

SECTION I

GENERAL INFORMATION

1-1. INTRODUCTION.

1-2. The Operating Manual contains information necessary to install and operate the Hewlett-Packard Model 3253A Analog Stimulus/Response Unit.

1-3. Section I contains the performance specifications and the general operating characteristics. Also listed are accessories, manual, and instrument identification information. Section II contains installation information for connection to external devices. Section III contains the operating and programming instruction for both front panel and remote (HP-IB) operation. This manual does not contain information on testing, adjusting, or repair of the 3253A.

1-4. The part number for this manual is listed on the title page. Also listed on the title page of this manual is a microfiche part number. This number can be used to order 4x6 inch microfilm transparencies of the manual. Each microfiche contains up to 96 photo duplicates of the manual pages. The microfiche package also includes the latest Manual Changes supplement as well as pertinent Service Notes.

1-5. SPECIFICATIONS.

1-6. Operating specifications for the 3253A are listed in Table 1-1. These specifications are performance standards or limits against which the instrument is tested. Table 1-2 lists general operating characteristics of the instrument. These characteristics are not specifications but are typical operating characteristics included as additional information for the user.

Table 1-1. 3253A Specifications.

Warm-up time – 30 minutes		
Source Section		
90 Day @ 23° C ± 5° C		
S1 (DC Source)	Voltage Mode	Current Mode
Accuracy	OPEN Circuit ± (0.08% of voltage setting + 0.000 485 V + (1.5 × 10 ⁻⁴)10 ⁿ)	SHORT Circuit ± (.25% of current setting + .03 mA) for amplitudes ≤ 120 mA ± .5% of current setting + .03 mA) for amplitudes > 120 mA.
Maximum Output Voltage	± 14.2 V	± [14.2 – (100)I _{OUT}]
Maximum Output Current	± 142 mA	± 142 mA
Temperature Coefficient	0° C to 55° C ± (0.001% of voltage setting + .00005 V) /° C	0° C to 55° C ± (.03% of current setting ± .006 mA) /° C
*n = Integer of (Log $\frac{V \text{ setting}}{0.15}$) **I = Output current in amps.		
S2, S3, S4 (AC Sources)	Voltage Mode	Current Mode
Accuracy	± (.22% of voltage setting + .001 VRMS + (1.5 × 10 ⁻⁴)10 ⁿ)	± (50% of current setting + .05 mA)
DC Offset	± .0005 V	---
Maximum Output Voltage	10 VRMS	[10 – (100) I _{OUT}]
Maximum Output Current	100 mA RMS	100 mA RMS
Temperature Coefficient (Amplitude)	0° C to 55° C ± (.02% of voltage setting + .005 VRMS) per ° C	0° C to 55° C ± (.05% of current setting + .006 mA) per ° C
Frequency Accuracy	± .3%	± .3%
Total Harmonic Distortion	< –60 dB	< –50 dB
Frequency Temperature Coefficient	0° C – 55° C .06% /° C	0° C – 55° C .06% /° C
*n = Integer of (Log $\frac{\text{setting}}{0.1}$) **I = Output current in amps.		

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General Information

Table 1-1. 3253A Specifications (Cont'd).

S5, S6, S7 (Function Generator)	Voltage Mode	Current Mode
Output Accuracy		
S5 (Sine)	\pm (4% of voltage setting + .005 V RMS) 10 Hz – 100 kHz Open Circuit	\pm (4% of current setting + .05 mA RMS) 10 Hz – 10 kHz Short Circuit
S6 (Square)	\pm (4% of voltage setting + .005 V Peak) 10 Hz – 100 kHz Open Circuit	\pm (4% of current setting + .05 mA Peak) 10 Hz – 10 kHz Short Circuit
S7 (Triangle)	\pm (4% of voltage setting + .005 V Peak) 10 Hz – 100 kHz Open Circuit	\pm (4% of current setting + .05 mA Peak) 10 Hz – 10 kHz Short Circuit
Maximum Output Voltage		
S5	10 VRMS	[10 VRMS – (100) I _{OUT} RMS]
S6	14.2 V Peak	[14.2 V Peak – (100) I _{OUT} Peak]
S7	14.2 V Peak	[14.2 V Peak – (100) I _{OUT} Peak]
Maximum Output Current		
S5	100 mA RMS	100 mA RMS
S6	142 mA Peak	142 mA Peak
S7	142 mA Peak	142 mA Peak
Temperature Coefficient	0° C to 55° C \pm .1% of setting /° C	0° C to 55° C \pm .1% of setting /° C
Frequency Accuracy	\pm (.5% of setting + 1 Hz) 10 Hz to 100 kHz	\pm (.5% setting + 1 Hz) 10 Hz to 10 kHz
Frequency Temperature Coefficient		0° C – 55° C \pm 1% of setting /° C
I = Output current in amps.		

Table 1-1. 3253A Specifications (Cont'd).

Detector Section			
NOTE			
<i>The following specifications are valid for a time period not to exceed 10 minutes after instrument Auto-Cal.</i>			
For 90 Days 23° C ± 5° C			
D1 (4 Digit DC Detector)		Maximum Input: ± 15 VDC	
	.1 V Range	1 V Range	10 V Range
Accuracy	± (.2% of reading + 300 μV)	± (.15% of reading + 500 μV)	± (.15% of reading + 5 mV)
Temperature Coefficient	± (.0025% of reading + 1 μV) /° C	± (.0025% of reading + 20 μV) /° C	± (.001% of reading) /° C

D2 (5 Digit DC Detector)		Maximum Input: ± 15 VDC	
	.1 V Range	1 V Range	10 V Range
Accuracy	± (.05% of reading + 300 μV)	± (.022% of reading + 300 μV)	± (.02% of reading + .001 V)
Temperature Coefficient	± (.0025% of reading + 10 μV) /° C	± (.0025% of reading + 20 μV) /° C	± (.0025% of reading) /° C

D3, D4, D5, D6 (AC Detector)		Maximum Input: 10 VRMS	
	.1 V Range	1 V Range	10 V Range
Accuracy (Quadrature Component ≤ 1% of Reading)	± (.2% of reading + 300 μV)	100 Hz, 1 kHz (S2, S3) ± (.2% of reading + 500 μV) 10 kHz (S4) ± (.2% of reading + 750 μV)	100 Hz, 1 kHz (S2, S3) ± (.2% of reading + 5 mV) 10 kHz (S4) ± (.2% of reading + 7.5 mV)
Temperature Coefficient	± (.0025% of reading + 2 μV) /° C	± (.002% of reading) /° C	± (.002% of reading) /° C
DC Voltage Rejection Ratio	≥ 55 dB		
Rejection of Quadrature Component			
D4, D6 (S2)	500:1		
D3, D6 (S3)	300:1		
D3, D6 (S4)	30:1		

Table 1-1. 3253A Specifications (Cont'd).

D7, D8 (Frequency Counters)	
Accuracy	$\pm (.02\%$ of frequency reading + the smallest of $(\frac{10^{-7}}{\text{gate time}})$ or $(10^{-7} \times \text{measured frequency.})$)
Sensitivity (Pk - Pk)	$300 \text{ mV} \leq 500 \text{ kHz}$ and $2.5 \text{ V} > 500 \text{ kHz}$
Frequency Range	(D8) 1 Hz to 5 MHz (D7) 10 Hz to 5 MHz
Maximum Input Voltage	10.5 V RMS
D8 Trigger Threshold Level	$\pm .3 \text{ V}$ of voltage setting + 12.7 V to - 12.7 V max input
D9, D10 (Pulse Width Detector)	
Accuracy	$\pm (.02\%$ of reading + 200 ns)
Sensitivity (Pk to Pk)	$300 \text{ mV} \leq 500 \text{ kHz}$ $2.5 \text{ V} > 500 \text{ kHz}$
Range	300 ns - 1 sec
Resolution	100 ns
Maximum Input Voltage	10.5 V RMS
D16, D17, D18, D19 (External Trigger Detectors)	
Maximum Delay	$\leq .5 \text{ ns}$
Measuring OP-AMP	
The following specifications are valid for a period not to exceed 10 minutes after instrument Auto Cal.	
Maximum offset on the input: 2×10^{-4} Volts	
Offset Temperature Coefficient: $0^\circ \text{ C} - 55^\circ \text{ C}$, $5 \times 10^{-5} \text{ V}/^\circ \text{ C}$	
Maximum Bias Current (minus terminal): 1×10^{-10} amp @ 23° C 1×10^{-9} amp @ 55° C	
Maximum Output Voltage: $\pm 15.0 \text{ V}$	
Maximum Output Current: $\pm 150 \text{ mA}$	
Maximum Common Mode Voltage + .1 V	
Minimum Common Mode Voltage - .1 V	

Table 1-2. General Operating Characteristics.

SOURCES		
S1 (DC Source)	Voltage Mode (Nominal Values)	Current Mode (Nominal Values)
Setability	0 to .15 V in .01 mV steps .15 V to 1.5 V .1 mV steps 1.5 V to 14.2 V in 1 mV steps	0 to 1.5 mA in .1 μ A steps 1.5 mA to 15 mA in 1 μ A steps 15 mA to 142 mA in 10 μ A steps
Output Impedance	Front Terminals 1.5 Ω Rear Terminals .8 Ω	0 – 1 mA: 100 k Ω 1 mA – 10 mA: 10 k Ω 10 mA – 100 mA: 1 k Ω
S2, S3, S4 (AC Sources)	Voltage Mode (Nominal Values)	Current Mode (Nominal Values)
Setability	0 to .15 V in .01 mV steps .15 V to 1.5 V in .1 mV steps 1.5 V to 10 V in 1 mV steps	0 to 1.5 mA in .1 μ A steps 1.5 mA to 15 mA in 1 μ A steps 15 mA to 100 mA in 10 μ A steps
Output Impedance S2 Output Impedance S3	Front Terminals 1.5 Ω Rear Terminals .8 Ω Front Terminals 1.6 Ω Rear Terminals .9 Ω	0 – 1 mA: 100 k Ω 1 mA – 10 mA: 10 k Ω 10 mA – 100 mA: 1 k Ω 0 – 1 mA: 65 k Ω 1 mA – 10 mA: 6.5 k Ω 10 mA – 100 mA: 650 Ω
S4	Front Terminals 2.2 Ω Rear Terminals 1.5 Ω	0 – 1 mA: 6.5 k Ω 1 mA – 10 mA: 650 Ω 10 mA – 100 mA: 65 Ω
S5, S6, S7 (Function Generator)	Voltage Mode (Nominal Values)	Current Mode (Nominal Values)
S5 (Sine) Setability S6, S7 (Square) (Triangle)	0 V – .15 V in .64 mV steps .15 V – 1.5 V in 6.4 mV steps 1.5 V – 10 V in 64 mV steps 0 V – .15 V in .64 mV steps .15 V – 1.5 V in 6.4 mV steps 1.5 V – 14.2 in 64 mV steps	0 mA – 1.5 mA in 6.4 mA steps 1.5 mA – 15 mA in 64 μ A steps 15 mA – 100 mA in 640 μ A steps 0 mA – 1.5 mA in 6.4 μ A steps 1.5 mA – 15 mA in 64 μ A steps 15 mA – 142 mA in 640 μ A steps
Frequency Setability	10 Hz to 1.5 kHz in .01 Hz steps 1.5 kHz to 15 kHz in .1 Hz steps 15 kHz to 100 kHz in 1 Hz steps	Same as Voltage Mode
Output Impedance	51 Ω (0 – 10 V RMS, S5) (0 – 10 V Peak S6, S7)	0 – 1 mA: 6.5 k Ω 1 mA – 10 mA: 650 Ω 10 mA – 100 mA: 65 Ω
S5 Total Harmonic Distortion	– 33 dB	
S6 Symmetry	\pm 2%	
S7 Ramp Linearity	30 mV Deviation	

Table 1-2. General Operating Characteristics (Cont'd).

DC Offset	Voltage Mode (Nominal Values)	Current Mode (Nominal Values)
Setability	- 12.8 V to + 12.7 V in .1 V steps	- 128 mA to + 127 mA in 1 mA steps
Typical Accuracy	± (.8% of setting + 60 mV)	± (1% of setting + 1.28 mA)
Compliance	Voltage	Current
Setability	.1 V to 15 V in .1 V steps	25 mA to 150 mA in .1 mA steps
Typical Accuracy	± (5% of setting + .5 V)	± (5% of setting + 25 mA)
Detectors		
D1		
Maximum Display:	.1 V Range 1 V Range 10 V Range	.15049 1.5049 15.049
Input Impedance:	1 x 10 ⁸ Ω	
D2		
Maximum Display:	.1 V Range 1 V Range 10 V Range	.150499 1.50499 15.0499
Input Impedance	1 x 10 ⁸ Ω	
Normal Mode Rejection Ratio:	40 dB ± .5% of Power Line Frequency	
D3 & D5		
Maximum Display:	.1 V Range 1 V Range 10 V Range	.10499 1.0499 10.499
Input Impedance:	1 x 10 ⁸ Ω Shunted by 200 pF	
D4 & D6		
Maximum Display:	.1 V Range 1 V Range 10 V Range	.104999 1.04999 10.4999
Input Impedance:	1 x 10 ⁸ Ω Shunted by 200 pF	
D7, D8, D9, D10		
Input Impedance:	100 kΩ Shunted by 200 pF	
Trigger Level Threshold:	- 12.8 V to + 127 V in .1 V steps	

Table 1-2. General Operating Characteristics (Cont'd).**Measuring Operational Amplifier**

Gain	Narrow Band	Wide Band
100 Hz	57 dB	73 dB
1 kHz	38 dB	61 dB
10 kHz	19 dB	48 dB
Phase	Narrow Band	Wide Band
100 Hz	77°	77°
1 kHz	77°	60°
10 kHz	72°	68°
CMRR:		
	100 Hz	38 dB
	1 kHz	37 dB
	10 kHz	35 dB
Output Impedance:	7 Ω	
Maximum Bias Current (+ Terminal):		
	Ambient Temperature = 23°C	
	.1 μ amps	
	Ambient Temperature = 55°C	
	1 μ amp	
S11 Through S14 (External Sources)		
Maximum Voltage:	\pm 100 V between S and G	
	\pm 42 V between G and Earth Gnd	
Maximum Current:	\pm 15 mA	
Maximum Freq:	1 MHz	
Cross Talk:	< 10 pF	

1-7. Safety Considerations.

1-8. This product is a Safety Class 1 instrument (provided with a protective earth terminal). The instrument and manual should be reviewed for safety markings and instructions before operation.

1-9. Safety information in this manual is identified by headings marked: CAUTION, WARNING, or DANGER. A Safety Summary (red bordered pages) is located after the Table of Contents.

1-10. Instrument Identification.

1-11. Instrument identification by serial number is located on the rear panel. Hewlett-Packard uses a two-section serial number consisting of a four-digit prefix and a five-digit suffix separated by a letter designating the country in which the instrument was manufac-

tured. (A = U.S.A; G = West Germany; J = Japan; U = United Kingdom.) The prefix is the same for all identical instruments and changes only when a major instrument change is made. The suffix, however, is assigned sequentially and is unique to each instrument.

1-12. Manual Changes.

1-13. This manual applies to instruments with serial numbers indicated on the title page. If changes to instrument operation are made, the manual may be revised. When this revision occurs, the changed pages will be marked by a revision letter (e.g., REV A) at the bottom of that page. The revision letter will also appear on the title page. A Record of Revision page is added after the title page listing a summary of the change made to the manual by Hewlett-Packard.

1-14. Section VII of the 3253A Service Manual, Change Information, contains back information that adapts the manual to instruments with serial numbers lower than those listed on the title page.

1-15. Description.

1-16. The Model 3253A Analog Stimulus/Response Unit provides analog test signals and measures analog test results. Test signals are generated by one of seven internal sources or by connecting one of four external sources to the output buses. Response signals are measured by: one of four internal A/D voltmeters, an internal frequency counter (AC or DC coupled), a pulse width counter, or one of six external detectors. The 3253A also contains circuitry consisting of an operational amplifier (i.e., it is termed the Measuring Operational Amplifier - MOA) and reference resistors for current to voltage conversion. An automatic calibration (auto-cal) routine can be programmed to correct for offset error in the internal sources, measuring operational amplifier (MOA), and offset and gain error in the internal detectors. The 3253A is programmable via the HP-IB with connectors located on the rear panel for system applications. Front panel connectors and programming controls are available for testing and instrument troubleshooting.

NOTE

HP-IB is Hewlett-Packard's implementation of IEEE std 488-1975, "standard digital interface for programmable instrumentation".

1-17. Accessories Available.

1-18. The following is a list of accessories available for use with the Model 3253A.

Accessory No.	Description
03253-61630	3253A System Extender Cable
03253-62701	Low Pass Filter
03495-66507	44-Pin P.C. extender board
5061-1120	12-Pin P.C. extender board
8710-1247	Connector pin removal tool
8710-1248	Connector pin insertion tool

1-19. Recommended Test Equipment.

1-20. Equipment required to maintain the Model 3253A is listed in Table 1-3. Other equipment may be substituted if it meets the requirements listed in the table.

Table 1-3. Recommended Test Equipment.

Instrument	Critical Specification	Recommended Model	Use
Digital Voltmeter	DC Volts: $\pm .008\%$ True RMS: 1 V to 10 @ $.05\%$ HP-IB Programmable	-hp- Model 3455A	PAT
Digital Multimeter	AC Volts: 0.15% accuracy below .1 V RMS 100 m sec integration time	-hp- Model 3465A or 3465B	PA
Frequency Counter	Time Base output to 1 Hz HP-IB Programmable	-hp- Model 5328A	PA
Distortion Measurement Set	Measurement Distortion < 70 dB	-hp- Model 339A	PA
Oscilloscope	DC to > 10 MHz	-hp- Model 1740A	T
Signature Analyzer		-hp- Model 5004A	T
Filter		-hp- Part No. 03253-62701	PA
Resistors	Resistances: 10 Ω $\pm .1\%$ 100 Ω $\pm .1\%$ 2 W MF 1 k Ω $\pm .01\%$ 10 k Ω $\pm .01\%$	-hp- Part No. 0811-3027 0698-3620 0698-8066 0699-0289	PAT
P = Performance Test A = Adjustments T = Troubleshooting			

Section II

INSTALLATION

2-1. INTRODUCTION.

2-2. This section provides installation instructions for the Model 3253A Analog/Stimulus Response Unit. Also included in this section is information about initial inspection, damage claims, preparation for use, packaging, and storage and shipment.

2-3. INITIAL INSPECTION.

WARNING

To avoid hazardous electrical shock, do not perform electrical tests when there are signs of shipping damage to any portion of the outer enclosure (covers or panels).

CAUTION

The 3253A contains Mercury Wetted relays under pressure.

2-4. Inspect the shipping container for damage. If the shipping container or cushioning material is damaged, it should be kept until the contents of the shipment have been checked for completeness and the instrument has been checked mechanically and electrically. Procedures for checking electrical performance are given in Section IV of the Service Manual. If there is mechanical damage or defect, or if the ASRU does not pass the Performance Tests, notify the nearest Hewlett-Packard office. Keep the shipping materials for carrier's inspection. The -hp- office will arrange for repair or replacement at -hp- options without waiting for claim settlement.

2-5. PREPARATION FOR USE.

2-6. Power Requirements.

2-7. The 3253A requires a power source of 100, 120, 220, or 240 V ac, +5% - 10%, 48 to 66Hz single phase. Power consumption is less than 200 V A.

2-8. Line Voltage Selection.

2-9. Figure 2-1 provides instruction for line voltage and fuse selection. The 3253A line voltage is factory set for 120 V ac operation.

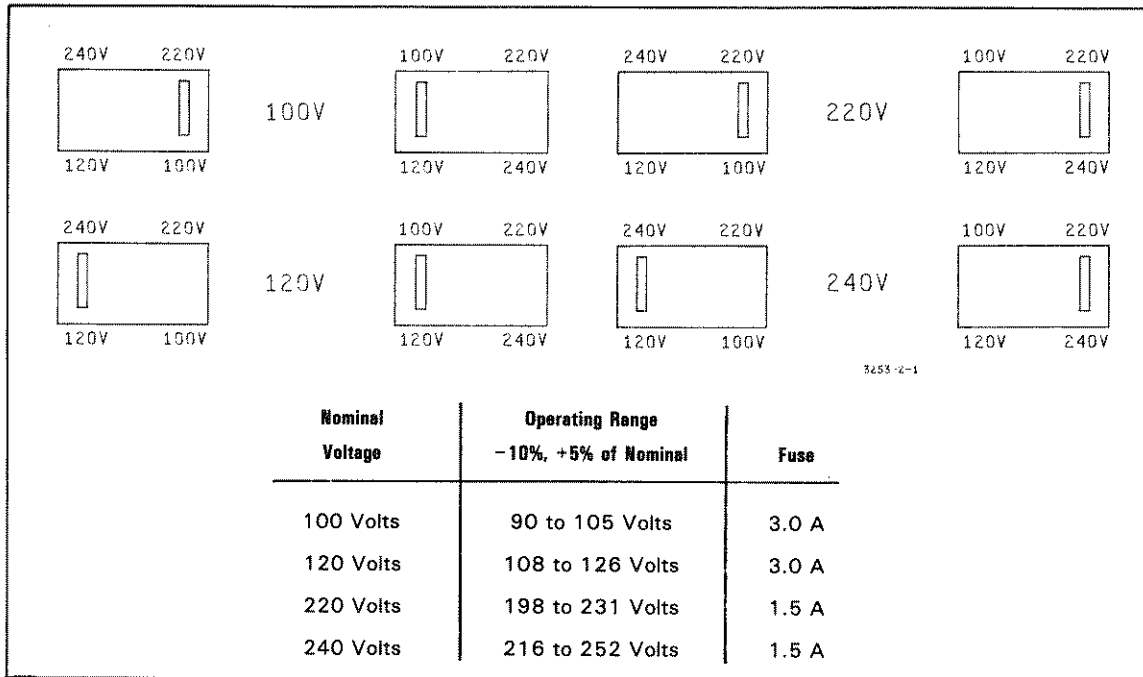


Figure 2-1. Line Voltage Selection.

2-10. Power Cable.

2-11. This instrument is equipped with a three-wire power cable. When connected to an appropriate ac power receptacle, this cable grounds the instrument cabinet. The type of power cable plug shipped with each instrument depends on the country of destination. Refer to Figure 2-2 for part number of the power cable and plug configurations available.

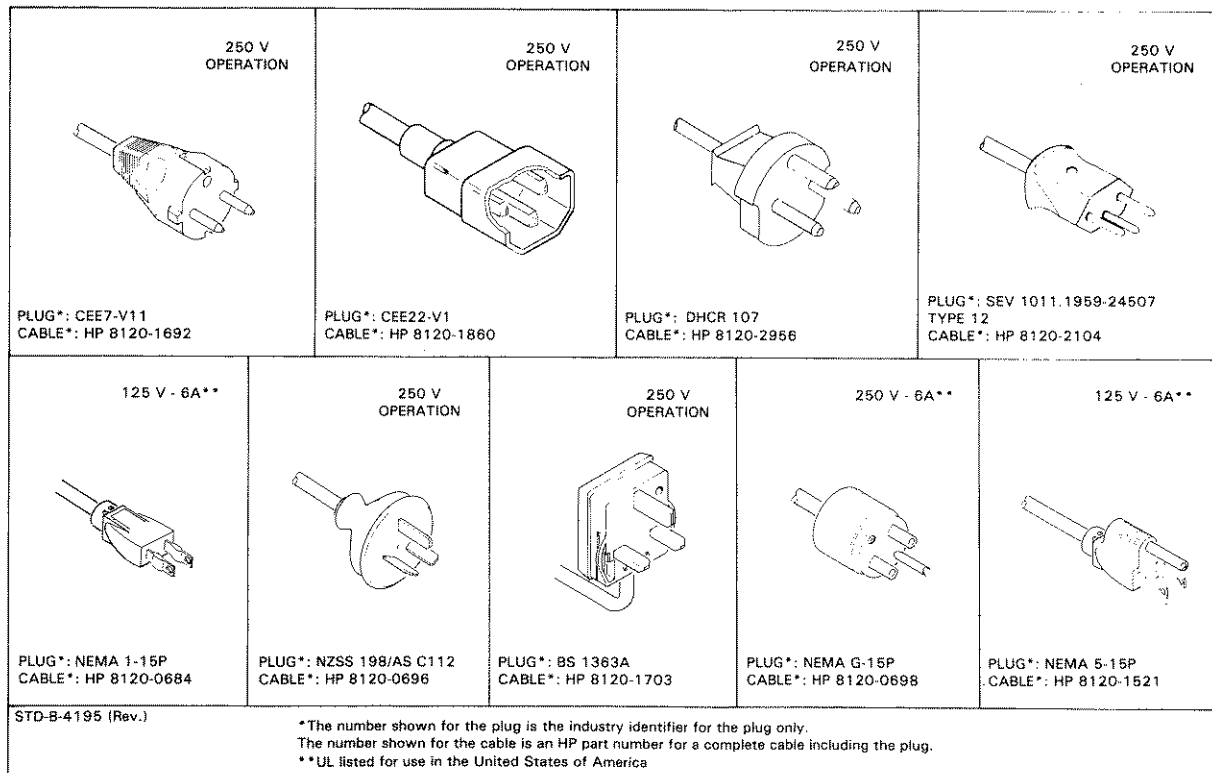


Figure 2-2. Available Power Cables and Plug Configurations.

NOTE

Check local electrical codes for proper plug (attachment cap) selection for your area.

NOTE

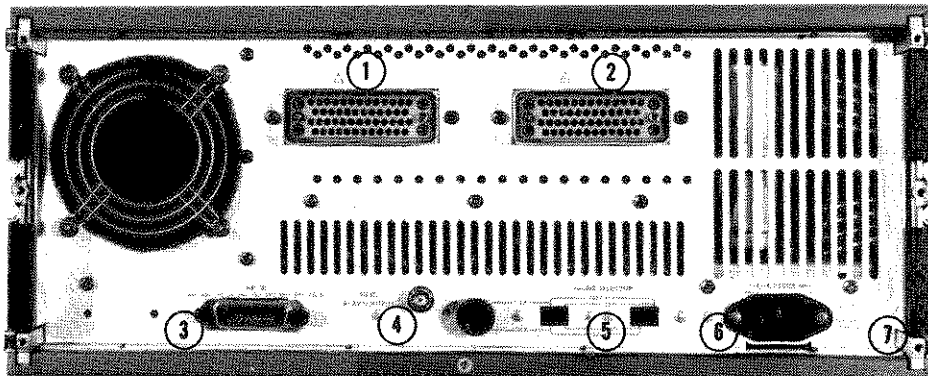
The cables defined by -hp- part number in the preceding example are not the only cables available with the plugs shown. The writer should ensure that part numbers shown in the manual are appropriate for the instrument.

2-12. Interconnections.

2-13. The 3253A is designed for system application with the primary connections located on the rear panel. Figure 2-3 provides instruction for these connection.

NOTE

It is possible to interchange the mating plug for J13 and J14. If they are interchanged, the 3253A or other devices that are connected will not be damaged. It will appear that the 3253A does not operate from the rear terminals.



- ⚠ ① J13 Stimulus Connector (in 3060A System connects to P13). Refer to Figure 2-4 for connector wiring.
- ⚠ ② J14 Response Connector (in 3060A System connects to P14). Refer to Figure 2-5 for connector wiring.
- ③ HP-IB Connector.
- ④ Sync output, BNC connection for TTL level trigger out.
- ⑤ Line voltage selector switch, refer to Figure 2-1 for instructions.
- ⑥ Three prong line voltage connector.
- ⑦ Chassis ground connection point, used in 3060A System.

Figure 2-3. Rear Panel Connections.

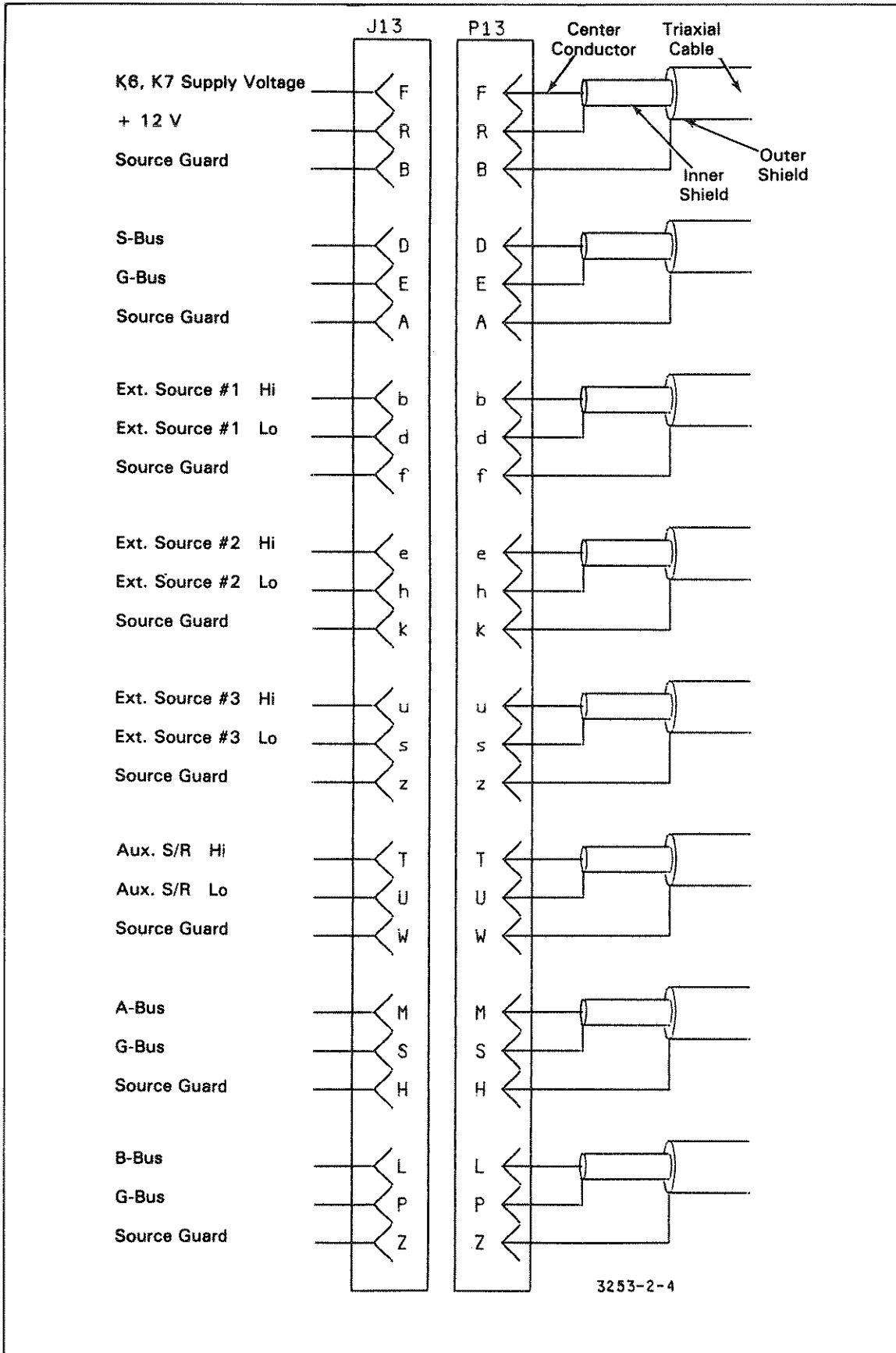


Figure 2.4. J13 Wiring Diagram.

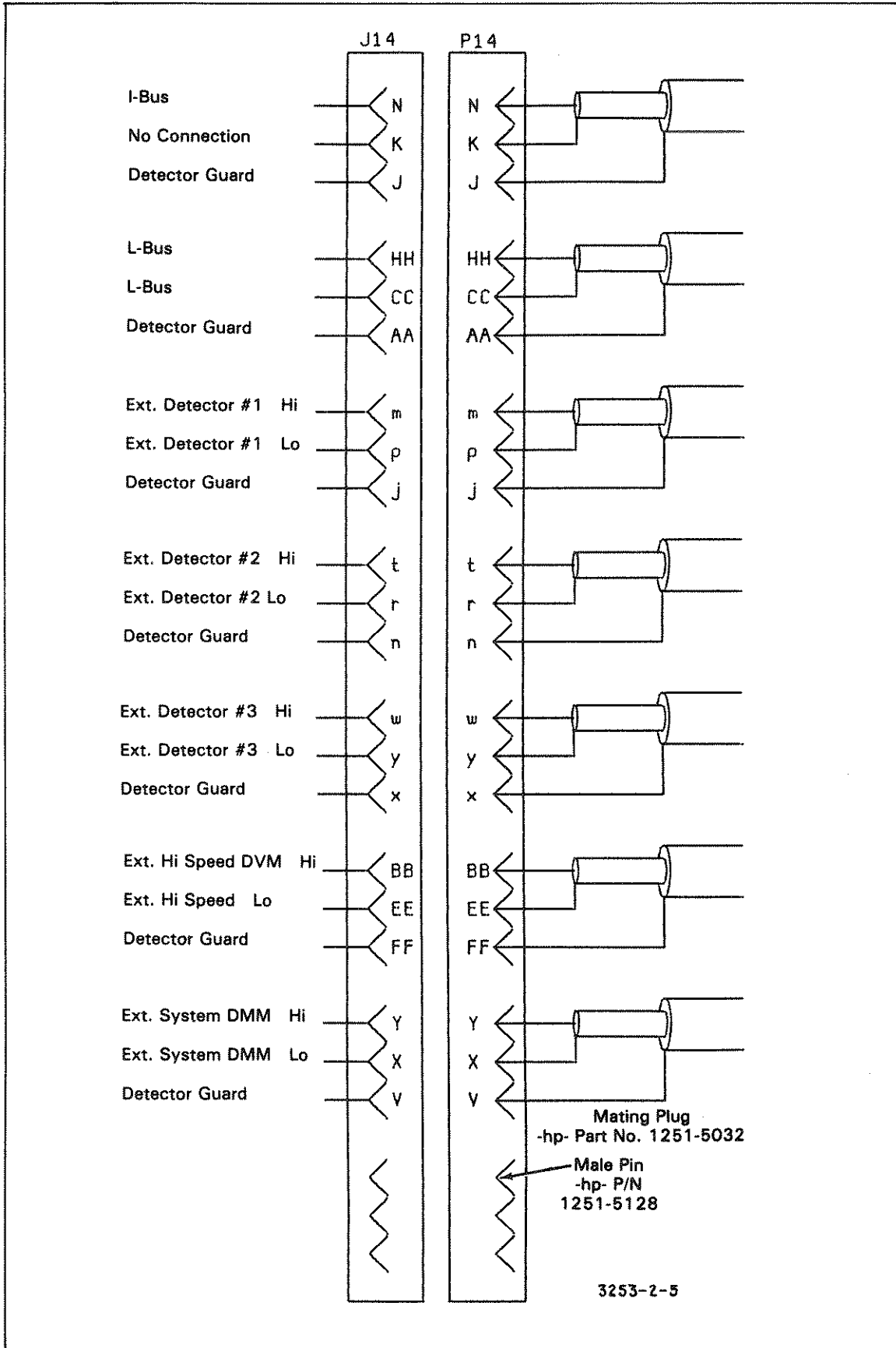


Figure 2-5. J14 Wiring Diagram.

2-14. Operating Environment.

2-15. Temperature. The 3253A must be operated at a temperature of 23°C ± 5°C to remain within the specifications. However, the 3253A may be operated from 0°C to 55°C with a reduction in accuracy.

2-18. Humidity. The 3253A may be operated in an environment with a relative humidity up to 95%. However, the instrument should be protected from temperature extremes which could cause condensation within the instrument.

2-19. Altitude. The instrument may be operated at altitudes up to 7,630 meters (25,000 feet).

2-20. HP-IB.

2-21. HP-IB Address Selection.

WARNING

The instruction for setting the HP-IB address switch and Parallel Poll Bit are for qualified service trained personnel. To avoid electrical shock, do not perform these instructions unless you are qualified to do so.

2-22. The “talk” and “listen” address for the 3253A are selected by the instrument Bus Address switch. This switch is the seven section “Dip” switch located on the A5 assembly. The five switches labeled 1 through 5 are used to select the unique talk and listen address. The 3253A left the factory with settings of (,) for listen address and (L) for talk address (decimal 12). Refer to Figure 2-6 for address and parallel poll bit selection.

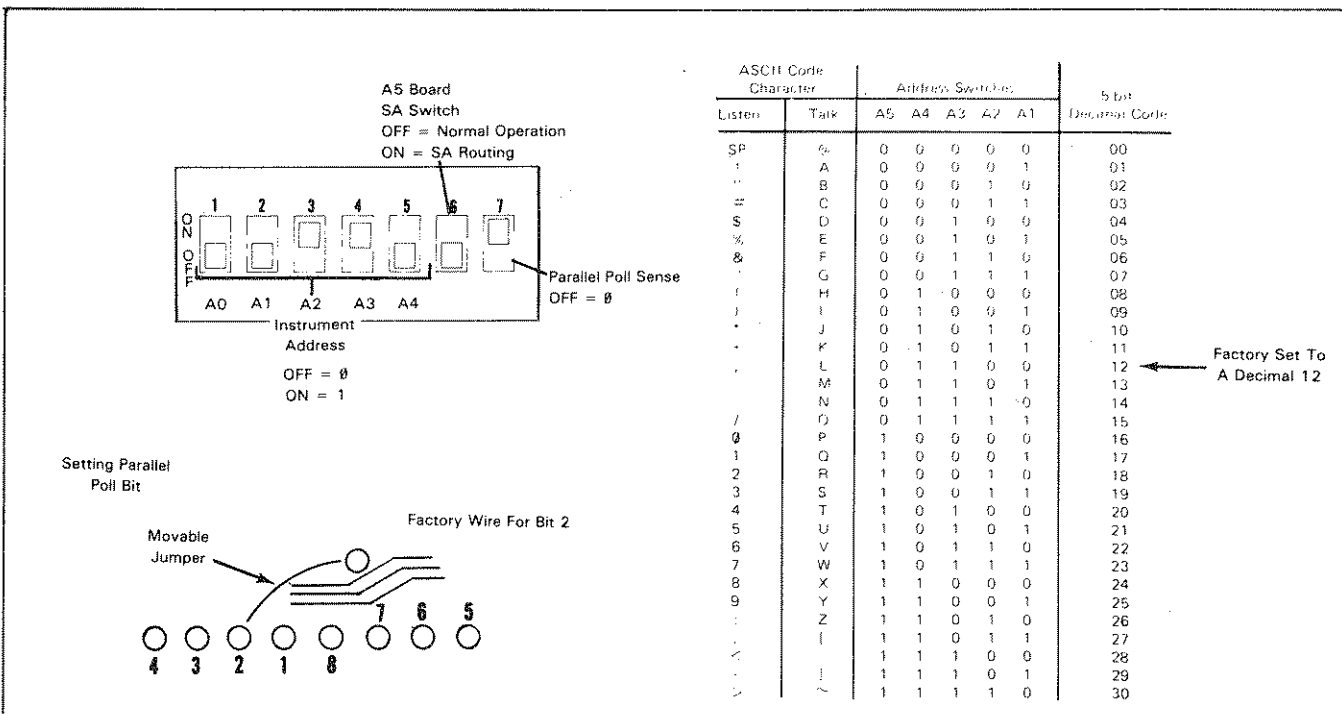


Figure 2-6. Address & Parallel Poll Bit Selection.

2-23. HP-IB System Interface Connections.

2-24. The Model 3253A is compatible with the Hewlett-Packard Interface Bus (HP-IB).

NOTE

The HP-IB is Hewlett-Packard implementation of IEEE std. 488-1975, "Standard Digital Interface for Programmable Instrumentation".

2-25. The 3253A is connected to the HP-IB by connecting an HP-IB interface cable to the connector located on the rear panel, refer to Figure 2-3. Figure 2-7 illustrated typical HP-IB System interconnection. Each end of the cable has both a male and female "piggyback" connector which simplifies interconnection of instruments and cables by allowing connectors to be stacked as shown in Figure 2-7. As many as 15 instruments can be connected by the same interface bus. The maximum length of cable that can be used to connect a group of instruments must not exceed 2 meters (6.5 ft.) times the number of instruments to be connected, or 20 meters (65.6 ft.) whichever is less. Refer to Figure 2-8 for a pictorial view of the HP-IB connector and pin designator.

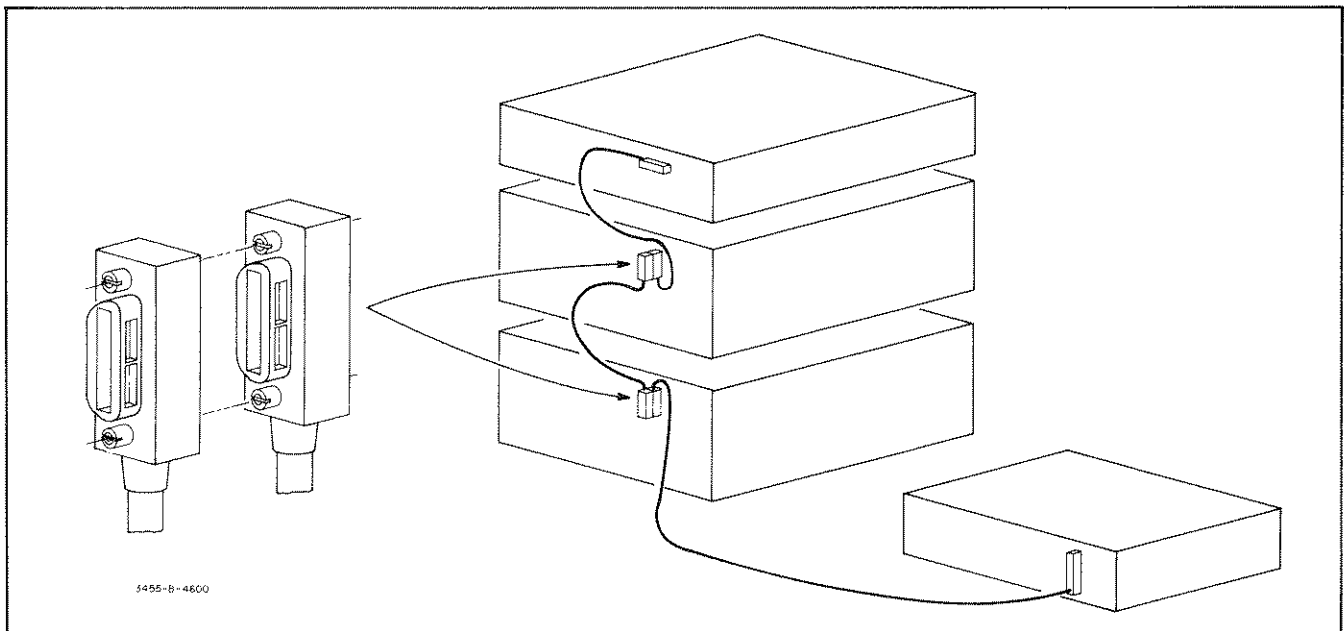


Figure 2-7. Typical HP-IB System Interconnections.

2-26. STORAGE AND SHIPMENT.**2-27. Environment.**

2-28. The 3253A may be stored or shipped in environments within the following limits.

Temperature	-40°C to +75°C
Humidity	Up to 95%
Altitude	Up to 7,630 meters (25,000 feet)

The instrument should also be protected from temperature extremes which could cause condensation within the instrument.

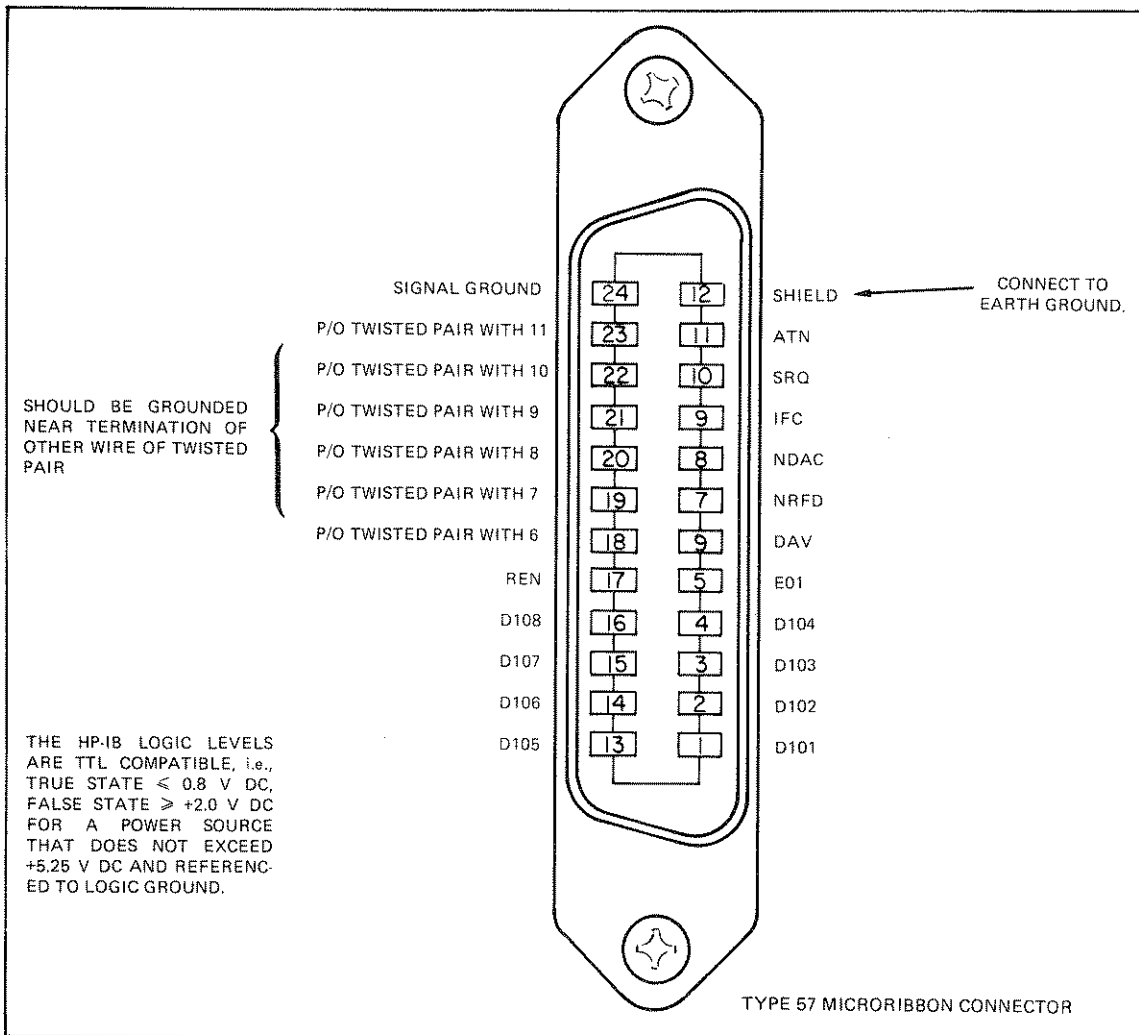


Figure 2-8. HP-IB Connector.

2-29. Packaging.

WARNING

This instrument contains metallic mercury under pressure, a potential hazard during shipping due to its possible affect on navigational instrumentation. Special packaging and markings are required by the government for shipping. If this instrument or the metallic mercury is being shipped into or within the United States, all applicable regulations of the US Department of Transportation (DOT) must be followed before release to the initial carrier in the US. Refer to DOT Regulations, Title 49, parts 171-177 (Hazardous Materials).

2-30. If shipping to an -hp- office or service center, attach a tag indicating the type of service required, return address, model number, and full serial number. In any correspondence refer to the instrument by model and full serial number.

SECTION III

OPERATING AND PROGRAMMING

3-1. INTRODUCTION.

3-2. Section III contains the Operating and Programming instructions for both local (front panel) and remote operation. Figure 3-1 describes the front panel controls and connections used by the 3253A.

3-3. 3253A TURN-ON.

3-4. Prior to connecting the 3253A to line voltage, the rear panel voltage selection switches should be checked to make certain that they are in the correct position for the line voltage to be applied. The fuse should be checked to make sure that it is the correct value for the line voltage selected.

3-5. After the Front Panel line switch is pressed, the 3253A performs an automatic calibration (Auto Cal) command. During the auto-cal routine, all of the front panel LED's should be on except the HP-IB status lights. A normal auto-cal runs for about 3 seconds and when completed will display a single zero with the Test button LED on. If an auto-cal measurement can not be performed a time-out occurs in the routine and a diagnostic message is displayed on the front panel. The message indicates the part of the routine where the time-out occurred. Refer to Figure 3-2 for the meaning of the diagnostic message.

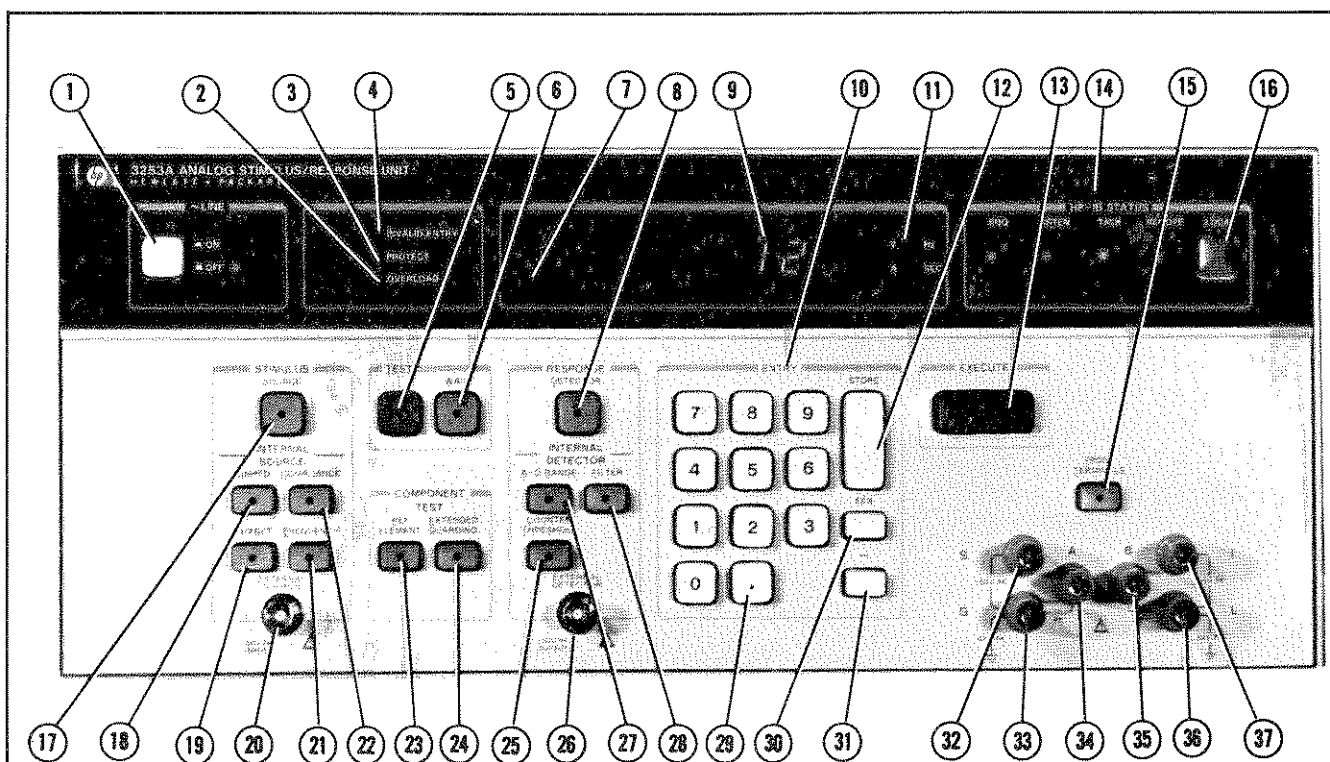
3-6. 3253A FUNCTIONAL DESCRIPTION.

3-7. In order to effectively operate the 3253A it is necessary to have an understanding of the major functional assemblies of the instrument. Refer to Figure 3-3 for the following paragraph describing the functional assemblies.

3-8. The 3253A is an Analog Stimulus and Response Unit that contains five major assemblies.

1. Source Assembly.
2. Detector Assembly.
3. Measuring Op-Amp Assembly (MOA).
4. Interconnect Assembly.
5. Multiplex Assembly.

The source assembly consists of programmable sources and an output amplifier which can be configured in either a voltage or a current mode to provide a stimulus for the device under test. The detector assembly consists of A-D (dual slope voltmeters) convertors and a computing counter to measure the response of the device under test. The measuring op amp assembly (MOA) is an operational amplifier used for current to voltage conversion. The interconnect assembly contains reference elements and interconnect relays. The reference elements are used in conjunction with the measuring op amp to provide a known conversion factor. The interconnect relays are used to connect the source assembly, detector assembly, and the measuring op amp assembly into specific measurement configurations. The multiplex assembly consists of eight relays that connect the internal configuration to the six input/output buses. The buses are defined as follows:



- ① Line Switch, push on/push off.
- ② Overload Indicator, illuminates when excessive voltage has been applied to the 3253A buses; or when the programmed compliance limit has been reached during a measurement.
- ③ Protect Indicator, illuminates when the 3253A is in the protect mode. When the 3253A is in the protected mode, the relays to the external buses are opened.
- ④ Invalid Entry, illuminates when programming entry is out of range, or unrecognized.
- ⑤ TEST, used with the numeric entry (10) to program the test code from the front panel.
- ⑥ WAIT, used with numeric entry (10) to program delay from the front panel.
- ⑦ Measurement in Process Indicator, illuminated when the 3253A is performing a measurement.
- ⑧ DETECTOR, used with numeric entry (10) to program detector code from the front panel.
- ⑨ Display, displays numeric entry and measurement results.
- ⑩ Numeric Entry, used in conjunction with front panel programming buttons to enter numeric part of programming code.
- ⑪ Units Indicator, V = voltage, A = amps, Hz = hertz, Sec = seconds.
- ⑫ STORE, stores front panel entries without executing the measurement.
- ⑬ EXECUTE, causes execution of a program or programming code entered from the front panel.

Figure 3-1. Front Panel Controls.

- ⑭ **HP-IB Status:**
 - SRQ—indicates when the 3253A requests service.
 - Listen—indicates when the 3253A is in the listen mode.
 - Talk—indicates when the 3253A is in the talk mode.
 - Remote—indicates when the 3253A is in remote operation.
- ⑮ **FRONT TERMINALS**, selects either the front or rear terminals for the S, G, I, L, A and B buses. LED on indicator front panel connections.
- ⑯ **LOCAL**, control for returning the 3253A from remote control to front panel control.
- ⑰ **SOURCE**, used with numeric entry (10) for front panel source code programming.
- ⑱ **AMPD**, used with numeric entry (10) for front panel programming of amplitude.
- ⑲ **OFFSET**, used with numeric entry (10) to program DC offset.
- ⑳ **EXTERNAL SOURCE**, triax connector for source No. 14.
- ㉑ **FREQUENCY**, used with numeric entry to program the internal function generator frequency.
- ㉒ **COMPLIANCE**, used with numeric entry (10) to program compliance limits from the front panel.
- ㉓ **REF ELEMENT**, used with numeric entry (10) to program reference resistor.
- ㉔ **EXTENDED GUARDING**, used with numeric entry (10) to program extended guarding from the front panel.
- ㉕ **COUNTER THRESHOLD**, used with numeric entry (10) to program threshold level of the internal counter.
- ㉖ **EXTERNAL DETECTOR**, triax connector for detector No. 14.
- ㉗ **A-D RANGE**, used with numeric entry (10) to program internal detector ranges.
- ㉘ **FILTER**, used with numeric entry (10) to program the number of readings to be averaged.
- ㉙ **Decimal Point**, used to enter a decimal point when performing numeric entries.
- ㉚ **EEX**, used to enter exponent when performing numeric entries.
- ㉛ **-**, used to enter a negative number from the numeric entry or negative exponent.
- ㉜ **S**, front panel terminal for the S bus.
- ㉝ **G**, front panel terminal for the G (guard) bus.
- ㉞ **A**, front panel terminal for the A bus.
- ㉟ **B**, front panel terminal for the B bus.
- ㊱ **L**, front panel terminal for the L bus.
- ㊲ **I**, front panel terminal for the I bus.

Figure 3-1. Front Panel Controls (Cont'd).

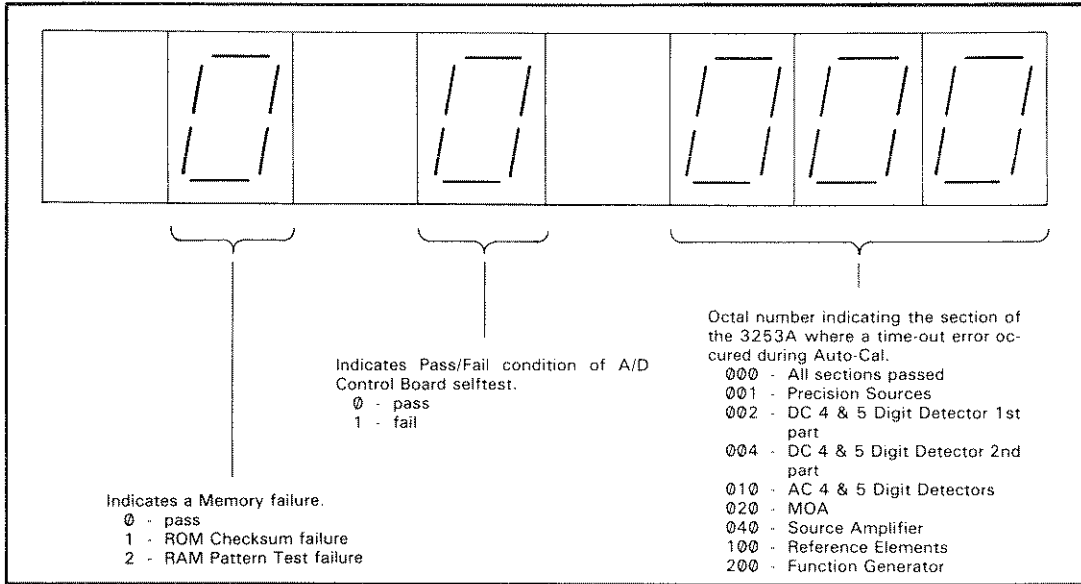


Figure 3-2. Turn-On Auto Cal Failure Indication.

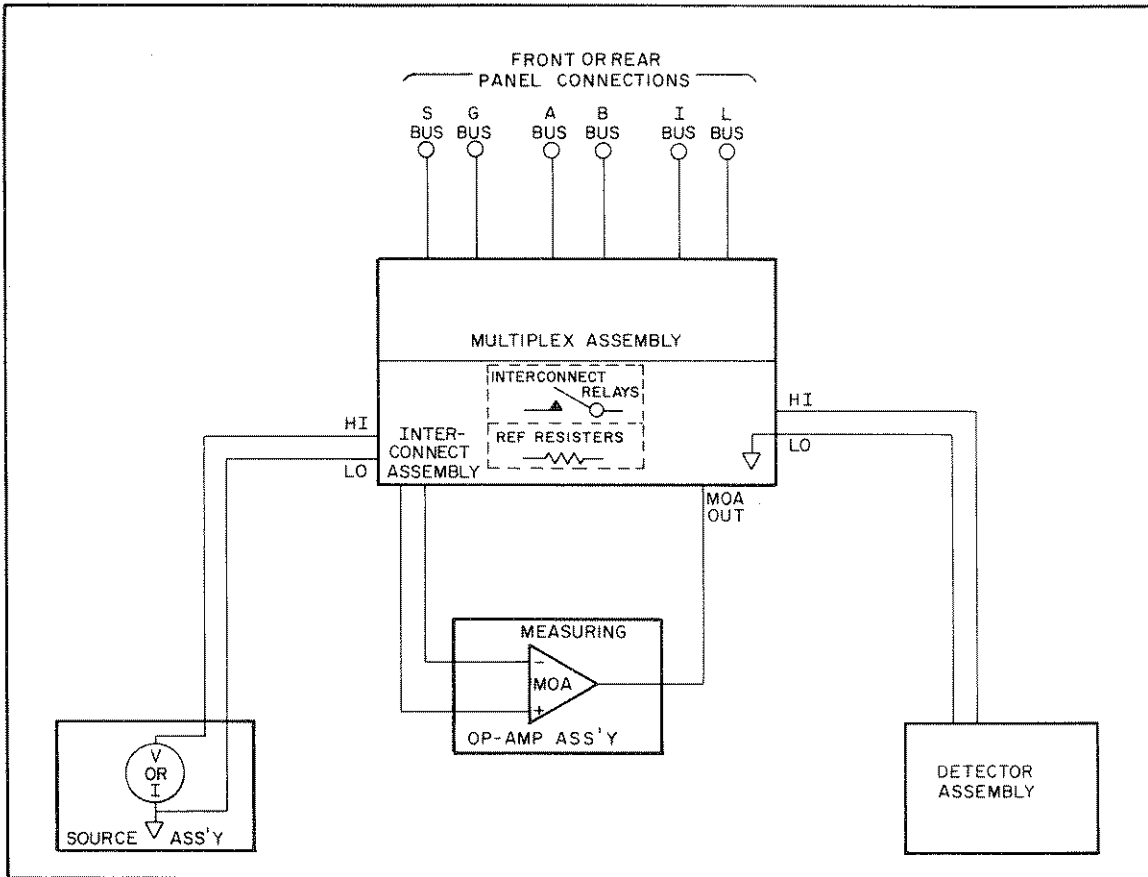


Figure 3-3. 3253A Block Diagram.

1. S Bus, the stimulus high output.
2. G (guard) Bus, the stimulus low output.
3. I Bus, the response (input) high terminal.
4. L Bus, the response (input) low terminal.
5. A bus, an auxiliary Bus whose definition is determined by the Test Code.
6. B Bus, an auxiliary Bus whose definition is determined by the Test Code.

The 3253A operates by connecting the functional assemblies into different measurement configurations. Each configuration supports a specific type of test.

3-9. PROGRAMMING CODE DEFINITIONS.

3-10. The following paragraphs and tables describe the programming codes used by the 3253A. These codes apply to both local (front panel) and remote (HP-IB) operation. The Programming codes are categorized as:

NOTE

The underscored letter (s) in the following program code represents the ASCII character (s) used for HP-IB operation. To identify a specific. Test, Source, etc., a number is added. In the remainder of this manual only the ASCII character (s) and numbers will be used.

1. TEST CODES
2. STIMULUS CODES
 - A. SOURCE CODES
 - B. INTERNAL SOURCE RELATED CODES
 - AMPTD
 - COMPLIANCE
 - OFFSET
 - FREQUENCY
3. RESPONSE CODES
 - A. DETECTOR CODES
 - B. INTERNAL DETECTOR RELATED CODES
 - A-D RANGE
 - COUNTER THRESHOLD
 - FILTER
4. COMPONENT TEST
 - A. EXTENDED GUARDING
 - B. REF ELEMENT
5. MISCELLANEOUS
 - A. WAIT
 - B. FRONT TERMINALS.
 - C. EXECUTE.

3-11. Test Codes.

3-12. The Test Codes control the 3253A's internal measurement configuration. Included is the mode of operation of the source amp (voltage or current), the configuration of the measuring op amp (where the reference element is placed in the configuration), the use of the A and the B buses, the connections of the S, G, I and L buses, and determines where the detector section is connected to the configuration. Because the configuration is controlled by the Test Code, it is the most important programming code and all other codes become a subset of the Test Code.

3-13. To understand the operation of the 3253A, it is necessary to understand how the instrument makes the different measurements. The following paragraphs provide this description for each Test Code, and the formulas necessary to convert the voltage measurements performed by the 3253A into a fundamental unit for each Test Code. Included with each explanation is a functional block diagram that illustrates the internal configuration of the 3253A and the connections to the device under test.

3-14. **T1—Resistance Test.** The 3253A measures resistance by applying a known voltage to the resistor under test. This causes a current to flow into the summing junction of the MOA as shown in Figure 3-4. The operational amplifier output voltage causes an equal current to flow through R_{ref} . By setting the source voltage to a known voltage and setting a known feedback element for the MOA and measuring its output voltage, it is possible to calculate the value of the resistor connected between the S and the I buses. The measurement returned by the 3253A is the output voltage of the measuring op amp. The formula for converting the output voltage into resistance is listed below:

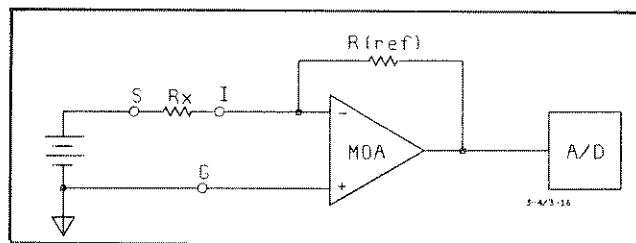


Figure 3-4. T1 Functional Block.

$$R_X = -\frac{R_{ref} V_{in}}{V_{outR}}$$

R_X = resistor under test

R_{ref} = resistance of the reference element used

V_{in} = source amplitude

V_{outR} = voltage measurement returned by the 3253A dc detector or real (in phase) detector

3-15. Reactance Measurements. In measuring reactive components two models must be considered. First is a parallel model where resistance is in parallel with reactive components. The second is a series model where resistance is in series with the reactive component. It should be noted that if the same reactive component were measured in a series model and a parallel model the values would probably be different. Because of this fact it is necessary to know which model the measuring device uses. The 3253A measures reactive component using a parallel model. For additional information on parallel and series modeling refer to Appendix A.

3-16. T2—Inductance Test. T2, like T1, applies a known voltage to the inductor under test. The current flowing in the inductor is converted to a voltage using the MOA with a known feedback resistor, see Figure 3-5. Detection is with an ac synchronous A/D. This A/D measures the imaginary (90° phase-shifted) signal that the front panel displays as a positive voltage. This voltage is inversely proportional to the inductive reactance as follows:

$$\frac{R_{\text{(ref)}}}{X_L} = \frac{V_{\text{out imaginary}}}{V_{\text{in (source voltage)}}$$

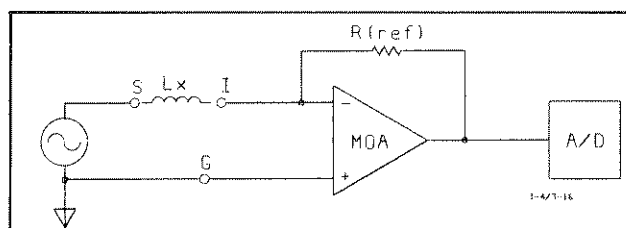


Figure 3-5. T2 Functional Block.

Note the inductive reactance in the formula is for a parallel model. Since most small inductors are measured in a series model it is necessary to determine the Q (quality) and convert the measurement. To find Q, a second measurement must be performed with the 3253A real part (in-phase) detector. The formulas for conversion of parallel to series models and reactance are listed below. Also listed are the formulas containing terms of real and imaginary voltages as measured by the 3253A.

NOTE

For some small inductors, converting the parallel inductance to series inductance, may not produce results that are the same as the marked inductance. This is because many small inductors are specified at frequencies of 1 MHz or higher, the 3253A test at 100 Hz, 1 kHz, and 10 kHz.

X_L = inductive reactance for a parallel model of the inductor under test

R_{ref} = resistance of the reference element used

V_{in} = source amplitude

V_{outI} = voltage measurement returned by the 3253A imaginary (90° phase shift) detector

R_P = resistance of the parallel model

V_{outR} = voltage measurement returned by the 3253A real (in phase) detector

Q = Q of the inductor under test (Q series = Q parallel)

L_P = parallel inductance

F = frequency of the internal source used (100 Hz, 1 kHz, 10 kHz)

L_S = series inductance

$$X_L = \frac{R_{ref} V_{in}}{V_{outI}} \quad \text{for a parallel model} \quad R_P = \frac{R_{ref} V_{in}}{V_{outR}}$$

$$Q = \frac{R_P}{X_L} = \frac{\frac{R_{ref} V_{in}}{V_{outR}}}{\frac{R_{ref} V_{in}}{V_{outI}}} = \frac{V_{outI}}{V_{outR}} \quad L_P = \frac{X_L}{2\pi F} = \frac{R_{ref} V_{in}}{2\pi F V_{outI}}$$

$$L_S = \frac{L_P}{1 + \frac{1}{Q^2}} = \frac{R_{ref} V_{in}}{2\pi F} \times \frac{V_{outI}}{(V_{outI})^2 + (V_{outR})^2}$$

$$R_S = \frac{R_P}{1 + Q^2} = \frac{R_{ref} V_{in}}{2\pi F} \times \frac{V_{outR}}{(V_{outI})^2 + (V_{outR})^2}$$

3-17. T3—Capacitance Test. The Capacitance Test, like the Inductance Test, Figure 3-6 measures capacitance for a parallel model. A synchronous A/D imaginary detector is used to measure MOA output voltage. The voltage measurement is displayed on the front panel or returned on the HP-IB as a negative voltage. Because most capacitors, with the exception of electrolytics and very large capacitors, are measured in the parallel mode, it is not necessary to convert to a series mode. However, if an electrolytic capacitor or a large capacitor is being measured, a second measurement should be made to determine the real part, and the formulas listed below should be used to convert the parallel capacitance to series capacitance.

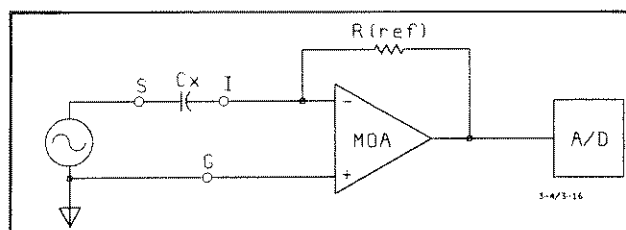


Figure 3-6. T3 Functional Block.

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$$X_C = \frac{R_{ref} V_{in}}{V_{outI}} \quad R_P = \frac{R_{ref} V_{in}}{V_{outR}} \quad R_S = \frac{R_P}{1+Q^2}$$

$$D = \frac{1}{Q} \quad Q = \frac{R_P}{X_C} = \frac{V_{outI}}{V_{outR}} \quad C_P = \frac{1}{2\pi F X_C} = \frac{V_{outI}}{2\pi F R_{ref} V_{in}}$$

$$C_S = C_P \left(\frac{1}{Q^2} + 1 \right) = C_P \frac{V_{outR} + V_{outI}^2}{V_{outI}^2} = \frac{V_{outR}^2 + V_{outI}^2}{2\pi F R_{ref} V_{in} V_{outI}}$$

X_C = Capacitance reactance for a parallel model of the capacitor under test

R_{ref} = Resistance of the reference element used

V_{in} = Source amplitude

V_{outI} = Voltage measurement returned by the 3253A imaginary (90° phase shift) detector

R_P = Parallel resistance

V_{outR} = Voltage measurement returned by the 3253A real (in phase) detector

C_P = Parallel capacitance

F = Frequency of the internal source used (100 Hz, 1 kHz, 10 kHz)

C_S = Series capacitance

D = Dissipation factor

3-18. T4—Diode Junction Test. Unlike T1, T2, and T3; T4 connects the reference element into the input circuit of the MOA and connects the diode junction in the feedback path, shown in Figure 3-7. In this configuration the MOA is converting a known current into an unknown voltage that is measured at the output of the MOA. In the Diode Junction Test the current used is in the forward direction of the diode and the forward junction voltage drop is measured. For a silicon diode this is typically 0.6 V at a specific current. For zener diodes a reverse bias current can be set up and the zener voltage (if less than 15 V) can be tested at the specified current. The formula for determining the current that will go through the diode junction is: Source Amplitude \div R_{ref} .

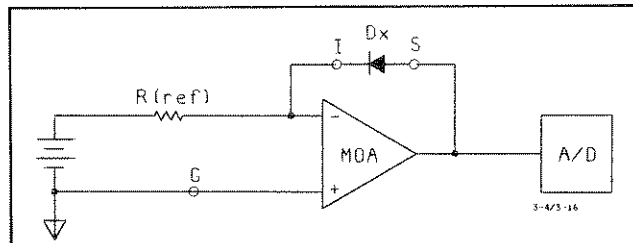


Figure 3-7. T4 Functional Block.

3-19. T5—Leakage Current Test— FET_{IDSS} . The Leakage Current Test is the same configuration as the Resistance Test, see Figure 3-8. To determine the current through the device under test, the output voltage measured by the 3253A A/D is divided by the resistive value of the reference element. When measuring FET_{IDSS} , the gate is connected to the G bus, the source is connected to the I bus and the drain is connected to the S bus. The internal voltage source should be considerably greater than the FET pinch-off voltage to assure that the FET is in a constant current mode. The formula for converting the output voltage measurement by the 3253A into current is listed below:

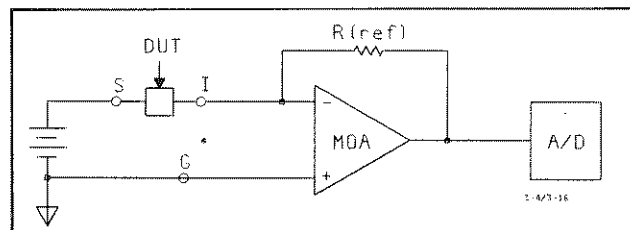


Figure 3-8. T5 Functional Block.

$$I = \frac{V_{out}}{R_{ref}}$$

I = the dc current flowing through the device under test

V_{out} = the voltage measurement returned by the 3253A

R_{ref} = resistance of the reference element used

3-20. T6, Transistor Beta. Transistor Beta Test supplies a known dc base current to forward bias the base emitter junction and a known ac drive current. An ac voltage measurement is taken across a two ohm collector load. The dc offset voltage (represented by the battery in Figure 3-9) and the reference element are selected to provide the proper bias current to place the transistor at an operating point in the active region. The ac source amplitude is selected to prevent the transistor from being cut-off or saturated by the peak-to-peak swing of the ac sine wave. Since an ac drive signal and an ac collector measurement are used, T6 is an ac beta test (hfe). Both NPN and PNP transistor can be tested by using a positive offset voltage for NPN and a negative offset voltage for PNP. The equations for calculating the various currents and beta are listed below.

$$i_b = \frac{V_s}{R_{ref}} \quad i_c = \frac{V_{out}}{2 \Omega} \quad \text{ac beta} = \frac{i_c}{i_b}$$

$$I_B = \frac{V_O}{R_{ref}}$$

i_b = ac base current

i_c = ac collector current

V_s = amplitude of ac voltage source

V_O = amplitude of dc offset voltage

V_{out} = ac voltage measured across the 2Ω collector load
(voltage display on 3253A front panel)

R_{ref} = resistance of reference element

I_B = dc bias current (base emitter)

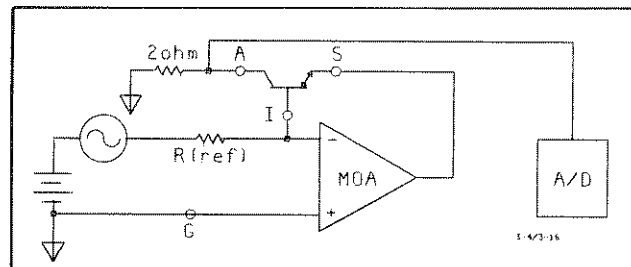


Figure 3-9. T6 Functional Block.

3-21. T7—Fet Pinch-Off. T7 configures the instrument similar to that of T1 where an unknown current is converted to a measurable voltage. The A bus, shown in Figure 3-10, is connected from the measuring op amp output back to the gate of the FET under test. By maintaining a high resistance feedback element, the current flowing through the FET is minimal. Reducing this current to the smallest practical value minimizes the error in estimating the pinch-off voltage. The estimated pinch-off voltage is measured on the A bus or the output of the MOA by the internal DC A/D. By changing the polarity of the source both N and P channel FETS can be tested.

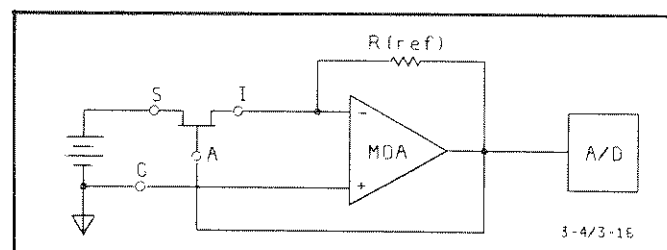


Figure 3-10. T7 Functional Block.

F.E.T. pinch-off $\approx V_{out}$

V_{out} = voltage measurement returned by the 3253A

3-22. T8, Shorts Test. Shorts Test is a resistance test that provides short/open indication instead of voltage. The MOA output is compared to a threshold level as shown in Figure 3-11. When this level is exceeded, the parallel poll bit is set indicating a short. With a positive source the indications are, one equals an open and zero equals a short. The opposite is true with a negative source, one indicates a short and zero indicates an open. In T8 the front panel will display the status of the parallel poll bit. Listed below are equations illustrating the effects of source amplitude, reference element, and counter threshold level on the value of resistance defined as a short.

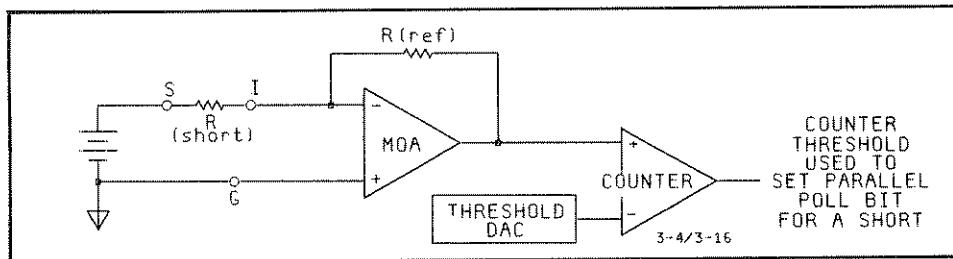


Figure 3-11. T8 Functional Block.

Equations for a positive source voltage

$$\text{if } \frac{-R_{\text{ref}}}{R_X} \times \text{ASRC} \leq -V_{\text{CT}} + 0.5 \text{ then } R_X = 1 \text{ (not a short)}$$

$$\text{if } \frac{-R_{\text{ref}}}{R_X} \times \text{ASRC} \geq -V_{\text{CT}} - 0.5 \text{ then } R_X = 0 \text{ (short)}$$

Equations for a negative source voltage

$$\text{if } \frac{-R_{\text{ref}}}{R_X} \times \text{ASRC} \leq V_{\text{CT}} + 0.5 \text{ then } R_X = 0 \text{ (not a short)}$$

$$\text{if } \frac{-R_{\text{ref}}}{R_X} \times \text{ASRC} \geq V_{\text{CT}} - 0.5 \text{ then } R_X = 1 \text{ (short)}$$

R_{ref} = resistance of the reference element used

R_X = resistance defined as a short

ASRC = amplitude of the internal source

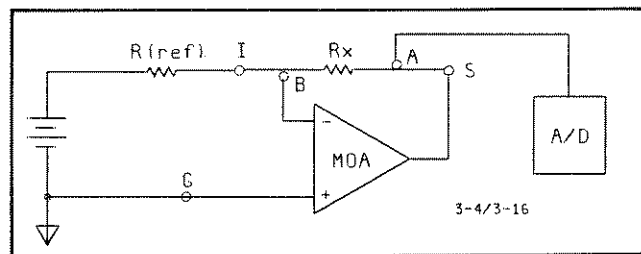
V_{CT} = counter threshold voltage setting

3-23. T10—Four Terminal Low Resistance Test. The Four Terminal Resistance Test uses a known current to measure the resistor under test. This connect Rx, shown in Figure 3-12, in the feedback path of the MOA with the B and A buses, connected at the desired point of measurement. Because this test is designed to measure small resistances, less than 100 Ω , a measurement enhancement is used to remove the effects of thermal and offset voltages. The formula for converting V_{out} to resistance is listed below.

NOTE

This test should not be used to measure the dc resistance of an inductor. An inductor connected in the feedback path of the MOA could cause oscillation and provide useless test results. Use the standard resistance test T1 for this measurement.

$$R_X = - \frac{R_{ref} V_{out}}{V_{in}}$$

**Figure 3-12. T10 Functional Block.**

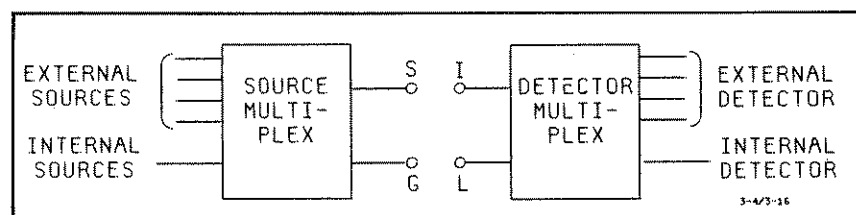
R_X = resistance under test

R_{ref} = resistance of the reference element

V_{out} = voltage measurement returned by the 3253A

V_{in} = internal source amplitude

3-24. T12, Transfer Test (Voltage Stimulus, Voltage Response). Transfer Test is designed to provide a voltage signal on the S and G buses and measure a voltage response on the I and L buses, see Figure 3-13. Any one of the internal sources or one of the four external sources are multiplexed directly to the S and G bus. The I and L buses are multiplexed directly to either one of the internal detectors, or one of six external detectors. By configuring the 3253A in this manner, functional testing can be performed on the device under test. T12 does not use the measuring op amp and the A and B bus can be used to provide two separate sources.

**Figure 3-13. T12 Functional Block.**

3-25. T13, Voltage Source To Detector. The T13 Test connects either the internal or one of the external sources to the S and G bus. It also connects the internal or external detector bus to the S and G bus for monitoring the source output, this is shown in Figure 3-14.

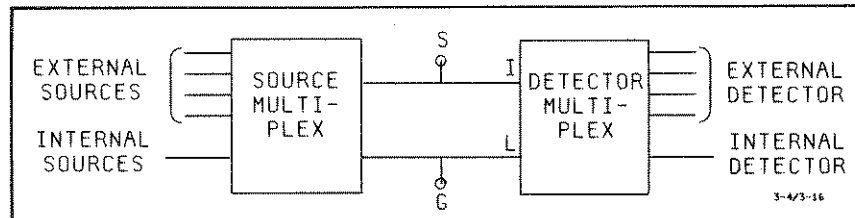


Figure 3-14. T13 Functional Block.

3-26. T14, Transfer Test (Current Stimulus, Voltage Response). This Transfer Test configures the output amplifier of the source section in a current mode, see Figure 3-15. Only internal sources can be used and the output of the amplifier is connected to the S and the G bus. The I and L bus are multiplexed to either the internal detectors or the external detectors. T14 is designed for functional testing of a device using a current stimulus.

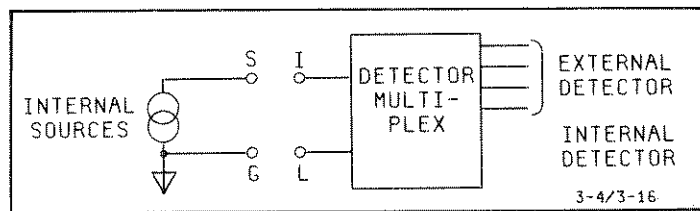


Figure 3-15. T14 Functional Block.

3-27. T15, Internal Current Stimulus To Voltage Response. T15 connects the outpost of the internal current source directly to the input of the MOA, shown in Figure 3-16. The MOA converts the current to a voltage that is measured at its output by either the internal or external detectors. This test is designed to check the internal current source. The equation listed below converts MOA output voltage to current.

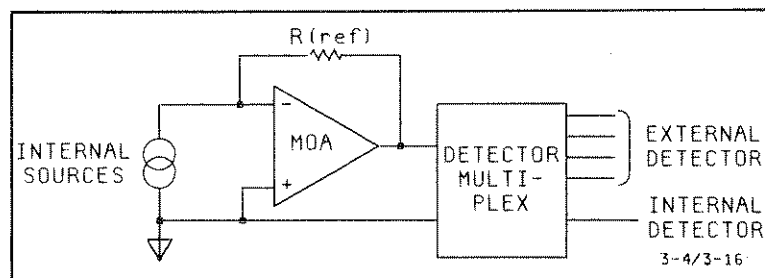


Figure 3-16. T15 Functional Block.

$$I = \frac{V_{out}}{R_{ref}}$$

I = internal source output current

V_{out} = voltage measurement returned by the 3253A

R_{ref} = resistance of reference element

3-28. T32, Automatic Calibration (Auto-Cal). Automatic Calibration (auto-cal) is an internal test routine that measures calibration constants and stores correction factors. A normal auto-cal routine is performed in about three seconds and upon completion display three zeros on the front panel. If during the routine a time-out (can not perform a measurement) occurs a diagnostic message is displayed on the front panel, Figure 3-17 explains the diagnostic code. For best test results an auto-cal routine should be performed every ten minutes or prior to precision measurements.

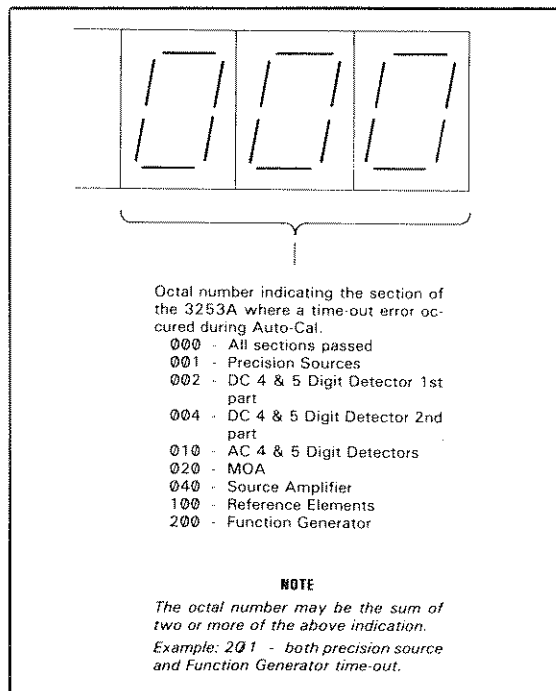


Figure 3-17. T32 Front Panel Display.

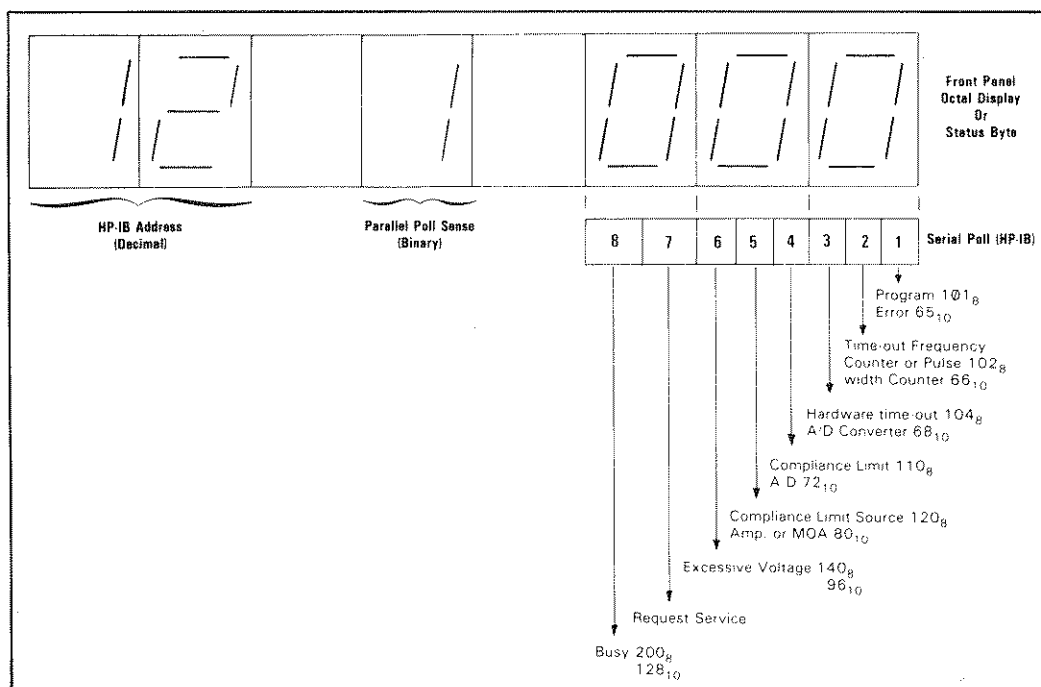


Figure 3-18. T210 Front Panel Display And Serial Poll Status Byte.

3-29. Additional Test Codes. Additional Test Codes are listed in Table 3-1. These codes provide useful information when operating the 3253A.

Table 3-1. Additional Test Code.

Test Code	Description	Remarks
T0 (front panel) P (HP-IB Code)	Protect	<ol style="list-style-type: none"> 1. Disconnects the External Bases from the internal configuration to prevent damage to both the device under test and the 3253A. 2. When programmed from the HP-IB (ASCII "P") execution is immediate, do not follow with an ASCII "X". 3. Protect is automatic when using internal detector should be performed when using external detectors.
T98	Free Run	<ol style="list-style-type: none"> 1. Will continuously loop on a previously executed test code. 2. If programmed from the HP-IB carriage return on line feed must be suppressed.
T99 (front panel) U (HP-IB Code)	Unprotect	<ol style="list-style-type: none"> 1. Prevents the 3253A from going to a protect mode following the execution of a test. 2. When programmed from the HP-IB or front panel it must be executed (X).
T200	Front Panel Device Clear	<ol style="list-style-type: none"> 1. Returns the 3253A to a turn on condition. 2. Do not program T200 from the HP-IB, use the controller device clear statement.
T210	Status Byte (front panel execution)	<ol style="list-style-type: none"> 1. Refer to Figure 3-18 for an explanation of the display. 2. Clears SRQ from the Front Panel.
T211	A/D Control Board Verification	<ol style="list-style-type: none"> 1. Performs a selftest of the A/D control board, if the test passes the display should be 000.000. 2. Refer to Figure 3-19 for failure indication.
T212	Delay Jumper	<ol style="list-style-type: none"> 1. Displays on the Front Panel the setting of the Delay Jumper for either 50 or 60 Hz line operation.

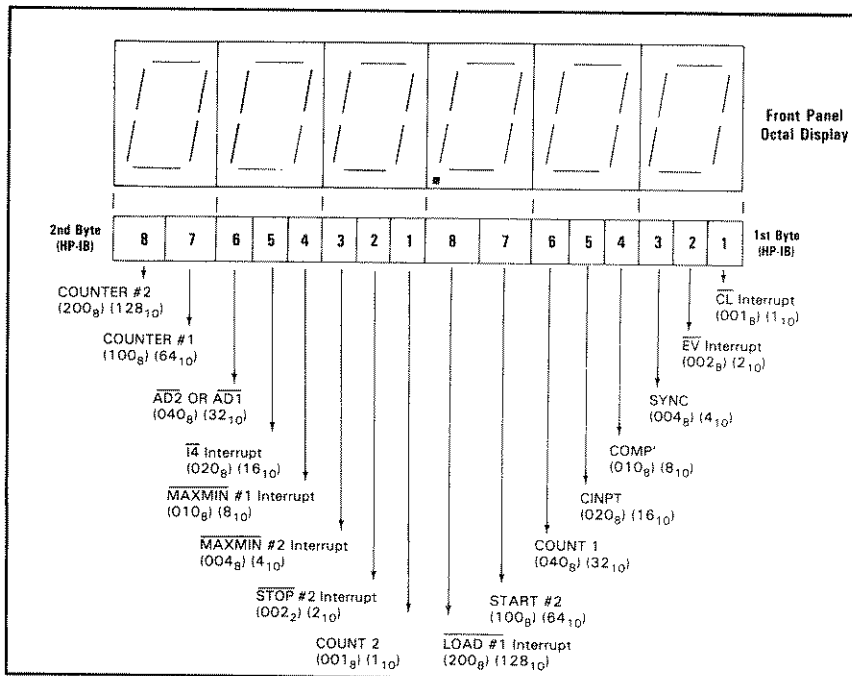


Figure 3-19. T211 Front Panel Display.

3-30. Stimulus Programming Codes.

3-31. Table 3-2 lists the source programming codes with a brief description and the operating characteristics. The source related codes (e.g. amplitude, offset, etc.) are listed in Table 3-3.

Table 3-2. Source Programming Codes.

Source Code	Description	Source Characteristics			
		Output Ranges Resolution	Voltage Mode	Current Mode	
S0	None Connected	---	---	---	
S1	Internal DC	10 V 1 mV	1 V .1 mV	10 mA 1 μ A	
S2	Internal 100 Hz Sine Wave	Maximum Output	± 14.2	± 142 mA	
S3	Internal 1 kHz Sine Wave	Output Ranges Resolution	10 V 1 mV	10 mA 1 μ A	
S4		Maximum Output Distortion (10 V Level)	0.1 V .01 mV	100 mA 10 μ A	
S5	Internal Function Generator, Sine Wave	Amplitude Ranges	10 V RMS ≤ -60 dB	100 mA RMS	
S6			Sine	Square	Sine
S7			10, 1, .1 V	10, 1, .1 V	100, 10, 1 mA
	Internal Function Generator, Square Wave	Amplitude Resolution	6.4 mV X Range	6.4 mA X Range	
			10 V RMS	14.2 V PK	100 mA RMS
			Freq. Accuracy Freq. Resolution	$\pm .5\%$ of Setting ± 1 Hz 10 Hz - 1.5 kHz: .01 Hz 1.5 kHz - 15 kHz: .1 Hz 15 kHz - 100 kHz: 1 Hz	6.4 mV X Range 14.2 V PK
S11	External Source #1 (Rear Panel)	Maximum Voltage between HI & LO Input	10 V RMS	100 mA RMS	
S12			External Source #2 (Rear Panel)	42 V PK	142 mA PK
S13				External Source #3 (Rear Panel)	1 MHz
S14			External Source #4 (Front Panel)		Maximum Current

Table 3-3. Source Related Code.

Code	Definition	Comments
$A \pm n$	A specific amplitude n = floating or fixed point number in volts or amps. - denotes negative DC output.	<ol style="list-style-type: none"> 1. Maximum amplitude and resolution are determined by the source code. 2. Units of amplitude (volts or amps) is determined by the test code. 3. Ranges are set automatically by the amplitude code. 4. Applies to internal sources only.
C_n	C specifies compliance n = floating or fixed point numbers in volts or amps.	<ol style="list-style-type: none"> 1. Current compliance is used in voltage mode and voltage compliance is used in current mode. 2. The Test Code automatically determines voltage or current compliance. 3. Current compliance range and resolution: 25 mA to 150 mA in 1 mA steps. 4. Voltage compliance range and resolution: -14.2 V to +14.2 V in 0.1 V steps. 5. Compliance means limit. 6. When compliance is reached the 3253A will set SRQ. 7. Applies to internal sources only.
$OF \pm n$	OF specifies offset n = floating or fixed point numbers in volts or amps. - denotes negative offset.	<ol style="list-style-type: none"> 1. Allows a DC offset of an AC signal. 2. Range: Voltage mode, +12.7 V to -12.7 V in .1 V steps; Current mode, +127 mA to -127 mA in 1 mA steps. 3. Max. voltage offset = 15 V - Vpk mA (AC signal). 4. Test code determines voltage or current mode. 5. Applies to internal AC and Function Generator only.
FR_n	FR specifies frequency n = positive floating or fixed point number.	<ol style="list-style-type: none"> 1. Sets the frequency of the internal Function Generator. Does not affect S2, S3, and S4. 2. Frequency Ranges: 10 Hz - 1 kHz, 1 kHz - 10 kHz, 10 kHz - 100 kHz, 100 kHz - 1 MHz. 3. Resolution: 0.01% of full scale range. 4. Range set automatically.

3-32. Response Codes.

3-33. Response codes are the detector codes and detector related codes. The detector codes are listed in Table 3-4 and the detector related codes in Table 3-5.

Table 3-4. Detector Codes.

Detector Code	Type of Detector	Detector Characteristics
D0	None connected	
D1	Internal DC Voltmeter (A/D)	<ol style="list-style-type: none"> 1. Integration Time: 1 ms 2. Ranges: 10 V, 1 V, 0.1 V 3. Resolution: 4½ Digits 4. Maximum Input: ± 15 V DC 5. Useable with external DC sources
D2	Internal DC Voltmeter (A/D)	<ol style="list-style-type: none"> 1. Integration Time: 16 2/3 ms (60 Hz line) 20 ms (50 Hz line) 2. Ranges: 10 V, 1 V, 0.1 V 3. Resolution: 5½ Digits 4. Maximum Input: ± 15 V DC 5. Useable with external DC source 6. Provides line frequency rejection
D3	Internal AC Synchronous Voltmeter (A/D)	<ol style="list-style-type: none"> 1. Integration Time: 1 ms 2. Synchronized to the internal 1 kHz (S3) or 10 kHz (S4) sinewave source to measure an inphase signal (real part) 3. DC Coupled Input 4. Ranges: 10 V, 1 V, 0.1 V 5. Resolution: 4½ Digit 6. Maximum Input: 10 V RMS
D4	Internal AC Synchronous Voltmeter (A/D)	<ol style="list-style-type: none"> 1. Integration Time: 10 ms 2. Synchronized to the internal 100 Hz (S2), 1 kHz (S3), or 10 kHz (S4) sinewave source to measure an inphase signal (real part) 3. DC Coupled Input 4. Ranges: 10 V, 1, 0.1 V 5. Resolution: 5½ Digits 6. Maximum Input: 10 V RMS
D5	Internal AC Synchronous Voltmeter (A/D)	<ol style="list-style-type: none"> 1. Integration Time: 1 ms 2. Synchronized to the internal 1 kHz (S3) or 10 kHz (S4) sinewave source to measure a 90° phase signal (imaginary part) 3. DC Coupled Input 4. Ranges: 10 V, 1 V, 0.1 V 5. Resolution: 4½ Digits 6. Maximum Input: 10 V RMS
D6	Internal AC Synchronous Voltmeter (A/D)	<ol style="list-style-type: none"> 1. Integration Time: 10 ms 2. Synchronized to the internal 100 Hz (S2), 1 kHz (S3), or 10 kHz (S4) sinewave source to measure a 90° phase signal (imaginary part) 3. DC Coupled Input 4. Ranges: 10 V, 1 V, 0.1 V 5. Resolution: 5½ Digit 6. Maximum Input: 10 V RMS

Table 3-4. Detector Codes (Cont'd).

D7	Internal Frequency Counter (AC Coupled)	<ol style="list-style-type: none"> 1. Frequency Range: 10 Hz to 5 MHz 2. Maximum Input Voltage: 10.5 V RMS 3. Minimum Input Voltage: 300 mV pk-pk \leq 500 kHz 2.5 V pk-pk $>$ 500 kHz 4. Gate Times: 1 ms, 10 ms, 100 ms, and 1 s 5. Useable with external sources
D8	Internal Frequency Counter (DC Coupled)	<ol style="list-style-type: none"> 1. Frequency Range: 1 Hz to 5 MHz 2. Maximum Input Voltage: 10.5 V RMS 3. Minimum Input Voltage: 300 mV pk-pk \leq 500 kHz 2.5 V pk-pk $>$ 500 kHz 4. Gate Times: 1 ms, 10 ms, 100 ms, and 1 s 5. Counter Threshold in programmable 6. Useable with external sources
D9	Internal Pulse Width; + Slope to - Slope	<ol style="list-style-type: none"> 1. Measures Time from a Voltage Level on the Positive Slope to the same Level on the Negative Slope 2. Maximum Measurement Time = 1 sec 3. Resolution: 100 ns 4. Maximum Input Voltage: 10.5 V RMS 5. Minimum Input Voltage: 300 mV pk-pk \leq 500 kHz 2.5 V pk-pk $>$ 500 kHz 6. Useable with external sources
D10	Internal Pulse Width; - Slope To + Slope	<ol style="list-style-type: none"> 1. Measures Time from a Voltage Level on the Negative Slope to the same Level on the Positive Slope 2. Maximum Measurement = 1 sec 3. Resolution: 100 ns 4. Maximum Input Voltage: 10.5 V RMS 5. Minimum Input Voltage: 300 mV pk-pk \leq 500 kHz 2.5 V pk-pk $>$ 500 kHz 6. Useable with external sources
D11	External Detector #1 (Rear Panel)	<ol style="list-style-type: none"> 1. Port available for a user assigned detector 2. The External Detector selected is connected to the I (hi point) and L (lo input) buses
D12	External Detector #2 (Rear Panel)	<ol style="list-style-type: none"> 1. Port available for a user assigned detector 2. The External Detector selected is connected to the I (hi input) and L (lo input) buses
D13	External Detector #3 (Rear Panel)	<ol style="list-style-type: none"> 1. Port available for a user assigned detector 2. The External Detector selected is connected to the I (hi input) and L (lo input) buses
D14	External Detector #4 (Front Panel)	<ol style="list-style-type: none"> 1. Port available for a user assigned detector 2. The External Detector selected is connected to the I (hi input) and L (lo input) buses
D15	External High Speed Voltmeter	<ol style="list-style-type: none"> 1. The 3253A provides one TTL negative going trigger when the source is applied. This trigger is available from the sync out connector on the rear panel.

Table 3-4. Detector Codes (Cont'd).

D16	External High Speed Voltmeter	<ol style="list-style-type: none"> 1. The 3253A provides TTL negative going trigger at the frequency of the measured signal. 2. Triggering occurs on the positive going slope of the measured signal with the level programmable from -12.8V to +12.7 V.
D17	External High Speed Voltmeter	<ol style="list-style-type: none"> 1. The 3253A provides TTL negative going trigger at the frequency of the measured signal. 2. Triggering occurs on the negative going slope of the measured signal with the level programmable from -12.8 V to +12.7 V.
D18	External High Speed Voltmeter	<ol style="list-style-type: none"> 1. The 3253A provides a TTL negative going trigger at the frequency of the internal source selected. 2. Triggering occurs at: S2-S4—zero crossing of the positive slope S5 and S7—positive peak S6—positive peak of the negative going edge
D19	External High Speed Voltmeter	<ol style="list-style-type: none"> 1. The 3253A provides a TTL negative going trigger at the frequency of the internal source selected. 2. Triggering occurs at: S2-S4—zero crossing of the negative slope S5 and S7—negative peak S6—negative peak of the positive going edge
D20	System High Resolution Multimeter	<ol style="list-style-type: none"> 1. External Detector

Table 3-5. Detector Related Programming Codes.

Code	Definition	Comments
AR _n	AR specifies range for the internal voltmeter and gate time for the internal counter. n = fixed no. from 0 - 3.	<ol style="list-style-type: none"> 1. Internal voltmeter: AR0 = AR1 - .1 V range autoranging up. AR2 = 1 V range with autoranging up. AR3 = 10 V range. 2. Internal frequency counter: AR0 = 1 msec gate AR1 = 10 msec gate AR2 - 100 msec gate AR3 = 1 sec gate. 3. For use with internal detectors only.
CT _n	CT specifies counter threshold. n = + 12.7 V to - 12.8 V in fixed or floating point no.	<ol style="list-style-type: none"> 1. Applies to D8, D9, D10, D16, and D17 only. 2. Sets the point at which the counter input triggers from a -12.8 V to +12.7 V. 3. Programming resolution ± .2 V.
F _n	F specifies filter. n = fixed or floating point no. from 1 to 9999.	<ol style="list-style-type: none"> 1. Filter specifies no. of measurement cycles only. 2. A single result is displayed as the average of the no. of readings. 3. Filter only applies to internal detectors.

3-34. Component Test.

3-35. Extended Guarding Codes. The Extended Guarding Codes control the mode of guarding (normal or extended), enhancement, MOA bandwidth or any combination of the three. In the following paragraph guarding, extended guarding, enhancement, and wide bandwidth will be defined and the effects of the codes on component measurements. The descriptions apply only to incircuit component test as performed by the 3253A.

3-36. Guarding. Guarding, as applied to in-circuit component testing, is defined as isolating components and circuits that form parallel paths around the component under test. It should be noted that guarding one component connected directly in parallel cannot be accomplished, e.g. two resistors, capacitors, or inductors in parallel. Use Figure 3-20 A in conjunction with the following description of how guarding functions. Z_{sg} and Z_{ig} are equivalent impedances of all the components and circuits that form a parallel path with the component under test Z_X . By connecting the component under test between the S and I buses and a node between Z_{sg} and Z_{ig} to the G (guard) bus the effects of these impedances can be removed. Z_{sg} is now in parallel with the internal voltage source and the current flowing through Z_{sg} does not flow into the summing node of the MOA and will not affect the measurement. By connecting Z_{ig} between the - and + terminals of the MOA there is no potential applied across the impedance and no current flows through Z_{ig} . Because there is no current flowing through Z_{ig} all of the current flowing through Z_X flows into the I bus and summing node of the MOA. Therefore, the current flowing through R_{ref} is equal to all of the current flowing through Z_X . Since the resistance R_{ref} is known and the MOA output voltage is measured the current can be calculated. Using this current and the source output voltage Z_X can be determined.

3-37. Extended Guarding. In most cases guarding will effectively isolate the component under test. However, when the impedances of Z_{sg} and Z_{ig} are less than Z_X three types of errors can occur. These errors are:

1. Guard lead resistance (guard gain error).
2. Current splitting.
3. Source loading (not corrected by extended guarding).

The following paragraphs describe the errors and how extended guarding can correct them.

3-38. Guard Lead Resistance (Guard Gain Error). In a normal guarding the (+) terminal of the MOA is connected internally through relay 2 to the source low and G bus as shown in Figure 3-20B. As Z_{sg} decreases in value the current flowing into the G bus increases. This current causes a voltage drop between the G bus connection and internal circuit common. This voltage drop will place an offset between the (+) and (-) terminal of the MOA, that causes what appears to be a gain error. To correct for this error, relay 2 is opened and relay 4 is closed. This connects the (+) terminal of MOA to the L bus and allows it to be externally connected to the G bus. Because only negligible current flows into a terminal of an op-amp the lead resistance does not cause an offset at the (+) terminal thereby effectively eliminating guard lead resistance error.

3-39. Current Splitting. Current splitting is caused by the resistance of the I bus. The resistance appears in parallel with Z_{ig} and, if Z_{ig} is a small impedance, a greater amount of the current flowing through Z_X will flow through Z_{ig} . Because all of the current does not flow into the MOA summing node, Z_X will appear larger. To correct for this error, relay 1 is

opened and relay 3 is closed, connecting the B bus to the MOA inverting terminal, shown in Figure 3-20B. The B bus is then connected externally to the same point as the I bus. Since the summing node (a virtual ground) is connected at the junction of Z_x and Z_{ig} , no error current flows through Z_{ig} . The A bus is also available with extended guarding but will not connect source load without enhancement. The A, B, and L buses can be used together or separately.

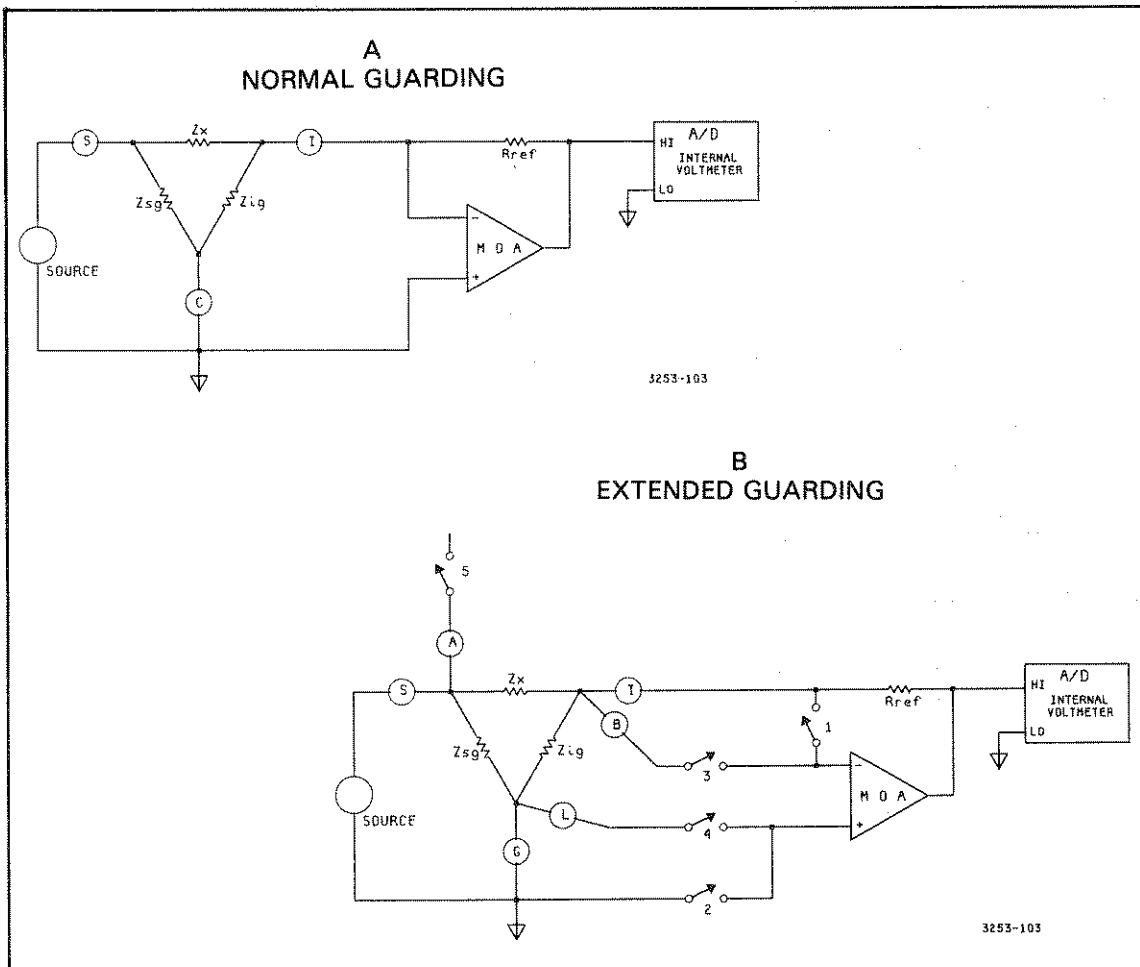


Figure 3-20. Guarding and Extended Guarding.

3-40. Accuracy Enhancement. Accuracy enhancement is a mathematical correction for errors caused by:

1. Source loading.
2. Relay thermal voltages.
3. Offset voltages.
4. Reference elements (ideal vs. actual resistance).
5. Source frequency (ideal vs. actual frequency of S2, S3, S4).

Corrections are performed by a series of eight internal voltage measurements. In Figure 3-21A relays 6, 7, 8, and 9 close momentarily in sequence to measure:

1. Source output voltage (corrects for source loading error).
2. MOA (-) terminal (corrects for offsets on summing mode).

3. Both sides of the reference element (determines actual current flowing through the reference element, four terminal resistor).

If the dc source is used the source amplitude is set to zero and the same four measurements are performed (this is to measure offsets voltages). If an ac source is used the first four measurements are performed using the real detectors and the second four are performed using the imaginary detectors. All eight measurements and the auto-cal constants for R_{ref} and source frequency (if an ac source is used) are used to calculate the MOA output voltage. The MOA output voltage is then used to determine Z_X .

3-41. With the 3253A, both accuracy enhancement and extended guarding can be used together or separately. When used together with the A bus, source loading is corrected by performing the source output measurement through relay 5, relay 6 is not used. See Figure 5-21B.

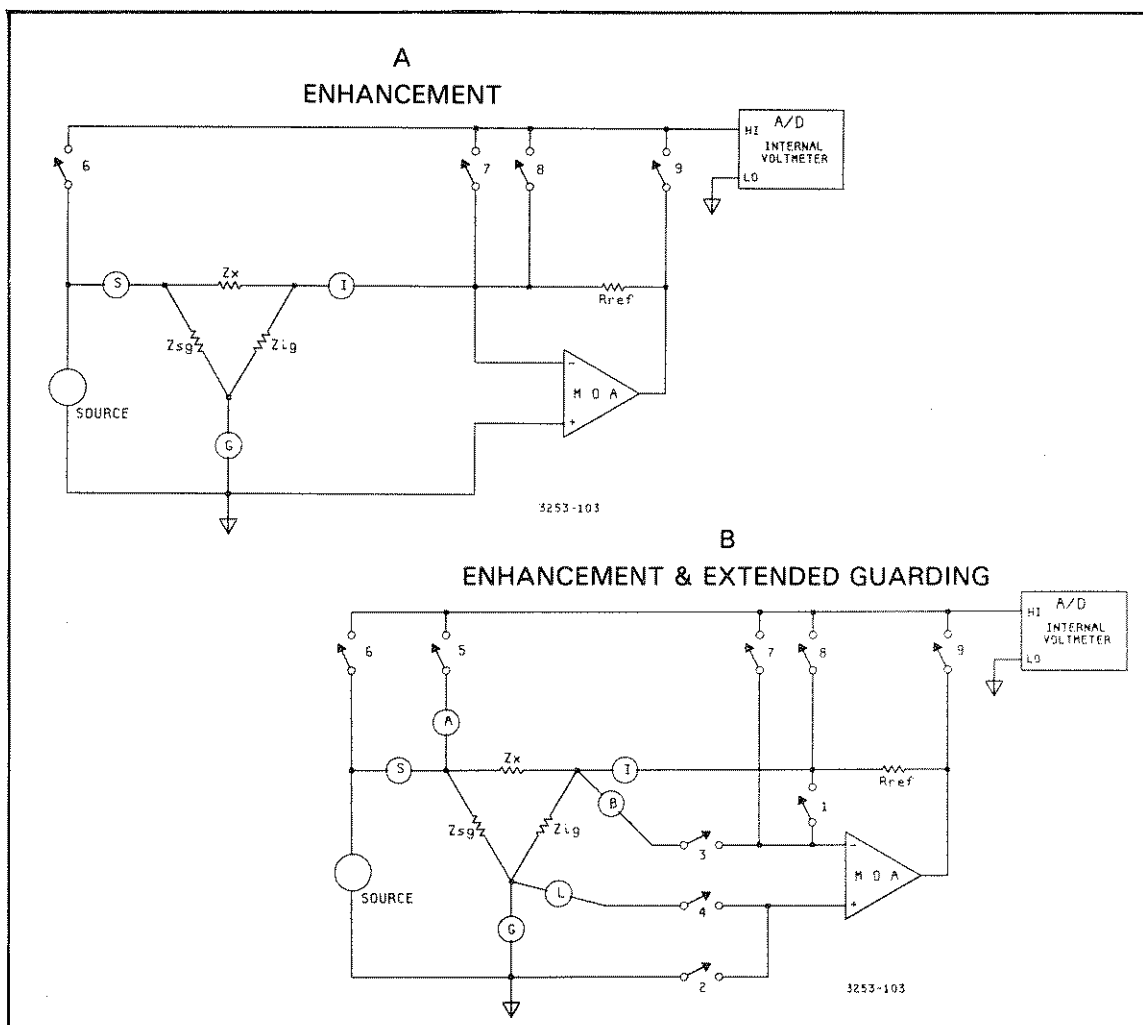


Figure 3-21. Enhancement and Enhancement with Extended Guarding.

3-42. **Wideband.** Wideband increases the MOA bandwidth thereby increasing the open loop gain for AC measurements. With the increase in gain comes a decrease in the impedance between the plus and minus terminal of the op-amp, this also helps in the guarding of Z_{lg} . Because of the increased bandwidth there is a greater tendency for the MOA to oscillate. To prevent this from happening, wideband should be used only when Extended

Guarding and Enhancement does not remove the errors for AC measurements. For DC measurements, wide band should only be used with reference elements R6 or R7.

3-43. With the 3253A, the operator can use Normal Guarding, Extended Guard, Accuracy Enhancement, and Wideband or any combination of the above. Refer to Table 3-6 for the correct Guarding codes. For more detailed information on guarding, extended guarding, enhancement, and wide bandwidth refer to Section IV "Analog Measurement Theory" of the 3060A Users Manual.

Table 3-6. Extended Guarding Codes.

Narrow Band Codes	Wide Band Codes	Buses Connected	Enhancement	Measurement Error Corrected
EG0	EG20	S,G,I	No	1. None
EG1	EG21	S,G,I,B	No	1. Current Splitting
EG2	EG22	S,G,I,L	No	1. Guard Gain
EG3	EG23	S,G,I,L,B	No	1. Current Splitting 2. Guard Gain
EG4	EG24	S,G,I,A*	No	1. None
EG5	EG25	S,G,I,A,B*	No	1. Current Splitting
EG6	EG26	S,G,I,A,L*	No	1. Guard Gain
EG7	EG27	S,G,I,A,B,L*	No	1. Current Splitting 2. Guard Gain
EG10	EG30	S,G,I	Yes	1. None
EG11	EG31	S,G,I,B	Yes	1. Current Splitting
EG12	EG32	S,G,I,L	Yes	1. Guard Gain
EG13	EG33	S,G,I,L,B	Yes	1. Current Splitting 2. Guard Gain
EG14	EG34	S,G,I,A	Yes	1. Source Loading
EG15	EG35	S,G,I,A,B	Yes	1. Source Loading 2. Current Splitting
EG16	EG36	S,G,I,A,L	Yes	1. Source Loading 2. Guard Gain
EG17	EG37	S,G,I,L,A,B	Yes	1. Source Loading 2. Current Splitting 3. Guard Gain

*In EG4-7, 24-27 the A bus is connected internally in the 3253A. Since enhancement is not used there is no correction for source loading error.

NOTE

Extended Guarding applies only to T1, T2, T3 and T5.

3-44. Reference Elements. The reference elements consist of seven precision resistors used in conjunction with the measuring op amp to provide current to voltage conversion. There are two normal configurations that the reference resistors are used in. First, as a feedback element in the measuring op amp and second, as the input resistor on the minus input of the measuring op amp. Table 3-7 contains the programming code with corresponding value for the different reference elements.

3-45. Miscellaneous Programming Codes.

3-46. The remainder of the programming codes necessary to operate the 3253A listed in Table 3-8.

Table 3-7. Reference Element.

Ref. Element Code	Value
R1	10 ohms
R2	100 ohms
R3	1 K ohm
R4	10 K ohm
R5	100 K ohms
R6	1 M ohm
R7	10 M ohms

Table 3-8. Miscellaneous Programming Codes.

Miscellaneous Codes	Definition	Remarks
Wn	W specifies <u>W</u> ait n = a fixed or floating point number between points 0.001 and 9.999	The wait statement programs a delay of n seconds in the following manner: 1. DC and AC (EG0 and EG30) a. applies the stimulus b. waits n seconds c. makes a measurement d. sets stimulus to 0 output e. waits n seconds 2. DC (with enhancement and extended guarding) a. applies the stimulus b. waits n seconds c. makes 4 internal measurements d. sets stimulus to 0 output e. waits n seconds f. makes 4 internal measurements g. waits n seconds h. returns measurement results 3. AC (with enhancement and extended guarding) a. applies the stimulus b. waits n seconds c. makes 8 internal measurements d. sets stimulus to 0 output e. waits n seconds f. returns measurement results
FT	FT specifies <u>F</u> ront <u>T</u> erminals	1. FT0 = rear terminals 2. FT1 = front panel terminals
X	X specifies <u>E</u> XECUTE	1. Execute program stored in 3253A memory. 2. Executes a change in program already stored in memory.

3-47. PROGRAMMING.

3-48. The programming for the 3253A is presented in a series of programming flowcharts that are in Test Code order. These flowcharts contain two types of blocks: 1) decision blocks (diamonds), 2) code blocks. The code blocks contain the actual programming codes

necessary to be entered into the program line or from the front panel (local). Before each flowchart is an outline that provides the application, programming tips, and default codes. Default codes are codes that are automatically stored in the 3253A memory when a Test Code is entered. The default codes may be changed or used depending on the parameters of the test being performed.

3-49. General Programming Tips.

3-50. The following programming tips are presented here to help avoid common pit-falls in operating the 3253A.

1. Always program the Test Code first.
2. Select the source amplitude and reference element to prevent the MOA output from exceeding ± 15 DC or 10 V RMS.
3. Do not use the MOA in wideband with DC unless R6 or R7 is used.
4. Do not use D3 or D5 with S2.
5. Use D3, D4, D5, or D6 to measure only voltage generated by S2, S3, and S4.

3-51. Input/Output Format.

3-52. **ASCII Mode.** The 3253A uses a free field input format with numeric enter in either fix or floating point decimal. The output format, when addressed to talk is:

$$\pm D.DDDDDDE \pm D$$

$$D = [\emptyset, 1, 2, 3, 4, 5, 6, 7, 8, 9]$$

3-53. **Binary Program and Readback.** Binary program consists of an ASCII "B" followed by 16 bytes. These are shown as in Figure 3-22.

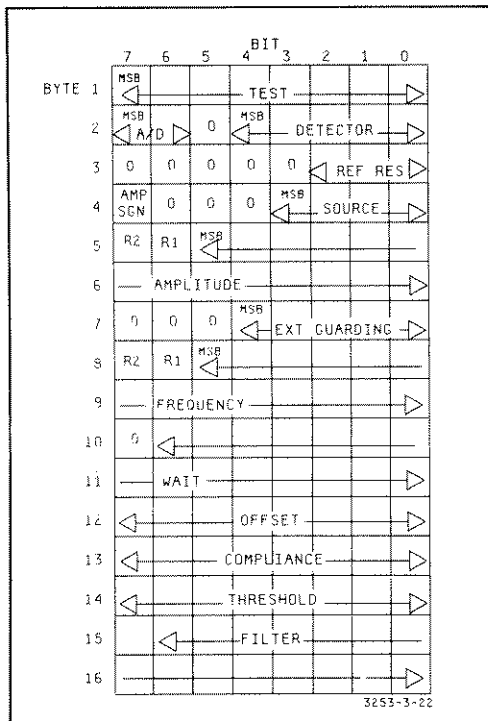


Figure 3-22. Binary Programming Format.

3-54. Binary Response—After the 3253A has been set up with a binary program, the read-back is also binary. Figure 3-23 shows the binary readback format.

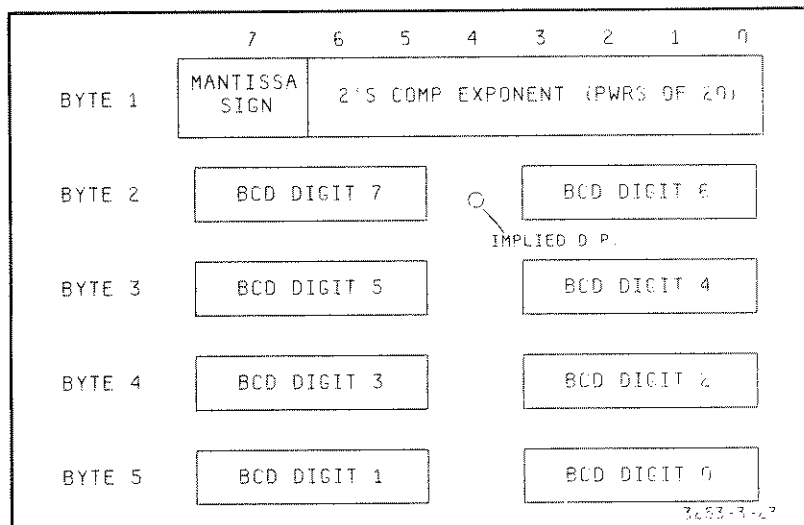


Figure 3-23. Binary Readback.

3-59. T2 (Inductance Test).

3-60. Applications.

- a. Inductor measurement (uses parallel model).

3-61. Programming Tips.

- a. Because most small inductors are measured in a series model, a real and imaginary measurement must be made to convert from parallel to series model (see programming flow chart).
- b. When using S4 (10 kHz) wideband is recommended.
- c. The voltage measurement result should be a positive voltage for inductive reactance.
- d. L_x is connected between S & I buses.

3-62. Default Codes.

Source.....	S3 (1 kHz)
Detector.....	D5 (4 digit)
Extended Guarding.....	EG00
Ref Element.....	R4 (10 KΩ)
Amptd.....	A0.1
A-D Range.....	AR3
Compliance.....	C.150
Filter.....	F1
Wait.....	W0

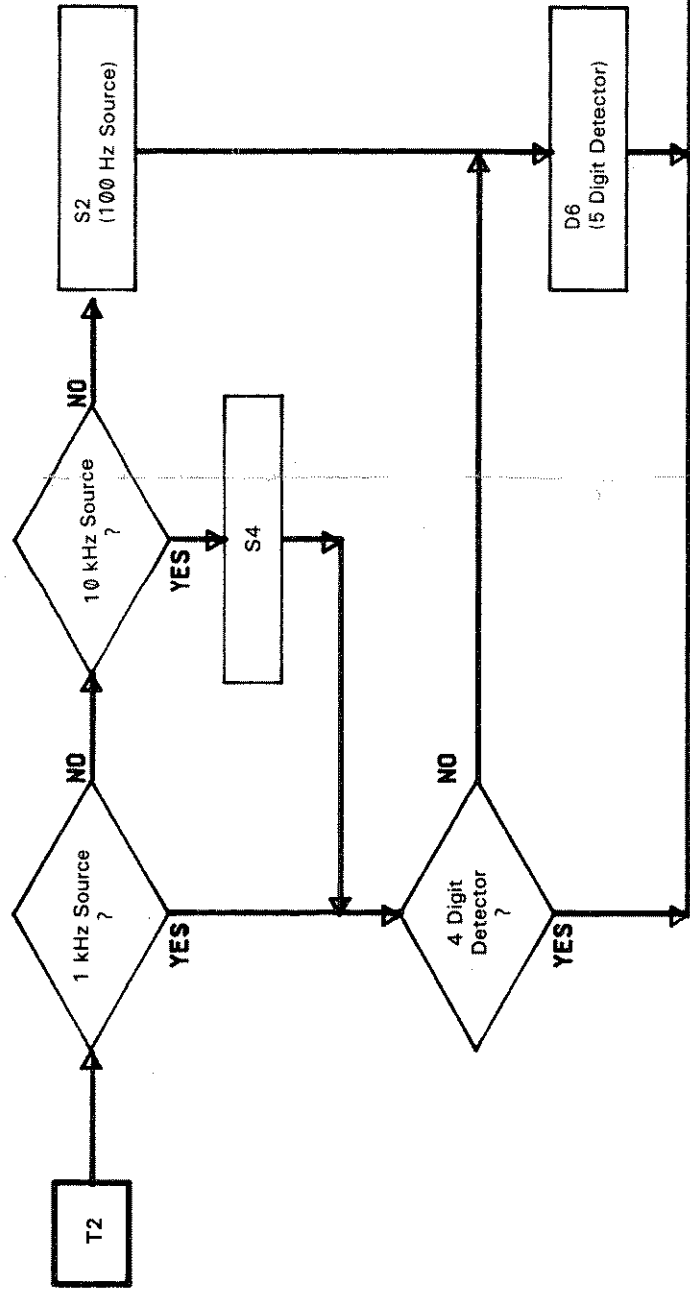
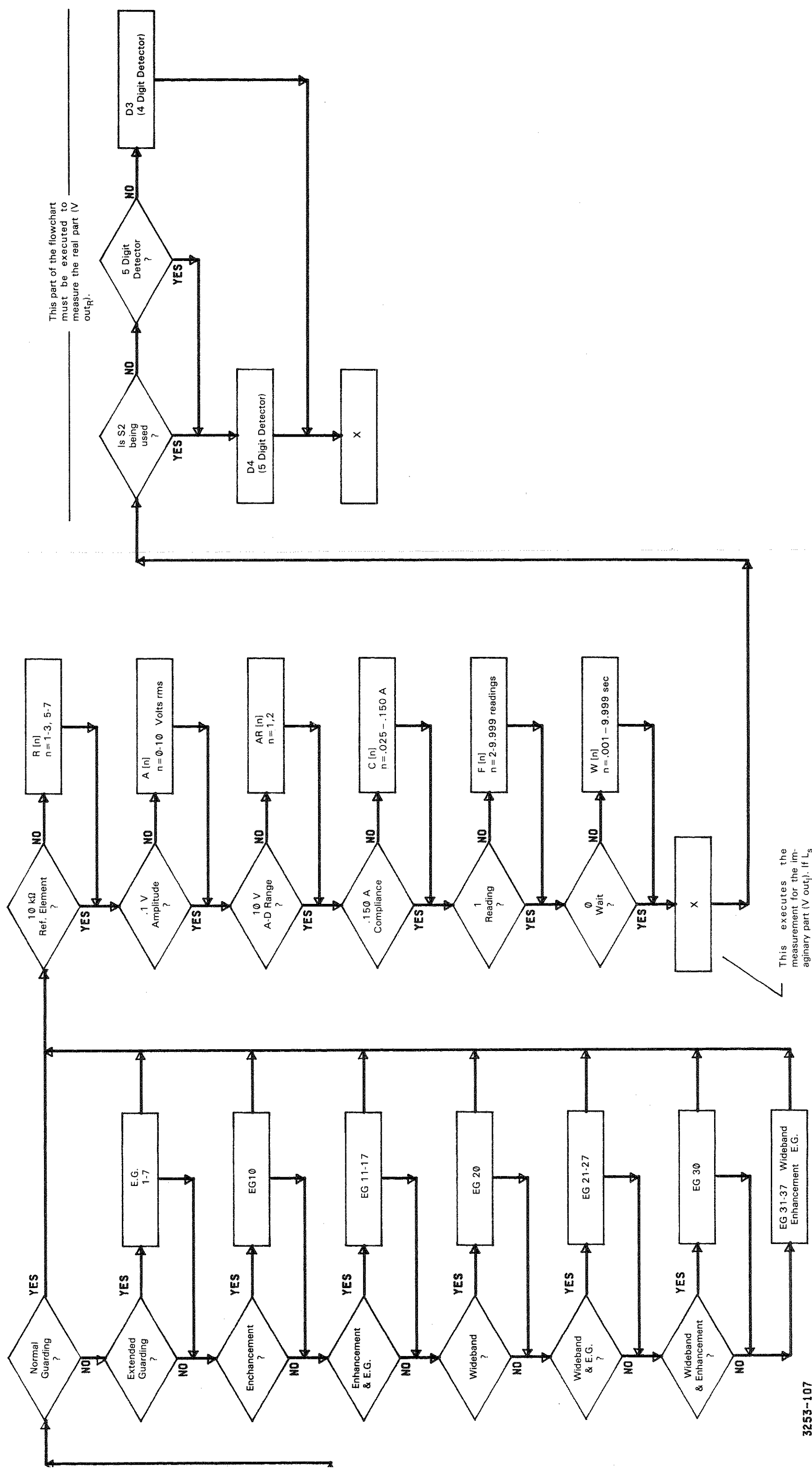


Figure 3-25. T2 Programming Flowchart.
3-33/3-34



3-63. T3 (Capacitance Test).

3-64. Applications.

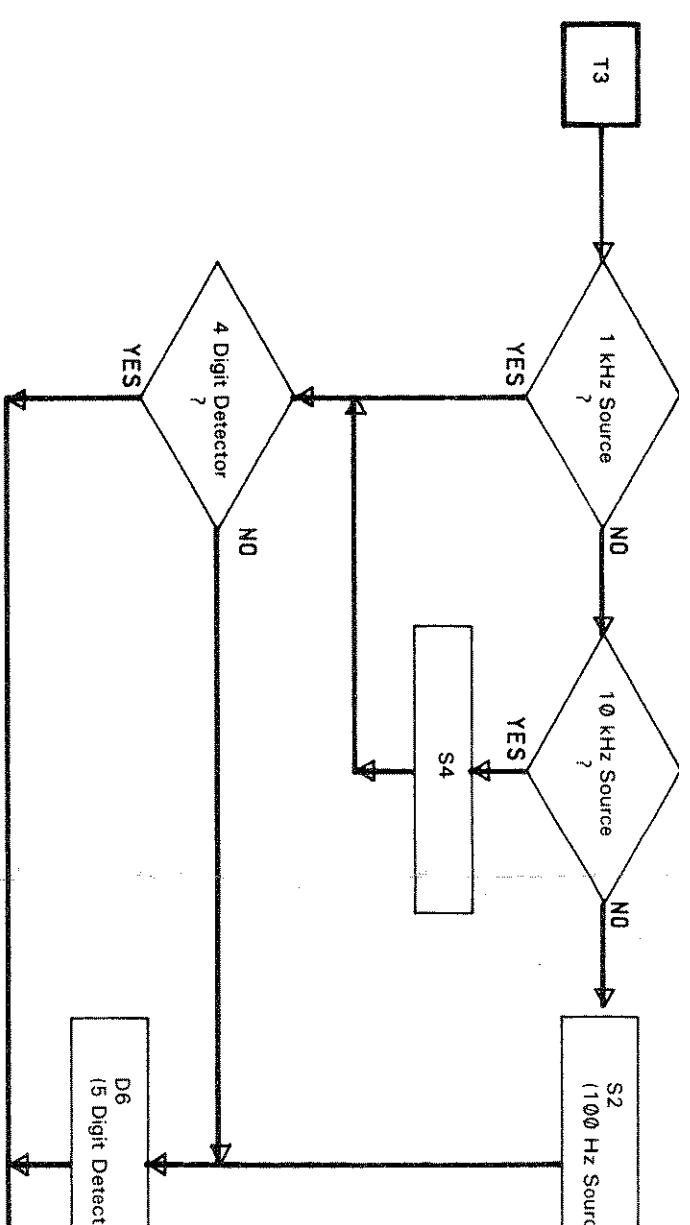
- a. Capacitor measurement (uses parallel model) from 1 pF to 10,000 μ F.

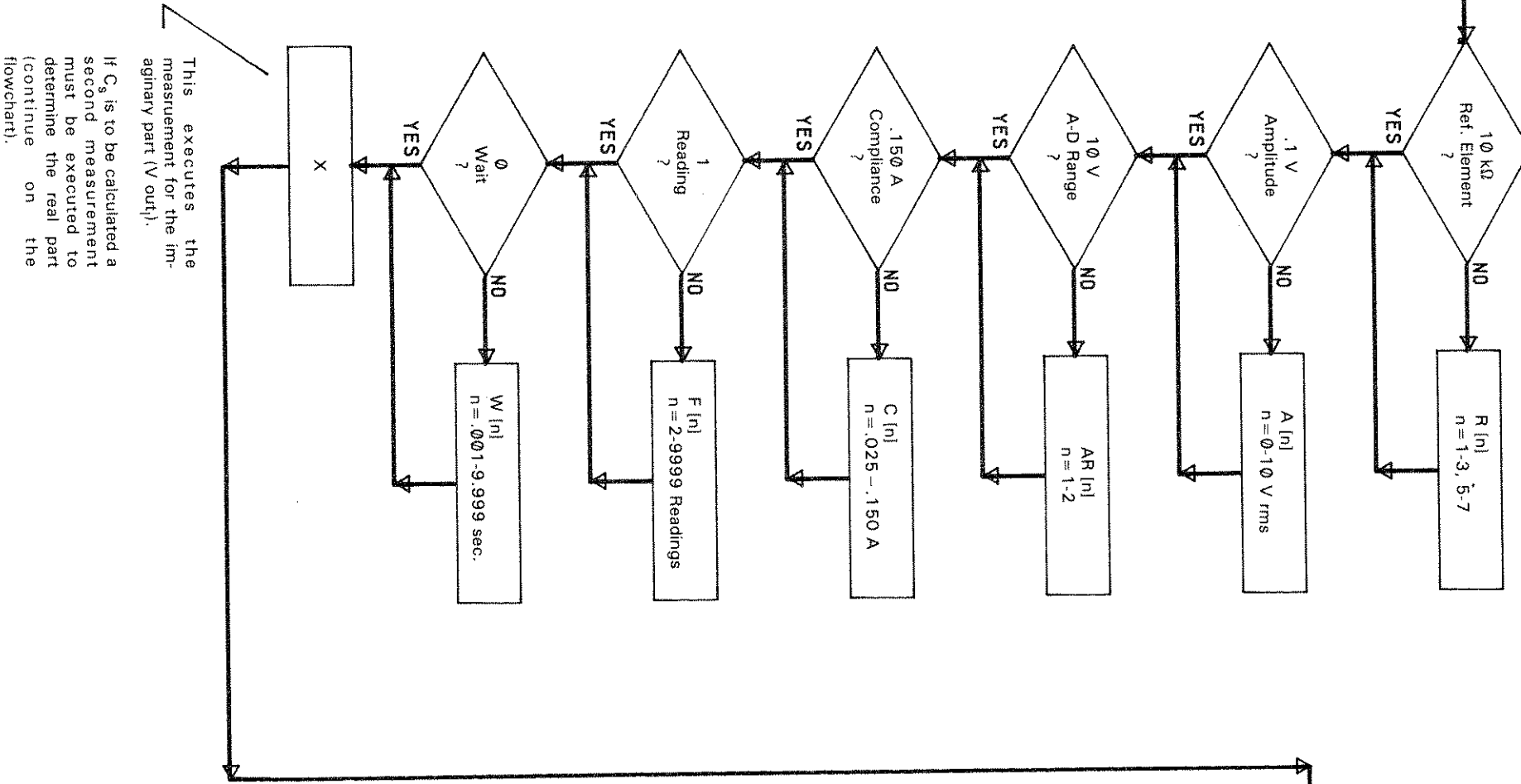
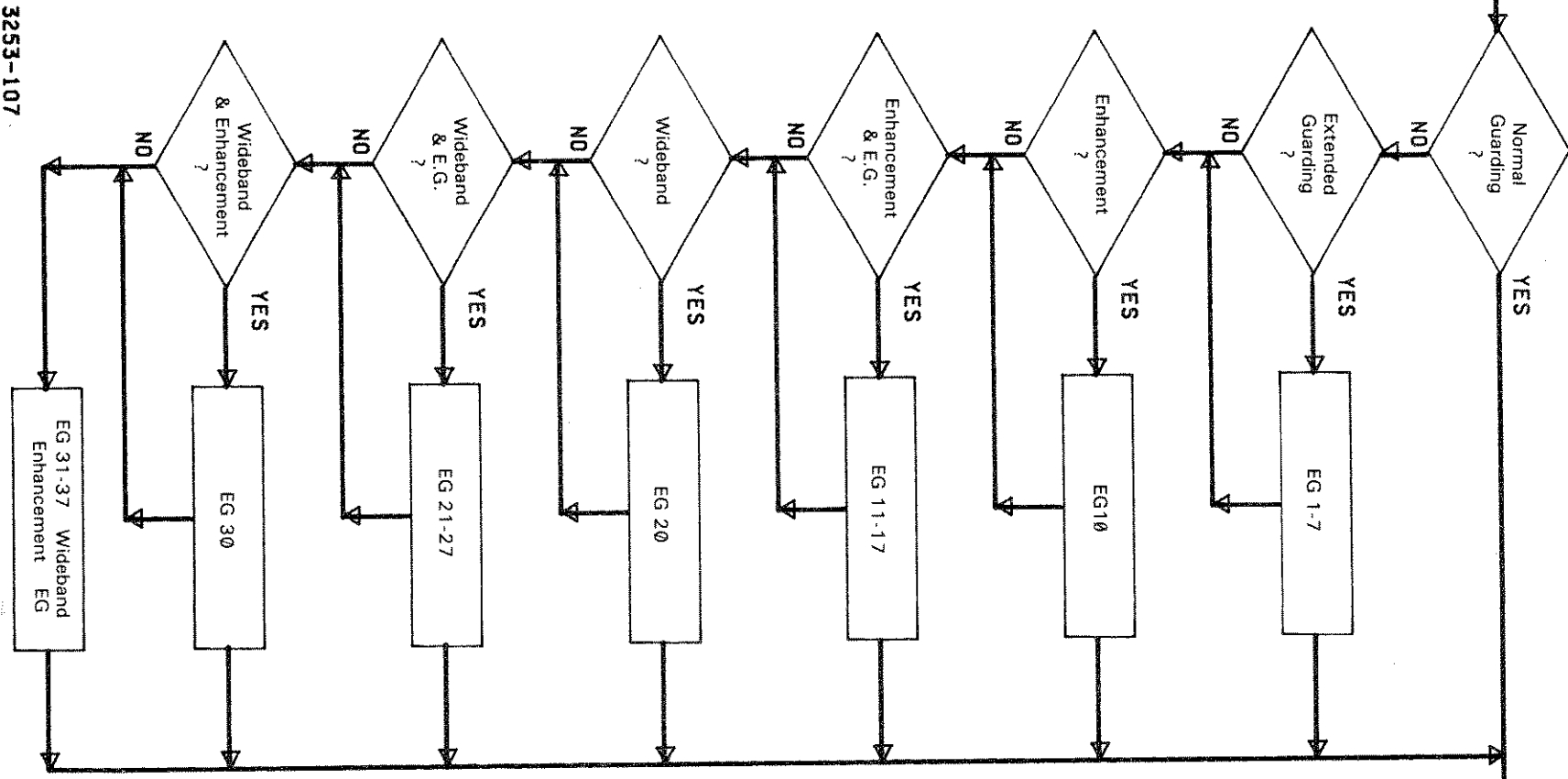
3-65. Programming Tips.

- a. When testing electrolytic capacitors, a real and imaginary measurement may be performed to convert from a parallel to series model (see flow chart).
- b. Use the DC offset to back-bias a vari-cap.
- c. When measuring small capacitors (1000 pF and below), the stray capacitance should be measured first and that value should be subtracted from the measured value.
- d. When using S4 (10 KHz) wideband is recommended.

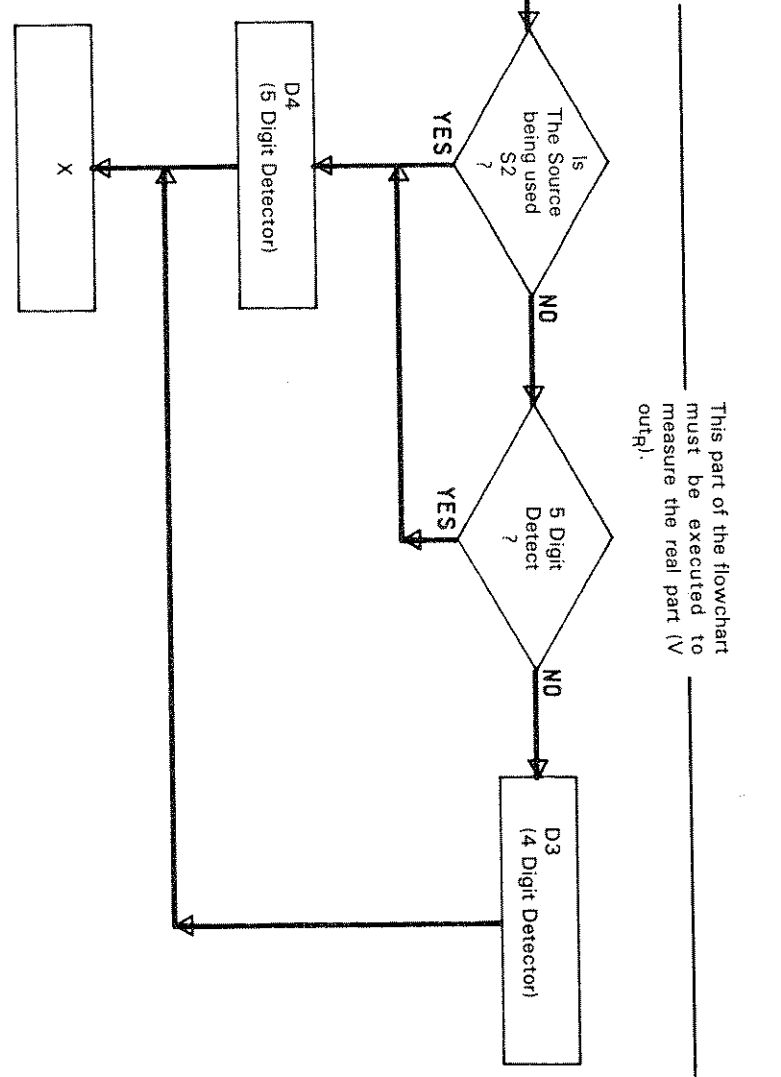
3-66. Default Codes.

Source.....	S3 (1 KHz)
Detector.....	D5 (4 digit)
Extended Guarding.....	EG0
Ref Element.....	R4 (10 K Ω)
Ampfd.....	A0 .1
A-D Range.....	AR3
Compliance.....	C.150
Filter.....	F1
Wait.....	W0





This executes the measurement for the imaginary part (V out_i).
If C_s is to be calculated a second measurement must be executed to determine the real part (continue on the flowchart).



This part of the flowchart must be executed to measure the real part (V out_r).

Figure 3-26. T3 Programming Flowchart. 3-35/3-36

3-67. T4 (Diode Junction).

3-68. Applications.

- a. Tests diode junction for forward voltage.
- b. Tests zener junction for zener voltage (must be between ± 15 V).

3-69. Programming Tips.

- a. To prevent possible damage to other components connected to the diode junction under test, the MOA voltage compliance should be programmed to slightly greater voltage than the anticipated junction voltage.
- b. Only S1 (DC) should be used for this test.
- c. Current through the diode under test is set by the source amplitude and reference element.
- d. The diode junction under test is connected between the S & I buses.

3-70. Default Codes.

Source.....	S1 (DC)
Ampld.....	A0.1
Ref Element.....	R2 (100 Ω)
A-D Range.....	AR2 (1 V)
Compliance.....	C15
Filter.....	1
Wait.....	0

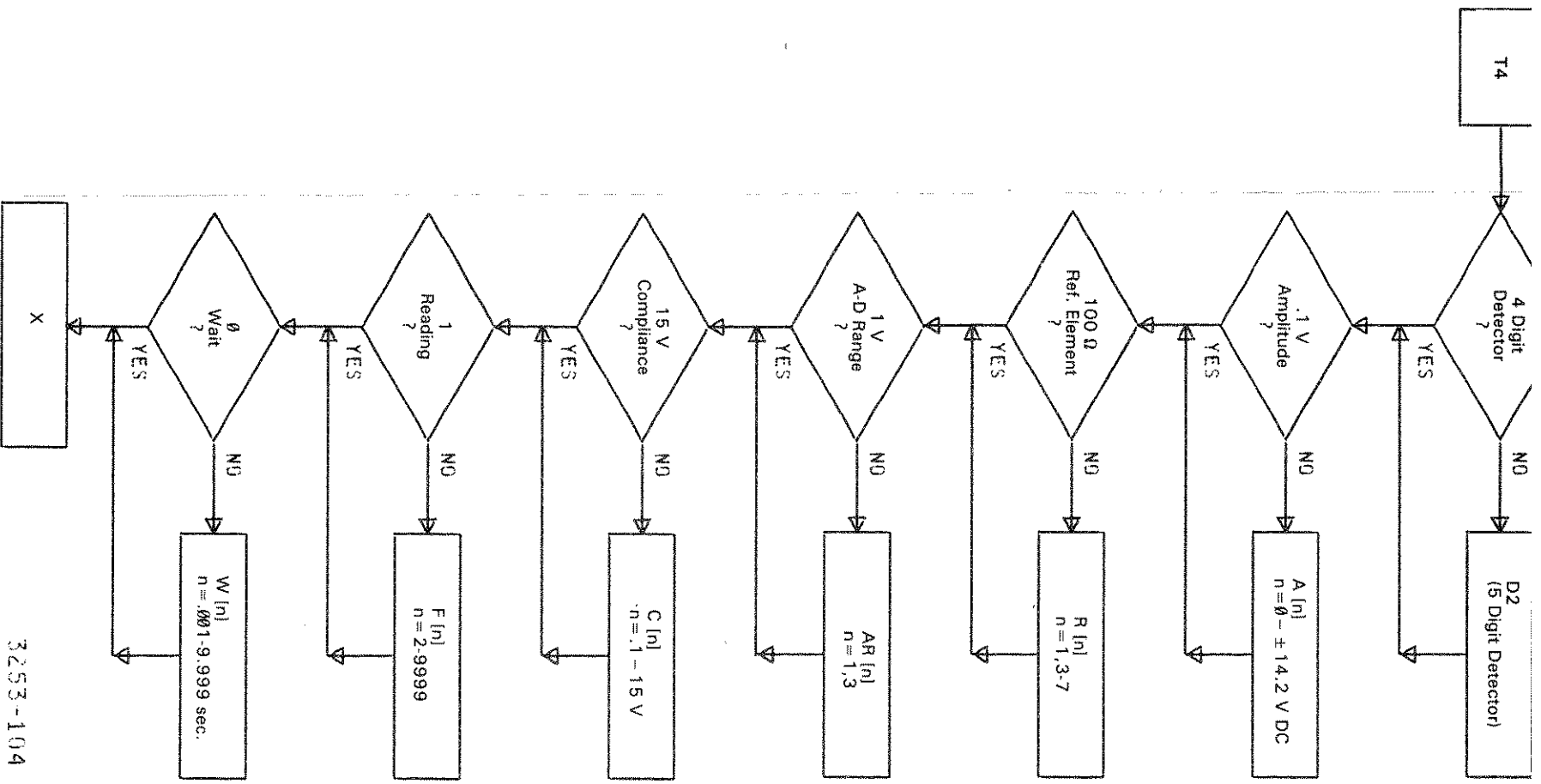


Figure 3-27. T4 Programming Flowchart.
3-37/3-38

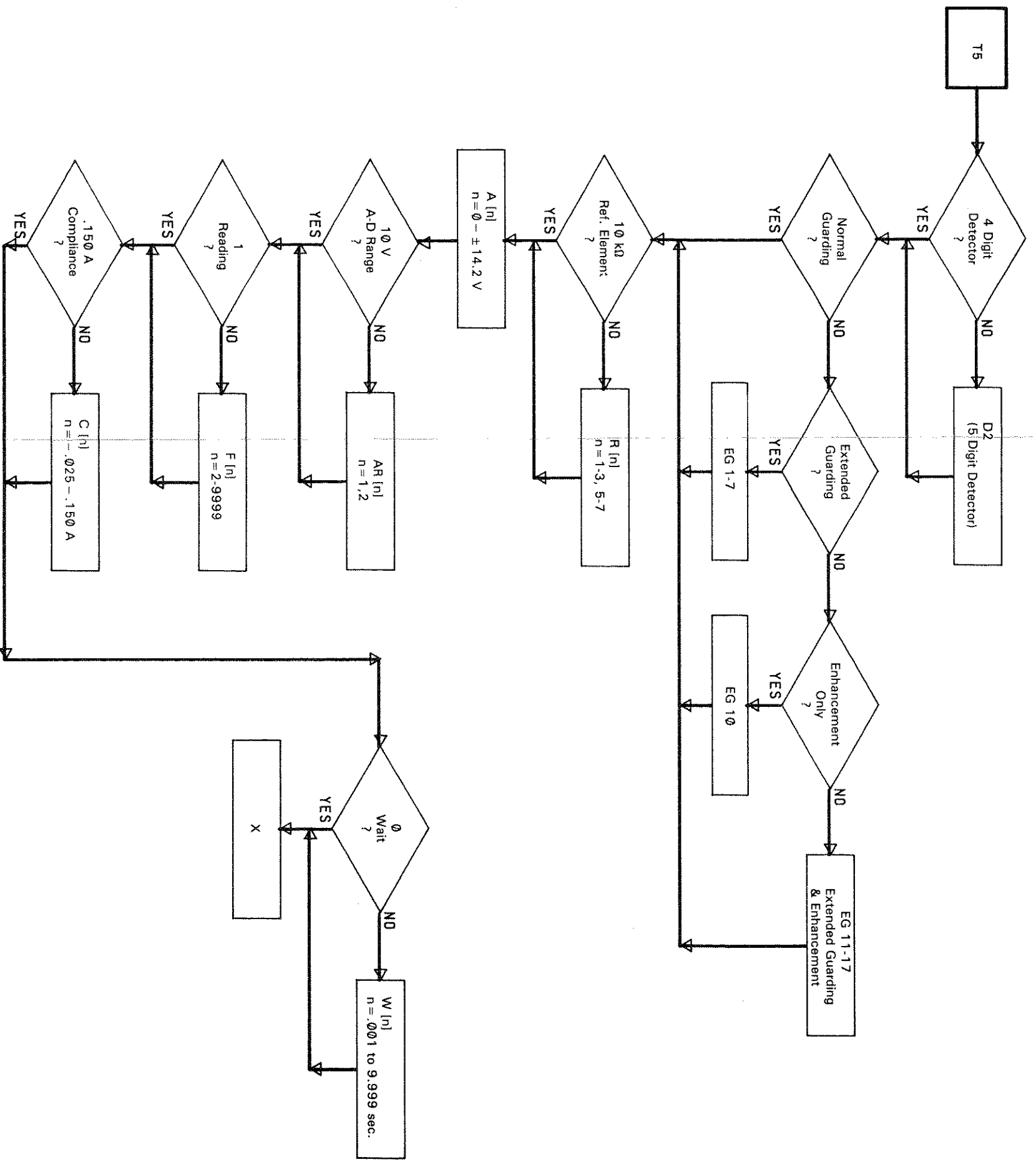


Figure 3-28. T5 Programming Flowchart.
3-39/3-40

3-71. T5 (Current Test).

3-72. Applications.

- a. FET I_{dss} .
- b. Leakage Current.

3-73. Programming Tips.

- a. FET I_{dss} .

1. Connections.

- Gate—G bus
- Drain—S bus
- Source—I bus

- 2. The 3253A source amplitude should be greater than the pinchoff voltage (refer to a data sheet for the FET).

3-74. Default Codes.

Source.....	S1 (DC)
Detector.....	D1 (4 digit)
Extended Guarding.....	EG0
Ref Element.....	R4 (10 K Ω)
Amptd	A0.1
A-D Range.....	AR3
Compliance	C.150
Filter	F1
Wait.....	W0

3-75. T6 (Beta Test).

3-76. Applications.

- a. Transistor Beta.

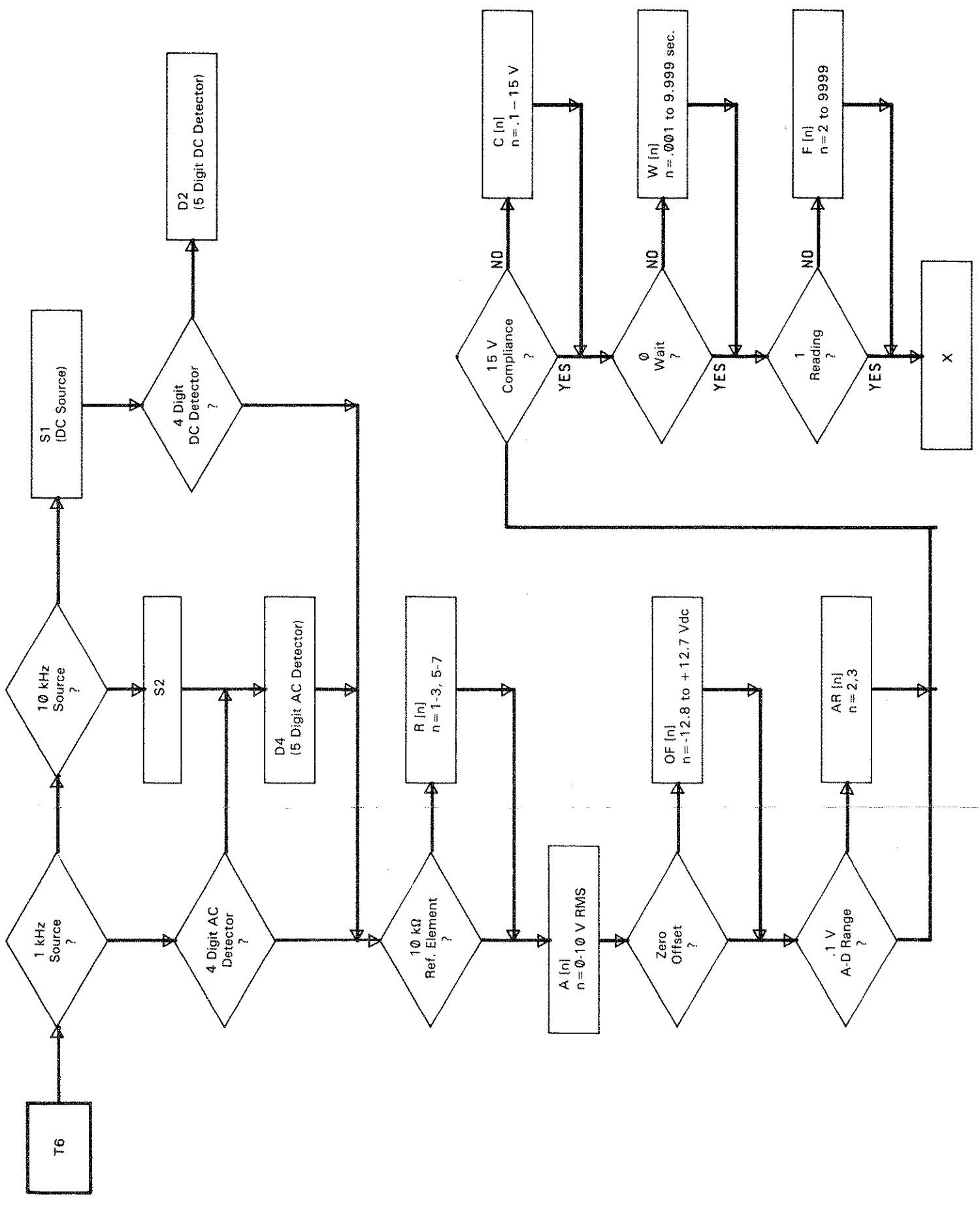
3-77. Programming Tips.

- a. Transistor connectives.
Collector—A bus
Base—I bus
Emitter—S bus
- b. If an AC source is used, a DC offset must be programmed to provide a bias current.
- c. The AC peak signal should be less than the DC offset (rule-of-thumb ACRMS amplitude = ½ DC offset).
- d. For DC: bias current is determined by dividing the DC offset voltage by the Ref. Element.
- e. For AC: the drive current is determined by dividing source amplitude by the Ref. Element.
- f. Amptd default = 0 V and must be programmed.
- g. Offset default = 0 V and must be programmed.

3-78. Default Codes.

Source.....	S3 (1 kHz)
Detector.....	D4 (4 digit)
Ref Element.....	R4 (10 KΩ)
Amptd.....	A0
Offset.....	OF0
Compliance.....	C15 (15 V)
Filter.....	F1
Wait.....	W0

Figure 3-29. T6 Programming Flowchart.
3-41/3-42



3-79. T7 (FET Pinchoff V_p).

3-80. Applications.

- a. Measure FET pinchoff voltage.

3-81. Programming Tips.

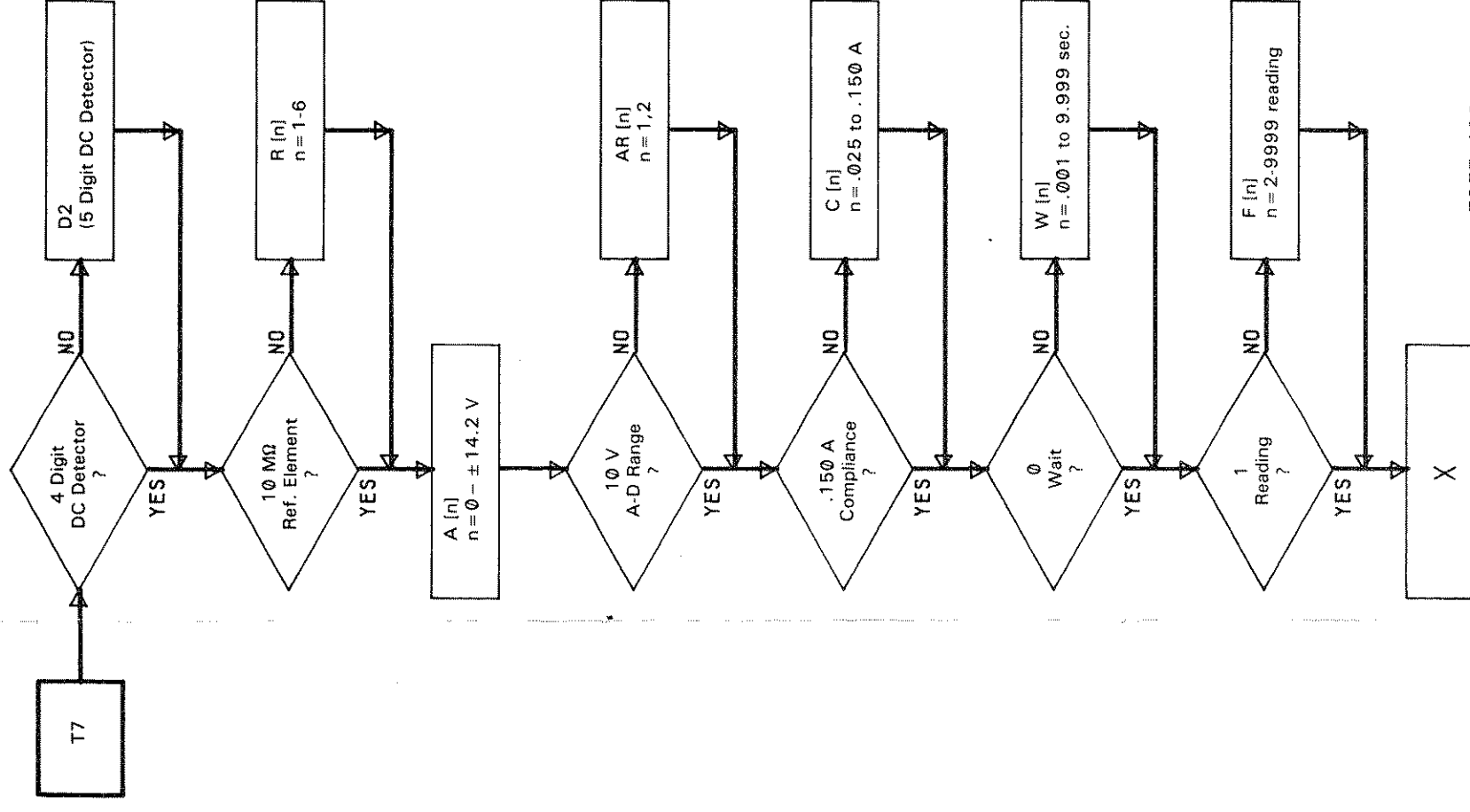
- a. FET connections.
Drain—S bus
Source—I bus
Gate—A bus

- b. Amplitude default = 0 V and must be programmed.

- c. By using large reference element a small current flows through the FET under test. The smaller the current the better the estimated pinchoff voltage.

3-82. Default Codes.

Source.....	S1 (DC)
Detector.....	D1 (4 digit)
Ref Element.....	R7 (10 M Ω)
Ampltd.....	A0
A-D Range.....	AR3
Compliance.....	C.150
Filter.....	F1
Wait.....	W0



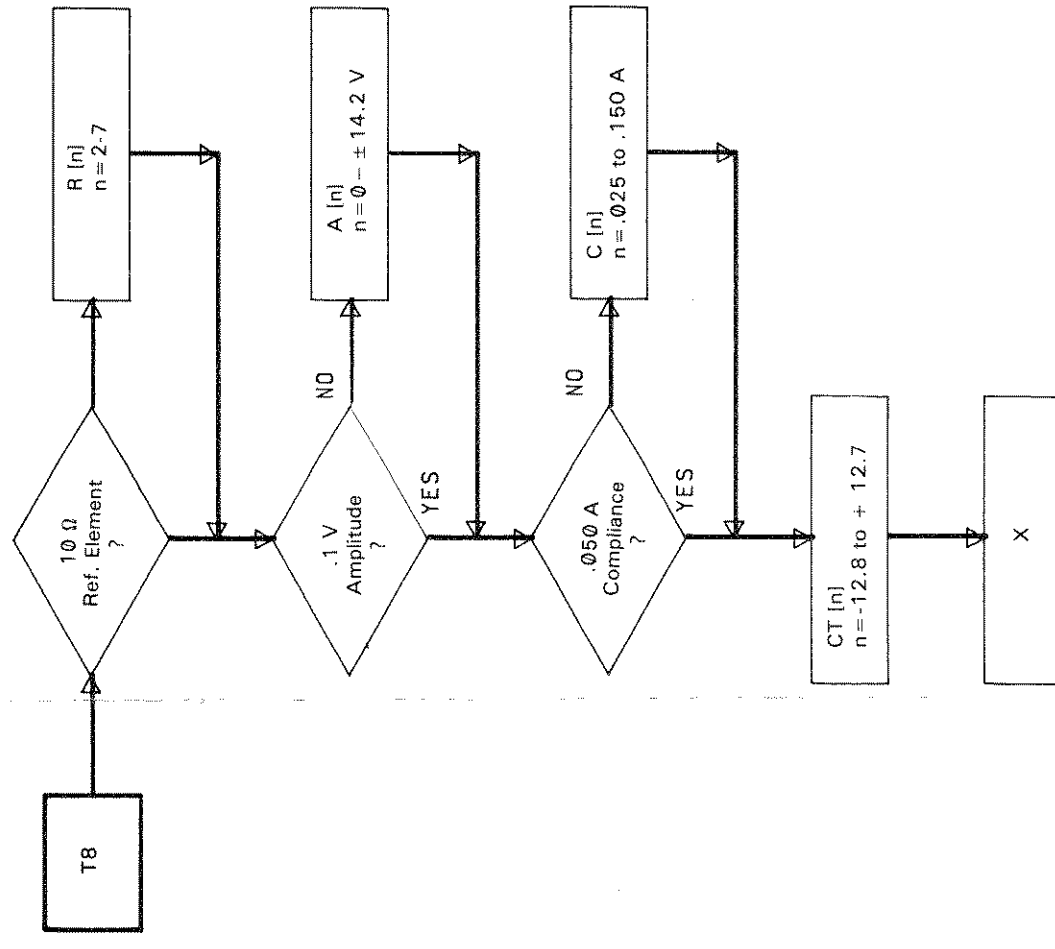
3-83. T8 (Shorts Test).

3-84. Program Tips.

- a. A combination of three parameters are used to define the resistance of the short:
 1. Source Amplitude.
 2. Reference Element.
 3. Counter Threshold voltage.
- b. The Counter Threshold voltage should be the opposite polarity of the source amplitude.
- c. If a controller is used to program the 3253A carriage return and line feed must be suppressed or the shorts test will be terminated.
- d. T8 will run continuously in the unprotect mode until terminated by another programming code.
- e. Service Request is suppressed in this mode of operation.

3-85. Default Codes.

Source.....S1 (DC)
 AmptdA0.1
 Ref Element.....R1 (10 Ω)
 Counter Threshold.....CT0
 Compliance.....C0.050



3-86. T10 (Four Terminal Low Resistance Test).

3-87. Applications.

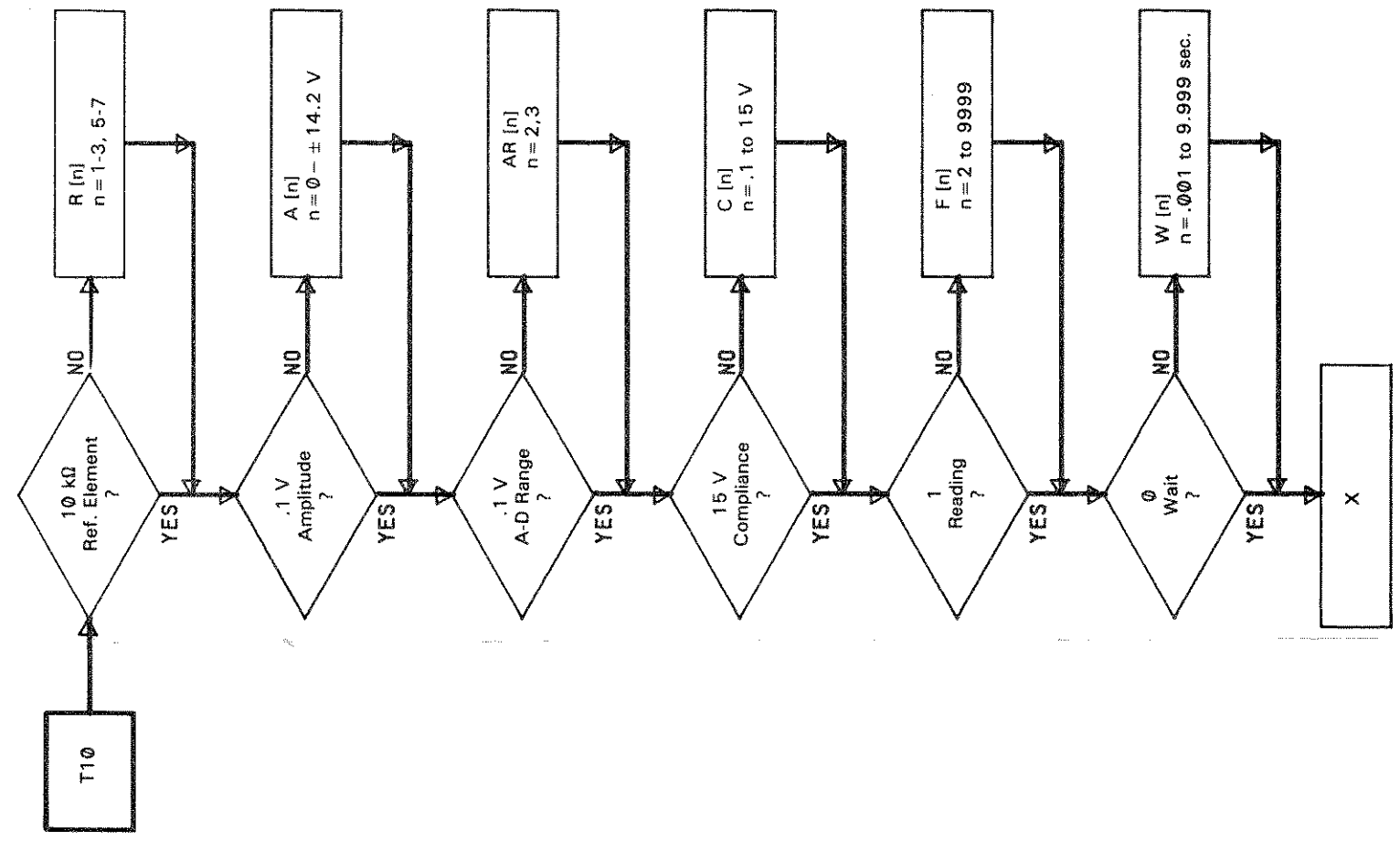
- a. Resistors below 100 Ω.
- b. Relay contact resistance.

3-88. Programming Tips.

- a. Connections.
 - 1. R_x between S & I buses.
 - 2. B bus is connected to a node as close to R_x as possible on the I bus side of R_x.
 - 3. A bus is connected to a node as close to R_x as possible on the S bias side of R_x.
- b. Current for this test is set by the source amplitude and the reference element.

3-89. Default Codes.

Source.....	S1 (DC)
Detector.....	D2 (5 digit)
Extended Guarding.....	EG15
Ref Element.....	R4 (10 KΩ)
Amptd.....	A0.1
A-D Range.....	AR1 (.1 V)
Compliance.....	CI5
Filter.....	FI
Wait.....	W0



30. T12 (Transfer Test [voltage stimulus—voltage response]).

31. Applications.

a. Analog Functional testing.

32. Programming Tips.

a. When using an external detector (D11-D20) or external source (S11-S14) the busy bit must be checked to make certain the 3253A is set up before taking a measurement.

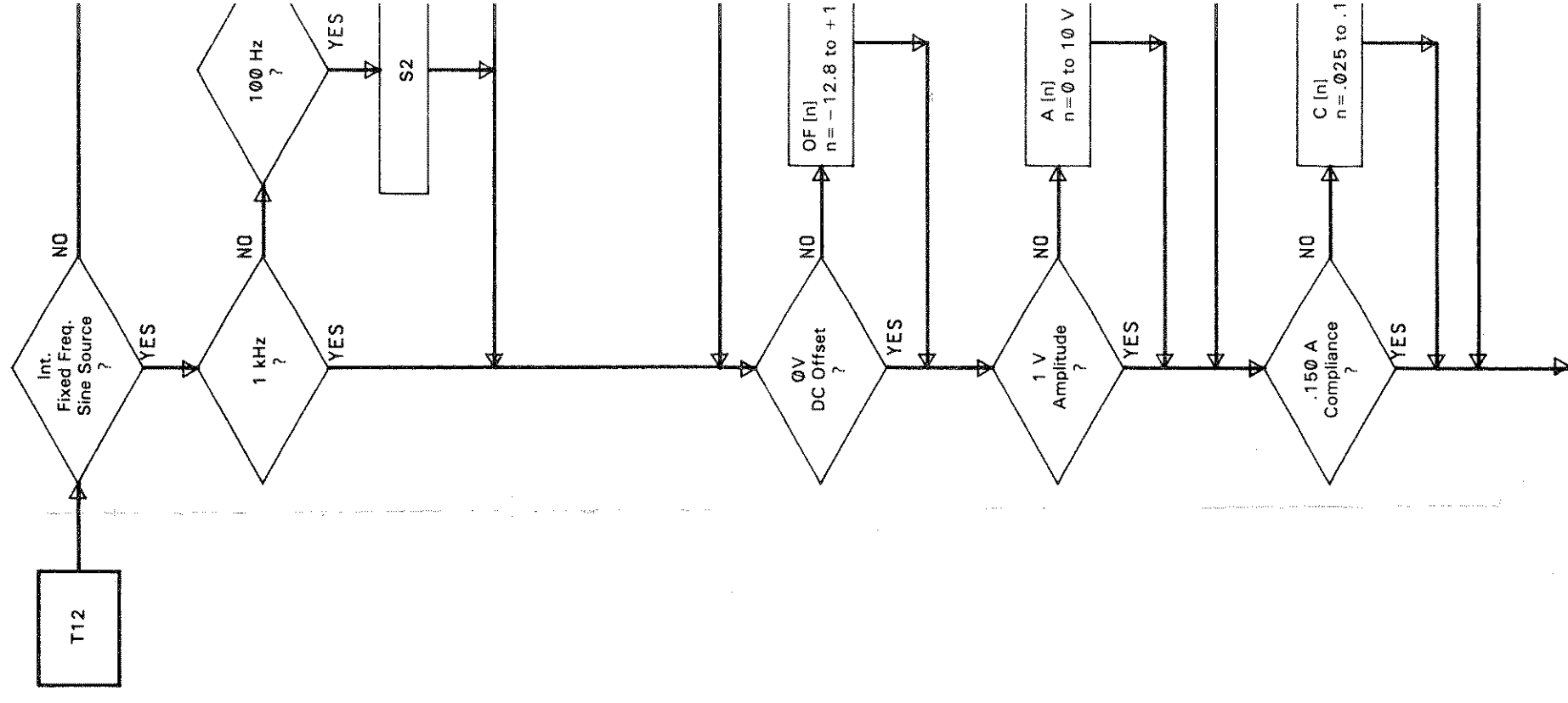
b. The internal synchronous detector (D3-D6) cannot be used with an external source or external function generator.

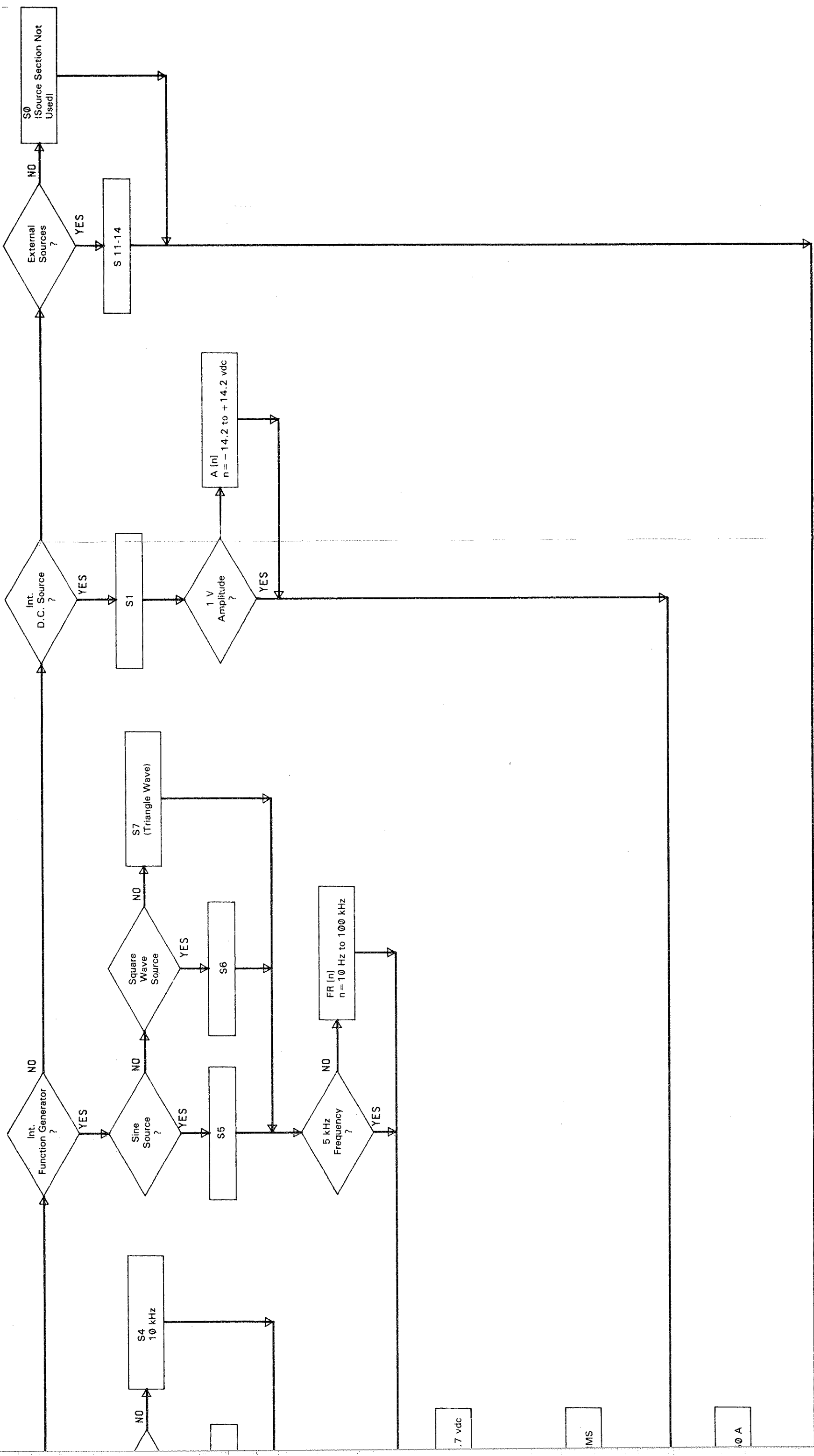
c. Frequency programming applies to only S5, S6, and S7.

d. Filter applies only when using internal detectors.

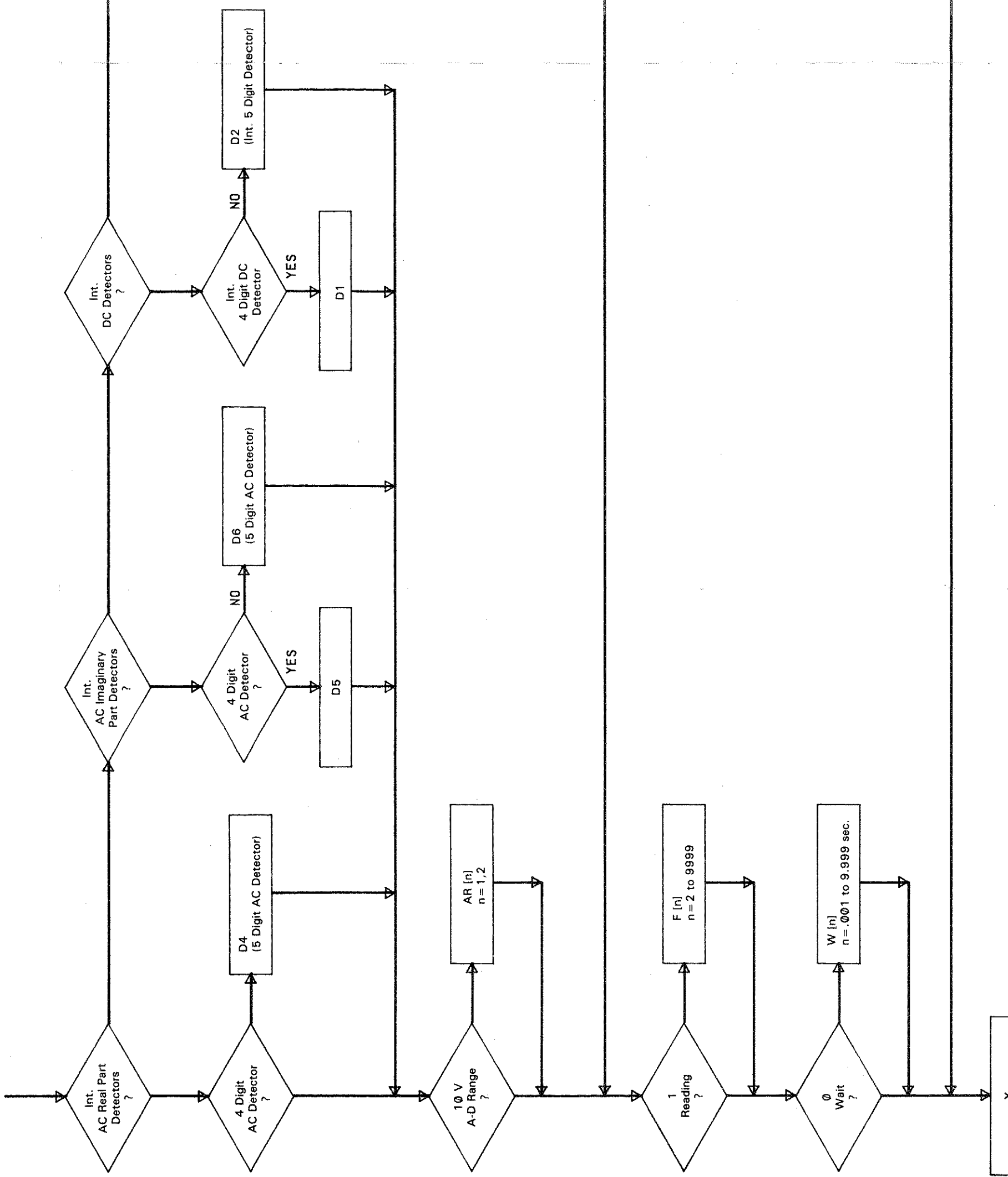
33. Default Codes.

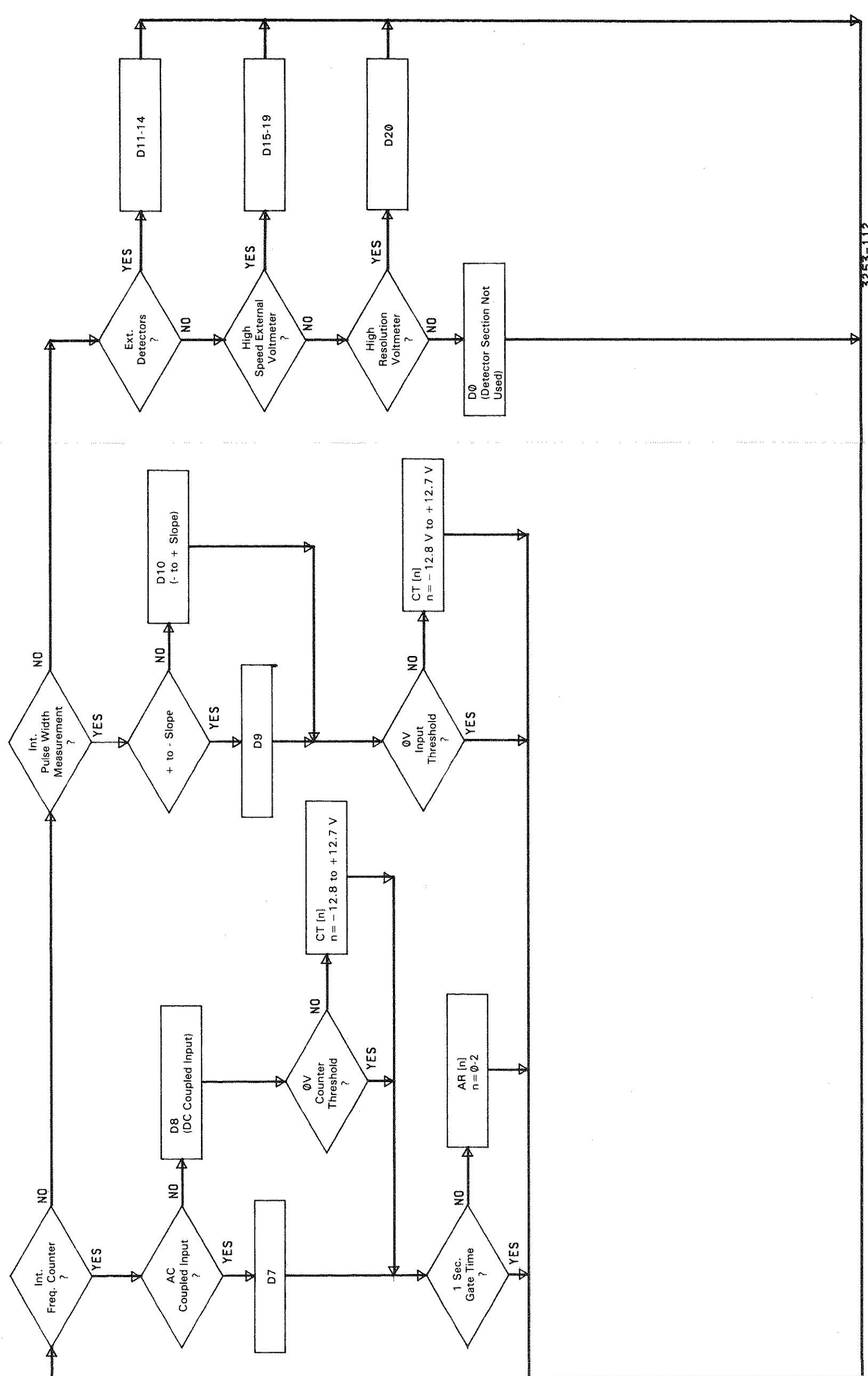
Source.....	S3 (1 kHz)
Offset.....	OF0
Amptd.....	A1
Compliance.....	C.15
Frequency.....	FR5000
Detector.....	D3
A-D Range.....	AR3
Counter Threshold.....	CT0
Filter.....	F1
Wait.....	W0





FROM T12





3-94. T13 (Transfer Test [voltage source to detector]).

3-95. Applications.

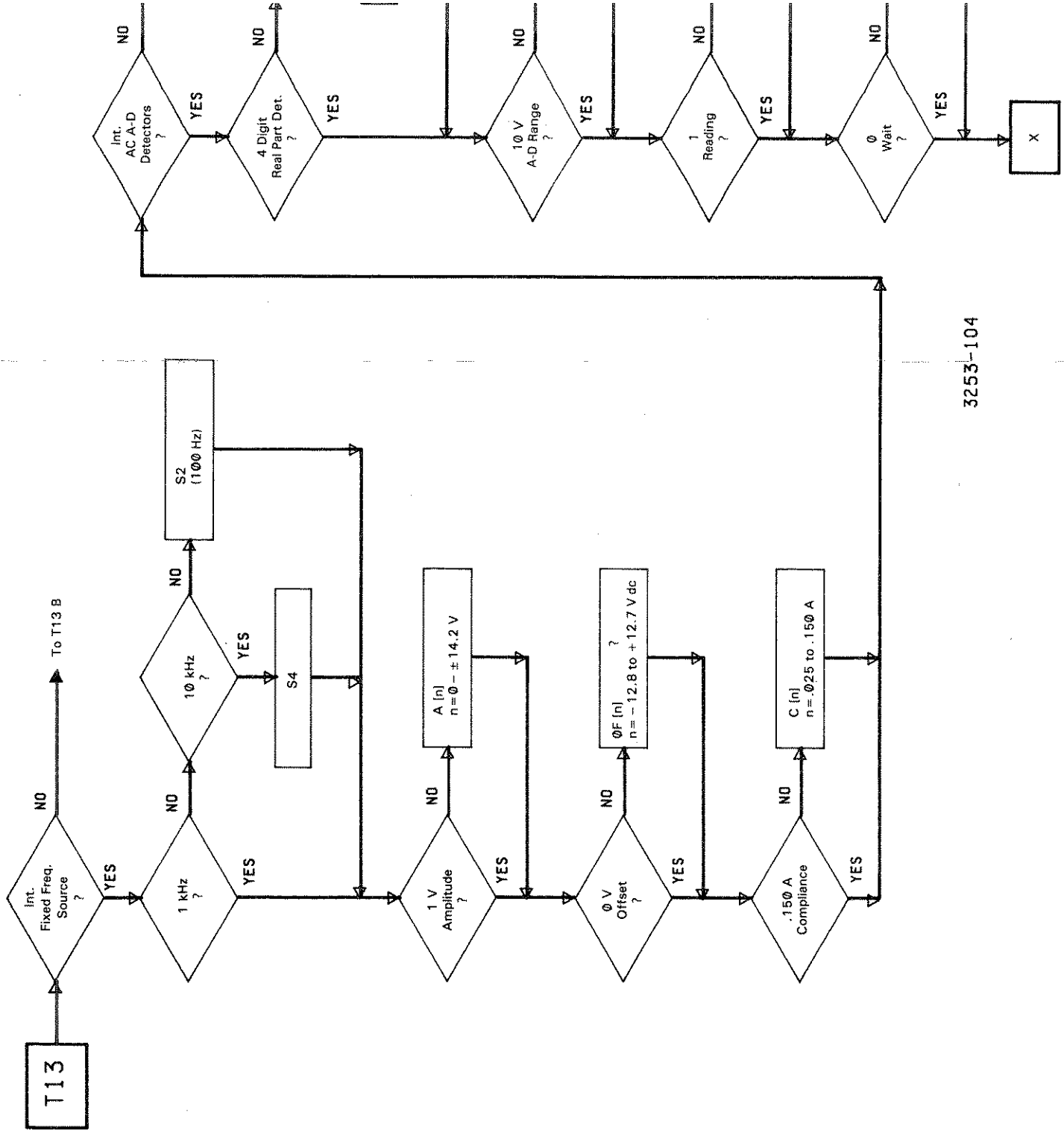
- a. Monitor the applied source with an internal or external detector.

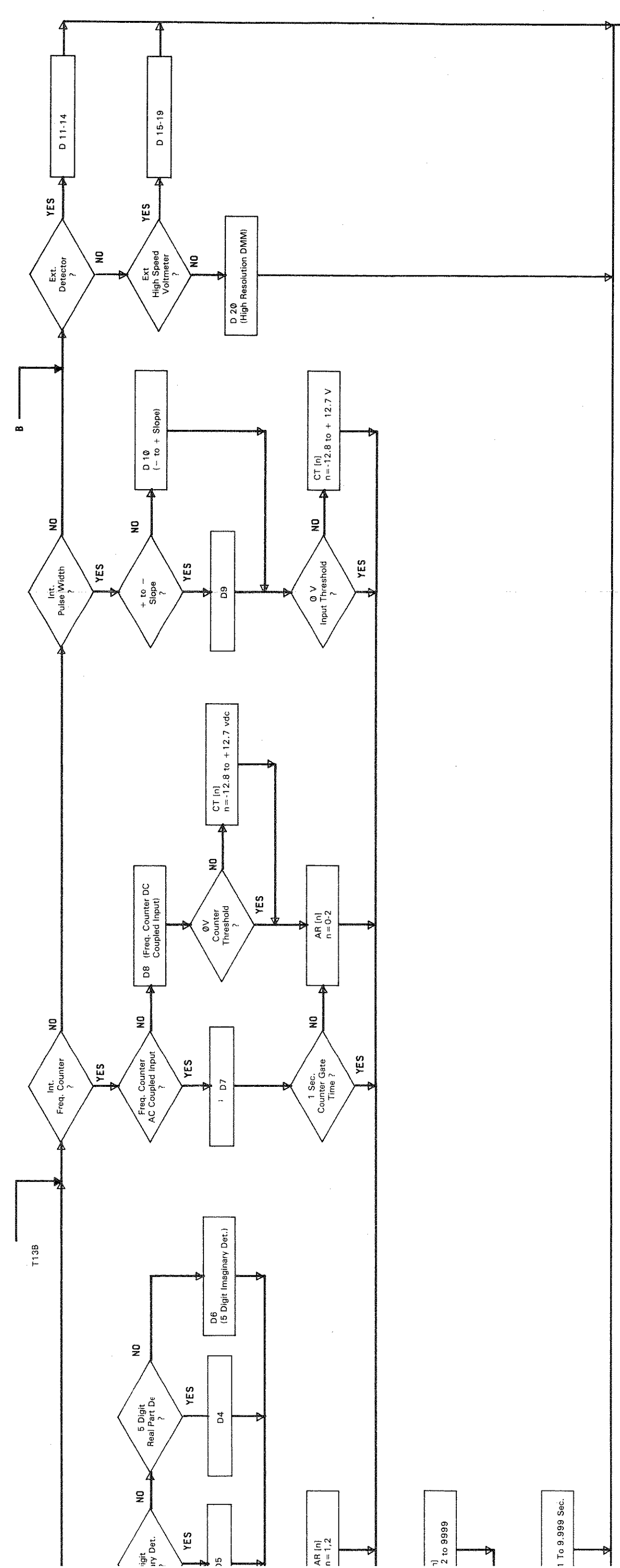
3-96. Programming Tips.

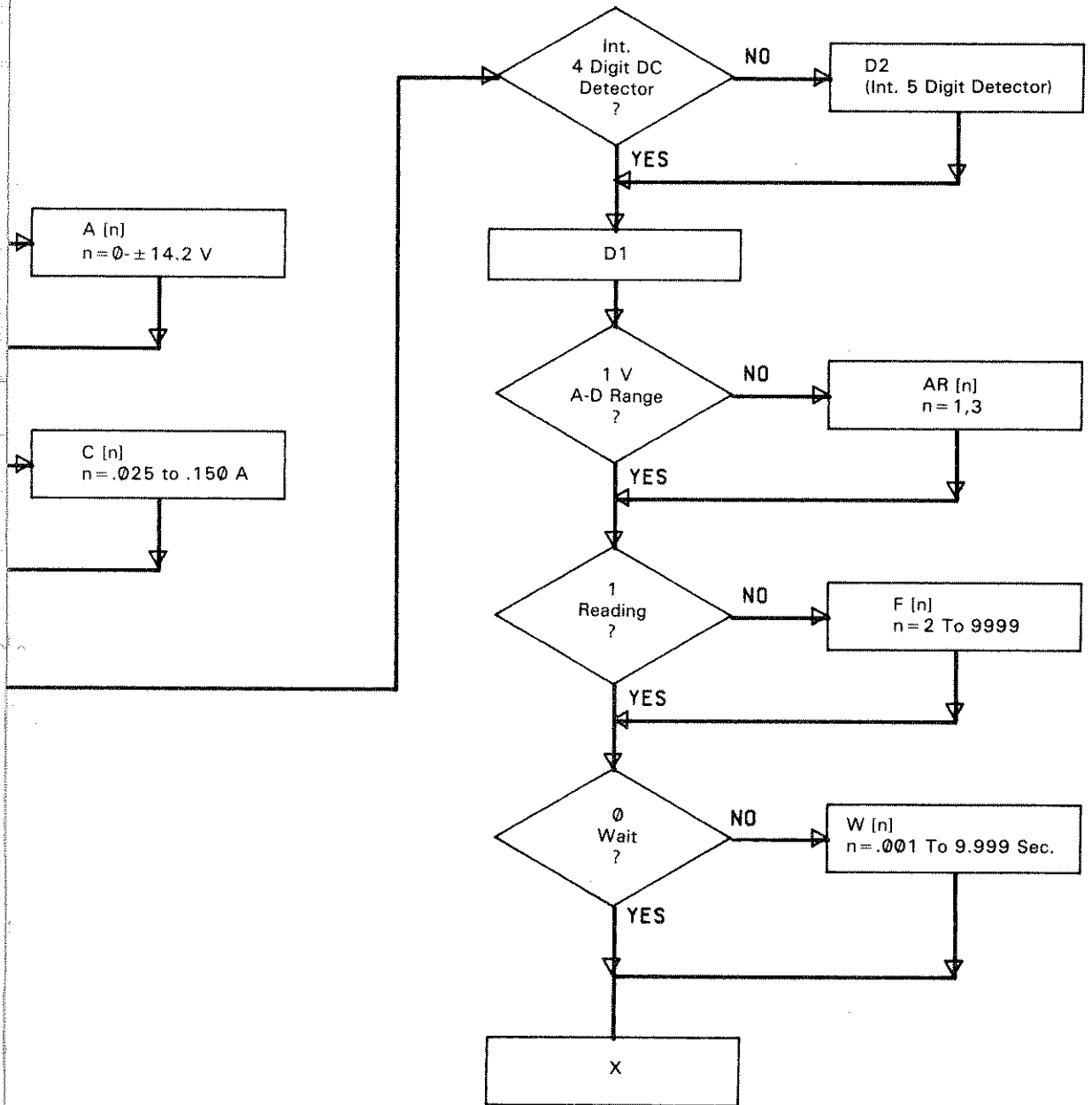
- a. Care should be taken to make certain that the detector used is compatible with the source (e.g. DC detector with a DC source).

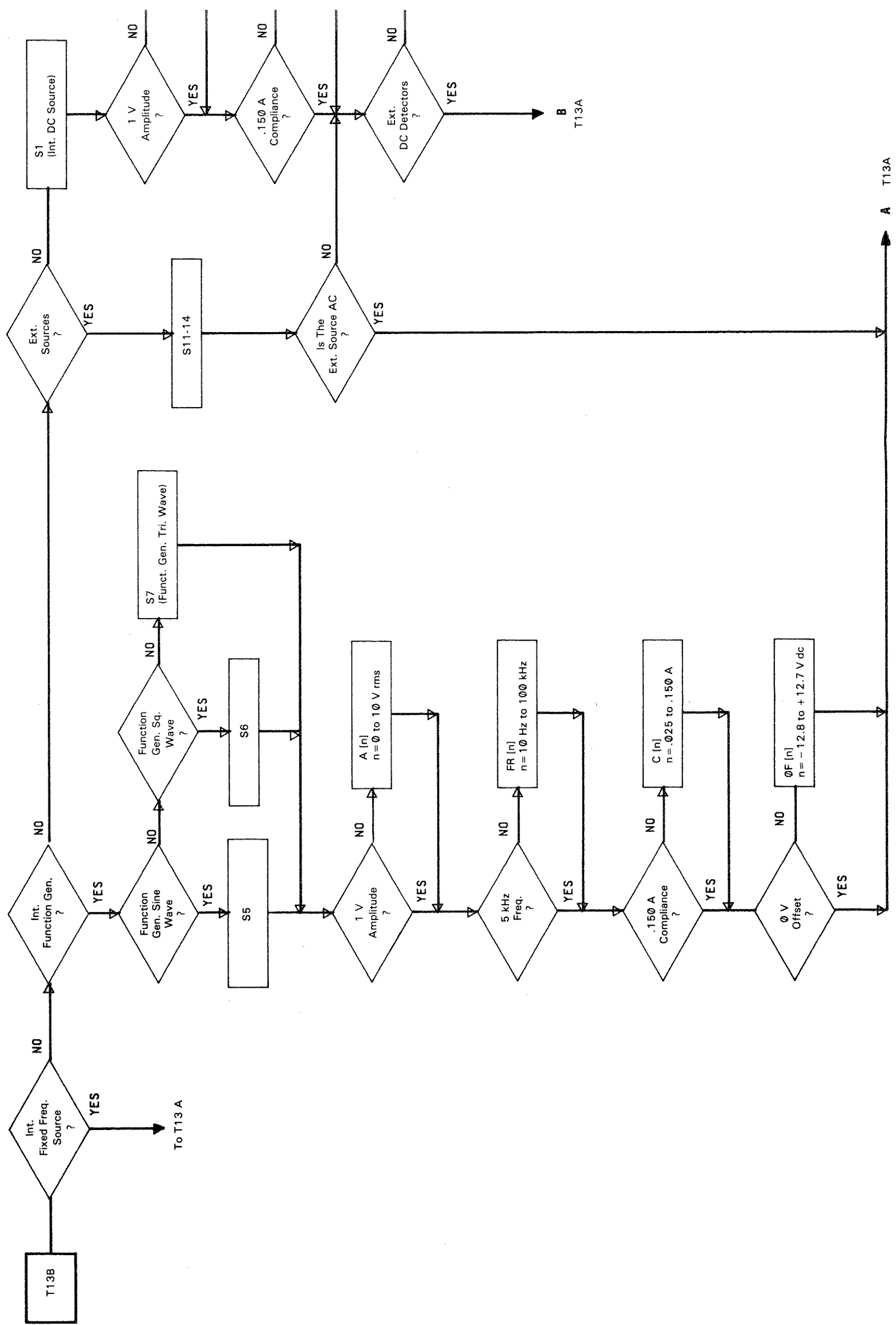
3-97. Default Codes.

Source.....S3 (1 kHz)
 Offset.....OF0
 Ampid.....A1
 Compliance.....C.150
 Frequency.....FR5000
 Detector.....D3
 A-D Range.....AR3
 Counter Threshold.....CT0
 Filter.....F1
 Wait.....0









3-98. T14 (Transfer Test [current stimulus, voltage response]).

3-99. Applications.

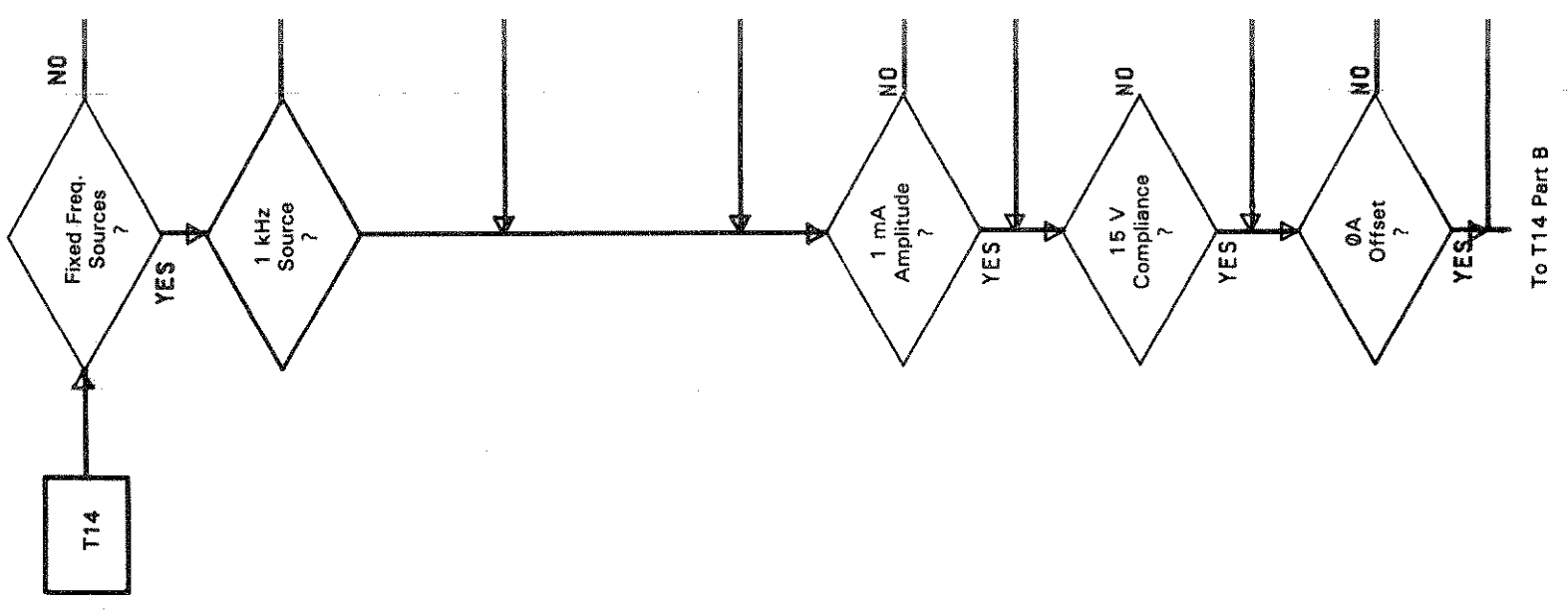
- a. Provides a programmable current signal for functional testing.

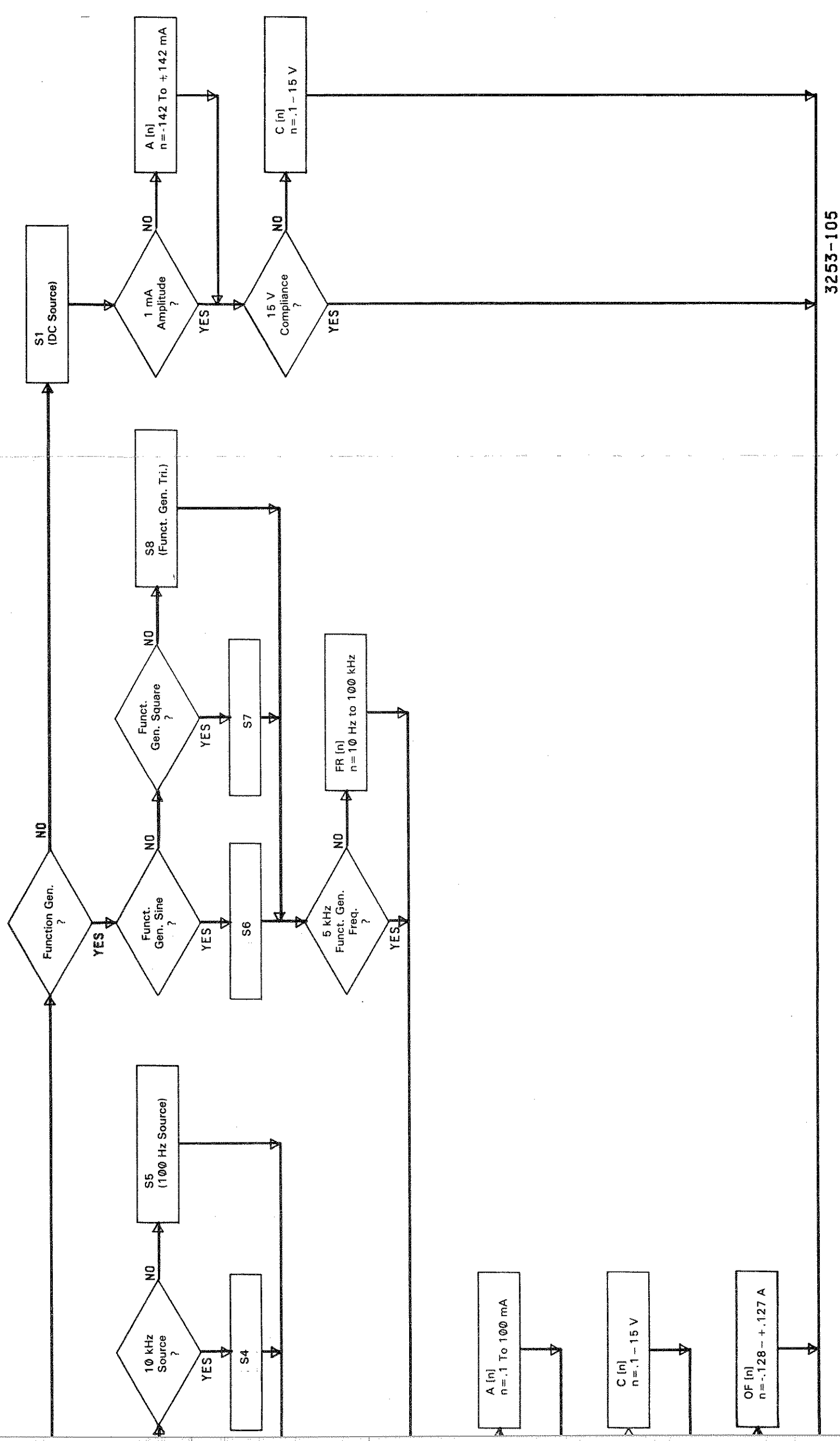
3-100. Programming Tips.

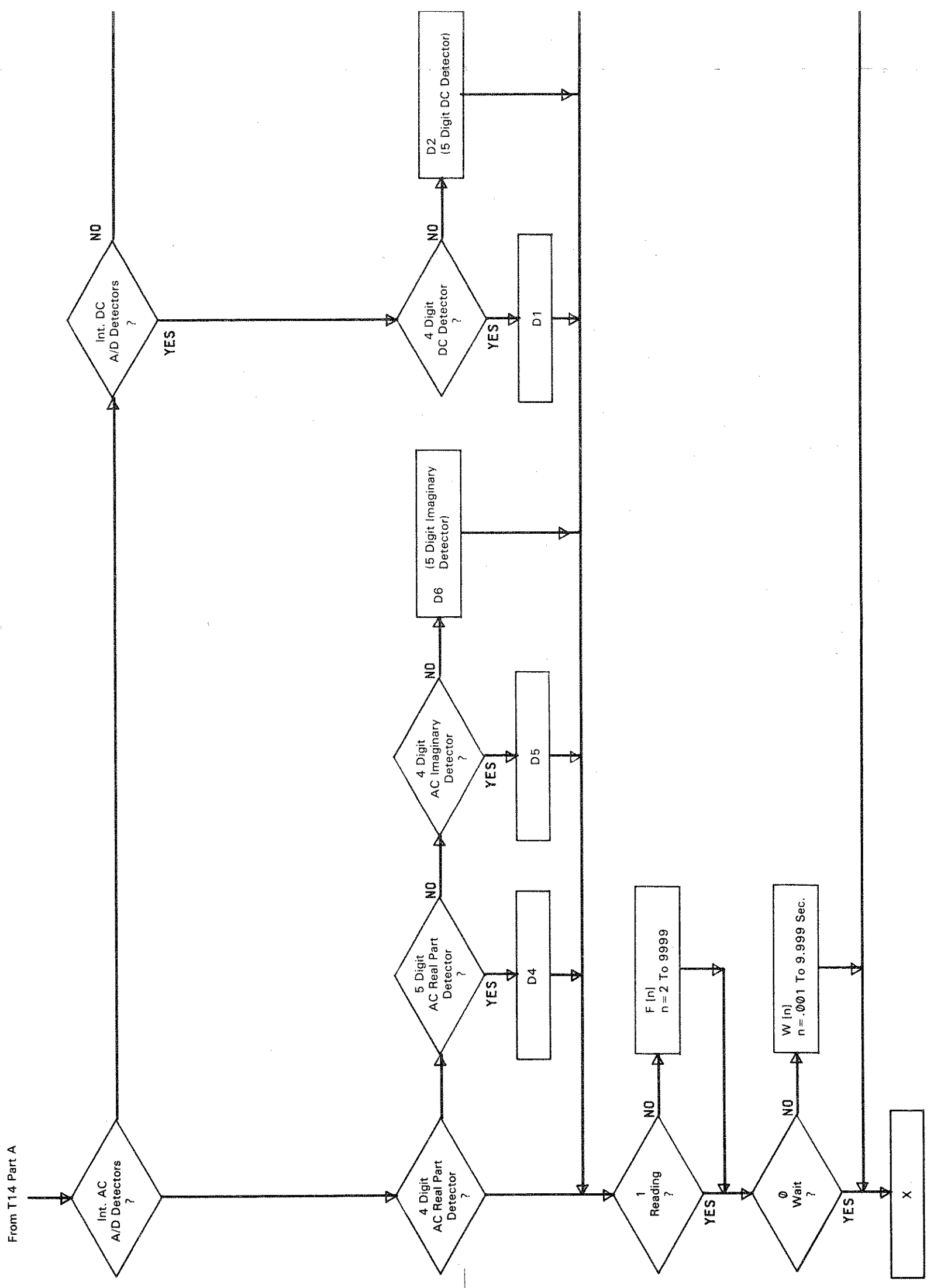
- a. Only internal source can be used.

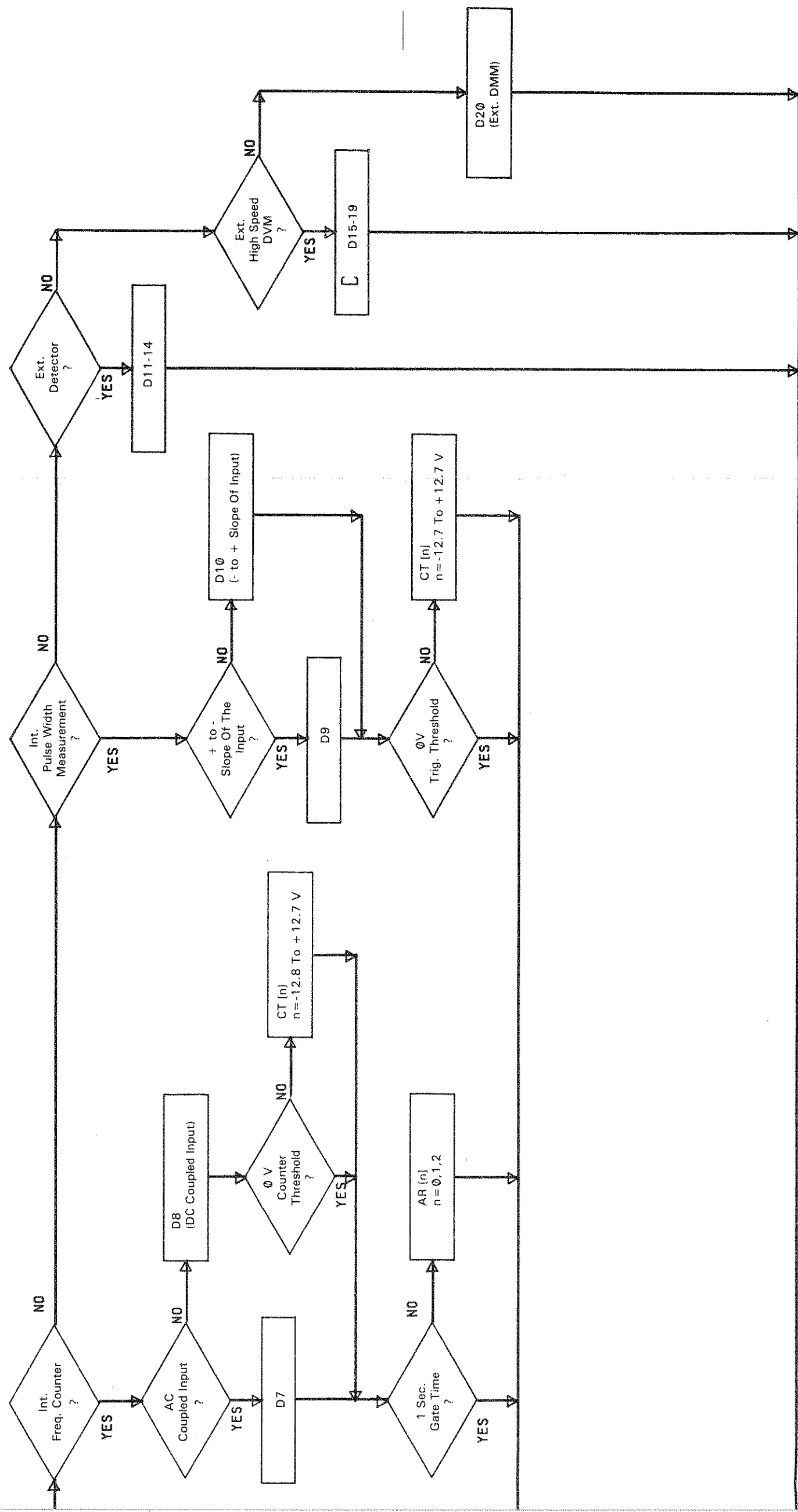
3-101. Default Codes.

Source.....S3 (1 kHz)
 Offset.....OF0 (amps)
 Amptd.....A.001 (amps)
 Compliance.....C15 (volts)
 Frequency.....FR5000
 Detector.....D3
 A-D Range.....AR3
 Counter Threshold.....CT0 (volts)
 Filter.....F1
 Wait.....W0









3-102. T15 (Transfer Test [current stimulus to detector]).

3-103. Applications.

- a. T15 does not have an external use.
- b. Used to set the internal current stimulus for a precise amplitude (uses the MOA and reference resistor to convert current to voltage).

3-104. Programming Tips.

- a. The reference resistor should be selected so that the resistance times the programmed current does not exceed the maximum output of the MOA (± 14.2 V DC or 10 V rms AC).

3-105. Default Codes.

Source.....	S3 (1 kHz)
Offset.....	OF0 (amps)
Amptd.....	A.001 (amps)
Compliance.....	C15 (volts)
Frequency.....	FR5000
Detector.....	D3
A-D Range.....	AR3
Counter Threshold.....	CT0 (volts)
Filter.....	F1
Reference Element.....	R4 (10 K Ω)

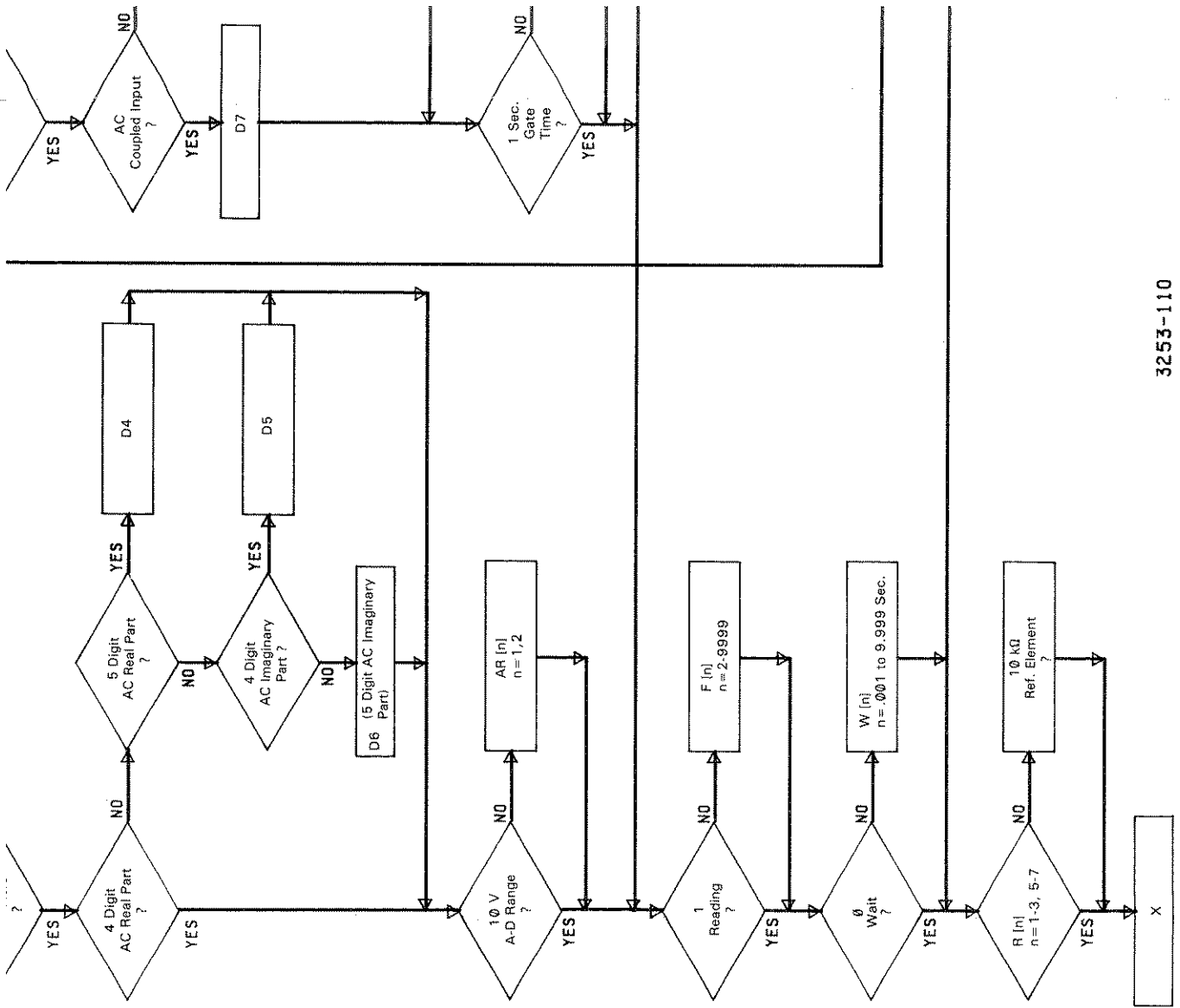
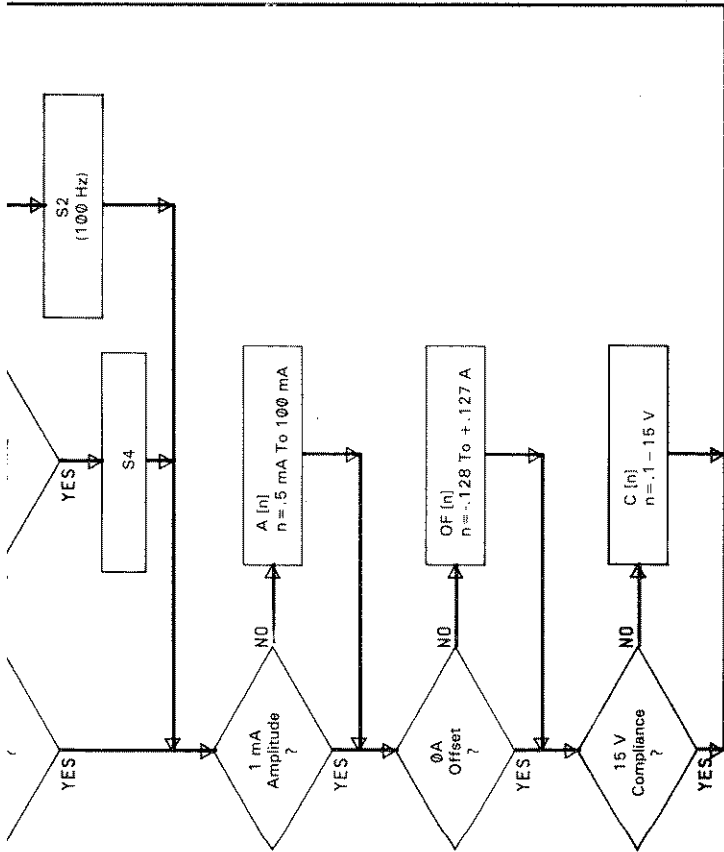
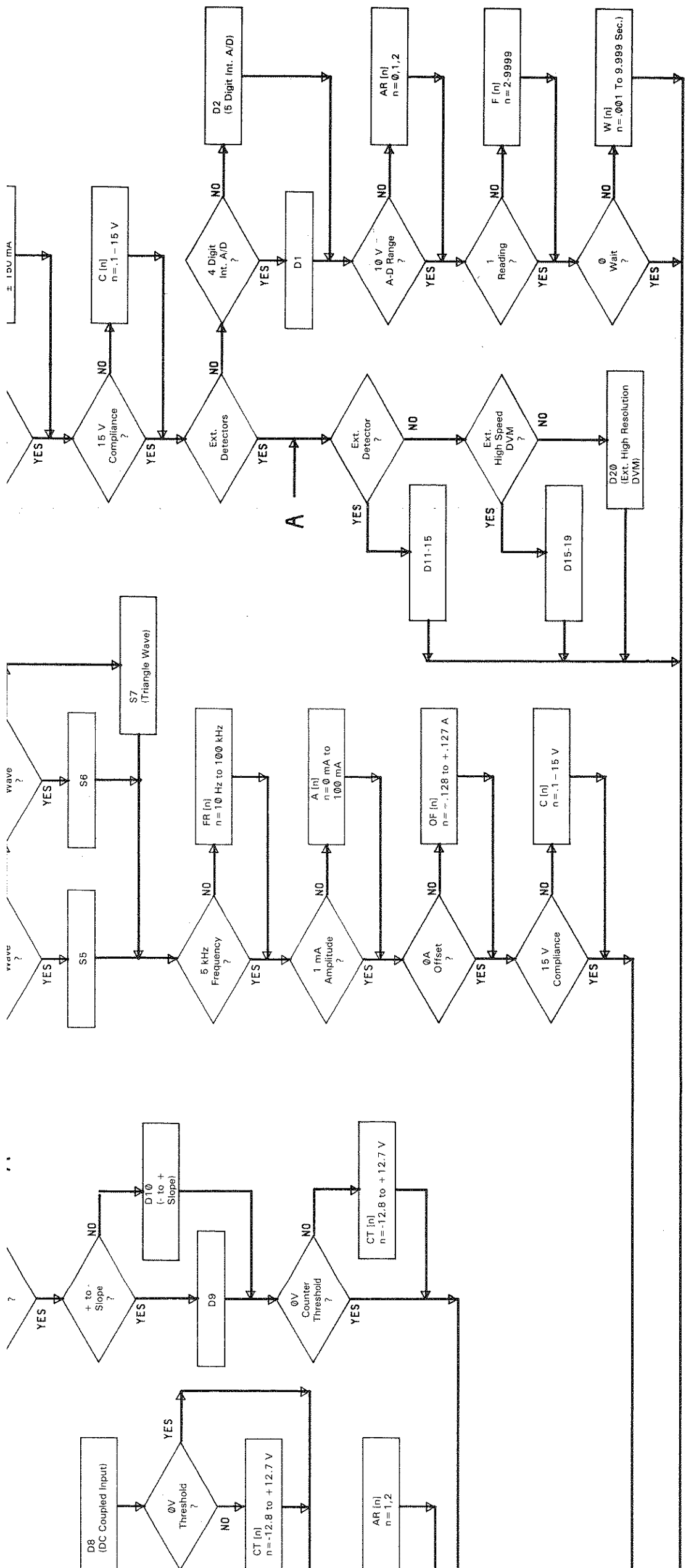


Figure 3-36. 115 Programming Flowchart.
3-63/3-64



3-106. REMOTE OPERATION.**3-107. General HP-IB Description.**

3-108. The Model 3253A remotely controlled by means of the Hewlett-Packard Interface Bus (HP-IB). The HP-IB is an instrumentation interface which simplifies the integration of instruments, calculators, and computers in a system.

NOTE

HP-IB is Hewlett-Packard's implementation of IEEE Std. 488-1975, Standard Digital Interface for Programmable Instrumentation.

3-109. The HP-IB is a parallel bus of 16 active signal lines grouped into three sets, according to function, to interconnect up to 15 instruments. See Figure 3-37 for a diagram of the Interface Connections and Bus Structure.

3-110. Eight signal lines form the first set and are termed DATA lines. The Data lines carry coded messages which represent addresses, program data, measurements, and status bytes. The same DATA lines are used for input-output of messages in bit-parallel, byte-serial form. Normally, a seven-bit ASCII code represents each piece of DATA with the eighth bit available for Parity Checking.

3-111. Data is transferred by means of an interlocked "handshake" technique which permits data transfer (asynchronously) at the rate of the slowest device participating in that particular conversation. The three DATA BYTE TRANSFER CONTROL lines are used to implement the handshake technique and form the second set of lines.

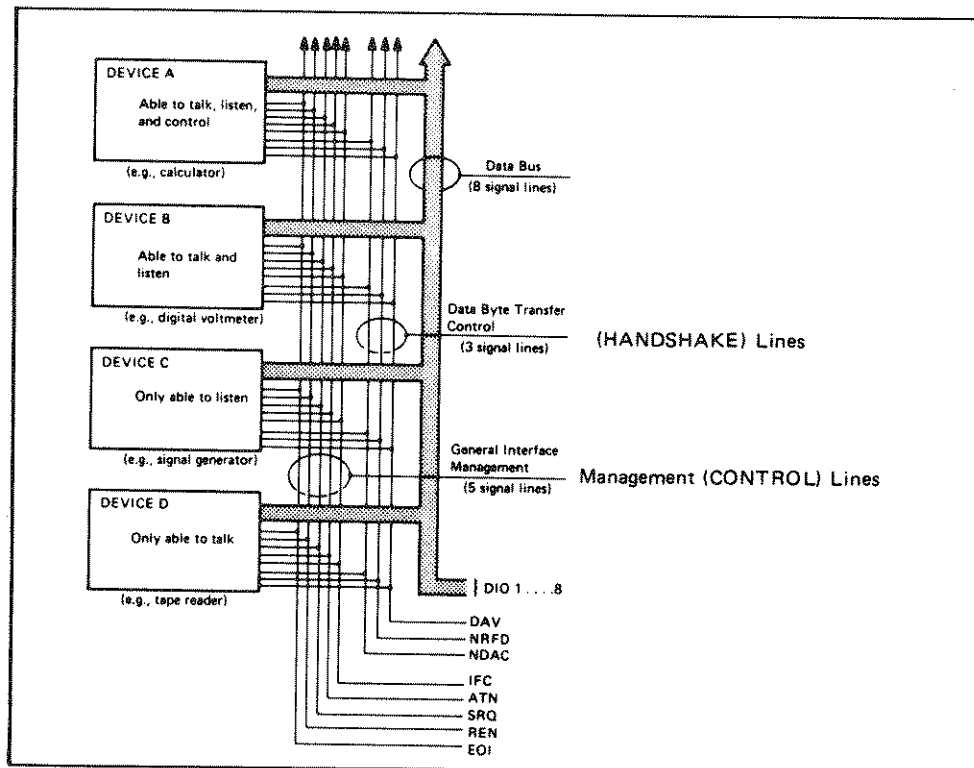


Figure 3-37. Interface Connections and Bus Structure.

3-112. The remaining five GENERAL INTERFACE MANAGEMENT lines form the third set, and in such ways are used as activating all the connected devices at once, clearing the interface, etc. Refer to Table 3-9 for the definition of each of the management lines.

Table 3-9. General Interface Management Lines.

Name	Mnemonic	Description
Attention	ATN	Enables a device to interpret data on the bus as a controller command (command mode) or data transfer (data mode).
Interface Clear	IFC	Initializes the HP-IB system to an idle state (no activity on the bus).
Service Request	SRQ	Alerts the controller to a need for communication.
Remote Enable	REN	Places instruments under remote program control.
End or Identify	EOI	Indicates last data transmission during a data transfer sequence; used with ATN to poll devices for their status.

3-113. Overview Of HP-IB System Operations.

3-114. The following are definitions of the terms and concepts used to describe HP-IB (bus) system operations.

HP-IB System Terms

- a. Byte—A unit of information consisting of 8 binary digits (bits).
- b. Device—Any unit that is compatible with the IEEE Standard 488-1975.
- c. Device Dependent—An action a device performs in response to information sent on the HP-IB. The action is characteristic of an individual device and may vary from device to device.
- d. Operator—The person that operates either the system or any device in the system.
- e. Address—The characters sent by a controlling device to specify which device will send information on the bus and which device(s) will receive that information. Addressing may also be accomplished by hardwiring a device so that it will only send information or only receive information.
- f. Polling—Polling is used as a means in which a controller can locate a device that needs interaction with it. The controller may poll devices for their operational condition one at a time, which is termed a Serial Poll, or as groups of devices simultaneously, which is termed a Parallel Poll.

3-115. Basis Device Communication Capability.

3-116. Devices which communicate along the interface bus can be classified into three basic categories:

- a. Talkers—Devices which *send* information on the bus when they have been addressed.
- b. Listeners—Devices which *receive* information sent on the bus when they have been addressed.
- c. Controllers—Devices that can specify the talker and listeners for an information transfer. The controller can be categorized as one of two types: Active Controller and System Controller. The Active Controller is defined as the current controlling device on the bus. The System Controller can take control of the bus even if it is not the Active Controller. Each System can only have one System Controller even if several controllers have the System Controller capability.

3-117. 3253A HP-IB Capability.

3-118. Table 3-10 lists the HP-IB Interface capability for the 3253A. The Interface capability is defined in accordance with IEEE Std. 488-1975, "Standard Digital Interface For Programmable Instrumentation."

Table 3-10. 3253A HP-IB Capability.

Code	Interface Function
SH1	Source handshake capability
AH1	Acceptor handshake capability
T6	Talker (basic talker, serial poll, unaddress to talk if address to listen)
L4	Listener (basic listener, unaddress to listen if address to talk)
SR1	Service request capability
RL1	Remote/local capability
PP2	Parallel poll capability, local configuration
DC1	Device clear capability
DT1	Device trigger capability
CØ	No controller capability
E1	Open collector bus drivers

3-119. Message Concepts.

3-120. Devices which communicate along the interface bus are transferring quantities of information from one device to one or more other devices. These quantities of information are called messages. Most of the messages consists of two basic parts: the address portion specified by the controller and the information that comprises the message. In turn, the messages can be classified into twelve types. The twelve types of messages are defined in Table 3-11.

Table 3-11. Definition Of Meta Messages.

Message	Definition
DATA	The actual information (binary bytes) which is sent from a talker to one or more listeners. The information or data can be in a numeric form or a string of characters.
TRIGGER	The trigger message causes the listening device(s) to perform a device-dependent action.
CLEAR	A clear message will cause a device(s) to return to a pre-defined device-dependent state.
REMOTE	The remote message causes the listening device(s) to switch from local front panel control, to remote program control. This message remains in effect so that devices subsequently addressed to listen will go into remote operation.
LOCAL	This message clears the remote message from the listening device(s) and returns the device(s) to local front panel control.
LOCAL LOCKOUT	The local lockout message is implemented to prevent the device operator from manually inhibiting remote program control.
CLEAR LOCKOUT AND SET LOCAL	This message causes all devices to be removed from the local lockout mode and revert to local. It will also clear the remote message for all devices.
REQUIRE SERVICE	A device can send this message at any time to signify that it needs some type of interaction with the controller. The message is cleared by the device's status byte message if it no longer requires service.
STATUS BYTE	A byte that represents the status of a single device. One bit indicates whether the device sent the required service message and the remaining 7 bits indicate operational conditions defined by the device. This byte is sent from the talking device in response to a "Serial Poll" operation performed by a controller.
STATUS BIT	<p>A byte that represents the operational conditions of a group of devices on the bus. Each device responds on a particular bit of the byte thus identifying a device dependent condition. This bit is typically sent by devices in response to a parallel poll operation.</p> <p>The status bit message can also be used by a controller to specify the particular bit and logic level that a device will respond with when a parallel poll operation is performed. Thus more than one device may respond on the same bit.</p>
PASS CONTROL	This message transfers the bus management responsibilities from the active controller to another controller.
ABORT	The system controller sends the abort message to unconditionally assume control of the bus from the active controller. The message will terminate all bus communications but does not implement the clear message.

3-121. Instrument Response To Messages. The 3253A is capable of using only those messages indicated in Table 3-11. In order for those messages to be implemented, certain bus actions are required. Those actions are detailed under the Interface Functions Column.

Table 3-12. 3253A Implementation of Meta Messages.

Message	Implementation*	Interface Functions**		3253A Response
		Sender	Receiver	
Data	SR	T, SH	L ⁿ , AH	Send or Receive Data
Trigger	R	C, SH	DT ⁿ , L, AH	Execute previously stored command
Clear	R	ID-List C, SH ALL C, SH	DC, L, AH DC, AH	Will return 3253A to turn on condition (T ₀)
Remote	R	ID-List C _s , SH Remote Enable	RL, AH	Goes to remote control when address to listen. Front Panel local button will return to local control
Local	R	C _s , SH	RL ⁿ , AH	Goes to local control (Front Panel)
Local Lockout	R	C, SH	RL, AH	Goes to remote control, can not be returned to local control from the front panel
Clear Local Lockout and set Local	R	C, SH	RL, AH	Clear remote and returns 3253A to local control
Require Service	S	SR	C	Sets DIO7 (SRQ)
Status Byte	S	SR ⁿ	L ⁿ , AH	Send 1 byte that indicates status of the 3253A
Status Bit	S	PP ⁿ	C	Sets DIO2 if service is requested
Pass Control	N/A			
Abort	R	C _s		Returns the 3253A to local
* S = Send only R = Receive only SR = Send and Receive N/A = Not Applicable		** SH = Source Handshake AH = Acceptor T = Talker L = Listener SR = Service Request RL = Remote Local PP = Parallel Poll DC = Device Clear C = Controller C _s = System Controller		

3-122. HP-IB Addressing.

3-123. Certain Meta Messages require that a specific listener and talker be designated on the bus. Each instrument on the bus has its own distinctive listen and or talk address. The device address provides the identity to distinguish it from other devices on the bus. The instrument receives programming instructions when address to listen. When address to talk, the instrument can output measurement data or send programming instructions if it is also the system controller. The address is set via jumpers or switches. Refer to Figure 3-38 for allowable address settings.

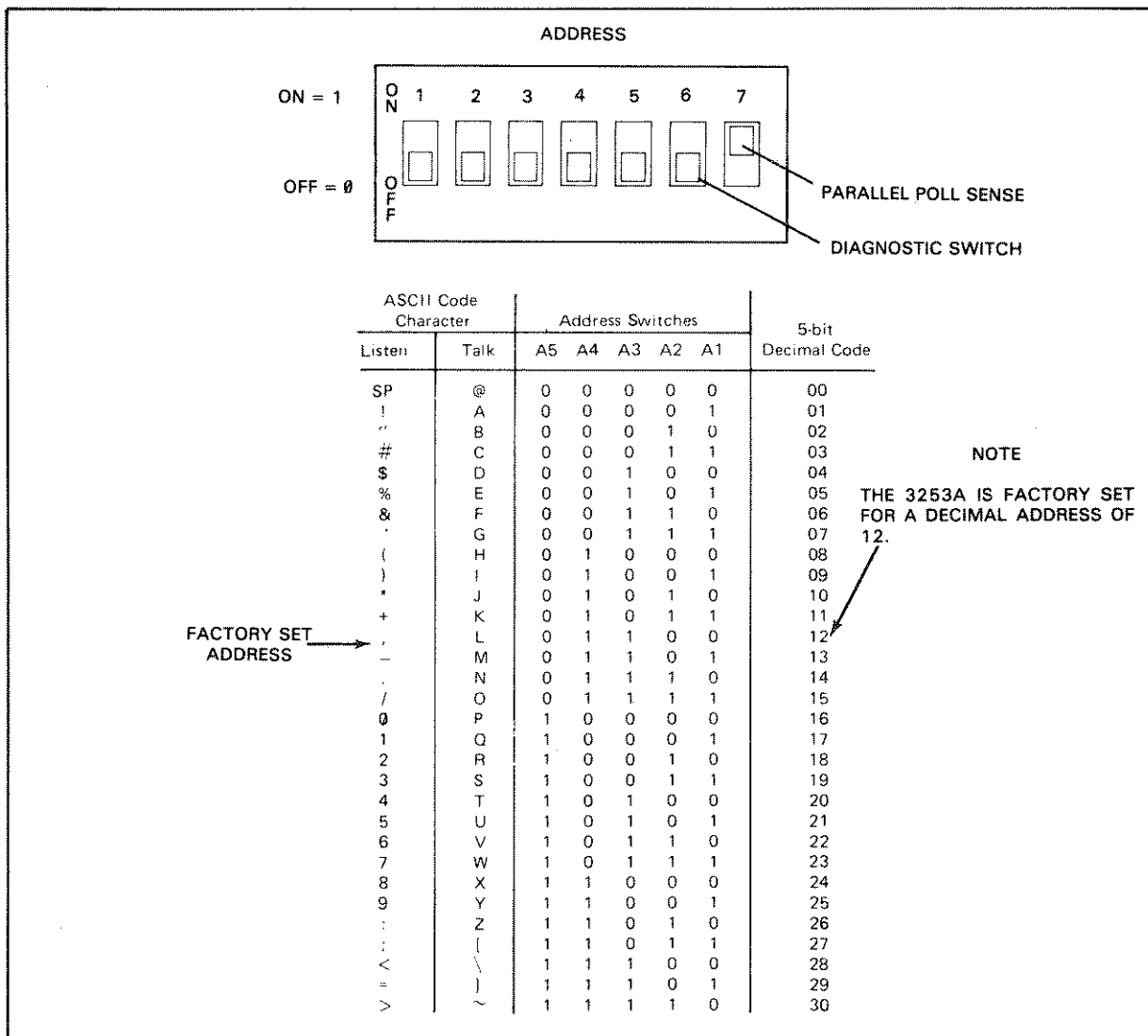


Figure 3-38. Address Selection.

3-124. Since each instrument has its own distinctive address, HP-IB programming requires that an address be designated when attempting to send information to, or receive information from, an individual instrument. An address is usually in the form of:

[universal unlisten, device talk, device listen].

The universal unlisten command removes all listeners from the bus, thus allowing only the specific listener(s) designated by the device listen parameter, to receive information. The information is sent by a talker which is designated by the device talk parameter. In many controllers this type of basic bus addressing is taken care of automatically.

3-125. Instrument Programming.

3-126. The instrument programming section provides the basic information to control the 3253A via the HP-IB. The first and most important step for the user is to completely define the measurement the instrument will be making. The next step is to define the measurement requirements in terms the instrument can use. These terms are called Program Codes. They are device-dependent since each instrument has its own set of Program Codes. The Program Codes are ASCII characters which are transmitted to the instrument via the HP-IB. The

codes are defined in the first part of this section and followed by programming flowcharts to aid in writing program lines.

3-127. The final step is to write the problem and solution down in the order it should be performed in (an algorithm) and then convert the Algorithm into controller language.

3-128. Once the Algorithm for the program has been completed, it can be converted to code. The conversion to code requires the conversion charts or block diagram for Meta Messages as mentioned before, plus the understanding of the instrument program codes.

NOTE

The Meta Message in itself is not a program code or an HP-IB command. It is only intended to be an uncomplicated means to translate a program written as an algorithm into the controller's code.

3-129. The Meta Message Block diagrams show which bus signals are required for a particular message. Note that some controllers may be able to implement the function with a single character of code or it may take several lines of code depending on the individual controller.

3-130. Algorithm. As described in the introduction to Instrument Programming, the Algorithm written for the instrument will express exactly how to set up and implement the instrument measurement or function. In order to make the transition from algorithm to program code as simple as possible, the user should use the twelve Meta Messages as key words. The twelve messages are shown below for reference.

DATA
TRIGGER
CLEAR
REMOTE
LOCAL
LOCAL LOCKOUT
CLEAR LOCKOUT AND SET LOCAL
REQUIRE SERVICE
STATUS BYTE
STATUS BIT
PASS CONTROL
ABORT

3-131. These messages may be directly converted to code using and -hp- Calculator Manual. The -hp- 9825A Calculator Extended I/O Manual provides a one to one chart for program code conversion, see this manual if this is your controller. In cases where the controller used with the instrument does not have a conversion chart, the user may refer to the block diagram associated with each Meta Message located in the expanded Meta Message topic. The block diagrams show the bus signals required to implement each message. Note that this is only required when a conversion chart is not available.

3-132. The following figures expand the Meta Message and contain a block diagram showing bus signal.

DATA

The DATA message is the actual information (8 bit byte) which is sent from a talker to one or more listeners. This action requires the controller to first enter the command mode to set up the talker and receiver(s) for the transfer of DATA. When the command mode is complete, the information is transmitted when the bus enters the Data Mode.

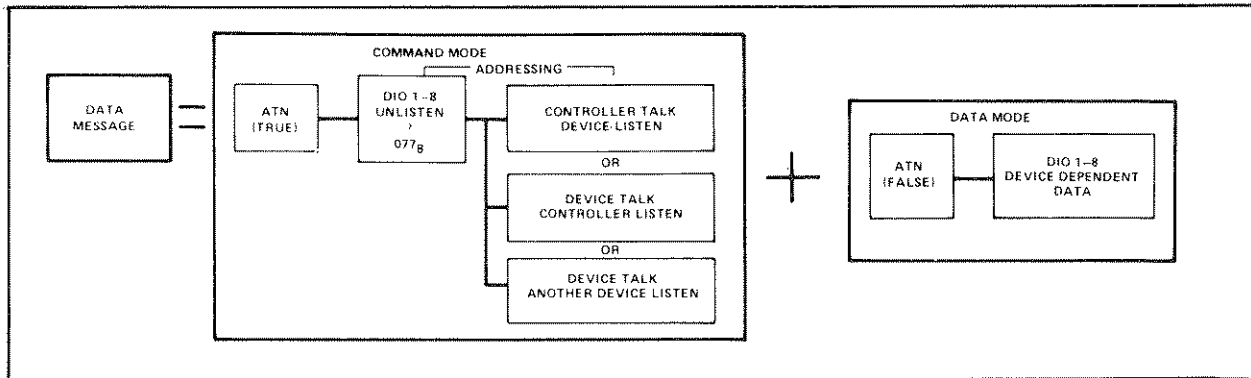


Figure 3-39. Meta Message—Data.

TRIGGER

The TRIGGER message will send a trigger to cause all addressed instruments to execute some predefined function simultaneously. Note that the bus must be in remote prior to implementing the Trigger Message.

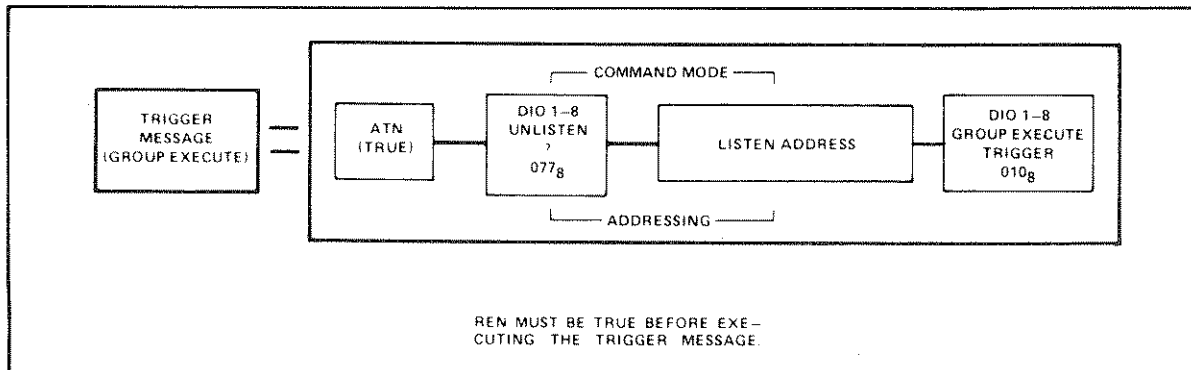


Figure 3-40. Meta Message—Trigger.

CLEAR

The CLEAR message may be implemented for addressed devices or for all devices on the bus capable of responding. In both cases the controller places the bus in the Command Mode to execute the message.

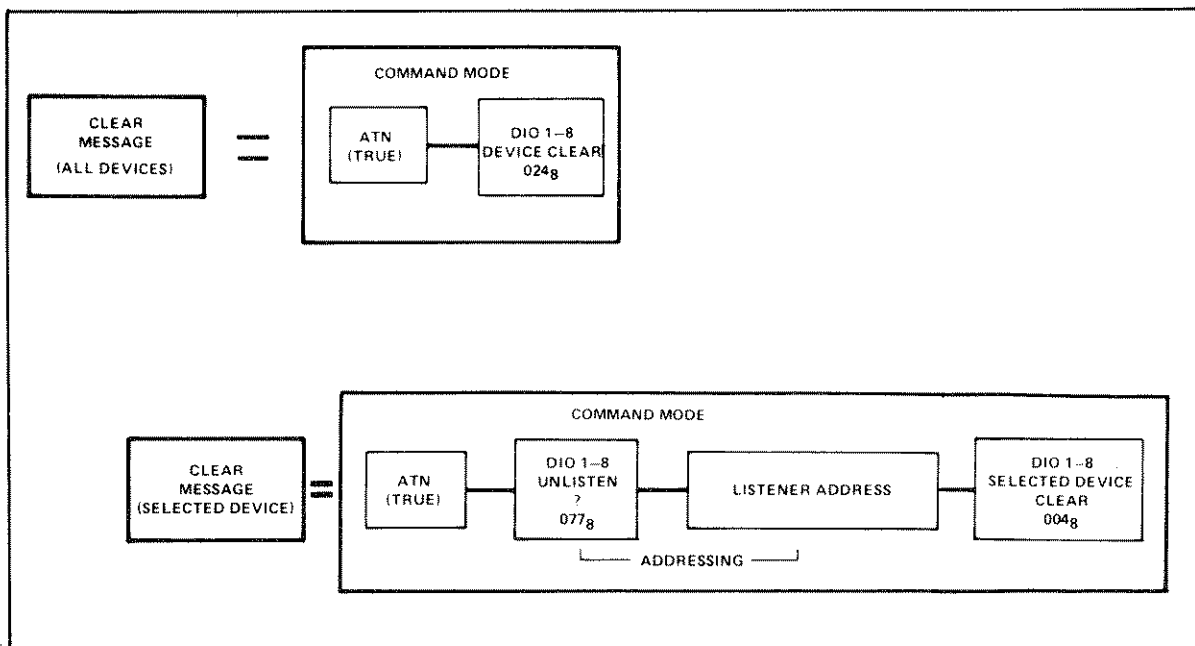


Figure 3-41. Meta Message-Clear.

REMOTE

Only the System controller can place the instrument into the Remote Operating condition. To implement the REMOTE message, the controller will set the REN line true. The HP-IB is then in the Enable-Only mode. In the Enable-Only mode, the bus instruments are not in remote but will go into remote as soon as they are addressed.

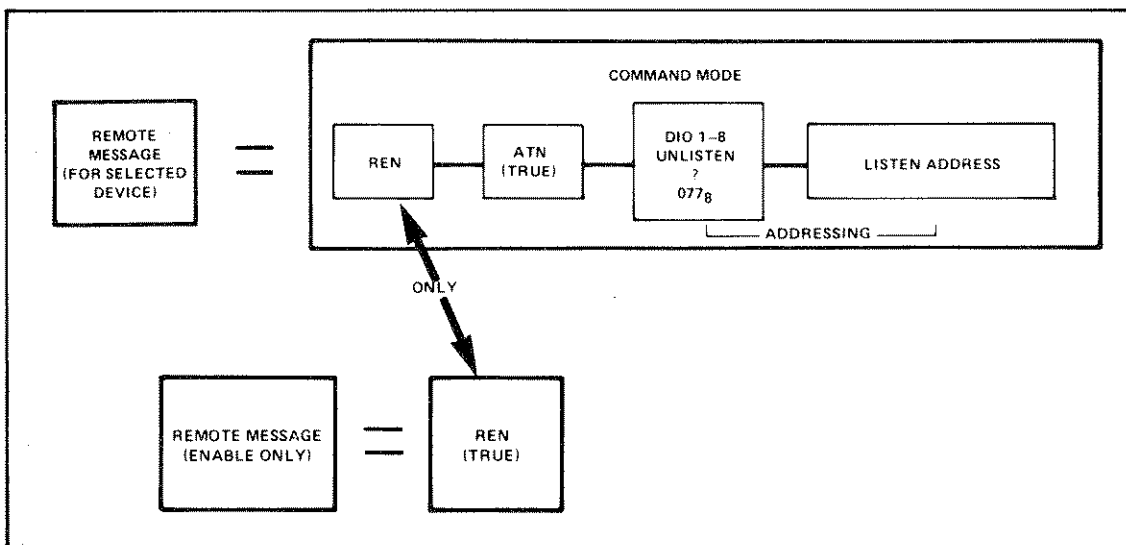


Figure 3-42. Meta Message-Remote.

LOCAL

The LOCAL message will remove addressed instruments from remote Operation Mode to Local-Front panel control. The controller must place the HP-IB into the command mode and address all instruments to listen that are to be returned to local. The local message will not remove the bus from the remote mode, only the listening devices.

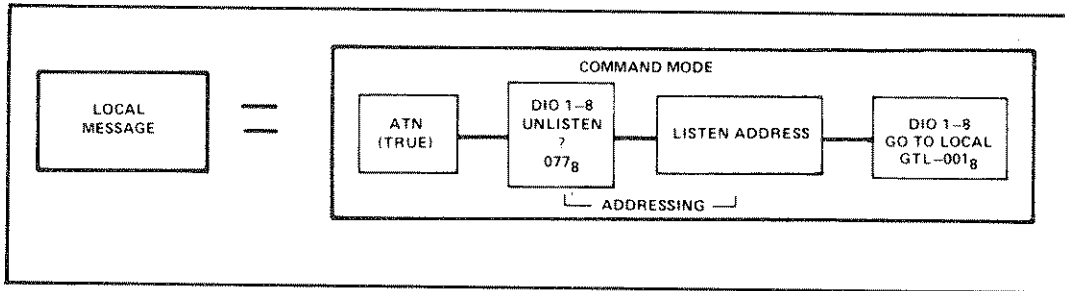


Figure 3-43. Meta Message—Local.

LOCAL LOCKOUT

The LOCAL LOCKOUT message prevents the instrument operator from placing the instrument into local control from the front panel. The controller must be in the command mode to send the local lockout message.

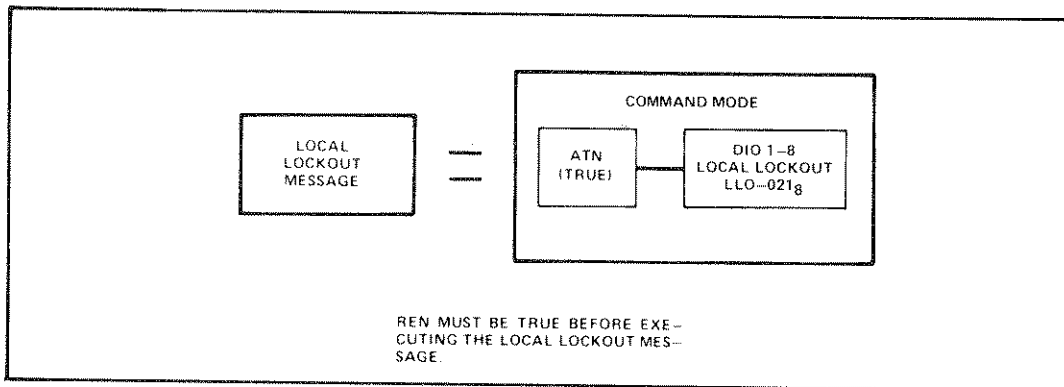


Figure 3-44. Meta Message—Local Lockout.

CLEAR LOCKOUT AND SET LOCAL

When implemented, this message removes all instruments from the local lockout mode and causes them to revert to local-front panel control. Since the REN line is sent false the bus is also in the local mode.

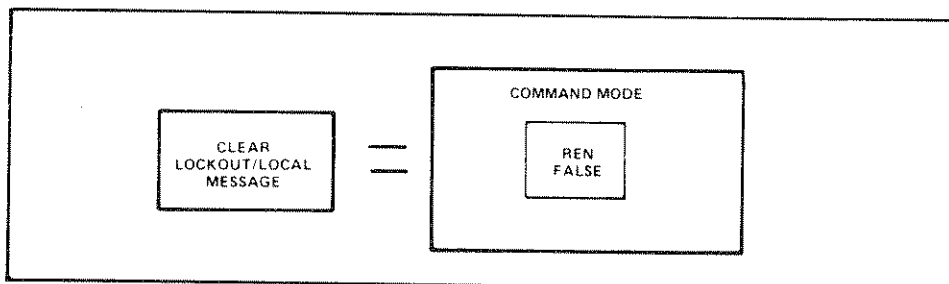


Figure 3-45. Meta Message—Clear Lockout and Set Local.

REQUIRE SERVICE

The REQUIRE SERVICE message is implemented by an instrument by causing the HP-IB SRQ line true state. The REQUIRE SERVICE message and therefore the SRQ line is held true until a poll is conducted to determine the cause of the request for service or until the device no longer needs service.

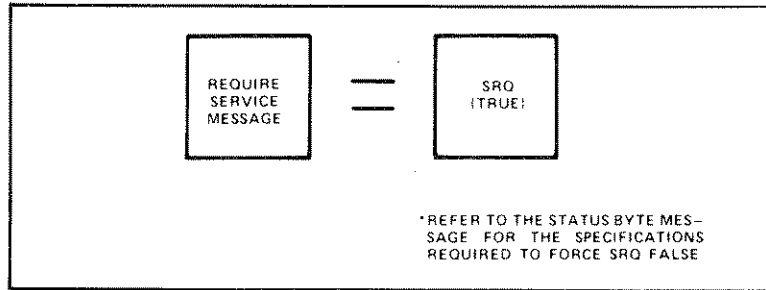


Figure 3-46. Meta Message—Require Service.

STATUS BYTE

The STATUS BYTE message represents the operational status of a single instrument during a Serial Poll. A controller usually Serial Polls devices in response to a request for service from the bus. Serial Polling consists of the controller requesting device status information from one device at a time. The status information byte (8 bits) sent by the polled device will tell whether that device needed service and why. A device will stop requesting service upon being Serial Polled or if it no longer needs service. The controller initiates the message by placing the bus into the command mode, sending the Serial Poll Enable Command, and addressing the specific devices to be polled. The device in turn sends its Status Byte back (DATA mode) and clears the SRQ line, provided the cause for the Require Service messages is no longer present. When the Data mode has been completed, the controller reenters the command mode to terminate the message with a Serial Poll Disable command.

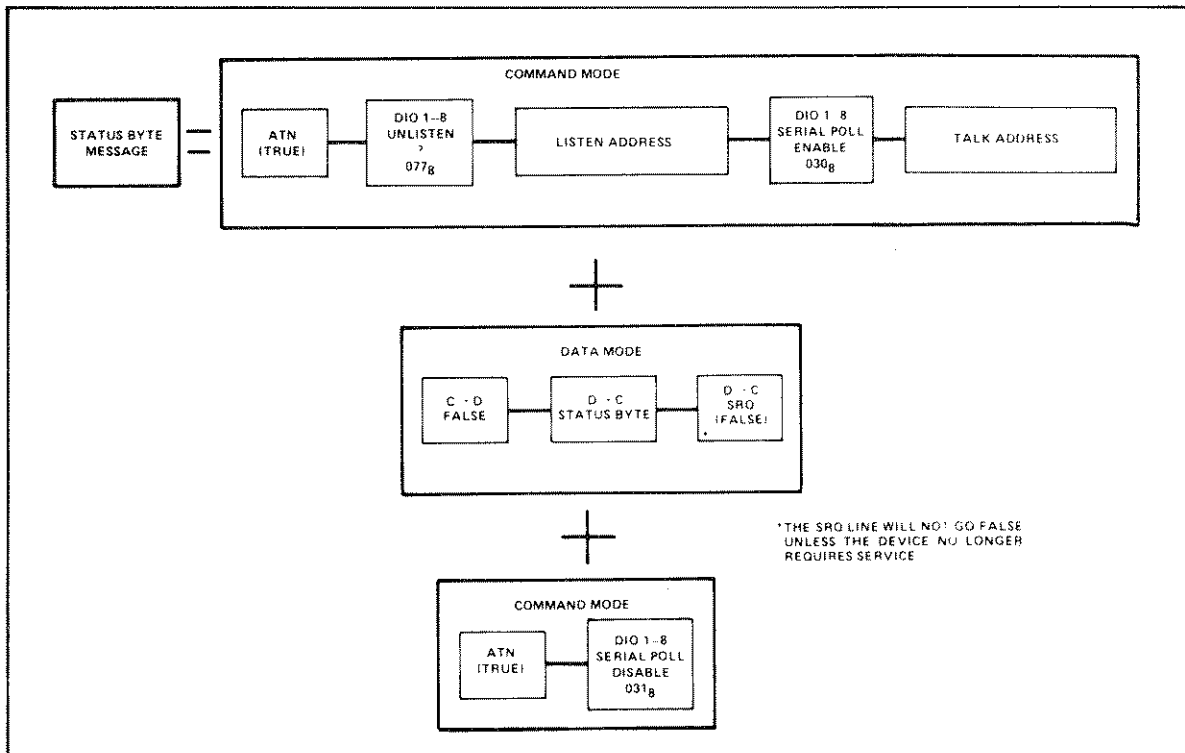


Figure 3-47. Meta Message—Status Byte.

STATUS BIT

The STATUS BIT message is sent by a device to the controller to indicate its operational status in response to a parallel poll operation. Parallel Polling consists of the controller requesting one bit of Status device, from each, all at once. The Parallel Poll may consist of three types of operations: Configuring, Polling, and Unconfiguring. In Configuring, the controller assigns each device a logic level and bit (bus data line) for a poll response. During polling, each device responds on its assigned bus data line with the appropriate logic level. In Unconfiguring, the controller negates the bit and level assignments for all or selected devices. Several devices may be assigned to the same bit and level, causing their response bits to be logically ORed or ANDed.

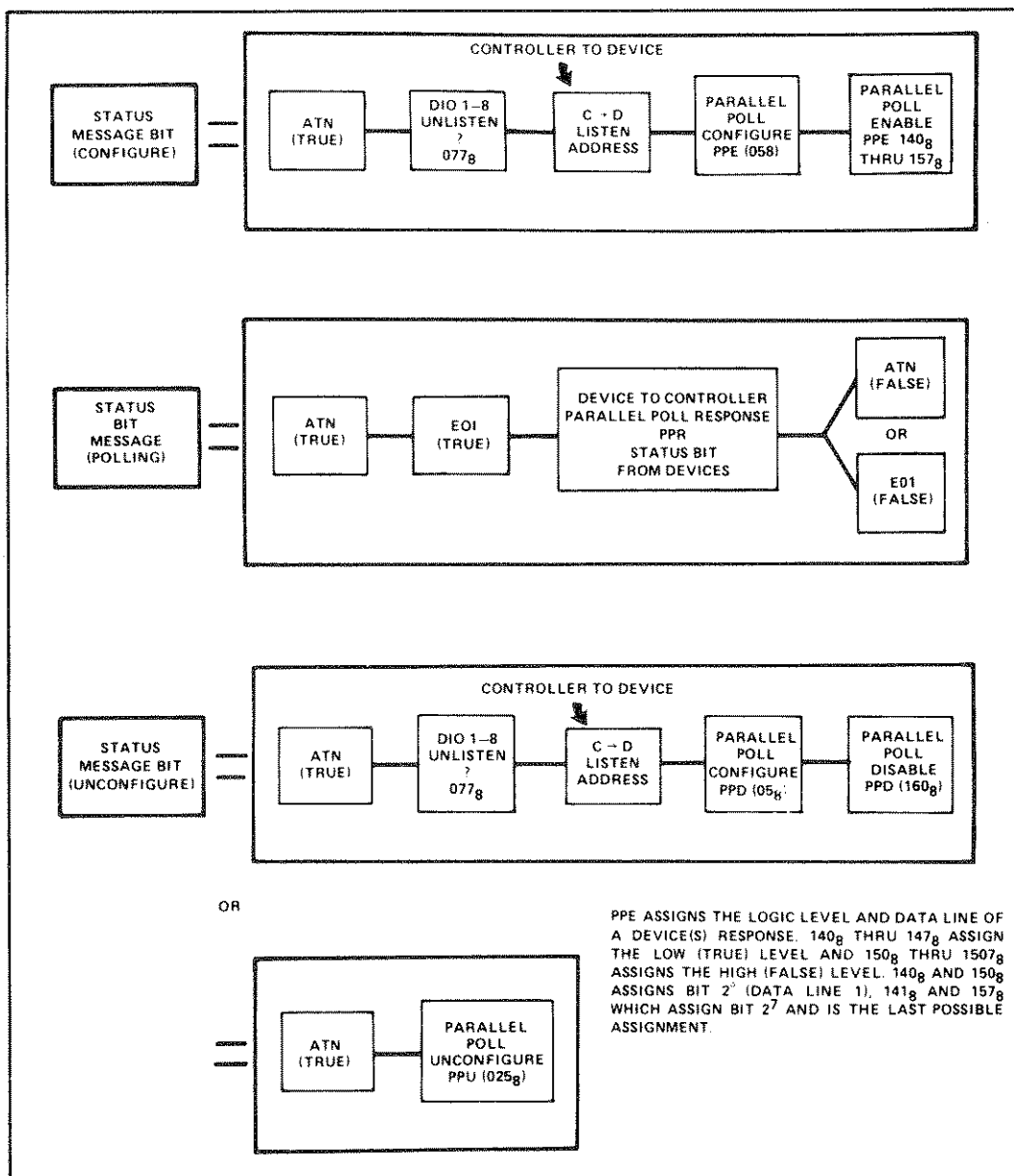


Figure 3-48. Meta Message—Status Bit.

PASS CONTROL

The PASS CONTROL message transfers the bus management responsibilities from the active controller to another controller. In order to pass control, the active controller must enter the command mode, send the talk address, and the talk control HP-IB characters.

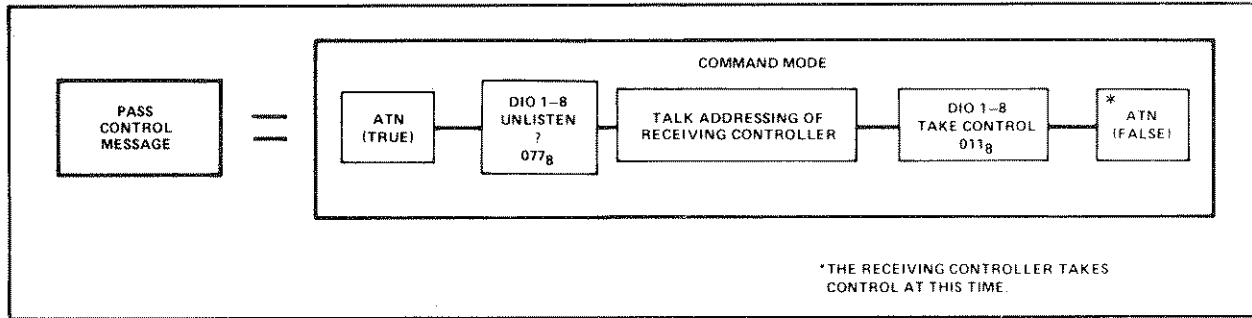


Figure 3-49. Meta Message—Pass Control.

ABORT

The System controller implements the ABORT message to regain control of the HP-IB from the active controller.

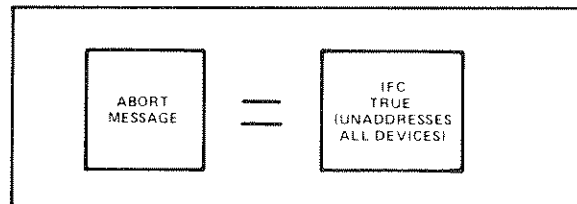


Figure 3-50. Meta Message—Abort.