013          STD   LRTS

1253  2006    A80   LDD   TCOMP
1254  0301          SCN   1
1255  4006          STD   TCOMP
1256  7101          JFI   1
1257  1323                88
1260  2051    A85   LDD   WST             DELAY 3
1261  6614          PJM   A80
1262  2100    A87   LDM   INT10           DELAY 9
1263  0010
1264  4100          STM   INT10
1265  0010
1266  7101          JFI   1
1267  1253                A80
1270  7701    A90   SLS1
1271  7101          JFI   1
1272  1274                A91     +1
1273  7702    A91   SLS2
1274  7500          EXC   30
1275  0030
1276  0120          CIL
1277  0104          CBC
1300  2200          LDC   TEXF
1301  0705
1302  0105    A91,1 ATE   A91,1
1303  1302
1304  0601          ADN   1
1305  0106    A91,2 ATX   A91,2
1306  1305
1307  7200    A91,3 IBI   A91,3
1310  1307
1311  7101          JFI   1
1312  1253                A80
1313  2600    A99   LCC   4250
1314  0651
1315  4067          STD   JUNK
1316  0405          LDN   5
1317  5067          MAD   JUNK
1320  6702          NJM   2
1321  7101          JFI   1
1322  1253                A80
                    REM                   BIRD CYCLE
1323  2066    88    LDD   TIME
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1324  6106          NZF   BB1
1325  0401          LDN   1
1326  4100          STM   TIMR
1327  0064
1330  7101          JFI   1
1331  1340                BHB
1332  0400    BB1   LDN
1333  4066          STD   TIMR
1334  0400          LDN                     DELAY
1335  4100          STM   INT10
1336  0010
1337  6204          PJF   BBB     +3
1340  2014    BBR   LDD   LRRA
1341  0301          SCN   1
1342  4007          STD   BCOMP
1343  0401          LDN   1
1344  4056          STD   BBSTAT
1345  4057          STD   WSB
1346  4060          STD   WPB
1347  4070          STD   BIRD
1350  2007          LDD   BCOMP
1351  6163          NZF   B25               IF COMP 2
1352  2061          LDD   BBR
1353  0201          LPN   1
1354  6042          ZJF   B11
1355  2062          LDD   BSKIP
1356  6142          NZF   B11     +2
1357  2100          LDM   INT10             DELAY 7
1360  0010
1361  4100          STM   INT10
1362  0010
1363  2100          LDM   T
1364  0674
1365  0042          SDC2
1366  4064          STD   STATB
1367  0040          SDC0
1370  2016          LDD   SFB
1371  0201          LPN   1
1372  6014          ZJF   B20
1373  0400    B19   LDN   0
1374  4016          STD   SFB
1375  0042          SDC2
1376  2064          LDD   STATB
1377  0601          ADN   1
1400  4064          STD   STATB
1401  0040          SDC0
1402  0401          LDN   1
1403  4063    B19,9 STD   BBRDY
1404  7101          JFI   1
1405  1515                B50
1406  0400    B20   LDN   0                 DELAY 13
1407  4100          STM   INT10
1410  0010
1411  4100          STM   INT10
1412  0010
1413  4010          STD   INT10
1414  0400          LDN   0
1415  6612          PJB   B19,9
1416  2100    B11   LDM   INT10
1417  0010
```

```
1420  0400          LDN   0
1421  4062          STD   @SKIP
1422  2100          LDM   T       +2
1423  0676
1424  0042          SDC2
1425  4064          STD   STAT@
1426  0040          SDC0
1427  2016          LDD   SF@
1430  0201          LPN   1
1431  6536          NZ@   @19
1432  7101          JFI   1
1433  1602                @99
1434  2061  @25     LDD   @@R
1435  0202          LPN   2
1436  6040          ZJF   @31
1437  2062          LDD   @SKIP
1440  6140          NZF   @31     +2
1441  2100          LDM   INT10           DELAY 7
1442  0010
1443  4100          STM   INT10
1444  0010
1445  2100          LDM   T       +1
1446  0675
1447  0042          SDC2
1450  4064          STD   STAT@
1451  0040          SDC0
1452  2016          LDD   SF@
1453  0202          LPN   2
1454  6013          ZJF   @40
1455  0400  @39     LDN   0
1456  4016          STD   SF@
1457  0042          SDC2
1460  2064          LDD   STAT@
1461  0601          ADN   1
1462  4064          STD   STAT@
1463  0040          SDC0
1464  0401          LDN   1
1465  4063  @39,9   STD   @@RDY
1466  6227          PJF   @50
1467  0400  @40     LDN   0               DELAY 13
1470  4100          STM   INT10
1471  0010
1472  4100          STM   INT10
1473  0010
1474  4010          STD   INT10
1475  6610          PJ@   @39,9
1476  2100  @31     LDM   INT10
1477  0010
1500  0400          LDN   0
1501  4062          STD   @SKIP
1502  2100          LDM   T       +3
1503  0677
1504  0022          SIC2
1505  4100          STM   STAT@
1506  0064
1507  0020          SIC0
1510  2016          LDD   SF@
1511  0202          LPN   2
1512  6535          NZ@   @30
1513  7101          JFI   1
```

```
1514  1602                     B99
1515  7500   B50      EXC      20                   INTERRUPT 4B
1516  0020
1517  0120            CIL
1520  2600            LCC      315D
1521  0473
1522  4067            STD      JUNK
1523  0405            LDN      5
1524  5067            MAD      JUNK
1525  6702            NJB      2
1526  0400            LDN      0
1527  4070            STD      BIRD
1530  0562            LCN      50D
1531  5067            MAD      JUNK
1532  6204            PJF      4
1533  0405            LDN      5
1534  5067            MAD      JUNK
1535  6702            NJB      2
1536  2056            LDD      BBSTAT
1537  6130            NZF      B90
1540  2063            LDD      BBRDY
1541  6016            ZJF      B85
1542  2057            LDD      WSB                  WAS ABLE SEND
1543  6127            NZF      B91
1544  2060   B60      LDD      WPB
1545  6114            NZF      B87
1546  0401            LDN      1                    WORD REC
1547  4062            STD      BSKIP
1550  2007            LDD      BCOMP
1551  4014            STD      LRBB
1552  2007   B80      LDD      BCOMP
1553  0301            SCN      1
1554  4007            STD      BCOMP
1555  7101            JFI      1
1556  0742                     TS
1557  2057   B85      LDD      WSB                  DELAY 3
1560  6614            PJB      B60
1561  2100   B87      LDM      INT10                DELAY 9
1562  0010
1563  4100            STM      INT10
1564  0010
1565  7101            JFI      1
1566  1552                     B80
1567  7701   B90      SLS1
1570  7101            JFI      1
1571  1573                     B91     +1
1572  7702   B91      SLS2
1573  7500            EXC      30
1574  0030
1575  7500            EXC      4702
1576  4702
1577  0120            CIL
1600  7101            JFI      1
1601  1552                     B80
1602  2600   B99      LCC      463D
1603  0717
1604  4067            STD      JUNK
1605  0405            LDN      5
1606  5067            MAD      JUNK
1607  6702            NJB      2
```

```
1610  0400          LDA   0
1611  7101          JFI   1
1612  1552                880
1613  2200  UPBUF   LDC   TExP        INT BUF UP
1614  0705
1615  0105  A00,1   ATE   A00,1
1616  1615
1617  0601          ADA   1
1620  0106  A00,2   ATX   A00,2
1621  1620
1622  7200  A00,3   IBI   A00,3
1623  1622
1624  7101          JFI   1
1625  0742                TS
      0000          END
```

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System Development Corporation,
Santa Monica, California
MILESTONE 11 160A COMPUTER PROGRAM
DESCRIPTION.
Scientific rept., TM-1003/010/00,
by V. J. Gergen. 26 March 1963, 30p.
(Contract AF 19(628)-1648, Space Systems
Division Program, for Space Systems
Division, AFSC)

Unclassified report

DESCRIPTORS: Programming (Computers).
Satellite Networks.

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Reports that the CCC Simulator provides a simulated intercommunication link between the Bird Buffer (BB) computer and the Tracking Station (TS) computer that is normally performed by the Computer Communication Converter (CCC) and associated equipment.

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