Errata

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HP References in this Manual

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OPTION 011
HP-IB INTERFACE
For Universal Counter HP 5328A

INSTALLATION AND SERVICE MANUAL

SERIAL NUMBER

This manual applies directly to Option 011 A15 board having serial number 1624. For serial numbers above 1624, a "Manual Change" sheet is included with this manual. For serial numbers below 1624, see back-dating Section VI in this manual.

MANUAL PART NUMBER 05328-90019
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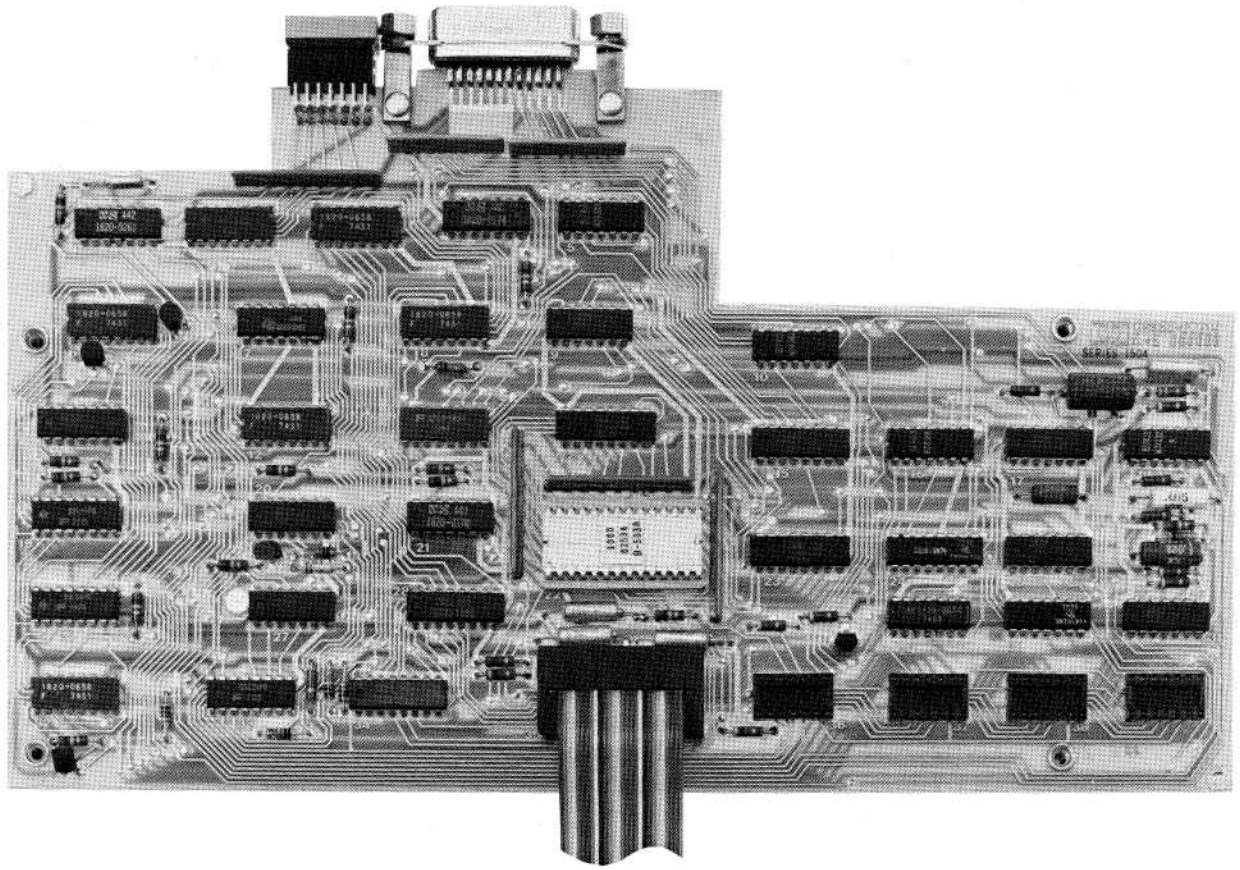


Figure 1-1. HP Model 5328A Option 011 HP-IB Interface

SECTION I
GENERAL INFORMATION

1-1. INTRODUCTION

1-2. This manual provides service and installation information for Option 011 Hewlett-Packard Interface Bus (HP-IB) Interface to the Hewlett-Packard Model 5328A Universal Counter.

1-3. The sections within this manual are labeled SECTION I GENERAL INFORMATION, SECTION II INSTALLATION, SECTION III THEORY OF OPERATION, SECTION IV MAINTENANCE, SECTION V REPLACEABLE PARTS, SECTION VI MANUAL CHANGES, and SECTION VII SCHEMATIC DIAGRAMS. These sections are designed to be compatible with the same sections of the 5328A Service Manual. Programming information for Option 011 is contained in Section V of the 5328A Users Manual.

1-4. DESCRIPTION

1-5. Option 011 HP-IB Interface consists of one printed-circuit card (see *Figure 1-1*) that mounts above and parallel to the A1 Motherboard in the 5328A. This option allows the 5328A to output measurement data and be controlled via the HP-IB. The option is designed for use with HP-IB compatible instruments, calculators, and computers. The functions of the 5328A are fully programmable when this option is installed. Complete specifications for Option 011 are listed in *Table 1-3* of the Users Manual and in the Service Manual for the 5328A.

NOTE

HP-IB Interconnect cable 10631A, B, C, or D is available as an accessory (not supplied with Option 011). The 10631A is 914 mm (3 feet) long, 10631B is 1828 mm (6 feet) long, the 10631C is 3656 mm (12 feet), and the 10631D is 500 mm (1.5 feet) long.

SECTION II

INSTALLATION

2-1. If Option 011 is included in the initial order for the 5328A, the option is installed at the factory and is ready for operation upon receipt. If Option 011 (HP Part No. 05328-80011) is ordered for field installation, it will include the following parts:

ITEM	QUANTITY	HP PART NO.
HP-IB Board	1	05328-60019
Cable Assembly	1	8120-2176
Cover Plate	1	05328-00014
Machine Screw	4	2360-0115

2-2. The HP-IB connector mounting studs accommodate lock screws with 150 metric thread M3.5x0.6 or equivalent Optimum Metric Fastener System (OMFS) thread 3.5P06.

2-3. Metric hardware supplied by HP for HP-IB connectors can be identified by the black finish. If metric tools are not available, a $^{9}/_{32}$ inch hex socket will fit the 7 mm hex stud.

2-4. Conversion kits for converting earlier instruments to use the metric lock screws are available through any HP Sales or Service Office listed in the back of this manual.

2-5. FIELD INSTALLATION

2-6. To field install the option, proceed as follows:

CAUTION

Avoid flexing Option 011 board. Due to the number of resistor packs and their location, flexing can cause resistor failures.

a. Disconnect the power cable from the 5328A (Safety Precaution).

b. Remove the top and bottom covers from the 5328A.

c. Remove the small plate from the rear panel, located above the STORAGE switch, by removing two screws.

d. Remove A4 Function Selector board from motherboard by pulling up on one end of extractor at top of board (use rocking motion to extract board).

e. Remove the nut on each side of digital bus connector J6 on the HP-IB Interface board.

CAUTION

In the following step, be sure that pin 1 of the plug (on each end of the cable) is aligned with pin 1 of the jack (on each board) before inserting. (Pins on plugs are numbered. Pin 1 on jacks has square solder dot.) Damage to equipment may occur if connectors are inserted incorrectly and power applied.

f. Connect one end of the 28-conductor cable to J-1 on the motherboard and insert the cable through the slot of the main bracket, MP10 (refer to *Figure 4–1* in the 5328A Service Manual) and bend remaining end of cable over top of MP10.

g. Install the HP-IB board, component side up (parallel to the motherboard) with digital bus connector J6 inserted out through the rear panel (where plate was removed).

h. Place 5328A on its side and attach four 6–32 x $\frac{5}{16}$ inch screws to the HP-IB board standoffs from underside the motherboard.

i. Mount the cover plate over digital bus connector J6 and switch S1 and attach with two screws. Replace two nuts on J6 that were removed in step e.

j. Connect the free end of the 28-conductor cable to J1 (position 35) on HP-IB board.

k. Connect the end of the lock-out cable (jumper wire) to terminal post at pin 4 of XA16 (below display board) on motherboard.

l. Install A4 Function Selector board removed in step d.

m. Install top and bottom covers and apply power.

n. Conduct the local operation test, Section IV *Table 4–2*, and one of the verification of performance tests, Section IV either paragraph 4–10 or 4–18.

2–7. REMOVAL

2–8. Procedures for removal of Option 011 are essentially the reverse of the above installation procedures.

SECTION III
THEORY OF OPERATION

3-1. HP INTERFACE BUS DESCRIPTION

3-2. The HP Interface Bus transfers data and commands between the components of an instrumentation system on 16 signal lines. The interface functions for each system component are performed within the component so only passive cabling is needed to connect the system. The cables connect all instruments, controllers, and other components of the system in parallel to the signal lines.

3-3. Eight of the lines (DIO1—DIO8) are reserved for the transfer of data and other messages in a byte-serial, bit-parallel manner. Data and message transfer is asynchronous, coordinated by the three handshake lines (DAV, NRFD, NDAC). The other five lines are for control of bus activity.

3-4. Devices connected to the bus may be talkers, listeners, or controllers. The controller dictates the role of each of the other devices by setting the ATN (attention) line low and sending talk or listen addresses on the data lines (DIO1—DIO8). Addresses are set into each device at the time of system configuration either by switches built into the device or by jumpers on a PC board. While the ATN line is low, all devices must listen to the data lines. When the ATN line is high, only devices that have been addressed will actively send or receive data. All others ignore the data lines.

3-5. Several listeners can be active simultaneously but only one talker can be active at a time. Whenever a talk address is put on the data lines (while ATN is low), all other talkers will be automatically unaddressed.

3-6. Information is transmitted on the data lines under sequential control of the three handshake lines. No step in the sequence can be initiated until the previous step is completed. Information transfer can proceed as fast as devices can respond, but no faster than allowed by the slowest device presently addressed as active. This permits several devices to receive the same message byte concurrently.

3-7. The ATN line is one of the five control lines. When ATN is low, addresses and universal commands are transmitted on only seven of the data lines using the ASCII (American Standard Code for Information Interchange) code. When ATN is high, any code of 8 bits or less understood by both talker and listener(s) may be used.

3-8. The other control lines are IFC, REN, SRQ, EOI. IFC (interface clear) places the interface system in a known quiescent state. REN (remote enable) is used with other coded messages to select either local or remote control of each device.

3-9. Any active device can set the SRQ (service request) line low. This indicates to the controller that some device on the bus wants attention, say a counter that has just completed a time-interval measurement and wants to transmit the reading to a printer.

3-10. EOI (end or identify) is used by a device to indicate the end of a multiple-byte transfer sequence. When a controller sets both the ATN and EOI lines low, each device capable of a parallel poll indicates its current status on the DIO line assigned to it.

3-11. For a more detailed description of bus operation, refer to the manual entitled "Condensed Description of the Hewlett-Packard Interface Bus", HP Part No. 59401-90030.

3-12. OPTION 011 HP-IB INTERFACE OPERATION

3-13. The 5328A HP-IB Interface is used to remotely program the 5328A and deliver the measurement results to the bus. Thus, the option operates both as a listen and as a talker.

3-14. As a listener, the interface is capable of programming most of the controls in the mainframe and all programmable modules that may be installed. The HP-IB board contains storage circuits to control the mainframe remotely, and is set up to program the storage circuits in any programmable module.

3-15. As a talker, the interface is capable of outputting the measurement data in exponential format with a mantissa of nine digits (leading zeros are output as spaces) and an exponent of one digit. Overflow and sign information is also contained along with a carriage return (CR), linefeed (LF) termination to make it compatible with the standard HP-IB serial data format.

3-16. In addition to being a talker and listener, the HP-IB Interface follows a set of HP-IB commands. This includes complete service request capability. The ASCII codes used for addressing and for data are shown in *Table 3-1*. Address switch information is shown in *Table 3-2*. The program code set is shown in *Table 3-3*.

3-17. Overall Operation

3-18. The heart of the HP-IB Interface is a 256 state algorithmic state machine (ASM) controlled by a 256 x 16 ROM (U22) as shown in the block diagram *Figure 3-2*. This state machine has two different format states determined by the format (F) bit from U22. One state (F=0) is an output mode state where the machine will proceed sequentially to the next state (address) after storing or outputting information. The other state (F=1) is a mode where the machine can either proceed to the next line or perform a conditonal jump to a different line in the program. The decision as to which state is chosen is made on the basis of whether the qualifier bit from U11A is low or high. Preset counters U14 and U23 provide presetting to a jump state when F=1 and the qualifier is low. These counters increment their count in all other cases. Altogether, there are 52 different bits that may be selected as the qualifier for a particular state.

3-19. Qualifier negate circuit U30C can invert the qualifier bit for any given state so that the machine can branch on the qualifier being low or being high. U7 is added for psuedo subroutine capability. In the output mode, the ASM goes through the same group of states once for every character being outputted on the bus. U7 is incremented every time so that the ASM can tell which character it is to output.

3-20. Bus Command Mode

3-21. In this mode (ATN low), the ASM accepts parallel bytes of information and decodes them into bus commands. This usually requires setting or clearing bits of storage in U19 or U26.

3-22. Listen Mode

3-23. In the listen mode, the listen qualifier of U26 must be low and ATN high. The interface will then accept 8-bit parallel bytes continuously. When receiving the ASCII characters P, Q, U, R, or T the counter will act upon the byte immediately (refer to programming in 5328A Users Manual). When receiving the letters F, G, A, B, C, D, or S the interface will then route any ASCII number or numbers following these letters into particular storage registers. These registers are U28, U33, and U34 along with any that are contained in any of the optional modules installed in the mainframe.

3-24. Talk Mode

3-25. The HP-IB Interface will go into the talk mode if the talk qualifier of U26 is low or the talk always switch is set to talk always and ATN high for both cases. There will be no output in normal

operation unless a completed measurement is present and has not been outputted. The information to be put on the bus is latched into latches U15 and U24. These drive the high current buffers U5, U10, and U16. Counter U7 is used as a pointer for the ASM to recognize which character in the serial output string the interface is to output. Additional information on the HP-IB Interface operation is contained in the 5328A Users Manual.

Table 3-1. American Standard Code for Information Interchange (ASCII)

USA STANDARD CODE FOR INFORMATION INTERCHANGE

BITS				b_7 b_6 b_5	$0\,0\,0$	$0\,0\,1$	$0\,1\,0$	$0\,1\,1$	$1\,0\,0$	$1\,0\,1$	$1\,1\,0$	$1\,1\,1$
b_4	b_3	b_2	b_1	COLUMN / ROW	0	1	2	3	4	5	6	7
0	0	0	0	0	NUL	DLE	SP (blank)	0	@	P	`	p
0	0	0	1	1	SOH	DC1	!	1	A	Q	a	q
0	0	1	0	2	STX	DC2	"	2	B	R	b	r
0	0	1	1	3	ETX	DC3	#	3	C	S	c	s
0	1	0	0	4	EOT	DC4	$	4	D	T	d	t
0	1	0	1	5	ENQ	NAK	%	5	E	U	e	u
0	1	1	0	6	ACK	SYN	&	6	F	V	f	v
0	1	1	1	7	BEL	ETB	'	7	G	W	g	w
1	0	0	0	8	BS	CAN	(	8	H	X	h	x
1	0	0	1	9	HT	EM	)	9	I	Y	i	y
1	0	1	0	10	LF	SUB	*	:	J	Z	j	z
1	0	1	1	11	VT	ESC	+	;	K	[	k	{
1	1	0	0	12	FF	FS	,	<	L	\	l	¦
1	1	0	1	13	CR	GS	-	=	M	]	m	}
1	1	1	0	14	SO	RS	.	>	N	↑	n	~
1	1	1	1	15	SI	US	/	?	O	←	o	DEL

UNIVERSAL ADDRESS COMMANDS

LISTEN ADDRESSES

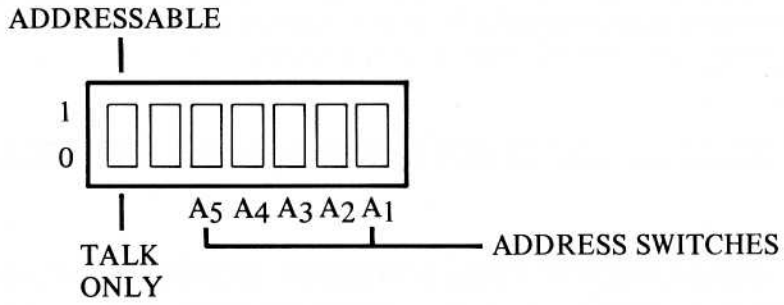
UNLISTEN COMMAND

TALK ADDRESSES

UNTALK COMMAND

DATA WHEN ATN IS HIGH.
ADDRESSES WHEN ATN IS LOW.

Table 3-2. Addressing



ASCII ADDRESS CODES

A_5	A_4	A_3	A_2	A_1	ASCII LISTEN ADDRESS	ASCII TALK ADDRESS
0	0	0	0	0	SP	@
0	0	0	0	1	!	A
0	0	0	1	0	"	B
0	0	0	1	1	#	C
0	0	1	0	0	$	D
0	0	1	0	1	%	E
0	0	1	1	0	&	F
0	0	1	1	1	'	G
0	1	0	0	0	(	H
0	1	0	0	1	)	I
0	1	0	1	0	*	J
0	1	0	1	1	+	K
0	1	1	0	0	,	L
0	1	1	0	1	-	M
0	1	1	1	0	.	N
0	1	1	1	1	/	O
1	0	0	0	0	Ø	P
1	0	0	0	1	1	Q
1	0	0	1	0	2	R
1	0	0	1	1	3	S
1	0	1	0	0	4	T
1	0	1	0	1	5	U
1	0	1	1	0	6	V
1	0	1	1	1	7	W
1	1	0	0	0	8	X
1	1	0	0	1	9	Y
1	1	0	1	0	:	Z
1	1	0	1	1	;	[
1	1	1	0	0	<	\
1	1	1	0	1	=	]
1	1	1	1	0	>	‾

Table 3-3. Program Code Set

Codes shown in bold face are start-up conditions. These conditions are set by the code "P", Remote Program Initialize, or by the bus commands Device Clear or Selected Device Clear.

1. Initialization
   - P Remote Program Initialize
2. Function
   - **FØ Stop**
   - F1 Start A
   - †F2 Start Clock
   - †F3 DVM/A
   - F4 Freq. A
   - †F5 DVM/T.I. A→B
   - F6 Period A
   - F7 Per. Avg. A
   - F8 T.I. A→B
   - F9 B/A
   - F: T.I. Avg . A→
   - F; Events C,T.I. A→B
   - F< Check
   - F= C/A
   - F> Freq. C
   - F? DVM
3. Time Base

Code	Freq Res	Multiplier	Time Res (Std)	Time Res (Opt. 040)
GØ	**1 MHz**	**1**	**100ns**	**10ns**
G1	100 kHz	10	1 μs	100ns
G2	10 kHz	10^2	10 μs	1 μs
G3	1 kHz	10^3	100 μs	10 μs
G4	100 Hz	10^4	1ms	100 μs
G5	10 Hz	10^5	10ms	1ms
G6	1 Hz	10^6	100ms	10ms
G7	0.1 Hz	10^7	1s	100ms

4. Single-Multiple Measurement
   - **SØ Single Measurement**
   - S1 Multiple Measurement
5. Measurement Cycle
   - **S2 Wait to output; Service Request at end of measurement**
   - S3 Continue cycle; no Service Request
6. Output Mode
   - **S4 Output at end of measurement**
   - S5 Output when addressed (on-the-fly)
7. Sample Rate
   - **S6 Maximum**
   - S7 Manual control (from front panel)
8. Arming
   - **S: Off**
   - S; On
9. Display Storage
   - **S< On (normal)**
   - S= Off
10. Decade Reset
    - **S> Normal**
    - S? Disabled (for cumulative measurements)
11. Display Blanking
    - **U Normal display**
    - Q Blank display (digits and decimal point)

†Functions not labeled on instrument front panel

Table 3-3. Program Code Set (Continued)

12. Channel A Signal Conditioning
    a. Impedance
       AØ 1 Megohm
       A1 50 Ohms
    b. Coupling
       A2 AC
       A3 DC
    c. Slope
       A4 +slope
       A5 -slope
    d. Attenuator
       A6 x10
       A7 x1
13. Separate - Common
    A8 Separate
    A9 Common A
14. Check
    A< Normal Operation
    A? Check, Measures internal clock

Code groups 12 to 18 apply only when Option 041 is installed.

15. Trigger Level A

    A{+/−}d_1 d_2 d_3 *

    (d_1: volts; d_2: tenths of volts; d_3: hundredths of volts)

    Permissible trigger level range: -2.50V to +2.50V.

The program sequence to set trigger level starts with the channel designation letter followed by a "+" or "-" sign. Next, three digits set the voltage level. An "*" terminates the sequence. The same sequence must be used even to set 0 volts.

Examples: "A+000*" 0 volts
"A-123*" -1.23 volts

16. Channel B Signal Conditioning
    a. Impedance
       BØ 1 Megohm
       B1 50 ohms
    b. Coupling
       B2 AC
       B3 DC
    c. Slope
       B4 +slope
       B5 -slope
    d. Attenuator
       B6 x10
       B7 x1
17. Trigger Level B

    B{+/−}d_1 d_2 d_3 *

    See Group 15, Trigger Level A, for details.
18. Channel Invert
    B8 Normal
    B9 Invert A and B inputs
19. Reset; Trigger
    (Also see Bus Command GET)
    R Reset, no trigger
    T Reset and trigger

3-26. Circuit Operation

3-27. The following paragraphs describe the circuit operation of Option 011.

3-28. STATE COUNTERS. As shown in the schematic diagram, *Figure 7-1*, the state of the ASM ROM (current state and next state) is determined by State Counters U14 and U23. These counters form an 8-bit presettable binary counter. When pin 1 of U25 is low, the counters will always increment. When pin 1 of U25 is high, the counters will preset (jump to another state in the program) if the output of U30C is high. The preset address is supplied to the State Counters input from the ROM. The program is shown in the operational flowchart, *Figures 4-1, 4-2* and *4-3*. The output of U30C is determined by the "not" bit from the ROM (through U21E) and the output of the Qualifier FF U11A. The preprogrammed state of the "not" bit determines whether a high or low output of the qualifier FF will result in a jump in the program. (This is shown in the ASM Operational Flowchart, by the use of the letter "N" in a decision diamond symbol.) The preset (jump) is synchronous and only occurs when pin 9 of U14 and U23 is low and when there is a rising edge at pin 2 of U14 and U23. FF U31A synchronizes the reset of the State Counters to occur at the proper time.

3-29. ASM OSCILLATOR. As shown in the ASM Oscillator Timing Diagram, *Figure 3-1*, the ASM oscillator circuit provides three separate phases of clock outputs. Schmitt trigger U18A is the fundamental oscillator element which uses hysteresis to develop oscillation. The output of U18A (through U13) strobes storage latches U11A and B, U15, U19, U24, U26, U28, U33, U31B and U34. The output of U18A is also sent through a delay circuit consisting of resistor R14 and capacitor C4 into U18B to provide another phase of the clock output that determines the next state of the ASM. In addition, the output of U18A is sent through U30A to provide a third clock phase which is applied to U31A. The output of U31A resets the 8-bit State Counter synchronously at power up or when the IFC signal occurs. (Synchronous reset prevents loading the storage latches with erroneous data.) The IFC signal also resets U26 (ASM storage). The power up reset circuit U18C and U18D clears all storage elements.

3-30. BUS INTERFACE. The bus interface circuit consists of bus line termination resistors, data output drivers and data input buffers. Resistors R29 and R30 form the line termination networks, U4 is used to buffer the bus line inputs and U5, U10, and U16 are high current drivers that drive the bus line output. The ATN signal is sent through U9A and U29D to ensure that the gates connected to bus lines DIO1—DIO7 and DAV do not output when ATN goes true. The DAO signal from U24(9) arms the DAC signal through U17B to ensure that DAC goes false within a few gate delays after ATN goes true. (In some cases, the DAC response from the ROM may be too slow.) After ATN is true, DAO is set to a "0" to allow normal operation of the DAC line.

3-31. END OF MEASUREMENT. When a measurement has been completed, FF U11B is set. This FF is clocked by the closing edge of the LMG signal. Diode CR2 and transistor Q3 keep U11B from going to the "1" state when LRES is low or HRD is high. (During these times the counter is being reset and noise appears on the LMG line which could trigger U11B).

3-32. QUALIFIER MULTIPLEXERS. Five 8 to 1 multiplexers are connected to allow 36 lines to be multiplexed into 1 line. ASM ROM U22 controls multiplexers U3, U6, U8, and U32 to select individual line qualifiers and U12 to select one of these multiplexers. In addition, U12 checks the output of auxiliary State Counter U7, a 4-bit binary counter that allows the same sequence of states to be repeated up to 16 times. In the output algorithm, each state represents an output character. Qualifier FF U11A eliminates erroneous results by ensuring that the State Counters U14 and U23 are not clocked when a qualifier is changing states. This would cause a partial preset and partial increment of the State Counters.

3-33. ADDRESSING. Address Comparator U2 monitors the Data Input/Output (DIO) lines 2 through 5 and the address switch (S1) settings. When a comparison occurs between the state of these DIO lines and the address switch settings, U2 sends qualifier ADDR to multiplexer U8. The

TALK ALWAYS section of the address switch provides a means of setting U6 so that interface is always addressed to talk.

3-34. DATA OUTPUT. The Data Output circuit outputs characters on the bus data lines. Storage circuit U24 transfers outputs from the ROM to DIO lines 5 through 7. U15 selects data from either the ROM or the 5328A data bus and transfers it to DIO1—DIO4. The state of the "not" bit from ROM U22(13) through U21E determines the selection made by U15. A displayed digit is selected from the 5328A, any other characters (decimal point, "E", carriage return, exponent, linefeed, etc.) are selected from the ROM.

3-35. ASM STORAGE. The internal memory for the ASM operation is in ASM Storage circuits U19, U26, and U31B. There are 17 information bits that can be set or cleared by these circuits. This section also includes one-shot U1 which outputs a 1 ms pulse (LRST) to ensure reliable operation of the state control circuit U4 on the motherboard. Diode CR3 ensures that LINH is low to inhibit the counter during the time that LRST is low.

3-36. STROBE ENABLE DECODER. Decoder U13 is a 4 to 10 line decoder used to strobe the various storage latches. Pins 1, 14, and 15 are used to select the device to be strobed and pin 2 is an enable which determines the width of the strobe pulse. This pulse is shown by the shaded area in *Figure 3-1*. The output of U25C disables U13 when the ASM is in the decision state mode. In the decision state mode, the format bit U22(17) goes high which disables U13.

3-37. REMOTE PROGRAM STORAGE. Storage circuits U28, U33, and U34 are used to program instrument functions. U28 stores Time Base codes in 3-bit bytes and U34 stores Function codes in 4-bit bytes. U33 stores 8 bits of information, one-bit at a time. The Sample Rate, Arming, Storage Off, and Decade Reset can be programmed by U33. In addition, U33(4, 5, and 6) control the manner in which measurements are made and output to the bus. The inputs to the remote program storage circuits are the Module Data A, B, C, and D lines from DIO lines, 1, 2, 3, and 4, respectively.

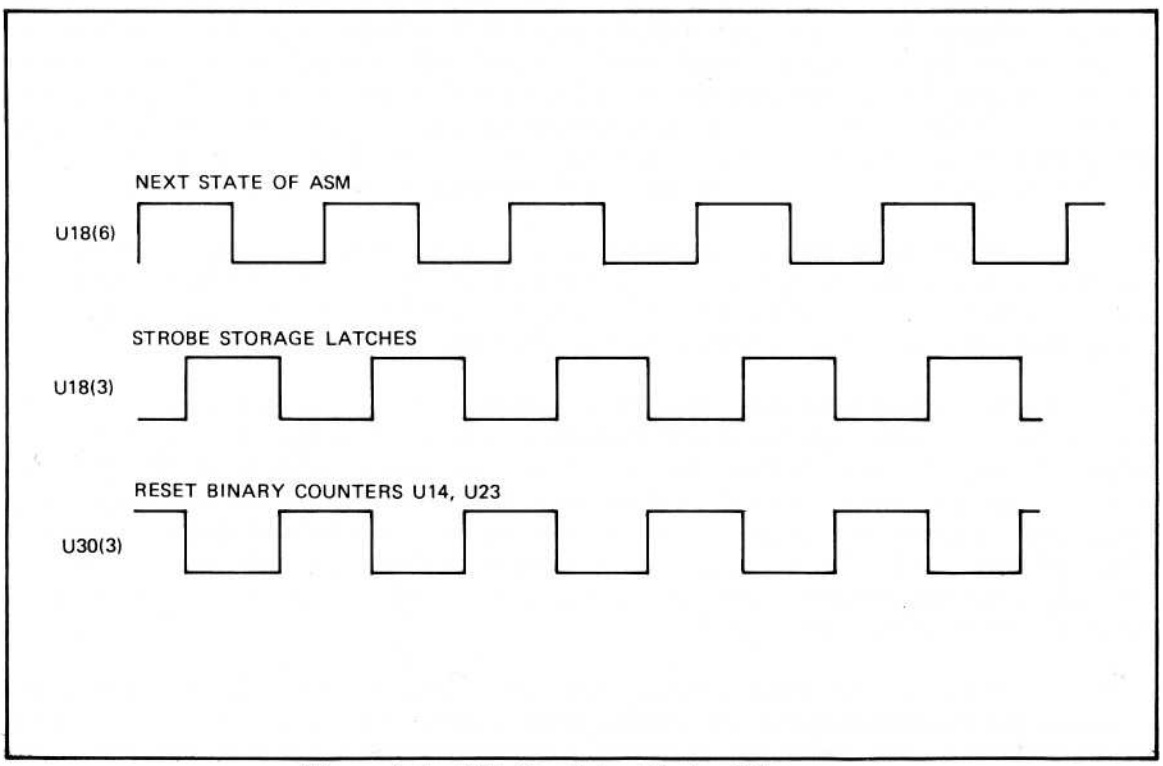
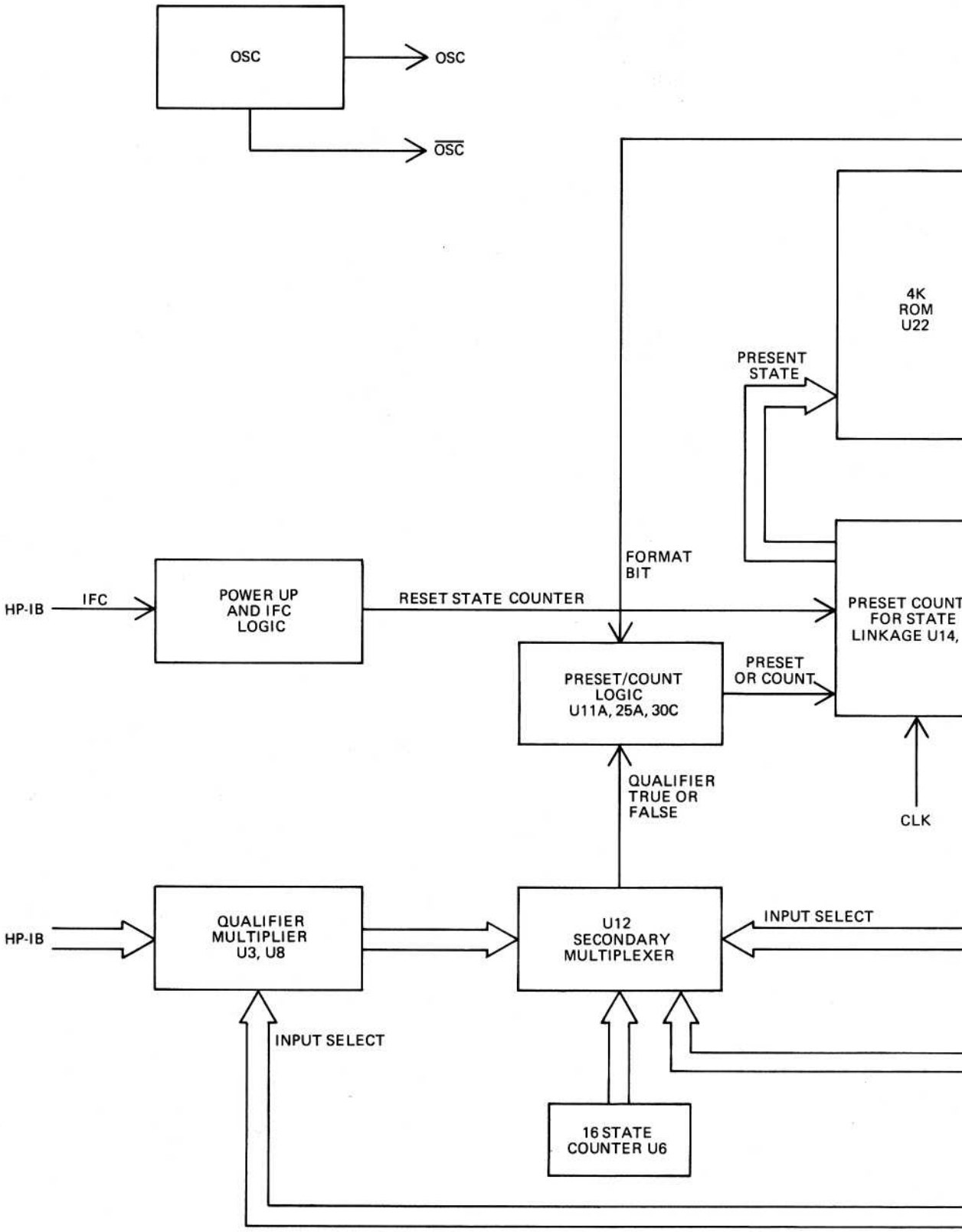
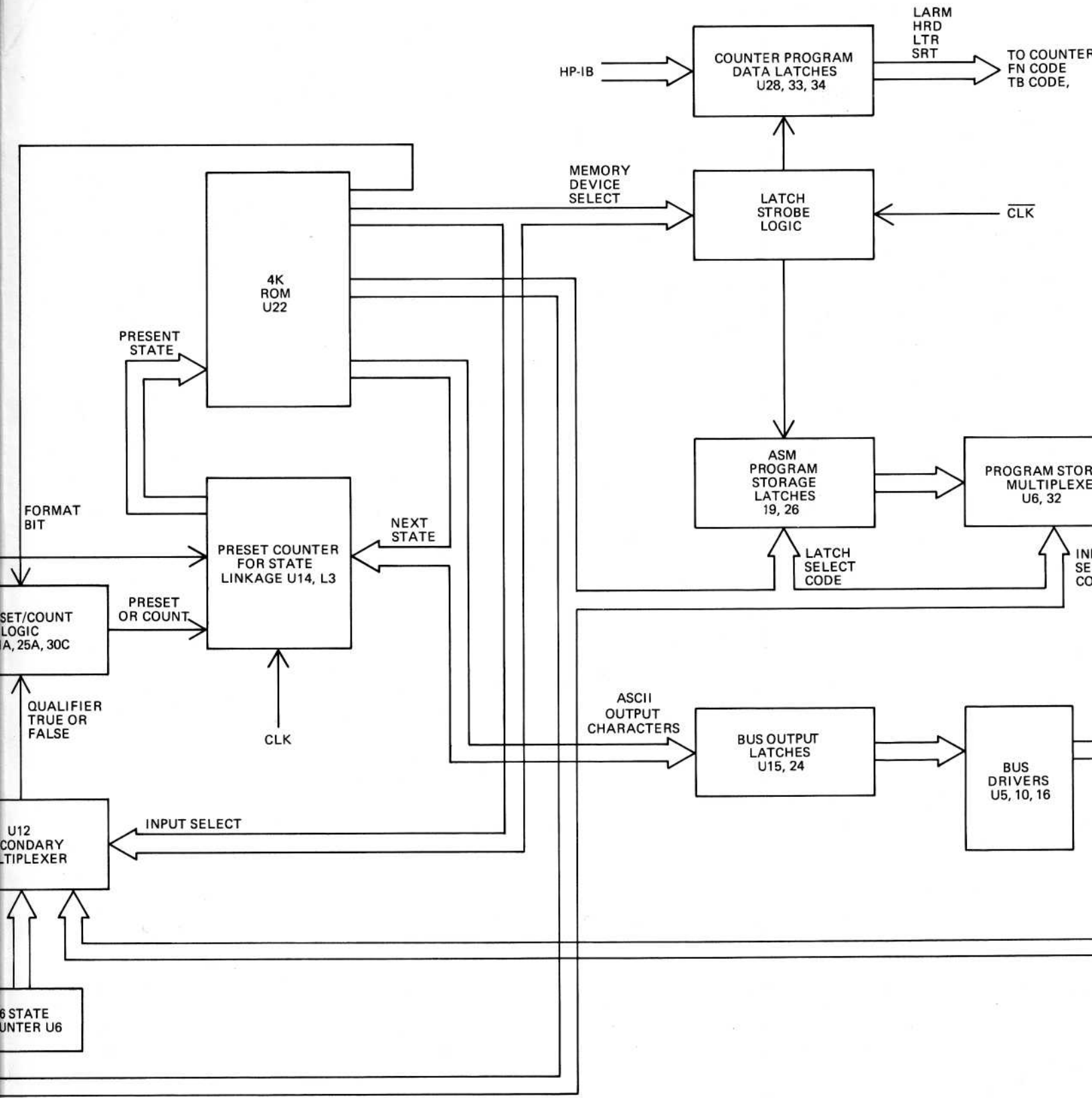


Figure 3-1. ASM Oscillator Timing Diagram


OSC
OSC
$\overline{OSC}$
4K
ROM
U22
PRESENT
STATE
FORMAT
BIT
HP-IB
IFC
POWER UP
AND IFC
LOGIC
RESET STATE COUNTER
PRESET COUNT
FOR STATE
LINKAGE U14,
PRESET/COUNT
LOGIC
U11A, 25A, 30C
PRESET
OR COUNT
QUALIFIER
TRUE OR
FALSE
CLK
HP-IB
QUALIFIER
MULTIPLIER
U3, U8
U12
SECONDARY
MULTIPLEXER
INPUT SELECT
INPUT SELECT
16 STATE
COUNTER U6


LARM
HRD
LTR
SRT
HP-IB
COUNTER PROGRAM DATA LATCHES U28, 33, 34
TO COUNTER
FN CODE
TB CODE,
MEMORY DEVICE SELECT
LATCH STROBE LOGIC
CLK
4K ROM U22
PRESENT STATE
ASM PROGRAM STORAGE LATCHES 19, 26
PROGRAM STOR
MULTIPLEXE
U6, 32
FORMAT BIT
NEXT STATE
PRESET COUNTER FOR STATE LINKAGE U14, L3
LATCH SELECT CODE
SET/COUNT LOGIC A, 25A, 30C
PRESET OR COUNT
QUALIFIER TRUE OR FALSE
CLK
ASCII OUTPUT CHARACTERS
BUS OUTPUT LATCHES U15, 24
BUS DRIVERS U5, 10, 16
U12 CONDARY LTIPLEXER
INPUT SELECT
6 STATE UNTER U6

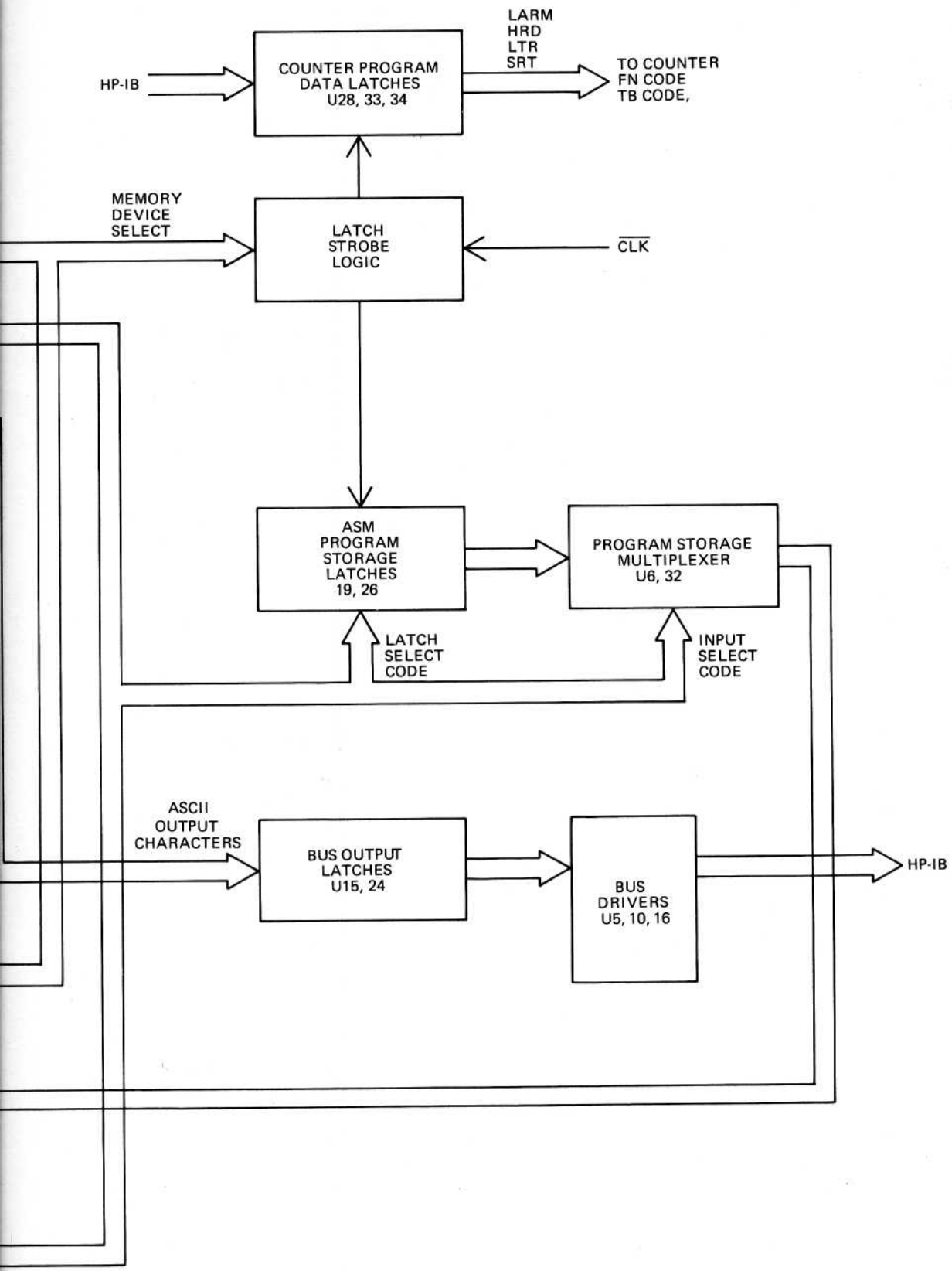


Figure 3-2. HP-IB Interface Block Diagram

SECTION IV
MAINTENANCE

4-1. INTRODUCTION

4-2. This section contains maintenance and service information. Included is a table of recommended test equipment, verification of performance tests, a diagnostic program, an ASM flowchart, troubleshooting flowcharts, and troubleshooting information.

4-3. RECOMMENDED TEST EQUIPMENT

4-4. Test equipment and system equipment recommended to maintain and service Option 011 is listed in *Table 4-1*. Test equipment with equivalent characteristics may be substituted for the test equipment listed. Due to the programs supplied, only system equipment listed should be used for the particular test involved.

Table 4-1. Recommended Test Equipment and System Equipment

RECOMMENDED TEST EQUIPMENT			
Instrument Type	**Recommended Characteristics**	**Suggested Model**	**Use**
Oscilloscope Vertical Plug-In Horizontal Plug-In	Bandwidth: 50 MHz Sensitivity: 50 mV/cm Sensitivity: 1 ms/cm	HP 180A HP 1801A HP 1820A	T T T
Logic State Analyzer	Clock Input: 60 kHz Trigger Word: 8 Bits Bit Input: TTL Display Word: 8 Bits	HP 1601A	T
Digital Voltmeter	Function: DC, resistance	HP 3490A	T
SYSTEM EQUIPMENT			
Instrument Type	**Recommended Characteristics**	**Suggested Model**	**Use**
Calculator	HP-IB compatible	9820A	V
HP-IB Calculator Interface	Connects 9820A to HP-IB	59405A Option 020	V
Calculator	HP-IB compatible	9830A	V,D,T
Printer	Compatible with 9830A	9866A	V,D,T
HP-IB Calculator Interface	Connects 9830A to HP-IB	59405A Option 030	V,D,T
V=Verification of Performance Test, D=Diagnostic Program Test, T=Troubleshooting			

4-5. VERIFICATION OF PERFORMANCE

4-6. To verify the performance of Option 011, a bus controller is required to control operation. Included is detailed information to verify the operation of Option 011, with either a 9820A Calculator or a 9830A Calculator used as the bus controller.

4-7. Before using one of the bus controllers and test programs to verify proper operation of the interface, a preliminary test must be performed. The preliminary test is called the Local Operation Test.

4-8. Local Operation Test

4-9. *Table 4-2* shows the preliminary test. This test checks for proper local operation, and must be performed prior to the verification of performance test.

Table 4-2. Local Operation Test

Instrument Setup and Test Procedure	Test Description and Expected Results
Set 5328A Counter with Option 011 as follows: FUNCTION ..... CHECK FREQ RES ..... .1 kHz SAMPLE RATE ..... CCW ARMING ..... OFF STORAGE ..... ON OSCILLATOR ..... INT	5328A with Option 011 should be displaying 10.0000 MHz The counter should also be gating and controllable by the sample rate. If the counter fails the above test, disconnect one end of the 28-conductor cable, and perform the test again. If the counter passes, refer to Local Troubleshooting Flowchart.

4-10. Verification Using a 9820A as a Bus Controller

4-11. When a 9820A is used as a bus controller to make a verification of performance check, the following equipment is required:

Model 5328A Counter with Option 011
Model 9820A Calculator with ASCII Bus Interface Model 11144A-020

4-12. Connect the equipment as follows:

a. Insert the peripheral control 11224A PC II ROM in ROM slot three of the 9820A Calculator.

b. Insert the 59405A HP-IB Calculator Interface card into one of the 9820A I/O slots.

c. Connect one end of a Bus Interface cable (any of the four lengths available) to the Option 011, and the other to the 59405A Interface card.

4-13. Before loading the program, press the END and EXECUTE keys. This positions the program counter to zero. Press the remaining keys in the program, as shown in the calculator key column of *Table 4-3*.

4-14. 9820A program list and program response

9820A Program Listing

```
0:
CMD "?U9","PF≤G6
T","?Y5"⊢
1:
FMT *;RED 13,A;
FLT 8;DSP A;PRT
A⊢
2:
GTO 0⊢
3:
END ⊢
R419
```

9820A Program Response

```
1.000000000E 07
1.000000000E 07
1.000000000E 07
1.000000000E 07
1.000000000E 07
1.000000000E 07
1.000000000E 07
1.000000000E 07
1.000000000E 07
1.000000000E 07
1.000000000E 07
1.000000000E 07
```

Table 4-3. 9820A Verification Program

PROGRAM LINE NO.	COMMAND	PROGRAM DESCRIPTION	CALCULATOR KEY
Ø	CMD	Control statement. Refer to 11222A peripheral control II operating manual HP Part No. 09820-99024, page 2-11.	Bus Command
Ø	"	First quotes following CMD statement specifies address mode.	"
Ø	?	Unaddresses all listeners on the Bus	?
Ø	μ	Calculator's talk address, puts calculator in talk mode.	μ
Ø	9	5328A's listen address, puts 5328A in remote and listen mode.	9
Ø	"	Terminates command mode	"
Ø	,	Delimiter between modes	,
Ø	"	Second quote field, after CMD statement, specifies data mode.	"
Ø	P	5328A remote program initialize (refer to *Table 3-3* Program Code Set)	P
Ø	F<	5328A program code for check	F <
Ø	G6	5328A program code for 1 s gate time	G 6
Ø	T	5328A reset and trigger command	T
Ø	"	Terminates data mode	"
Ø	,	Delimiter between modes	,
Ø	"	Specifies address mode	"
Ø	?	Unaddresses all listeners on the bus	?
Ø	Y	5328A's talk address, puts 5328A in talk mode.	Y
Ø	5	9820A's listen address, puts 9820A in listen mode	5
Ø	"	Terminates address mode	"
Ø	STORE	Stores program line Ø into calculators storage	STORE
1	FMT*	Defines free-field format, refer to 11224A peripheral control II operating manual	FORMAT *
1	;	End of statement delimiter	;
1	RED13,A	Reads data, over the Bus through the interface card into register "A"	RED 1 3 , A
1	;	End of statement delimiter	;
1	FLT8	Specifies 8 digits to the right decimal	FLOAT 8
1	;	End of statement delimiter	;
1	DSP A	Causes contents of "A" register to be displayed	DISPLAY A
1	;	End of statement delimiter	;
1	PRTA	Causes contents of "A" register to be printed	PRINT A
1	STORE	Stores program line 1 into calculator memory	STORE
2	GO TO Ø	Causes program to loop back and execute line Ø again	GTO Ø
2	STORE	Stores line 2 in memory	STORE
3	END	Ends program	END
3	STORE	Stores program line 3 into calculator	STORE

4–15. To verify proper program loading, press the END and LIST keys. This gives a printed listing starting from line zero. Check the program listing received against the listing in 4–14 to assure proper program loading.

4–16. Running the program is accomplished by pressing the END and RUN PROGRAM keys. The program will continue to run and printout until the STOP key is pressed.

4–17. Successful completion of the verification test is shown by the 9820A Program response in paragraph 4–14.

4–18. Verification Using a 9830A as a Bus Controller

4–19. When a 9830A is used as a bus controller to make a verification of performance check, the following equipment is required.

Model 5328A Counter with Option 011 under test
Model 9830A Calculator
Model 9866A Printer
59405A HP-IB Calculator Interface (Option 030)

4–20. Connect the equipment as follows:

a. Connect the 9866A to the 9830A as outlined in the HP 9866A Printer peripheral manual.

b. If the 9830A does not have Option 274, insert Extended I/O ROM 11272B in any available ROM slot.

c. Insert the 59405A HP-IB Calculator Interface card into one of the 9830A I/O slots.

d. Connect one end of a bus interface cable to Option 011, and the other to the 59405A Interface card.

4–21. Before loading the program, press the SCRATCH and EXECUTE keys. This clears the memory and allows the new program to be entered. Press the remaining keys in the program, as shown in the calculator key column of *Table 4–4.*

4–22. 9830A program listing and program response.

9830A Program Listing

```
10 FORMAT 10B
20 OUTPUT (13,10)768;
30 CMD "?U9","PF<G6T","?Y5"
40 ENTER (13,*)A
50 DISP A
60 PRINT A
70 GOTO 30
80 END
```

9830A Program Response

```
100000000
100000000
100000000
100000000
100000000
100000000
100000000
100000000
```

4–23. To verify program loading, press the LIST and EXECUTE keys. This gives a program listing from the 9866A Printer. Compare the printed listing received, against the 9830A program listing in 4–22 to assure correct program loading.

4–24. To run the program, press the RUN and EXECUTE keys. The program will continue to run and printout until the STOP key is pressed.

4–25. Successful completion of the 9830A verification program is shown by the 9830A Program response in paragraph 4–22.

Table 4-4. 9830A Verification Program

PROGRAM LINE NO.	COMMAND	PROGRAM DESCRIPTION	CALCULATOR KEY
10	10	Defines statement line number	1 0
10	FORMAT 10B	Defines binary format that can be called by its line number	FORMAT 1 0 B
10	END OF LINE	Stores line number 10 into memory of Calculator	END OF LINE
20	20	Defines statement line number	2 0
20	OUTPUT(13,10) 768	Output statement, causes 768 to be sent over the bus (select code 13) in the format of line 10. (Refer to 9830A HP Interface Bus Users Guide. HP Stock No. 59300-90002)	OUTPUT (1 3 , 1 0) 7 6 8
20	;	End of statement delimiter	;
20	END OF LINE	Stores line number 20 into memory of Calculator	END OF LINE
30	30	Defines statement line number	3 0
30	CMD	Bus command statement. Defines following information as bus data or command information	C M D
30	"	First quote field following CMD statement specifies command mode	"
30	?	Unlistens all listeners on the bus	?
30	μ	Calculator talk address. Places Calculator in talk mode.	μ
30	9	5328A listen address. Places 5328A in listen mode	9
30	"	Terminates command mode	"
30	,	Delimiter between modes (command and data)	,
30	"	Second quote field specifies data mode	"
30	P	5328A programming code for remote program initialize (refer to *Table 3-3* Program Code Set)	P
30	F<	5328A program code for check function	F <
30	G6	5328A program code for 1 second gate time	G 6
30	T	5328A program code for reset and trigger command	T
30	"	Terminates data mode	"

Table 4-4. 9830A Verification Program (Continued)

PROGRAM LINE NO.	COMMAND	PROGRAM DESCRIPTION	CALCULATOR KEY
30	,	Delimiter between modes	,
30	"	Third quote field following CMD statement specifies address mode	"
30	?	Unlistens all listeners on the bus	?
30	Y	5328A talk address. Places 5328A in talk mode	Y
30	5	Calculator listen address. Places calculator in listen mode.	5
30	"	Terminates address mode	"
30	END OF LINE	Stores line number 30 into memory of calculator	END OF LINE
40	40	Defines statement line number	4 0
40	ENTER(13,*)A	Enters data over 13 (bus) in *(free-field format) into the "A" register of the calculator	ENTER (1 3 , *) A
40	END OF LINE	Stores line number 40 into memory of calculator	END OF LINE
50	50	Defines statement line number	5 0
50	DISP A	Causes contents of "A" register of calculator to be displayed.	DISP A
50	END OF LINE	Stores line number 50 into memory of calculator	END OF LINE
60	60	Defines statement line number	6 0
60	PRINT A	Causes contents of "A" register to be printed by 9866A	PRINT
60	END OF LINE	Stores line number 60 into memory of calculator	END OF LINE
70	70	Defines statement line number	7 0
70	GTO30	Causes program to loop back to line 30	G O T O 3 0
70	END OF LINE	Stores line number 70 into memory of calculator	END OF LINE
80	80	Defines statement line number	8 0
80	END	Ends program	END
80	END OF LINE	Stores line number 80 into memory of calculator	END OF LINE

4-26. DIAGNOSTIC PROGRAM AND TROUBLESHOOTING

4-27. Since Option 011 is an interface controlled by software, effective problem diagnosis and troubleshooting require a thorough understanding of program execution. The interface connects the 5328A Counter to the HP-IB. Therefore, a good understanding of the 5328A Counter and the HP-IB is also required.

4-28. The diagnostic program in *Table 4-5* is written for the 9830A. It performs overall testing and failure diagnosis of Option 011. A description of its use and an explanation of each test are included with the program.

4-29. Each test in the diagnostic program has a corresponding troubleshooting flowchart. With the troubleshooting flowcharts is a description that includes when and how to use them. The names of the troubleshooting flowcharts correspond with the test in the diagnostic program for easy reference. If the problem cannot be isolated by use of the troubleshooting flowchart, the flowchart will lead to an ASM state table where troubleshooting will require evaluation of ASM operation.

4-30. The overall ASM flowchart, included with a description, shows the possible ASM operational loops. Use it in conjunction with the ASM state tables, when troubleshooting, to determine what operation the ASM is performing during a given ASM address.

4-31. The examples of basic ASM problems at the end of this section include identification procedures and troubleshooting techniques.

4-32. Option 011 Diagnostic Program

4-33. The diagnostic program in *Table 4-5* is written for the 9830A Calculator and is designed to completely test Option 011. It is intended for use when the Option 011 either fails the performance test, local operation test, or the user feels that there is a problem with the interface board, not found in the above stated tests.

4-34. If it is necessary to type the total diagnostic program into the 9830A memory, it is advisable to store the program on a cassette for possible future use. Refer to Hewlett-Packard 9830A Calculator, Simplified Operating Instructions, HP Part No. 09830-90000 for explanation of cassette use.

4-35. LOADING THE PROGRAM. Prior to loading the program, push the STOP key down until STOP appears on the display. If the display remains blank refer to 9830A Operating and Programming Manual, Appendix A. Push the remaining keys to program the calculator as shown in the printer list in *Table 4-5*.

4-36. VERIFY THE PROGRAM. After the program has been loaded, push LIST and EXECUTE keys. This will run a printer list of the program. Check the list to verify that the program was entered correctly.

4-37. RUNNING THE PROGRAM. To run the program push the RUN and EXECUTE keys. When the calculator display asks for a response, perform as requested then press CONT, then press EXECUTE. If the display asks a question for which the answer is "no", answer by pressing N then pressing EXECUTE. The first part of the program, as shown in the printer list in *Table 4-5*, consists of many tests. Each test has a subroutine number that follows the test title in the list. Any single test can be performed by pressing CONT, typing the number next to the specific test and the EXECUTE keys.

Table 4–5. Diagnostic Program List

```
10 FORMAT 10B
20 FORMAT F5.0
30 DIM A$[10],B$[1],C$[5],Z$[32],P$[9]
40 B$="C"
50 DISP "5328A HPIB INTERFACE TEST"
60 WAIT 1500
70 DISP "SET LISTEN ADD.  TO 9, NO TLKR"
80 STOP
90 REM:            TEST RMT/LOC
100 GOSUB 510
110 REM:            TEST LLO
120 GOSUB 660
130 REM:           TEST GTL
140 GOSUB 880
150 REM:            TEST TALK AND UNTALK
160 GOSUB 950
170 REM:            TEST LISTEN AND UNLISTEN
180 GOSUB 1040
190 REM:            TEST GET
200 GOSUB 1140
210 REM:            TEST DCL
220 GOSUB 1260
230 REM:            TEST SDC
240 GOSUB 1390
250 REM:            TEST FN CODE, TB CODE, DP AND ANN
260 GOSUB 1730
270 REM:            TEST P
280 GOSUB 1910
290 REM:            TEST R
300 GOSUB 2000
310 REM:            TEST MULT
320 GOSUB 2120
330 REM:            TEST ODU
340 GOSUB 2220
350 REM:            TEST SAMPLE RATE CONTROL
360 GOSUB 2280
370 REM:            TEST ARMING
380 GOSUB 2440
390 REM:            TEST STORAGE
400 GOSUB 2520
410 REM:            TEST DECADE RESET DISABLE AND DIG OUT
420 GOSUB 2650
430 REM:            TEST OVERFLOW
440 GOSUB 2750
450 REM:            TEST TALK ALWAYS
460 GOSUB 2820
470 REM:            TEST ADDRESS SWITCH
480 GOSUB 2920
490 DISP "5328A HPIB INT. CHECK COMPLETED"
500 STOP
```

Table 4-5. Diagnostic Program List (Continued)

```
510 REM:            SUB FOR TESTING RMT/LOC
520 OUTPUT (13,10)768;
530 CMD "?U9"
540 DISP "IS COUNTER IN REMOTE";
550 INPUT C$
560 IF POS(C$[1,1],B$) THEN 590
570 DISP "COUNTER FAILS RMT TEST"
580 STOP
590 OUTPUT (13,10)1024;
600 DISP "DOES COUNTER GO TO LOCAL";
610 INPUT C$
620 IF POS(C$[1,1],B$) THEN 650
630 DISP "COUNTER FAILS TO GO TO LOCAL";
640 STOP
650 RETURN
660 REM:            SUBROUTINE FOR TESTING LLO
670 OUTPUT (13,10)768;
680 OUTPUT (13,10)256,17,512;
690 CMD "?U9"
700 DISP "PUSH RESET BUTTON";
710 STOP
720 DISP "DOES COUNTER STAY IN RMT";
730 INPUT C$
740 IF POS(C$[1,1],B$) THEN 770
750 DISP "LLO FAILS";
760 STOP
770 OUTPUT (13,10)1024
780 OUTPUT (13,10)768
790 CMD "?U9"
800 DISP "PUSH RESET BUTTON";
810 STOP
820 DISP "DOES COUNTER GO TO LOCAL";
830 INPUT C$
840 IF POS(C$[1,1],B$) THEN 870
850 DISP "COUNTER FAILS TO GO TO LOCAL";
860 STOP
870 RETURN
880 REM:            SUB FOR TESTING GTL
890 CMD "?U9","PF<G0T"
900 OUTPUT (13,10)256,1,512;
910 IF STAT13>1 THEN 940
920 DISP "INTERFACE FAILS TO TO TO LOCAL";
930 STOP
940 RETURN
950 REM:            SUB FOR TESTING TALK AND
960 CMD "?U9","PF<G0T","?Y5"
970 OUTPUT (13,10)256,24,512;
980 A=RBYTE13
990 OUTPUT (13,10)256,25,512;
1000 IF A=64 THEN 1030
1010 DISP "IMPROPER SRQ";
1020 STOP
1030 RETURN
```

Table 4–5. Diagnostic Program List (Continued)

```
1040 REM:           SUBROUTINE FO TESTING LISTEN AND UNLISTEN
1050 CMD "?U9","PF<G0T"
1060 IF STAT13<2 THEN 1090
1070 DISP "COUNTER DOES NOT LISTEN PROPERLY"
1080 STOP
1090 CMD "?U9","PF<G0R","?","T"
1100 IF STAT13>1 THEN 1130
1110 DISP "COUNTER DID NOT LISTEN"
1120 STOP
1130 RETURN
1140 REM:           SUBROUTINE FOR TESTING GET
1150 CMD "?U9","PF<G0R","?"
1160 OUTPUT (13,10)256,8,512;
1170 IF STAT13>1 THEN 1200
1180 DISP "TRIGGERS WHEN NOT ADDR TO LISTEN"
1190 STOP
1200 CMD "9"
1210 OUTPUT (13,10)256,8,512
1220 IF STAT13<1 THEN 1250
1230 DISP "COUNTER FAILS TO RESPOND TO GET"
1240 STOP
1250 RETURN
1260 REM:           TEST DCL
1270 CMD "?U9","PF<G0S5T","?Y5"
1280 ENTER (13,*)Z$
1290 IF Z$[15,15]="6" THEN 1320
1300 DISP "NO CHECK N=1"
1310 STOP
1320 OUTPUT (13,10)256,20,512;
1330 CMD "?U9","S5","?Y5"
1340 ENTER (13,*)Z$
1350 IF Z$[15,15]="0" THEN 1380
1360 DISP "DCL DOES NOT WORK"
1370 STOP
1380 RETURN
1390 REM:           TEST SDC
1400 CMD "?U9","PF<G0S5T","?Y5"
1410 ENTER (13,*)Z$
1420 IF Z$[15,15]="6" THEN 1450
1430 DISP "NO CHECK N=1"
1440 STOP
1450 OUTPUT (13,10)256,4,512;
1460 CMD "?U9","S5"
1470 CMD "?Y5"
1480 ENTER (13,*)Z$
1490 ENTER (13,*)Z$
1500 IF Z$[15,15]="6" THEN 1530
1510 DISP "RESPONSE TO SDC WHEN NOT MLA"
1520 STOP
1530 CMD "9"
1540 OUTPUT (13,10)256,4,512;
1550 CMD "?U9","S5","?Y5"
1560 ENTER (13,*)Z$
1570 IF Z$[15,15]="0" THEN 1600
1580 DISP "NO RESPONSE TO SDC"
1590 STOP
1600 RETURN
```

Table 4–5. Diagnostic Program List (Continued)

```
1610 REM: SUBROUNTINE FOR TESTING TB,FN CODES,DP AND
     ANNUNCIATOR READOUT
1620 CMD "?U9",A$,"?Y5"
1630 ENTER (13,*)Z$
1640 FOR I=1 TO 32
1650 IF POS(Z$[I,I],",")=1 THEN 1670
1660 NEXT I
1670 IF I#A THEN 1700
1680 J=VAL(Z$[15,15])
1690 IF J=B THEN 1720
1700 DISP "IMPROPER DATA OUTPUT",A$
1710 STOP
1720 RETURN
1730 REM: SUBROUTINE FOR TESTING FN,TB CODES,DP AND ANN.
1740 FOR K=0 TO 7
1750 A$="PF<G0S5T"
1760 OUTPUT (P$,20)K
1770 A$[5,5]=P$[5,5]
1780 A=11-K
1790 B=6
1800 GOSUB 1610
1810 NEXT K
1820 A=11
1830 B=0
1840 A$="PF0G0S5T"
1850 GOSUB 1610
1860 A=10
1870 B=3
1880 A$="PF?G0S5T"
1890 GOSUB 1610
1900 RETURN
1910 REM:              SUBROUTINE FOR TESTING P
1920 CMD "?U9","PF<G0TPS5","?Y5"
1930 A=11
1940 B=0
1950 GOSUB 1630
1960 IF STAT13>1 THEN 1990
1970 DISP "P FAILED TO CLEAR SRQ"
1980 STOP
1990 RETURN
2000 REM:                TEST R
2010 CMD "?U9","PF<G0S5T","?Y5"
2020 ENTER (13,*)D
2030 IF D=1E+07 THEN 2060
2040 DISP "COUNTER FAILED CHECK MEAS";
2050 STOP
2060 CMD "?U9","S5R","?Y5"
2070 ENTER (13,*)D
2080 IF D=0 THEN 2110
2090 DISP "RESET FAILS";
2100 STOP
2110 RETURN
```

Table 4–5. Diagnostic Program List (Continued)

```
2120 REM:            SUBROUTINE FOR TESTING MLT
2130 CMD "?U9","PF<G0R"
2140 IF STAT13>1 THEN 2170
2150 DISP "CTR WILL NOT MAKE SINGLE MEAS"
2160 STOP
2170 CMD "?U9","S1"
2180 IF STAT13<1 THEN 2210
2190 DISP "COUNTER WILL NOT MAKE MULT MEAS"
2200 STOP
2210 RETURN
2220 REM:            SUBROUTINE FOR CHECKING OWU
2230 CMD "?U9","PF<G0S3T"
2240 IF STAT13>1 THEN 2270
2250 DISP "HPIB DOES NO RESPOND TO OWU"
2260 STOP
2270 RETURN
2280 REM:            SUBROUTINE FOR TESTING SR CONTROL
2290 CMD "?U9","PF<G0S13T"
2300 DISP "PUT COUNTER INTO HOLD"
2310 STOP
2320 DISP "IS GATE LIGHT ON CONTINUOUSLY";
2330 INPUT C$
2340 IF POS(C$[1,1],B$) THEN 2370
2350 DISP "COUNTER SHOULD BE IN MAX SR";
2360 STOP
2370 CMD "?U9","S7"
2380 DISP "DOES SAMPLE RATE POT WORK";
2390 INPUT C$
2400 IF POS(C$[1,1],B$) THEN 2430
2410 DISP "SAMPLE RATE POT SHOULD WORK";
2420 STOP
2430 RETURN
2440 REM:            SUBROUTINE FOR TESTING ARMING
2450 DISP "NO TRIGGER INTO CH B ALLOWED";
2460 STOP
2470 CMD "?U9","PF<G0S;T"
2480 IF STAT13>1 THEN 2510
2490 DISP "COUNTER FAILED TO ARM CORRECTLY";
2500 STOP
2510 RETURN
2520 REM:            SUBROUTINE FOR TESTING STORAGE
2530 CMD "?U9","PF<G7TS=5T"
2540 WAIT 1000
2550 CMD "?U9","S<","?Y5"
2560 ENTER (13,*)D
2570 IF D#0 THEN 2600
2580 DISP "STORAGE FAILED TO TURN OFF";
2590 STOP
2600 ENTER (13,*)D1
2610 IF D1=D THEN 2640
2620 DISP "STORAGE FAILS TO GO BACK ON";
2630 STOP
2640 RETURN
```

Table 4-5. Diagnostic Program List (Continued)

```
2650 REM:              SUBROUTINE FOR TESTING DECADE RESET
                       DISABEL AND DIG OUT
2660 CMD "?U9","PF<G5S?R"
2670 FOR I=1 TO 10
2680 CMD "?U9","T","?Y5"
2690 ENTER (13,*)D
2700 IF D=I*1E+07 THEN 2730
2710 DISP "DEC RES DIS OR DIG OUT BAD";
2720 STOP
2730 NEXT I
2740 RETURN
2750 REM:              SUBROUTINE FOR TESTING OVERFLOW
2760 CMD "?U9","PF<G7T","?Y5"
2770 ENTER (13,*)Z$
2780 IF Z$[1,1]="0" THEN 2810
2790 DISP "OVERFLOW FAILED";
2800 STOP
2810 RETURN
2820 REM:              SUBROUTINE FOR TESTING TALKA
2830 CMD "9"
2840 OUTPUT (13,10)256,1,512;
2850 DISP "TALK ALWAYS; CHK,N=1; MAX";
2860 STOP
2870 CMD "?5"
2880 ENTER (13,*)Z$
2890 DISP "TURN OFF TALK ALWAYS";
2900 STOP
2910 RETURN
2920 REM:              SUBROUTINE FOR TESTING ADDRESS SWITCH
2930 OUTPUT (13,10)256,20,512;
2940 DISP "SWITCH TO LISTEN ADDRESS 4";
2950 STOP
2960 CMD "?U4","PF<G0T","?5T"
2970 A=11
2980 B=6
2990 GOSUB 1630
3000 DISP "SWITCH TO LISTEN ADDRESS *";
3010 STOP
3020 OUTPUT (13,10)256,20,512;
3030 CMD "?U*","PF<G0T","?J5"
3040 GOSUB 1630
3050 RETURN
```

4-38. PROGRAM DESCRIPTION. In the diagnostic program, A$ is used as the string variable to program the counter. Z$ is the string variable that represents what the counter delivered as output. After any test failure, these two strings may be examined showing what the counter was programmed to and what it outputted. The following tests exercise the operations as described:

a. Test REMOTE/LOCAL (RMT/LOC)

REN is sent true in line 520 of the program. The counter is addressed to listen in line 530. At this point it should go to remote. Line 590 turns REN false which returns the counter to local.

b. Test LOCAL LOCKOUT (LLO)

Line 680 programs LLO and 690 sends it into remote. At this point, pushing the counter RESET button should not return the counter to local. Lines 770 and 780 cause REN to go high and then low causing LLO to go off. The counter then should go to local when the RESET button is pushed.

c. Test GO TO LOCAL (GTL)

Statement 890 causes a service request while 900 causes the instrument to go to local, disabling that request. If there is a service request it is assumed that the counter didn't respond to GTL.

d. Test TALK and UNTALK

The counter is programmed to service request and talk in lines 960 and 970. If the counter reads out a status byte of 64 it is talking correctly.

e. Test LISTEN and UNLISTEN

The counter is programmed to service request and must listen correctly in order to do so. In line 1090 it is instructed to unlisten before a trigger command. Not receiving a service request from the counter would signify correct response to the unlisten command.

f. Test GROUP EXECUTE TRIGGER (GET)

The counter is prepared for a measurement but not triggered and unaddressed to listen in line 1150. The GET command is then sent. The counter must not respond to this since the GET command is an addressed one. The counter is then addressed to listen and should trigger, giving a service request.

g. Test DEVICE CLEAR (DCL)

The counter is programmed for a standard "Check" measurement in line 1270. In 1280, the data output is received from the counter to see if it programmed correctly. DCL is programmed in line 1320. The counter is then told to read out on the fly (that is the only way it will read out the string the second time) and the exponent digit is checked for a "Ø" where it was a "6" before DCL was applied.

h. Test SELECTED DEVICE CLEAR (SDC)

The test for SDC is the same as for DCL except the counter is also checked for not responding to SDC when not addressed in lines 1450 and 1520.

i. Test FUNCTION (FN), TIME BASE (TB), DECIMAL POINT (DP), and ANNUNCIATOR READOUT

In this test "A" represents the position in the output string where the DP is expected (A=4 fn DP on right of MSD, increasing to right). The B represents the value of the exponent read out by the 5328A. In this test a series of function and time base code combinations are programmed and their output strings checked for proper DP position and exponent value. This subroutine calls the one beginning at line 1610 which actually checks to see if the A and B numbers are correct.

j. Test "P"

In line 1920 an SRQ is generated and then cleared by the second "P" in the A$ string. The counter is then checked to see if the Function code reset to STOP and Time Base code to Ø and that SRQ was cleared. The command "P" sets the counter to a power up reset state, the same as SDC and DCL.

k. Test "R"

The counter is programmed to a normal check measurement in line 2010. The reading is then checked to be correct (nonzero). "R" is then programmed in line 2060 and the data output is then checked to be zero since "R" resets the DCA, Display, and Time Base.

l. Test MULTIPLE MEASUREMENTS (MLT)

Line 2130 sets the counter to MLT true (S1) and the counter will make multiple measurements. Thus it checks to see that it is off by testing for no completed measurement. MLT is then turned on in line 2170 and the counter is tested for triggering which it should do.

m. Test for not WAIT UNTIL ADDRESSED ($\overline{\text{ODU}}$)

$\overline{\text{ODU}}$ is tested by checking to see if SRQ is disabled when ODU is on (S3). ODU disables SRQ.

n. Test SAMPLE RATE (SR) Control

The counter is put into maximum cycle mode (S13) first to see if the counter will cycle rapidly. Then (S7) in line 2370 is also programmed causing the sample rate pot to work and is tested by the user.

o. Test ARMING

The counter is programmed to an armed check function in line 2470 when Channel B arms the measurement. With B not triggering the counter should not trigger.

p. Test STORAGE

Storage is turned off on line 2530 for a check measurement with a long gate time. It is then turned on again. Two samples of the data are read out and if they are the same and not zero storage, on and off must have worked properly.

q. Test DECADE RESET DISABLE and DIGIT OUT

In this test, 10 check measurements are made with Decade Reset Disable on. The measurement is set up in line 2660. The triggering is done in 2680. The reading is then checked to increment by 10^7 each trigger.

r. Test OVERFLOW

The counter is made to overflow and a "Ø" is checked for in the leading output digit.

s. Test TALK ALWAYS

Putting the counter in talk always is similar to having it programmed to talk. Thus the calculator looks for output from the counter without addressing it to talk.

t. Test ADDRESS SWITCH

Here different combinations of the addressed switch are set and the counter is checked to respond to the corresponding address on the bus.

4-39. USE OF THE DIAGNOSTIC PROGRAM. When the diagnostic program is used proceed as follows:

a. The following equipment is needed to perform the diagnostic program:

Model 9830A Calculator with Extended I/O ROM and String Variables ROM
Model 9866A Printer
Model 59405A HP-IB Calculator Interface (Option 030)
Model 5328A Counter with Option 011 board under test

b. Configure the equipment as outlined in paragraph 4-20. If the 9830A is not equipped with Option 274, insert the String Variables ROM into one of the 9830A ROM slots.

c. Set the 5328A Counter controls as follows:

FUNCTION	CHECK
FREQ RESOLUTION	.1 kHz
SAMPLE RATE	CCW
ARMING	OFF
STORAGE	ON
OSCILLATOR	INT
TALK ALWAYS	NOT TALK ALWAYS
ADDRESS	"9"

d. Referring to paragraph 4-20, load the diagnostic program into the memory of the 9830A. Verify the program as outlined in paragraph 4-23.

e. To execute the diagnostic program, refer to paragraph 4-24, if the Option 011 under test fails any test, the 9830A will display the failure mode and the program will stop. The operator may continue the program by pressing the CONTINUE and the EXECUTE keys. Successful completion of the diagnostic is confirmed by the 9830A displaying "5328A HP-IB INT. CHECK COMPLETED".

f. If a board fails, and the 9830A displays the failure mode, refer to the diagnostic program listing in *Table 4-5* to find the test that contains the failure display statement. Once it is determined which test the board failed, refer to the corresponding troubleshooting flowchart to localize the failure.

4-40. ASM Flowchart

4-41. The ASM flowchart in *Figure 4-1* shows all of the possible states that the ASM may exercise. In any given mode, program sequence, or output routine, the ASM may exercise some states once or some states many times depending on the particular case.

4-42. Above each symbol are two numbers. The number above and to the right is the decimal number equivalent, of the binary ASM address, that is present at the input of the ROM. The address is present at pins 3, 4, 5, 14, 15, 25, 26, and 27 of the ROM, with the least-significant-bit at pin 3. The number above and to the left of each symbol is the octal equivalent of that state address. Both numbers are included for ease of service and troubleshooting.

4-43. THE RECTANGLE. A rectangle symbol represents a process state. In this state, the ASM causes some action to take place. As an example, in ASM address or state (octal) "6", inhibit is set low by the ASM and associated circuitry. Also, while in the process state, the Format Bit from the ROM (U22) is low assuring that the state counters will only increment the ASM address by one count at the next positive clock pulse transition.

4-44. THE DIAMOND. A diamond shaped symbol represents a decision state. In a decision state, the Format Bit from the ROM is set high allowing the state counters to either increment by one count or parallel enable the jump state information from the output of the ROM as the next ASM address information to the ROM input. The jump is executed if the qualifier associ-

ated with the state is high during the given ASM address. The jump is accomplished by the ROM setting U30(8) to the high state. When U30(8) is set high, U30C will give the necessary positive output required for the jump if the qualifier is high and the parallel enable will take place at the next positive clock pulse transition. If the qualifier is low during the particular ASM address, the state counters will increment the ASM address by one count.

4-45. "N" DECISION STATE. If an "N" is in a decision symbol, the jump is executed if the qualifier associated with the state is low during that ASM address. The jump, in this case, is caused by the ROM setting U30(10) low. When U30(10) is low, U30C will give the necessary positive output required for a jump if the qualifier is low at the next positive clock pulse transition. The state counters will increment the ASM address by one count, at the next positive clock pulse transition, in an "N" decision state if the associated qualifier is high.

4-46. THE CIRCLE. A circle symbol at the end of a flow line, indicates the line is continued at another such symbol on the sheet.

4-47. Troubleshooting Flowcharts

4-48. The troubleshooting flowcharts included in *Figures 4-2* through *4-22* are provided for failure isolation. They will either lead directly to the problem, or require evaluation of ASM operation to isolate the problem.

4-49. Included with most of the troubleshooting flowcharts (whenever ASM operation must be evaluated) are ASM state tables. The state tables contain programming information, logic state analyzer control settings, and expected results needed to analyze ASM operation in the given mode of operation.

4-50. Whenever the troubleshooting flowchart calls for PGM (program), first press the STOP and EXECUTE then press the SCRATCH and EXECUTE keys on the 9830A Calculator. This will clear the memory and allow the operator to enter the new program.

4-51. When the memory is clear, type the program information supplied, into the memory of the 9830A Calculator, and execute the program by pressing the RUN and EXECUTE keys. After executing the program if the troubleshooting flowchart asks a question (decision state) stop and check for the condition.

4-52. To check the condition of STAT 13, which indicates the status of the Bus, type STAT 13= on the 9830A Calculator and then press the EXECUTE key. The 9830A will either display 0, 1, 2, or 3. A "Ø" or "1" condition indicates the 5328A has vompleted a measurement. A "2" or "3" condition indicates the 5328A has not completed a measurement. For further explanation of STAT 13, refer to Hewlett-Packard Interface Bus Users Guide 9830A, HP Part No. 59300-90002.

4-53. ASM Troubleshooting

4-54. If an Option 011 fails a test in the diagnostic program and the troubleshooting flowchart for that test leads to an ASM state table, then it is necessary to troubleshoot the board by evaluating the ASM with a logic state analzyer.

4-55. The following paragraphs describe how to use a logic state analyzer and the ASM state tables to locate problems on an Option 011 board.

4-56. SYSTEM CONFIGURATION AND USE. To troubleshoot by ASM flow evaluation, in a given mode, proceed as follows:

a. The following equipment is needed to troubleshoot the ASM:

Model 9830A Calculator with Extended I/O ROM
Model 9866A Printer
Model 59405A HP-IB Calculator Interface (Option 030)
Model HP 180A Oscilloscope with HP 1601 Logic State Analyzer
Model 5328A Counter with Option 011 under test

b. Connect the 9830A Calculator with Extended I/O ROM, the 9866A Printer, and the 5328A Counter with Option 011 under test as outlined in paragraph 4–20.

c. Insert the HP 1601 Logic State Analyzer into the HP 180A Oscilloscope and connect to 5328A as follows:

1. Remove 5328A top cover.
2. Connect 10230A Clock Probe to U14 Pin 2 and common to U14 Pin 8.
3. Connect the 10231A Six-Bit Probes as follows:

Bit Ø to U14 Pin 14
Bit 1 to U14 Pin 13
Bit 2 to U14 Pin 12
Bit 3 to U14 Pin 11
Bit 4 to U23 Pin 14
Bit 5 to U23 Pin 13
Bit 6 to U23 Pin 12
Bit 7 to U23 Pin 11

4. Set the controls on the 1601A Logic State Analyzer as follows:

DISPLAY
LOGIC ..... POS
MARK ..... OFF
BYTE ..... 3 BIT
THRESHOLD ..... TTL
CLOCK .....
DISPLAY TIME ..... CCW
COLUMN BLANKING ..... CCW
DELAY SET 00000
TRIGGER MODE ..... START DELAY
SAMPLE MODE ..... REPET
TRIGGER WORD ..... Set Switches 0–7 to 003, Switches 8–11 to OFF

d. With all of the equipment turned on, the HP 180A Oscilloscope should display bit patterns on the display. To assure this, set the 5328A Function to STOP and make sure it is in local operation. If the oscilloscope is not displaying bit patterns, refer to example 1 paragraph 4–56 to locate the problem.

e. When a specific test is failed and the troubleshooting flowchart leads the user to the ASM state table proceed as follows:

1. Use the information in the ASM state table to set controls differently than in paragraph 4–39c.
2. If programming information is supplied in the state table, enter the program into the 9830A and RUN the program.
3. Set the analyzers TRIGGER WORD to agree with the "trigger word" in the ASM state table.
4. The top line (bits of information) of the analyzer display will be the octal representation of the trigger word.

5. Increment the DELAY SET switch by one count and check the analyzer display. The top line should be the octal equivalent of the number listed next to the corresponding delay setting in the state table.

6. Continue step 5 until the entire ASM state table is verified or the problem is determined.

4-57. BASIC ASM PROBLEMS. There are several possible ASM problems. In the following paragraphs, a description of the problem, how to identify the problem, and troubleshooting techniques will be given for some common problems.

4-58. Example 1: State Counters will not Increment. In a no increment failure mode, the state counters U14 and U23 will not up-count.

4-59. The problem will be discovered when the diagnostic program is used. When the program is started, the display, on the 9830A Calculator, will blank and the program will stop.

4-60. With this problem first make sure that clock pulses are present at U14(2) and U23(2). The clock pulse check can be made in two ways. The first, a quick check, can be made if the logic state analyzer is connected. This check is accomplished by observing the "NO CLOCK" lights on the logic state analyzer. If either light is on, the analyzer is indicating that there are no clock pulses present and shows the condition (high or low) of the clock input. The second method is to use a standard oscilloscope on U14(2) or U23(2).

4-61. If clock pulses are present, remove the ROM U22 and check the logic state analyzer (as connected in paragraph 4-56c., to make certain the state counters are up-counting correctly. To check the state counters for proper up-counting, trigger the logic state analyzer on TRIGGER WORD "Ø" (all switches 0-7 to low position) with the other controls set as outlined in paragraph 4-56c. The analyzer should be displaying binary state address "Ø" on the top line of the display. As the DELAY SWITCH on the analyzer is increased by one number, the top line, ASM address, of the display should increase by one number (decimal) until decimal 255 appears, and the count sequence starts over.

4-62. Example 2: ASM Jumps Only. In a jump only failure mode, the state counters always parallel enable the ROM's output jump information as the next ASM address.

4-63. When the diagnostic program is used, the jump only problem will be discovered. The Option 011 will fail a test in the diagnostic program. The test failed will lead to the troubleshooting flowchart associated with the test, and the flowchart will lead to use of the ASM state table, where it will be necessary to evaluate the ASM flow in the particular mode.

4-64. After the logic state analyzer is connected, as in paragraph 4-56c., and the analyzer TRIGGER WORD is set to the ASM state table requirement, observe the display on the logic state analyzer. The pattern on the display will not agree with the ASM state table addresses. A close evaluation of the ASM flow will show that, in every decision state, the ASM executes a jump to a new address.

4-65. To further evaluate the problem, take data bit probe number eight (on the logic state analyzer), isolated with a 1000Ω resistor, and connect it to U25(3). Set the number 8 trigger word switch to the off position. If the display, on the analyzer, in column eight is always low, check U25 and associated circuitry (it may be necessary to use a standard oscilloscope to assure that waveforms go to both logic levels). U25(3) should only be low during an ASM decision state, with the proper qualifier condition.

4-66. Use of data bit probe number eight with the 1000Ω isolation is a powerful aid. It may be used to help isolate problems at a certain ASM address state.

4-67. Example 3: ASM will not Jump. In a no jump failure mode, the new or next state ASM address (decimal) always increases by only one count.

4-68. This problem will be discovered when the diagnostic program is used. After the test failed leads the user to a troubleshooting flowchart, the flowchart will lead to use of the ASM state table and the logic state analyzer. When the analyzer is connected (refer to paragraph 4-54c.), the pattern on the display will not match the ASM addresses in the state table, each next state address will be incremented by one count only.

4-69. To troubleshoot the problem, find an ASM address in the ASM state table where the next ASM address (decimal) is increased by more than one count. Using this ASM address and data probe number 8 as explained in example 2, check U25(1) at the ASM address. At this and all decision state addresses, U25(1) must be high.

4-70. Referencing to the same ASM address, check U25(2) with data probe 8. It also should be high at the ASM address. If U25(2) is low, check U30(9,10) with the data probe. Pins 9 and 10 must be of different logic states during the ASM address if the jump is to take place.

4-71. Example 4: ASM will not Jump due to Improper Qualifier. Unlike example 3, where the problem was within the ASM itself, this example is where the associated qualifier, for the state in question, is of the wrong condition.

4-72. If the wrong qualifier is received, the problem will be recognized by use of the diagnostic program. When the diagnostic program is used, the particular interface will fail a test. The troubleshooting flowchart will lead to use of the ASM state table.

4-73. This failure mode is different than example 3. The difference is, that in all decision states in example 3 the ASM did not jump. In this example, the ASM will jump in some decision states.

4-74. To locate the problem, compare the display on the analyzer against the ASM state table for the test in question. The error will always be spotted in a decision state. Even if the interface fails to perform a process state function (i.e., set listen low), it will not be noticed until the ASM "looks" at the listen bit in a decision state.

4-75. The method of using data bit probe number 8 (refer to paragraph 4-65), is useful to check the qualifier bit in a decision state, and also useful to make sure a process state is causing the proper action.

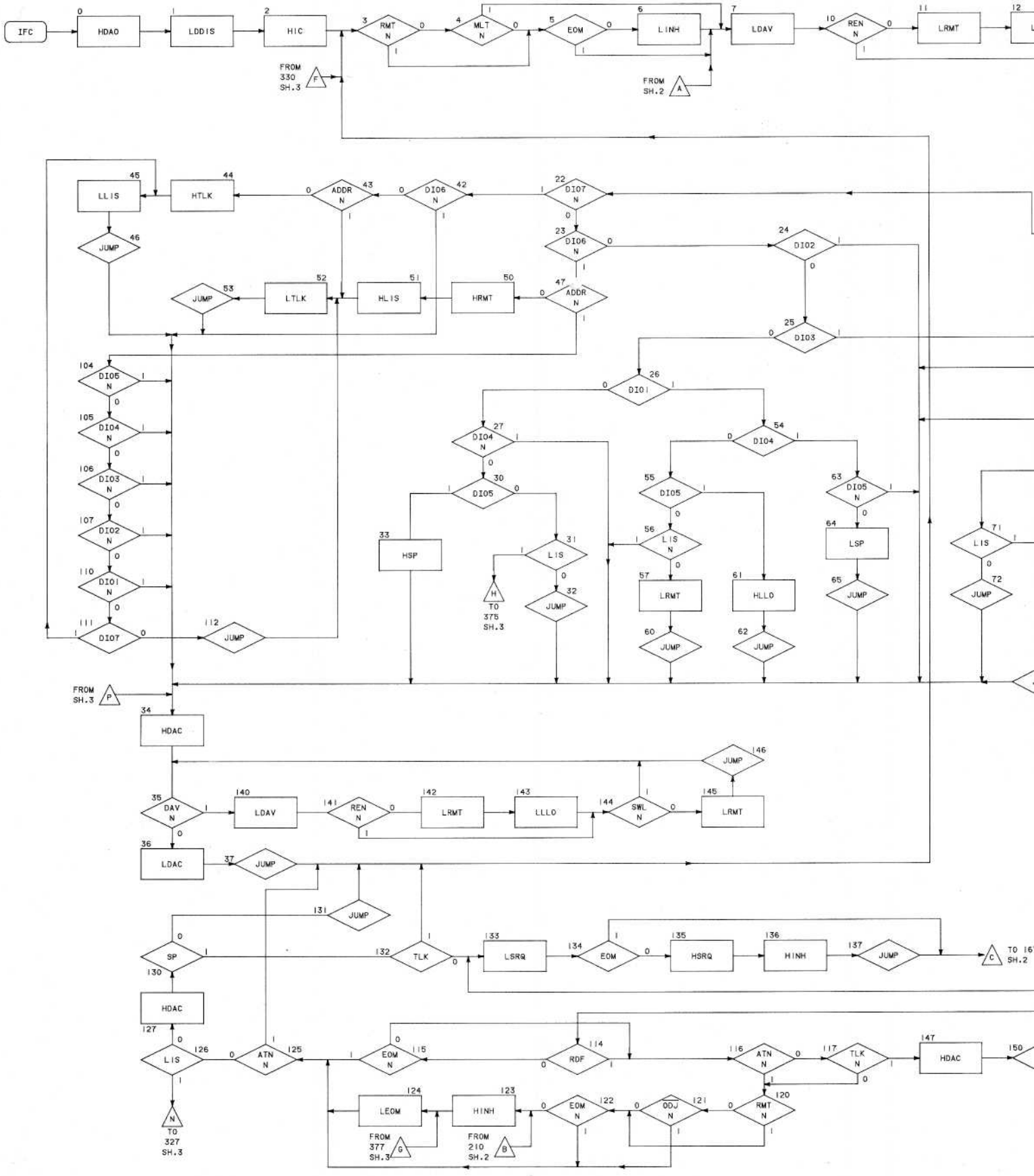
4-76. After comparing the display on the analzyer against the ASM state table an incorrect decision state move will be found. Check the qualifier for the decision state in question by using data bit probe number 8. If the qualifier is correct for the jump, and the jump does not take place, follow the path that the qualifier takes to arrive at U30C(9) to locate the error. If the qualifier is incorrect, and generated by the ASM (in a process state), check to see if the ASM flow in the particular mode exercises the process state in question. It may be checked by the data bit probe method.

Table 4-6. 5328A Option 011 Signal Mnemonics

QUALIFIERS		
Signal	**Source**	**Description**
ADDR	U26(4)	H = My Listen Address
ANN	U32(3)	L = Annunciator On
ATN	U8(5)	L = Attention
BØ	U12(5)	16 State Sequence Count for Output of ASCII Code
B1	U12(6)	16 State Sequence Count for Output of ASCII Code
B2	U12(7)	16 State Sequence Count for Output of ASCII Code
B3	U12(9)	16 State Sequence Count for Output of ASCII Code
BLK	U6(7)	
D	U32(5)	H = Decimal Point has been Outputted
DAC	U8(7)	H = Data Accepted
DAV	U3(1)	L = Data is Valid
DIO1	U3(2)	HP-IB Data Bit 1
DIO2	U3(3)	HP-IB Data Bit 2
DIO3	U3(4)	HP-IB Data Bit 3
DIO4	U3(5)	HP-IB Data Bit 4
DIO5	U3(6)	HP-IB Data Bit 5
DIO6	U3(7)	HP-IB Data Bit 6
DIO7	U3(9)	HP-IB Data Bit 7
EOM	U8(1)	H = End of Measurement
J	U8(2)	Always HIGH, used for unconditional jump
LDP	U32(2)	L = Decimal Point On
LIS	U6(1)	H = Address to Listen
LLO	U19(9)	H = Local Lockout On
MA	U6(5)	L = Enable Strobe to Function Select Latch U34 and Select Bit on Module Strobe Code
MB	U6(6)	L = Enable Strobe to Time Base Select Latch U28 and Select Bit on Module Strobe Code
MLT	U32(6)	H = Make Multiple Measurements
MS	U29(3)	H = Module Strobe L = FC & TB Strobe
OVFL	U32(4)	L = Overflow
ODV	U32(7)	L = Wait until Addressed
RDF	U32(9)	H = Read Data on the fly
REN	U8(4)	L = Remote Enabled
RFD	U8(9)	H = Ready for Data
RMT		H = Option 011 in Remote
S	U32(1)	H = Measurement has dimension of time
SP	U32(1)	H = Serial Pole Active
SRQ	U6(3)	L = Service Request
SWL	U8(6)	H = Switch to Local
TALK A	U6(2)	L = Talk Always
TLK	U26(5)	H = Address to Talk

Table 4-6. 5328A Option 011 Signal Mnemonics (Continued)

OUTPUTS		
Signal	**Source**	**Description**
LLIS		Unlisten
HLIS		Listen
LTLK		Untalk
HTLK		Talk
LSP		Serial Poll Disable
HSP		Serial Poll Enable
LMA		Enable Function Code Latch Input Module Select Code. Also used in putting out Exponent
HMA		Opposite of LMA
LS		Measurement does not have dimension of time. Output POS EXP
HS		Opposite of LS
HLTCH		Latch Data into U28, U33, or U34
LRMT		Go to Local
HRMT		Go to Remote
LD		Decimal Point has not been outputted
HD		Decimal Point has been outputted
LMB		Enable Time Base Code Latch input, Module Select Code. Also used in putting out Exponent
HMB		Opposite of LMB
LMS		Enable Function and Time Base Code Latches Disable Module Strobe Line
HMS		Opposite of LMS
LDAV		5328A says Data Not Valid
HDAV		5328A says Data Valid
LRFD		5328A says Not Ready for Data
HRFD		5328A says Ready for Data
LDAC		5328A says Data not Accepted
HDAC		5328A says Data Accepted
LLO		Local Lockout Off
HLLO		Local Lockout On
LEOM		Reset End of Measurement F/F (U11B)
HIC		Initialize 16 State Counter
HDSA		Strobe Mainframe Display and 16 State Counter
LRPR		Turn OFF Master Remote Programming Reset
HRPR		Turn ON Master Remote Programming Reset
LDDIS		Low Disable Display. TTL active low turns blanks display except LHS Annunciators
HDDIS		Opposite of HDDIS
LINH		Inhibit Counter from Arming
LRST		Turn OFF Counter Mainframe Reset
HRST		Turn ON Counter Mainframe Reset
LSRQ		Output (on U15, U24) Binary Ø on ASCII Bus
HSRQ		Output (on U15, U24) Binary 64 on ASCII Bus
ASP		Output (on U15, U24) ASCII space
LDAO		Output (on U15, U24) all HIGHS on Bus and Disarm DAC Line
HDAO		Output (on U15, U24) all HIGHS on Bus and Arm DAC Line All succeeding bits put out on U15, U24 to be put on HP-IB as ASCII Characters
ADIG		ASCII Digit from Display
ALF		ASCII Line Feed
AØ		ASCII Ø
ACR		ASCII Carriage Return
AE		ASCII E
ADP		ASCII Decimal Point
A3		ASCII 3
A6		ASCII 6
A9		ASCII 9
A+		ASCII +
A-		ASCII -
AOVF		ASCII Letter O


IFC
0 HDAO
1 LDDIS
2 HIC
3 RMT N
4 MLT N
5 EOM
6 LINH
7 LDAV
10 REN N
11 LRMT
12
FROM 330 SH.3
F
FROM SH.2
A
45 LLIS
44 HTLK
43 ADDR N
42 DI06 N
22 DI07 N
46 JUMP
23 DI06 N
24 DI02
53 JUMP
52 LTLK
51 HLIS
50 HRMT
47 ADDR N
25 DI03
104 DI05 N
26 DI01
105 DI04 N
27 DI04 N
54 DI04
106 DI03 N
30 DI05
55 DI05
63 DI05 N
107 DI02 N
33 HSP
31 LIS
56 LIS N
64 LSP
71 LIS
110 DI01 N
H
TO 375 SH.3
32 JUMP
57 LRMT
61 HLLO
65 JUMP
72 JUMP
111 DI07
112 JUMP
60 JUMP
62 JUMP
FROM SH.3
P
34 HDAC
146 JUMP
35 DAV N
140 LDAV
141 REN N
142 LRMT
143 LLLO
144 SWL N
145 LRMT
36 LDAC
37 JUMP
131 JUMP
SP
132 TLK
133 LSRQ
134 EOM
135 HSRQ
136 HINH
137 JUMP
C
TO 16 SH.2
130 HDAC
127 LIS
126 ATN N
125 EOM N
115 RDF
114
116 ATN N
117 TLK N
147 HDAC
150
N
TO 327 SH.3
124 LEOM
123 HINH
122 EOM N
121 ODJ N
120 RMT N
FROM 377 SH.3
G
FROM 210 SH.2
B

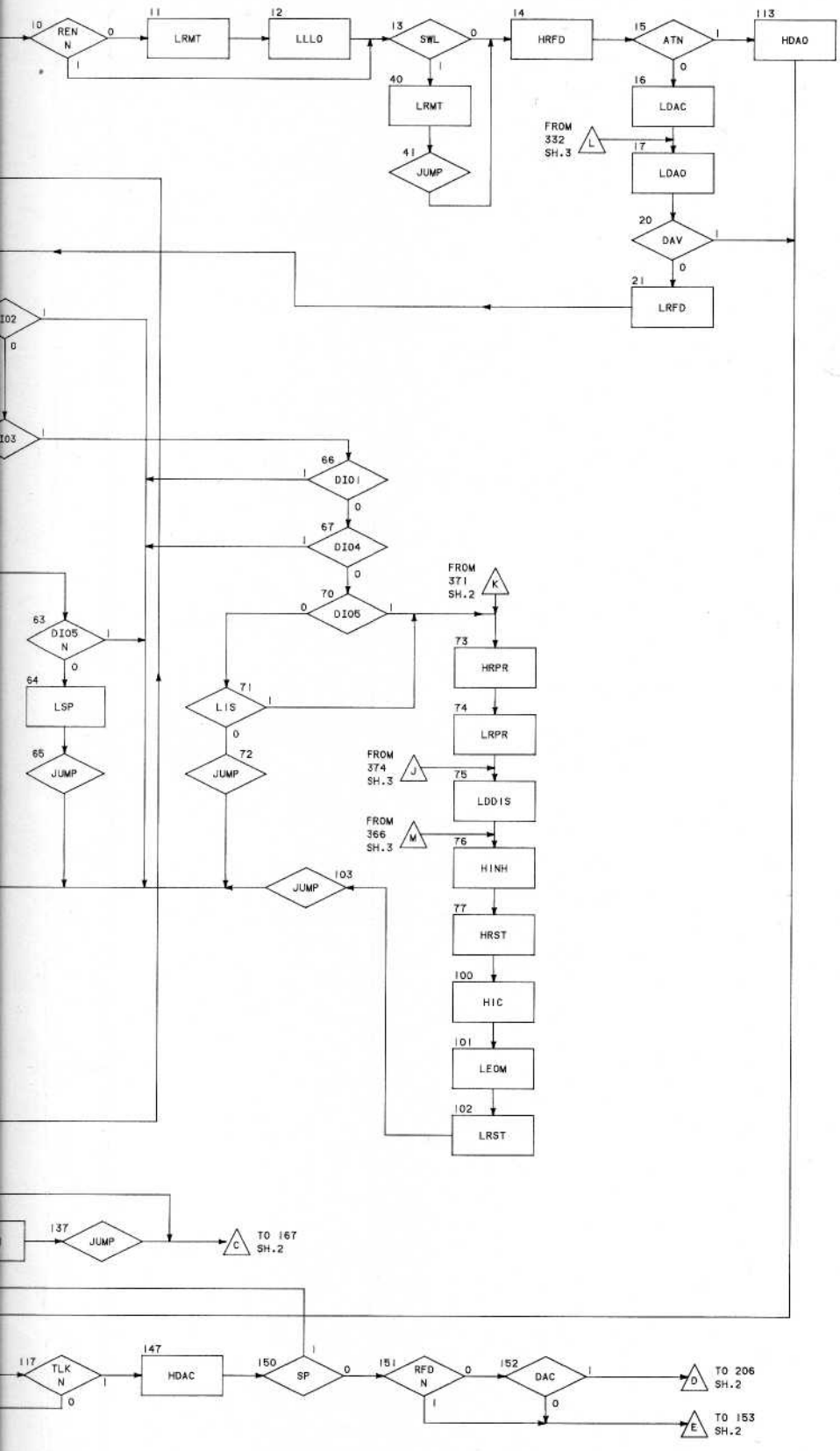
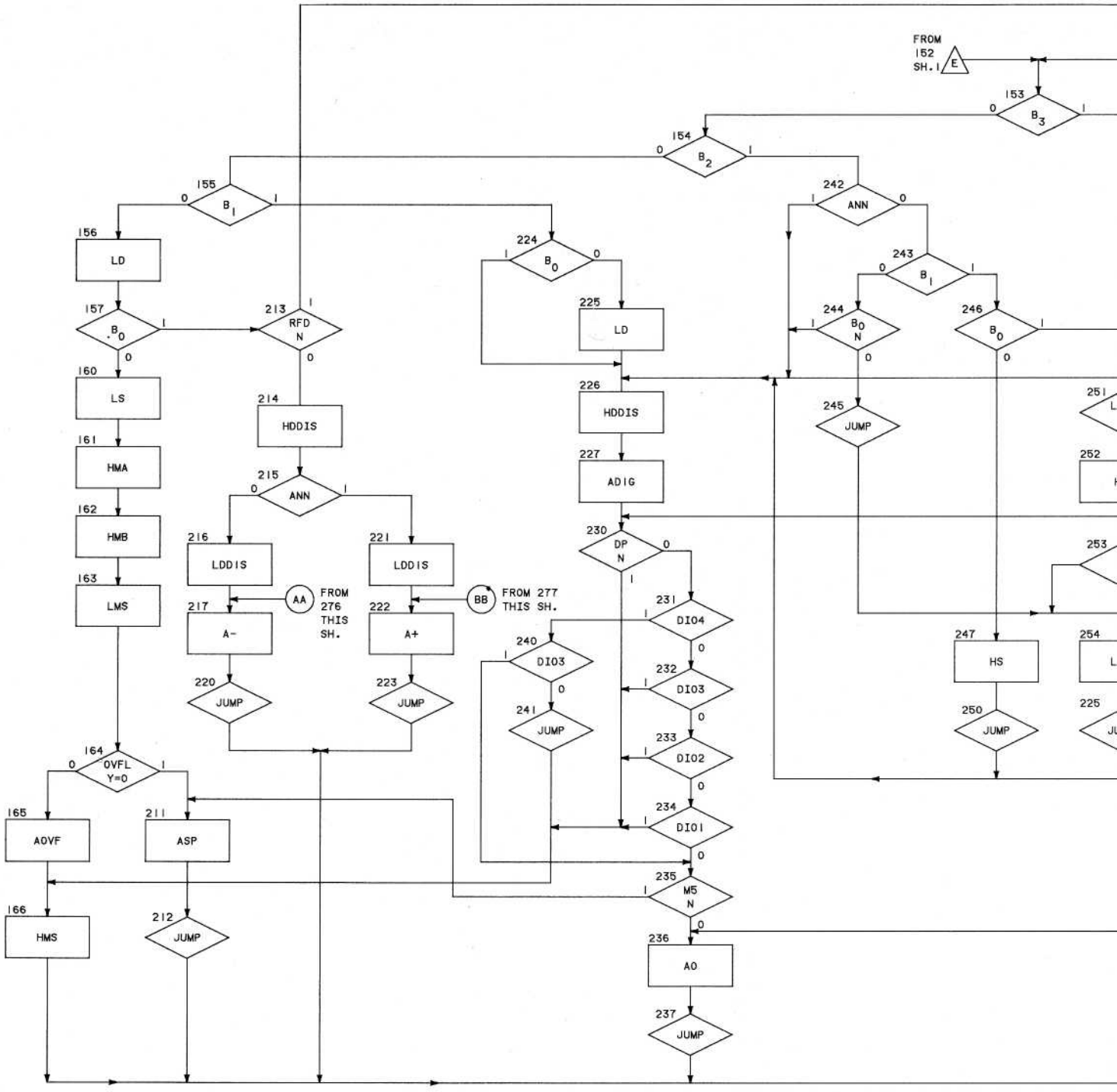
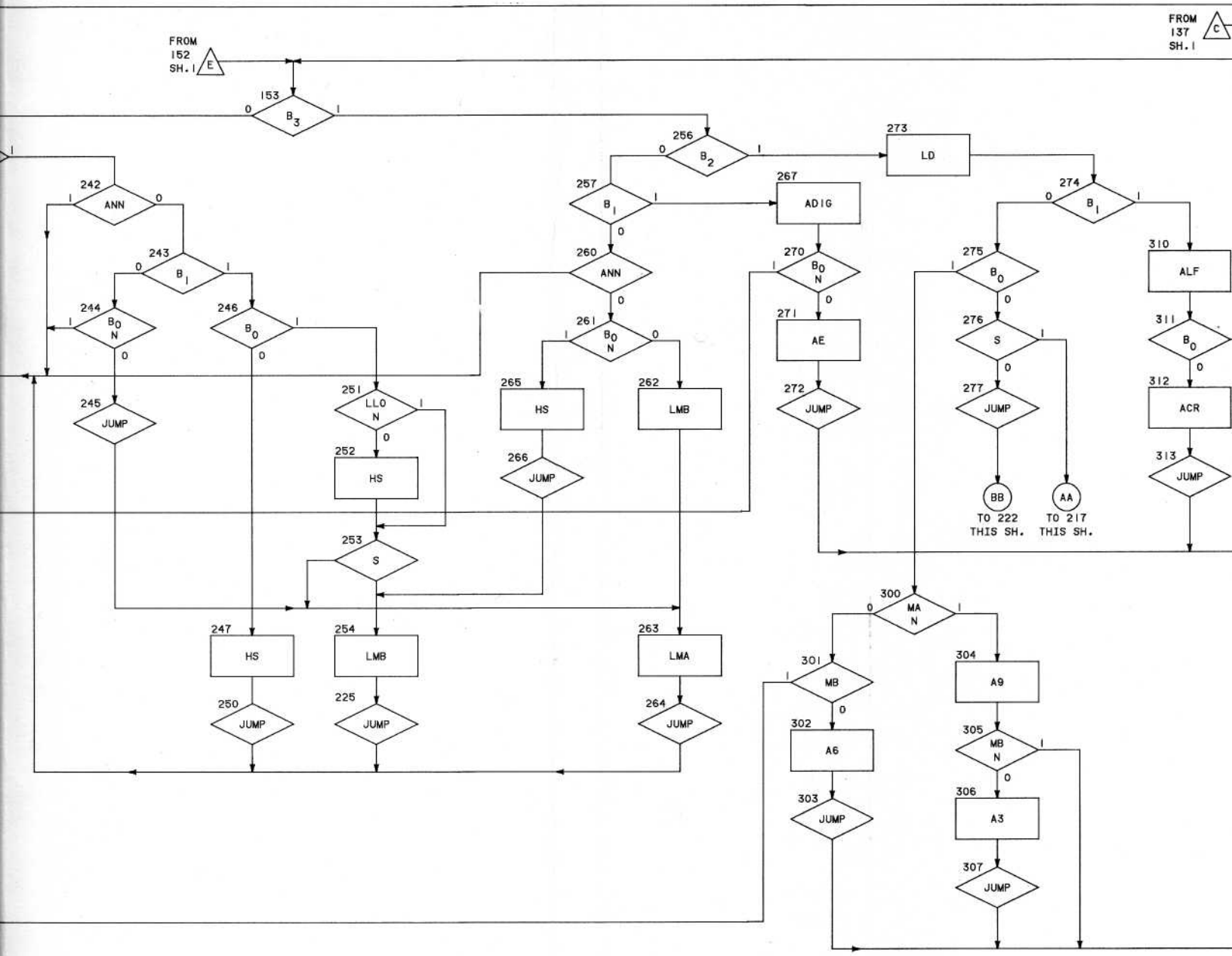


Figure 4–1. ASM Flowchart
(Sheet 1 of 3)


FROM 152 SH. 1
E
153
B3
154
B2
155
B1
156
LD
157
B0
160
LS
161
HMA
162
HMB
163
LMS
164
OVFL Y=0
165
AOVF
166
HMS
211
ASP
212
JUMP
213
RFD N
214
HDDIS
215
ANN
216
LDDIS
217
A-
220
JUMP
221
LDDIS
222
A+
223
JUMP
AA
FROM 276 THIS SH.
BB
FROM 277 THIS SH.
224
B0
225
LD
226
HDDIS
227
ADIG
230
DP N
231
DIO4
232
DIO3
233
DIO2
234
DIO1
235
M5 N
236
AO
237
JUMP
240
DIO3
241
JUMP
242
ANN
243
B1
244
B0 N
245
JUMP
246
B0
247
HS
250
JUMP
251
252
253
254
225


FROM 152 SH. 1
E
153
B3
0
1
256
B2
273
LD
FROM 137 SH. 1
C
242
ANN
243
B1
244
B0 N
245
JUMP
246
B0
257
B1
260
ANN
261
B0 N
262
LMB
265
HS
266
JUMP
251
LLO N
252
HS
253
S
247
HS
250
JUMP
254
LMB
225
JUMP
263
LMA
264
JUMP
267
ADIG
270
B0 N
271
AE
272
JUMP
274
B1
275
B0
276
S
277
JUMP
BB
TO 222 THIS SH.
AA
TO 217 THIS SH.
310
ALF
311
B0
312
ACR
313
JUMP
300
MA N
301
MB
302
A6
303
JUMP
304
A9
305
MB N
306
A3
307
JUMP

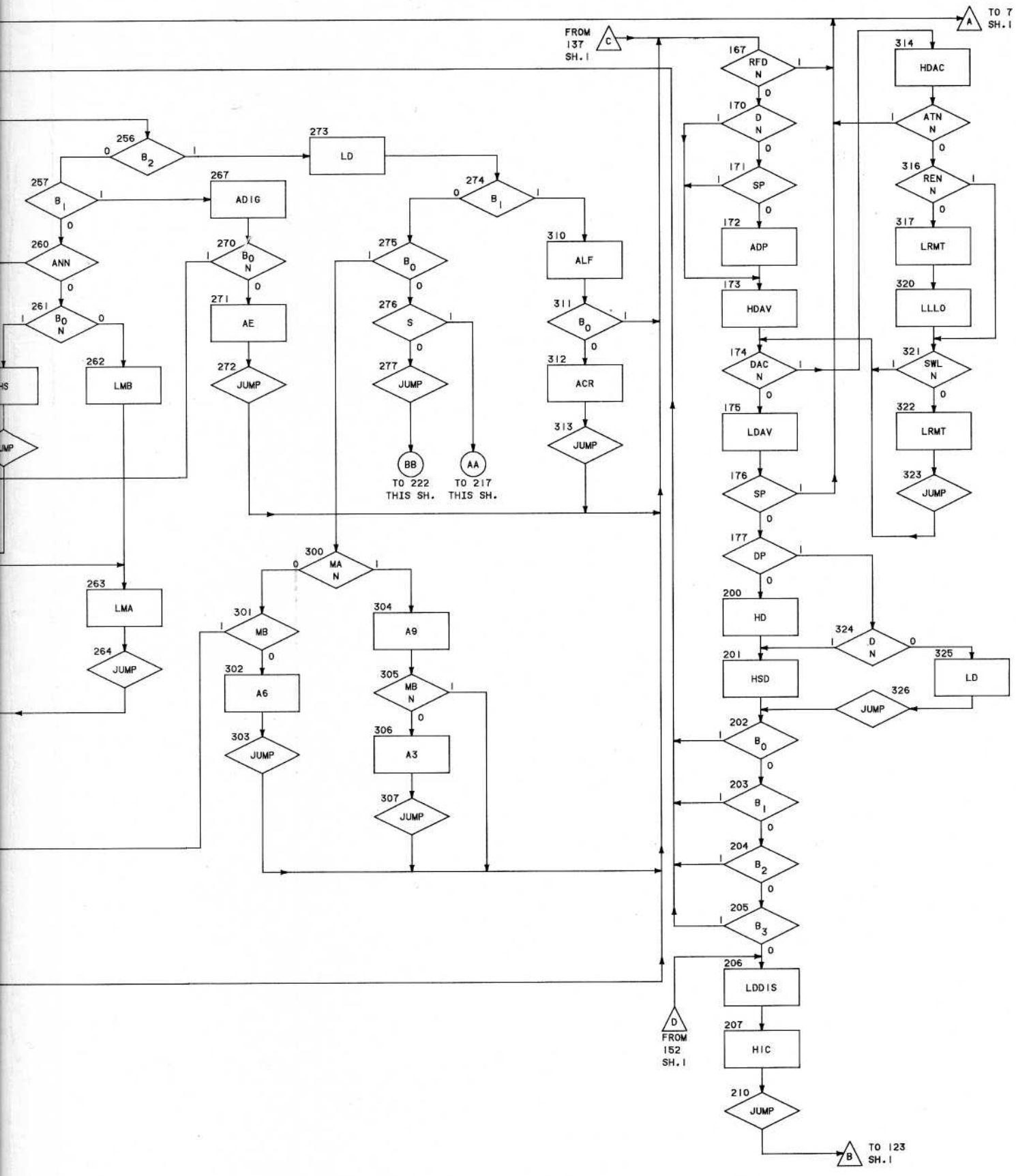
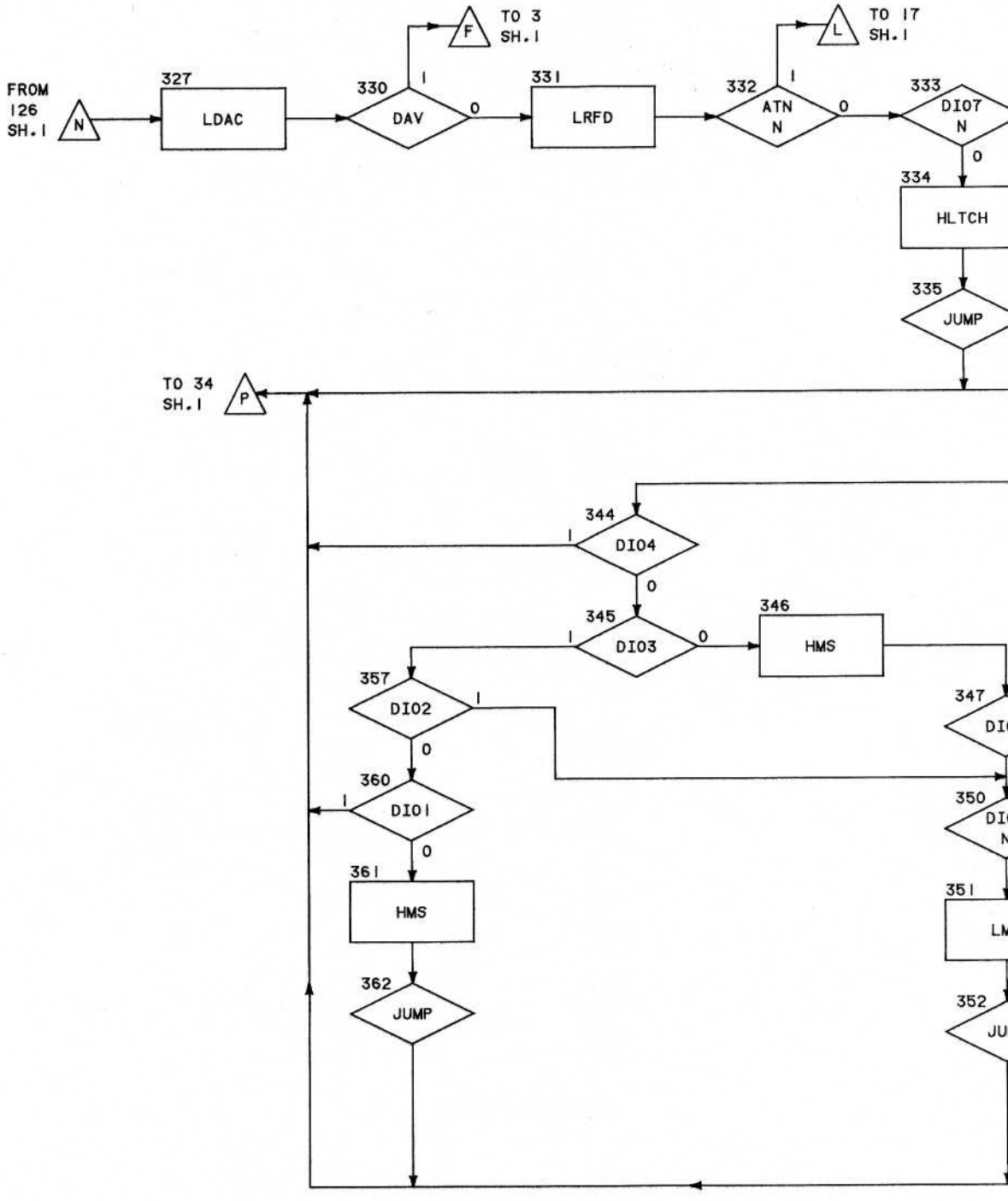
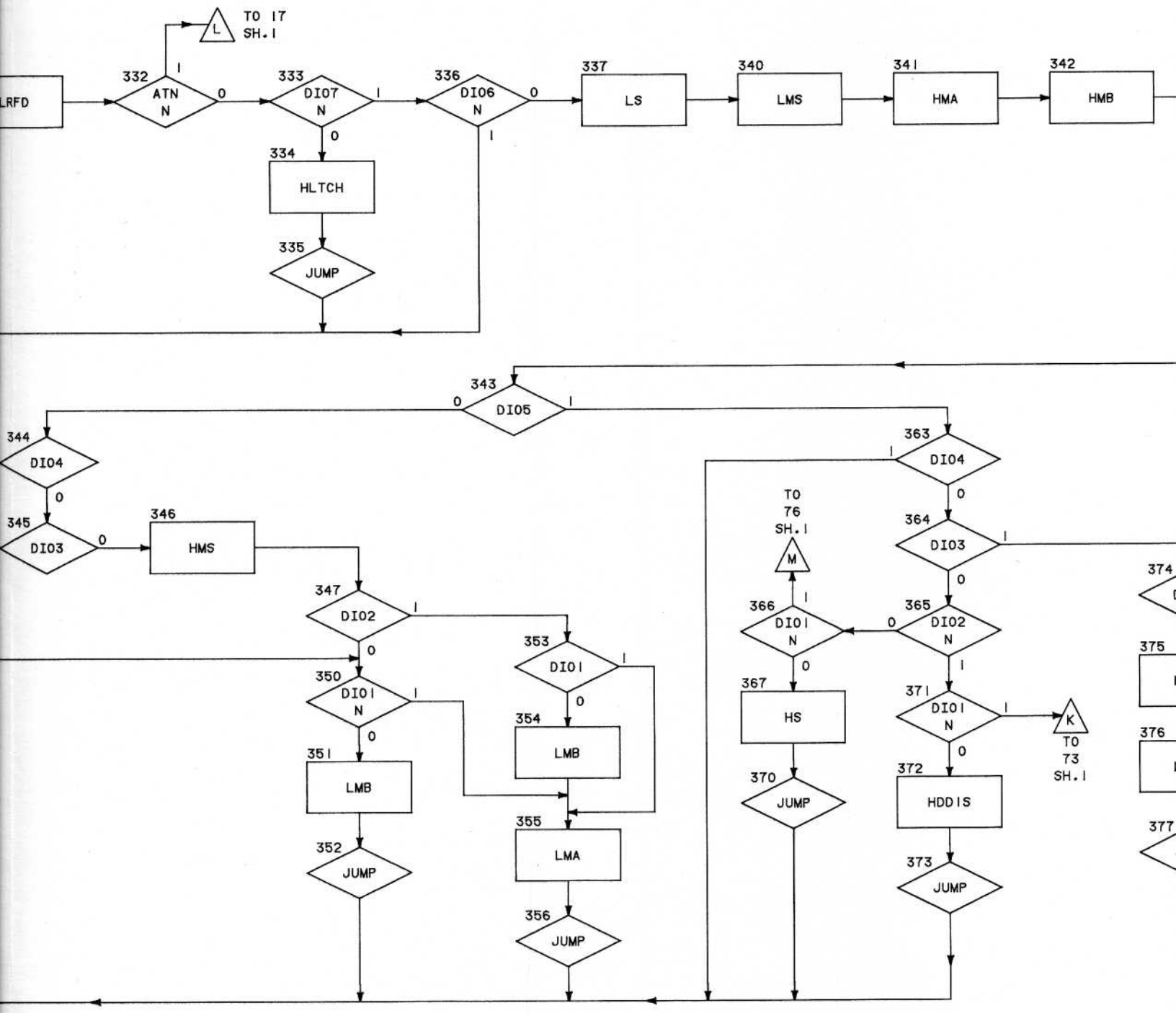


Figure 4-1. ASM Flowchart
(Sheet 2 of 3)


FROM
126
SH. 1
N
327
LDAC
330
DAV
1
0
F
TO 3
SH. 1
331
LRFD
332
ATN
N
1
0
L
TO 17
SH. 1
333
DI07
N
0
334
HLTCH
335
JUMP
TO 34
SH. 1
P
344
DI04
1
0
345
DI03
1
0
346
HMS
357
DI02
1
0
360
DI01
1
0
361
HMS
362
JUMP
347
350
351
352


TO 17
SH.1
L
LRFD
332
ATN
N
333
DI07
N
336
DI06
N
337
LS
340
LMS
341
HMA
342
HMB
334
HLTCH
335
JUMP
343
DI05
344
DI04
345
DI03
346
HMS
347
DI02
350
DI01
N
351
LMB
352
JUMP
353
DI01
354
LMB
355
LMA
356
JUMP
363
DI04
364
DI03
365
DI02
N
366
DI01
N
367
HS
370
JUMP
371
DI01
N
372
HDDIS
373
JUMP
TO
76
SH.1
M
K
TO
73
SH.1
374
375
376
377

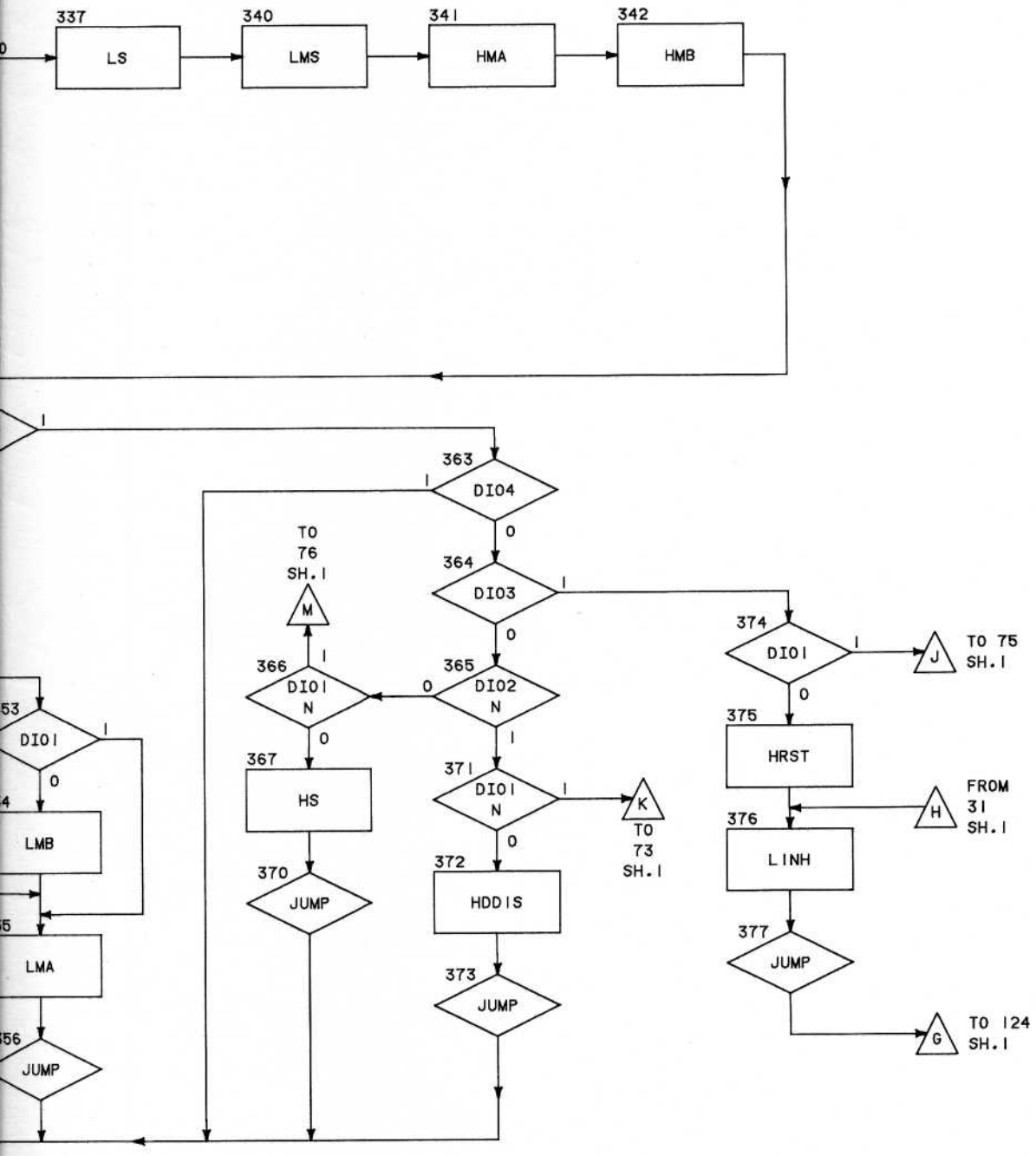
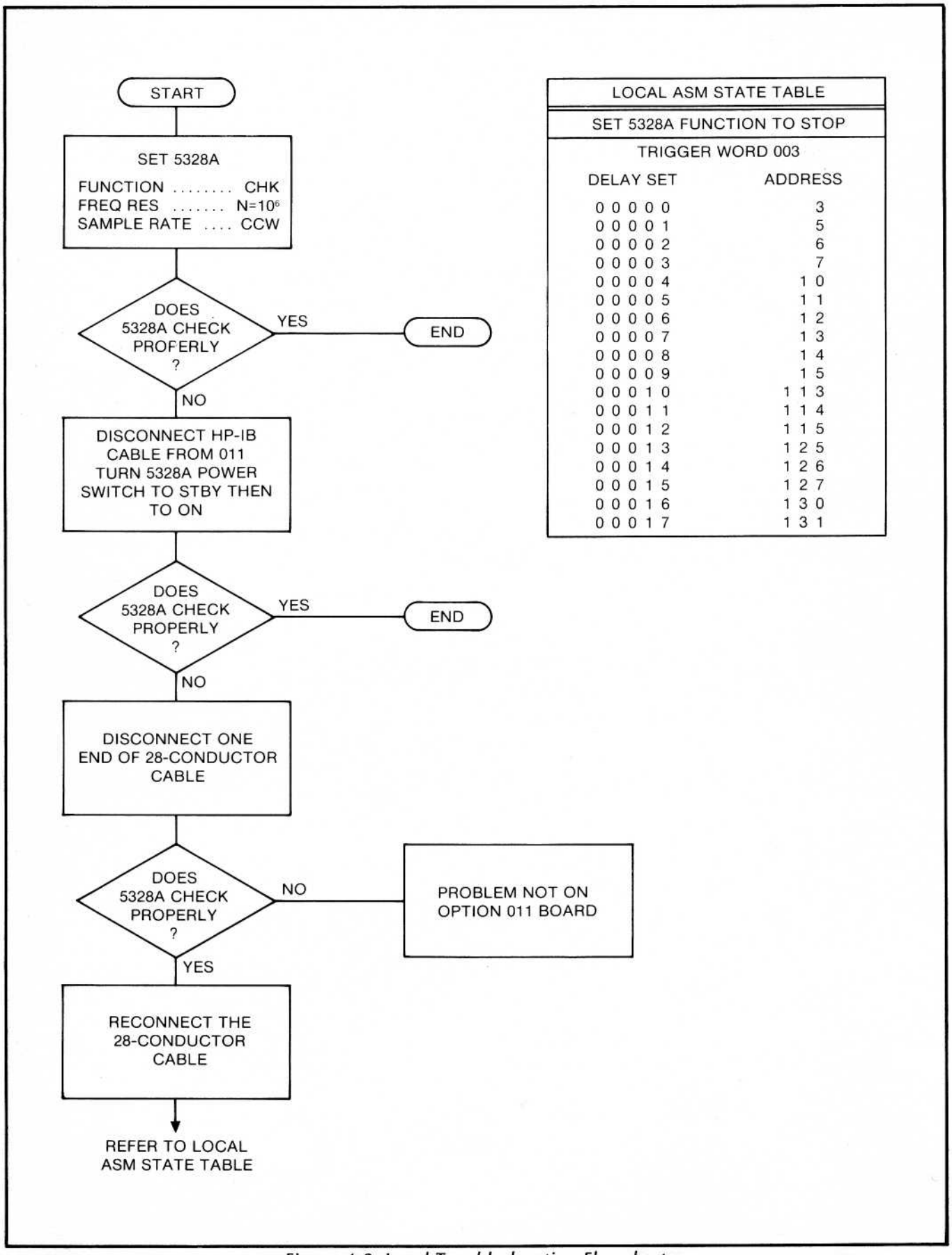


Figure 4–1. ASM Flowchart
(Sheet 3 of 3)



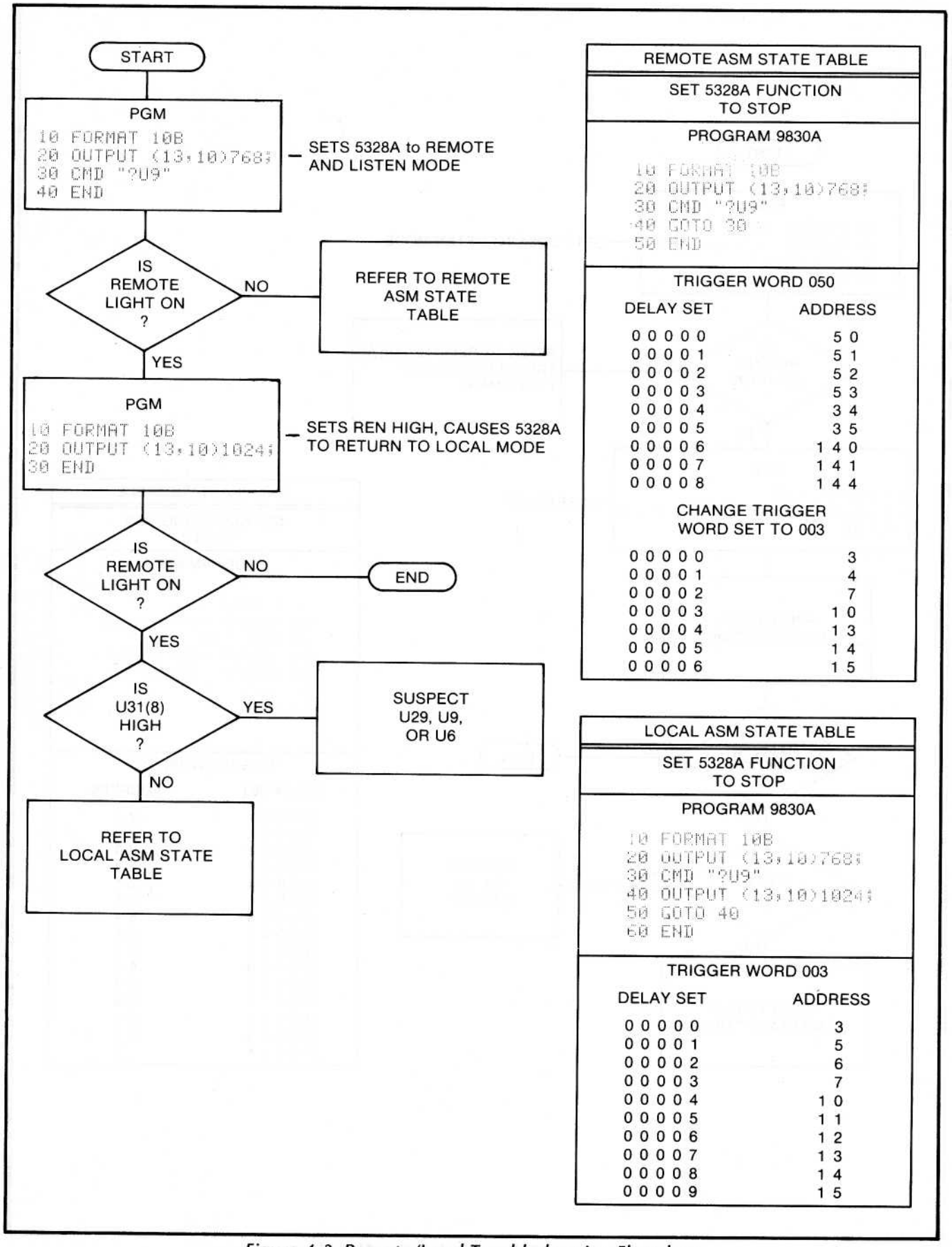
LOCAL ASM STATE TABLE

SET 5328A FUNCTION TO STOP

TRIGGER WORD 003

DELAY SET	ADDRESS
0 0 0 0 0	3
0 0 0 0 1	5
0 0 0 0 2	6
0 0 0 0 3	7
0 0 0 0 4	1 0
0 0 0 0 5	1 1
0 0 0 0 6	1 2
0 0 0 0 7	1 3
0 0 0 0 8	1 4
0 0 0 0 9	1 5
0 0 0 1 0	1 1 3
0 0 0 1 1	1 1 4
0 0 0 1 2	1 1 5
0 0 0 1 3	1 2 5
0 0 0 1 4	1 2 6
0 0 0 1 5	1 2 7
0 0 0 1 6	1 3 0
0 0 0 1 7	1 3 1

Figure 4–2. Local Troubleshooting Flowchart



REMOTE ASM STATE TABLE

SET 5328A FUNCTION TO STOP

PROGRAM 9830A

```
10 FORMAT 10B
20 OUTPUT (13,10)768;
30 CMD "?U9"
40 GOTO 30
50 END
```

TRIGGER WORD 050

DELAY SET	ADDRESS
0 0 0 0 0	5 0
0 0 0 0 1	5 1
0 0 0 0 2	5 2
0 0 0 0 3	5 3
0 0 0 0 4	3 4
0 0 0 0 5	3 5
0 0 0 0 6	1 4 0
0 0 0 0 7	1 4 1
0 0 0 0 8	1 4 4

CHANGE TRIGGER WORD SET TO 003

0 0 0 0 0	3
0 0 0 0 1	4
0 0 0 0 2	7
0 0 0 0 3	1 0
0 0 0 0 4	1 3
0 0 0 0 5	1 4
0 0 0 0 6	1 5

LOCAL ASM STATE TABLE

SET 5328A FUNCTION TO STOP

PROGRAM 9830A

```
10 FORMAT 10B
20 OUTPUT (13,10)768;
30 CMD "?U9"
40 OUTPUT (13,10)1024;
50 GOTO 40
60 END
```

TRIGGER WORD 003

DELAY SET	ADDRESS
0 0 0 0 0	3
0 0 0 0 1	5
0 0 0 0 2	6
0 0 0 0 3	7
0 0 0 0 4	1 0
0 0 0 0 5	1 1
0 0 0 0 6	1 2
0 0 0 0 7	1 3
0 0 0 0 8	1 4
0 0 0 0 9	1 5

Figure 4–3. Remote/Local Troubleshooting Flowchart

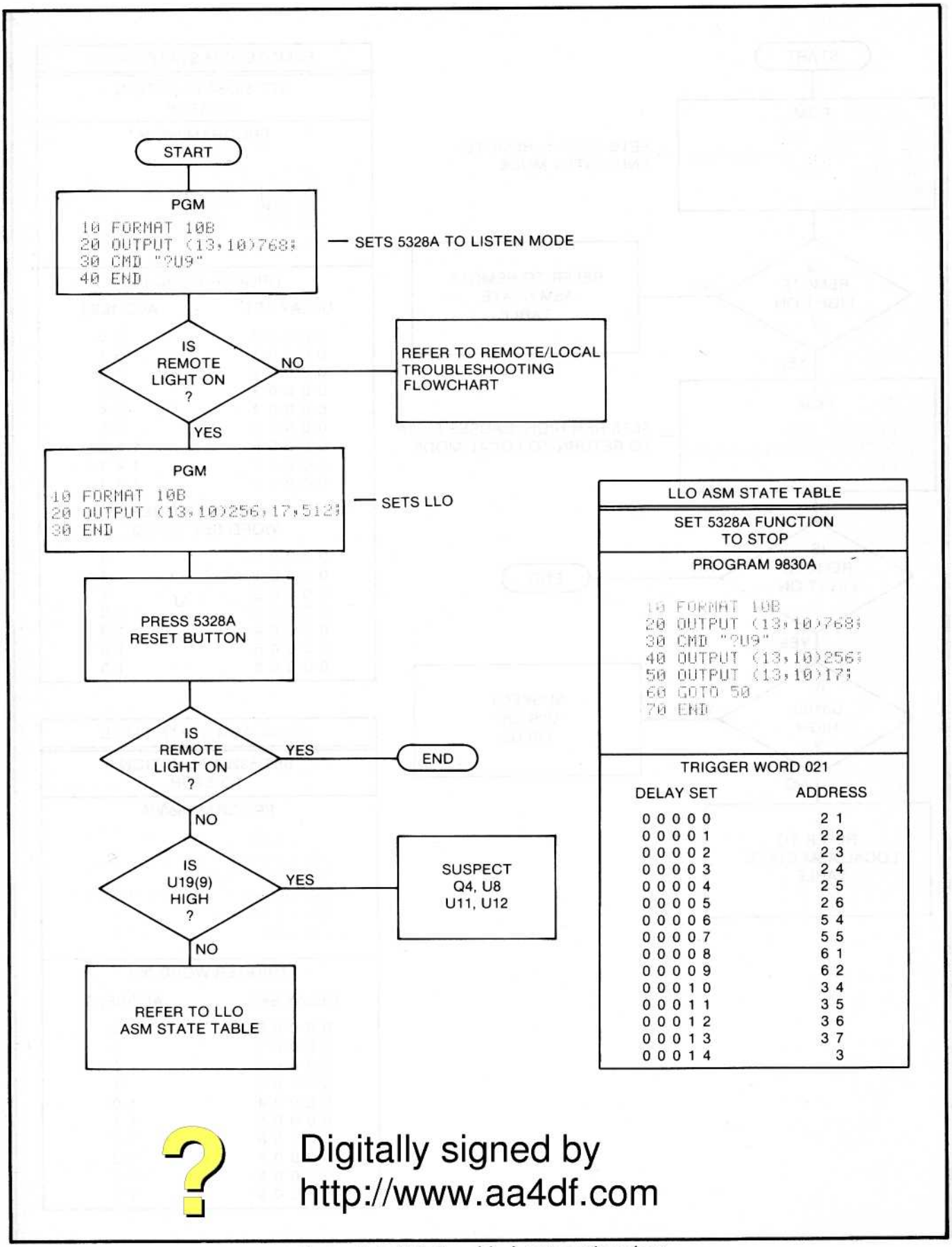


Figure 4–4. LLO Troubleshooting Flowchart

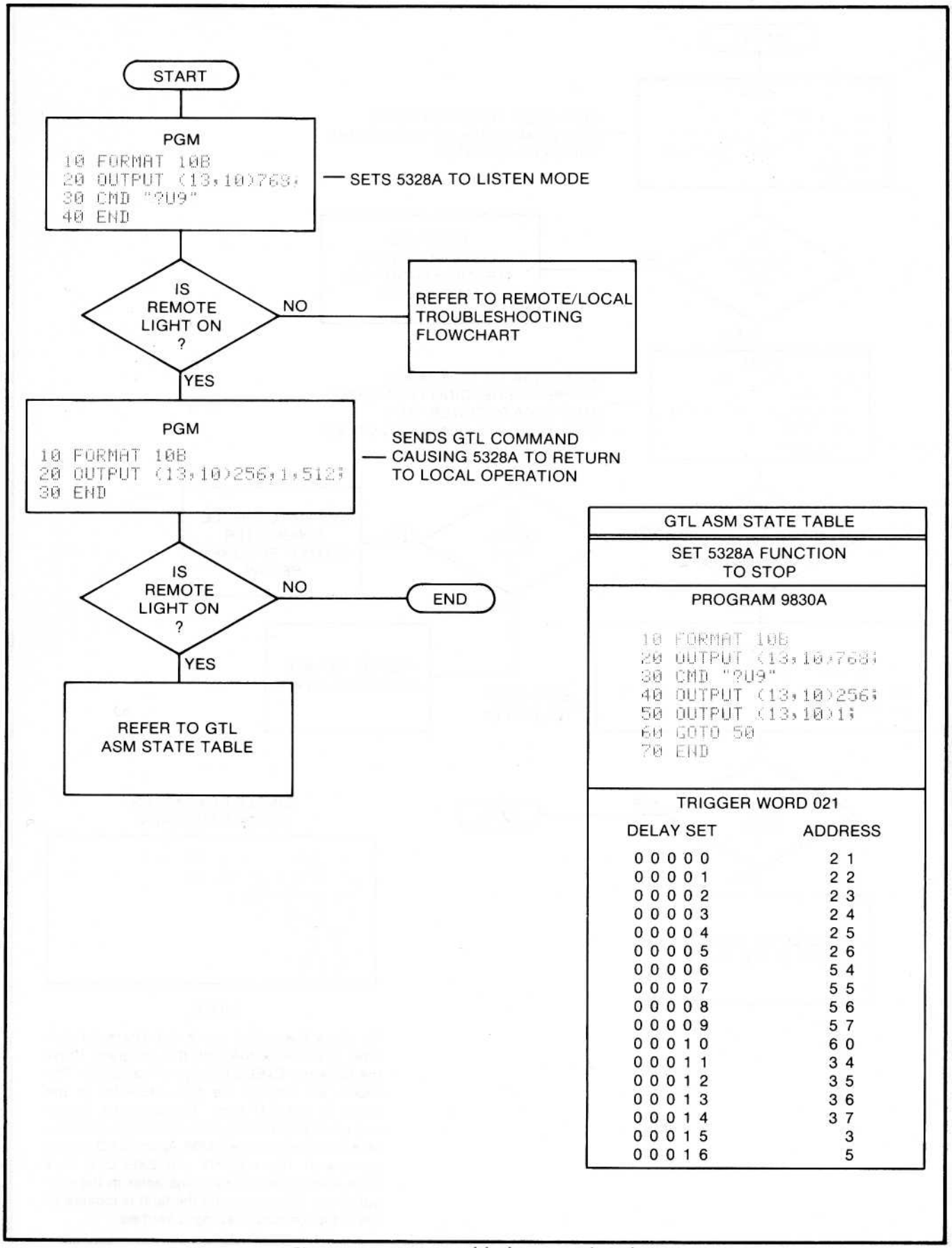


Figure 4–5. GTL Troubleshooting Flowchart

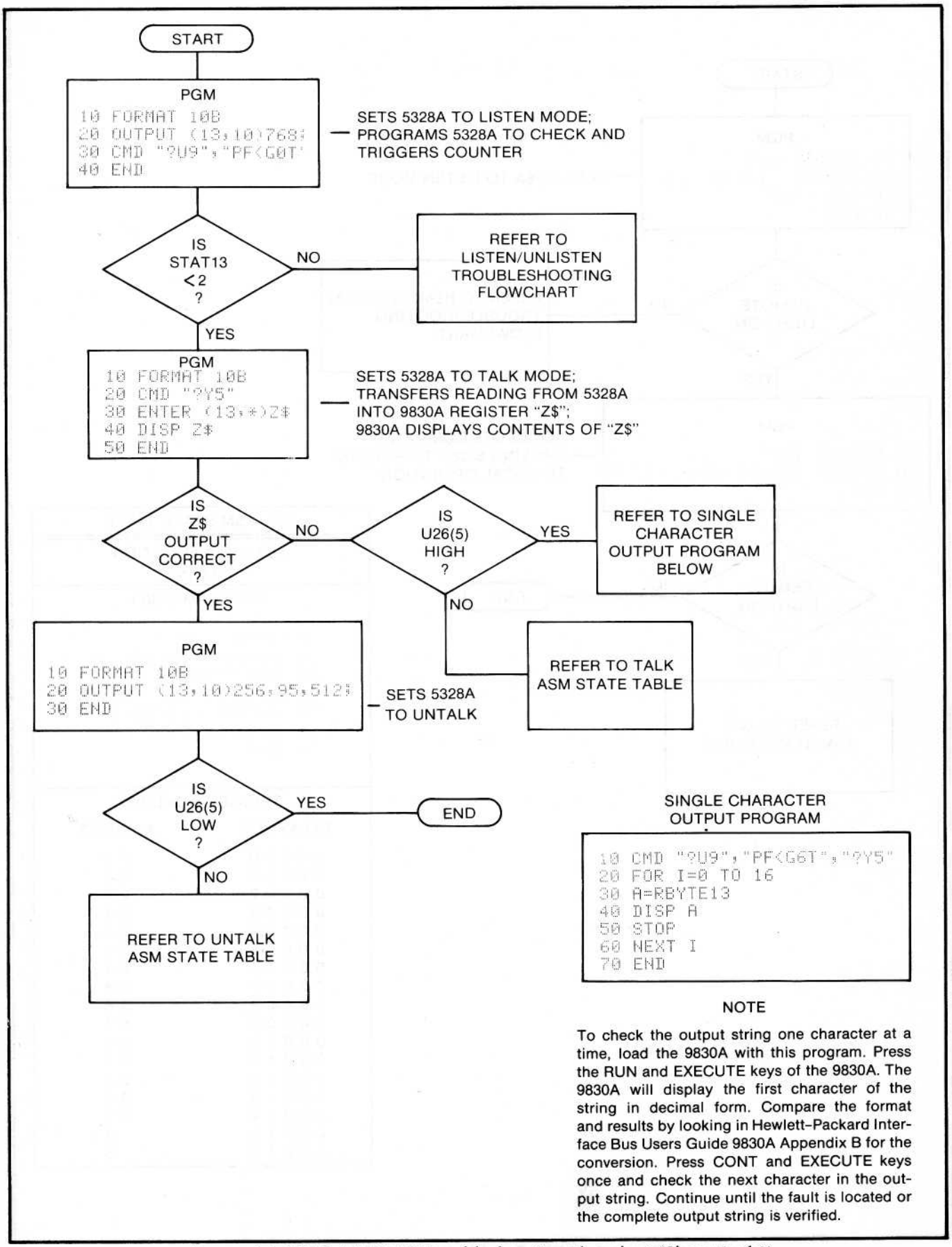


Figure 4-6. TALK/UNTALK Troubleshooting Flowchart (Sheet 1 of 2)

TALK ASM STATE TABLE

SET 5328A FUNCTION TO STOP

PROGRAM 9830A

```
10 FORMAT 10B
20 OUTPUT (13,10)768;
30 CMD "?U9","PF<G0T"
40 CMD "Y"
50 GOTO 40
60 END
```

TRIGGER WORD 021

DELAY SET	ADDRESS
0 0 0 0 0	2 1
0 0 0 0 1	2 2
0 0 0 0 2	4 2
0 0 0 0 3	4 3
0 0 0 0 4	4 4
0 0 0 0 5	4 5
0 0 0 0 6	4 6
0 0 0 0 7	3 4
0 0 0 0 8	3 5
0 0 0 0 9	3 6
0 0 0 1 0	3 7
0 0 0 1 1	3

UNTALK ASM STATE TABLE

SET 5328A FUNCTION TO STOP

PROGRAM 9830A

```
10 FORMAT 10B
20 OUTPUT (13,10)768;
30 CMD "?U9","PF<G0T","?Y5"
40 OUTPUT (13,10)256,95,512;
50 GOTO 40
60 END
```

TRIGGER WORD 021

DELAY SET	ADDRESS
0 0 0 0 0	2 1
0 0 0 0 1	2 2
0 0 0 0 2	4 2
0 0 0 0 3	4 3
0 0 0 0 4	5 2
0 0 0 0 5	5 3
0 0 0 0 6	3 4
0 0 0 0 7	3 5
0 0 0 0 8	3 6
0 0 0 0 9	3 7
0 0 0 1 0	3

Figure 4–6. TALK/UNTALK Troubleshooting Flowchart (Sheet 2 of 2)

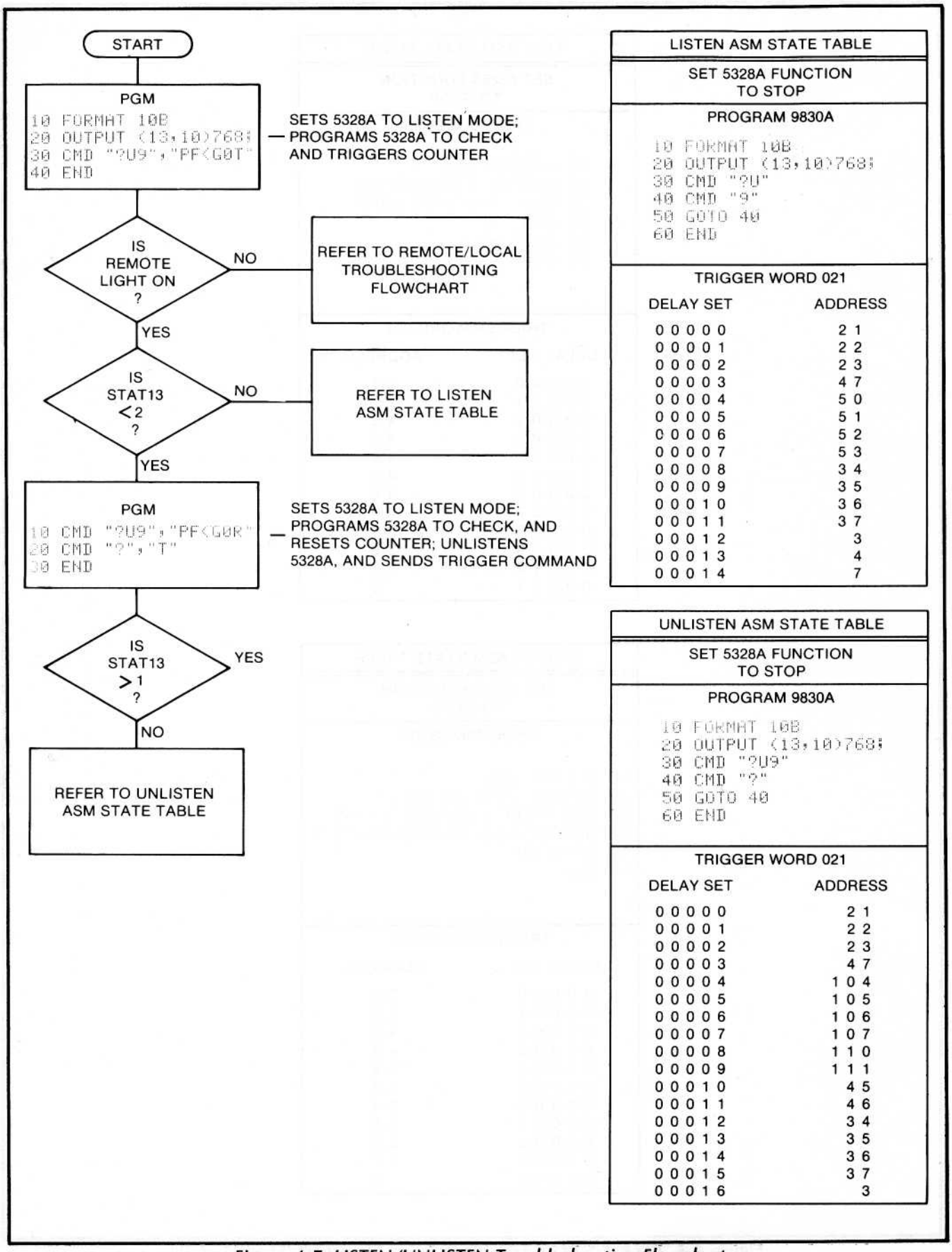


Figure 4–7. LISTEN/UNLISTEN Troubleshooting Flowchart

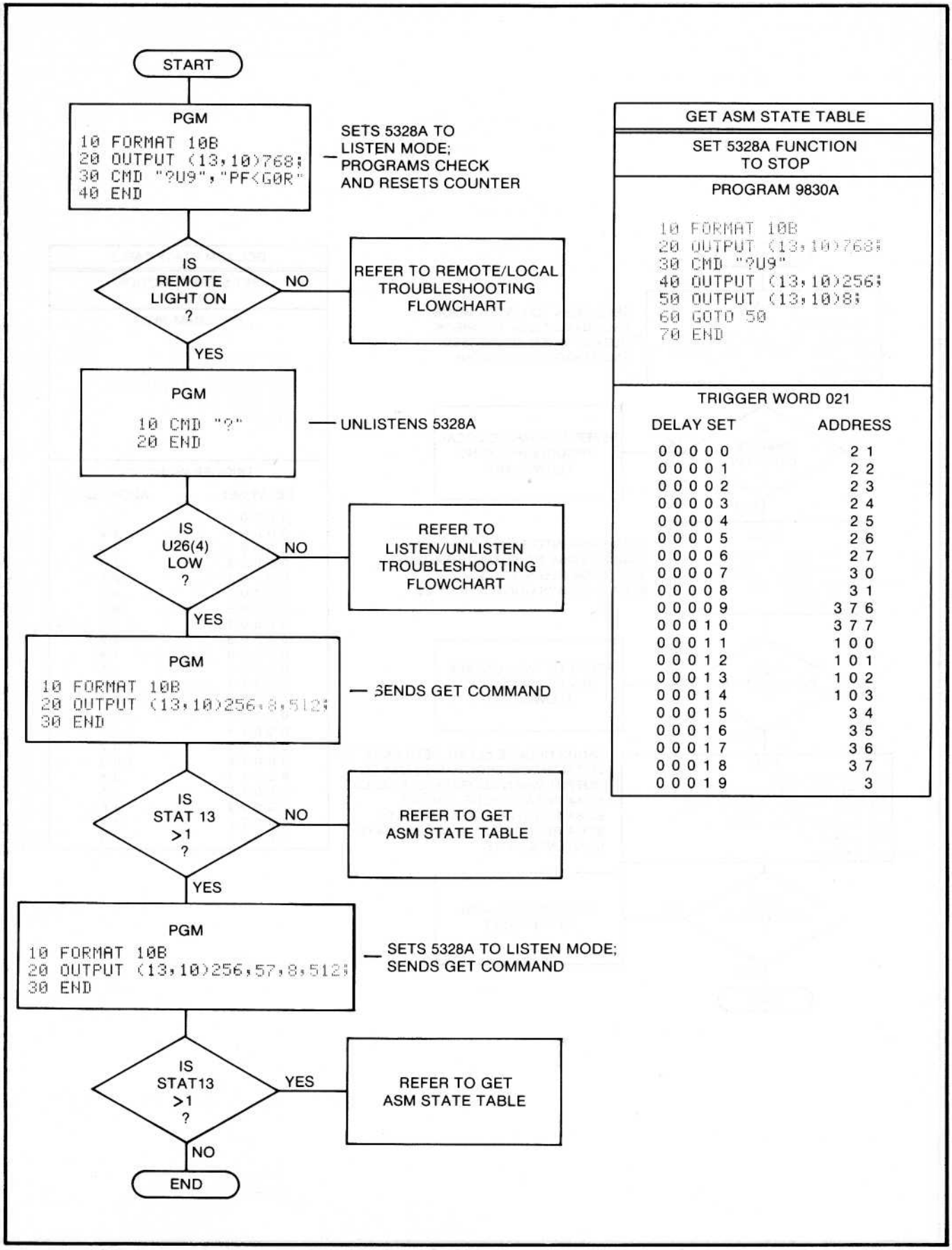


Figure 4–8. GET Troubleshooting Flowchart

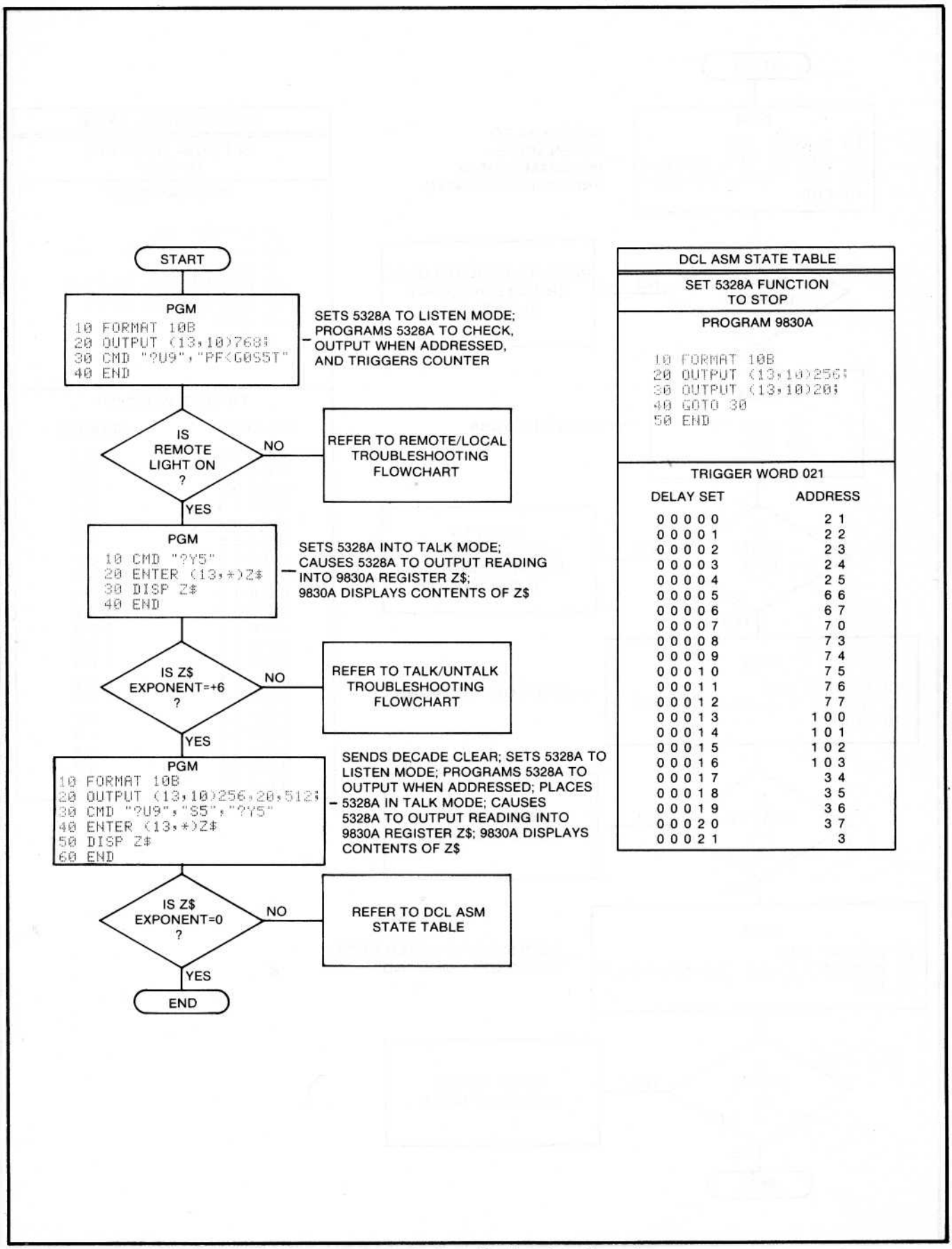


Figure 4–9. DCL Troubleshooting Flowchart

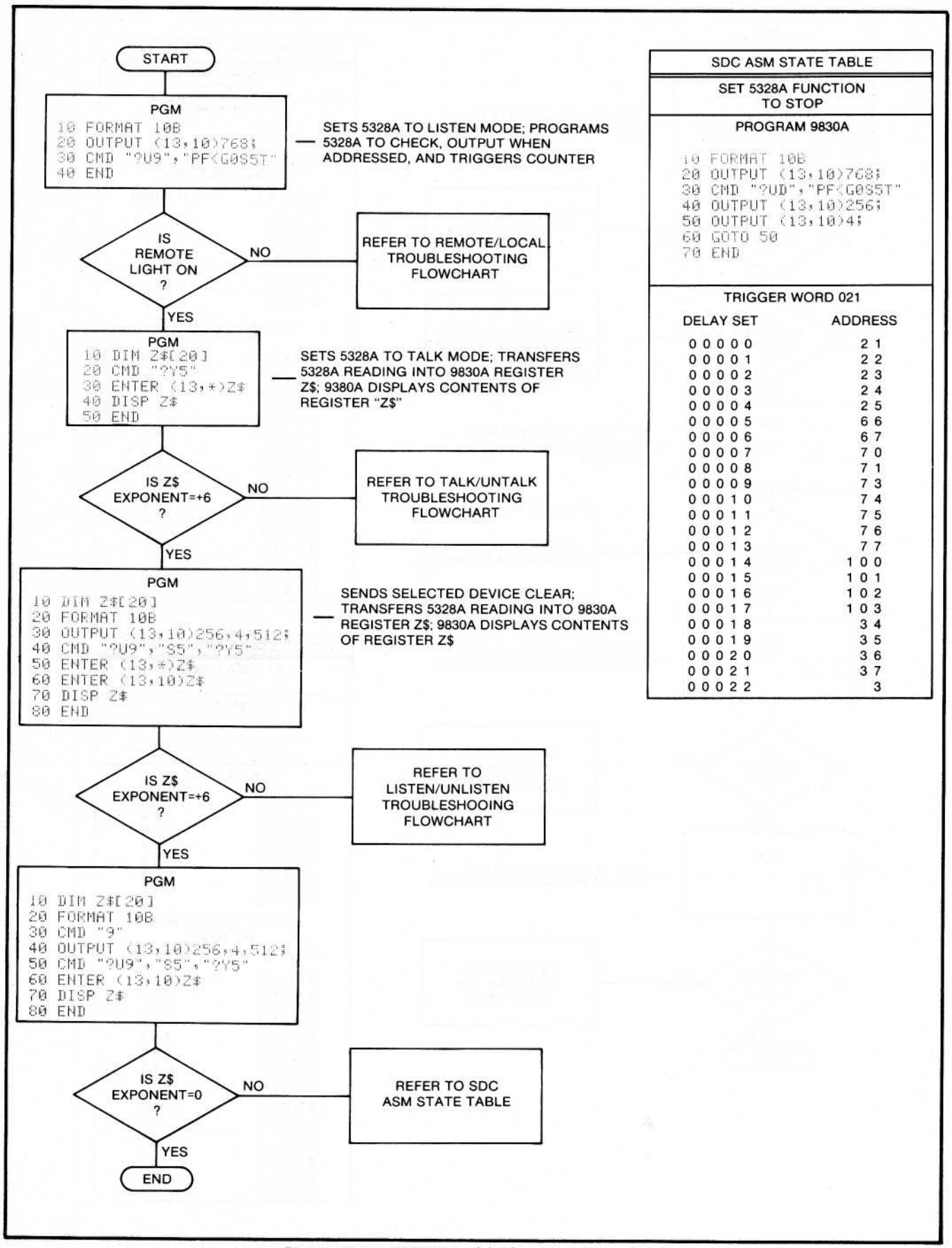
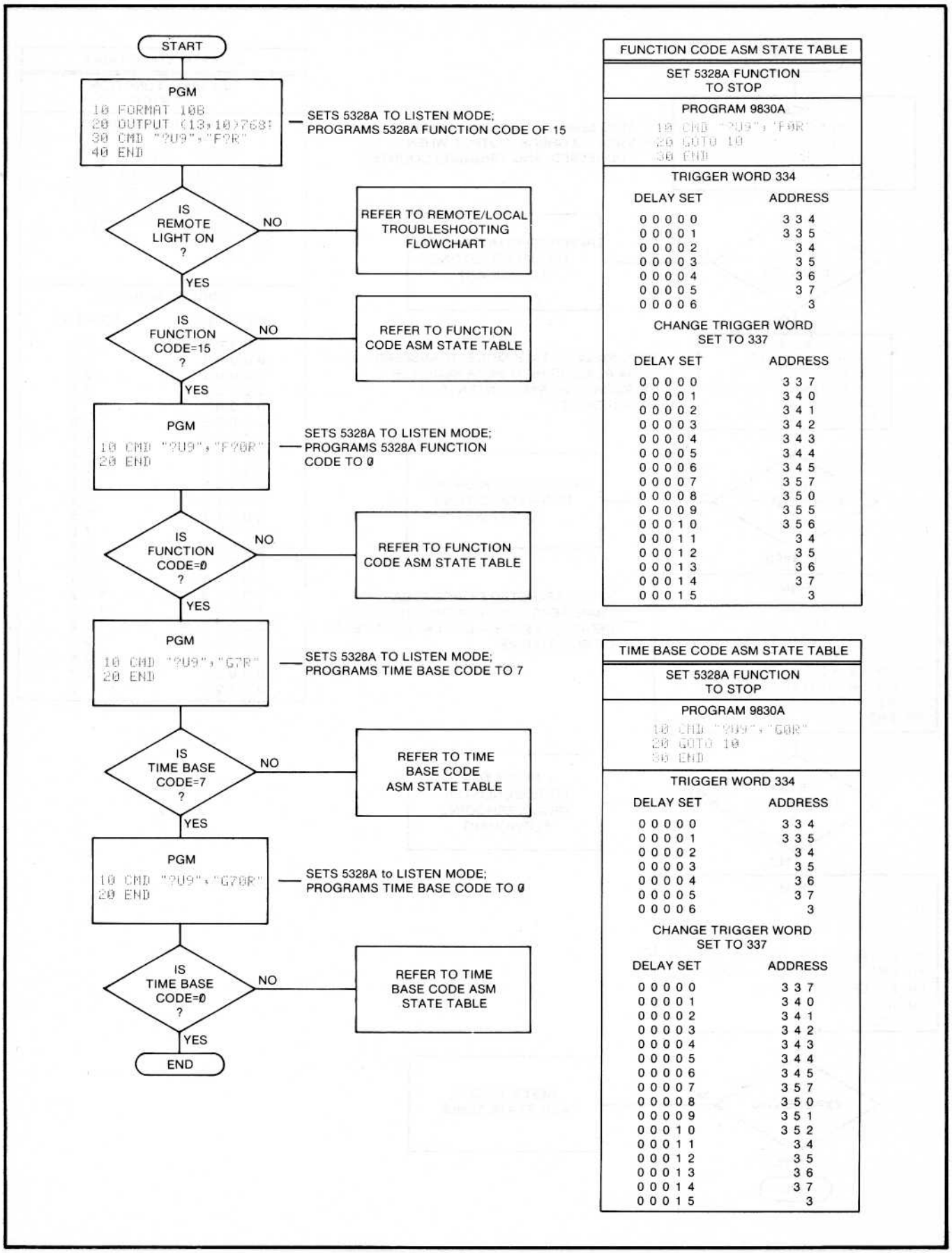


Figure 4–10. SDC Troubleshooting Flowchart



FUNCTION CODE ASM STATE TABLE

SET 5328A FUNCTION TO STOP

PROGRAM 9830A

```
10 CMD "?U9";"F0R"
20 GOTO 10
30 END
```

TRIGGER WORD 334

DELAY SET	ADDRESS
0 0 0 0 0	3 3 4
0 0 0 0 1	3 3 5
0 0 0 0 2	3 4
0 0 0 0 3	3 5
0 0 0 0 4	3 6
0 0 0 0 5	3 7
0 0 0 0 6	3

CHANGE TRIGGER WORD SET TO 337

DELAY SET	ADDRESS
0 0 0 0 0	3 3 7
0 0 0 0 1	3 4 0
0 0 0 0 2	3 4 1
0 0 0 0 3	3 4 2
0 0 0 0 4	3 4 3
0 0 0 0 5	3 4 4
0 0 0 0 6	3 4 5
0 0 0 0 7	3 5 7
0 0 0 0 8	3 5 0
0 0 0 0 9	3 5 5
0 0 0 1 0	3 5 6
0 0 0 1 1	3 4
0 0 0 1 2	3 5
0 0 0 1 3	3 6
0 0 0 1 4	3 7
0 0 0 1 5	3

TIME BASE CODE ASM STATE TABLE

SET 5328A FUNCTION TO STOP

PROGRAM 9830A

```
10 CMD "?U9";"G0R"
20 GOTO 10
30 END
```

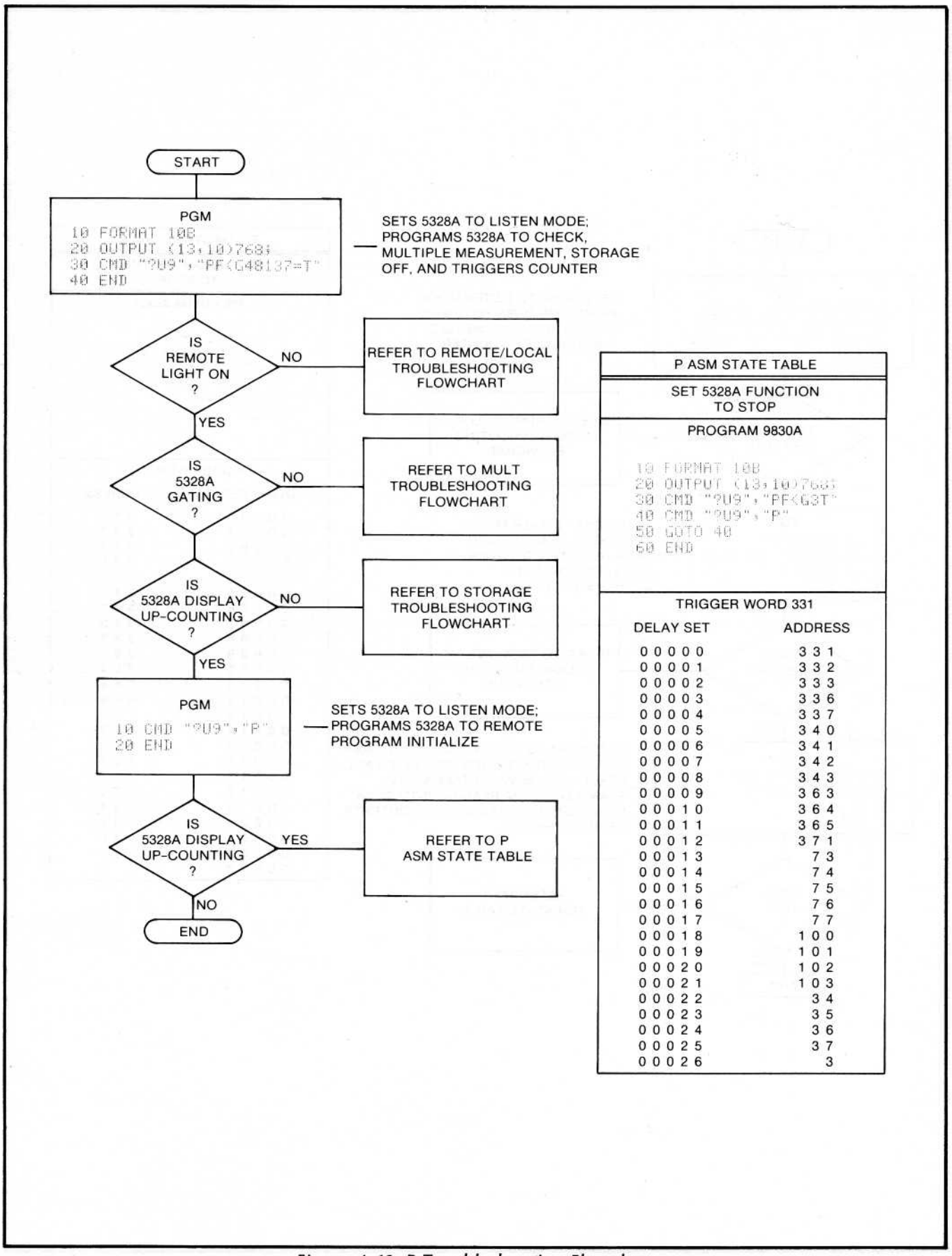
TRIGGER WORD 334

DELAY SET	ADDRESS
0 0 0 0 0	3 3 4
0 0 0 0 1	3 3 5
0 0 0 0 2	3 4
0 0 0 0 3	3 5
0 0 0 0 4	3 6
0 0 0 0 5	3 7
0 0 0 0 6	3

CHANGE TRIGGER WORD SET TO 337

DELAY SET	ADDRESS
0 0 0 0 0	3 3 7
0 0 0 0 1	3 4 0
0 0 0 0 2	3 4 1
0 0 0 0 3	3 4 2
0 0 0 0 4	3 4 3
0 0 0 0 5	3 4 4
0 0 0 0 6	3 4 5
0 0 0 0 7	3 5 7
0 0 0 0 8	3 5 0
0 0 0 0 9	3 5 1
0 0 0 1 0	3 5 2
0 0 0 1 1	3 4
0 0 0 1 2	3 5
0 0 0 1 3	3 6
0 0 0 1 4	3 7
0 0 0 1 5	3

Figure 4–11. FUNCTION CODE and TIME BASE CODE Troubleshooting Flowchart



P ASM STATE TABLE

SET 5328A FUNCTION TO STOP

PROGRAM 9830A

```
10 FORMAT 10B
20 OUTPUT (13,10)768;
30 CMD "?U9","PF<G3T"
40 CMD "?U9","P"
50 GOTO 40
60 END
```

TRIGGER WORD 331

DELAY SET	ADDRESS
0 0 0 0 0	3 3 1
0 0 0 0 1	3 3 2
0 0 0 0 2	3 3 3
0 0 0 0 3	3 3 6
0 0 0 0 4	3 3 7
0 0 0 0 5	3 4 0
0 0 0 0 6	3 4 1
0 0 0 0 7	3 4 2
0 0 0 0 8	3 4 3
0 0 0 0 9	3 6 3
0 0 0 1 0	3 6 4
0 0 0 1 1	3 6 5
0 0 0 1 2	3 7 1
0 0 0 1 3	7 3
0 0 0 1 4	7 4
0 0 0 1 5	7 5
0 0 0 1 6	7 6
0 0 0 1 7	7 7
0 0 0 1 8	1 0 0
0 0 0 1 9	1 0 1
0 0 0 2 0	1 0 2
0 0 0 2 1	1 0 3
0 0 0 2 2	3 4
0 0 0 2 3	3 5
0 0 0 2 4	3 6
0 0 0 2 5	3 7
0 0 0 2 6	3

Figure 4–12. P Troubleshooting Flowchart

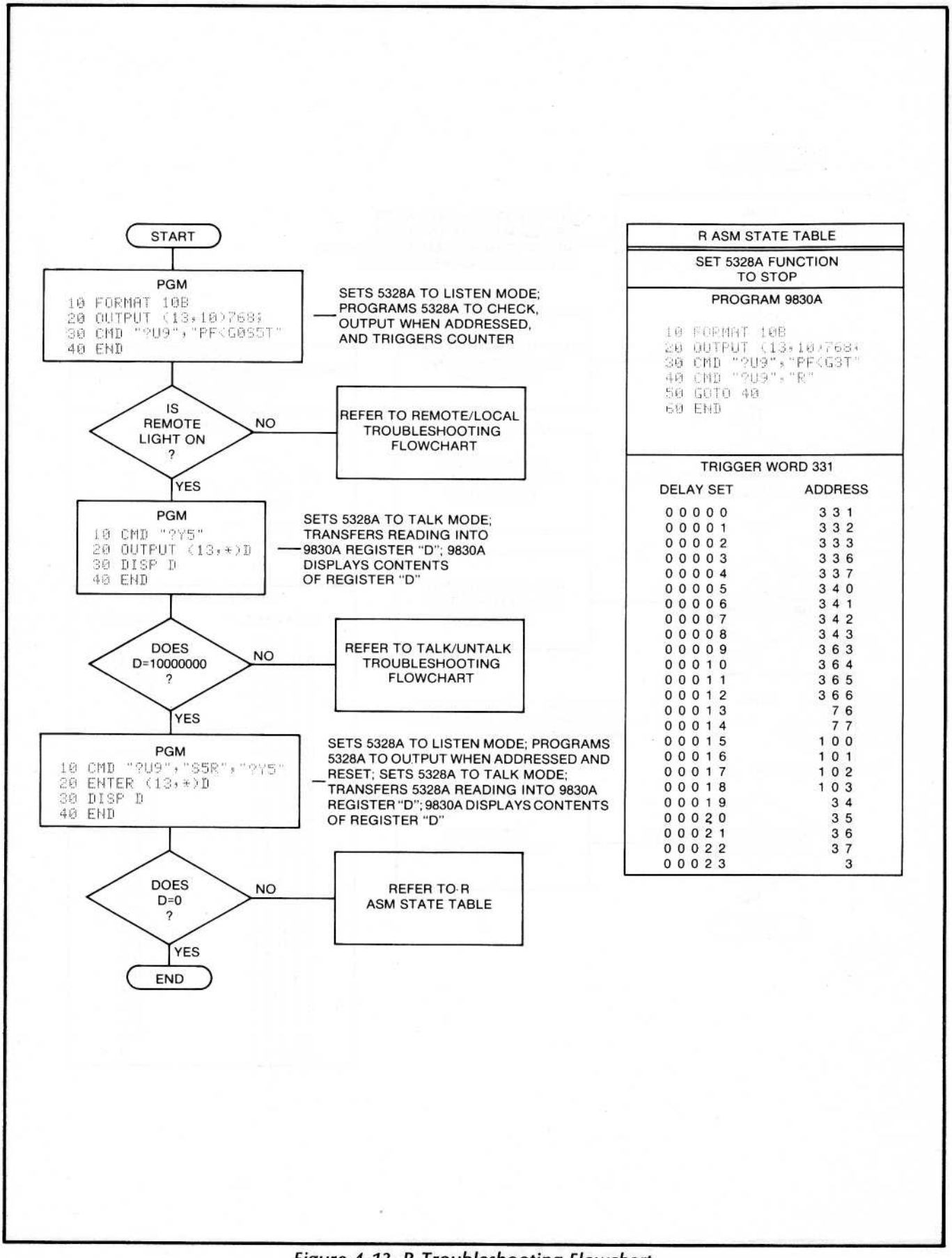
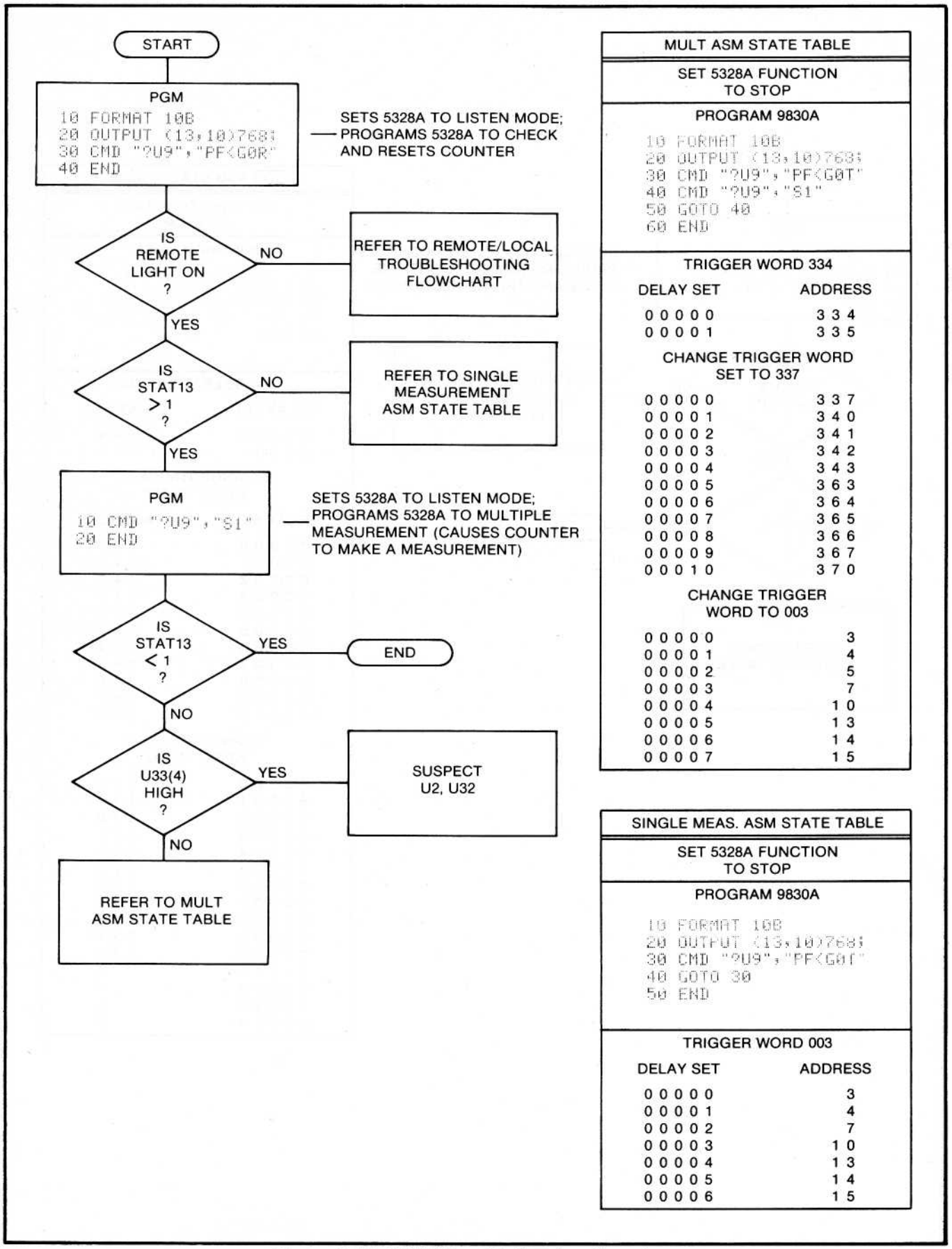


Figure 4–13. R Troubleshooting Flowchart



MULT ASM STATE TABLE

SET 5328A FUNCTION TO STOP

PROGRAM 9830A

```
10 FORMAT 10B
20 OUTPUT (13,10)768;
30 CMD "?U9","PF<G0T"
40 CMD "?U9","S1"
50 GOTO 40
60 END
```

TRIGGER WORD 334

DELAY SET	ADDRESS
0 0 0 0 0	3 3 4
0 0 0 0 1	3 3 5

CHANGE TRIGGER WORD SET TO 337

0 0 0 0 0	3 3 7
0 0 0 0 1	3 4 0
0 0 0 0 2	3 4 1
0 0 0 0 3	3 4 2
0 0 0 0 4	3 4 3
0 0 0 0 5	3 6 3
0 0 0 0 6	3 6 4
0 0 0 0 7	3 6 5
0 0 0 0 8	3 6 6
0 0 0 0 9	3 6 7
0 0 0 1 0	3 7 0

CHANGE TRIGGER WORD TO 003

0 0 0 0 0	3
0 0 0 0 1	4
0 0 0 0 2	5
0 0 0 0 3	7
0 0 0 0 4	1 0
0 0 0 0 5	1 3
0 0 0 0 6	1 4
0 0 0 0 7	1 5

SINGLE MEAS. ASM STATE TABLE

SET 5328A FUNCTION TO STOP

PROGRAM 9830A

```
10 FORMAT 10B
20 OUTPUT (13,10)768;
30 CMD "?U9","PF<G0I"
40 GOTO 30
50 END
```

TRIGGER WORD 003

DELAY SET	ADDRESS
0 0 0 0 0	3
0 0 0 0 1	4
0 0 0 0 2	7
0 0 0 0 3	1 0
0 0 0 0 4	1 3
0 0 0 0 5	1 4
0 0 0 0 6	1 5

Figure 4-14. MULT Troubleshooting Flowchart

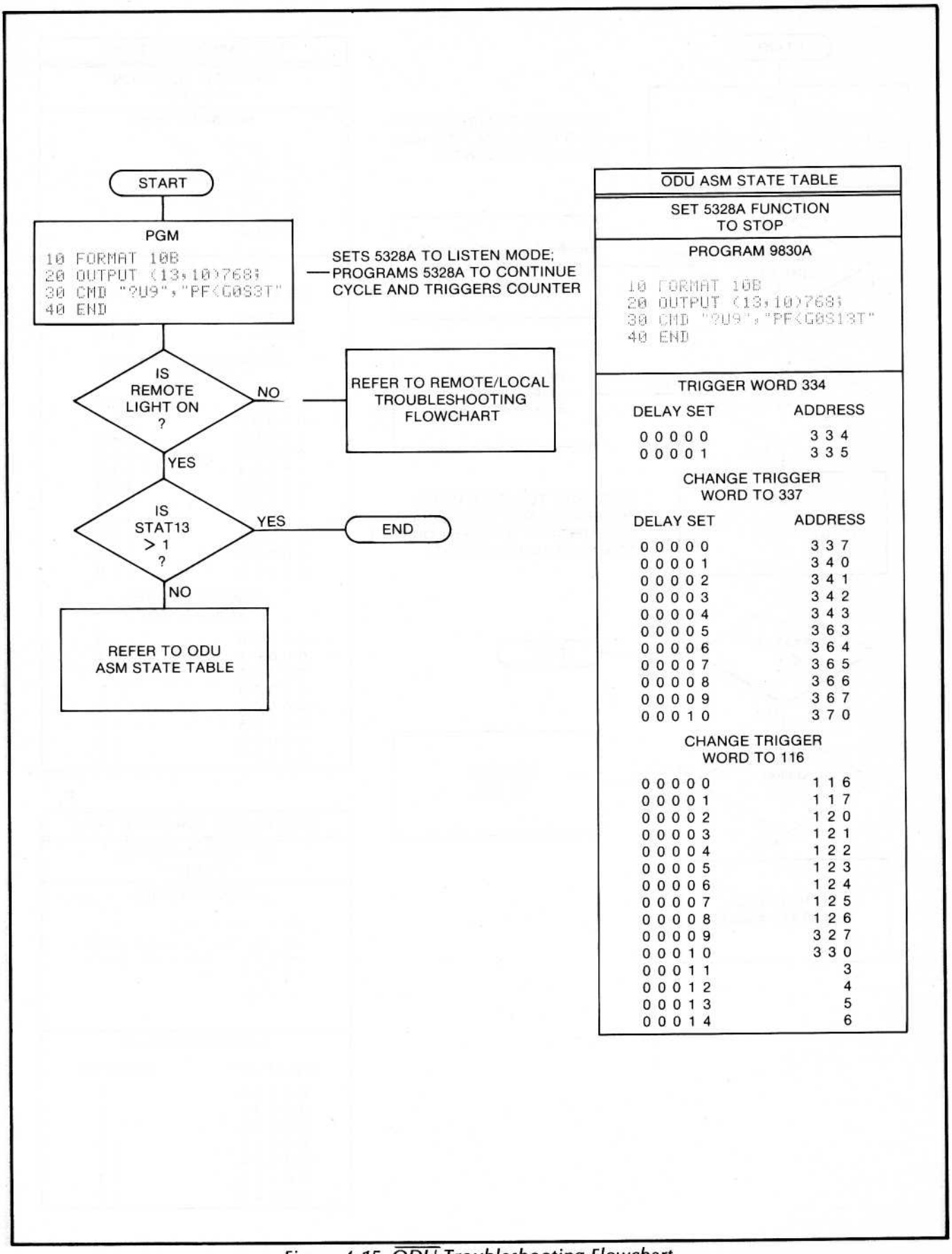


Figure 4–15. ODU Troubleshooting Flowchart

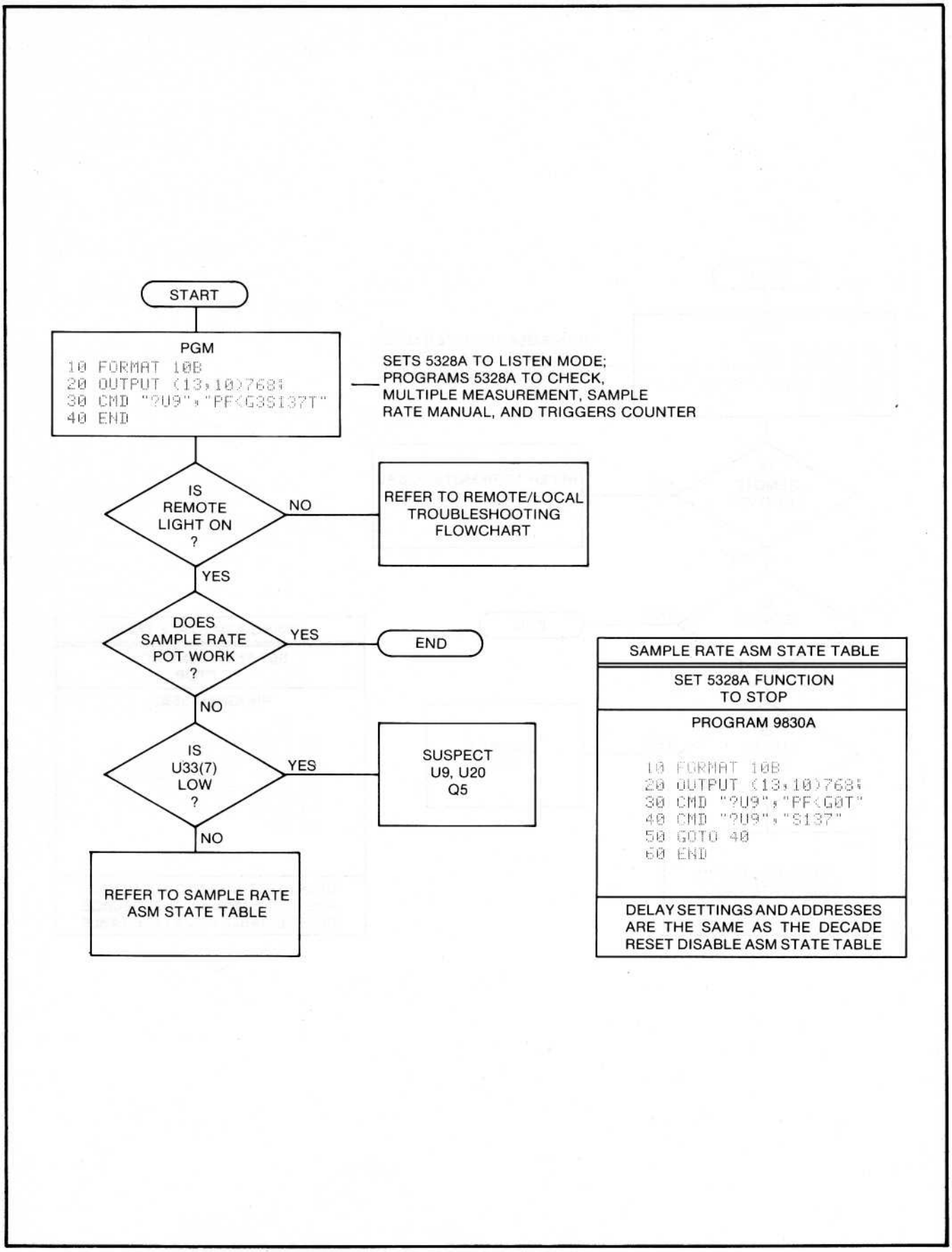


Figure 4–16. SAMPLE RATE Troubleshooting Flowchart

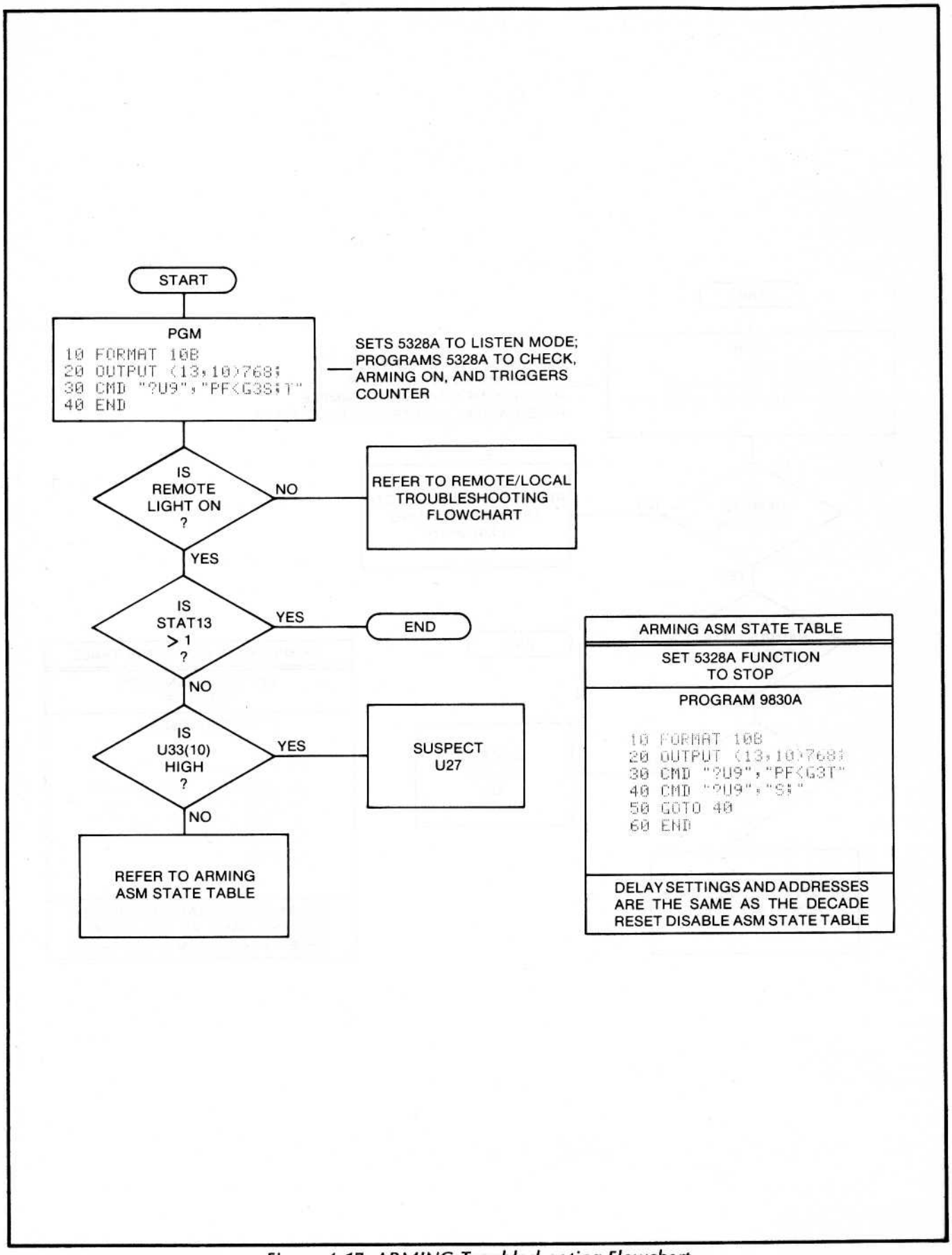


Figure 4-17. ARMING Troubleshooting Flowchart

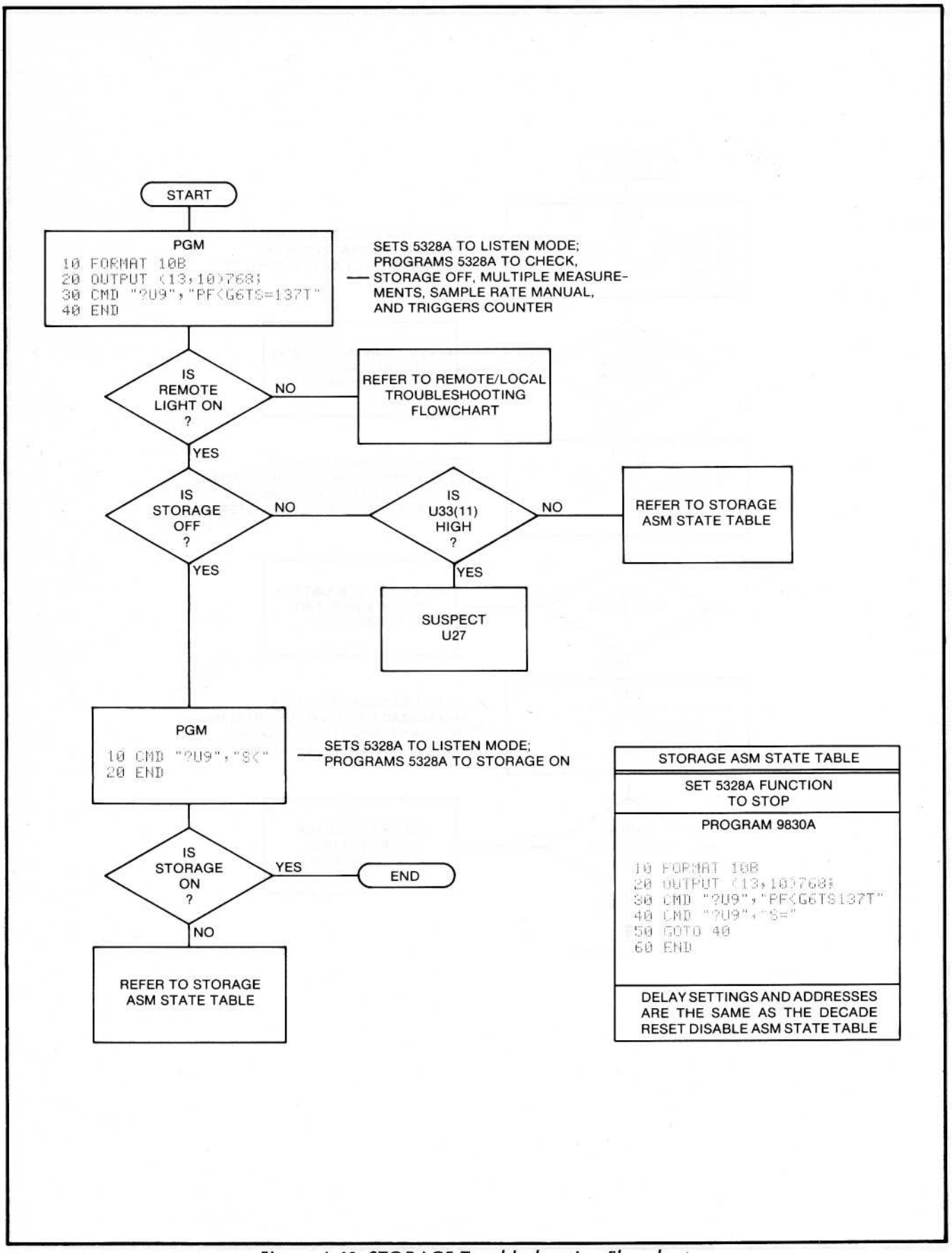


Figure 4–18. STORAGE Troubleshooting Flowchart

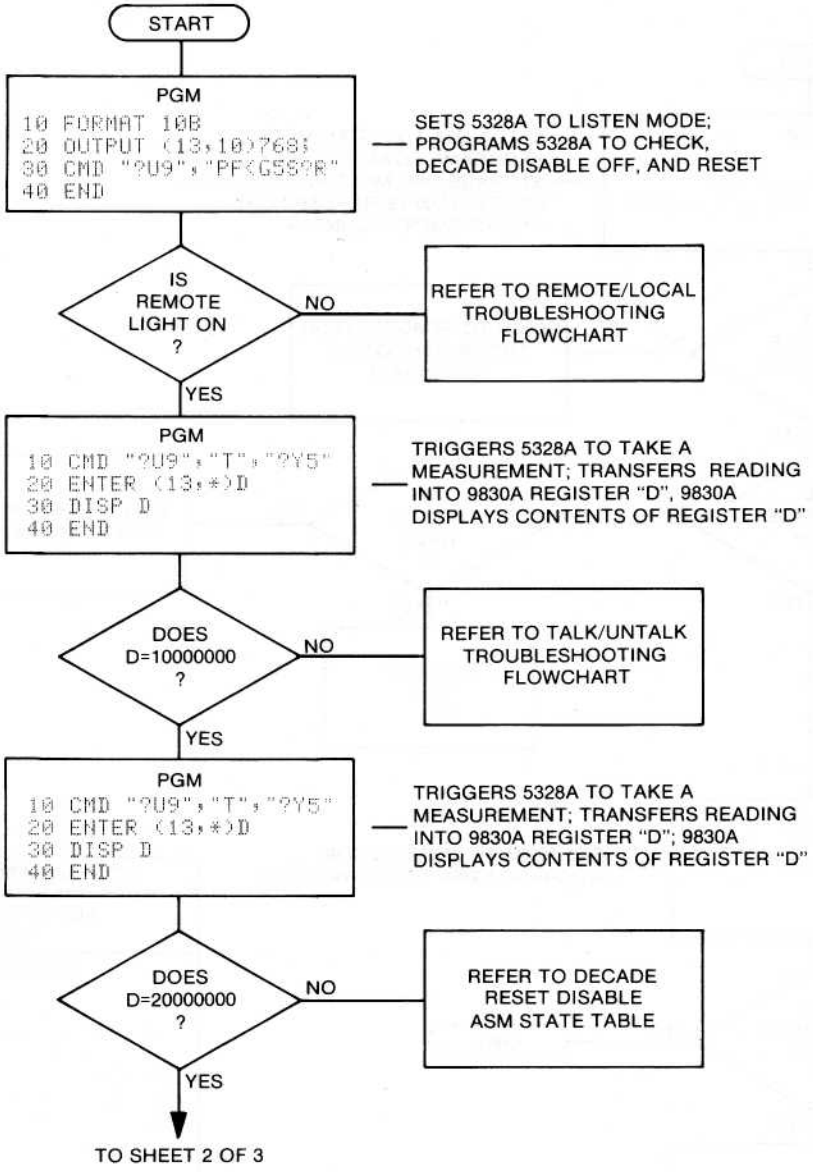


Figure 4–19. DECADE RESET DISABLE and DIGIT OUTPUT Troubleshooting Flowchart (Sheet 1 of 3)

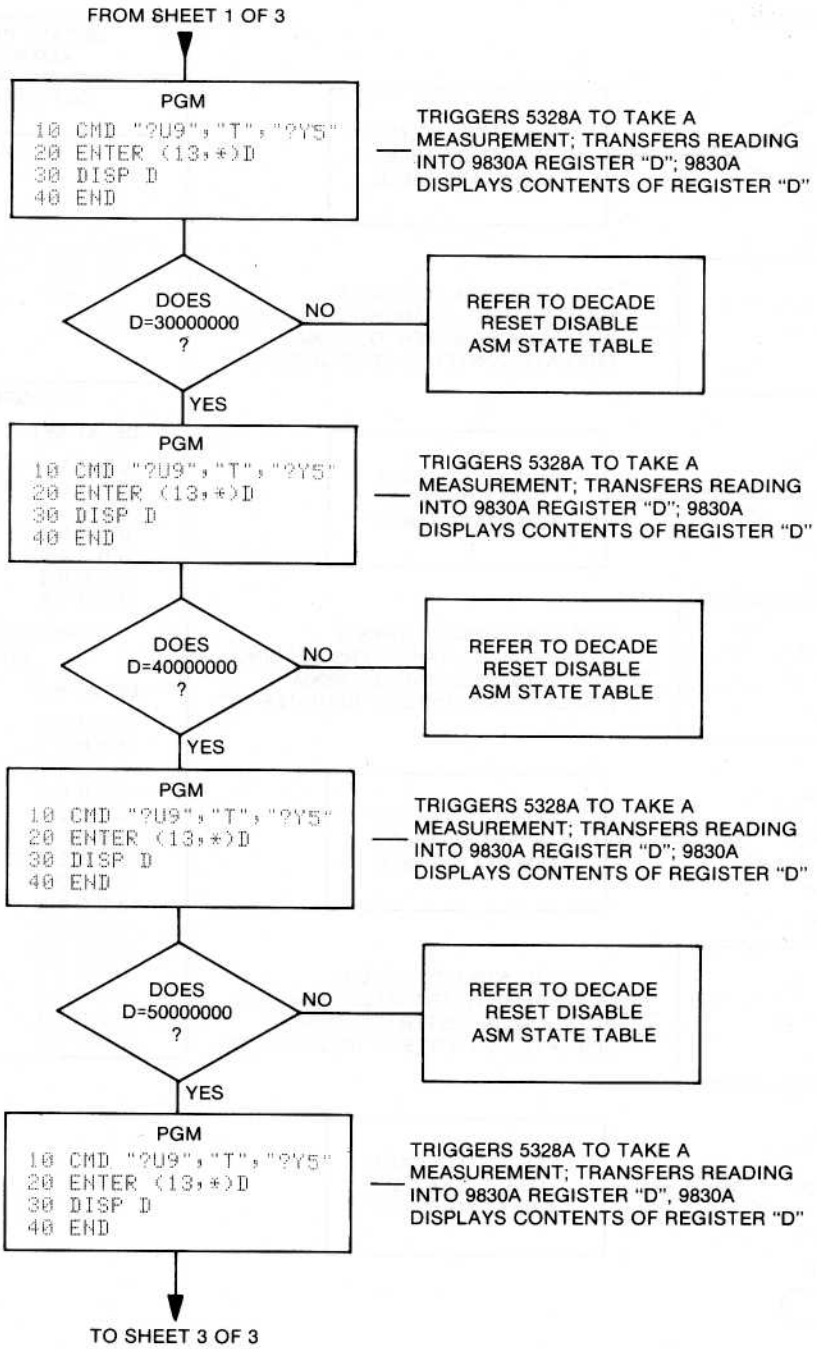


Figure 4–19. DECADE RESET DISABLE and DIGIT OUTPUT Troubleshooting Flowchart (Sheet 2 of 3)

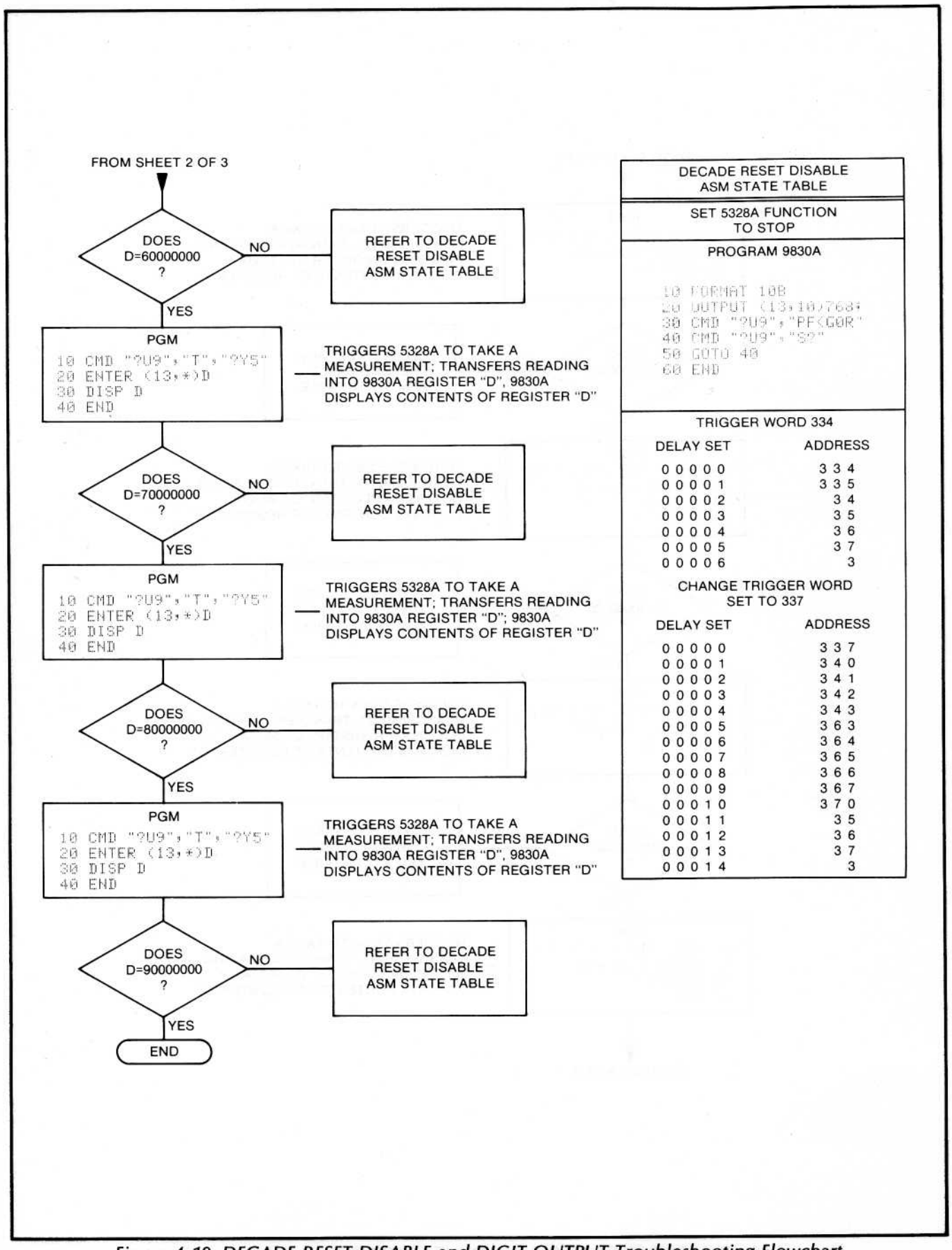
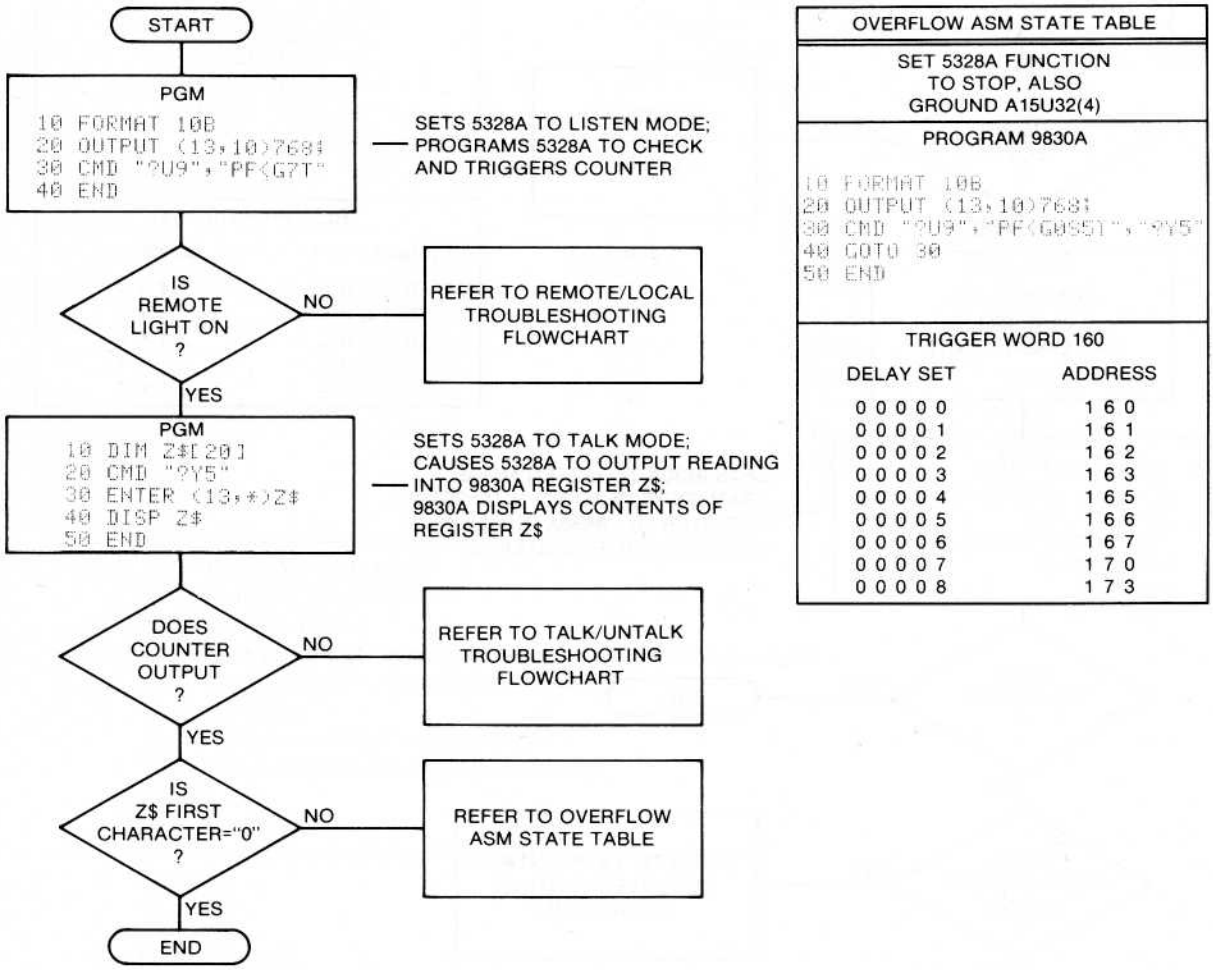


Figure 4–19. DECADE RESET DISABLE and DIGIT OUTPUT Troubleshooting Flowchart (Sheet 3 of 3)



OVERFLOW ASM STATE TABLE

SET 5328A FUNCTION TO STOP, ALSO GROUND A15U32(4)

PROGRAM 9830A

```
10 FORMAT 10B
20 OUTPUT (13,10)768;
30 CMD "?U9","PF(G0SST","?Y5"
40 GOTO 30
50 END
```

TRIGGER WORD 160

DELAY SET	ADDRESS
0 0 0 0 0	1 6 0
0 0 0 0 1	1 6 1
0 0 0 0 2	1 6 2
0 0 0 0 3	1 6 3
0 0 0 0 4	1 6 5
0 0 0 0 5	1 6 6
0 0 0 0 6	1 6 7
0 0 0 0 7	1 7 0
0 0 0 0 8	1 7 3

Figure 4–20. OVERFLOW Troubleshooting Flowchart

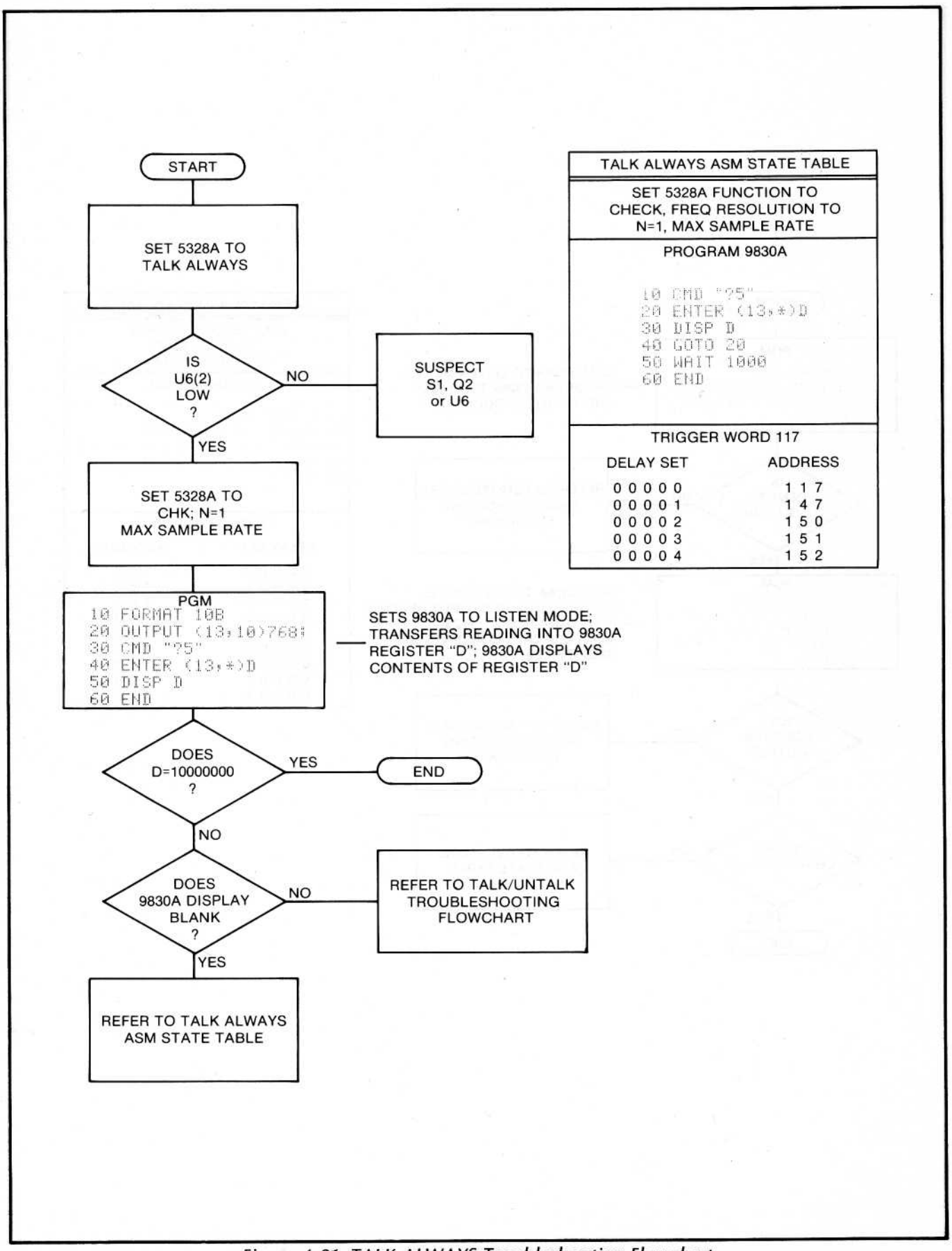


Figure 4-21. TALK ALWAYS Troubleshooting Flowchart

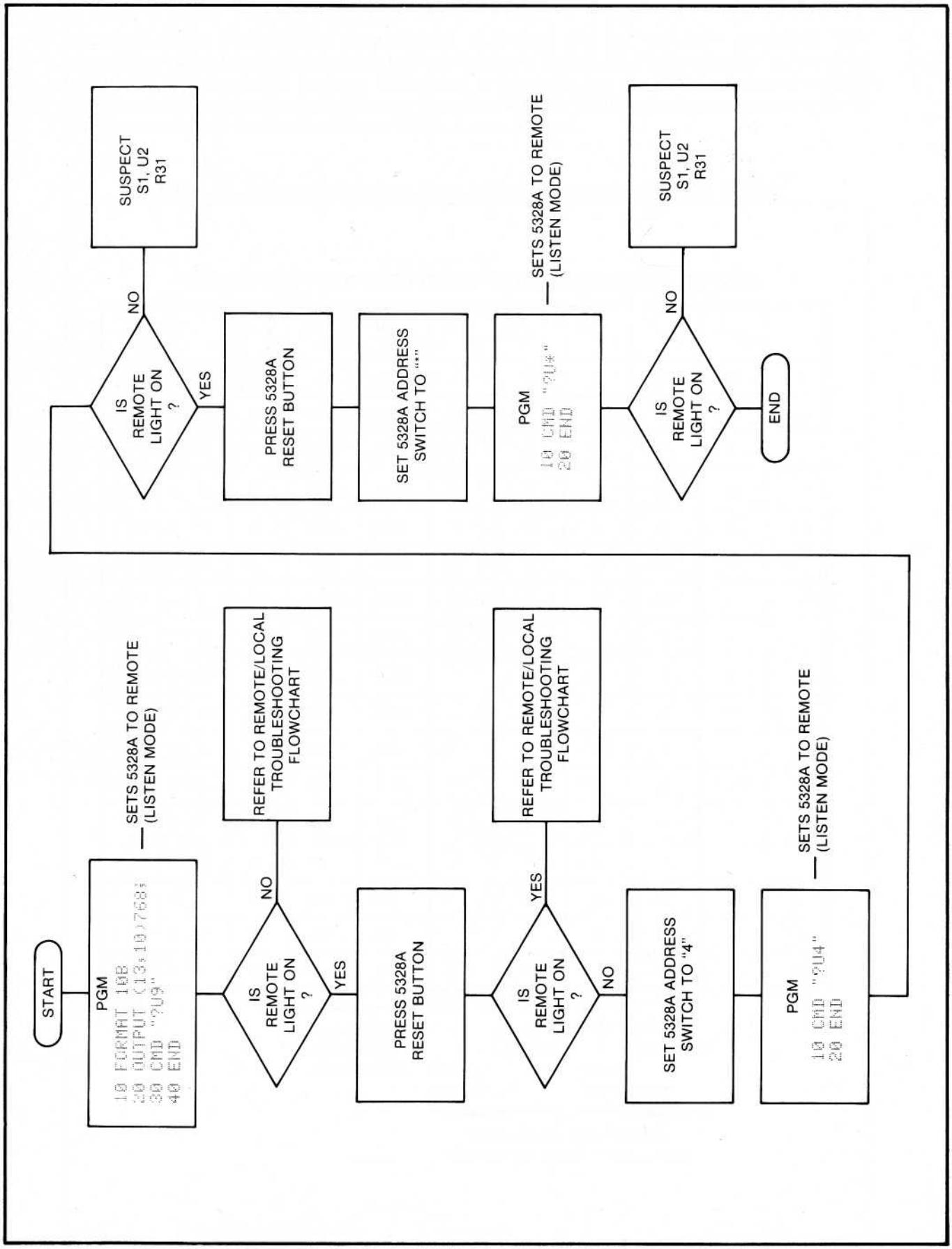


Figure 4–22. ADDRESS SWITCH Troubleshooting Flowchart

SECTION V
REPLACEABLE PARTS

5-1. INTRODUCTION

5-2. This section contains information for ordering replacement parts. *Table 5-1* lists parts used in the Option 011. The table lists parts in alphanumeric order of their reference designations and provides the following information on each part:

a. Hewlett-Packard part number.
b. Description of part (see abbreviations below).
c. Total quantity used in the instrument (the first time that the part appears in the list, the total quantity of that part number is printed).
d. Typical manufacturer of the part in a five-digit code (see list of manufacturers in *Table 5-2*).
e. Manufacturer's part number.

5-3. Miscellaneous parts are listed at the end of *Table 5-1*.

5-4. ORDERING INFORMATION

5-5. To obtain replacement parts, address order or inquiry to your local Hewlett-Packard Sales and Service Office (see lists at rear of 5328A Service Manual for addresses). Identify parts by their Hewlett-Packard part number. To obtain a part that is not listed, include:

a. Instrument model number.
b. Instrument serial number.
c. Description of the part.
d. Function and location of the part.

REFERENCE DESIGNATIONS

A	= assembly	E	= micellaneous electrical part	P	= electrical connector (movable portion); plug	V	= electron tube
AT	= attenuator; isolator; termination	F	= fuse			VR	= voltage regulator; breakdown diode
B	= fan; motor	FL	= filter	Q	= transistor; SCR; triode thyristor	W	= cable; transmission path; wire
BT	= battery	H	= hardware			X	= socket
C	= capacitor	HY	= circulator	R	= resistor	Y	= crystal unit-piezo-electric
CP	= coupler	J	= electrical connector (stationary portion); jack	RT	= thermistor	Z	= tuned cavity; tuned circuit
CR	= diode; diode thyristor; varactor			S	= switch		
DC	= directional coupler	K	= relay	T	= transformer		
DL	= delay line	L	= coil; inductor	TB	= terminal board		
DS	= annunciator; signaling device (audible or visual); lamp; LED	M	= meter	TC	= thermocouple		
		MP	= miscellaneous mechanical part	TP	= test point		
				U	= integrated circuit; microcircuit		

ABBREVIATIONS

A	= ampere	BAL	= balance	COEF	= coefficient	°C	= degree Celsius (centrigrade)
ac	= alternating current	BCD	= binary coded decimal	COM	= common	°F	= degree Fahrenheit
ACCESS	= accessory	BD	= board	COMP	= composition	°K	= degree Kelvin
ADJ	= adjustment	BE CU	= beryllium copper	COMPL	= complete	DEPC	= deposited carbon
A/D	= analog-to-digital	BFO	= beat frequency oscillator	CONN	= connector	DET	= detector
AF	= audio frequency			CP	= cadmium plate	diam	= diameter
AFC	= automatic frequency control	BH	= binder head	CRT	= cathode-ray tube	DIA	= diameter (used in parts list)
		BKDN	= breakdown	CTL	= complementary transistor logic		
AGC	= automatic gain control	BP	= bandpass			DIFF AMPL	= differential amplifier
AL	= aluminum	BPF	= bandpass filter	CW	= continuous wave	div	= division
ALC	= automatic level control	BRS	= brass	cw	= clockwise	DPDT	= double-pole, double-throw
AM	= amplitude modulation	BWO	= backward-wave oscillator	D/A	= digital-to-analog		
AMPL	= amplifier			dB	= decibel	DR	= drive
APC	= automatic phase control	CAL	= calibrate	dBm	= decibel referred to 1 mW	DSB	= double sideband
		ccw	= counterclockwise			DTL	= diode transistor logic
ASSY	= assembly	CER	= ceramic	dc	= direct current	DVM	= digital voltmeter
AUX	= auxiliary	CHAN	= channel	deg	= degree (temperature interval or difference)	ECL	= emitter coupled logic
avg	= average	cm	= centimeter				
AWG	= american wire gauge	CMO	= coaxial	...°	= degree (plane angle)		

ABBREVIATIONS (CONTINUED)

EMF	= electromotive force
EDP	= electronic data processing
ELECT	= electrolytic
ENCAP	= encapsulated
EXT	= external
F	= farad
FET	= field-effect transistor
F/F	= flip-flop
FH	= flat head
FOL H	= fillister head
FM	= frequency modulation
FP	= front panel
FREQ	= frequency
FXD	= fixed
g	= gram
GE	= germanium
GHz	= gigahertz
GL	= glass
GND	= ground(ed)
H	= henry
h	= hour
HET	= heterodyne
HEX	= hexagonal
HD	= head
HDW	= hardware
HF	= high frequency
HG	= mercury
HI	= high
HP	= Hewlett-Packard
HPF	= high pass filter
HR	= hour (used in parts list)
HV	= high voltage
Hz	= Hertz
IC	= integrated circuit
ID	= inside diameter
IF	= intermediate frequency
IMPG	= impregnated
in	= inch
INCD	= incandescent
INCL	= include(s)
INP	= input
INS	= insulation
INT	= internal
kg	= kilogram
kHz	= kilohertz
kΩ	= kilohm
kV	= kilovolt
lb	= pound
LC	= inductance-capacitance
LED	= light-emitting diode
LF	= low frequency
LG	= long
LH	= left hand
LIM	= limit
LIN	= linear taper (used in parts list)
lin	= linear
LK WASH	= lockwasher
LO	= low; local oscillator
LOG	= logarithmic taper (used in parts list)
log	= logarithm(ic)
LPF	= low pass filter
LV	= low voltage
m	= meter (distance)
mA	= milliampere
MAX	= maximum
MΩ	= megohm
MEG	= meg (10^6) (used in parts list)
MET FLM	= metal film
MET OX	= metal oxide
MF	= medium frequency; microfared (used in parts list)
MFR	= manufacturer
mg	= milligram
MHz	= megahertz
mH	= millihenry
mho	= mho
MIN	= minimum
min	= minute (time)
... '	= minute (plane angle)
MINAT	= miniature
mm	= millimeter
MOD	= modulator
MOM	= momentary
MOS	= metal-oxide semi-conductor
ms	= millisecond
MTG	= mounting
MTR	= meter (indicating device)
mV	= millivolt
mVac	= millivolt, ac
mVdc	= millivolt, dc
mVpk	= millivolt, peak
mVp-p	= millivolt, peak-to-peak
mVrms	= millivolt, rms
mW	= milliwatt
MUX	= multiplex
MY	= mylar
μA	= microampere
μF	= microfarad
μH	= microhenry
μmho	= micromho
μs	= microsecond
μV	= microvolt
μVac	= microvolt, ac
μVdc	= microvolt, dc
μVpk	= microvolt, peak
μVp-p	= microvolt, peak-to-peak
μVrms	= microvolt, rms
μW	= microwatt
nA	= nanoampere
NC	= no connection
N/C	= normally closed
NE	= neon
NEG	= negative
nF	= nanofarad
NI PL	= nickel plate
N/O	= normally open
NOM	= nominal
NORM	= normal
NPN	= negative-positive-negative
NPO	= negative-positive zero (zero temperature coefficient)
NRFR	= not recommended for field replacement
NSR	= not separately replaceable
ns	= nanosecond
nW	= nanowatt
OBD	= order by description
OD	= outside diameter
OH	= oval head
OP AMPL	= operational amplifier
OPT	= option
OSC	= oscillator
OX	= oxide
oz	= ounce
Ω	= ohm
P	= peak (used in parts list)
PAM	= pulse-amplitude modulation
PC	= printed circuit
PCM	= pulse-code moudulation; pulse-count modulation
PDM	= pulse-duration modulation
pF	= picofarad
PH BRZ	= phosphor bronze
PHL	= Phillips
PIN	= positive-intrinsic-negative
PIV	= peak inverse voltage
pk	= peak
PL	= phase lock
PLO	= phase lock oscillator
PM	= phase modulation
PNP	= positive-negative-positive
P/O	= part of
POLY	= polystyrene
PORC	= porcelain
POS	= positive; position(s) (used in parts list)
POSN	= position
POT	= potentiometer
p-p	= peak-to-peak
PP	= peak-to-peak (used in parts list)
PPM	= pulse-position modulation
PREAMPL	= preamplifier
PRF	= pulse-repetition frequency
PRR	= pulse repetition rate
ps	= picosecond
PT	= point
PTM	= pulse-time modulation
PWM	= pulse-width modulation
PWV	= peak working voltage
RC	= resistance capacitance
RECT	= rectifier
REF	= reference
REG	= regulated
REPL	= replaceable
RF	= radio frequency
RFI	= radio frequency interference
RH	= round head; right hand
RLC	= resistance-inductance-capacitance
RMO	= rack mount only
rms	= root-mean-square
RND	= round
ROM	= read-only memory
R&P	= rack and panel
RWV	= reverse working voltage
S	= scattering parameter
s	= second (time)
... "	= second (plane angle)
S-B	= slow-blow (fuse (used in parts list)
SCR	= silicon controlled rectifier; screw
SE	= selenium
SECT	= sections
SEMICON	= semiconductor
SHF	= superhigh frequency
SI	= silicon
SIL	= silver
SL	= slide
SNR	= signal-to-noise ratio
SPDT	= single-pole, double-throw
SPG	= spring
SR	= split ring
SPST	= single-pole, single-throw
SSB	= single sideband
SST	= stainless steel
STL	= steel
SQ	= square
SWR	= standing-wave ratio
SYNC	= synchronize
T	= timed (slow-blow fuse)
TA	= tantalum
TC	= temperature compensating
TD	= time delay
TERM	= terminal
TFT	= thin-film transistor
TGL	= toggle
THD	= thread
THRU	= through
TI	= titanium
TOL	= tolerance
TRIM	= trimmer
TSTR	= transistor
TTL	= transistor-transistor logic
TV	= television
TVI	= television interference
TWT	= traveling wave tube
U	= micro (10^{-6}) (used in parts list)
UF	= microfarad (used in parts list)
UHF	= ultrahigh frequency
UNREG	= unregulated
V	= volt
VA	= voltampere
Vac	= volts ac
VAR	= variable
VCO	= voltage-controlled oscillator
Vdc	= volts dc
VDCW	= volts dc, working (used in parts list)
V(F)	= volts, filtered
VFO	= variable-frequency oscillator
VHF	= very-high frequency
Vpk	= volts peak
Vp-p	= Volts peak-to-peak
Vrms	= volts rms
VSWR	= voltage standing wave ratio
VTO	= voltage-tuned oscillator
VTVM	= vacuum-tube voltmeter
V(X)	= volts, switched
W	= watt
W/	= with
WIV	= working inverse voltage
WW	= wirewound
W/O	= without
YIG	= yttrium-iron-garnet
Zo	= characteristic impedance

NOTE

All abbreviations in the parts list will be in upper case.

MULTIPLIERS

Abbreviation	Prefix	Multiple
T	tera	10^{12}
G	giga	10^{9}
M	mega	10^{6}
k	kilo	10^{3}
da	deka	10
d	deci	10^{-1}
c	centi	10^{-2}
m	milli	10^{-3}
μ	micro	10^{-6}
n	nano	10^{-9}
p	pico	10^{-12}
f	femto	10^{-15}
a	atto	10^{-18}

Table 5-1. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
			OPTION 011		
A15	05328-60019	1	HP-IB INTERFACE ASSEMBLY (SERIES 1504A	28480	05328-60019
A15C1	0180-1735	1	CAPACITOR-FXD; .22UF+-10% 35VDC TA	56289	150D224X9035A2
A15C2	0170-0040	1	CAPACITOR-FXD .047UF +-10% 200WVDC POLYE	56289	292P47392
A15C3	0180-0106	1	CAPACITOR-FXD; 6UF+-20% 6VDC TA-SOLID	56289	150D606X000682
A15C4	0160-0154	1	CAPACITOR-FXD 2200PF +-10% 200WVDC POLYE	56289	292P22292
A15C5	0160-0161	1	CAPACITOR-FXD .01UF +-10% 200WVDC POLYE	56289	292P10392
A15C6	0170-0024	1	CAPACITOR-FXD .022UF +-20% 200WVDC POLYE	56289	292P22302
A15C7	0180-0229	2	CAPACITOR-FXD; 33UF+-10% 10VDC TA-SOLID	56289	150D336X901082
A15C8	0180-0229		CAPACITOR-FXD; 33UF+-10% 10VDC TA-SOLID	56289	150D336X901082
A15C9	0180-1746	1	CAPACITOR-FXD; 15UF+-10% 20VDC TA-SOLID	56289	150D156X902082
A15CR1	1910-0016	6	DIODE-SWITCHING 1US 60V 60MA	28480	1910-0016
A15CR2	1910-0016		DIODE-SWITCHING 1US 60V 60MA	28480	1910-0016
A15CR3	1910-0016		DIODE-SWITCHING 1US 60V 60MA	28480	1910-0016
A15CR4	1910-0016		DIODE-SWITCHING 1US 60V 60MA	28480	1910-0016
A15CR5	1910-0016		DIODE-SWITCHING 1US 60V 60MA	28480	1910-0016
A15CR6	1910-0016		DIODE-SWITCHING 1US 60V 60MA	28480	1910-0016
A15J1	1251-3283	1	CONNECTOR; 24-CONT; FEM; MICRORIBBON	28480	1251-3283
A15J2	1200-0548	4	SOCKET; ELEC; IC 14-CONT DIP SLDR TERM	28480	1200-0548
A15J3	1200-0548		SOCKET; ELEC; IC 14-CONT DIP SLDR TERM	28480	1200-0548
A15J4	1200-0548		SOCKET; ELEC; IC 14-CONT DIP SLDR TERM	28480	1200-0548
A15J5	1200-0548		SOCKET; ELEC; IC 14-CONT DIP SLDR TERM	28480	1200-0548
A15Q1	1854-0215	4	TRANSISTOR NPN SI PD=310MW FT=300MHZ	04713	SPS 3611
A15Q2	1854-0215		TRANSISTOR NPN SI PD=310MW FT=300MHZ	04713	SPS 3611
A15Q3	1854-0215		TRANSISTOR NPN SI PD=310MW FT=300MHZ	04713	SPS 3611
A15Q4	1854-0215		TRANSISTOR NPN SI PD=310MW FT=300MHZ	04713	SPS 3611
A15Q5	1853-0036	1	TRANSISTOR PNP SI PD=310MW FT=250MHZ	28480	1853-0036
A15R1	0683-3035	1	RESISTOR 30K 5% .25W FC TC=-400/+800	01121	CB3035
A15R2	0683-1035	13	RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A15R3	0683-1035		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A15R4	0683-2715	3	RESISTOR 270 5% .25W FC TC=-400/+600	01121	CB2715
A15R5	0683-3325	1	RESISTOR 3.3K 5% .25W FC TC=-400/+700	01121	CB3325
A15R6	0683-4725	5	RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A15R7	0683-1035		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A15R8	0683-1035		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A15R9	0683-1035		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A15R10	0683-1035		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A15R11	0683-1235	1	RESISTOR 12K 5% .25W FC TC=-400/+800	01121	CB1235
A15R12	0683-1035		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A15R13	0683-2715		RESISTOR 270 5% .25W FC TC=-400/+600	01121	CB2715
A15R14	0683-2715		RESISTOR 270 5% .25W FC TC=-400/+600	01121	CB2715
A15R15	0683-1035		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A15R16	0683-1035		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A15R17	0683-1535	1	RESISTOR 15K 5% .25W FC TC=-400/+800	01121	CB1535
A15R18	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A15R19	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A15R20	0683-1035		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A15R21	0683-1035		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A15R22	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A15R23	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A15R24	0683-1035		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A15R25	0683-2725	1	RESISTOR 2.7K 5% .25W FC TC=-400/+700	01121	CB2725
A15R26	0683-2025	1	RESISTOR 2K 5% .25W FC TC=-400/+700	01121	CB2025
A15R27	0683-3025	2	RESISTOR 3K 5% .25W FC TC=-400/+700	01121	CB3025
A15R28	0683-3025		RESISTOR 3K 5% .25W FC TC=-400/+700	01121	CB3025
A15R29	1810-0136	2	NETWORK-RES 10-PIN SIP .1-PIN-SPCG	28480	1810-0136
A15R30	1810-0136		NETWORK-RES 10-PIN SIP .1-PIN-SPCG	28480	1810-0136
A15R31	1810-0055	4	NETWORK-RES 9-PIN SIP .15-PIN-SPCG	28480	1810-0055
A15R32	1810-0055		NETWORK-RES 9-PIN SIP .15-PIN-SPCG	28480	1810-0055
A15R33	1810-0055		NETWORK-RES 9-PIN SIP .15-PIN-SPCG	28480	1810-0055
A15R34	1810-0055		NETWORK-RES 9-PIN SIP .15-PIN-SPCG	28480	1810-0055
A15R35	0683-1035	1	RESISTOR 10K 5% .25W FC TC=-400,+700	01121	CB1035
A15S1	3101-1973	1	SWITCH, DIP	28480	3101-1973
A15U1	1820-0261	1	IC SN74 121 N	01295	SN74121N
A15U2	1820-0904	1	IC COMPARATOR	07263	93L24DC
A15U3	1820-0658	5	IC MULTIPLEXER	07263	93L12DC
A15U4	1820-0174	3	IC SN74 04 N	01295	SN7404N
A15U5	1820-0621	3	IC SN74 38 N	01295	SN7438N
A15U6	1820-0658		IC MULTIPLEXER	07263	93L12DC
A15U7	1820-0099	1	IC SN74 93 N	01295	SN7493N
A15U8	1820-0658		IC MULTIPLEXER	07263	93L12DC
A15U9	1820-0174	1	IC SN7404A	01295	SN7404N
A15U10	1820-0621		IC SN74 38 N	01295	SN7438N

Table 5-1. Replaceable Parts (Continued)

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A15U11	1820-0077	2	IC SN7474N	01295	SN7474N
A15U12	1820-0658		IC MULTIPLEXER	07263	93L12DC
A15U13	1820-0627	1	IC DECODER	07263	93L01DC
A15U14	1820-1057	2	IC DM86L 76N	27014	DM86L76N
A15U15	1820-0656	1	IC SN74L 98 N	01295	SN74L98N
A15U16	1820-0621		IC SN74 38 N	01295	SN7438N
A15U17	1820-0054	1	IC SN7400N	01295	SN7400N
A15U18	1820-1056	1	IC SN74 132 N	01295	SN74132N
A15U19	1820-1358	3	IC LATCH	07263	93L34PC
A15U20	1820-0269	2	IC SN74 03 N	01295	SN7403N
A15U21	1820-0174		IC SN74 04 N	01295	SN7404N
A15U22	1818-2253	1		28480	1818-2253
	1200-0549	2	SOCKET-IC 14-CONT STRIP-PKG	28480	1200-0549
A15U23	1820-1057		IC DM86L 76N	27014	DM86L75N
A15U24	1820-0876	1	IC SN74L 75 N	01295	SN74L75N
A15U25	1820-0583	1	IC DM74L 00N	27014	DM74L00N
A15U26	1820-1358		IC LATCH	07263	93L34PC
A15U27	1820-0269		IC SN74 03 N	01295	SN7403N
A15U28	1820-1166	2	IC DM85L 51N	27014	DM85L51N
A15U29	1820-0054	1	IC SN74 00 N	01295	SN7400N
A15U30	1820-0282	1	IC SN7486N	01295	SN7486N
A15U31	1820-0077		IC SN7474N	01295	SN7474N
A15U32	1820-0658		IC MULTIPLEXER	07263	93L12DC
A15U33	1820-1358		IC LATCH	07263	93L34PC
A15U34	1820-1166		IC DM85L 51N	27014	DM85L51N
	1200-0549		SOCKET-IC 14-CONT STRIP-PKG	28480	1200-0549
			A15 MISCELLANEOUS		
	0360-0124	1	.040 040	28480	0360-0124
	0380-0384	4	STANDOFF-RVT-ON 1.25-LG 6-32-THD .25-OD	28480	0380-0384
	0380-0644	2	STANDOFF: HEX HD; 6-32 THD; 0.595 LG; 6	28480	0380-0644
	1200-0485	1	SOCKET:IC 14-PIN PC MOUNTING	28480	1200-0485
	1530-1098	2	FASTENER:0.136" DIA 6-32 THREAD	00000	OBD
	05328-00007	1	PLATE, COVER, ASCII	28480	05328-00007
	05328-60110	1	CABLE ASSEMBLY, LOCK OUT	28480	05328-60110

See introduction to this section for ordering information

Table 5-2. Manufacturers Code List

Mfr No.	Manufacturer Name	Address	Zip Code
00000	No M/F Description for this Mfg Number		
01121	Allen Bradley Co.	Milwaukee, Wi.	53212
01295	Texas Instr. Inc. Semicond. Cmpnt Div.	Dallas, Tx.	75231
04713	Motorola Semiconductor Div.	Mountain View, Ca.	94949
27014	National Semiconductor Corp.	Santa Clara, Ca.	95051
28480	Hewlett-Packard Co., Corporate Hq.	Palo Alto, Ca.	94304
56289	Sprague Electric Co.	North Adams, Ma.	01247

SECTION VI
MANUAL CHANGES

6-1. INTRODUCTION

6-2. This section contains information necessary to adapt this manual to older instruments.

6-3. MANUAL CHANGES

6-4. This manual applies directly to Model 5328A Option 011 (05328-60019) boards series numbers 1612.

6-5. Newer Option 011 Boards

6-6. As changes are made, newer boards may have series numbers not listed in this manual. The manual for these instruments are supplied with a manual change sheet which contains the required updating information. If this sheet is missing contact any Hewlett-Packard Sales and Service Office listed at the back of this manual.

6-7. Older Option 011 Boards

6-8. To adapt this manual to Option 011 boards with series numbers prior to 1612, perform the backdating that appleis to your boards series number as listed in *Table 6-1.*

Table 6-1. Manual Backdating

If Your Board Has Series Number	Make The Following Changes to Your Manual
1548	1
1544	1,2
1504	1,2,3

CHANGE 1 (A15 SERIES 1548)

Page 5-2, *Table 5-1,* A15 Replaceable Parts:

Change A15U11 and U31 from 1820-0077 (SN7474N) to 1820-0596; IC DM74L74N; 27014; DM74L74N.

Change A15U17 and U25 from 1820-0054 (SN7400N) to 1820-0583; IC DM74L00N; 27014; DM74L00N.

Change A15U30 from 1820-0282 (SN7486N) to 1820-0598; IC DM74L86N; 27014; DM74L86N.

Change hex head standoff (A15 miscellaneous) from 0380-0644 to 0280-0513.

Page 7-3, *Figure 7-1,* A15 Active Elements:

Change A15U11 and U31 from 1820-0077 (SN7474N) to 1820-0596 (DM74L74N).

Change A15U17 and U25 from 1820-0054 (SN7400N) to 1820-0583 (DM74L00N).

Change A15U30 from 1820-0054 (SN7400N) to 1820-0598 (DM74L86N).

CHANGE 2 (A15 SERIES 1544)

The series 1544 board is electrically identical to 1548. The only difference is improved clearance between the circuit board mounting post and DIO5 line to HP-IB connector pin 13.

Change 3 (A15 SERIES 1504)

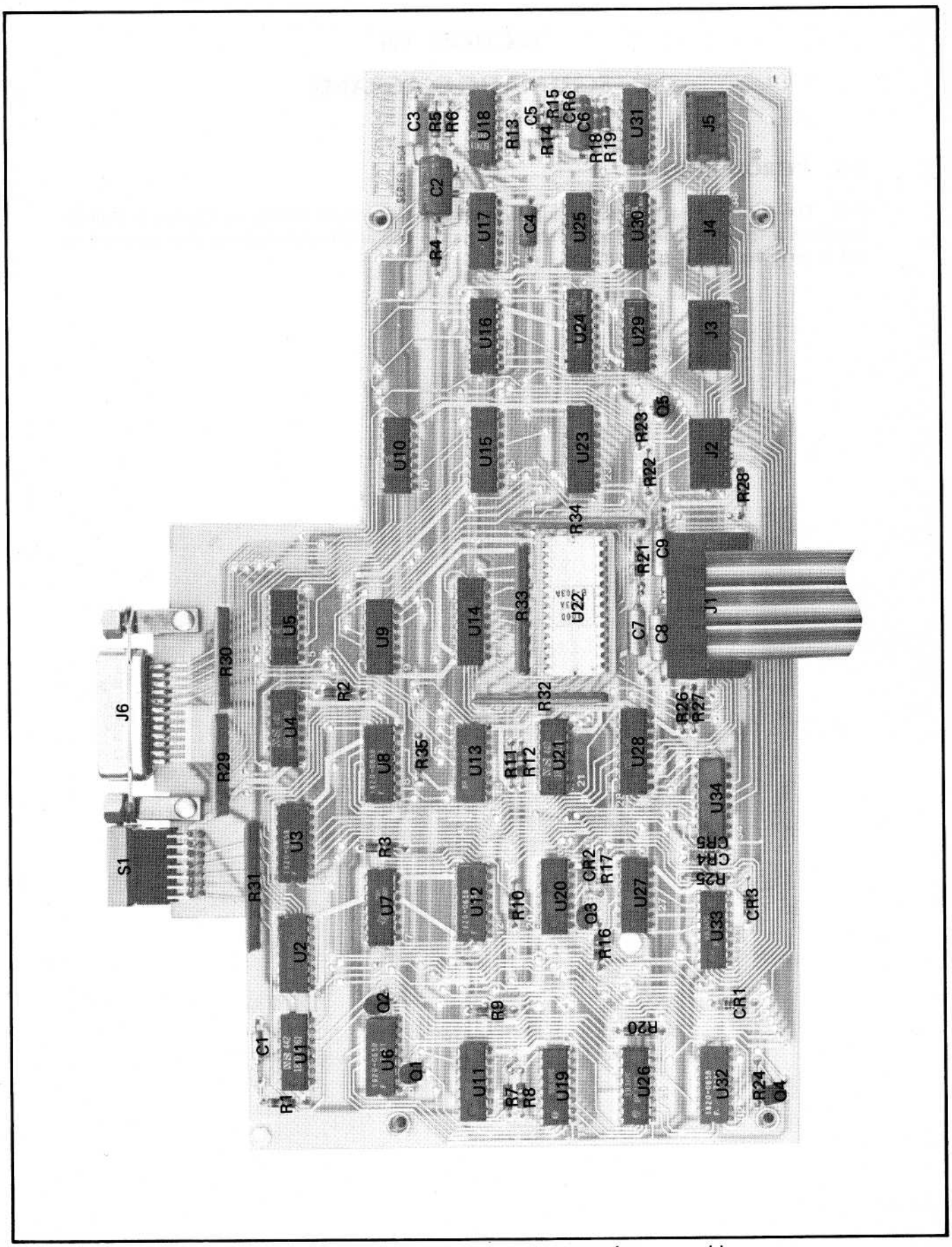
Page 7-3, *Figure 7-1,* A15 Schematic Diagram:

Disconnect the line from U8(5) to U29(11). Connect the line from U8(5) at the junction of R29(3) and U9(1).

SECTION VII
SCHEMATIC DIAGRAMS

7-1. INTRODUCTION

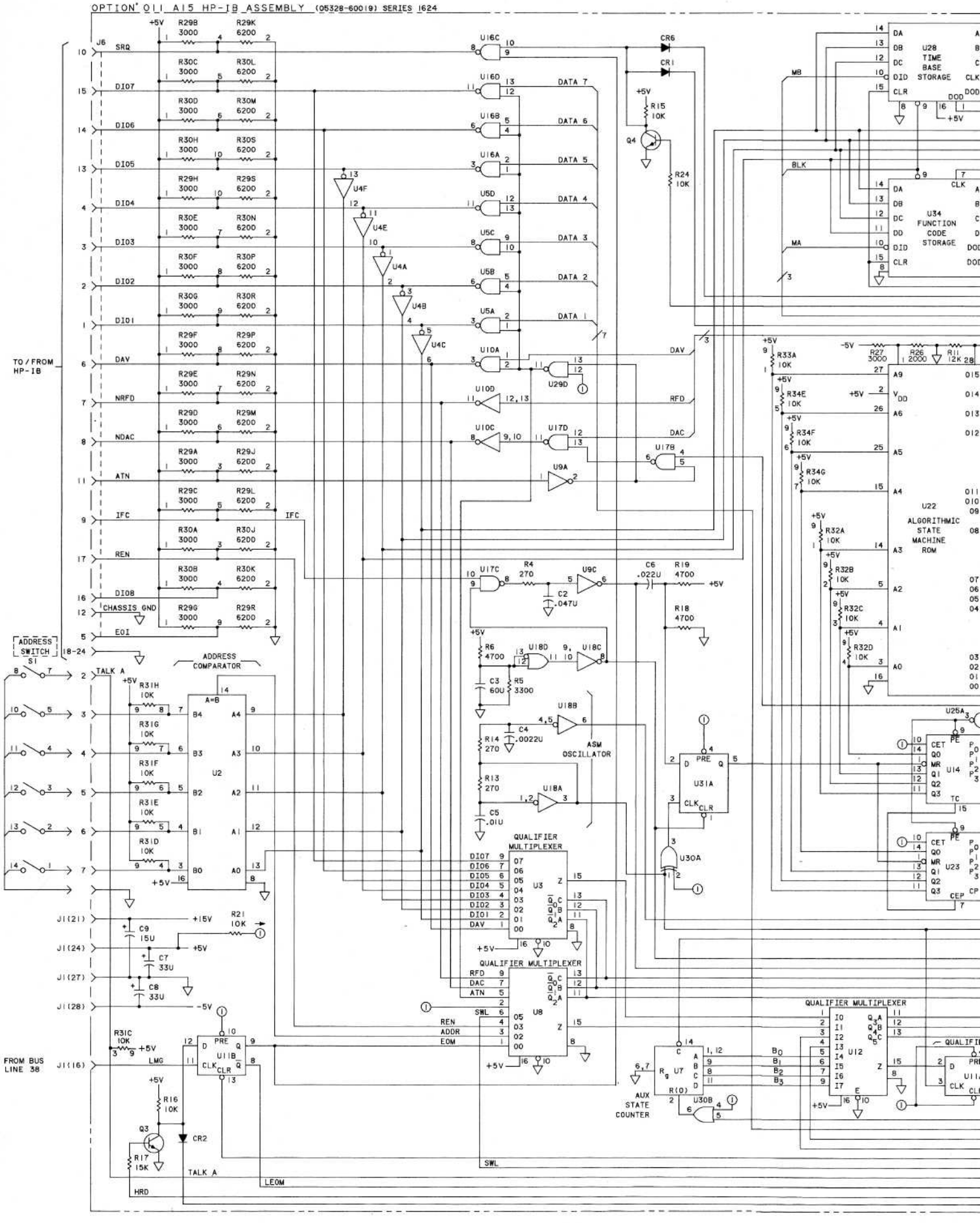
7-2. This section contains a schematic diagram and component locator for Option 011 HP-IB Interface assembly. Tables of reference designators and active elements are also supplied to aid in servicing.

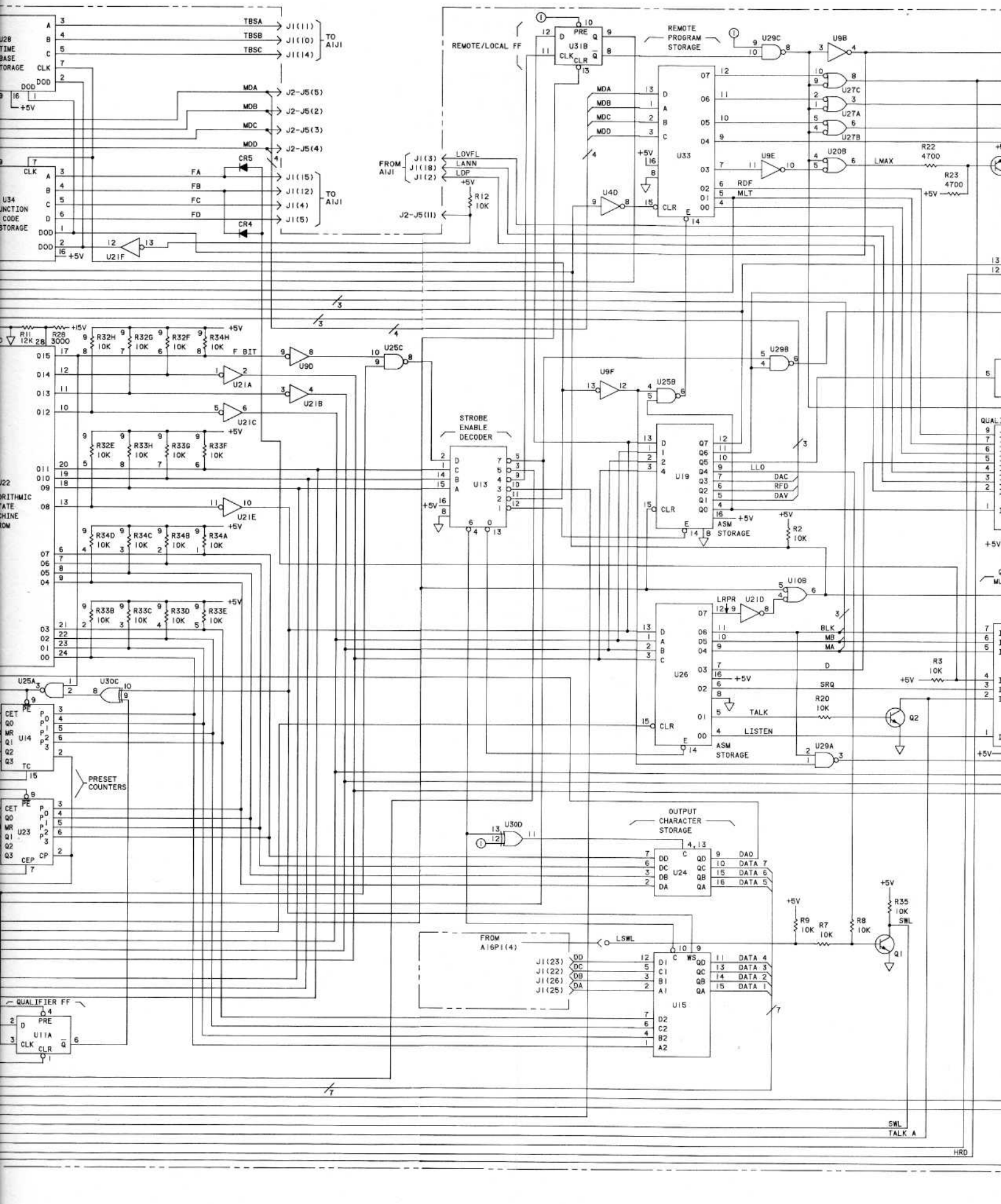


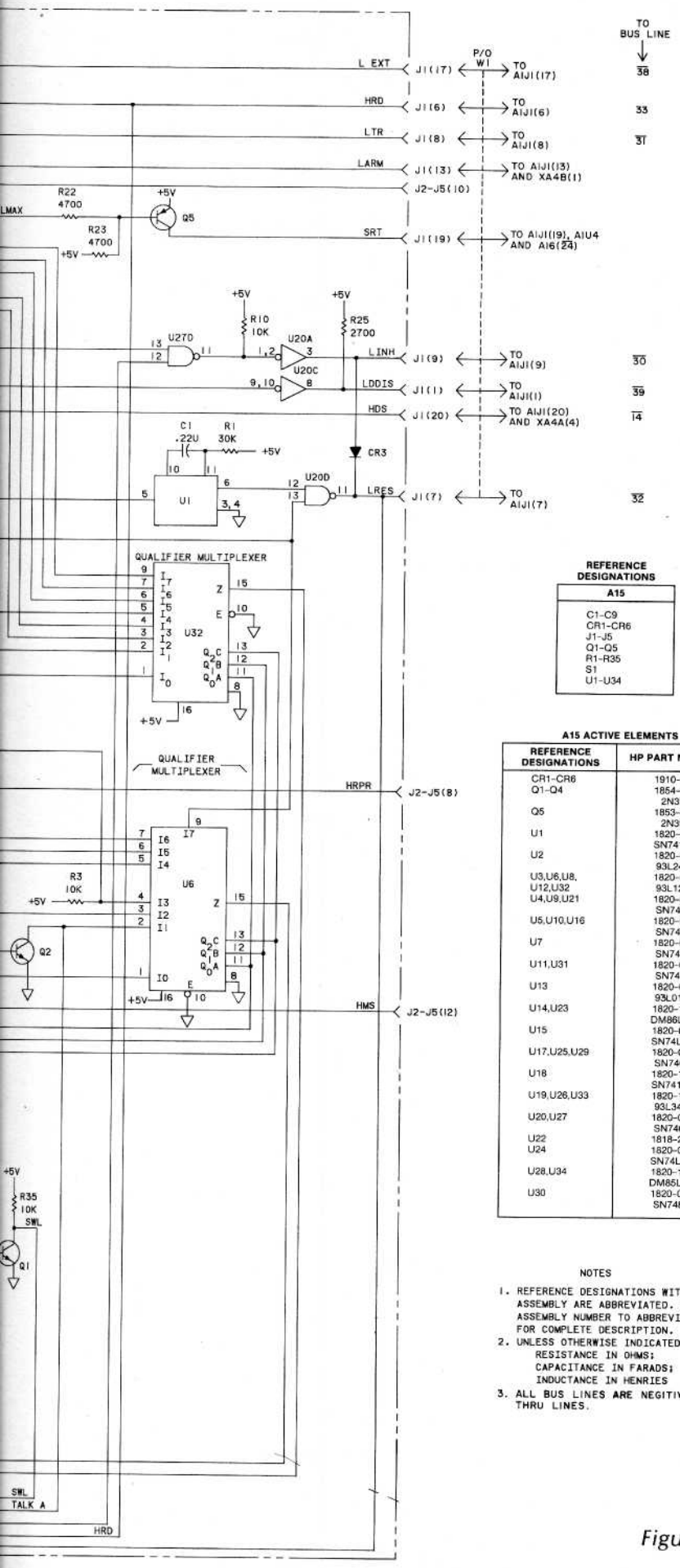
P/O Figure 7-1. Option 011 A15 HP-IB Interface Assembly

Signals from A15J1 through Cable to A1J1 (Motherboard)

1 LDDIS → BUS (39)
2 LDP → BUS (41)
3 LOVFL → BUS (28)
4 FC → BUS (36) → XA16(5)
5 FD → BUS (36) → XA16(5)
6 HRD → BUS (33)
7 LRES → BUS (32)
8 LTR → BUS (31) → XA4A(12)
9 LINH → BUS (30)
10 TBSB → BUS (35) → XA16(24)
11 TBSA → BUS (35) → XA16(23)
12 FB → BUS (37) → XA16(7)
13 LARM → XA4B(1)
14 TBSC → BUS (34) → XA16(22)
15 FA → BUS (37) → XA16(6)
16 LMG → XA4(A17) → BUS (38)
17 LEXT → BUS (38)
18 LANN → BUS (41)
19 SRT → A1(U4) → XA16(24)
20 HDS → XA4A(4) → BUS (14)
21 +15V
22 DC → XA4(B15) → BUS (42)
23 DD → XA4(B16) → BUS (42)
24 +5V
25 DA → XA4(B17) → BUS (43)
26 DB → XA4(B18) → BUS (43)
27 GND
28 -5V


OPTION 011 A15 HP-IB ASSEMBLY (05328-60019) SERIES 1624
TO / FROM HP-IB
SRQ
DIO7
DIO6
DIO5
DIO4
DIO3
DIO2
DIO1
DAV
NRFD
NDAC
ATN
IFC
REN
DIO8
EOI
CHASSIS GND
ADDRESS SWITCH S1
ADDRESS COMPARATOR
TALK A
LMG
FROM BUS LINE 38
DATA 7
DATA 6
DATA 5
DATA 4
DATA 3
DATA 2
DATA 1
RFD
DAC
ASW OSCILLATOR
QUALIFIER MULTIPLEXER
AUX STATE COUNTER
SWL
LEOM
HRD
U28 TIME BASE STORAGE
U34 FUNCTION CODE STORAGE
U22 ALGORITHMIC STATE MACHINE ROM


TBSA
TBSB
TBSC
J1(11)
J1(10)
J1(14)
TO AIJI
MDA
MDB
MDC
MDD
J2-J5(5)
J2-J5(2)
J2-J5(3)
J2-J5(4)
CR5
CR4
FA
FB
FC
FD
J1(15)
J1(12)
J1(4)
J1(5)
U21F
+5V
REMOTE/LOCAL FF
U31B
PRE
CLR
REMOTE PROGRAM STORAGE
U29C
U9B
U27C
U27A
U27B
U33
U9E
U20B
LMAX
R22 4700
R23 4700
RDF
MLT
FROM AIJI
J1(3)
J1(18)
J1(2)
LOVFL
LANN
LDP
R12 10K
J2-J5(11)
U4D
U9F
U25B
U29B
U25C
U9D
F BIT
U21A
U21B
U21C
U21E
R11 12K
R26 3000
R32H
R32G
R32F
R34H
R32E
R33H
R33G
R33F
R34D
R34C
R34B
R34A
R33B
R33C
R33D
R33E
STROBE ENABLE DECODER
U13
U19
LLO
DAC
RFD
DAV
ASM STORAGE
R2 10K
U10B
U21D
LRPR
U26
BLK
MB
MA
SRQ
TALK
LISTEN
R3 10K
R20 10K
Q2
U29A
U25A
U30C
U14
PRESET COUNTERS
U23
U30D
OUTPUT CHARACTER STORAGE
U24
DAO
DATA 7
DATA 6
DATA 5
DATA 4
DATA 3
DATA 2
DATA 1
FROM A16P1(4)
LSWL
U15
R9 10K
R7 10K
R8 10K
R35 10K
SWL
Q1
QUALIFIER FF
U11A
SWL
TALK A
HRD



REFERENCE DESIGNATIONS

A15
C1-C9 CR1-CR6 J1-J5 Q1-Q5 R1-R35 S1 U1-U34

A15 ACTIVE ELEMENTS

REFERENCE DESIGNATIONS	HP PART NUMBERS
CR1-CR6	1910-0016
Q1-Q4	1854-0215 2N3904
Q5	1853-0036 2N3906
U1	1820-0261 SN74121N
U2	1820-0904 93L24DC
U3,U6,U8, U12,U32	1820-0658 93L12DC
U4,U9,U21	1820-0174 SN7404N
U5,U10,U16	1820-0621 SN7438N
U7	1820-0099 SN7493N
U11,U31	1820-0077 SN7474N
U13	1820-0627 93L01DC
U14,U23	1820-1057 DM86L76N
U15	1820-0656 SN74L98N
U17,U25,U29	1820-0054 SN7400N
U18	1820-1056 SN74132N
U19,U26,U33	1820-1358 93L34PC
U20,U27	1820-0269 SN7403N
U22	1818-2253
U24	1820-0876 SN74L75N
U28,U34	1820-1166 DM85L51N
U30	1820-0282 SN7486N

NOTES

1. REFERENCE DESIGNATIONS WITHIN THIS ASSEMBLY ARE ABBREVIATED. ADD ASSEMBLY NUMBER TO ABBREVIATION FOR COMPLETE DESCRIPTION.
2. UNLESS OTHERWISE INDICATED:
   RESISTANCE IN OHMS;
   CAPACITANCE IN FARADS;
   INDUCTANCE IN HENRIES
3. ALL BUS LINES ARE NEGITIVE THRU LINES.

Figure 7-1. Option 011 A15 HO-IB Interface Assembly

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MANUAL CHANGES

MANUAL DESCRIPTION

INSTRUMENT:	5328A Option 011 HP-IB Interface Installation and Service Manual
SERIAL PREFIX:	1624
DATE PRINTED:	DEC 1976
HP PART NO:	05328-90019
MICROFICHE NO:	05328-90020

CHANGE DATE: June 13, 1980

(This change supersedes all earlier dated changes)

- Make all changes listed as ERRATA.
- Check the following table for your instrument's serial prefix or serial number and make listed change(s) to manual.

IF YOUR INSTRUMENT HAS SERIAL PREFIX OR SERIAL NUMBER	MAKE THE FOLLOWING CHANGES TO YOUR MANUAL	IF YOUR INSTRUMENT HAS SERIAL PREFIX OR SERIAL NUMBER	MAKE THE FOLLOWING CHANGES TO YOUR MANUAL
A15 Series 1952	1		
■ A15 Series 2024	1,2		

■ **NEW OR REVISED ITEM**

ERRATA

Inside Front Cover:

Change SERIAL NUMBER to SERIES NUMBER and paragraph to read as follows:

SERIES NUMBER

This manual applies directly to Option 011 A15 circuit boards with series number 1624 or 1632. For series numbers above 1632, a "Manual Changes" sheet is included with this manual. For series numbers below 1624, see backdating Section VI of this Installation and Service Manual. The 1624 and 1632 series of A15 circuit boards are electrically identical.

Page 1-1, Section I, General Information:

Add the following:

1-6. MANUAL CHANGES

1-7. The title page lists the circuit board series number to which this manual directly applies. If the series number etched or stamped on any circuit board or circuit board assembly (refer to Section VIII of the 5328A Service Manual for a description of board identification) is higher than the series number on the title page, a change sheet should accompany the manual. If this change sheet is missing, the information can be supplied by any Hewlett-Packard Sales and Service Office listed at the back of this manual.

This Installation and Service Manual for Option 011 is keyed to the series numbers on the circuit board(s) for the option and not the serial prefix number on the rear of the 5328A Counter. Consequently, the series number on any circuit board for this option may be higher than the serial prefix number on a particular 5328A Counter.

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CHANGE 1 (A15 Series 1952)

Page 5-3, Table 5-1, A15 Replaceable Parts:
Change A15 part number from 05328-60019 to 05328-60043 in "HP" and "Mfr Part Number" columns.
Change A15 series number to (SERIES 1952).
Delete 60 UF capacitor A15C3 (0180-0106).
Delete 3.3K resistor A15R5 (0683-3325).
Delete 4.7K resistor A15R6 (0683-4725).

Page 7-2, P/O Figure 7-1, A15 Component Locator:
Delete capacitor C3 and resistors R5 and R6.
Add a wire connection to the common connection of these three parts and U18 pins 1 and 2. This added wire crosses over the top of the HP-IB board and the push-on connector attaches to a pin connector on the LMRES line on series 1952 Motherboards. This add pin is at the junction of A1U2A(1,2); C5; and R7 in the left rear corner of A1. This connection must be made before fastening the A15 HP-IB board in place.

Page 7-3, P/O Figure 7-1, A15 Schematic Diagram:
Change HP Part Number and SERIES number, at top of diagram, from (05328-60019) SERIES 1624 to (05328-60043) SERIES 1952. Delete capacitor C3 and resistors R5 and R6. These three parts connect to U18D pins 1 and 2 in the left center of the diagram.
Add a wire leaving A15 and having a female connector on the free end. This wire connects to the LMRES line in SERIES 1952 Motherboard A1. The wire must be dressed over the top of HP-IB board A15.

■ Page 2-1, Paragraph 2-5, Field Installation:
Change paragraph 2-5 to read "2-5 Field Installation (Serial numbers 1944A13474 and above)."
Change paragraph 2-7 and 2-8 Removal to 2-8 and 2-9 (increment the paragraph numbers by one).
Add the following as the new paragraph 2-7.

■ 2-7 Field Installation (Serial Numbers 1944A13473 and below)

NOTE

Serial numbers 1944A13473 and below require a modification to the A1 Motherboard (05328-60001) to operate with the HP-IB A15 assembly (05328-60043). The following installation procedure describes this modification.

CAUTION

Avoid flexing Option 011 Board. Due to the number of resistor packs and their location, flexing can cause resistor failures.

a. Disconnect the power cable from the 5328A (Safety Precaution).

b. Remove the top and bottom covers from the 5328A.

c. Remove the small plate from the rear panel, located above the STORAGE switch, by removing two screws.

d. Remove A4 Function Selector board from motherboard by pulling up on one end of extractor at top of board (use rocking motion to extract board).

e. Remove the nut on each side of digital bus connector J6 on the HP-IB Interfac board.

A1 Motherboard Modifications (f through h)

f. Disconnect the cathode of A1CR9 (common with CR10) and insert pin terminal (P/N 1251-4707) in the plated-through hole vacated by cathode of CR9; reconnect CR9 to this terminal.

g. The trace from the junction of the two diodes (CR9 and CR10) to U41(3) must be cut close to the diodes CR9 and CR10; the cathode of the new diode CR21 (P/N 1901-0040) is connected to the cathodes of CR9 and CR10 at the pin terminal. The anode of CR21 is connected to the plated-through hole located approximately 1¼ inch away from front-left corner of A1 Motherboard. This connects the anode of CR21 to the junction of U41(3) and Q9 collector.

h. Add a terminal pin (P/N 0360-0451) through a plated-through hole that exists on the LMRES line at the junction A1R7, C5, and U2A(1,2). This added pin is located in the left-rear corner of A1. It is used to connect the wire that originates from A15U18(12,13).

CAUTION

In the following step, be sure that pin 1 of the plug (on each end of the cable) is aligned with pin 1 of the jack (one each board) before inserting. (Pins on plugs are numbered. Pin 1 on jacks has square solder dot.) Damage to equipment may occur if connectors are inserted incorrectly and power applied.

i. Connect one end of the 28-conductor cable to J-1 on the motherboard and insert the cable through the slot of the main bracket, MP10 (refer to *Figure 4-1* in the 5328A Service Manual) and bend remaining end of cable over top of MP10.

j. Connect the blue wire from A15U18D(12,13) to the pin terminal at the junction of A1C5, R7, and U2A(1,2) located in the left-rear corner of A1. The wire must be dressed over the top of the A15 HP-IB board.

k. Install the HP-IB board, component side up (parallel to the motherboard) with digital bus connector J6 inserted out through the rear panel (where plate was removed).

l. Place 5328A on its side and attach four 6-32 × 5/16 inch screws to the HP-IB board stand-offs from underside the motherboard.

m. Mount the cover plate over digital bus connector J6 and switch S1 and attach with two screws. Replace to nuts on J6 that were removed in step e.

n. Connect the free-end of the 28-conductor cable to J1 (position 35) on HP-IB board.

o. Connect the end of the lock-out cable (jumper wire) to terminal post at pin 4 of XA16 (below display board) on motherboard.

p. Install A4 Function Selector board removed in step d.

q. Install top and bottom covers and apply power.

r. Verify proper operation of the 5328A using the HP-IB verification program in the 5328A Operating and Service Manual, page 4-16. This program can also be loaded from the HP-IB Verification Cassette, P/N 59300-10001 (Revision D or later)."

CHANGE 2 (A15 Series 2024)

Page 5-3, Table 5-1, A15 (05328-60043) Replaceable Parts:

Change A15 series number from 1952 to 2024.

Change A15C1 from 1809-1735 (.22 UF 35V tant) to 0160-2453; CAPACITOR-FXD .22UF 10% 80VDC POLYE; 28480; 0160-2453.

Add A15C10; 0160-3878; CAPACITOR-FXD .001UF 20% 100VDC CER; 28480; 0160-3878.

Add A15R36; 0683-2715; RESISTOR 270 5% .25W FC; 01121; CB2715.

Page 7-3, Figure 7-1, A15 Schematic Diagram:

Change SERIES number, at top of diagram, from 1952 to 2024.

Add capacitor A15C10 (.001 UF) between A15U11A pin 2 and circuit board common.

Add resistor A15R36 (270 ohms) in series with the connection between A15U12 pin 15 and the junction of A15U11A pin 2 and newly added capacitor A15C10.