HEWLETT hp PACKARD

OPERATING AND SERVICE MANUAL

12554A

16-BIT DUPLEX REGISTER

(POSITIVE-IN/POSITIVE-OUT LOGIC)

COMPUTER INTERFACE KIT

Note

This manual should be retained with Volume Three of the HP Computer System Documentation.

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SECTION I

GENERAL INFORMATION

x1-1. INTRODUCTION.

1-2. The Hewlett-Packard 12554A 16-Bit Duplex Register Interface Kit provides a general-purpose interface between the computer and most digital input/output devices. The interface card in this kit uses positive-true input-output logic and permits input, output, or combined input/output operations between the computer and an external device. Sections II through V of this manual provide installation and programming, theory of operation, maintenance, and replaceable parts and ordering information.

1-3. INTERFACE KIT CONTENTS.

1-4. The HP 12554A Interface Kit consists of the following:

a. 16-bit duplex register card, positive-in/positive-out logic (part no. 12554-60023).

b. Test connector, 24 pin (part no. 1251-0332).

c. Connector Kit, 48-pin (part no. 02116-6128).

d. HP 12554A interface kit manual (part no. 12554-90021).

e. Diagnostic test tape (part no. 20416C).

Note

Diagnostic test tape revisions are indicated by a change in the part number suffix letter. Required changes to the diagnostic operating procedures are included with the Diagnostic Program Procedures Manual attached to this manual.

1-5. SPECIFICATIONS.

1-6. Table 1-1 lists the characteristics and specifications of the 16-bit duplex register card.

1-7. IDENTIFICATION.

1-8. Printed circuit card revisions are identified by a letter and a date code stamped on the card. The letter code identifies the version of the etched trace pattern on the card before components are installed on the card. The date code refers to the electrical characteristics of the card after the installation of all components. If the date code stamped on the 16-bit duplex register printed circuit

card does not agree with the date code shown on the logic diagram in section V of this manual, there are differences between your card and the card described in this manual. These differences are described in change sheets and manual supplements available at the nearest HP Sales and Service Office. (Refer to the back of this manual for a listing of Hewlett-Packard Sales and Service Offices and their addresses.)

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Table 1-1. 16-Bit Duplex Register Card Specifications

CHARACTERISTICS	SPECIFICATIONS
Output Levels	
"1" state	0 to +0.5V, 12 mA max.
"0" state	+12V, 10K source
Input Levels	
"1" state	0 to +0.5V, 12 mA max.
"0" state	+8V
Current Requirements	
+12V	230 mA
-12V	25 mA
-2V	60 mA
+5V	1.11A
Device Command Signal Output	Command signal to external device indicating that data is ready in output register. Signal is terminated by a device flag input.
Device Flag Signal Input	External device command to interface card. Signal strobes data into input storage register, resets device command flip-flop, and sets flag buffer flip-flop on interface card.
Card Dimension	
Width	7-3/4 inches (196,8 mm)
Height	8-11/16 inches (220,7 mm)

SECTION II

INSTALLATION AND PROGRAMMING

2-1. GENERAL.

2-2. This section provides procedures and information for unpacking and inspection, installation, and programming of the 16-bit duplex register card.

2-3. UNPACKING AND INSPECTION.

2-4. If the shipping carton is damaged upon receipt, request that the carrier's agent be present when the card is unpacked. Inspect the card for damage (cracks, broken parts, etc.). If the card is damaged or fails to meet specifications, notify the carrier and the nearest HP Sales and Service Office immediately. (Sales and Service Offices are listed at the back of this manual.) Retain the shipping container and the packing material for the carrier's inspection. The HP Sales and Service Office will arrange for the repair or replacement of the damaged card without waiting for any claims against the carrier to be settled.

2-5. INSTALLATION.

2-6. Install the 16-bit duplex register card as follows:

a. Insert the card into the assigned computer I/O card slot.

b. Attach the 24-pin test connector to the card and perform the diagnostic test for the card as outlined in the Diagnostic Program Procedures Manual Supplement attached to this manual.

Note

Prior to performing the diagnostic test, ensure that relocatable jumpers W4, W5, W6, and W7 are properly positioned. Table 2-1 lists the valid jumper combinations for the diagnostic test.

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Table 2-1. Valid Jumper Combinations for the Diagnostic Test

COMBINATION 1		COMBINATION 2		COMBINATION 3		COMBINATION 4		COMBINATION 5		COMBINATION 6	
W4	B	W4	B	W4	A/B	W4	A	W4	A	W4	A/B
W5	B	W5	A	W5	A/B	W5	A	W5	B	W5	A/B
W6	A/B	W6	A	W6	C	W6	A/B	W6	A	W6	C
W7	A	W7	A	W7	A	W7	B	W7	B	W7	B
NOTE: This card is shipped with jumpers W4,W5, and W6 in position B and W7 in position A.											

2-7. Since the 16-bit duplex register card is designed for use as an interface card for various devices, an interconnecting cable must be prepared by the computer user for the particular external device being used. Table 2-2 lists the contents of the 48-pin connector kit which is provided for this purpose. The interconnecting cable itself is not provided by this kit and must be supplied by the computer user. Figure 2-1 illustrates the proper assembly of the 48-pin connector when fabricating the interconnecting cable. Table 2-3 contains interconnecting cable leadwire information. After the cable has been completed, connect the computer and external device as follows:

a. Turn off computer and external device power.

b. Pass the end of the interconnecting cable, which contains the hooded 48-pin connector, through the I/O cable opening in the back of the computer. Remove the 24-pin test connector from the 16-bit duplex register card and attach the hooded connector in its place.

c. Attach the opposite end of the interconnecting cable to the external device.

d. Close all computer and external device access openings. This completes the installation of the HP 12554A Computer Interface Kit.

2-8. PROGRAMMING.

2-9. The programs listed in tables 2-4 through 2-6 are examples of input, output, and combined input/output instructions using HP assembly language. The 16-bit duplex register card is assumed to be assigned the assembly language select code of DPR (duplex register).

2-10. INPUT PROGRAM.

2-11. The input function (table 2-4) commands the external device to acquire and transfer 16 bits of information to the computer. The results are left in the A-register.

2-12. OUTPUT PROGRAM.

2-13. The output function (table 2-5) sends out 16 bits of information from the A-register to the external device and commands the device to accept the data.

Table 2-2. 48-Pin Connector Kit Parts List

ITEM	QUANTITY	DESCRIPTION	PART NO.
1	1	Hood	02116-4001
2	2	Tapping Screw	0642-0096
3	1	Connector, 48-pin	1251-0335
4	1	Set Screw	3030-0143
5	1	Cable Clamp	02116-4003

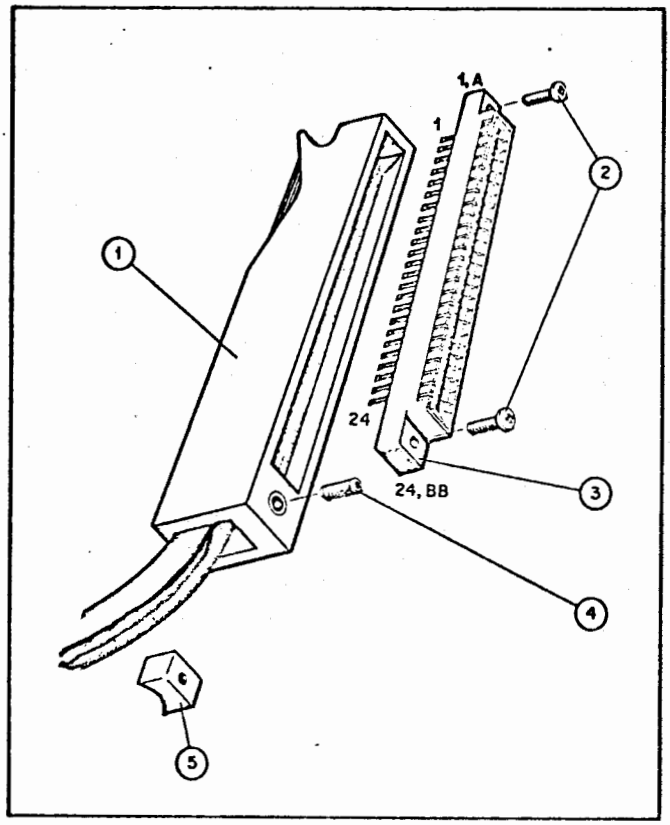

Figure 2-1. 48-Pin Connector Kit Assembly Diagram

2-14. COMBINED INPUT/OUTPUT PROGRAM.

2-15. The combined input/output function (table 2-6) sends out 16-bits of information to the external device, commands the external device to perform an operation, then reads into the computer 16 bits of information from the external device. The output command data is retained in the A-register, and the input data is read into the B-register.

Table 2-3. 16-Bit Duplex Register Card Pin Connections

FROM I/O DEVICE		TO I/O DEVICE	
PIN	SIGNAL	PIN	SIGNAL
1	Bit 0	A	Bit 0
2	Bit 1	B	Bit 1
3	Bit 2	C	Bit 2
4	Bit 3	D	Bit 3
5	Bit 4	E	Bit 4
6	Bit 5	F	Bit 5
7	Bit 6	H	Bit 6
8	Bit 7	J	Bit 7
9	Bit 8	K	Bit 8
10	Bit 9	L	Bit 9
11	Bit 10	M	Bit 10
12	Bit 11	N	Bit 11
13	Bit 12	P	Bit 12
14	Bit 13	R	Bit 13
15	Bit 14	S	Bit 14
16	Bit 15	T	Bit 15
23	Device Flag	AA	Device Command
24	Ground	BB	Ground

Table 2-4. Input Program

```
MAIN PROGRAM

Label    Operation   Operand
           .
           .
         JSB         INPUT     Jump to input subroutine.
         STA         CODE      Store A-register contents in memory location CODE.
           .
           .
           .
SUBROUTINE

INPUT    NOP                   Entry point.
         STC         DPR,C     Command external device to perform its function.
         SFS         DPR       Is operation complete?
         JMP         *-1       No, jump back to SFS instruction.
         LIA         DPR       Yes, transfer input data to A-register.
         JMP         INPUT,I   Jump to main program.
```

Table 2-5. Output Program

```
MAIN PROGRAM
Label     Operation   Operand
                :
          LDA         N         Load A-register with
                                contents of memory
                                location N.
          JSB         OUTPUT    Jump to output sub-
                                routine.
                :
                :
SUBROUTINE
OUTPT     NOP                   Entry point.
          SFS         DPR       Can external device
                                accept data?
          JMP         *-1       No, jump back to SFS
                                instruction.
          OTA         DPR       Yes, transfer output
                                data to duplex register.
          STC         DPR,C     Command external de-
                                vice to accept the data.
          JMP         OUTPT,I   Jump to main pro-
                                gram.
```

Table 2-6. Combined Input/Output Program

```
MAIN PROGRAM
Label     Operation   Operand
                :
          LDA         N         Load A-register with
                                contents of memory
                                location N.
          JSB         IOSB      Jump to input/output
                                subroutine.
          STB         CODE      Store B-register con-
                                tents in memory loca-
                                tion CODE.
                :
                :
SUBROUTINE
IOSB      NOP                   Entry point.
          OTA         DPR       Transfer data to
                                duplex register.
          STC         DPR,C     Command external de-
                                vice to accept or act on
                                the data.
          SFS         DPR       Has external device
                                sent data?
          JMP         *-1       No, jump back to SFS
                                instruction.
          LIB         DPR       Yes, transfer input
                                data to B-register.
          JMP         IOSB,I    Jump to main pro-
                                gram.
```

2-16. RELOCATABLE JUMPERS.

2-17. Several different applications of the 16-bit duplex register card may be obtained by changing the position of certain wire jumpers located on the card. These jumpers are labeled W1 through W12.

2-18. Jumpers W1, W2, W3, and W8 are not relocatable. Jumpers W4, W5, W6, and W7 may be relocated by the computer user to fit various needs. Table 2-7 illustrates the possible applications obtainable by selectively positioning these jumpers. (Refer to figure 4-1 for relocatable jumper locations on the 16-bit duplex register card and to figure 4-3 for circuit applications of each jumper.)

2-19. Jumpers W9, W10, W11, and W12 are not relocatable but may be removed if desired. As each jumper is removed, the clocking input to a group of four flip-flops in the input storage register is removed (see figure 4-3). This allows each of the four respective flip-flops to be used to input status information rather than data. (These jumpers are further explained in paragraph 3-28.)

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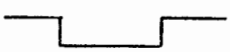
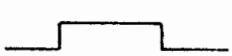
Table 2-7. Relocatable Jumper Positions

SIGNAL AND FUNCTION	JUMPER	POSITION
Device Flag 		
Set flag buffer FF and reset command FF both on leading edge.	W4 W5 W6	B B A or B
Set flag buffer FF and reset command FF on trailing edge.	W4 W5 W6	A A A or B
Set flag buffer FF on leading edge, reset command FF on trailing edge.	W4 W5 W6	A B A
Set flag buffer FF trailing edge, reset command FF on leading edge.	W4 W5 W6	B A A
Self Reset in 10 μsec		
(W4 and W5 do not affect this function.)	W6	C
Device Command Signal		
 +V oV	W7	B
 +V oV	W7	A

SECTION III

THEORY OF OPERATION

3-1. GENERAL.

3-2. Refer to figure 4-3 for a logic diagram of the 16-bit duplex register card. Logic diagram reference designations preceded by MC (microcircuit package) are identified by part number and description in section IV of this manual. Section IV also provides logic diagrams for each type of microcircuit package used.

3-3. COMPUTER POWER ON.

3-4. When power is initially applied by the POWER switch on the computer, the POPIO and CRS signals are applied simultaneously to the 16-bit duplex register card from the computer. These signals establish the following initial conditions for operation of the duplex register card. The POPIO signal sets the flag buffer FF and is also applied through gate MC97A (where it is inverted) to the clock input of all flip-flops in the output storage register. This strobes a logic 0 into all of the register flip-flops in preparation for the output of data to an external device. The CRS signal resets both the control FF and the command FF for initialization of the flag and control logic.

3-5. OUTPUT OPERATION.

3-6. To output data to an external device, the computer program must issue an output (OTA/B) instruction. This applied the IOO signal and the LSCL, LSCM, and IOG signals to the duplex register card. The IOO signal strobes the clock input of all flip-flops in the output storage register, cuasing them to latch-in output data from the computer. Once latched, the flip-flops apply the data to the external device via the bit 0 through bit 15 output lines. Before the external device will accept this data, it must receive a device command signal from the duplex register card.

3-7. OUTPUT STORAGE REGISTER.

3-8. The output storage register of the duplex register card is composed of 16 latch-type flip-flops and associated circuitry. It receives input signals of +2.5 volts (logic 1) and -0.5 volts (logic 0) from the computer and applied them to an external device as a ground-true or a positive-false signal, respectively. Since each of the 16 bit FFs and their associated circuitry operate identically, only the operation of the bit 0 FF is explained in the following.

3-9. When an output instruction is executed by the computer program, the IOO signal is applied to the clock input of the bit 0 FF as a true signal. This causes the flip-flop to latch-in the data which is present on the IOBO 0 line. The flip-flop then applies the data signal to transistor Q1 as a positive or negative signal. If the flip-flop has latched-in a logic 1 signal, Q1 will begin conducting at saturation. In this state, Q1 applies a ground-true signal to the external device.

3-10. If the flip-flop has latched-in a logic 0 signal, Q1 will turn off, and applies a positive-false signal to the external device.

3-11. DEVICE COMMAND SIGNAL.

3-12. (Refer to figure 3-1 for device command signal timing.) To initiate the device command signal, a programmed STC, CLF instruction must be issued by the computer. The STC signal is applied to the duplex register card through gate MC46C (which is enabled by the LSCL, LSCM, and IOG signals) and sets the control FF and the device command FF. The true set-side output of the device command FF is then applied to the base of transistor Q17 as a true (jumper W7A in position) or false signal (jumper W7B in position). A true signal at the base of Q17 causes a negative-going device command signal to be applied to the external device; a false signal applied to the base of Q17 causes a positive-going device command signal to be applied to the external device (see table 2-7). The device command signal tells the external device that data is available from the computer.

3-13. INPUT OPERATION.

3-14. When the external device is ready to transmit data to the computer, it applies a device flag signal to the duplex register card, requesting a normal phase 4 interrupt or a direct memory access (DMA) transfer of data.

3-15. DEVICE FLAG SIGNAL.

3-16. (Refer to figure 3-1 for device flag signal timing.) The negative-going device flag signal is applied to the base of transistor Q34, turning it off and turning transistor Q35 on. This applies a false signal to pin 9, and a true signal to pin 13, of the device flag FF, causing the flip-flop to change state. The device flag FF now has a true reset-side output signal at pin 8 and a false set-side output signal at pin 11. Depending upon jumper positions, any one of four possible functions may now be performed in relation to the leading and trailing edges of the device flag signal. Table 2-6 lists jumper positions for each of the four functions. Due to the similarity of circuit operation, only the W4B, W5B, and W6B jumper combination is explained in detail in the following paragraph.

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DEVICE COMMAND SIGNAL OUTPUT:

W7 IN POSITION B

DEVICE COMMAND SIGNAL OUTPUT:

W7 IN POSITION A

DEVICE FLAG SIGNAL INPUT

CONDITION:

1. GATE MC105B OUTPUT TO FLAG BUFFER FF AND COMMAND FF: W5 AND W6 IN POSITION B

2. GATE MC105B OUTPUT TO FLAG BUFFER FF AND COMMAND FF: W5 IN POSITION A, W6 IN POSITION B

3. GATE MC107C OUTPUT TO COMMAND FF: W4 IN POSITION B, W6 IN POSITION A

4. GATE MC107C OUTPUT TO COMMAND FF: W4 AND W6 IN POSITION A

2046-4

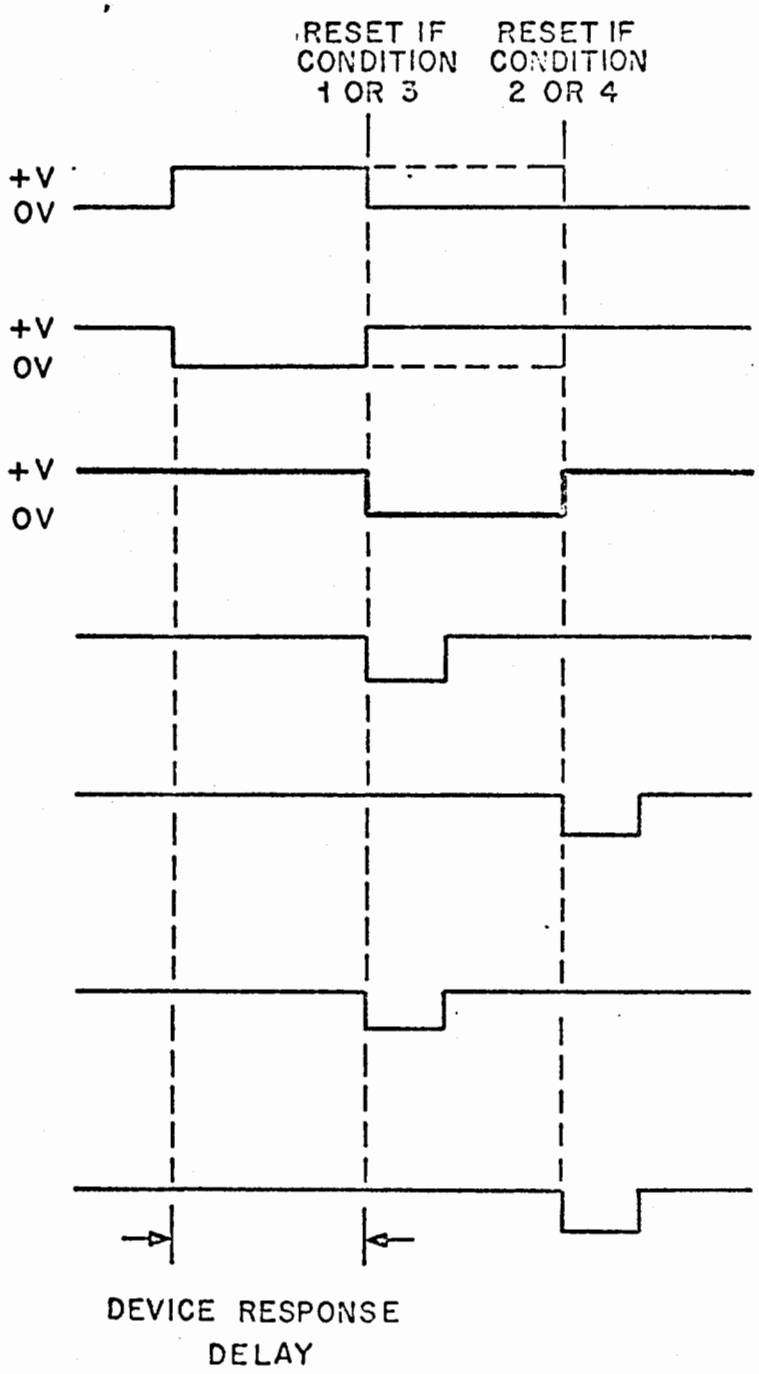

Figure 3-1. Device Command and Device Flag Signal Timing

3-17. With jumpers W4 and W5 in position B (as shown in figure 4-3), the true reset-side output signal at pin 8 of the device flag FF, which represents the leading edge of the device flag signal, is applied to both the MC107A, MC107B circuit and the MC107C, MC107D circuit. With this signal at pin 2 of gate MC107A and its complement (inverted by gate MC107B) at pin 6 of gate MC107B, resistor R57 and capacitor C41 form a time delay network. The time delay prevents the false signal at pin 6 of gate MC107B from reaching pin 1 of gate MC107A for approximately 0.6 microseconds. This causes gate MC107A to apply a false output signal to gate MC97B during the time delay. Gate MC97B inverts this signal and applies it to the clock input of all flip-flops in the input storage register as a true signal. This signal causes input data to be strobed into the input storage register from the external device data lines. The true output signal from gate MC97B is also applied to gate MC105B, and when coincident with a true reset-side output signal from the flag FF, it causes gate MC105B to set the flag buffer FF. With jumper W6 in position B (as shown in figure 4-3), the command FF is also reset by the false output signal of gate MC105B.

3-18. Operation of the MC107C, MC107D circuit is identical to the MC107A, MC107B circuit. With jumper W6 in position B, as shown, the false output signal of gate MC107C does not affect input operation. (Refer to table 2-7 for further information on relocatable jumper positioning.)

3-19. INTERRUPT REQUEST LOGIC.

3-20. (Refer to the respective HP computer manual, volume 3, Input/Output System Operation, for interrupt logic timing information.) At time T2 of the computer machine cycle, the true set-side output signal of the flag buffer FF and the true ENF signal set the flag FF. The false reset-side output of the flag FF is then applied to gate MC105B as a disabling signal. This prevents a second device flag signal from requesting an interrupt before the computer has reset the flag FF with a CLF instruction.

3-21. At time T5 of the computer machine cycle, the IRQ FF is set by the true set-side output signals of the Flag Buffer FF, the flag FF, and the control FF, and by the true IEN, PRH, and SIR signals. The true set-side output signal of the IRQ FF is then applied to the computer as the FLGL (Flag, Lower select code) and the IRQL (Interrupt Request, Lower select code) signals. These signals request an interrupt of the computer program in order to input data from the external device.

3-22. When the interrupt occurs, a programmed input (LIA/B) instruction applies the IOI signal and the LSCL, LSCM, and IOG signals to the duplex register card. These signals enable all of the output ''and'' gates of the input storage register, causing the data which has been strobed in the input storage register to be transferred to the computer. At time T2 of every computer machine cycle, the ENF signal (inverted by gate MC55C) resets the IRQ FF.

3-23. At time T1 of the computer machine cycle following interrupt phase 4, the IAK signal and the true set-side output signal of the IRQ FF reset the flag buffer FF.

3-24. INPUT STORAGE REGISTER.

3-25. The input storage register of the duplex register card is composed of 16 latch-type flip-flops and associated circuitry. It receives input signals as a positive voltage (or an open circuit) and as a ground potential from an external device and transfers them to the computer as false and true IOBI signals, respectively. Since each of the flip-flop circuits are identical, only the operation of the bit 0 FF is explained in the following.

3-26. When the bit 0 input signal is applied to the resistor network attached to the base of transistor Q18 as a positive voltage or an open circuit (a logic 0 condition), Q18 begins to conduct at saturation. In this condition Q18 applies a false output signal to the bit 0 FF. When a device flag signal is applied to the duplex register card the clock input of the bit 0 FF is strobed. This latches the false signal into the flip-flop which then applies this signal to gate MC67A. When gate MC67A is enabled by the IOI signal and the LSCL, LSCH, and IOG signals as a result of an input instruction, it applies a false IOBI 0 signal to the computer.

3-27. If the bit 0 input signal to transistor Q18 is at ground potential (a logic 1 condition), Q18 turns off. The true output signal of Q18 is then latched into the bit 0 FF and applied to gate MC67A. Again, as in paragraph 3-25, an input instruction enables gate MC67A, which then applies a true IOBI 0 signal to the computer.

3-28. Jumpers W9, W10, W11, and W12 provide a method of removing the clock input from one or more groups of four flip-flops each. With the clock input removed, a flip-flop assumes a permanently latched condition, allowing input data to pass through the flip-flop at all times. The flip-flops may then be used as status lines to monitor external device operation.

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SECTION IV

MAINTENANCE

4-1. GENERAL.

4-2. This section contains preventive maintenance information, a reference designation index, and maintenance diagrams for the 12554A interface kit.

4-3. PREVENTIVE MAINTENANCE.

4-4. Perform the following preventive maintenance procedures every three months:

a. Visually inspect all cables and cable connectors of the 12554A interface kit for fraying or chafing. Repair or replace all cables and cable connectors found to be damaged.

b. Visually inspect components on the 16-bit duplex register card for damage caused by excessive heat.

c. Perform the diagnostic test for the duplex register card as outlined in the Diagnostic Program Procedures Manual Supplement attached to this manual.

4-5. REFERENCE DESIGNATION INDEX.

4-6. The reference designation index, table 4-1, provides an alphanumerical listing of all components on the 16-bit duplex register card by their reference designation. This table also provides the HP part number, description, manufacturer's code number, and manufacturer's part number for each component. Abbreviations used in the DESCRIPTION column are listed in table 5-3. Manufacturer's codes are listed in table 5-4.

4-7. MAINTENANCE DIAGRAMS.

4-8. The following maintenance diagrams are provided in this section:

a. 16-bit duplex register card parts location diagram (figure 4-1).

b. Microcircuit package logic diagrams (figure 4-2).

c. 16-bit duplex register card logic diagram (figure 4-3).

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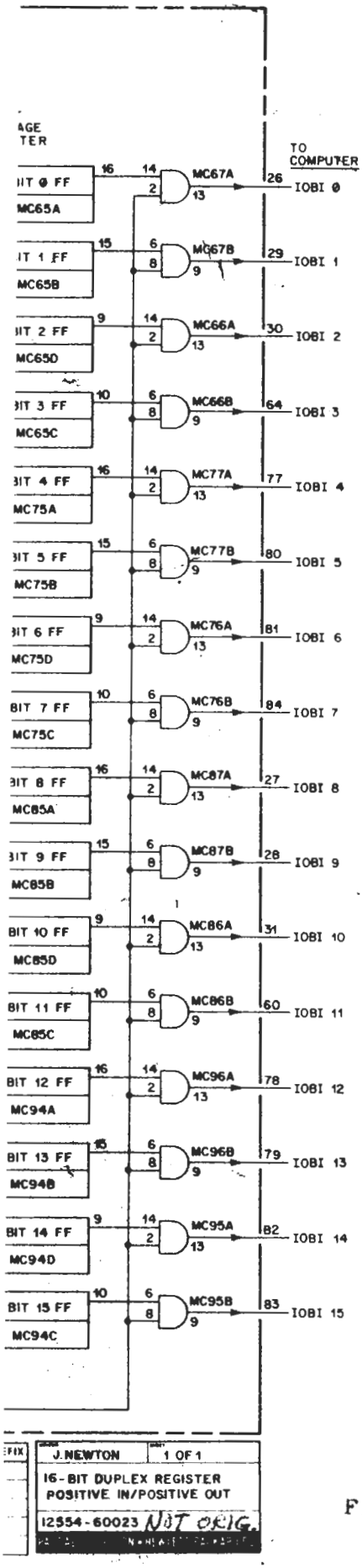
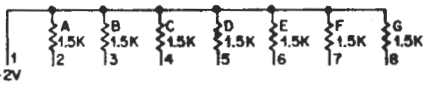
Table 4-1. 16-Bit Duplex Register Card Reference Designation Index

REFERENCE DESIGNATION*	HP PART NUMBER	DESCRIPTION	MANUFACTURER'S CODE NUMBER	MANUFACTURER'S PART NUMBER
C1-16	0140-0191	C: FXD MICA 56 PF 5%	28480	0140-0191
C17-32	0140-0198	C: FXD MICA 200 PF 5%	28480	0140-0198
C33-36,42,43, 46,47	0150-0093	C: FXD CER 0.01 uF +80-20% 100 VDCW	91418	OBD
C37	0140-0192	C: FXD MICA 68 PF 5%	28480	0140-0192
C38,39,55	0160-0153	C: FXD MY 100 PF 10% 200 VDCW	28480	0160-0153
C40,41	0160-0154	C: FXD MY 2200 PF 10%	28480	0160-0154
C44,45,48-54	0180-0291	C: FXD ELECT 1.0 uF 10% 35 VDCW	28480	0180-0291
CR1-17	1901-0040	DIODE: SILICON 30 MA 30 WV	07263	FDG 1088
CR18	1902-0048	DIODE: BREAKDOWN: 6.81V 5%	28480	1902-0048
MC24,36,44-46, 55,105,107	1820-0054	INTEGRATED CIRCUIT: QUAD 2-INPUT NAND	01295	SN7400N
MC25,35,56	1820-0068	INTEGRATED CIRCUIT: TTL	56289	USN 7410A
MC26,27,37,66, 67,76,77,86, 87,95,96	1820-0956	INTEGRATED CIRCUIT: CTL	07263	SL3459
MC34	1820-0069	INTEGRATED CIRCUIT: TTL	56289	USN 7420A
MC54,64,65,74, 75,84,85,94	1820-0301	INTEGRATED CIRCUIT: QUAD BISTABLE LATCH	01295	SN 7475N
MC97	1820-0071	INTEGRATED CIRCUIT: 4-INPUT DR NAND	01295	SN 7440N
Q1-37	1854-0215	TRANSISTOR: SILICON NPN 2N3904	28480	1854-0215
R1-16,51,60,64, 77-80	0757-0442	R: FXD MET FLM 10K 1% 1/8W	28480	0757-0442
R17-32,52,53	0757-0417	R: FXD MET FLM 562 OHM 1% 1/8W	28480	0757-0417
R33-49,55,58, 62,68	0757-0280	R: FXD MET FLM 1K 1% 1/8W	28480	0757-0280
R50,59,63	0698-0083	R: FXD MET FLM 1.96K 1% 1/8W	28480	0698-0083
R54	0698-3446	R: FXD MET FLM 383 OHM 1% 1/8W	28480	0698-3446



1. ALL RESISTOR VALUES ARE IN OHMS UNLESS OTHERWISE NOTED.
2. ALL LOGIC IS POSITIVE - TRUE
3. CARD TO BE SHIPPED WITH JUMPER W68 IN POSITION.
4. SCHEMATIC DIAGRAM FOR RESISTOR NETWORKS R70 THRU R74:

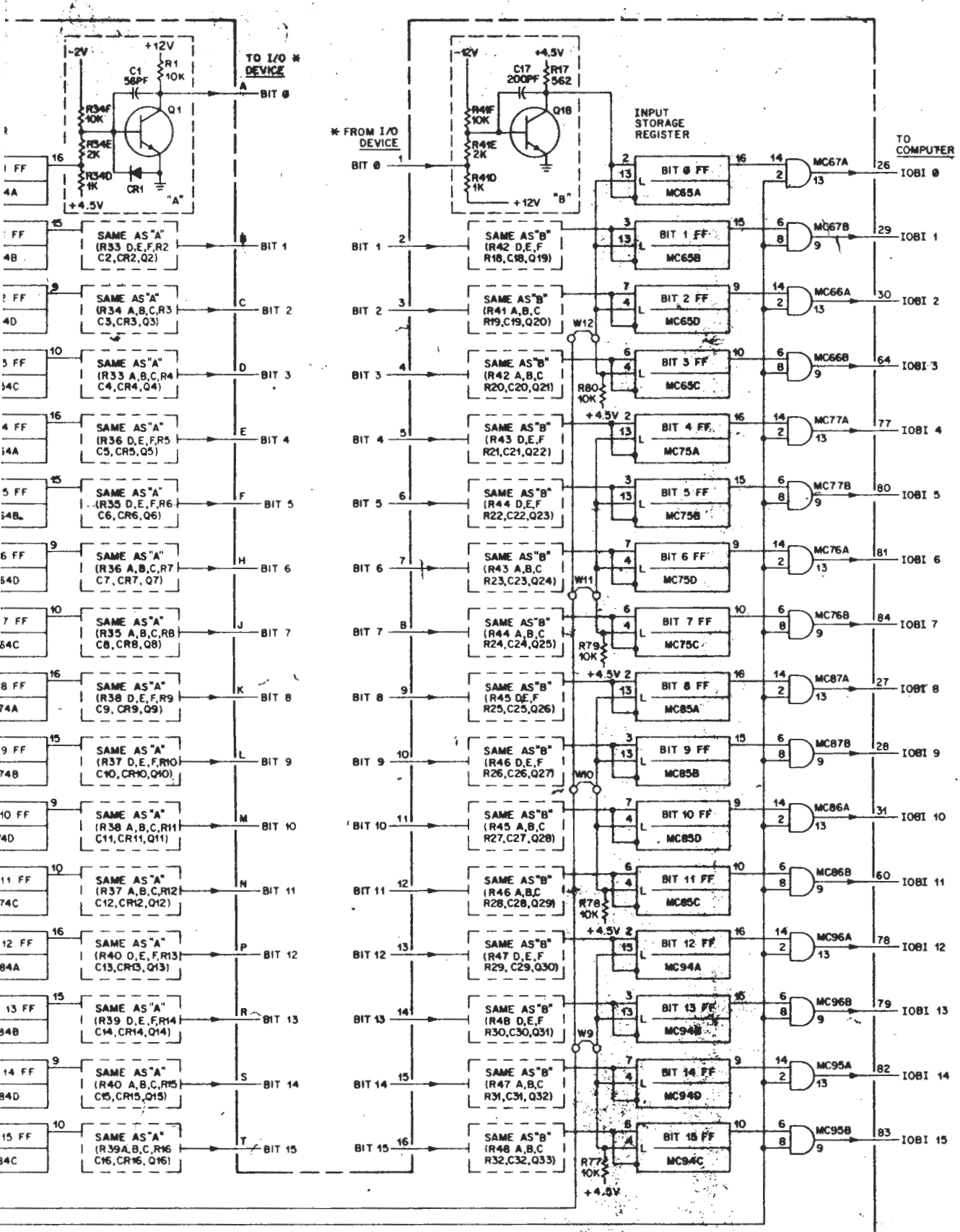


5. SCHEMATIC DIAGRAM FOR RESISTOR NETWORKS R33 THRU R48

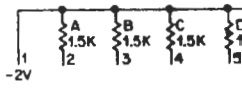
6. SCHEMATIC DIAGRAM FOR RESISTOR NETWORKS R41 THRU R48.

7. * INDICATES SIGNALS FROM/TO EXTERNAL DEVICE VIA 48-PIN CONNECTOR. ALL OTHER SIGNALS ARE FROM/TO COMPUTER VIA 86-PIN CONNECTOR.

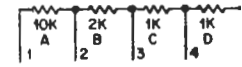
Figure 4-3. 16-Bit Duplex Register Card Logic Diagram



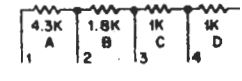
1. ALL RESISTOR VALUES ARE I
OTHERWISE NOTED.
2. ALL LOGIC IS POSITIVE - TRU
3. CARD TO BE SHIPPED WITH
4. SCHEMATIC DIAGRAM FOR RE
NETWORKS R70 THRU R74:



5. SCHEMATIC DIAGRAM FOR RE



6. SCHEMATIC DIAGRAM FOR RE



7. * INDICATES SIGNALS FROM
CONNECTOR. ALL OTHER SI
VIA 86-PIN CONNECTOR.

CHANGE	REFERENCE	REVISION/PREFIX
A	P22-1062	915

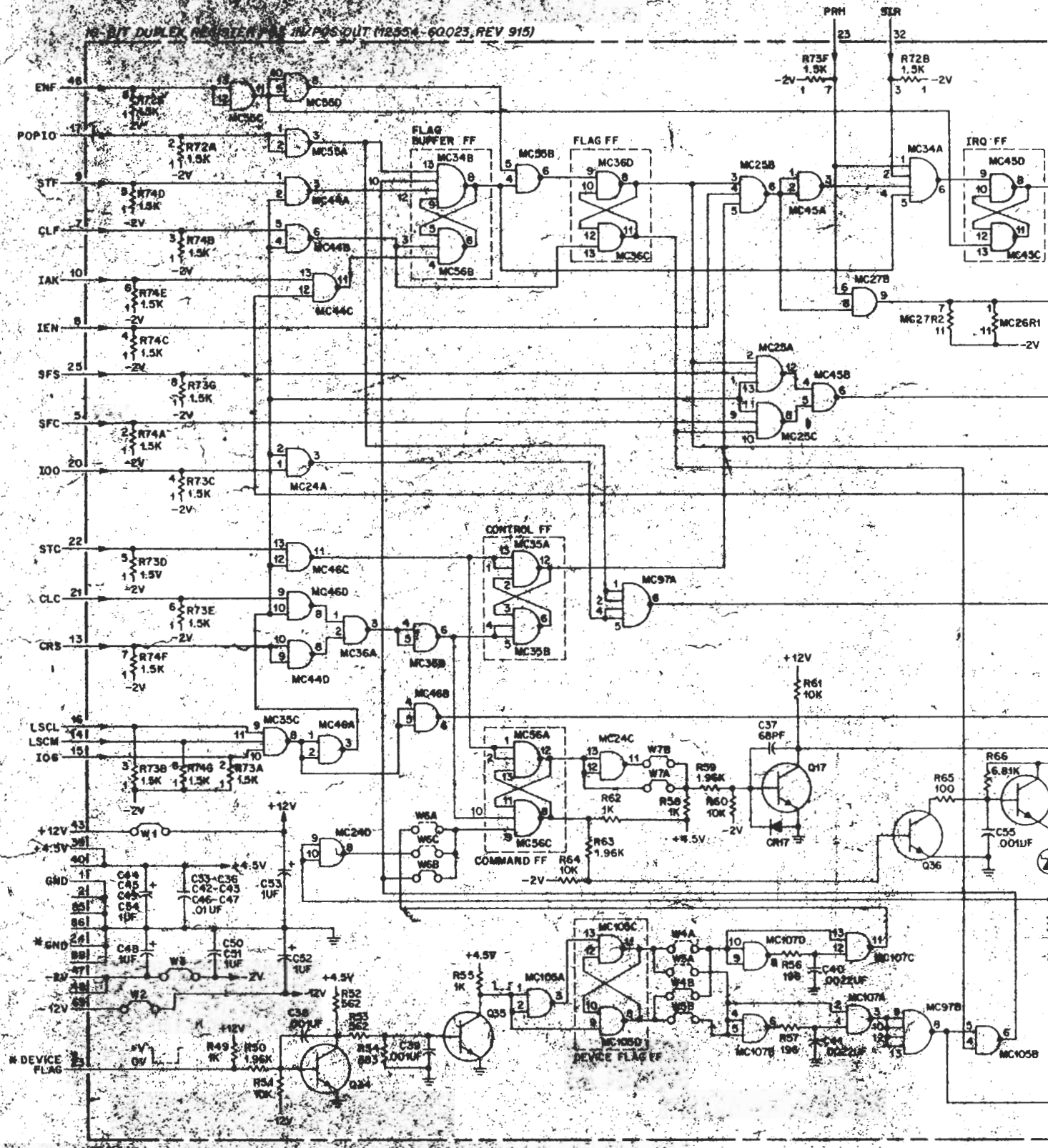
J.NEWTON | 1 OF 1

16-BIT DUPLEX REGISTER
POSITIVE IN/POSITIVE OUT

12554-60023 NOT ORIG.

Figure 4-3. 16-B
Card

IOI
24
IRQ FF
MC45D
MC45C
+4.5V
R75 348
R76 196
MC26A
MC26B
FLGL
IRQL
PRL
MC26R1
-2V
MC37A
MC37B
SKF
SRQ
MC27R1 1K
MC27A
AA
* DEVICE COMMAND
R66 6.81K
W8
Q37
+12V
C55 .001μF
CR18 6.8V
R68 1K
MC105B
OUTPUT STORAGE REGISTER
FROM COMPUTER
IOBO 0
IOBO 1
IOBO 2
IOBO 3
IOBO 4
IOBO 5
IOBO 6
IOBO 7
IOBO 8
IOBO 9
IOBO 10
IOBO 11
IOBO 12
IOBO 13
IOBO 14
IOBO 15
R72C 1.5K
R72D 1.5K
R72E 1.5K
R72F 1.5K
R71A 1.5K
R71B 1.5K
R71D 1.5K
R71C 1.5K
R71E 1.5K
R70B 1.5K
R71G 1.5K
R71F 1.5K
R70C 1.5K
R70E 1.5K
R70G 1.5K
R70F 1.5K
BIT 0 FF MC54A
BIT 1 FF MC54B
BIT 2 FF MC54D
BIT 3 FF MC54C
BIT 4 FF MC64A
BIT 5 FF MC64B
BIT 6 FF MC64D
BIT 7 FF MC64C
BIT 8 FF MC74A
BIT 9 FF MC74B
BIT 10 FF MC74D
BIT 11 FF MC74C
BIT 12 FF MC84A
BIT 13 FF MC84B
BIT 14 FF MC84D
BIT 15 FF MC84C
-2V
+12V
C1 56PF
R1 10K
R34F 10K
R34E 2K
R34D 1K
Q1
CR1
+4.5V
"A"
SAME AS "A" (R33 D,E,F,R2 C2,CR2,Q2)
SAME AS "A" (R34 A,B,C,R3 C3,CR3,Q3)
SAME AS "A" (R33 A,B,C,R4 C4,CR4,Q4)
SAME AS "A" (R36 D,E,F,R5 C5,CR5,Q5)
SAME AS "A" (R35 D,E,F,R6 C6,CR6,Q6)
SAME AS "A" (R36 A,B,C,R7 C7,CR7,Q7)
SAME AS "A" (R35 A,B,C,R8 C8,CR8,Q8)
SAME AS "A" (R38 D,E,F,R9 C9,CR9,Q9)
SAME AS "A" (R37 D,E,F,R10 C10,CR10,Q10)
SAME AS "A" (R38 A,B,C,R11 C11,CR11,Q11)
SAME AS "A" (R37 A,B,C,R12 C12,CR12,Q12)
SAME AS "A" (R40 D,E,F,R13 C13,CR13,Q13)
SAME AS "A" (R39 D,E,F,R14 C14,CR14,Q14)
SAME AS "A" (R40 A,B,C,R15 C15,CR15,Q15)
SAME AS "A" (R39A,B,C,R16 C16,CR16,Q16)
TO I/O * DEVICE
BIT 0
BIT 1
BIT 2
BIT 3
BIT 4
BIT 5
BIT 6
BIT 7
BIT 8
BIT 9
BIT 10
BIT 11
BIT 12
BIT 13
BIT 14
BIT 15
* FROM I/O DEVICE
R41F 10K
R41E 2K
R41D 1K


16-BIT DUPLEX REGISTER FILE (MP/OS OUT M2554-60023, REV 915)
PRH
SIR
ENF
POPIO
STF
CLF
IAK
IEN
SFS
SFC
IOO
STC
CLC
CRS
LSCL
LSCM
IOG
+12V
+4.5V
GND
-2V
-12V
* DEVICE FLAG
FLAG BUFFER FF
FLAG FF
IRQ FF
CONTROL FF
COMMAND FF
DEVICE FLAG FF
MC34B
MC36D
MC34A
MC45D
MC25B
MC45A
MC27B
MC26R1
MC27R2
MC25A
MC45B
MC25C
MC24A
MC35A
MC35B
MC97A
MC46C
MC46D
MC36A
MC44D
MC46B
MC56A
MC56C
MC24C
MC24D
MC35C
MC46A
MC105C
MC105A
MC105D
MC107C
MC107D
MC107A
MC107B
MC97B
MC105B
Q17
Q36
Q35
Q34
CR17
W1
W2
W3
W4A
W4B
W5A
W5B
W6A
W6B
W6C
W7A
W7B
R61 10K
R62 1K
R63 1.96K
R64 10K
R65 100
R66 6.81K
R59 1.96K
R60 10K
R58 1K
R55 1K
R56 196
R57 196
R52 562
R53 562
R54 383
R49 1K
R50 1.96K
R51 10K
C37 68PF
C40 .0022UF
C41 .0022UF
C55 .001UF
C38 .001UF
C39 .001UF
C53 1UF
C52 1UF
C50 C51 1UF
C48 1UF
C44 C45 C54 1UF
C33-C36 C42-C43 C46-C47 .01 UF

SECTION V

REPLACEABLE PARTS AND ORDERING INFORMATION

5-1. GENERAL.

5-2. This section contains replaceable parts and ordering information for the HP 12554A Interface Kit and a listing of reference designations and abbreviations used in this manual.

5-3. Table 5-1 provides the HP part number, description, manufacturer's code, manufacturer's part number, and total quantity used for each item and assembly in the 12554A interface kit. Table 5-2 provides thesame information for each component on the 16-bit duplex register card. Table 5-3 provides a listing of all reference designations and abbreviations used in the DESCRIPTION column of table 5-2. Table 5-4 gives a numerical listing of all manufacturer's codes used in table 5-2 with corresponding manufacturing companies and their addresses.

5-4. ORDERING INFORMATION.

5-5. To order replacement parts, address order or inquiry to the nearest Hewlett-Packard Sales and Service Office. (Refer to the back of this manual for a listing of Hewlett-Packard Sales and Service Offices and their addresses.) Specify the following information for each part ordered:

a. Hewlett-Packard part number.
b. Complete description.
c. Circuit reference designation (if applicable).

x5-6. To order a part not listed in tables 5-1 and 5-2, give a complete description of the part and include its function and location.

Table 5-1. Interface Kit Replaceable Parts

Part No.	Description #	Mfr.	Mfr. Part No.	TQ
02116-6128	CONNECTOR KIT, 48-PIN	28480	02116-6128	1
1251-0332	TEST CONNECTOR, 24-PIN	28480	1251-0332	1
12554-60023	16-BIT DUPLEX REGISTER, POSITIVE-IN/POSITIVE-OUT LOGIC	28480	12554-60023	1
12554-90021	OPERATING AND SERVICE MANUAL, HP 12554A COMPUTER INTERFACE KIT	28480	12554-90021	1
20416C	DIAGNOSTIC TEST TAPE	28480	20416C	1

Table 5-2. Duplex Register Card Replaceable Parts

Part No.	Description #	Mfr.	Mfr. Part No.	TQ
0140-0191	C: FXD MICA 56 PF 5%	28480	0140-0191	16
0140-0192	C: FXD MICA 68 PF 5%	28480	0140-0192	1
0140-0198	C: FXD MICA 200 PF 5%	28480	0140-0198	16
0150-0191	C: FXD CER 0.01 UF +80-20% 100 VDCW	91418	TA	8
0160-0153	C: FXD MY 1000 PF 10% 200 VDCW	28480	0160-0153	3
0160-0154	C: FXD MYLAR 2200 PF 10%	28480	0160-0154	2
0180-0291	C: FXD ELECT 1.0 UF 10% 35 VDCW	28480	0180-0291	9
0698-0083	R: FXD MET FLM 1.96K OHM 1% 1/8W	28480	0698-0083	3
0698-3440	R: FXD MET FLM 196 OHM 1% 1/8W	28480	0698-3440	3
0698-3445	R: FXD MET FLM 348 OHM 1% 1/8W	28480	0698-3445	1
0698-3446	R: FXD MET FLM 383 OHM 1% 1/8W	28480	0698-3446	1
0757-0280	R: FXD MET FLM 1K OHM 1% 1/8W	28480	0757-0280	5
0757-0401	R: FXD MET FLM 100 OHM 1% 1/8W	28480	0757-0401	1
0757-0417	R: FXD MET FLM 562 OHM 1% 1/8W	28480	0757-0417	18
0757-0439	R: FXD MET FLM 6.81K OHM 1% 1/8W	28480	0757-0439	1
0757-0442	R: FXD MET FLM 10.0K OHM 1% 1/8W	28480	0757-0442	24
1810-0020	RESISTOR NETWORK: MET FLM (7 RES)	28480	1810-0020	5
1820-0054	INTEGRATED CIRCUIT: QUAD 2 - INPUT NAND	01295	SN7400N	8
1820-0068	INTEGRATED CIRCUIT: TTL	56289	USN7410A	3
1820-0069	INTEGRATED CIRCUIT: TTL	56289	USN7420A	1
1820-0071	INTEGRATED CIRCUIT: 4 - INPUT DR NAND	01295	SN 7440N	1
1820-0301	INTEGRATED CIRCUIT: QUAD BISTABLE LATCH	01295	SN 7475N	8
1820-0956	INTEGRATED CIRCUIT: CTL	07263	SL 346	11
1854-0215	TRANSISTOR: SILICON NPN 2N3904	28480	1854-0215	37
1901-0040	DIODE: SILICON 30 MA 30 WV	07263	FDG1088	17
1902-0048	DIODE BREAKDOWN: 6.81V 5%	28480	1902-0048	1
8159-0005	JUMPER WIRE	28480	8159-0005	12

Table 5-3. Reference Designations and Abbreviations

REFERENCE DESIGNATIONS

A = assembly	J = receptacle connector	TB = terminal board
B = motor	K = relay	TP = test point
BT = battery	L = inductor	U = integrated circuit
C = capacitor	M = meter	V = vacuum tube, neon bulb, photocell, etc.
CP = coupler	MC = microcircuit	
CR = diode	P = plug connector	VR = voltage regulator
DL = delay line	Q = transistor	W = cable, jumper
DS = device signaling (lamp)	R = resistor	X = socket
E = misc hardware	RT = thermistor	Y = crystal
F = fuse	S = switch	Z = tuned cavity, network
FL = filter	T = transformer	

ABBREVIATIONS

A = amperes	IMPG = impregnated	P/O = part of
AC = alternating current	IN. = inch, inches	POLY = polystyrene
AFC = automatic frequency control	INCD = incandescent	PORC = porcelain
ALUM = aluminum	INCL = include(s)	POS = position(s)
AL-ELECT = aluminum electrolytic	INS = insulation(ed)	POT = potentiometer
ASSY = assembly	INT = internal	PP = peak-to-peak
	I/O = input/output	PT = point
BFO = beat frequency oscillator		PWV = peak working voltage
BE CU = beryllium copper	K = kilo = 1000	
BH = binder head		R = resistor
BP = bandpass	LH = left hand	RECT = rectifier
BRS = brass	LIN = linear taper	RF = radio frequency
BWO = backward wave oscillator	LK WASH = lock washer	RH = round head or right hand
	LOG = logarithmic taper	RMO = rack mount only
C = capacitor	LPF = low pass filter	RMS = root-mean square
CCW = counterclockwise		RWV = reverse working voltage
CER = ceramic	M = milli = 10^{-3}	
CMO = cabinet mount only	MEG = mega = 10^{6}	S-B = slow-blow
COEF = coefficient	MET FLM = metal film	SCR = screw
COM = common	MET OX = metal oxide	SE = selenium
COMP = composition	MFR = manufacturer	SECT = section(s)
COMPL = complete	MHz = megahertz	SEMICON = semiconductor
CONN = connector	MINAT = miniature	SI = silicon
CP = cadmium plate	MOM = momentary	SIL = silver
CRT = cathode-ray tube	MTG = mounting	SL = slide
CTL = capacitor-transistor logic	MY = Mylar	SPDT = single-pole, double-throw
CW = clockwise		SPG = spring
	N = nano (10^{-9})	SPL = special
DC = direct current	N/C = normally closed	SPST = single-pole, single-throw
DEPC = deposited carbon	NE = neon	SR = split ring
DPDT = double-pole, double-throw	NI PL = nickel plate	SST = stainless steel
DPST = double-pole, single-throw	NO. = number	STL = steel
DR = drive	N/O = normally open	
	NPN = negative-positive-negative	TA = tantalum
ELECT = electrolytic		TD = time delay
ENCAP = encapsulated	NPO = negative positive zero (zero temperature coefficient)	TGL = toggle
EXT = external		THD = thread
	NRFR = not recommended for field replacement	TI = titanium
F = farads		TOL = tolerance
FH = flat head	NSR = not separately replaceable	TRIM = trimmer
FIL H = fillister head		TTL = transistor-transistor logic
FXD = fixed	OBD = order by description	TWT = traveling wave tube
	OD = outer diameter	
G = giga (10^{9})	OH = oval head	U (μ) = micro = 10^{-6}
GE = germanium	OX = oxide	
GL = glass		VAR = variable
GND/GRD = ground(ed)	P = peak	VDCW = direct current working volts
	PC = printed circuit	
H = henries	PF = picofarads = 10^{-12} farads	W/ = with
HDW = hardware	PH = Phillips head	W = watts
HEX = hexagonal	PH BRZ = phosphor bronze	WIV = working inverse voltage
HG = mercury	PHL = Phillips	WW = wirewound
HR = hour(s)	PIV = peak inverse voltage	W/O = without
HZ = hertz	PNP = positive-negative-positive	
ID = inner diameter		
IF = intermediate frequency		

Table 5-4.
CODE LIST OF MANUFACTURERS

The following code numbers are from the Federal Supply Code for Manufacturers Cataloging Handbooks H4-1 (Name to Code) and H4-2 (Code to Name) and their latest supplements. The date of revision and the date of the supplements used appear at the bottom of each page. Alphabetical codes have been arbitrarily assigned to suppliers not appearing in the H4 Handbooks.

Code No.	Manufacturer	Address
00000	U.S.A. Common	Any supplier of U.S.
00136	McCoy Electronics	Mount Holly Springs, Pa.
00213	Sage Electronics Corp.	Rochester, N.Y.
00287	Cemco Inc.	Danielson, Conn.
00334	Humidial	Colton, Calif.
00348	Microtron Co., Inc.	Valley Stream, N.Y.
00373	Garlock Inc.	Cherry Hill, N.J.
00656	Aerovox Corp.	New Bedford, Mass.
00779	Amp. Inc.	Harrisburg, Pa.
00781	Aircraft Radio Corp.	Boonton, N.J.
00815	Northern Engineering Laboratories, Inc.	Burlington, Wis.
00853	Sangamo Electric Co., Pickens Div.	Pickens, S.C.
00866	Goe Engineering Co.	City of Industry, Cal.
00891	Carl E. Holmes Corp.	Los Angeles, Calif.
00929	Microlab Inc.	Livingston, N.J.
01002	General Electric Co., Capacitor Dept.	Hudson Falls, N.Y.
01009	Alden Products Co.	Brockton, Mass.
01121	Allen Bradley Co.	Milwaukee, Wis.
01255	Litton Industries, Inc.	Beverly Hills, Calif.
01281	TRW Semiconductors, Inc.	Lawndale, Calif.
01295	Texas Instruments, Inc., Transistor Products Div.	Dallas, Texas
01349	The Alliance Mfg. Co.	Alliance, Ohio
01589	Pacific Relays, Inc.	Van Nuys, Calif.
01670	Gudebrod Bros. Silk Co.	New York, N.Y.
01930	Amerock Corp.	Rockford, Ill.
01961	Pulse Engineering Co.	Santa Clara, Calif.
02114	Ferroxcube Corp. of America	Saugerties, N.Y.
02116	Wheelock Signals, Inc.	Long Branch, N.J.
02286	Cole Rubber and Plastics Inc.	Sunnyvale, Calif.
02660	Amphenol-Borg Electronics Corp.	Broadview, Ill.
02735	Radio Corp. of America, Semiconductor and Materials Div.	Somerville, N.J.
02771	Vocaline Co. of America, Inc.	Old Saybrook, Conn.
02777	Hopkins Engineering Co.	San Fernando, Calif.
02875	Hudson Tool & Die Co.	Newark, N.J.
03508	G.E. Semiconductor Prod. Dept.	Syracuse, N.Y.
03705	Apex Machine & Tool Co.	Dayton, Ohio
03797	Eldema Corp.	Compton, Calif.
03818	Parker Seal Co.	Los Angeles, Calif.
03877	Transitron Electric Corp.	Wakefield, Mass.
03888	Pyrofilm Resistor Co., Inc.	Cedar Knolls, N.J.
03954	Singer Co., Diehl Div. Finderne Plant	Sumerville, N.J.
04009	Arrow, Hart and Hegeman Elect. Co.	Hartford, Conn.
04013	Taurus Corp.	Lambertville, N.J.
04062	Arco Electronic Inc.	Great Neck, N.Y.
04222	Hi-Q Division of Aerovox	Myrtle Beach, S.C.
04354	Precision Paper Tube Co.	Wheeling, Ill.
04404	Dymec Division of Hewlett-Packard Co.	Palo Alto, Calif.
04651	Sylvania Electric Products, Microwave Device Div.	Mountain View, Calif.
04673	Dakota Engr. Inc.	Culver City, Calif.
04713	Motorola, Inc., Semiconductor Prod. Div.	Phoenix, Arizona
04732	Filtron Co., Inc. Western Div.	Culver City, Calif.
04773	Automatic Electric Co.	Northlake, Ill.
04796	Sequoia Wire Co.	Redwood City, Calif.
04811	Precision Coil Spring Co.	El Monte, Calif.
04870	P.M. Motor Company	Westchester, Ill.
04919	Component Mfg. Service Co.	W. Bridgewater, Mass.
05006	Twentieth Century Plastics, Inc.	Los Angeles, Calif.
05245	Components Corp.	Chicago, Ill.
05277	Westinghouse Electric Corp. Semi-Conductor Dept.	Youngwood, Pa.
05347	Ultronix, Inc.	San Mateo, Calif.
05397	Union Carbide Corp., Elect. Div.	New York, N.Y.
05574	Viking Ind. Inc.	Canoga Park, Calif.
05593	Icore Electro-Plastics Inc.	Sunnyvale, Calif.
05616	Cosmo Plastic (c/o Electrical Spec. Co.)	Cleveland, Ohio
05624	Barber Colman Co.	Rockford, Ill.
05728	Tiffen Optical Co.	Roslyn Heights, Long Island, N.Y.
05729	Metro-Tel Corp.	Westbury, N.Y.
05783	Stewart Engineering Co.	Santa Cruz, Calif.
05820	Wakefield Engineering Inc.	Wakefield, Mass.
06004	Bassick Co., Div. of Stewart Warner Corp.	Bridgeport, Conn.
06090	Raychem Corp.	Redwood City, Calif.
06175	Bausch and Lomb Optical Co.	Rochester, N.Y.
06402	E.T.A. Products Co. of America	Chicago, Ill.
06540	Amatom Electronic Hardware Co., Inc.	New Rochelle, N.Y.
06555	Beede Electrical Instrument Co., Inc.	Penacook, N.H.
06666	General Devices Co., Inc.	Indianapolis, Ind.
06751	Components Inc., Ariz. Div.	Phoenix, Ariz.
06812	Torrington Mfg. Co., West Div.	Van Nuys, Calif.
06980	Varian Assoc. Eimac Div.	San Carlos, Calif.
07088	Kelvin Electric Co.	Van Nuys, Calif.
07126	Digitran Co.	Pasadena, Calif.
07137	Transistor Electronics Corp.	Minneapolis, Minn.
07138	Westinghouse Electric Corp. Electronic Tube Div.	Elmira, N.Y.
07149	Filmohm Corp.	New York, N.Y.
07233	Cinch-Graphik Co.	City of Industry, Calif.
07256	Silicon Transistor Corp.	Carle Place, N.Y.
07261	Avnet Corp.	Culver City, Calif.
07263	Fairchild Camera & Inst. Corp. Semiconductor Div.	Mountain View, Calif.
07322	Minnesota Rubber Co.	Minneapolis, Minn.
07387	Britcher Corp., The	Monterey Park, Calif.
07397	Sylvania Elect. Prod. Inc., Mt. View Operations	Mountain View, Calif.
07700	Technical Wire Products Inc.	Cranford, N.J.
07829	Bodine Elect. Co.	Chicago, Ill.
07910	Continental Device Corp.	Hawthorne, Calif.
07933	Raytheon Mfg. Co., Semiconductor Div.	Mountain View, Calif.
07980	Hewlett-Packard Co., Boonton Radio Div.	Rockaway, N.J.
08145	U.S. Engineering Co.	Los Angeles, Calif.
08289	Blinn, Delbert Co.	Pomona, Calif.
08358	Burgess Battery Co.	Niagara Falls, Ontario, Canada
08524	Deutsch Fastener Corp.	Los Angeles, Calif.
08664	Bristol Co., The	Waterbury, Conn.
08717	Sloan Company	Sun Valley, Calif.
08718	ITT Cannon Electric Inc., Phoenix Div.	Phoenix, Arizona
08727	National Radio Lab. Inc.	Paramus, N.J.
08792	CBS Electronics Semiconductor Operations, Div of C.B.S. Inc.	Lowell, Mass.
08806	General Electric Co. Miniat. Lamp Dept.	Cleveland, Ohio
08984	Mel-Rain	Indianapolis, Ind.
09026	Babcock Relays Div.	Costa Mesa, Calif.
09134	Texas Capacitor Co.	Houston, Texas
09145	Tech. Ind. Inc. Atohm Elect.	Burbank, Calif.
09250	Electro Assemblies, Inc.	Chicago, Ill.
09353	C & K Components Inc.	Newton, Mass.
09569	Mallory Battery Co. of Canada, Ltd.	Toronto, Ontario, Canada
09922	Burndy Corp.	Norwalk, Conn.
10214	General Transistor Western Corp.	Los Angeles, Calif.
10411	Ti-Tal, Inc.	Berkeley, Calif.
10646	Carborundum Co.	Niagara Falls, N.Y.
11236	CTS of Berne, Inc.	Berne, Ind.
11237	Chicago Telephone of California, Inc.	So. Pasadena, Calif.
11242	Bay State Electronics Corp.	Waltham, Mass.
11312	Teledyne Inc., Microwave Div.	Palo Alto, Calif.
11314	National Seal	Downey, Calif.
11453	Precision Connector Corp.	Jamaica, N.Y.
11534	Duncan Electronics Inc.	Costa Mesa, Calif.
11711	General Instrument Corp., Semiconductor Div., Products Group	Newark, N.J.
11717	Imperial Electronic, Inc.	Buena Park, Calif.
11870	Melabs, Inc.	Palo Alto, Calif.
12040	National Semiconductor	Danbury, Conn.
12136	Philadelphia Handle Co.	Camden, N.J.
12361	Grove Mfg. Co., Inc.	Shady Grove, Pa.
12574	Gulton Ind. Inc. Data System Div.	Albuquerque, N.M.
12697	Clarostat Mfg. Co.	Dover, N.H.
12728	Elmar Filter Corp.	W. Haven, Conn.
12859	Nippon Electric Co., Ltd.	Tokyo, Japan
12881	Metex Electronics Corp.	Clark, N.J.
12930	Delta Semiconductor Inc.	Newport Beach, Calif.
12954	Dickson Electronics Corp.	Scottsdale, Arizona
13103	Thermoloy	Dallas, Texas
13396	Telefunken (GmbH)	Hanover, Germany
13835	Midland-Wright Div. of Pacific Industries, Inc.	Kansas City, Kansas
14099	Sem-Tech	Newbury Park, Calif.
14193	Calif. Resistor Corp.	Santa Monica, Calif.
14298	American Components, Inc.	Conshohocken, Pa.
14433	ITT Semiconductor, A Div. of Int. Telephone & Telegraph Corp.	West Palm Beach, Fla.
14493	Hewlett-Packard Company	Loveland, Colo.
14655	Cornell Dubilier Electric Corp.	Newark, N.J.
14674	Corning Glass Works	Corning, N.Y.
14752	Electro Cube Inc.	San Gabriel, Calif.
14960	Williams Mfg. Co.	San Jose, Calif.
15203	Webster Electronics Co.	New York, N.Y.
15287	Scionics Corp.	Northridge, Calif.
15291	Adjustable Bushing Co.	N. Hollywood, Calif.
15558	Micron Electronics	Garden City, Long Island, N.Y.
15566	Amprobe Inst. Corp.	Lynbrook, N.Y.
15631	Cabletronics	Costa Mesa, Calif.
15772	Twentieth Century Coil Spring Co.	Santa Clara, Calif.
15801	Fenwal Elect. Inc.	Framingham, Mass.
15818	Ameico Inc.	Mt. View, Calif.
16037	Spruce Pine Mica Co.	Spruce Pine, N.C.
16179	Omni-Spectra Inc.	Farmington, Mich
16352	Computer Diode Corp.	Lodi, N.J.
16585	Boots Aircraft Nut Corp.	Pasadena, Calif.
16688	Ideal Prec. Meter Co., Inc. De Jur Meter Div.	Brooklyn, N.Y.
16758	Delco Radio Div. of G.M. Corp.	Kokoma, Ind.
17109	Thermonetics Inc.	Canoga Park, Calif.
17474	Tranex Company	Mountain View, Calif.
17554	Components Inc.	Biddeford, Me.
17675	Hamlin Metal Products Corp.	Akron, Ohio
17745	Angstrohm Prec. Inc.	No. Hollywood, Calif.

Table 5-4.
CODE LIST OF MANUFACTURERS (Continued)

Code No.	Manufacturer	Address
17870	McGraw-Edison Co.	Manchester, N.H.
18042	Power Design Pacific Inc.	Palo Alto, Calif.
18083	Clevite Corp., Semiconductor Div.	Palo Alto, Calif.
18324	Signetics Corp.	Sunnyvale, Calif.
18476	Ty-Car Mfg. Co., Inc.	Holliston, Mass.
18486	TRW Elect. Comp. Div.	Des Plaines, Ill.
18583	Curtis Instrument, Inc.	Mt. Kisco, N.Y.
18612	Vishay Instruments Inc.	Malvern, Pa.
18873	E.I. DuPont and Co., Inc.	Wilmington, Del.
18911	Durant Mfg. Co.	Milwaukee, Wis.
19315	The Bendix Corp., Navigation & Control Div.	Teterboro, N.J.
19500	Thomas A. Edison Industries, Div. of McGraw-Edison Co.	West Orange, N.J.
19589	Concoa	Baldwin Park, Calif.
19644	LRC Electronics	Horseheads, N.Y.
19701	Electra Mfg. Co.	Independence, Kansas
20183	General Atronics Corp.	Philadelphia, Pa.
21226	Executone, Inc.	Long Island City, N.Y.
21335	Fafnir Bearing Co., The	New Britain, Conn.
21520	Fansteel Metallurgical Corp.	N. Chicago, Ill.
23042	Texscan Corp.	Indianapolis, Ind.
23783	British Radio Electronics Ltd.	Washington, D.C.
24455	G.E. Lamp Division	Nela Park, Cleveland, Ohio
24655	General Radio Co.	West Concord, Mass.
24681	Memcor Inc., Comp. Div.	Huntington, Ind.
24796	Parelco Inc.	San Juan Capistrano, Calif.
26365	Gries Reproducer Corp.	New Rochelle, N.Y.
26462	Grobet File Co. of America, Inc.	Carlstadt, N.J.
26851	Compac Hollister Co.	Hollister, Calif.
26992	Hamilton Watch Co.	Lancaster, Pa.
27251	Specialties Mfg. Co., Inc.	Stratford, Conn.
28480	Hewlett-Packard Co.	Palo Alto, Calif.
28520	Heyman Mfg. Co.	Kenilworth, N.J.
30817	Instrument Specialties Co., Inc.	Little Falls, N.J.
33173	G.E. Receiving Tube Dept.	Owensboro, Ky.
35434	Lectrohm Inc.	Chicago, Ill.
36196	Stanwyck Coil Products Ltd.	Hawkesbury, Ontario, Canada
36287	Cunningham, W.H. & Hill, Ltd.	Toronto Ontario, Canada
37942	P.R. Mallory & Co. Inc.	Indianapolis, Ind.
39543	Mechanical Industries Prod. Co.	Akron, Ohio
40920	Miniature Precision Bearings, Inc.	Keene, N.H.
42190	Muter Co.	Chicago, Ill.
43990	C.A. Norgren Co.	Englewood, Colo.
44655	Ohmite Mfg. Co.	Skokie, Ill.
46384	Penn Eng. & Mfg. Corp.	Doylestown, Pa.
47904	Polaroid Corp.	Cambridge, Mass.
48620	Precision Thermometer & Inst. Co.	Southampton, Pa.
49956	Microwave & Power Tube Div.	Waltham, Mass.
52090	Rowan Controller Co.	Westminster, Md.
52983	Sanborn Company	Waltham, Mass.
54294	Shallcross Mfg. Co.	Selma, N.C.
55026	Simpson Electric Co.	Chicago, Ill.
55933	Sonotone Corp.	Elmsford, N.Y.
55938	Raytheon Co. Commercial Apparatus & Systems Div.	So. Norwalk, Conn.
56137	Spaulding Fibre Co., Inc.	Tonawanda, N.Y.
56289	Sprague Electric Co.	North Adams, Mass.
59446	Telex Corp.	Tulsa, Okla.
59730	Thomas & Betts Co.	Elizabeth, N.J.
60741	Triplett Electrical Inst. Co.	Bluffton, Ohio
61775	Union Switch and Signal, Div. of Westinghouse Air Brake Co.	Pittsburgh, Pa.
62119	Universal Electric Co.	Owosso, Mich.
63743	Ward-Leonard Electric Co.	Mt. Vernon, N.Y.
64959	Western Electric Co., Inc.	New York, N.Y.
65092	Weston Inst. Inc. Weston-Newark	Newark, N.J.
66295	Wittek Mfg. Co.	Chicago, Ill.
66346	Minnesota Mining & Mfg. Co. Revere Mincom Div.	St. Paul, Minn.
70276	Allen Mfg. Co.	Hartford, Conn.
70309	Allied Control	New York, N.Y.
70318	Allmetal Screw Product Co., Inc.	Garden City, N.Y.
70417	Amplex, Div. of Chrysler Corp.	Detroit, Mich.
70485	Atlantic India Rubber Works, Inc.	Chicago, Ill.
70563	Amperite Co., Inc.	Union City, N.J.
70674	ADC Products Inc.	Minneapolis, Minn.
70903	Belden Mfg. Co.	Chicago, Ill.
70998	Bird Electronic Corp.	Cleveland, Ohio
71002	Birnbach Radio Co.	New York, N.Y.
71034	Bliley Electric Co., Inc.	Erie, Pa.
71041	Boston Gear Works Div. of Murray Co. of Texas	Quincy, Mass.
71218	Bud Radio, Inc.	Willoughby, Ohio
71279	Cambridge Thermionics Corp.	Cambridge, Mass.
71286	Camloc Fastener Corp.	Paramus, N.J.
71313	Cardwell Condenser Corp.	Lindenhurst L.I., N.Y.
71400	Bussmann Mfg. Div. of McGraw-Edison Co.	St. Louis, Mo.
71436	Chicago Condenser Corp.	Chicago, Ill.
71447	Calif. Spring Co., Inc.	Pico-Rivera, Calif.
71450	CTS Corp.	Elkhart, Ind.
71468	ITT Cannon Electric Inc.	Los Angeles, Calif.
71471	Cinema, Div. Aerovox Corp.	Burbank, Calif.
71482	C.P. Clare & Co.	Chicago, Ill.
71590	Centralab Div. of Globe Union Inc.	Milwaukee, Wis.
71616	Commercial Plastics Co.	Chicago, Ill.
71700	Cornish Wire Co., The	New York, N.Y.
71707	Coto Coil Co., Inc.	Providence, R.I.
71744	Chicago Miniature Lamp Works	Chicago, Ill.
71785	Cinch Mfg. Co., Howard B. Jones Div.	Chicago, Ill.
71984	Dow Corning Corp.	Midland, Mich.
72136	Electro Motive Mfg. Co., Inc.	Willimantic, Conn.
72619	Dialight Corp.	Brooklyn, N.Y.
72656	Indiana General Corp., Electronics Div.	Keasby, N.J.
72699	General Instrument Corp., Cap. Div.	Newark, N.J.
72765	Drake Mfg. Co.	Harwood Heights, Ill.
72825	Hugh H. Eby Inc.	Philadelphia, Pa.
72928	Gudeman Co.	Chicago, Ill.
72962	Elastic Stop Nut Corp.	Union, N.J.
72964	Robert M. Hadley Co.	Los Angeles, Calif.
72982	Erie Technological Products, Inc.	Erie, Pa.
73061	Hansen Mfg. Co., Inc.	Princeton, Ind.
73076	H.M. Harper Co.	Chicago, Ill.
73138	Helipot Div. of Beckman Inst., Inc.	Fullerton, Calif.
73293	Hughes Products Division of Hughes Aircraft Co.	Newport Beach, Calif.
73445	Amperex Elect Co.	Hicksville, L.I., N.Y.
73506	Bradley Semiconductor Corp.	New Haven, Conn.
73559	Carling Electric, Inc.	Hartford, Conn.
73586	Circle F Mfg. Co.	Trenton, N.J.
73682	George K. Garrett Co., Div. MSL Industries Inc.	Philadelphia, Pa.
73734	Federal Screw Products Inc.	Chicago, Ill.
73743	Fischer Special Mfg. Co.	Cincinnati, Ohio
73793	General Industries Co., The	Elyria, Ohio
73846	Goshen Stamping & Tool Co.	Goshen, Ind.
73899	JFD Electronics Corp.	Brooklyn, N.Y.
73905	Jennings Radio Mfg. Corp.	San Jose, Calif.
73957	Groov-Pin Corp.	Ridgefield, N.J.
74276	Signalite Inc.	Neptune, N.J.
74455	J.H. Winns, and Sons	Winchester, Mass.
74861	Industrial Condenser Corp.	Chicago, Ill.
74868	R.F. Products Division of Amphenol-Borg Electronics Corp.	Danbury, Conn.
74970	E.F. Johnson Co.	Waseca, Minn.
75042	International Resistance Co.	Philadelphia, Pa.
75263	Keystone Carbon Co., Inc.	St. Marys, Pa.
75378	CTS Knights Inc.	Sandwich, Ill.
75382	Kulka Electric Corporation	Mt. Vernon, N.Y.
75818	Lenz Electric Mfg. Co.	Chicago, Ill.
75915	Littlefuse, Inc.	Des Plaines, Ill.
76005	Lord Mfg. Co.	Erie, Pa.
76210	C.W. Marwedel	San Francisco, Calif.
76433	General Instrument Corp., Micamold Division	Newark, N.J.
76487	James Millen Mfg. Co., Inc.	Malden, Mass.
76493	J.W. Miller Co.	Los Angeles, Calif.
76530	Cinch-Monadnock, Div. of United Carr Fastener Corp.	San Leandro, Calif.
76545	Mueller Electric Co.	Cleveland, Ohio
76703	National Union	Newark, N.J.
76854	Oak Manufacturing Co.	Crystal Lake, Ill.
77068	The Bendix Corp., Electrodynamics Div.	N. Hollywood, Calif.
77075	Pacific Metals Co.	San Francisco, Calif.
77221	Phanostran Instrument and Electronic Co.	South Pasadena, Calif.
77252	Philadelphia Steel and Wire Corp.	Philadelphia, Pa.
77342	American Machine & Foundry Co. Potter & Brumfield Div.	Princeton, Ind.
77630	TRW Electronic Components Div.	Camden, N.J.
77638	General Instrument Corp., Rectifier Div.	Brooklyn, N.Y.
77764	Resistance Products Co.	Harrisburg, Pa.
77969	Rubbercraft Corp. of Calif.	Torrance, Calif.
78189	Shakeproof Division of Illinois Tool Works	Elgin, Ill.
78277	Sigma	So. Braintree, Mass.
78283	Signal Indicator Corp.	New York, N.Y.
78290	Struthers-Dunn Inc.	Pitman, N.J.
78424	Specialty Leather Prod. Co.	Newark, N.J.
78452	Thompson-Bremer & Co.	Chicago, Ill.
78471	Tilley Mfg. Co.	San Francisco, Calif.
78488	Stackpole Carbon Co.	St. Marys, Pa.
78493	Standard Thomson Corp.	Waltham, Mass.
78553	Tinnerman Products, Inc.	Cleveland, Ohio
78790	Transformer Engineers	San Gabriel, Calif.
78947	Ucinite Co.	Newtonville, Mass.
79136	Waldes Kohinoor Inc.	Long Island City, N.Y.
79142	Veeder Root, Inc.	Hartford, Conn.
79251	Wenco Mfg. Co.	Chicago, Ill.
79727	Continental-Wirt Electronics Corp.	Philadelphia, Pa.
79963	Zierick Mfg. Corp.	New Rochelle, N.Y.
80031	Mepco Division of Sessions Clock Co.	Morristown, N.J.
80120	Schnitzer Alloy Products Co.	Elizabeth, N.J.
80131	Electronic Industries Association. Any brand Tube meeting EIA Standards-Washington, DC	
80707	Unimax Switch, Div. Maxon Electronics Corp.	Wallingford, Conn.
80223	United Transformer Corp.	New York, N.Y.
80248	Oxford Electric Corp.	Chicago, Ill.
80294	Bourns Inc.	Riverside, Calif.
80411	Acro Div. of Robertshaw Controls Co.	Columbus, Ohio

Table 5-4.
CODE LIST OF MANUFACTURERS (Continued)

Code No.	Manufacturer	Address
80486	All Star Products Inc.	Defiance, Ohio
80509	Avery Label Co.	Monrovia, Calif.
80583	Hammarlund Co., Inc.	Mars Hill, N.C.
80640	Stevens, Arnold, Co., Inc.	Boston, Mass.
80813	Dimco Gray Co.	Dayton, Ohio
81030	International Instruments Inc.	Orange, Conn.
81073	Grayhill Co.	LaGrange, Ill.
81095	Triad Transformer Corp.	Venice, Calif.
81312	Winchester Elec. Div. Litton Ind., Inc.	Oakville, Conn.
81349	Military Specification	. . . . .
81483	International Rectifier Corp.	El Segundo, Calif.
81541	Airpax Electronics, Inc.	Cambridge, Maryland
81860	Barry Controls, Div. Barry Wright Corp.	Watertown, Mass.
82042	Carter Precision Electric Co.	Skokie, Ill.
82047	Sperti Faraday Inc., Copper Hewitt Electric Div.	Hoboken, N.J.
82116	Electric Regulator Corp.	Norwalk, Conn.
82142	Jeffers Electronics Division of Speer Carbon Co.	Du Bois, Pa.
82170	Fairchild Camera & Inst. Corp. Space & Defense System Div.	Paramus, N.J.
82209	Maguire Industries, Inc.	Greenwich, Conn.
82219	Sylvania Electric Prod. Inc. Electronic Tube Division	Emporium, Pa.
82376	Astron Corp.	East Newark, Harrison, N.J.
82389	Switchcraft, Inc.	Chicago, Ill.
82647	Metals & Controls Inc. Spencer Products	Attleboro, Mass.
82768	Phillips-Advance Control Co.	Joliet, Ill.
82866	Research Products Corp.	Madison, Wis.
82877	Rotron Mfg. Co., Inc.	Woodstock, N.Y.
82893	Vector Electronic Co.	Glendale, Calif.
83014	Hartwell Corp.	Los Angeles, Calif.
83058	Carr Fastener Co.	Cambridge, Mass.
83086	New Hampshire Ball Bearing, Inc.	Peterborough, N.H.
83125	General Instrument Corp., Capacitor Div.	Darlington, S.C.
83148	ITT Wire and Cable Div.	Los Angeles, Calif.
83186	Victory Eng. Corp.	Springfield, N.J.
83298	Bendix Corp., Red Bank Div.	Red Bank, N.J.
83315	Hubbell Corp.	Mundelein, Ill.
83324	Rosan Inc.	Newport Beach, Calif.
83330	Smith, Herman H., Inc.	Brooklyn, N.Y.
83332	Tech Labs	Palisade's Park, N.J.
83385	Central Screw Co.	Chicago, Ill.
83501	Gavitt Wire and Cable Co. Div. of Amerace Corp.	Brookfield, Mass.
83594	Burroughs Corp. Electronic Tube Div.	Plainfield, N.J.
83740	Union Carbide Corp. Consumer Prod. Div.	New York, N.Y.
83777	Model Eng. and Mfg., Inc.	Huntington, Ind.
83821	Loyd Scruggs Co.	Festus, Mo.
83942	Aeronautical Inst. & Radio Co.	Lodi, N.J.
84171	Arco Electronics Inc.	Great Neck, N.Y.
84396	A.J. Glesener Co., Inc.	San Francisco, Calif.
84411	TRW Capacitor Div.	Ogallala, Neb.
84970	Sarkes Tarzian, Inc.	Bloomington, Ind.
85454	Boonton Molding Company	Boonton, N.J.
85471	A.B. Boyd Co.	San Francisco, Calif.
85474	R.M. Bracamonte & Co.	San Francisco, Calif.
85660	Koiled Kords, Inc.	Hamden, Conn.
85911	Seamless Rubber Co.	Chicago, Ill.
86174	Fafnir Bearing Co.	Los Angeles, Calif.
86197	Clifton Precision Products Co., Inc.	Clifton Heights, Pa.
86579	Precision Rubber Products Corp.	Dayton, Ohio
86684	Radio Corp. of America, Electronic Comp. & Devices Div.	Harrison, N.J.
86928	Seastrom Mfg. Co.	Glendale, Calif.
87034	Marco Industries	Anaheim, Calif.
87216	Philco Corporation (Lansdale Division)	Lansdale, Pa.
87473	Western Fibrous Glass Products Co.	San Francisco, Calif.
87664	Van Waters & Rogers Inc.	San Francisco, Calif.
87930	Tower Mfg. Corp.	Providence, R.I.
88140	Cutler-Hammer, Inc.	Lincoln, Ill.
88220	Gould-National Batteries, Inc.	St. Paul, Minn.
88698	General Mills, Inc.	Buffalo, N.Y.
89231	Graybar Electric Co.	Oakland, Calif.
89473	G.E. Distributing Corp.	Schenectady, N.Y.
89665	United Transformer Co.	Chicago, Ill.
90030	United Shoe Machinery Corp.	Beverly, Mass.
90179	US Rubber Co., Consumer Ind. & Plastics Prod. Div.	Passaic, N.J.
90970	Bearing Engineering Co.	San Francisco, Calif.
91146	ITT Cannon Elect, Inc., Salem Div.	Salem, Mass.
91260	Connor Spring Mfg. Co.	San Francisco, Calif.
91345	Miller Dial & Nameplate Co.	El Monte, Calif.
91418	Radio Materials Co.	Chicago, Ill.
91506	Augat Inc.	Attleboro, Mass.
91637	Dale Electronics, Inc.	Columbus, Nebr.
91662	Elco Corp.	Willow Grove, Pa.
91737	Gremar Mfg. Co., Inc.	Wakefield, Mass.
91827	K F Development Co.	Redwood City, Calif.
91886	Malco Mfg. Co., inc.	Chicago, Ill.
91929	Honeywell Inc., Micro Switch Div.	Freeport, Ill.
91961	Nahm-Bros. Spring Co.	Oakland, Calif.
92180	Tru-Connector Corp.	Peabody, Mass.
92367	Elgeet Optical Co. Inc.	Rochester, N.Y.
92607	Tensolite Insulated Wire Co., Inc.	Tarrytown, N.Y.
92702	IMC Magnetics Corp.	Wesbury Long Island, N.Y.
92966	Hudson Lamp Co.	Kearney, N.J.
93332	Sylvania Electric Prod. Inc. Semiconductor Div.	Woburn, Mass.
93369	Robbins & Myers Inc.	Palisades Park, N.J.
93410	Stemco Controls, Div. of Essex Wire Corp.	Mansfield, Ohio
93632	Waters Mfg. Co.	Culver City, Calif.
93929	G.V. Controls	Livingston, N.J.
94137	General Cable Corp.	Bayonne, N.J.
94142	Phelps Dodge	Yonkers, N.Y.
94144	Raytheon Co., Comp. Div., Ind. Comp. Operations	Quincy, Mass.
94148	Scientific Electronics Products, Inc.	Loveland, Colo.
94154	Wagner Elect. Corp., Tung-Sol Div.	Newark, N.J.
94197	Curtiss-Wright Corp. Electronics Div.	East Paterson, N.J.
94222	South Chester Corp.	Chester, Pa.
94330	Wire Cloth Products, Inc.	Bellwood, Ill.
94375	Automatic Metal Products Co.	Brooklyn, N.Y.
94662	Worcester Pressed Aluminum Corp.	Worcester, Mass.
94696	Magnecraft Electric Co.	Chicago, Ill.
95023	George A. Philbrick Researchers, Inc.	Boston, Mass.
95236	Allies Products Corp.,	Dania, Fla.
95238	Continental Connector Corp.	Woodside, N.Y.
95263	Leecraft Mfg. Co., inc.	Long Island, N.Y.
95265	National Coil Co.	Sheridan, Wyo.
95275	Vitramon, Inc.	Bridgeport, Conn.
95348	Gordos Corp.	Bloomfield, N.J.
95354	Methode Mfg. Co.	Rolling Meadows, Ill.
95566	Arnold Engineering Co.	Marengo, Ill.
95712	Dage Electric Co., Inc.	Franklin, Ind.
95984	Siemon Mfg. Co.	Wayne, Ill.
95987	Weckesser Co.	Chicago, Ill.
96067	Microwave Assoc., West Inc.	Sunnyvale, Calif.
96095	Hi-Q Div. of Aerovox Corp.	Olean, N.Y.
96256	Thordarson-Meissner Inc.	Mt. Carmel, Ill.
96296	Solar Manufacturing Co.	Los Angeles, Calif.
96306	Microswitch, Div. of Minn.-Honeywell	Freeport, Ill.
96330	Carlton Screw Co.	Chicago, Ill.
96341	Microwave Associates, Inc.	Burlington, Mass.
96501	Excel Transformer Co.	Oakland, Calif.
96733	San Fernando Elect. Mfg. Co.	San Fernando, Calif.
96881	Thomson Ind. Inc.	Long Is., N.Y.
97464	Industrial Retaining Ring Co.	Irvington, N.J.
97539	Automatic & Precision Mfg.	Englewood, N.J.
97979	Reon Resistor Corp.	Yonkers, N.Y.
97983	Litton System Inc., Adler-Westrex Commun. Div.	New Rochelle, N.Y.
98141	R-Troncis, Inc.	Jamaica, N.Y.
98159	Rubber Teck, Inc.	Gardena, Calif.
98220	Hewlett-Packard Co., Moseley Div.	Pasadena, Calif.
98278	Microdot, Inc.	So. Pasadena, Calif.
98291	Sealectro Corp.	Mamaroneck, N.Y.
98376	Zero Mfg. Co.	Burbank, Calif.
98410	Etc Inc.	Cleveland, Ohio
98731	General Mills Inc., Electronics Div.	Minneapolis, Minn.
98734	Paeco Div. of Hewlett-Packard Co.	Palo Alto, Calif.
98821	North Hills Electronics, Inc.	Glen Cove, N.Y.
98978	International Electronic Research Corp.	Burbank, Calif.
99109	Columbia Technical Corp.	New York, N.Y.
99313	Varian Associates	Palo Alto, Calif.
99378	Atlee Corp.	Winchester, Mass.
99515	Marshall Ind., Capacitor Div.	Monrovia, Calif.
99707	Control Switch Division, Controls Co. of America	El Segundo, Calif.
99800	Delevan Electronics Corp.	East Aurora, N.Y.
99848	Wilco Corporation	Indianapolis, Ind.
99928	Branson Corp.	Whippany, N.J.
99934	Renbrandt, Inc.	Boston, Mass.
99942	Hoffman Electronics Corp. Semiconductor Div.	El Monte, Calif.
99957	Technology Instrument Corp. of Calif.	Newbury Park, Calif.

THE FOLLOWING HP VENDORS HAVE NO NUMBER ASSIGNED IN THE LATEST SUPPLEMENT TO THE FEDERAL SUPPLY CODE FOR MANUFACTURERS HANDBOOK.

0000F	Malco Tool and Die	Los Angeles, Calif.
0000Z	Willow Leather Products Corp.	Newark, N.J.
000AB	ETA	England
000BB	Precision Instrument Components Co.	Van Nuys, Calif.
000CS	Hewlett-Packard Co., Colorado Springs	Colorado Springs, Colorado
000MM	Rubber Eng. & Development	Hayward, Calif.
000NN	A [illegible] D Mfg. Co.	San Jose, Calif.
000QQ	Cooltron	Oakland, Calif.
000WW	California Eastern Lab.	Burlington, Calif.
000YY	S.K. Smith Co.	Los Angeles, Calif.

HEWLETT hp PACKARD

MANUAL SUPPLEMENT

DIAGNOSTIC PROGRAM

for

12554A AND 12554A-01

16-BIT DUPLEX REGISTER INTERFACE KITS

12554-90021
12554-90022

HEWLETT-PACKARD COMPANY
11000 WOLFE ROAD, CUPERTINO, CALIFORNIA, U.S.A.

SEPT 1969

DIAGNOSTIC TEST PROCEDURE
12554A AND 12554A-01
16-BIT DUPLEX REGISTER INTERFACE KITS

GENERAL.

The diagnostic test program (part no. 20416C) for the 12554A and 12554A-01 Interface Kits performs an operational check of the 16-bit duplex register card which is contained in each kit. The program is designed for maximum speed in testing and may be used with any of the 2114, 2115, and 2116 Hewlett-Packard computers.

The test program consists of a background control program and three task routines. The background program obtains information via the teleprinter and the switch register, controls message printout, and directs task performance according to the information. The first task routine inserts the address of the duplex register card into all input/output instructions. The second task routine (also referred to as the basic test) checks the flag, control, and interrupt circuitry on the duplex register card. The third task routine (also referred to as the data buffer test) checks the input and output storage registers and associated discrete circuitry on the duplex register card by transferring all possible combinations of 16 bits through the registers. When using the diagnostic test program, the computer operator may choose to repeat each task routine a number of times or may simply run the entire program, stopping at the end of each task routine to evaluate the results.

REQUIRED EXTERNAL DEVICES.

To allow communication between the operator and the computer during the diagnostic test, a buffered teleprinter must be interconnected to the computer. The teleprinter may also be used to load the diagnostic test program into the computer if another program-loading device is not available.

DIAGNOSTIC TEST OPERATING PROCEDURE.

To perform the diagnostic test program, do the following:

a. After installation of the 16-bit duplex register card is complete, install the 24-pin test connector (part no. 1251-0332) on the card.

b. Ensure that relocatable jumper W6 is in position ''B''.

c. To load the diagnostic test program and prepare the computer for program execution, do the following:

(1) Set the switch register to 000002_8.

(2) Press the LOAD ADDRESS switch.

(3) Set the switch register to the address (octal) of the buffered teleprinter.

(4) Press the RUN switch.

d. The computer will then cause the teleprinter to print the ollowing:

16 BIT DUPLEX REGISTER DIAGNOSTIC
I/O CHANNEL?

e. Using the teleprinter, enter the address of the duplex regis- er card followed by a line termination (RETURN, LINE FEED), into the omputer.

f. In reply the computer will cause the teleprinter to print the ollowing:

SET SW. REG. FOR DATA BITS TO BE TESTED.

g. The program will then halt with the following indications:

(1) The M and P registers will read 203_8.

(2) The A, B, and T registers will read 102002_8.

h. Set all switches of the switch register to ''1'' and press the RUN switch.

i. The computer will cause the teleprinter to print the following:

SET SW. REG. FOR DESIRED PROGRAM OPTIONS.

j. The computer will then halt with the following indications:

(1) The M and P registers will read 214_8.

(2) The A, B, and T registers will read 102001_8.

k. Set the switch register switches to the desired control function setting (see table 1) and press the RUN switch.

PROGRAM CONTROL.

After completion of steps ''a'' through ''k'' of the diagnostic test operating procedure above, control of the diagnostic test program is accomplished through the switch register. Switch register settings and corresponding control functions are provided by table 1.

Table 1. Switch Register Control Functions

SWITCH REGISTER SETTINGS						CONTROL FUNCTIONS
BITS	4	3	2	1	0	
	0	0	0	0	1	Computer will enter the program at step ''d'' of the diagnostic test operating procedure.
	0	0	0	1	0	Computer will enter the program at step ''j'' of the diagnostic test operating procedure.
	0	0	1	0	0	Computer will not print a message at the beginning and end of each test.
	0	1	0	0	0	Computer will perform the basic test of flag, control, and interrupt circuitry.
	1	0	0	0	0	Computer will perform the data buffer test.
NOTE: Bits 5 through 15 do not affect the control functions.						

EXTERNAL INTERRUPT.

If any other I/O device should request an interrupt during performance of the diagnostic test program, the test program will halt. The address of the interrupting device will be displayed by the last six bits in the T-register.

ERROR CODES.

The error codes for the basic test are listed in table 2.

Errors for the data buffer test are as follows:

a. If the data transferred to the output storage register does not equal the data fed back from the input storage register, the following codes will be printed:

OUTPUT = $XXXXXX_8$ INPUT = $XXXXXX_8$

b. If the flag is not set within 12 microseconds after a STC XX, C instruction, the following will be printed:

FLAG FAILURE IN DATA TEST

c. If any one of the IOBI drivers is not working properly, the following will be printed (decoding the octal number to binary will show the drivers which are bad):

IOBI ERROR = $XXXXXX_8$

Table 2. Error Codes for the Basic Test

CODE	DEFINITION
E01	SFS XX True after CLF XX Instruction
E02	SFC XX False after CLF XX Instruction
E03	SFS XX False after STF XX Instruction
E04	SFC XX True after STF XX Instruction
E05	SFS XX True after CLF XX Instruction
E06	SFC XX False after CLF XX Instruction
E07	SFS XX False after STC XX,C Instruction
E10	SFC XX True after STC XX,C Instruction
E11	Failure to interrupt after STF 0, STC XX, STF XX
E12	SFS XX False after interrupt test
E13	SFC XX True after interrupt test
E14	Program address = XXXXXX Illegal Interrupt from Duplex Register

```
0001                    ASMB,A,R,L
0002*
0003*
0004*
0005*16 BIT DUPLEX REGISTER DIAGNOSTIC
0006*
0007*
0008*
0009*STARTING OCTAL ADDRESS = 100
0010*
0011*
0012*THE FOLLOWING SWITCH REGISTER SETTINGS
0013*ARE USED FOR PROGRAM CONTROL
0014*
0015******
0016*BIT 0 = 1   ->  HALT AT BEGINNING OF PROGRAM
0017*BIT 1 = 1   ->  HALT AT BEGINNING OF BASIC TEST
0018*BIT 2 = 1   ->  SUPPRESS SUPERFLUOUS MESSAGES
0019*BIT 3 = 1   ->  PERFORM BASIC TEST
0020*BIT 4 = 1   ->  PERFORM DATA BUFFER TEST
0021******
0022*
0023*
0024*MAIN PROGRAM
0025*
0026*
0027  00100                 ORG 100B
0028  00100 024110          JMP 1108
0029  00105                 ORG 105B
0030  00105 001337          DEF X           FIRST AVAIL MEMORY
0031  00110                 ORG 1108
0032  00110 107700          CLC 0,C       INTERRUPT OFF
0033  00111 014456          JSB EOL       LINE FEED
0034  00112 060311          LDA ML1       PRINT
0035  00113 064267          LDB MAD1        FIRST
0036  00114 114102          JSB 102B,I        MESSAGE
0037  00115 014456          JSB EOL       LINE FEED
0038  00116 024122          JMP *+4
0039  00117 060121  P1      LDA *+2       HALT AT
0040  00120 064121          LDB *+1         BEGINNING
0041  00121 102000          HLT 0             OF PROGRAM
0042  00122 064452          LDB M67       PREPARE
0043  00123 060457          LDA HIS         TRAP
0044  00124 070126          STA *+2           FOR
0045  00125 060450          LDA HI              ILLEGAL
0046  00126 070010          STA 10B               INTERRUPT
0047  00127 034126          ISZ *-1                 FROM
0048  00130 002004          INA                       ANY
0049  00131 005046          INB,SZR                     DEVICE
0050  00132 024126          JMP *-4
0051  00133 014456  P2      JSB EOL       LINE FEED
0052  00134 060321          LDA ML2       PRINT
0053  00135 064312          LDB MAD2        SECOND
0054  00136 114102          JSB 102B,I        MESSAGE
0055  00137 014455          JSB EOL       LINE FEED
0056  00140 060456          LDA RL1       RECEIVE
0057  00141 064454          LDB RAD1        FIRST
```

```
0058  00142 114134          JSB 1048,I        REPLY
0059  00143 060455          LDA REP1      CHECK FIRST CHARACTER
0060  00144 010453          AND MSK1        FOR VALIDITY
0061  00145 050465          CPA C1        VALID?
0062  00146 024150          JMP *+2       YES.
0063  00147 024133          JMP P2        NO.
0064  00150 060455          LDA REP1      CHECK SECOND
0065  00151 001727          ALF,ALF         CHARACTER
0066  00152 010453          AND MSK1          FOR VALIDITY
0067  00153 050465          CPA C1        VALID?
0068  00154 024156          JMP *+2       YES.
0069  00155 024133          JMP P2        NO.
0070  00156 002400          CLA           GENERATE
0071  00157 060455          LDA REP1        DUPLEX
0072  00160 010454          AND MSK2          REGISTER
0073  00161 070522          STA ADDR            ADDRESS
0074  00162 060455          LDA REP1
0075  00163 001727          ALF,ALF
0076  00164 010454          AND MSK2
0077  00165 001721          ALF,ARS
0078  00166 030522          IOR ADDR
0079  00167 070522          STA ADDR      ADDRESS COMPLETE
0080  00170 014533          JSB ADIN
0081  00171 060451          LDA IBAD      ILLEGAL INTERRUPT
0082  00172 074000  STA1    STA 0           TRAP
0083  00173 014456          JSB EOL
0084  00174 060347          LDA ML3       PRINT
0085  00175 064322          LDB MAD3        THIRD
0086  00176 114102          JSB 1028,I        MESSAGE
0087  00177 014456          JSB EOL
0088  00200 060202          LDA *+2       HALT
0089  00201 064202          LDB *+1         TO SET
0090  00202 102002          HLT 2             SW. REG.
0091  00203 102501          LIA 1         LOAD MASK FOR
0092  00204 071257          STA DAMSK       DATA TESTING
0093  00205 060375          LDA ML4       SET SW. REG.
0094  00206 064350          LDB MAD4        FOR DESIRED
0095  00207 114102          JSB 1028,I        PROGRAM OPTIONS
0096  00210 014456          JSB EOL
0097  00211 060213  P3      LDA *+2       HALT AT
0098  00212 064213          LDB *+1         BEGINNING
0099  00213 102001          HLT 1             OF BASIC TEST
0100  00214 014531  P4      JSB MODE      CHECK SW. REG.
0101  00215 060531          LDA BIT3      PERFORM
0102  00216 002011          SLA,RSS         BASIC TEST?
0103  00217 024241          JMP P5        NO.
0104  00220 050530          LDA BIT2      YES.  SUPPRESS
0105  00221 000010          SLA             MESSAGES?
0106  00222 024230          JMP *+6       YES.
0107  00223 014456          JSB EOL       NO.
0108  00224 060407          LDA ML5       PRINT FIRST
0109  00225 064376          LDB MAD5        BASIC TEST
0110  00226 114102          JSB 1028,I        MESSAGE
0111  00227 014456          JSB EOL
0112  00230 014523          JSB BAT       PERFORM BASIC TEST
0113  00231 064530          LDA BIT2      SUPPRESS
0114  00232 000010          SLA             MESSAGES?
```

```
0001                    ASMB,A,R,L
0002*
0003*
0004*
0005*16 BIT DUPLEX REGISTER DIAGNOSTIC
0006*
0007*
0008*
0009*STARTING OCTAL ADDRESS = 100
0010*
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0012*THE FOLLOWING SWITCH REGISTER SETTINGS
0013*ARE USED FOR PROGRAM CONTROL
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0018*BIT 2 = 1   ->  SUPPRESS SUPERFLUOUS MESSAGES
0019*BIT 3 = 1   ->  PERFORM BASIC TEST
0020*BIT 4 = 1   ->  PERFORM DATA BUFFER TEST
0021******
0022*
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0024*MAIN PROGRAM
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0027  00100                 ORG 100B
0028  00100 024110          JMP 110B
0029  00105                 ORG 105B
0030  00105 001337          DEF X           FIRST AVAIL MEMORY
0031  00110                 ORG 110B
0032  00110 107700          CLC 0,C         INTERRUPT OFF
0033  00111 014456          JSB EOL         LINE FEED
0034  00112 060311          LDA ML1         PRINT
0035  00113 064267          LDB MAD1          FIRST
0036  00114 114102          JSB 102B,I          MESSAGE
0037  00115 014456          JSB EOL         LINE FEED
0038  00116 024122          JMP *+4
0039  00117 060121  P1      LDA *+2         HALT AT
0040  00120 064121          LDB *+1           BEGINNING
0041  00121 102000          HLT 0               OF PROGRAM
0042  00122 064452          LDB M67         PREPARE
0043  00123 060457          LDA HIS           TRAP
0044  00124 070126          STA *+2             FOR
0045  00125 060450          LDA HI                ILLEGAL
0046  00126 070010          STA 10B                 INTERRUPT
0047  00127 034126          ISZ *-1                   FROM
0048  00130 002004          INA                         ANY
0049  00131 006006          INB,SZB                       DEVICE
0050  00132 024126          JMP *-4
0051  00133 014456  P2      JSB EOL         LINE FEED
0052  00134 060321          LDA ML2         PRINT
0053  00135 064312          LDB MAD2          SECOND
0054  00136 114102          JSB 102B,I          MESSAGE
0055  00137 014455          JSB EOL         LINE FEED
0056  00140 060456          LDA RL1         RECEIVE
0057  00141 064454          LDB RAD1          FIRST
```

```
0058  00142 114134          JSB 1048,I        REPLY
0059  00143 060455          LDA REP1      CHECK FIRST CHARACTER
0060  00144 010453          AND MSK1        FOR VALIDITY
0061  00145 050455          CPA C1        VALID?
0062  00146 024150          JMP *+2       YES.
0063  00147 024133          JMP P2        NO.
0064  00150 060455          LDA REP1      CHECK SECOND
0065  00151 001727          ALF,ALF         CHARACTER
0066  00152 010453          AND MSK1          FOR VALIDITY
0067  00153 050455          CPA C1        VALID?
0068  00154 024156          JMP *+2       YES.
0069  00155 024133          JMP P2        NO.
0070  00156 002400          CLA           GENERATE
0071  00157 060455          LDA REP1        DUPLEX
0072  00160 010454          AND MSK2          REGISTER
0073  00161 070522          STA ADDR            ADDRESS
0074  00162 060455          LDA REP1
0075  00163 001727          ALF,ALF
0076  00164 010454          AND MSK2
0077  00165 001721          ALF,ARS
0078  00166 030522          IOR ADDR
0079  00167 070522          STA ADDR      ADDRESS COMPLETE
0080  00170 014533          JSB ADIN
0081  00171 060451          LDA IBAD      ILLEGAL INTERRUPT
0082  00172 070000  STA1    STA 0           TRAP
0083  00173 014456          JSB EOL
0084  00174 060347          LDA ML3       PRINT
0085  00175 064322          LDB MAD3        THIRD
0086  00176 114102          JSB 1028,I        MESSAGE
0087  00177 014456          JSB EOL
0088  00200 060202          LDA *+2       HALT
0089  00201 064202          LDB *+1         TO SET
0090  00202 102002          HLT 2             SW. REG.
0091  00203 102501          LIA 1         LOAD MASK FOR
0092  00204 071257          STA DAMSK       DATA TESTING
0093  00205 060375          LDA ML4       SET SW. REG.
0094  00206 064350          LDB MAD4        FOR DESIRED
0095  00207 114102          JSB 1028,I        PROGRAM OPTIONS
0096  00210 014456          JSB EOL
0097  00211 060213  P3      LDA *+2       HALT AT
0098  00212 064213          LDB *+1         BEGINNING
0099  00213 102001          HLT 1             OF BASIC TEST
0100  00214 014531  P4      JSB MODE      CHECK SW. REG.
0101  00215 060531          LDA BIT3      PERFORM
0102  00216 002011          SLA,RSS         BASIC TEST?
0103  00217 024241          JMP P5        NO.
0104  00220 060530          LDA BIT2      YES.  SUPPRESS
0105  00221 000010          SLA             MESSAGES?
0106  00222 024230          JMP *+6       YES.
0107  00223 014456          JSB EOL       NO.
0108  00224 060407          LDA ML5       PRINT FIRST
0109  00225 064376          LDB MAD5        BASIC TEST
0110  00226 114102          JSB 1028,I        MESSAGE
0111  00227 014456          JSB EOL
0112  00230 014523          JSB BAT       PERFORM BASIC TEST
0113  00231 060530          LDA BIT2      SUPPRESS
0114  00232 000010          SLA             MESSAGES?
```

```
0115  00233 024241          JMP *+6       YES.
0116  00234 014456          JSB EOL       NO.
0117  00235 050421          LDA ML6       PRINT SECOND
0118  00236 054410          LDB MAD6        BASIC TEST
0119  00237 114102          JSB 1028,I        MESSAGE
0120  00240 014456          JSB EOL
0121  00241 014501  P5      JSB MODE      CHECK SW. REG.
0122  00242 060532          LDA BIT4      PERFORM DATA
0123  00243 002011          SLA,RSS         BUFFER TEST?
0124  00244 024214          JMP P4        NO.
0125  00245 060530          LDA BIT2      YES.  SUPPRESS
0126  00246 000010          SLA             MESSAGES?
0127  00247 024255          JMP *+6       YES.
0128  00250 014456          JSB EOL       NO.
0129  00251 060436          LDA ML7       PRINT FIRST
0130  00252 054422          LDB MAD7        DATA TEST
0131  00253 114102          JSB 1028,I        MESSAGE
0132  00254 014456          JSB EOL
0133  00255 015120          JSB DAT       PERFORM DATA BUFFER TEST
0134  00256 060530          LDA BIT2      SUPPRESS
0135  00257 000010          SLA             MESSAGES?
0136  00260 024214          JMP P4        YES.
0137  00261 014456          JSB EOL       NO.
0138  00262 050453          LDA ML8       PRINT SECOND
0139  00263 054437          LDB MAD8        DATA TEST
0140  00264 114102          JSB 1028,I        MESSAGE
0141  00265 014456          JSB EOL
0142  00266 024214          JMP P4
0143*
0144*
0145  00267 000270  MAD1    DEF *+1
0146  00270 030466  MES1    ASC 17,16 BIT DUPLEX REGISTER DIAGNOSTIC
      00271 020102
      00272 044524
      00273 020104
      00274 052520
      00275 045105
      00276 054040
      00277 051105
      00300 043511
      00301 051524
      00302 042522
      00303 020124
      00304 044501
      00305 043516
      00306 047523
      00307 052111
      00310 041440
0147  00311 000042  ML1     DEC 34
0148*
0149  00312 000313  MAD2    DEF *+1
0150  00313 044457  MES2    ASC 6,I/O CHANNEL?
      00314 047440
      00315 041510
      00316 040516
      00317 047105
      00320 046077
```

```
0151   00321 000014   ML2    DEC 12
0152*
0153   00322 000323   MAD3   DEF *+1
0154   00323 051505   MES3   ASC 20,SET SW. REG. FOR DATA BITS TO BE TESTED
       00324 052040
       00325 051527
       00326 027040
       00327 051105
       00330 043456
       00331 020136
       00332 047522
       00333 020124
       00334 042524
       00335 040440
       00336 041111
       00337 052123
       00340 020124
       00341 047440
       00342 041105
       00343 020124
       00344 042523
       00345 052105
       00346 042040
0155   00347 000050   ML3    DEC 40
0156*
0157   00350 000351   MAD4   DEF *+1
0158   00351 051505   MES4   ASC 20,SET SW. REG. FOR DESIRED PROGRAM OPTION
       00352 052040
       00353 051527
       00354 027040
       00355 051105
       00356 043455
       00357 020136
       00360 047522
       00361 020124
       00362 042523
       00363 044522
       00364 042504
       00365 020120
       00366 051117
       00367 043522
       00370 040515
       00371 020117
       00372 050124
       00373 044517
       00374 047123
0159   00375 000050   ML4    DEC 40
0160*
0161   00376 000377   MAD5   DEF *+1
0162   00377 041105   MES5   ASC 8,BEGIN BASIC TEST
       00400 043511
       00401 047040
       00402 041101
       00403 051511
       00404 041440
       00405 052105
       00406 051524
```

```
0163   00407 000020   ML5    DEC 16
0164*
0165   00410 000411   MAD6   DEF *+1
0166   00411 042516   MES6   ASC 8,END    BASIC TEST
       00412 042040
       00413 020040
       00414 041101
       00415 051511
       00416 041440
       00417 052105
       00420 051524
0167   00421 000020   ML6    DEC 16
0168*
0169   00422 000423   MAD7   DEF *+1
0170   00423 041105   MES7   ASC 11,BEGIN DATA BUFFER TEST
       00424 043511
       00425 047040
       00426 042101
       00427 052101
       00430 020102
       00431 052506
       00432 043105
       00433 051040
       00434 052105
       00435 051524
0171   00436 000026   ML7    DEC 22
0172*
0173   00437 000440   MAD8   DEF *+1
0174   00440 042516   MES8   ASC 11,END    DATA BUFFER TEST
       00441 042040
       00442 020040
       00443 042101
       00444 052101
       00445 020102
       00446 052506
       00447 043105
       00450 051040
       00451 052105
       00452 051524
0175   00453 000026   ML8    DEC 22
0176*
0177   00454 000455   RAD1   DEF *+1
0178   00455 000000   REP1   OCT 0
0179   00456 000002   RL1    OCT 2
0180*
0181   00457 070010   HIS    STA 10B
0182   00460 102010   HI     HLT 10B
0183   00461 015045   IBAD   JSB ILINT
0184   00462 177711   M67    OCT 177711
0185   00463 000170   MSK1   OCT 170
0186   00464 000007   MSK2   OCT 7
0187   00465 000060   C1     OCT 60
0188*
0189*LINE FEED, CARRIAGE RETURN
0190*
0191   00466 000000   EOL    NOP            ENTER SUBROUTINE
0192   00467 070477          STA AS1        STORE
```

```
0193  00470 074500          STB BS1         A & B
0194  00471 002400          CLA           LINE
0195  00472 006400          CLB             FEED
0196  00473 114102          JSB 102B,I
0197  00474 062477          LDA AS1       RESTORE
0198  00475 064500          LDB BS1         A & B
0199  00476 124466          JMP EOL,I     EXIT SUBROUTINE
0200  00477 000000  AS1     OCT 0
0201  00500 000000  BS1     OCT 0
0202*
0203*MODE SUBROUTINE
0204*
0205  00501 000000  MODE    NOP           ENTER SUBROUTINE
0206  00502 070525          STA AS2       STORE A
0207  00503 102501          LIA 1         EACH BIT
0208  00504 070526          STA BIT0       FROM THE
0209  00505 001300          RAR              SWITCH REGISTER
0210  00506 070527          STA BIT1          IS ROTATED
0211  00507 001300          RAR                INTO THE
0212  00510 070530          STA BIT2            LEAST SIGNIFICANT
0213  00511 001300          RAR                  POSITION AND
0214  00512 070531          STA BIT3               STORED IN THE
0215  00513 001300          RAR                      STORAGE LOCATION
0216  00514 070532          STA BIT4                   BEARING ITS NAME
0217  00515 060526          LDA BIT0      HALT AT
0218  00516 000010          SLA             BEGINNING OF PROGRAM?
0219  00517 024117          JMP P1        YES.
0220  00520 060527          LDA BIT1      NO.  HALT AT
0221  00521 000010          SLA             BEGINNING OF BASIC TEST?
0222  00522 024211          JMP P3        YES.
0223  00523 060525          LDA AS2       NO.  RESTORE A
0224  00524 124501          JMP MODE,I    EXIT SUBROUTINE
0225  00525 000000  AS2     OCT 0
0226  00526 000000  BIT0    OCT 0
0227  00527 000000  BIT1    OCT 0
0228  00530 000000  BIT2    OCT 0
0229  00531 000000  BIT3    OCT 0
0230  00532 000000  BIT4    OCT 0
0231*
0232*
0233*ADDRESS INCLUSION ROUTINE
0234*
0235*
0236  00533 000000  ADIN    NOP           ENTER ROUTINE
0237  00534 107700          CLC 0,C       INTERRUPT SYSTEM OFF
0238  00535 014515          JSB INCLU     PUT DUPLEX REG. ADDR.
0239  00536 072000          STA 0           INTO STA INSTRUCTIONS
0240  00537 070172          STA STA1
0241  00540 070723          STA STA2
0242  00541 070732          STA STA3
0243  00542 014515          JSB INCLU     SAME FOR STC XX,C
0244  00543 103700          STC 0,C
0245  00544 070525          STA STCC1
0246  00545 070702          STA STCC2
0247  00546 071174          STA STCC3
0248  00547 014515          JSB INCLU     SAME FOR SFS XX
0249  00550 102300          SFS 0
```

```
0250   00551 070552          STA SFS1
0251   00552 070552          STA SFS2
0252   00553 070572          STA SFS3
0253   00554 070706          STA SFS4
0254   00555 070733          STA SFS5
0255   00556 071200          STA SFS6
0256   00557 014515          JSB INCLU     SAME FOR SFC XX
0257   00560 102200          SFC 0
0258   00561 070556          STA SFC1
0259   00562 070565          STA SFC2
0260   00563 070576          STA SFC3
0261   00564 070711          STA SFC4
0262   00565 070736          STA SFC5
0263   00566 014515          JSB INCLU     SAME FOR CLF XX
0264   00567 103100          CLF 0
0265   00570 070532          STA CLF1
0266   00571 070571          STA CLF2
0267   00572 014515          JSB INCLU     SAME FOR STF XX
0268   00573 102100          STF 0
0269   00574 070561          STA STF1
0270   00575 070716          STA STF2
0271   00576 071122          STA STF3
0272   00577 014515          JSB INCLU     SAME FOR CLC XX
0273   00600 103700          CLC 0
0274   00601 070715          STA CLC1
0275   00602 071154          STA CLC2
0276   00603 014515          JSB INCLU     SAME FOR STC XX
0277   00604 102700          STC 0
0278   00605 070724          STA STC1
0279   00606 014515          JSB INCLU     SAME FOR OTA XX
0280   00607 102500          OTA 0
0281   00610 071152          STA OTA1
0282   00611 014515          JSB INCLU     SAME FOR LIB XX
0283   00612 105500          LIB 0
0284   00613 071202          STA LIB1
0285   00614 124533          JMP ADIN,I    EXIT ROUTINE
0286*
0287*INCLUSION SUBROUTINE
0288*
0289   00615 000000  INCLU   NOP           ENTER SUBROUTINE
0290   00616 160515          LDA INCLU,I   PUT ADDRESS
0291   00617 030622          IOR ADDR        INTO INSTRUCTION
0292   00620 034515          ISZ INCLU     EXIT
0293   00621 124515          JMP INCLU,I     SUBROUTINE
0294   00622 000000  ADDR    OCT 0         ADDRESS STORAGE
0295*
0296*
0297*BASIC TEST ROUTINE
0298*
0299*
0300   00623 000000  BAT     NOP           ENTER ROUTINE
0301   00624 107700          CLC 0,C
0302   00625 103704  STCC1   STC 0,C
0303   00626 051774          LDA C2
0304   00627 002006          INA,SZA
0305   00630 024527          JMP *-1
0306   00631 107700          CLC 0,C
```

```
0307   00632 103100  CLF1   CLF 0
0308   00633 102100         STF 0          INTERRUPT SYSTEM ON
0309   00634 006400         CLB            INITIALIZE
0310   00635 074757         STB E1           ERROR
0311   00636 074770         STB E2             BUFFER
0312   00637 074771         STB E3
0313   00640 074772         STB E4
0314   00641 074773         STB E5
0315   00642 074774         STB E6
0316   00643 074775         STB E7
0317   00644 074776         STB E10
0318   00645 074777         STB E11
0319   00646 075000         STB E12
0320   00647 075001         STB E13
0321   00650 075003         STB E14
0322   00651 005004         INB
0323   00652 102300  SFS1   SFS 0          FLAG SET?
0324   00653 024655         JMP *+2        NO.
0325   00654 074757         STB E1         YES.  ERROR 1
0326   00655 005004         INB            INCREMENT ERROR CODE
0327   00656 102200  SFC1   SFC 0          FLAG CLEAR?
0328   00657 074770         STB E2         NO.  ERROR 2
0329   00660 005004         INB            YES.
0330   00661 102100  STF1   STF 0          SET FLAG
0331   00662 102300  SFS2   SFS 0          FLAG SET?
0332   00663 074771         STB E3         NO.  ERROR 3
0333   00664 005004         INB            YES.
0334   00665 102200  SFC2   SFC 0          FLAG CLEAR?
0335   00666 024670         JMP *+2        NO.
0336   00667 074772         STB E4         YES.  ERROR 4
0337   00670 005004         INB
0338   00671 103100  CLF2   CLF 0          CLEAR FLAG
0339   00672 102300  SFS3   SFS 0          FLAG SET?
0340   00673 024675         JMP *+2        NO.
0341   00674 074773         STB E5         YES.  ERROR 5
0342   00675 005004         INB
0343   00676 102200  SFC3   SFC 0          FLAG CLEAR?
0344   00677 074774         STB E6         NO.  ERROR 6
0345   00700 006004         INB            YES.
0346   00701 107700         CLC 0,C        INTERRUPT SYSTEM OFF
0347   00702 103700  STCC2  STC 0,C        ENCODE
0348   00703 051004         LDA C2         WAIT
0349   00704 002006         INA,SZA          FOR
0350   00705 024704         JMP *-1            FLAG
0351   00706 102300  SFS4   SFS 0          FLAG SET?
0352   00707 074775         STB E7         NO.  ERROR 7
0353   00710 005004         INB            YES.
0354   00711 102200  SFC4   SFC 0          FLAG CLEAR?
0355   00712 024714         JMP *+2        NO.
0356   00713 074776         STB E10        YES.  ERROR 10
0357   00714 005004         INB
0358   00715 105700  CLC1   CLC 0          CLEAR CONTROL
0359   00716 102100  STF2   STF 0          SET FLAG
0360   00717 102100         STF 0          INTERRUPT SYSTEM ON
0361   00720 000000         NOP
0362   00721 000000         NOP
0363   00722 051005         LDA TOK
```

```
0364   00723 073000  STA2  STA 0
0365   00724 102700  STC1  STC 0          TEST
0366   00725 000000        NOP             INTERRUPT
0367   00726 000000        NOP               CIRCUITRY
0368   00727 074777        STB E11         ERROR 11 - FAILURE TO INTERRUPT
0369   00730 005004  P6    INB
0370   00731 050461        LDA IBAD
0371   00732 073000  STA3  STA 0
0372   00733 102300  SFS5  SFS 0           FLAG SET?
0373   00734 075000        STB E12         NO.  ERROR 12
0374   00735 006004        INB             YES.
0375   00736 102200  SFC5  SFC 0           FLAG CLEAR?
0376   00737 024741        JMP *+2         NO.
0377   00740 075001        STB E13         YES.  ERROR 13
0378   00741 005004        INB
0379   00742 103700        CLC 0,C         INTERRUPT SYSTEM OFF
0380   00743 050756        LDA ERBUF       CHECK ERROR BUFFER
0381   00744 164000  P7    LDB 0,I
0382   00745 005003        SZB,RSS         ERROR?
0383   00746 024755        JMP *+7         NO.
0384   00747 006007        INB,SZB,RSS     END OF ERROR BUFFER?
0385   00750 024757        JMP *+7         YES.
0386   00751 164000        LDB 0,I         NO.
0387   00752 071255        STA AS5         PRINT
0388   00753 015776        JSB ERR           OUT
0389   00754 051255        LDA AS5             ERROR
0390   00755 002004        INA                   CODE
0391   00756 024744        JMP P7
0392   00757 051003        LDA E14         INTERRUPT
0393   00760 002003        SZA,RSS           ERROR?
0394   00761 024765        JMP *+4         NO.
0395   00762 051117        LDA ML10        PRINT
0396   00763 055776        LDB MAD10         OUT
0397   00764 114102        JSB 1028,I          MESSAGE
0398   00765 124523        JMP BAT,I       EXIT ROUTINE
0399*
0400   00766 000767  ERBUF DEF *+1         ERROR BUFFER
0401   00767 000000  E1    OCT 0           SFS  TRUE AFTER CLF
0402   00770 000000  E2    OCT 0           SFC FALSE AFTER CLF
0403   00771 000000  E3    OCT 0           SFS FALSE AFTER STF
0404   00772 000000  E4    OCT 0           SFC  TRUE AFTER STF
0405   00773 000000  E5    OCT 0           SFS  TRUE AFTER CLF
0406   00774 000000  E6    OCT 0           SFC FALSE AFTER CLF
0407   00775 000000  E7    OCT 0           SFS FALSE AFTER STC   ,C
0408   00776 000000  E10   OCT 0           SFC  TRUE AFTER STC   ,C
0409   00777 000000  E11   OCT 0           FAILURE TO INTERRUPT
0410   01000 000000  E12   OCT 0           SFS FALSE AFTER INTERRUPT TEST
0411   01001 000000  E13   OCT 0           SFC  TRUE AFTER INTERRUPT TEST
0412   01002 177777        OCT 177777      ERROR BUFFER TERMINATION
0413   01003 000000  E14   OCT 0           ILLEGAL INTERRUPT
0414*
0415   01004 177774  C2    OCT 177774
0416   01005 024730  IOK   JMP P6
0417*
0418*BASIC TEST ERROR PRINTOUT SUBROUTINE
0419*
0420   01006 000000  ERR   NOP             ENTER SUBROUTINE
```

```
0421  01007 075020          STB BS2       STORE B
0422  01010 063001          LDA 1
0423  01011 015025          JSB .2NUM     PACK 2 NUMBERS
0424  01012 075023          STB MES9+1    PRINT
0425  01013 061024          LDA ML9         OUT
0426  01014 065021          LDB MAD9          ERROR
0427  01015 114002          JSB 1002B,I         MESSAGE
0428  01016 065020          LDB BS2       RESTORE B
0429  01017 125006          JMP ERR,I     EXIT SUBROUTINE
0430  01020 000000  BS2      OCT 0
0431  01021 001022  MAD9     DEF *+1
0432  01022 042440  MES9     ASC 1,E
0433  01023 000000          OCT 0
0434  01024 000004  ML9      DEC 4
0435*
0436*PACK TWO ASCII NUMBERS SUBROUTINE
0437*
0438  01025 000000  .2NUM    NOP           ENTER SUBROUTINE
0439  01026 071044          STA AS3       STORE A
0440  01027 001323          RAR,RAR       FORMAT
0441  01030 001300          RAR             FIRST
0442  01031 010464          AND MSK2          NUMBER
0443  01032 030465          IOR C1
0444  01033 001727          ALF,ALF
0445  01034 070001          STA 1         STORE IT
0446  01035 061044          LDA AS3       FORMAT
0447  01036 010464          AND MSK2        SECOND
0448  01037 030465          IOR C1            NUMBER
0449  01040 030001          IOR 1         PACK THEM
0450  01041 070001          STA 1           INTO B
0451  01042 061044          LDA AS3       RESTORE A
0452  01043 125025          JMP .2NUM,I   EXIT SUBROUTINE
0453  01044 000000  AS3      OCT 0
0454*
0455*ILLEGAL DUPLEX REGISTER INTERRUPT SUBROUTINE
0456*
0457  01045 000000  ILINT    NOP           ENTER SUBROUTINE
0458  01046 071073          STA AS4       STORE
0459  01047 075074          STB BS3         A & B
0460  01050 061045          LDA ILINT     PACK
0461  01051 001700          ALF             FIRST
0462  01052 011075          AND MSK3          TWO
0463  01053 015025          JSB .2NUM           NUMBERS
0464  01054 075114          STB IA        STORE THEM
0465  01055 061045          LDA ILINT     PACK
0466  01056 001727          ALF,ALF         SECOND
0467  01057 001222          RAL,RAL           TWO
0468  01060 015025          JSB .2NUM      NUMBERS
0469  01061 075115          STB IA+1       STORE THEM
0470  01062 001700          ALF           PACK
0471  01063 001222          RAL,RAL         LAST TWO
0472  01064 015025          JSB .2NUM         NUMBERS
0473  01065 075116          STB IA+2      STORE THEM
0474  01066 002404          CLA,INA
0475  01067 071003          STA E14
0476  01070 061073          LDA AS4       RESTORE
0477  01071 065074          LDB BS3         A & B
```

```
0478  01072 125045          JMP ILINT,I   EXIT SUBROUTINE
0479  01073 000000  AS4     OCT 0
0480  01074 000000  PS3     OCT 0
0481  01075 000017  MSK3    OCT 17
0482  01076 001077  MAD10   DEF *+1
0483  01077 042440  MES10   ASC 13,E 14    PROGRAM ADDRESS =
      01100 030464
      01101 020040
      01102 020120
      01103 051117
      01104 043522
      01105 040515
      01106 020101
      01107 042144
      01110 051105
      01111 051523
      01112 020075
      01113 020040
0484  01114 000000  IA      OCT 0,0,0
      01115 000000
      01116 000000
0485  01117 000040  ML10    DEC 32
0486*
0487*
0488*DATA BUFFER TEST ROUTINE
0489*
0490*
0491  01120 000000  DAT     NOP           ENTER ROUTINE
0492  01121 107700          CLC 0,C       INTERRUPT SYSTEM OFF
0493  01122 102100  STF3    STF 0
0494  01123 002400          CLA
0495  01124 015160  P8      JSB DOIC      OUTPUT A CHARACTER
0496  01125 003000          CMA           OUTPUT ITS
0497  01126 015160          JSB DOIC        COMPLEMENT
0498  01127 003000          CMA           OUTPUT THE
0499  01130 015160          JSB DOIC        CHARACTER AGAIN
0500  01131 002006          INA,SZA       INCREMENT CHARACTER.     = 0?
0501  01132 025124          JMP P8        NO.
0502  01133 102500          LIA 0         YES.  CHECK IOBI DRIVERS
0503  01134 002043          SZA,RSS       ANY ERRORS?
0504  01135 125120          JMP DAT,I     NO.  EXIT ROUTINE
0505  01136 071256          STA AS6       YES.
0506  01137 015025          JSB .2NUM     PACK
0507  01140 075335          STB MES13+9     A REG.
0508  01141 051256          LDA AS6           AND
0509  01142 001700          ALF                 STORE
0510  01143 071256          STA AS6               IT IN THE
0511  01144 011475          AND MSK3                ERROR
0512  01145 015025          JSB .2NUM                 MESSAGE
0513  01146 075333          STB MES13+7
0514  01147 051256          LDA AS6
0515  01150 001700          ALF
0516  01151 001222          PAL,RAL
0517  01152 015025          JSB .2NUM
0518  01153 075334          STB MES13+8
0519  01154 051336          LDA ML13      OUTPUT
0520  01155 055323          LDB MAD13       ERROR
```

```
0521  01156 114102          JSB 1028,I        MESSAGE
0522  01157 125120          JMP DAT,I     EXIT ROUTINE
0523*
0524*DATA OUT, IN, AND COMPARE SUBROUTINE
0525*
0526  01160 000000  DOIC    NOP             ENTER SUBROUTINE
0527  01161 071255          STA AS5         STORE A
0528  01162 102500  OTA1    OTA 0           OUTPUT A
0529  01163 025170          JMP *+5
0530  01164 106700  CLC2    CLC 0
0531  01165 061276          LDA ML11        LOSS
0532  01166 065260          LDB MAD11         OF FLAG
0533  01167 114102          JSB 1028,I          MESSAGE
0534  01170 014501          JSB MODE        CHECK SW. RE3.
0535  01171 060532          LDA BIT4        EXIT DAT
0536  01172 002011          SLA,RSS           ROUTINE?
0537  01173 125120          JMP DAT,I       YES.
0538  01174 103700  STCC3   STC 0,C         NO.  ENCODE
0539  01175 061004          LDA C2          WAIT
0540  01176 002006          INA,SZA           FOR
0541  01177 025176          JMP *-1             FLAG
0542  01200 102300  SFS6    SFS 0           FLAG SET?
0543  01201 025164          JMP CLC2        NO.  REPEAT ENCODING
0544  01202 106500  LIB1    LIB 0           YES.  READ DATA
0545  01203 060001          LDA 1           MASK OFF
0546  01204 011257          AND DAMSK         UNWANTED BITS
0547  01205 070001          STA 1
0548  01206 061255          LDA AS5         MASK OFF
0549  01207 011257          AND DAMSK         UNWANTED BITS
0550  01210 050001          CPA 1           OUTPUT = INPUT ?
0551  01211 025252          JMP P9          YES.
0552  01212 075254          STB BS4         NO.
0553  01213 071256          STA AS6
0554  01214 001700          ALF             PACK
0555  01215 011275          AND MSK3          OUTPUT
0556  01216 015025          JSB .2NUM           WORD
0557  01217 075305          STB MES12+5           AND
0558  01220 061256          LDA AS6                 STORE
0559  01221 001727          ALF,ALF                   IT IN THE
0560  01222 001222          RAL,RAL                     ERROR
0561  01223 015025          JSB .2NUM                     MESSAGE
0562  01224 075306          STB MES12+6
0563  01225 001700          ALF
0564  01226 001222          RAL,RAL
0565  01227 015025          JSB .2NUM
0566  01230 075307          STB MES12+7
0567  01231 061254          LDA BS4         PACK
0568  01232 001700          ALF               INPUT
0569  01233 011275          AND MSK3            WORD
0570  01234 015025          JSB .2NUM             AND
0571  01235 075317          STB MES12+15            STORE
0572  01236 061254          LDA BS4                   IT IN THE
0573  01237 001727          ALF,ALF                     ERROR
0574  01240 001222          RAL,RAL                       MESSAGE
0575  01241 015025          JSB .2NUM
0576  01242 075320          STB MES12+16
0577  01243 001700          ALF
```

```
0578   01244 001222          RAL,RAI
0579   01245 015025          JSB .2NUM
0580   01246 075321          STB MES12+17
0581   01247 061322          LDA ML12       OUTPUT
0582   01250 065277          LDB MAD12        ERROR
0583   01251 114132          JSB 1028,I         MESSAGE
0584   01252 061255  P9      LDA AS5        RESTORE A
0585   01253 125160          JMP DOIC,I     EXIT SUBROUTINE
0586   01254 000000  BS4     OCT 0
0587   01255 000000  AS5     OCT 0
0588   01256 000000  AS6     OCT 0
0589   01257 000000  DAMSK   OCT 0          DATA MASK STORAGE
0590*
0591   01260 001251  MAD11   DEF *+1
0592   01261 043114  MES11   ASC 13,FLAG FAILURE IN DATA TEST
       01262 040507
       01263 020106
       01264 040511
       01265 045125
       01266 051105
       01267 020111
       01270 047440
       01271 042101
       01272 052101
       01273 020124
       01274 042523
       01275 052040
0593   01276 000032  ML11    DEC 26
0594*
0595   01277 001300  MAD12   DEF *+1
0596   01300 047525  MES12   ASC 18,OUTPUT =              INPUT   =
       01301 052120
       01302 052524
       01303 020075
       01304 020040
       01305 020040
       01306 020040
       01307 020040
       01310 020040
       01311 020040
       01312 044516
       01313 050125
       01314 052040
       01315 020075
       01316 020040
       01317 020040
       01320 020040
       01321 020040
0597   01322 000044  ML12    DEC 36
0598   01323 001324  MAD13   DEF *+1
0599   01324 044517  MES13   ASC 10,IOBI ERROR =
       01325 041111
       01326 020135
       01327 051122
       01330 047522
       01331 020075
       01332 020040
```

```
       01333 020340
       01334 020343
       01335 020346
0600   01336 000024   ML13   DEC 20
0601   01337          X      EQU *          FWAM
0602                         END
** NO ERRORS*
```