EIP

Models 585/588 Microwave Pulse Counters

Service

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SECTION 5
ADJUSTMENT AND CALIBRATION

INTRODUCTION

To adjust the 585 or 588 counter correctly, use the procedures described in the following paragraphs. The recommended calibration interval is 6 months. Additional adjustments should be made if the counter does not operate as specified, or if it has been repaired. If the adjustments do not result in the specified performance, refer to the troubleshooting section of this manual.

The adjustment and calibration procedure comprises five calibrations:

1. Power supply adjustment
2. Time-base adjustment
3. Band 2 YIG DAC Automatic Calibration
4. Gate Error calibration
5. Display intensity adjustment

Adjustments 1, 2, and 5 require removal of the top cover for adjustment. The display intensity adjustment is for user comfort only and need not be performed.

Table 5-1 describes the functions, specifications, and methods to be used when the adjustment and calibration routines are performed.

Table 5-1. Procedure Description

FUNCTION	PERFORMANCE SPECIFICATION	METHOD
Power Supply Adjustment	Voltage between A2TP1 (+12 V) and ground is +12 ±0.01 V.	Adjust A2R3, Check with DVM
	Voltage between A2TP2 (−12 V) and ground is −12 ±0.01 V.	Adjust A2R6, Check with DVM
Time Base	Adjust the output frequency of the TCXO to 10 MHz ±0.1 Hz	Turn the TCXO calibrations screw, check count output with 545B counter
YIG DAC Calibration	Auto-calibration of DAC to YIG filter	Use special function 91
Gate Error Calibration	Gate error is ≤ ±0.05 times the gate width	Use special function 92 to calibrate gate accuracy in each band
Display intensity	LED brightness level is adjusted to suit operator's comfort	Adjust A12A2R4 on Front Panel Logic board

CALIBRATION TEST EQUIPMENT

Minimum use specifications are the principal parameters required for performance of the calibration, and are included to assist in the selection of alternate equipment. Satisfactory performance of alternate items should be verified prior to use. All applicable equipment must bear evidence of current calibration.

Table 5-2. Equipment Description

DESCRIPTION	CRITICAL PARAMETER	MFR	MODEL
Microwave Counter	0.1 Hz resolution	EIP	545B
Digital Voltage Meter	4 1/2 digit resolution	Fluke	8050A
Pulse Generator	20-ns pulses	Wavetek	801
50-ohm Feedthrough Termination	50 ohms resistance	Pamona	4119-50
Oscilloscope	100 MHz Bandwidth	Tektronix	475
Frequency Extender	26.5 - 60 GHz range	Watkins Johnson	1204-42
Microwave Synthesizer	300 MHz to 26.5 GHz	HP	8340A
Power Meter	300 MHz to 26.5 GHz	HP	436A
Power Sensor	300 MHz to 26.5 GHz	HP	8484A

PRELIMINARY OPERATIONS

Review the entire procedure before starting the calibration. Connect the instrument to local line voltage and turn on. Allow 5 minutes for the instrument to warm up before starting any procedure. Set the instrument controls to their default values by pressing the "INIT" key.

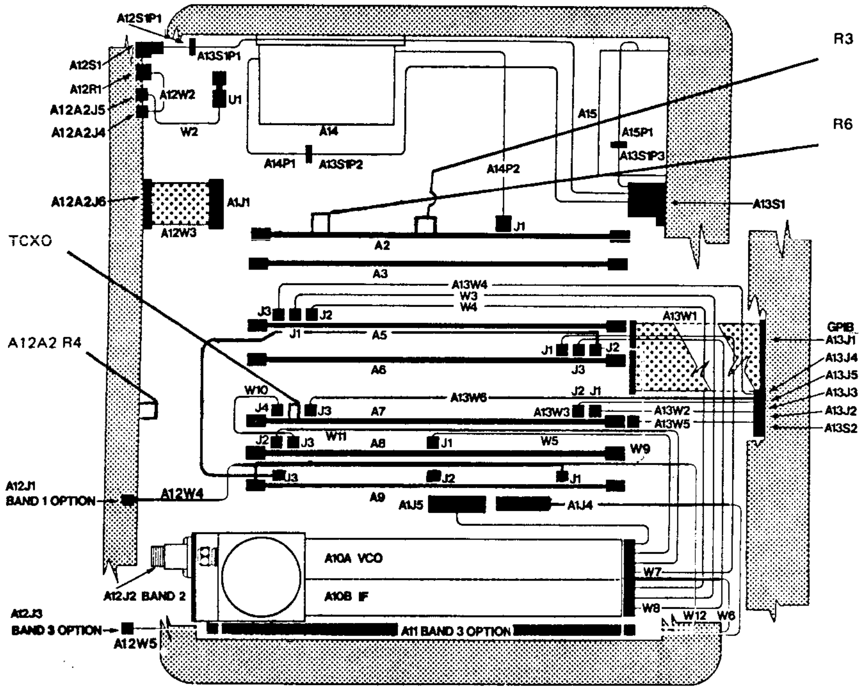

Figure 5-1. Adjustment Locations

CALIBRATION PROCESS

POWER SUPPLY ADJUSTMENT

EQUIPMENT

Digital Voltmeter Fluke 8050A

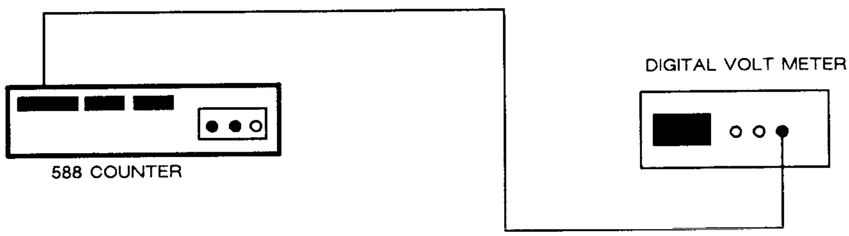

Figure 5-2. Power Supply Adjustment

1. Set up equipment as shown in Figure 5-2.
2. Remove the top cover. Turn the counter on and let it warm up for five minutes. The following voltage adjustments are done on the Power Supply board (A2).
3. Connect the digital volt meter (DVM) between A2TP1 (+12) and ground.
4. Adjust A2R3 until the voltage measures +12.000 ±0.01 Vdc.
5. Connect the DVM between A2TP2 (-12 Volts) and ground.
6. Adjust A2R6 until the voltage measures -12.000 ±0.01 Vdc.

TIME BASE CALIBRATION

The time base oscillator used in the counter is a 10-MHz temperature-compensated crystal oscillator (TCXO). The accuracy of this oscillator directly affects the measurement accuracy of the counter. From the time an oscillator is set to its specified frequency it will begin drifting. The magnitude of this drift is specified as the aging rate of the oscillator. Time base calibration adjust for this drift and should be performed at least every 6-months.

The procedure described on the next page uses an EIP Model 545B Microwave Frequency Counter to measure the frequency of the time base. The 545B was chosen because it provides a 0.1 Hz resolution in Band 1. The external reference input on the 545B must be connected to a 10 MHz frequency standard. The accuracy of the standard should be several orders of magnitude better than the TCXO.

EQUIPMENT

Microwave Counter	EIP 545B
50-ohm Feedthrough Termination	Pamona

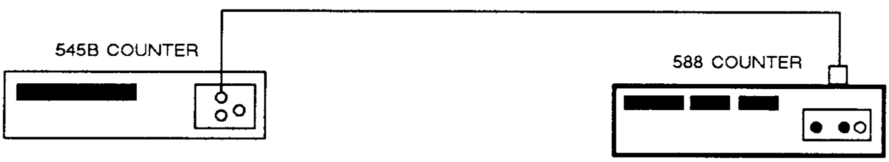

Figure 5-3. Time Base Calibration

PROCEDURE

1. Set up equipment as shown in Figure 5-3.

2. Remove the top cover. Turn the counter on and let the counter warm up for 15 minutes.

3. Connect the 10 MHz IN/OUT connector on the rear panel of the 585/588 through a 50-ohm feedthrough termination to the Band 1 input of an EIP 545B counter. Select 0.1 Hz resolution on the 545B by pressing the ''RES'' key followed by the decimal point key and then the 1 key. Make sure that IN/EXT switch on the rear panel of the 585/588 in the internal position.

4. Connect a 10 MHz frequency standard to the 10 MHz TIME BASE (external reference) input connector on the rear panel of the EIP 545B counter. On the 545B counter, set the 10 MHz INT/EXT switch to the EXT position.

5. Adjust the TCXO (on the gate generator board) to 10 MHz +/- 0.1 Hz. The frequency of the TCXO is adjusted by turning the adjustment screw located on the top of the TCXO case.

YIG DAC AUTOMATIC CALIBRATION

This counter uses an electronically tunable microwave band-pass filter (YIG) the Band 2 input. This filter is called a YIG because of the type of material used in its construction. The frequency that the filter is tuned to is controlled by a digital to analog converter (DAC). The YIG DAC calibration develops a table of correction factors that correlate the digital information sent to the DAVC to the frequency that the YIG filter is tuned to.

When this function is activated, the counter will display F1 and measure a user-supplied 2 GHz input. Then it will display F1 and measure a user-supplied 2 GHz input. Then it will display F2, wait for the user to change the input to 18 GHz, and measure it. The counter then calculates and stores (in non-volatile memory) the correction factors for the YIG DAC.

CAUTION

Care must be used when operating Special Function 91. Although the counter cannot be damaged by this function, improper operation of it can affect the counter calibration, possibly rendering the counter unusable until it can be recalibrated. Do not call this function unless familiar with its operation.

To calibrate the YIG DAC:

1. Apply a signal at 2 GHz ±2 MHz at approximately 0 dBm to the Band 2 input connector.
2. Call Special Function 91 when the counter displays F1 and press the TRIG key.
3. When the display changes from F1 to F2, apply a signal at 18 GHz ±2 MHz, at approximately 0 dBm and press the TRIG key.
4. When the display returns to normal, the counter YIG DAC is calibrated.

GATE ACCURACY CALIBRATION

The purpose of this adjustment is to reduce the gate error. When narrow pulses are counted, the gate is opened and closed many times in order to accumulate enough gate time to provide the required resolution. Each time the gate opens and closes, there will be a small but finite error. The total error is proportional to the number of times the gate is cycled during a measurement, and is inversely proportional to the gate width. This error is also related to both temperature and input frequency. Unlike averaging error, which is random, gate error is systematic, and is not reduced by averaging.

In the 585/588, the worst case gate error, including all variables, is specified as:

Band 1: Gate Error = ±0.07/GW
Band 2: Gate Error = ±0.01/GW
Band 3: Gate Error = ±0.03/GW

Where: GW in seconds is the logical AND of the pulse width and the inhibit signal minus 30 ns.

Performing this adjustment at room temperature (25°C) will guarantee performance to specifications over the temperature range of the counter. If the counter is to be used at a temperature other than 25°C, performance may be improved by performing this calibration at that temperature.

Gate widths less than 20 ns (less than 50-ns pulse widths) are subjected to constant erroneous readings. If such a gate width is desired, performance may be improved by performing a special calibration for this gate width in the required frequency. This calibration may be performed without removing the covers from the instrument.

EQUIPMENT

Microwave Synthesizer	Hewlett Packard 8340A
Pulse Generator	Wavetek 801
50-ohm Feedthrough Termination	Pamona
Oscilloscope	Tektronix 475

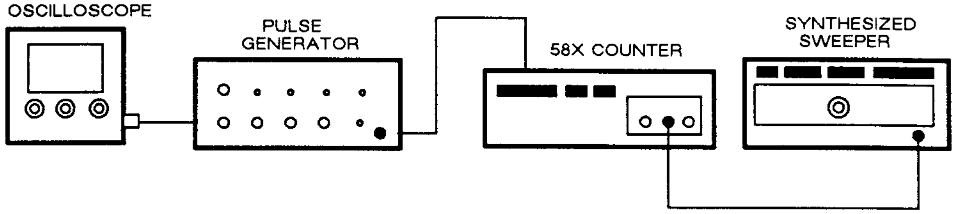

Figure 5-4. Band 1 and 2 Gate Error Calibration

BAND 2 GATE ERROR CALIBRATION

PROCEDURE

1. Set up equipment as shown in Figure 5-4.
2. Apply a CW signal between 2 and 10 GHz at approximately 0 dBm to the BAND 2 input connector.
3. Connect the pulse generator to the oscilloscope through a 50-ohm feedthrough at the oscilloscope. Set the pulse generator as follows: 1 MHz PRF, 50 ns complementary pulse width, base line at zero volts, and amplitude at -1 volt. Connect the pulse generator to the INHIBIT INPUT connector on the rear panel of the counter.
4. Press keys for SPECIAL FUNCTION 92, then press Trigger key. The counter is in the autocalibrate state for about 1 minute.

BAND 1 GATE ERROR CALIBRATION (Option 5802)

1. Set up equipment as shown in Figure 5-4, and adjust as specified in step 3, Band 2 Calibration.
2. Press BAND 1 key. Apply a CW signal at 650 MHz, 0 dBm to the BAND 1 input connector.
3. Press keys for SPECIAL FUNCTION 92, then press Trigger key. The counter is in the autocalibrate state for about 2 minutes.

BAND 3 GATE ERROR CALIBRATION (Option 5804)

EQUIPMENT

Microwave Synthesizer	Hewlett Packard 8340A
Pulse Generator	Wavetek 801
50-ohm Feedthrough	Pamona
Oscilloscope	Tektronix 475
Frequency Extender	Watkins Johnson 1204-42

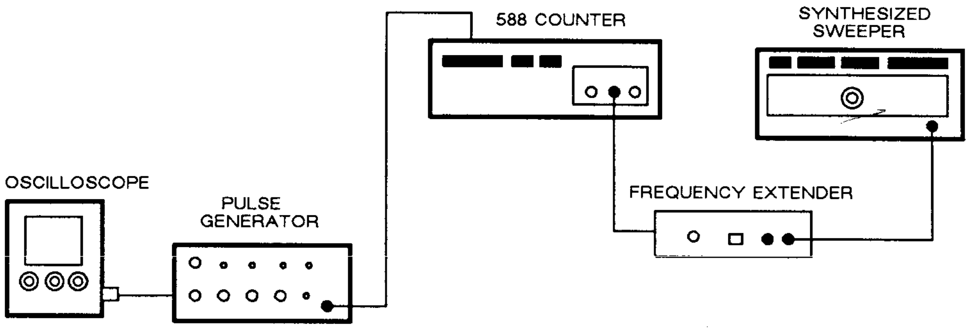

Figure 5-5. Band 3 Gate Error Calibration

PROCEDURE

1. Set up equipment as shown in Figure 5-5.
2. Using the appropriate remote sensor, apply a CW signal to the BAND 3 input connector of the counter.
3. Select Band 3 and the appropriate sub-band.
4. Adjust equipment as in step 3, Band 2 Calibration.
5. Press the keys for SPECIAL FUNCTION 92, then press Trigger Key. The counter is in the autocalibrate state for about 3 minutes.

NOTE

Band 3 need not be calibrated for every sub-band. Calibration of any sub-band is sufficient for all of Band 3.

DISPLAY INTENSITY ADJUSTMENT

An adjustment (A12A2R4) is provided on the Front Panel Logic board for display intensity; it may be adjusted for most comfortable viewing.

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SECTION 6
TROUBLESHOOTING

INTRODUCTION

This section defines troubleshooting aids that can be used with the 585/588 counter. They are:

- Signature analysis
- Self diagnostics
- Keyboard controlled circuit tests

The procedures and tables are provided for troubleshooting to a functional circuit level.

SIGNATURE ANALYSIS

Signature analysis is a technique used to troubleshoot complex logic circuitry. It uses data compression to reduce any data pattern to a four-character alphanumeric word.

The start and stop inputs define the measurement window. Each time a transition within the measurement window occurs on the clock input, the probe is sampled, and the logic level is shifted into the analyzer. This information is used to generate a signature unique to that data string. That signature can then be compared to a reference signature, taken from a known good product, to determine if the data string is correct. The counter implements signature analysis in either a free running or program controlled manner.

FREE RUNNING

When performing signature analysis the microprocessor board is set up in a free running mode by moving the header in A3 E1 to A3 E2. Free running means forcing a simple instruction such as NOP on the data bus, which the microprocessor sees at every address location. This causes the microprocessor to continually cycle through its entire address range, accessing everything on the address bus as it does. By strategically placing the start and stop connections from the signature analyzer, the user can probe the entire bus system for bad signatures.

Table 6-1. Microprocessor Free Running Signatures

	Start	Stop	Clock
Connections	A3 TP4	A3 TP4	A3 TP3
Buttons	In	In	In

Line	Signature	Line	Signature
A0 (P1 Pin 54)	UUUU	U5 Pin 6	76AC
A1 (P1 Pin 53)	FFFF	U5 Pin 8	0000
A2 (P1 Pin 52)	8484	U5 Pin 12	65F5
A3 (P1 Pin 51)	P763		
A4 (P1 Pin 50)	1U5P		
A5 (P1 Pin 49)	0356		
A6 (P1 Pin 48)	U759		
A7 (P1 Pin 47)	6F9A		
A8 (P1 Pin 46)	7791		
A9 (P1 Pin 45)	6321		
A10 (P1 Pin 44)	37C5		
A11 (P1 Pin 43)	6U28		
A12 (P1 Pin 42)	4FCA		
A13 (P1 Pin 41)	4868		
A14 (P1 Pin 40)	9UP1		
A15 (P1 Pin 39)	00001		
U3 Pin 7	76AC		
TP6	854F		
TP7	PACH		
TP8	755F		
TP9	755H		
U8 Pin 19	U3P7		
U9 Pin 18	0003		
U10 Pin 18	0003		
U17 Pin 1	9F14		
U17 Pin 2	9F17		

+ 5V 0003, phase 2 0003 *

NOTE

The signatures shown are taken using the HP 5004A Signature Analyzer

* Due to the synchronous qualities of the signature analyzer, phase 2 will read the same as + 5V but the logic probe will be flashing. Likewise, anything gated with phase 2 may have the same signature as the ungated signal.

SELF DIAGNOSTICS

At turn-on, the counter performs several internal diagnostic checks, checking the RAM, PROM, and the associated decoding circuitry. The display shows dashes during these checks. If the counter passes the tests, it then enters the normal operating mode. If the counter fails any checks, an error message will be displayed. Please refer to Table 6-2.

Table 6-2. Self Diagnostic Error Indications

PROBLEM	ERROR MESSAGE
RAM Bad	60
A3 U11 (Basic Program) Bad	61
A3 U12 (Basic Program) Bad	62
A3 U13 (Basic Program) Bad	63

KEYBOARD CONTROLLED CIRCUIT TESTS

There are seven keyboard-controlled circuit tests (01 through 07). All tests are accessed by pressing the SPECIAL FUNC and the two digit test number. Tests that do not require keyboard inputs to function (tests 01, 02, 03, 04, 06, 07) can be exited by pressing any key. This causes the counter to exit the test and enter the functions selected. Test 05, which uses the keyboard in its operation, can be exited by pressing CLEAR DISPLAY. This causes the counter to return to normal operation.

01 **100 MHz Self Test.** This test sets the VCO to 400 MHz, divides it by four, and counts the 100 MHz output from the divider. It checks the count chain, VCO, VCO phase lock circuitry, and the gate generator.

02 **Display 8s Test.** This test lights all LEDs, annunciators, and decimal points. It checks that everything on the display is operational.

03 **Display Segment Test.** This test lights each segment of each digit and each annunciator one at a time, cycling through all segments. The cycle rate can be adjusted with the sample rate knob. It verifies that each segment of the display, segment drivers, and display multiplexer operate properly and independently.

04 **Display Digit Test.** This test lights one entire digit, and its decimal point, at a time. It cycles through all digits and annunciators. The cycle rate is determined by the sample rate knob. It checks each digit and digit driver independently, and verifies operation of the display multiplexer.

05 **Keyboard Test.** This test displays the key code of each key as it is pressed. Test 05 checks the keyboard, keyboard interrupt, and keyboard decode circuitry. The key codes (coordinates) for each key are shown in Table 6-3.

Table 6-3. Keyboard Test Coordinates

Key	Key Code
7	11
8	12
9	13
GHz	14
4	21
5	22
6	23
MHz	24
1	31
2	32
3	33
kHz	34
±	41
0	42
.	43
Hz	44
PULSE WIDTH	51
PULSE PERIOD	52
CLEAR DATA	53
INIT/LOCAL	61
CLR DISPLAY	EXIT TEST

06 PROM Check Sum Test. This test generates the check sum for each PROM in the counter and compares it with the check sum stored in the firmware. If all the check sums generated are correct, the counter displays the word PASSED on the front panel. If any one of the check sums is incorrect, an error message corresponding to that particular check sum is output to the display.

07 Display Counter Model Number. This function shows the user whether the counter is configured as 585 or a 588.

TROUBLESHOOTING TREES

Troubleshooting trees are intended only as a guide, and do not describe every possible failure situation. Turn power off before removing or installing any PC boards or connectors. If the following assemblies are repaired or replaced, recalibration of the counter will be necessary.

- A2 Power Supply
- A3 Microprocessor
- A6 Count Chain
- A7 Gate Generator
- A8 Converter Control
- A10 Band 2 Converter Assembly

CAUTION

Do not attempt to repair or disassemble the A10 hybrid assembly.

TEST EQUIPMENT REQUIRED

Table 6-4. Troubleshooting Test Equipment

Manufacturer	Model	Description	Critical Parameter
Tektronix	475	Oscilloscope	100 MHz min. Bandwidth
Fluke	8050A	Digital Voltmeter	4-1/2 digit resolution
Hewlett Packard	8559A/ 853A	Spectrum Analyzer	6 GHz
Hewlett Packard	5004A	Signature Analyzer	
Wavetek	801	Delay Pulse Generator	
HP	8340A	Microwave Synthesizer	300 MHz - 26.5 GHz
HP	436A	Power Meter	300 MHz - 26.5 GHz
HP	8485A	Power Sensor	300 MHz - 26.5 GHz

To use the troubleshooting trees.

1. Refer to the main troubleshooting tree.
2. Step through the main troubleshooting tree, performing all necessary checks, until the failure mode is noted.
3. Refer to the appropriate troubleshooting tree for that failure mode.

Before servicing unit, verify that:

1. The line voltage and fuse are correct for the voltage setting.
2. The rear panel 10 MHz INT/EXT switch is set to internal. If the switch is set to external, check that a proper 10 MHz signal is applied to the 10 MHz IN/OUT connector.
3. The MIN PRF function is properly set. (See Section 3).
4. The counter is not inhibited by the rear panel inhibit input.

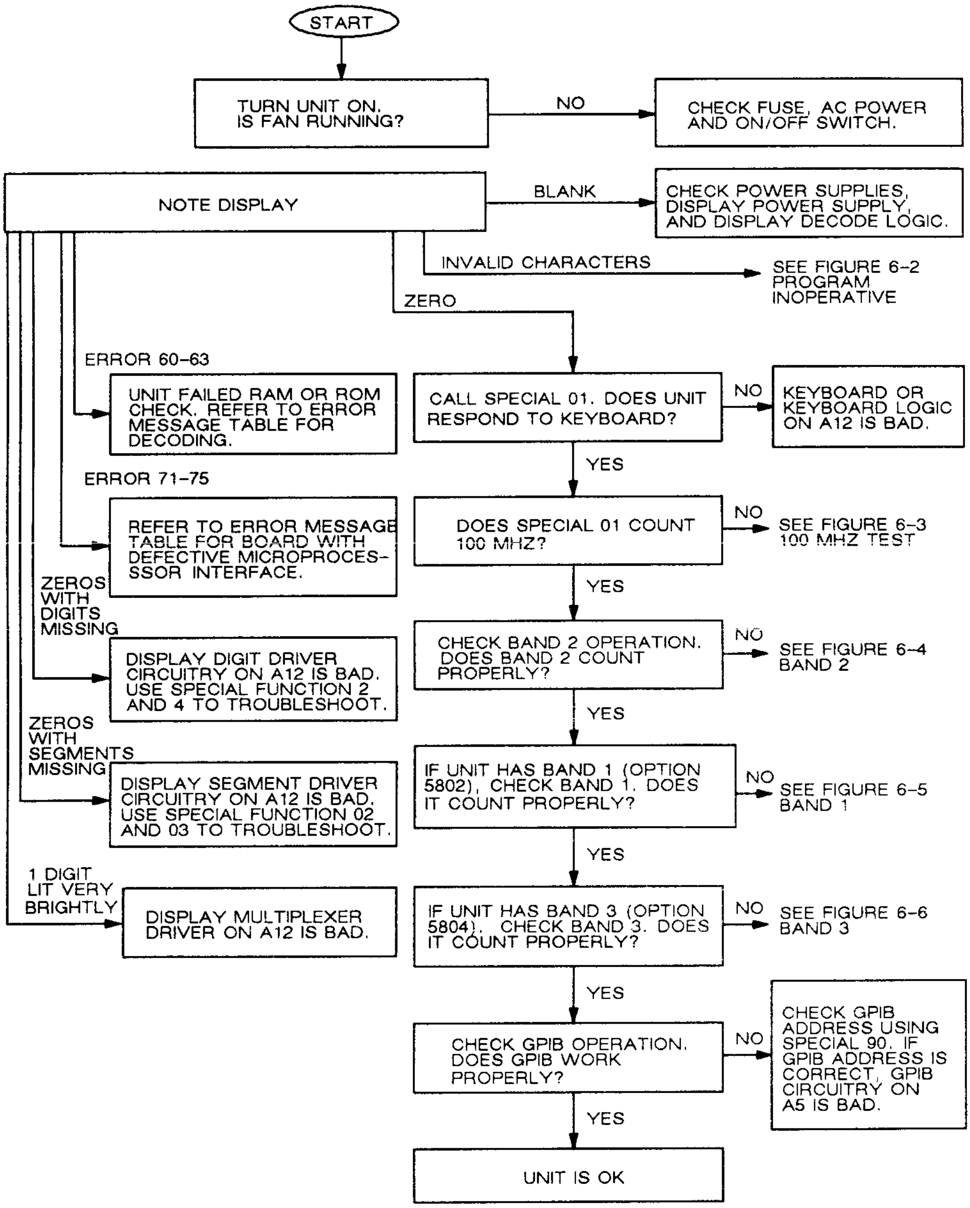


Figure 6-1. Main Troubleshooting Tree

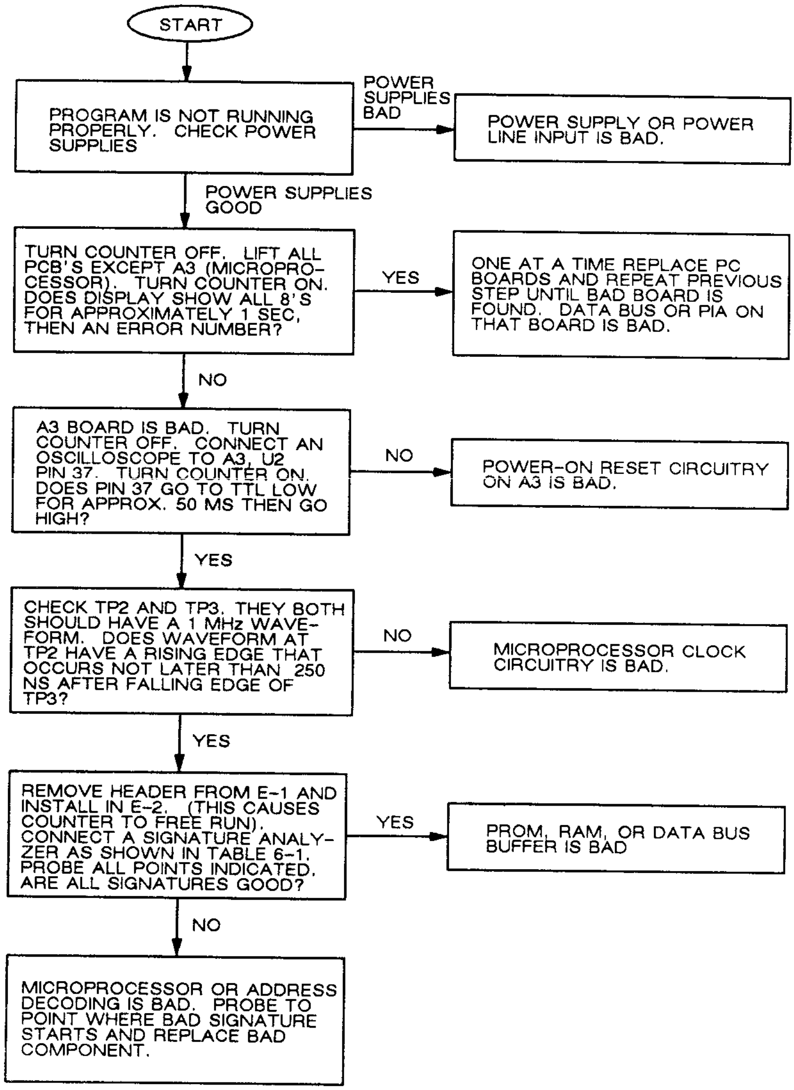


Figure 6-2. Program Inoperative Troubleshooting Tree

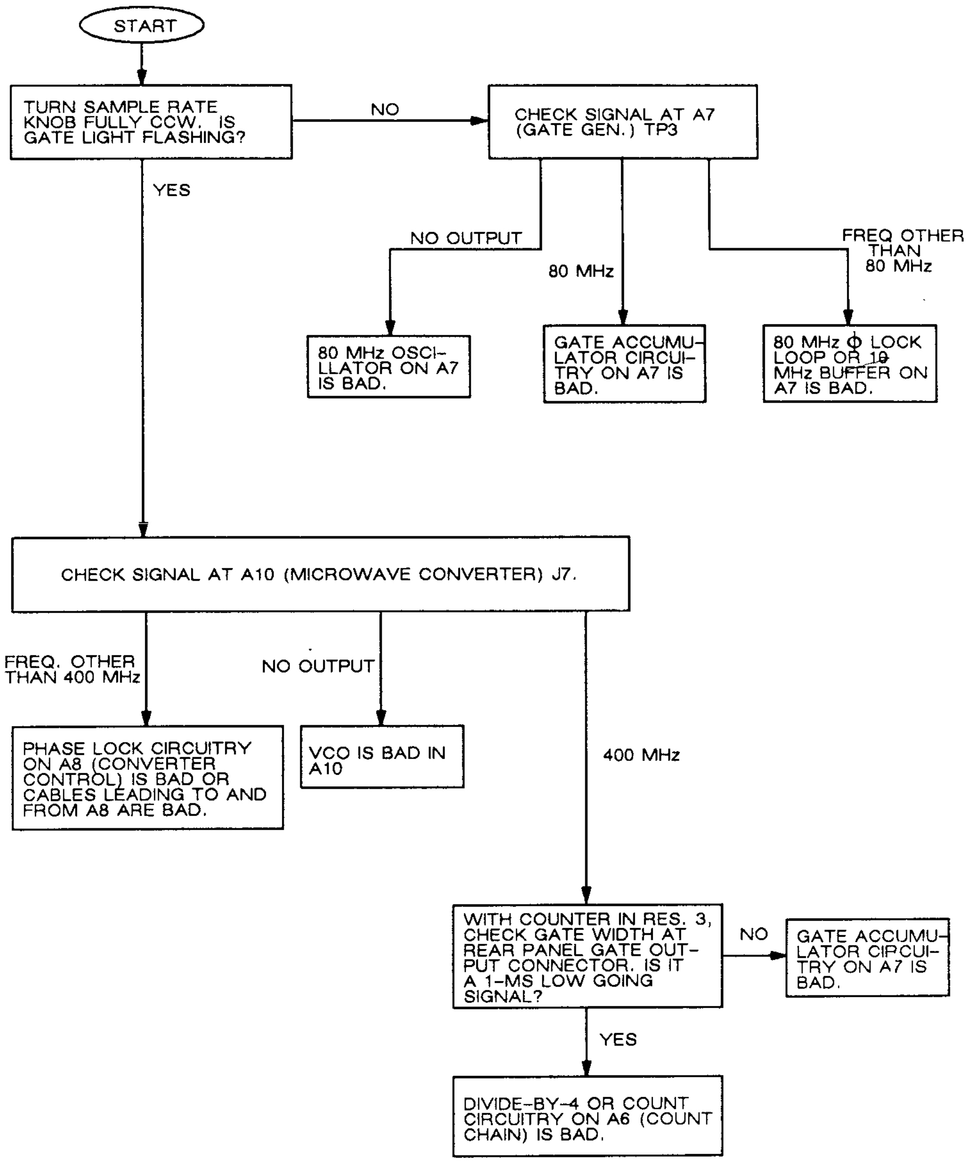


Figure 6-3. 100-MHz Self Test Troubleshooting Tree

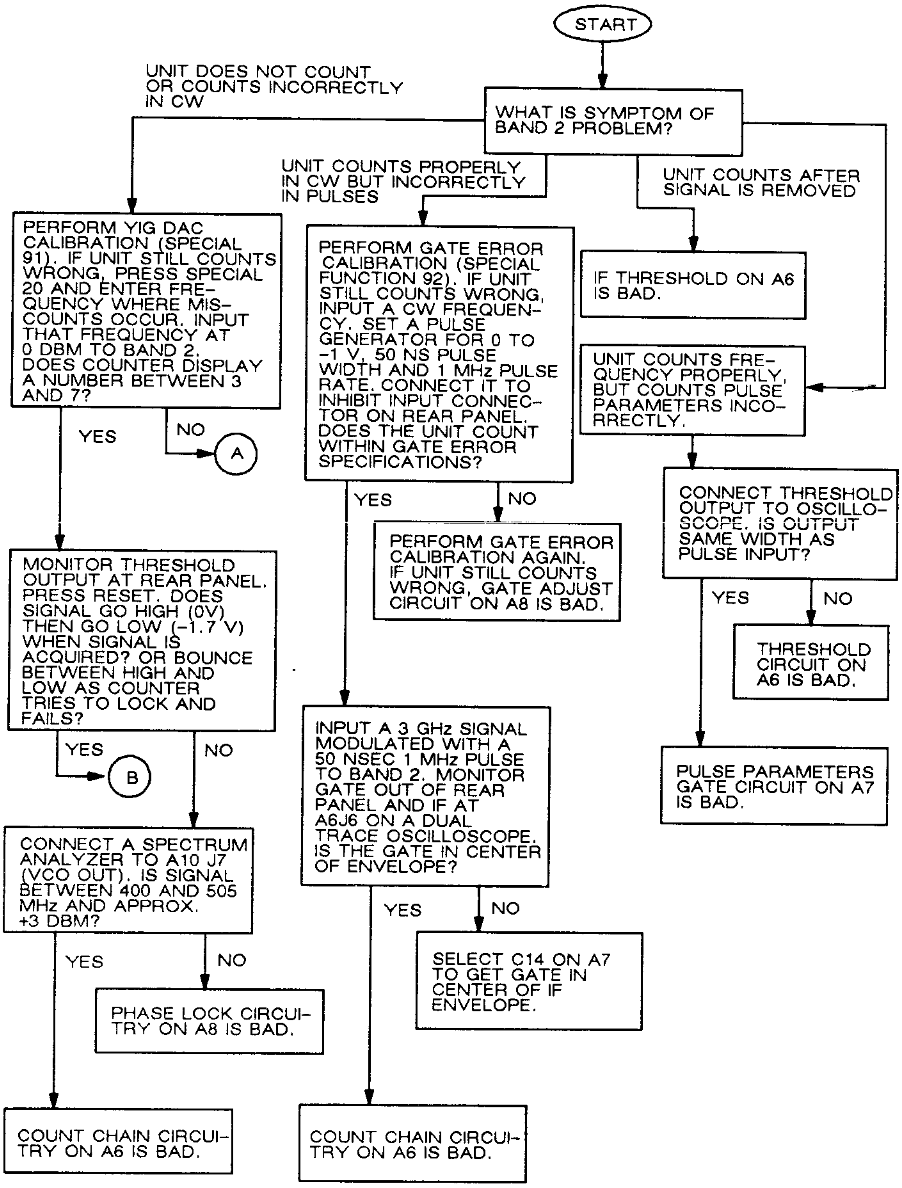


Figure 6-4. Band 2 Troubleshooting Tree

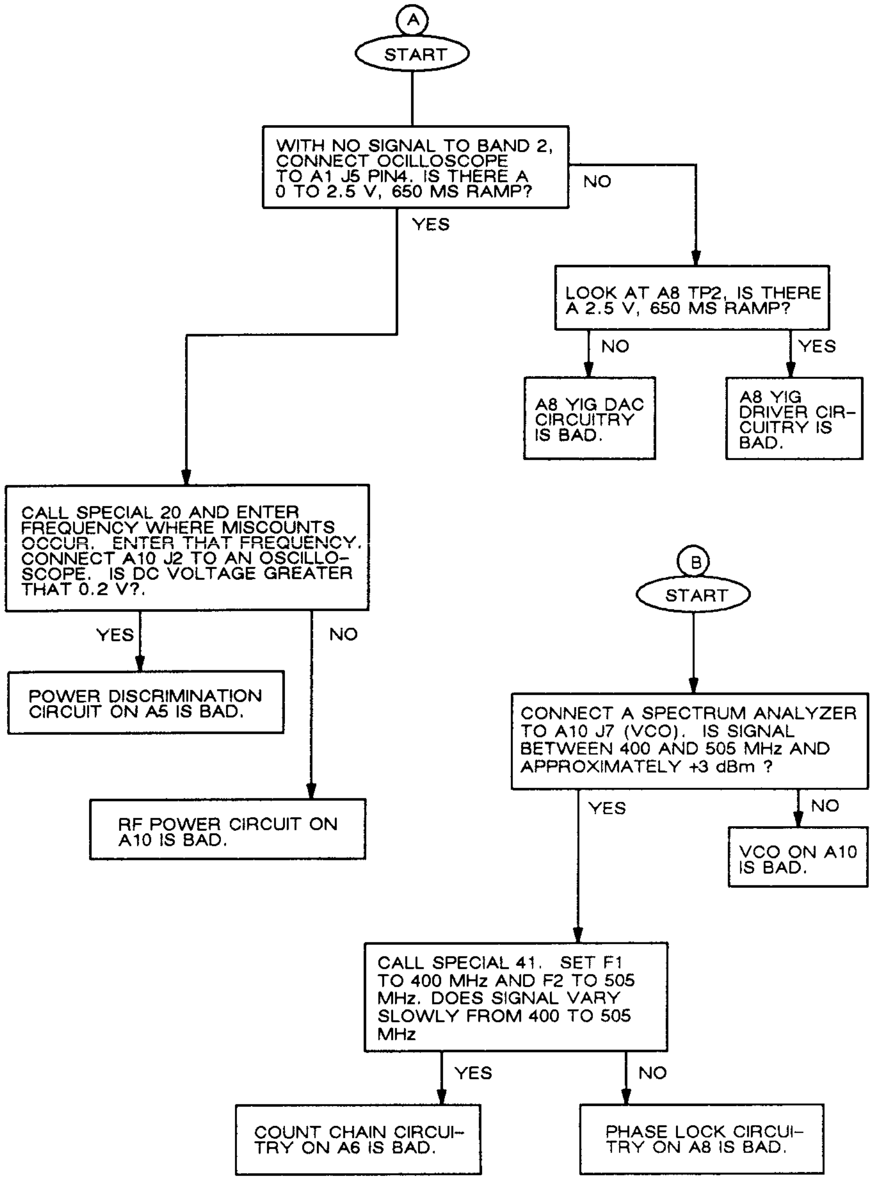


Figure 6-4. Band 2 Troubleshooting Tree, continued

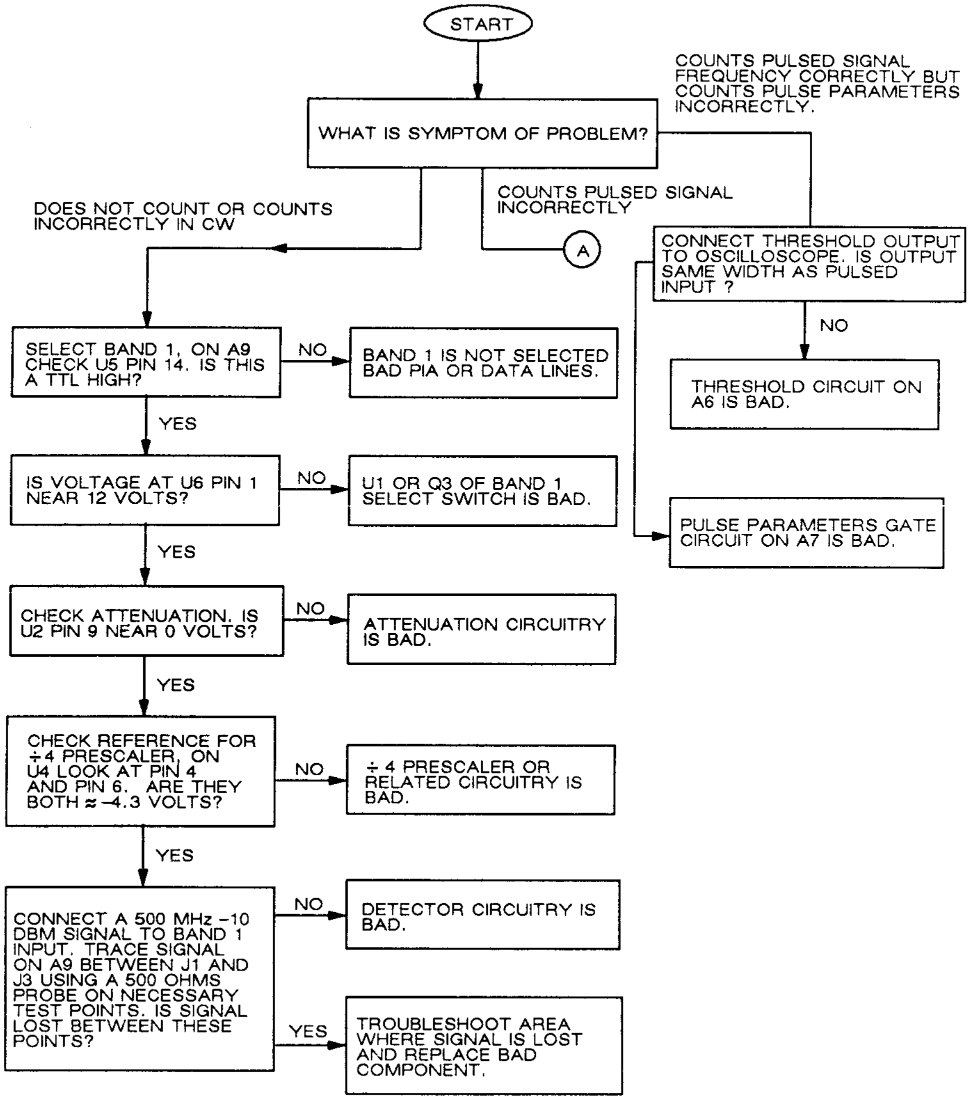


Figure 6-5. Band 1 Troubleshooting Tree (Option)

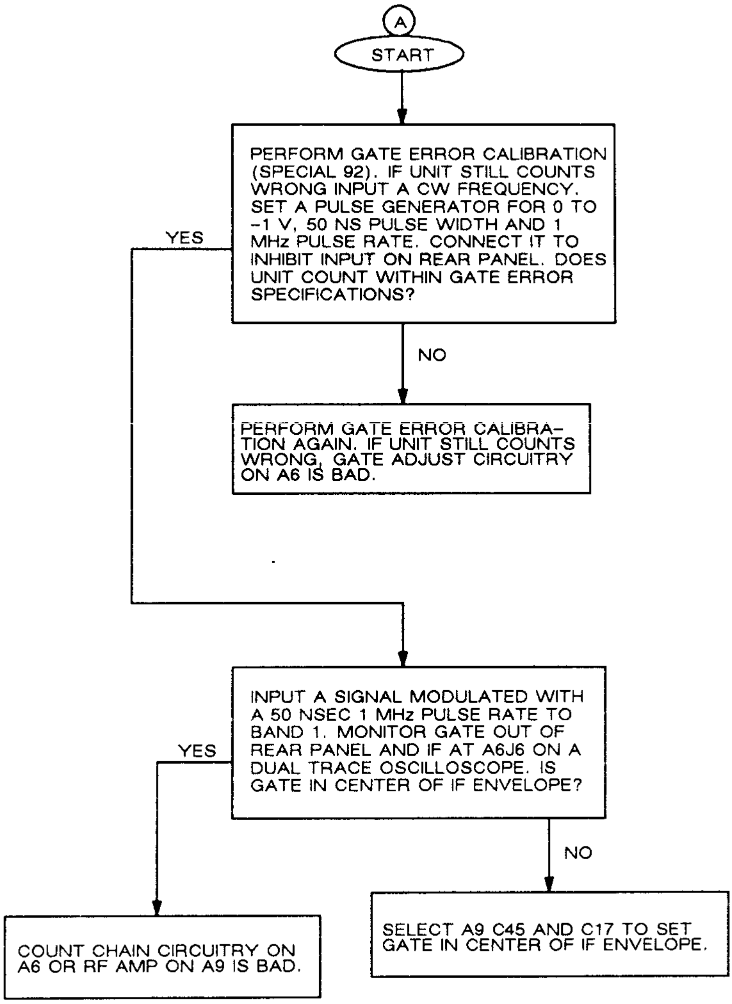


Figure 6-5. Band 1 Troubleshooting Tree (Option), continued

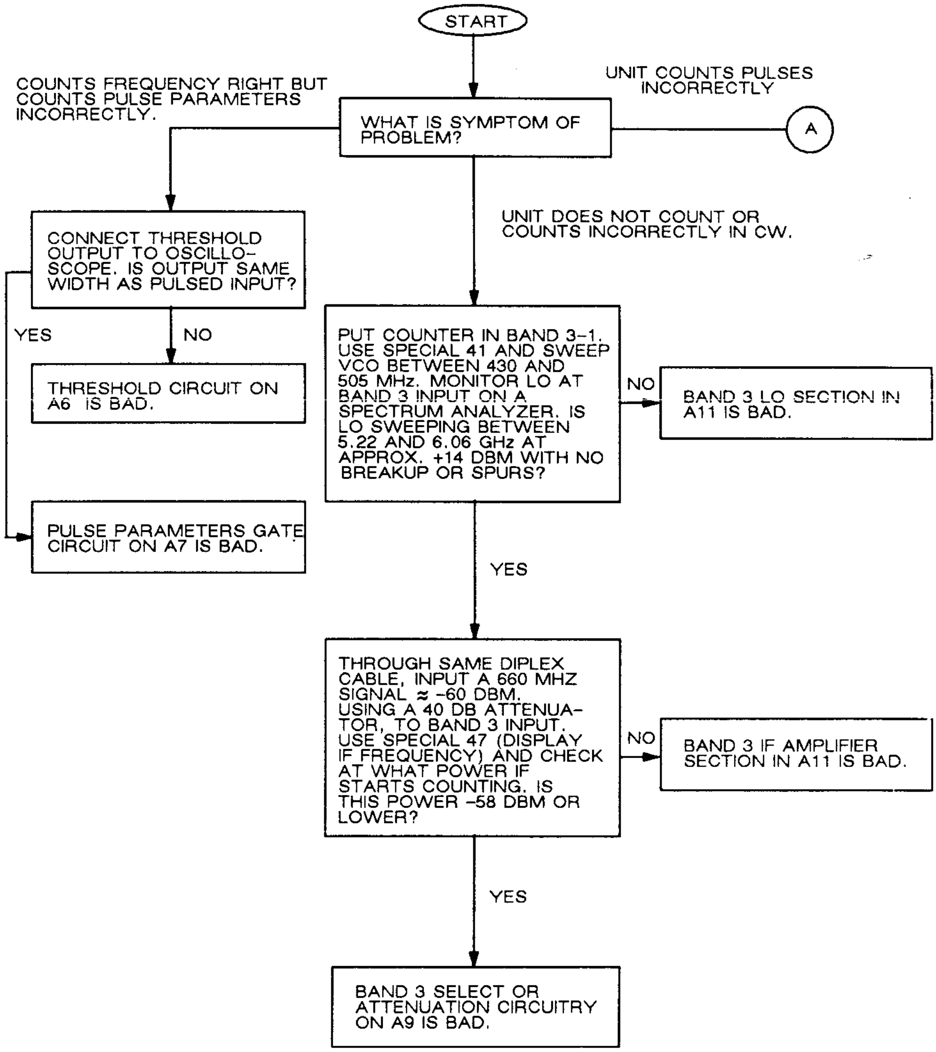


Figure 6-6. Band 3 Troubleshooting Tree, (Option)

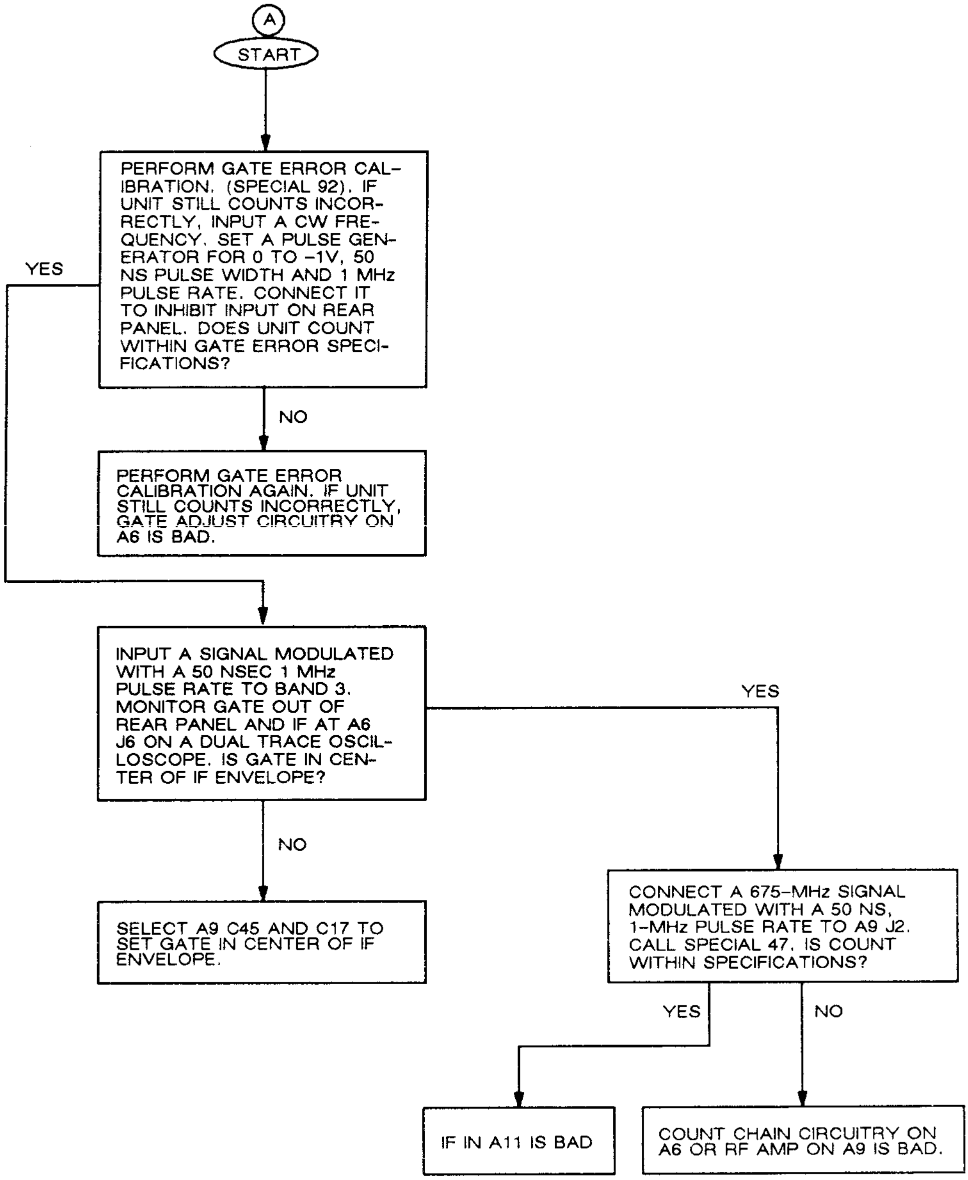


Figure 6-6. Band 3 Troubleshooting Tree (Option), continued

SECTION 7
THEORY OF OPERATION

INTRODUCTION

The Models 585 and 588 microwave pulsed counters are microprocessor-based multifunction instruments. These counters are able to measure CW and pulsed signals automatically with pulse widths as narrow as 50 ns and pulse periods as short as 250 ns. These counters also measure the pulse width or pulse period of the input signal to a 15-ns resolution. Through the inhibit input, the instruments can profile pulsed or chirped CW signals with gates as narrow as 15 ns. No manual switching is required to measure CW or pulsed signals. A block diagram of the 585/588 counter is shown in Figure 7-1.

The frequency range of the 585 is 0.95 GHz to 18 GHz, and can be extended by option down to 300 MHz. The frequency range of the 588 is 0.95 GHz to 26.5 GHz, and can be extended by option down to 300 MHz and up to 110 GHz. On both instruments the range of the pulse parameter measurements is 10 ns (when profiling) to 9.99 seconds.

All major functions are controlled through the 21-button, functionally grouped keyboard. Information is output via a 9- digit sectionalized LED frequency display, a 3-digit floating point LED pulse parameter display, and a 20-message LED annunciator bank.

Microprocessor control and the unique architecture permit not only the major counter functions such as frequency offsets, frequency range limits, and averaging capabilities, but also a variety of special functions such as internal diagnostics, calibration and test aids, and sophisticated operational enhancements.

All front panel controls except the ON/OFF switch, and all background functions are externally programmable via the IEEE 488-1978 standard GPIB (General Purpose Interface Bus) port. Additionally, all displayed information, as well as instrument setup status, is accessible via the GPIB.

The instrument can best be understood by considering the three major sections: the basic counter, the microwave converter, and the optional millimeter/ RF converters.

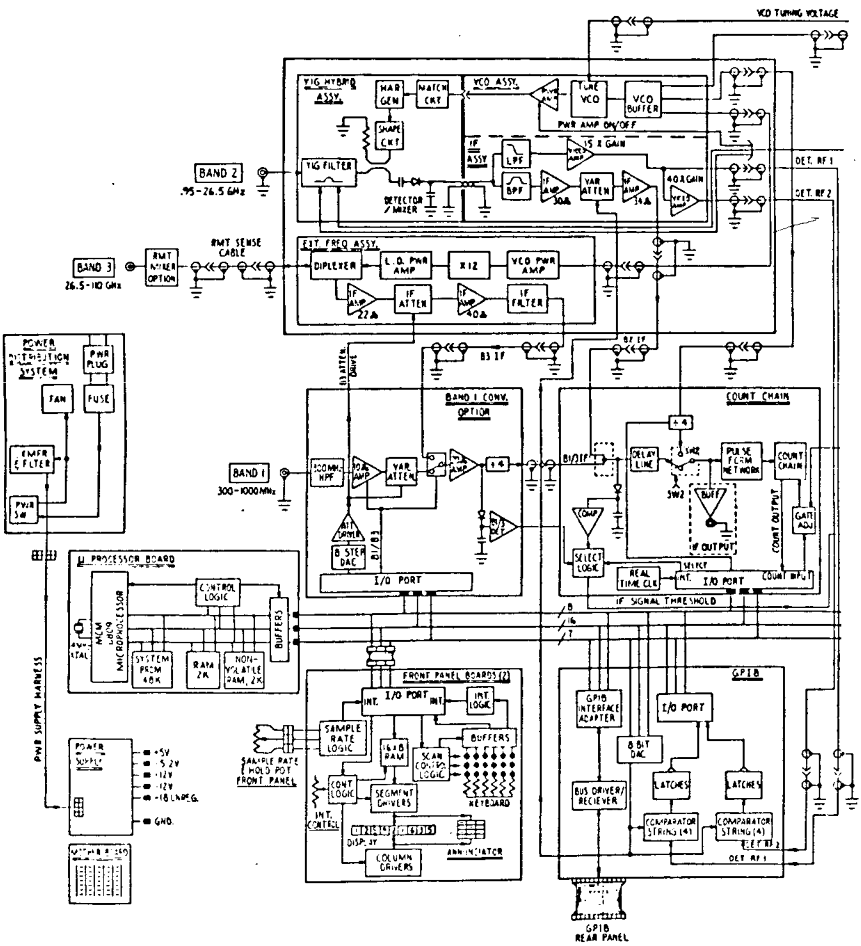


Figure 7-1. Functional Block Diagram of 585/588 Counters

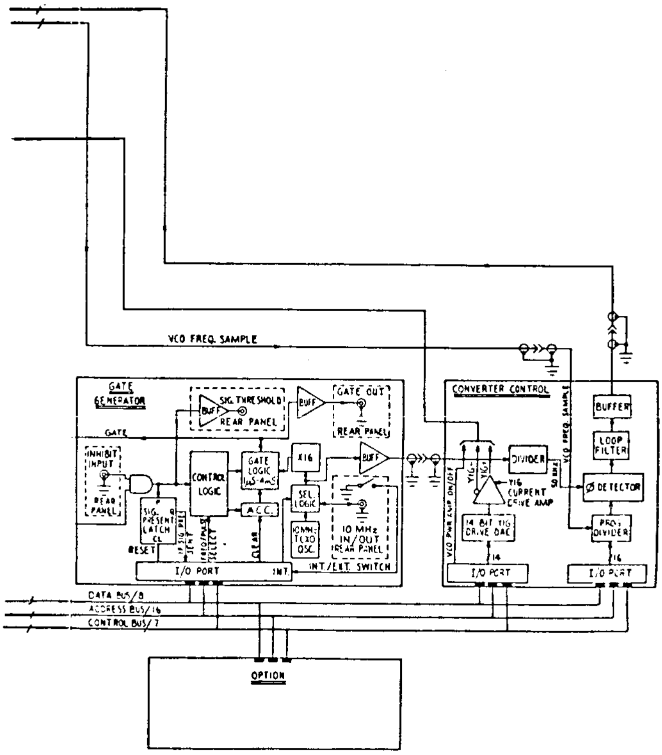


Figure 7-1. Functional Block Diagram of 585/588 Counters (cont.)

BASIC COUNTER

The basic counter accepts the IF signal from either the microwave converter or the millimeter/RF converters and measures the frequency, pulse width, or pulse period of the IF. A block diagram of the basic counter is shown in Figure 7-2.

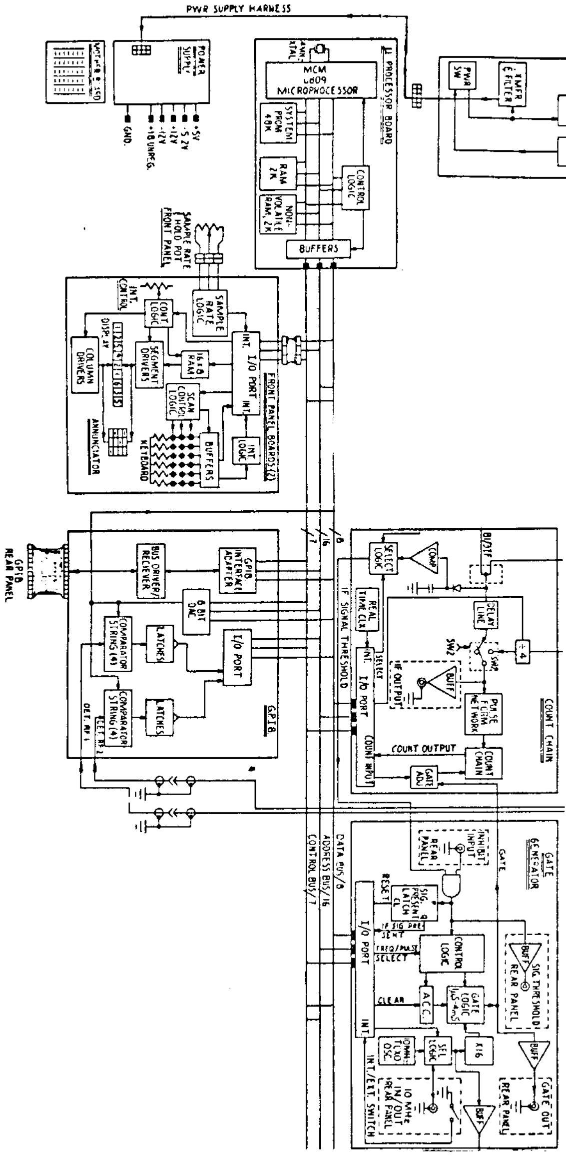


Figure 7-2. Block Diagram of Basic Counter

Overall operation is controlled by the microprocessor assembly, A3. This assembly contains a Motorola 6809 microprocessor, its control logic, and the system memory. It communicates with all other assemblies in the instrument by means of a triple bus system: the data bus, address bus, and control bus. On each assembly there is a peripheral interface adapter (PIA) that provides the interface between the bus system and the instrument hardware.

Frequency measurements are performed by comparing an unknown signal to a reference frequency, namely the time base. A 10 MHz temperature compensated crystal oscillator (TCXO) is used as the internal reference. For coherence with system clocks, the user may select an external 10 MHz reference.

A frequency measurement is made by generating a time interval (gate time) consisting of a number of cycles of the reference. This gate time is used as an interval during which the input signal is counted by the count chain assembly. This function is considerably more difficult for pulsed signals than it is for CW signals and must be accomplished as two functions. The first is to supply a gate to the count chain that is present only when an input signal is also present. The second is to accumulate the total time during which the gate is applied, until the desired gate time is reached.

The first operation requires that the gate begin after the signal is present at the count chain and end prior to the end of the signal. This is accomplished by generating a gate approximately 30 nanoseconds shorter than the RF signal. The arrival time at the count chain of the IF from the converter is then controlled by a delay line so the gate will fall entirely within the IF pulse.

The second operation is accomplished by counting reference clock pulses whenever the gate is open until a total time equal to 1/resolution is obtained. This requires that each gate opening is an exact integral number of clock pulses. An 80-MHz clock is used for this, causing the gate to be an exact multiple of 12.5 nanoseconds.

Pulse width is measured by counting a known frequency for the time the signal is present. Pulse period is measured by counting a known frequency for the time between the start of one pulse and the start of the next. The known frequency is the 400-500 MHz VCO prescaled by four.

BAND 2 MICROWAVE CONVERTER

Measurement of a signal in the microwave band is accomplished by down converting from the microwave range to approximately 110 MHz. This is accomplished by mixing the input signal with a known reference frequency that is a harmonic of the VCO. The VCO frequency (400–500 MHz) can be selected in 50 kHz increments by using a microprocessor–controlled phase lock system while retaining the accuracy and stability of the counter's time base reference.

A simplified diagram of the microwave converter is shown in Figure 7–3. There are two major assemblies, the Converter Control assembly and the Converter assembly.

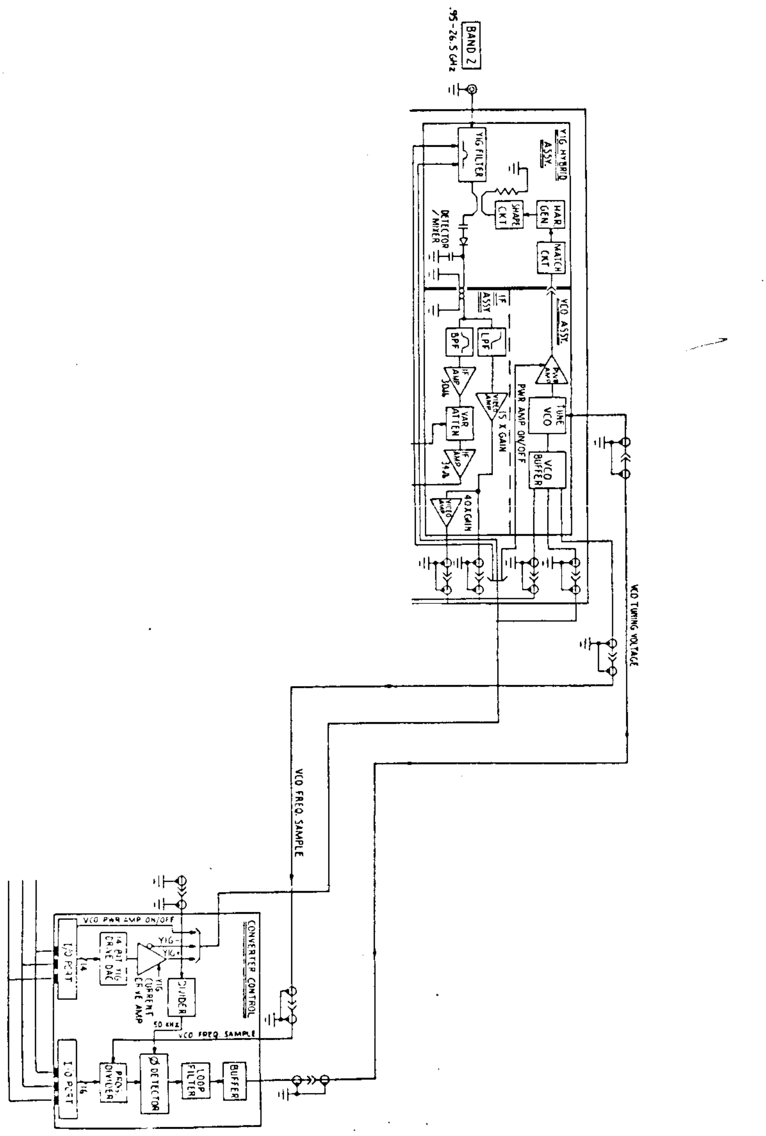


Figure 7-3. Block Diagram, Microwave Converter

MICROWAVE CONVERTER CONTROL

The Converter Control assembly contains the interface between the microprocessor bus system and the Converter. A digital-to-analog converter and a precision current driver provide a 2-MHz frequency resolution for setting the YIG filter of the Microwave assembly.

The Converter Control also contains the programmable VCO phase lock control system. This system lets the microprocessor select any VCO frequency between 400 and 500 MHz, in increments of 50 kHz.

MICROWAVE CONVERTER

The Converter assembly consists of three subassemblies.

- Voltage Controlled Oscillator (VCO) assembly
- IF Amplifier assembly
- Microwave assembly (YIG)

The Microwave assembly contains the YIG filter, mixer, and comb generator.

The input signal (0.95 GHz to 18 GHz/26.5 GHz) passes through a YIG filter. The filter is an electronically tunable bandpass filter with an operating frequency proportional to its tuning current. This filter determines the approximate frequency of the input signal and filters out any undesired signals, making it possible to count a signal at one frequency even if a larger signal is present at another frequency.

When the YIG filter is being tuned to the input signal, the mixer is used as an RF detector, and its output is amplified in the video amplifier on the IF assembly.

The output of the video amplifier is maximum when the YIG filter is tuned to the input signal. In the case of multiple input signals, the video amplifier output determines which signal is largest.

Once the YIG filter is tuned to the input signal, the appropriate harmonic number (N) and VCO frequency (F_{VCO}) are selected to produce an IF frequency (F_{IF}) at approximately 110 MHz. The input signal frequency is found by using:

$$F_{IN} = N \times F_{VCO} \pm F_{IF}$$

The IF frequency produced in the mixer is amplified by the high-gain IF amplifier and sent to the count chain.

OPERATION

See Figure 7-4 for a simplified diagram of microwave converter operation.

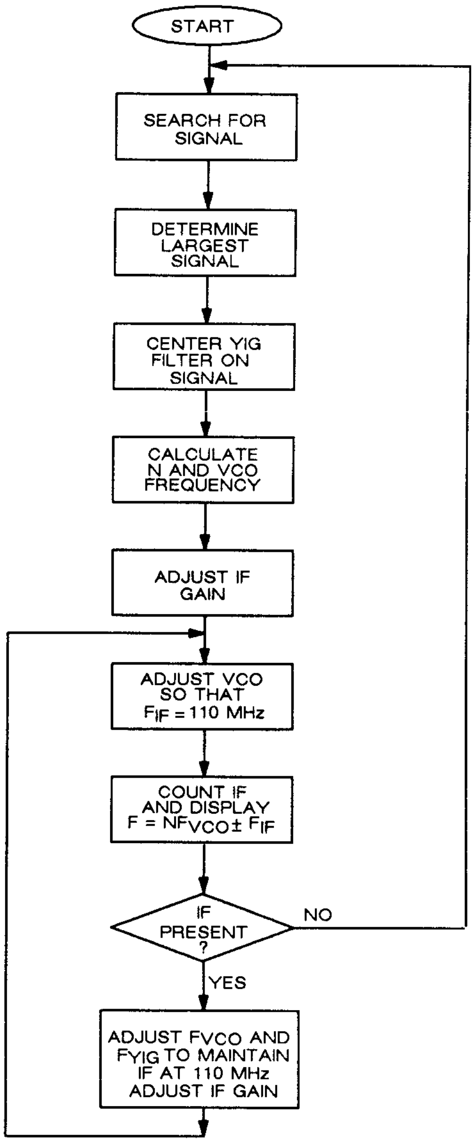


Figure 7-4. Flow Diagram Microwave Converter Operation

First the YIG filter is stepped from its low to high limits. During this search, the RF detected output is fed to a series of detectors set 4.5 dB apart. After each step, the threshold detectors are checked. If the detectors are triggered, the approximate amplitude of the signal is remembered by the microprocessor. The counter then returns to the search mode to look for any larger signals. After searching the entire frequency range, it returns to the largest signal and begins to center the YIG filter precisely on the input frequency.

The centering process consists of finding the exact relative power of the signal, then stepping the YIG in 2-MHz steps until four points are found: the points on either side of the peak 1.5 dB down from the peak, and the points on either side of the peak 4.5 dB down from the peak. From these points the approximate "center of mass frequency" of the signal is found and the YIG filter set to that frequency. The "center of mass" algorithm compensates for pulsed signals that deviate from a perfect sinX/X shape, and for non-symmetries in the YIG filter.

After the signal is centered, N is determined from

$$N = \frac{F_{YIG} - 110}{500}$$

and then rounded up to the next higher integer. From this, Fvco is calculated using

$$F_{VCO} = \frac{F_{YIG} - 110}{N}$$

Should this yield Fvco = <400 MHz, then Fvco is recalculated using

$$F_{VCO} = \frac{F_{YIG} - 110}{N}$$

After the IF is found, the IF gain is adjusted to set the signal threshold approximately 3 dB below the peak amplitude.

Since F_{YIG} is only approximately equal to F_{IN}, the IF frequency will not be exactly 110 MHz. Therefore, the next step in the operation is a VCO frequency adjustment to shift F_{IN} into the middle of the IF passband.

VCO frequency correction is achieved by counting F_{IF} and changing F_{VCO} by

$$\frac{\pm F_{IN} - 110}{N}$$

Once the VCO corrections have been made, the converter has acquired the signal and the counter counts and displays the input frequency.

After each measurement, new frequencies for the YIG and VCO are calculated to maintain the IF at 110 MHz and the IF gain is re-adjusted to keep the signal 3 dB above threshold. This method provides rapid tracking of a signal being tuned.

MILLIMETER/RF CONVERTERS

A block diagram of the millimeter/RF converters is shown in Figure 7-5.

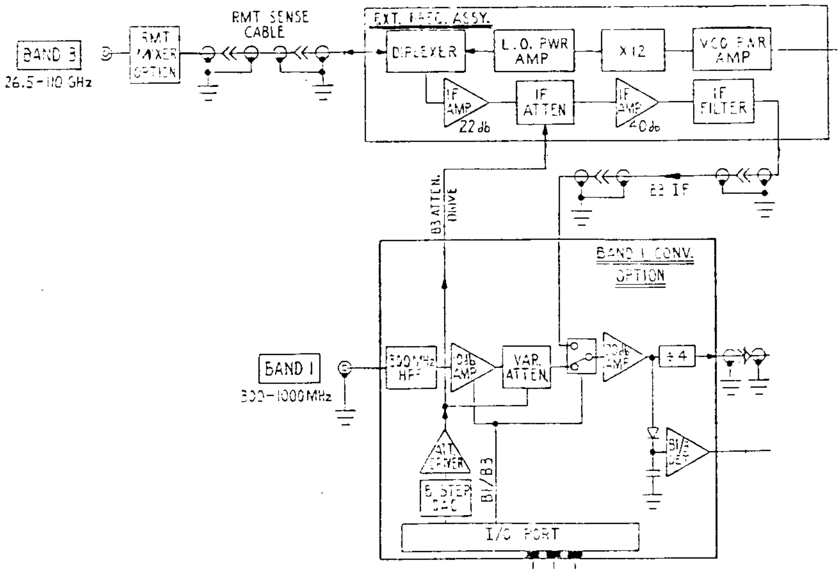


Figure 7-5. Millimeter/RF Converter

BAND 3 MILLIMETER WAVE CONVERTER

When the 588 measures a signal frequency greater than 26.5 GHz, using a Model 890 cable and a remote sensor, it converts the signal to approximately 675 MHz, where it is directly counted by the RF converter. The VCO signal, used in this band between 435 and 505 MHz, is multiplied by 12 to the 5.22–6.06 GHz range. This signal provides the LO power which is transmitted through a diplexer to the remote sensor. The remote sensor is a harmonic mixer that generates harmonics of the LO. One of these harmonics mixes with the input to provide an IF at 675 MHz. The IF returns on the same line as the LO, is amplified by a variable gain amplifier to approximately -5 dBm, and is counted by the RF converter. See Figure 7-6, Millimeter Wave Converter Lock Process.

Initially the instrument determines the sweep range limits of the LO based on the entered sub-band. The highest the sub-band number, the smaller the LO sweep range. Then the LO is swept between its sweep limits and searches for a signal.

When a signal is found, the LO is stepped a small amount and, depending on the direction of the IF step, the mix side is found. If the instrument is in the normal mode, it determines the LO harmonic number using an eight-point algorithm that determines the harmonic nummber from the ration of the IF step to the LO step. If the instrument is in the center frequency mode, the harmonic number is calculated based on the entered center frequency. The LO is then adjusted to set the IF to approximately 675 MHz. After each LO step, the IF gain is adjusted to set the detector threshold 3 dB below the peak amplitude.

The IF is measured and the frequency calculated and displayed using the formula:

$$\text{FREQ} = N \times (\text{LO}) \pm \text{IF}$$

After each measurement, the IF frequency is re-adjusted to 675 MHz and the IF gain is re-adjusted to set the peak 3 dB above threshold.

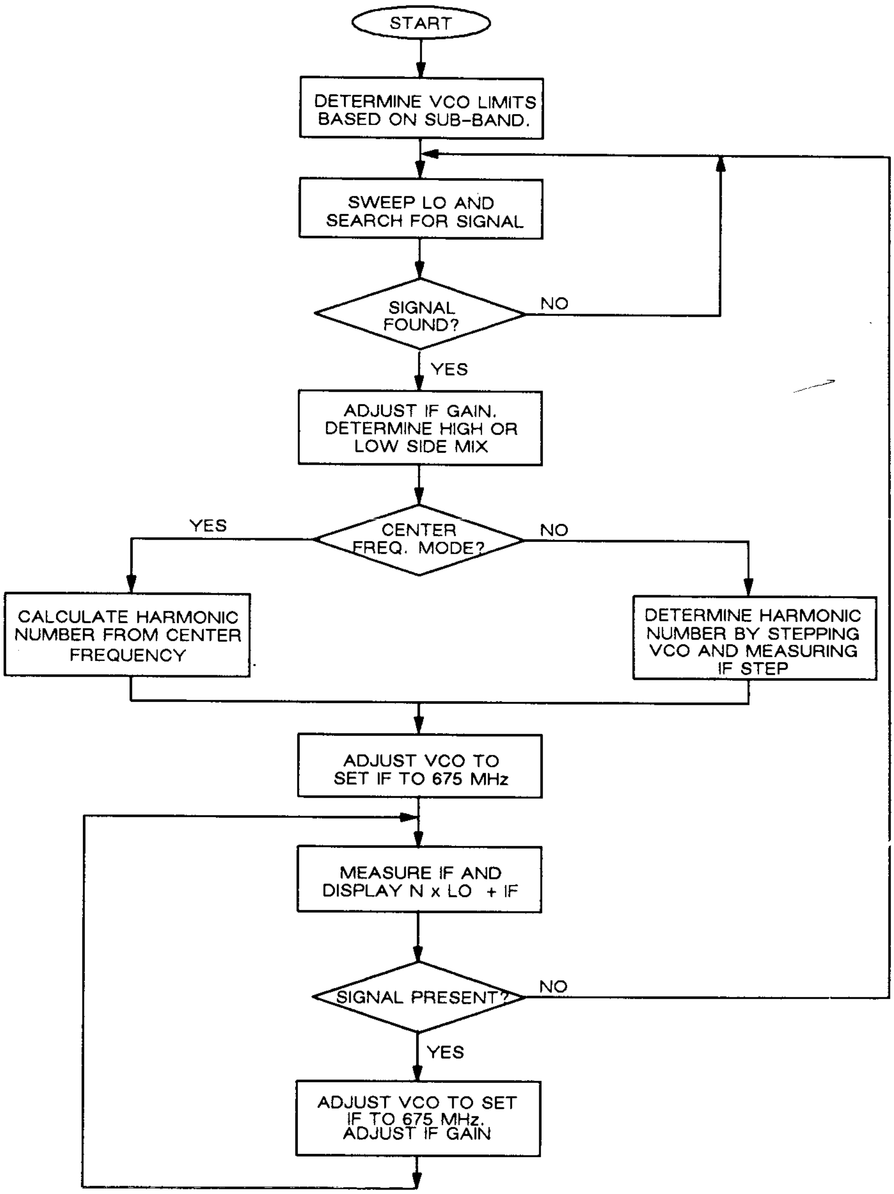


Figure 7-6. Flow Diagram Millimeter Wave Converter Lock Process

BAND 1 RF CONVERTER

Signals between 300 MHz and 1 GHz are counted directly through a divide-by-four prescaler. In this mode, the gate must be made four times longer to properly count the prescaled signal. Signal acquisition in the RF band is straightforward: the instrument simply monitors the RF detector. When a signal is detected, the RF gain is adjusted to set the detected signal threshold approximately 3 dB below the peak amplitude and the signal is counted. After every measurement, the RF gain is re-adjusted to ensure rapid tracking of a moving signal. See Figure 7-7, RF Converter Lock Process.

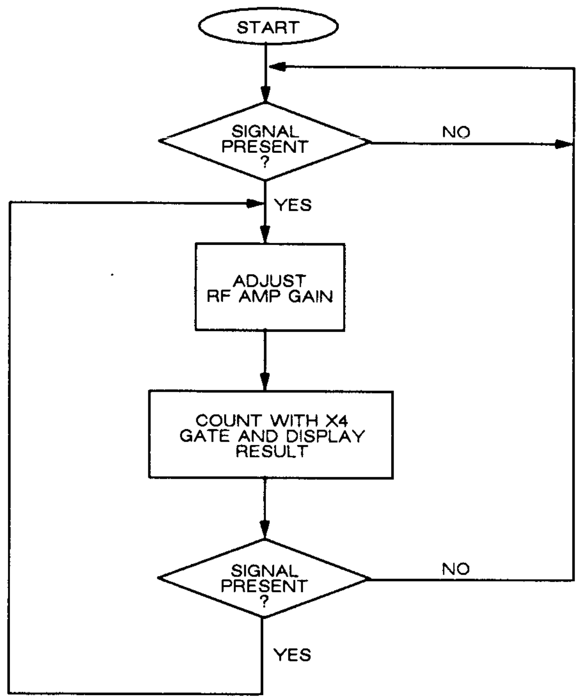


Figure 7-7. RF Converter Lock Process

SECTION 8
FUNCTIONAL DESCRIPTION AND ILLUSTRATED PARTS BREAKDOWN

INTRODUCTION

This section contains a functional description, a parts list, and illustration of componant location, and a schematic diagram for each printed circuit board used in this counter.

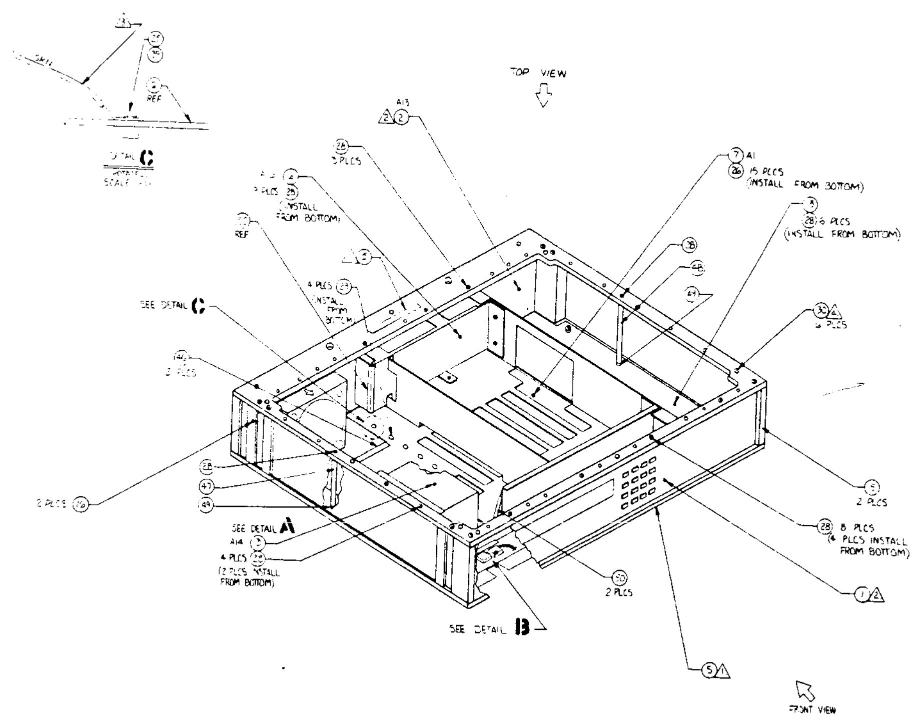
The parts list is broken down by types of components, listed in alphanumeric sequence. The components that have a different reference designator (REF DES), but have the same EIP part number, are described for the first such component listed. Subsequent descriptions of that component will refer to the first entry. The total number of like components used on the same assembly will be listed with the first entry in the column identified as UNITS PER ASSY.

REFERENCE DESIGNATORS

A	Assembly	P	Plug or PCB contacts
B	Battery or Fan	R	Resistor
C	Capacitor	RN	Resistor Network
CR	Diode	S	Switch
DS	Indicator (display)	T	Transformer
F	Fuse	TP	Test Point
J	Jack or Connector	U	Integrated Circuit
K	Relay	X	Socket or Holder
L	Inductor	Q	Transistor

585/588 MICROWAVE PULSE COUNTERS 2000063-02/ 2010717-02

REF DES.	DESCRIPTION	EIP NO.	UNITS PER ASSY
	CHASSIS ASSY,585-Y16	2010725-02	1
A1	COUNTER INTERCONNECT (PART OF CHASSIS ASSY)	2020221-01	1
A2	PCB ASSY, PWR SUPPLY,58X	2020222-06	1
A3	PCB ASSY, MICROPROCESSOR	2020215-01	1
A5	PCB ASSY,GPIB/B2 PWR	2020218-01	1
A6	PCB ASSY, COUNT CHAIN	2020219-01	1
A7	PCB ASSY, GATE GENERATOR	2020217-01	1
A8	PCB ASSY,CONV CONTROL,58X	2020200-05	1
A9	PCB ASSY, B1 CONV	2020224-02	1
A10	CONV ASSY,B2,58X	2020296-01	1
A12A1	PCB ASSY,FR PNL DISPLAY/CONTROL	2020140-02	1
A12A2	PCB ASSY,FR PNL LOGIC	2020191-01	1
W3	CABLE ASSY,COAX,DETECTED VID 1	2040288-01	1
W4	CABLE ASSY,COAX,DETECTED VID 2	2040289-01	1
W5	CABLE ASSY,COAX,VCO FREQ	2040263-01	1
W7	CABLE ASY,COAX VCO OUTPUT	2040261-01	1
W8	CABLE ASY,COAX,B2 IF	2040260-01	1
W10	HARN ASSY,10MHZ REF	2040296-01	1
W11	CABLE ASSY,COAX,VCO TUNE	2040262-01	1
W13	CABLE ASSY,FLAT RBN,F/P LOGIC	2040169-01	1



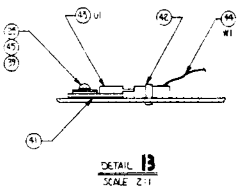


Figure 8-1. Chassis Assembly, 585-Y16

ITEM NO.	DESCRIPTION	EIP NO.	UNITS PER ASSY
1	PANEL ASSY,FRONT,585	2010284-03	1
2	PANEL ASSY,REAR,585-Y16	2010722-01	1
3	XFMR ASSY,PWR,58X	2010359-01	1
5	FRAME,MOD,14IN,W/O HANDLES	5210248-02	2
6	CARD CAGE ASSY,TYPE 2	2010748-01	1
7	PCB ASSY, CNTR INTCON 58X	2020221-01	1
13	PANEL,MICROWAVE SUPPORT,58X	5210393-00	1
15	POST,COR,FRONT,BLK 2.70	5210430-02	2
16	POST,COR,REAR,BLK,2.70	5210431-02	2
17	PANEL,SIDE,VINYL CLAD,2.830	5210811-02	2
25	SCR,PNH X-REC 4-40X1/4 UNC	5120004-04	2
26	SCR,PNH,X-REC,SEMS,INTL,4-40X5/16	5171004-05	15
28	SCR,PNH X-REC SLFLKG 6-32X3/8 UNC	5124006-06	32
29	SCR,PNH,X-REC,SEMS,INTL,6-32X7/16	5171006-07	4
30	SCR,PNH X-REC SLFLKG 8-32X1/2 UNC	5124008-08	16
39	WASH,LK,INTL-T,CRES # 4	5163004-00	2
41	PAD,INSULATOR,SILICON TO-220	5000235-00	1
42	TIE,CABLE 0-.75 ID	5000093-00	1
43	IC,7805C,VOLT RGLTR,+5V,TO-220	3057805-02	1
44	HARN ASSY,REG,F/P	2040168-01	1
45	WASHER,FLAT,CRES NO.4	5160004-00	1
46	GROMMET,CATERPILLAR	5000122-00	7.5 (IN)
47	STANDOFF,1/4 HEX,6-32X2.535LG	5100099-02	1
48	STANDOFF,1/4 HEX,6-32X2.560LG	5100099-03	1
49	SCR,PNH,X-REC,SEMS,INTL,6-32X1/2	5171006-08	2
50	GROMMET,CATERPILLAR,1/16"	5000355-00	2

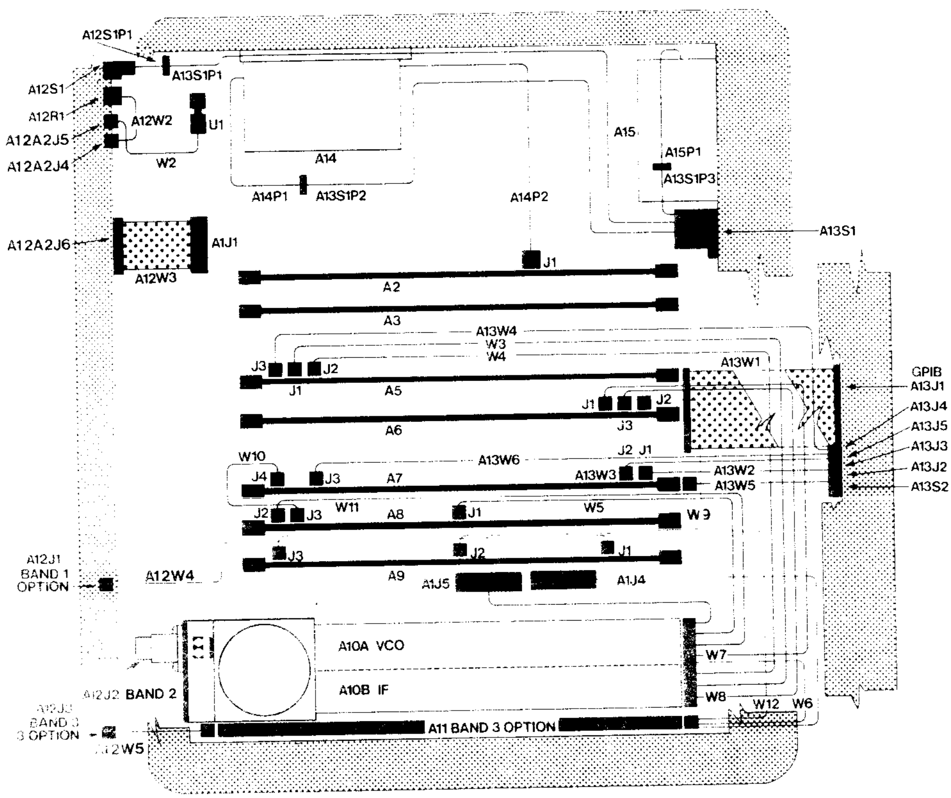


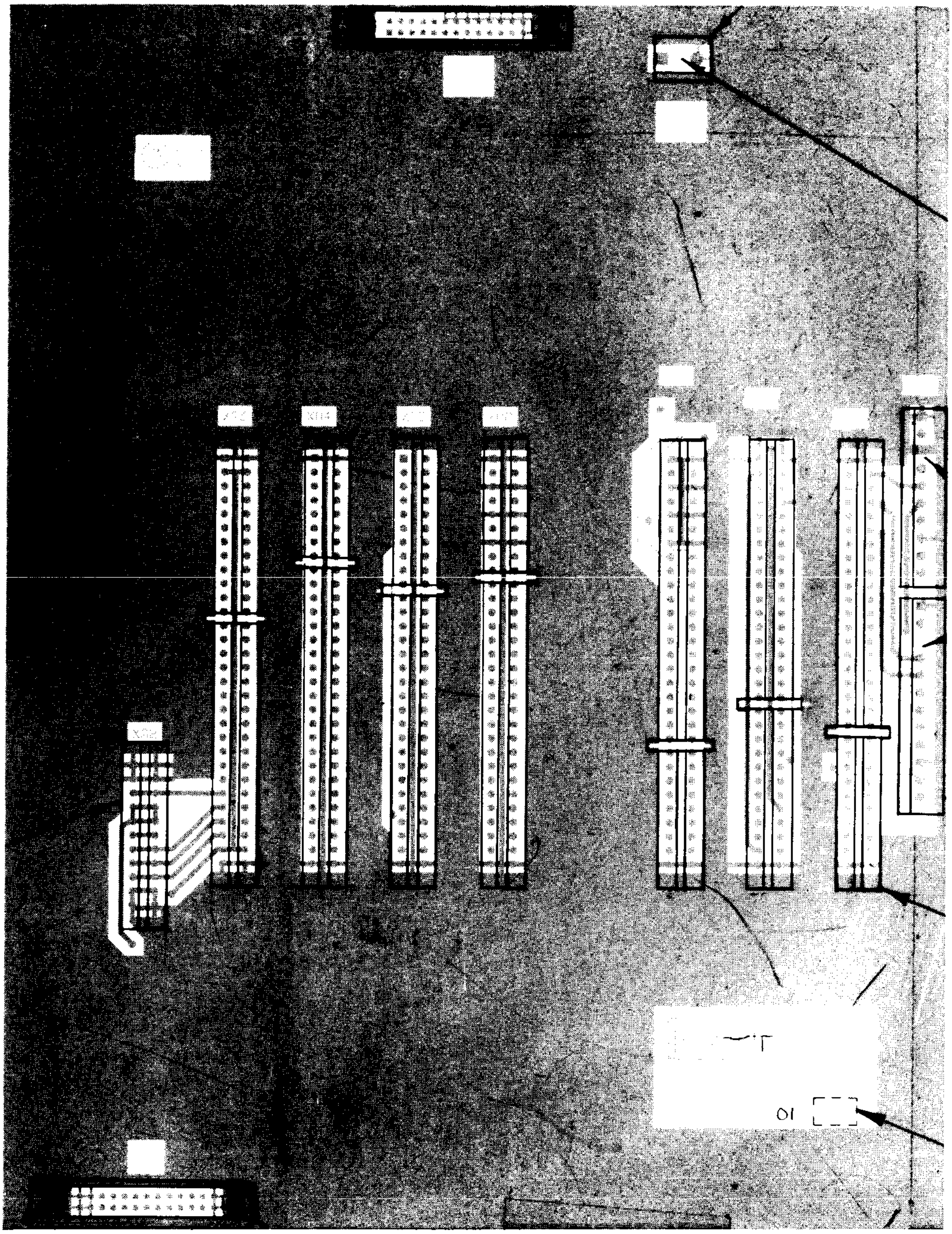
Figure 8-2. 585/588 Cable Guide

585/588 CABLE GUIDE

FROM	CONNECTOR	DESIG.	CONNECTOR	TO	DESCRIPTION
A12S1P1	A13S1P1	A13S1	A13S1	REAR PANEL	VOLTAGE SELECT
A14P1	A13S1P2	A13S1	A13S1	REAR PANEL	VOLTAGE SELECT
A15P1	A13S1P3	A13S1	A13S1	REAR PANEL	VOLTAGE SELECT
U1	W2P1	A16W1	W2P2	A12AJ5	DISPLAY HARNESS
A5J1	W3P1	W3	W3P2	A10J1	DETECTED VIDEO 1
A5J2	W4P1	W4	W4P2	A10J2	DETECTED VIDEO 2
A8J1	W5P1	W5	W5P2	A10J6	VCO OUT CONVERTER CONTROL
A10J7	W6P1	W6	W6P2	A11J3	OPTION: VCO OUT, BAND 3
A6J1	W7P1	W7	W7P2	A10J5	VCO OUT, COUNT CHAIN
A6J3	W8P1	W8	W8P2	A10J3	BAND 2 IF
A6J2	W9P1	W9	W9P2	A9J3	OPT.: BAND 1/BAND 3 IF
A7J4	W10P1	W10	W10P2	A8J3	10 MHz REFERENCE
A8J2	W11P1	W11	W11P2	A10J4	VCO TUNING VOLTAGE
A9J2	W12P1	W12	W12P2	A11J2	OPTION: BAND 3 IF
	W13P1	W13	W13P2		
A13S1P1	A12S1P1	A12S1	A12S1S1	FRONT PANEL	POWER SWITCH
A12A2J4	A12W2P1	A12W2	A12W2R1	FRONT PANEL	SAMPLE RATE CONTROL
A9J1	A12W4P1	A12W4	A12W4J1	FRONT PANEL	OPTION: BAND 1 INPUT
A11J1	A12W5P1	A12W5	A12W5J3	FRONT PANEL	OPTION: BAND 3 INPUT
A1J2	A13W1P1	A13W1	A13W1J1	REAR PANEL	GPIB INTERFACE
A7J1	A13W2P1	A13W2	A13W2J2	REAR PANEL	GATE OUTPUT
A7J2	A13W3P1	A13W3	A13W3J3	REAR PANEL	SIGNAL THRESHOLD OUTPUT
A5J3	A13W4P1	A13W4	A13W4J4	REAR PANEL	INHIBIT INPUT
A1J3	A13W5P1	A13W5	A13W5S2	REAR PANEL	10 MHz INT/EXT SWITCH
A7J3	A13W6P1	A13W6	A13W6J5	REAR PANEL	10 MHz IN/OUT
A9J1	A13W7P1	A13W7	A13W7J6	REAR PANEL	OPTION: BAND 1 IN, REAR IN
A11J1	A13W8P1	A13W8	A13W8J8	REAR PANEL	OPTION: BAND 3 IN, REAR IN
A1J5	A10P1	A10			CONVERTER POWER HARNESS
A1J4	A11P1	A11			BAND 3 HARNESS
A2J1	A14P2	A14			TRANSFORMER

A1 COUNTER INTERCONNECT (2020221-01)

REF DES.	SAME AS	DESCRIPTION	EIP NO.	UNITS PER ASSY
J1		CONN,PCB HEADER,26 PIN,W/EJCTR	2620078-00	2
J2	J1			
J3		CONN,PC,RCPT LK 156,3 PIN	2620201-00	1
J4		CONN,PCB,FRICT LK 156,10 PIN	2620092-00	1
J5		CONN,PCB,RCPT LK,156,12 PIN	2620143-00	1
XA2		CONN,PCB EDGE,AMPL,11 PIN	2620183-00	1
XA3		CONN,PCB EDGE,30 PIN	2620184-00	7
XA4	XA3			
XA5	XA3			
XA6	XA3			
XA7	XA3			
XA8	XA3			
XA9	XA3			
		KEYING PLUG	5000155-00	7



2020221-01

Figure 8A1-1. Component Locator, Counter Interconnect

5500221-00

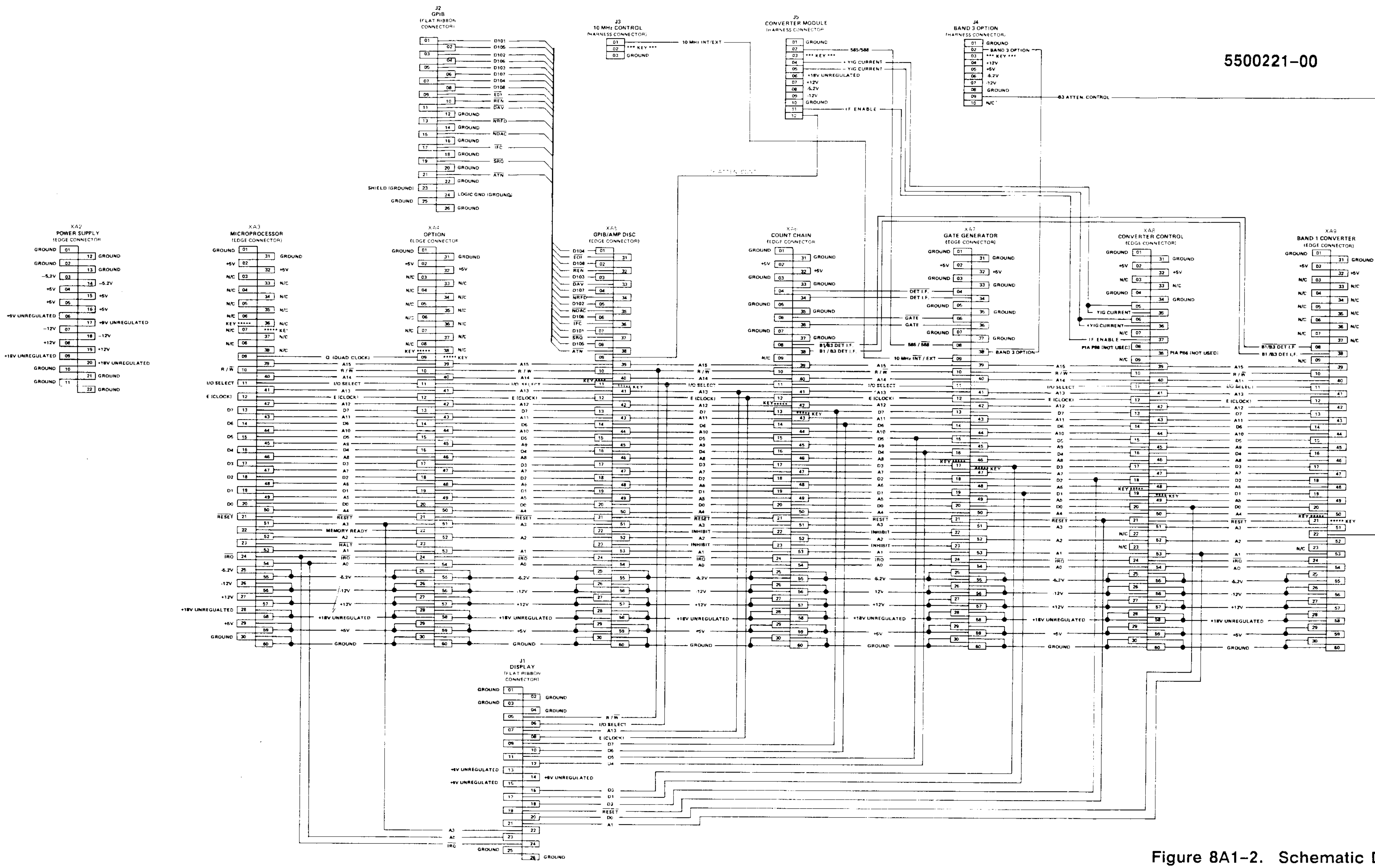


Figure 8A1-2. Schematic D

A2 POWER SUPPLY (2020222-06)

The power supply furnishes all basic operating voltages required by the counter. The supply consists of two main circuits:

1. AC line conditioning circuits, consisting of the input power transformer, the input line filter, the voltage select switch, the fuse, and the front panel POWER ON/OFF switch.
2. PC Board A2; containing rectifiers, filter capacitors, and regulator circuitry.

The basic voltages supplied are:

+18 V Unregulated

+12 V

+9 V Unregulated

+5 V

-5.2 V

-12 V

The input ac voltages are full wave rectified and filtered to produce the unregulated dc voltages of +9 V, -9 V, +18 V, and -18 V.

+18 V The unregulated 18 volts is used directly as one supply voltage for the microwave converter.

+12 V The +18 volts is regulated to +12 volts by an LM317 three-terminal series regulator employing thermal current protection.

+9 V The unregulated 9 volts is used to drive the front panel, and is regulated to +5V at the front panel.

+5 V The +5 volts is regulated by a single three-terminal regulator from the +9 volts unregulated supply. This regulator contains internal current and thermal sensing circuitry.

-5.2 V The -5.2 volts is also regulated by a single three-terminal regulator. The -9 volt unregulated supply is used for this regulator. This regulator also contains internal thermal and current shutdown circuitry.

-12 V The -18 volts is regulated to -12 volts by the action of an LM337 three-terminal series regulator employing thermal current protection.

A2 POWER SUPPLY 2020222-06

REF DES.	SAME AS	DESCRIPTION				EIP NO.	UNITS PER ASSY
C1		CAP,ELCTLT	32000μF	U%	15V	2200019-00	1
C2		CAP,ELCTLT	27000μF		15V	2200027-00	1
C3		CAP,TANTALUM	10μF	20%	25V	2300029-00	4
C4		CAP,ELCTLT	14000μF		25V	2200017-00	1
C5		CAP,ELCTLT	9500μF	U%	25V	2200016-00	1
C6	C3						
C7		CAP,TANTALUM	1μF		35V	2300008-00	3
C8	C3						
C9		CAP,TANTALUM	22μF		35V	2300034-00	1
C10	C3						
C11	C7						
C12	C7						
C13		CAP,MK CER	1μF	20%	50V	2150023-00	4
C14	C13						
C15	C13						
C16	C13						
CR1		DIODE,MDA970-2,BRIDGE,100V				2710045-00	1
CR2		DIODE,MDA990-1,BRIDGE				2710028-00	1
J1		CONN,SQ POST,6 PIN,156				2620157-00	1
J2		CONN,POST,SQ 156,3 PIN				2620154-00	1
U1		IC,78H05A,VOLT RGLTR,+5V,TO-3				3057805-01	1
U2		IC,LM317,VOLT RGLTR,ADJ,POS,TO-220				3040317-00	1
U3		IC,LM337,VOLT RGLTR,ADJ,NEG,TO-220				3040337-00	1
U4		IC,LM345-5.2,VOLT RGLTR,NEG,TO-3				3040345-00	1
TP1		CONN,PIN-TP,SWAGE .040D-.150L				2620193-00	4
TP2-4	TP1						
R1		RES,MF	475	1/10W	1%	4504750-00	1
R2		RES,MF	3.01K	1/8W	1%	4053011-00	1
R3		POT,CERMET	2.0	KT05	0.5W	4250016-00	2
R4		RES,CC	5.1	1W	5%	4030519-00	2
R5	R4						
R6	R3						
R7		RES,MF	8.66K	1/8W	1%	4068661-00	1
R8		RES,MF	1.21K	1/10W	1%	4051211-00	1
R9		RES,M/OX	200	1/4W	2%	4130201-00	1
R10		RES,CC	5.6	1/4W	5%	4010569-00	1
R11		RES,M/OX	13	1/4W	2%	4130130-00	1
R12		RES,CC	4.7	1/4W	5%	4010479-00	1

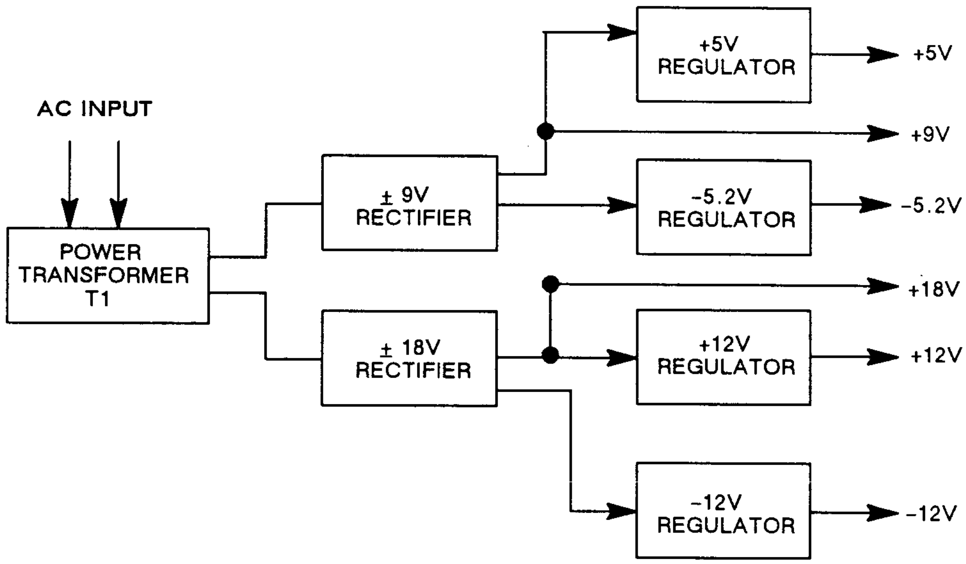
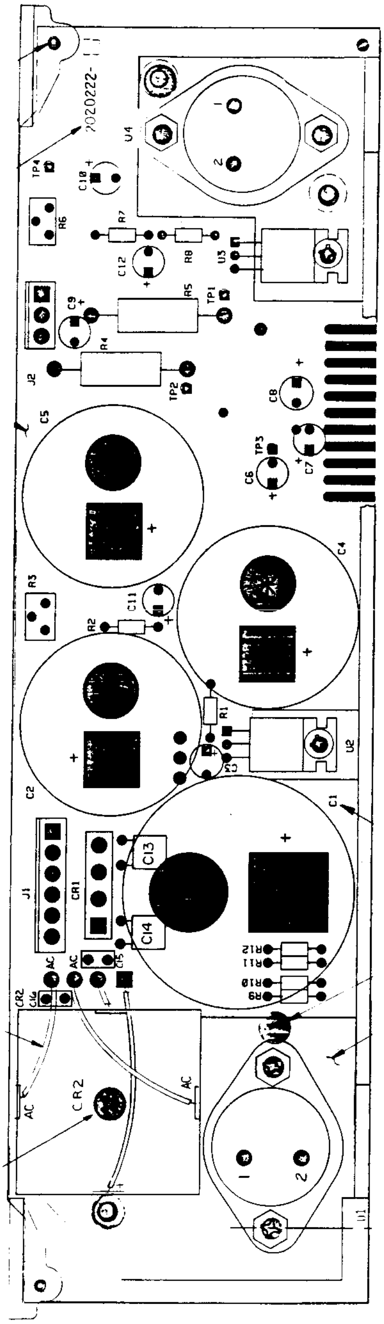
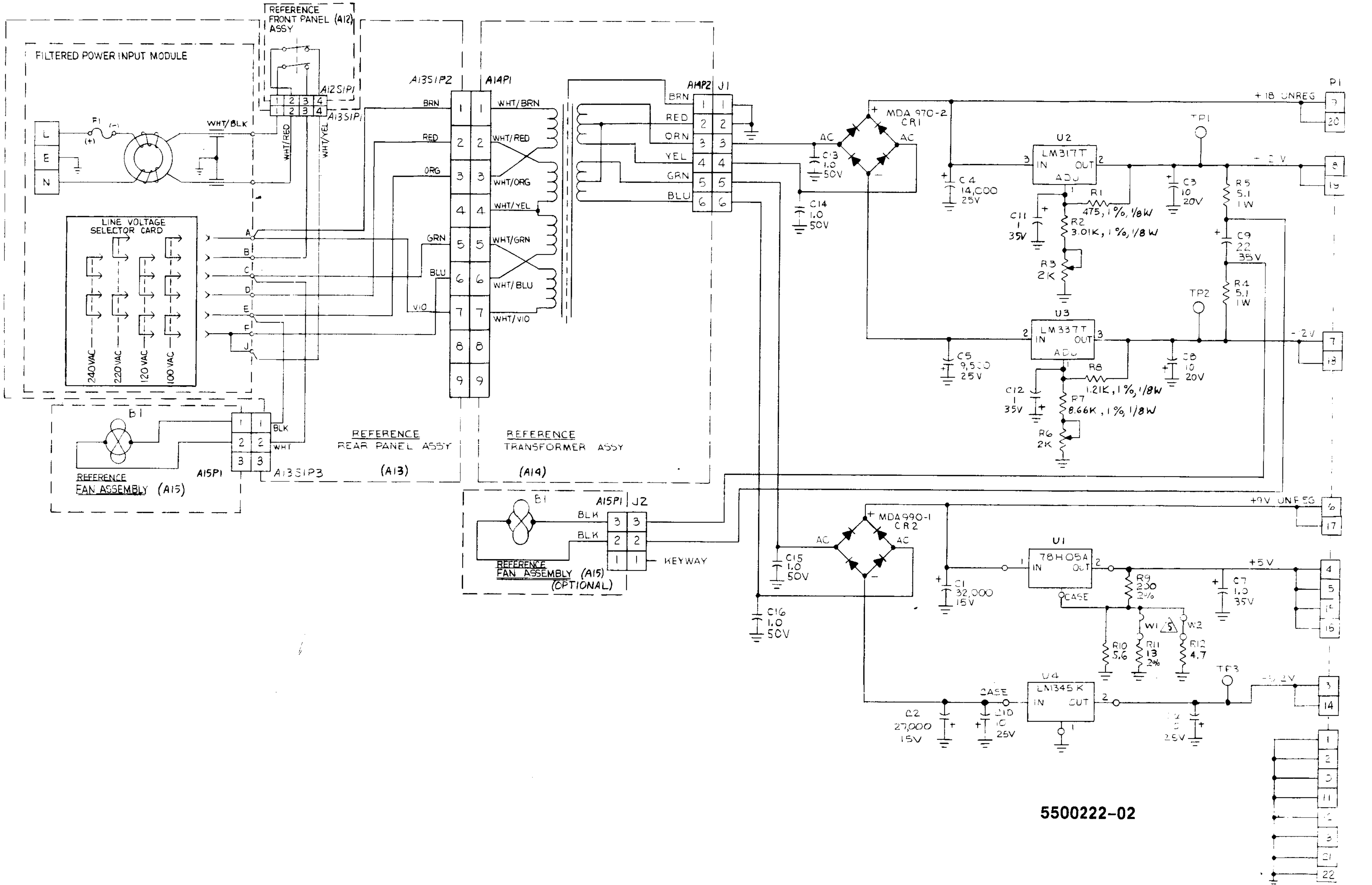


Figure 8A2-1. Functional Block Diagram, Power Supply



2020222-06

Figure 8A2-2. Component Locator, Power Supply



5500222-02

Figure 8A2-3. Schem

A3 MICROPROCESSOR (2020215-01)

The Microprocessor board contains the microprocessor, the control logic, and the firmware for controlling the operation of the counter. The board can be divided into five functional blocks.

- Microprocessor
- Power-up Reset Circuit
- Address Decoder
- RAM and Program Memory
- Control Logic Buffers.

MICROPROCESSOR

The counter uses a Motorola 6809 microprocessor. The clock generation circuitry for the digital system is contained within the 6809. The only external components required for clock generation are two 24-pF capacitors and an AT-cut 4-MHz crystal.

The NMI, FIRO, and DMA functions of the 6809 are not used. Their corresponding control lines are always disabled. The processor state indicators (BS, BA) are also not used by the counter. The HALT and the MRDY controls are connected to the Interconnect board through the edge connector.

POWER-UP RESET CIRCUIT

The Power-up Reset circuit provides a 100-ms reset signal to the entire digital system after the counter is turned on. The reset signal remains true as long as the +5-volt power supply stays below +4 volts.

When the counter is turned on, the voltage across C5 is O volts. The output of the comparator U1 is at logic low. The capacitor C5 slowly charges up through R2. The output of the comparator remains low as long as the voltage across C5 is lower than the voltage on pin 3 of the comparator. When the voltage across C5 becomes higher than than on pin 3, the output of the comparator becomes true, removing the reset signal. R3 is provided for hysteresis purposes. When power is removed, C5 will discharge quickly through CR1.

ADDRESS DECODER

The address decoding is performed by a 4-to-16 line decoder. The 64K-byte address space is divided into sixteen 4K-byte blocks, one of which is always enabled.

The enable signals for the memory blocks become true no later than 51 ns after Q. They stay true until a maximum of 40 ns after E has become false. The 4-to-16-line decoder has open collector outputs. This enables the addressed memory block to be enlarged by wire-ORing two or more outputs together.

The memory map for the counter is as follows:

Volatile RAM Memory	0000 - 07FF
Non-Volatile RAM Memory	0800 - 0FFF
I/O	1000 - 2FFF
Signature Analysis	3000 - 3FFF
Program Memory	4000 - FFEF
Reserved (6809)	FFF0 - FFF1
SW13	FFF2 - FFF3
SW12	FFF4 - FFF5
FIRQ	FFF6 - FFF7
IRQ	FFF8 - FFF9
SWI	FFFA - FFFB
NMI	FFFC - FFFD
RESET	FFFE - FFFF

RAM AND PROGRAM MEMORY

RAM

A 2K-byte-wide volatile RAM is provided for the normal operation of the counter. To prevent data from being erroneously written into the RAM, the chip enable signal is active only when the E clock and the RAM memory block enable signal from the address decoder are both active and when the A11 address line is at logic1.

PROM

A block of 48K bytes of memory are assigned for system program. The Microprocessor board contains three 28-pin sockets for PROMs. Each of the sockets is wired to accept a 16K-byte PROM.

CONTROL LOGIC AND BUFFERS

The digital system of the counter contains three buses: the data bus, the address bus, and the control bus.

DATA BUS

The data bus originates from the microprocessor. For signature analysis, the data bus can be disconnected from the rest of the system at the microprocessor by removing jumper header E1 and installing it in E2. The data bus on the microprocessor board is buffered from the rest of the digital system. The data bus buffer is enabled only when the address space assigned to I/O is addressed. The direction of the data bus buffer is determined by the state of the R/W control line.

ADDRESS BUS

The address bus also originates from the microprocessor. The address bus buffer is always enabled.

CONTROL BUS

The control bus contains eight control lines. Five of the control lines originate from the Microprocessor board. The other three control lines originate from the rest of the digital system.

R/W, E, and Q originate from the microprocessor. Reset is supplied by the power-up reset circuit. The I/O SEL control line is true when A15 and A14 are at logic O and either A13 or A12 or both are at logic 1 levels. The IRQ control line is the wired-OR of all the interrupt request lines. MRDY is the wired-OR of all the memory ready control lines. The MRDY and HALT control lines are provided for future expansion

A3 MICROPROCESSOR 2020215-01

REF DES.	SAME AS	DESCRIPTION				EIP NO.	UNITS PER ASSY
C1		CAP,MICA	24PF	5%	500V	2260018-00	2
C2	C1						
C3		CAP,CER	.01µF	20%	100V	2150003-00	14
C4	C3						
C5		CAP,TANTALUM	3.9µF	10%	15V	2300027-00	1
C6	C3						
C7	C3						
C8	C3						
C9		CAP,TANTALUM	33µF		10V	2300015-00	2
C10	C3						
C11	C3						
C12	C3						
C13	C3						
C14	C3						
C15	C3						
C16	C3						
C17	C3						
C18	C3						
C19	C9						
CR1		DIODE,5082-2835,PSVT SCHOTTKY				2710004-00	1
CR2		DIODE,1N5228,ZENER 3.9V				2705228-00	1
R1		RES,CC	1M	1/4W	5%	4010105-00	1
R2		RES,CC	22K	1/4W	5%	4010223-00	1
R3		RES,CC	300K	1/4W	5%	4010304-00	1
R4		NOT USED					
R5		RES,CC	240	1/4W	5%	4010241-00	1
R6		RES,CC	4.7K	1/4W	5%	4010472-00	4
R7	R6						
R8	R6						
R9	R6						
RN1		RES, NTWK	9X10K	2.7W	2%	4170003-00	3
RN2	RN1						
RN3	RN1						
RN4		RES, NTWK, SIP	9X4.7K	1.25W	2%	4170014-00	1
TP1-10		CONN, PCB, .040D PIN, GOLD				2620032-00	10

A3 MICROPROCESSOR (Continued) 2020215-01

REF DES.	SAME AS	DESCRIPTION	EIP NO.	UNITS PER ASSY
U1		IC, LM311, VOLT COMPARATOR	3050311-00	1
U2		IC, 6809, M/P, HIGH PERF, MOS, 1MHZ	3056809-00	1
U3		IC, 74LS365	3084365-00	1
U4		NOT USED		
U5		IC, 74LS27	3087427-00	1
U6		IC, 74LS244	3084244-00	2
U7		NOT USED		
U8		IC, 74LS245	3084245-00	1
U9		IC, 6116, 2KX8 BIT RAM, CMOS	3056116-00	1
U10		PROM, 2KX8	6420000-00	1
U11		PROM SET 58X	2060006-01	1
U12	U11			
U13	U11			
U14		IC, 74LS10	3087410-00	1
U15	U6			
U16		IC, 74159	3074159-00	1
U17		IC, 74LS04	3087404-00	1
E1		HEADER, PROGRAM DIP 16 PIN	5000205-00	1
Y1		CRYSTAL, 4.000000MHZ	2030015-00	1
XU1		CONN, SOCKET, DIP, 8 PIN	2630014-00	1
XU2		CONN, SOCKET, DIP, 40 PIN	2630022-00	1
XU3		CONN, SOCKET, DIP, 16 PIN	2630016-00	3
XU4		NOT USED		
XU5		CONN, SOCKET, DIP, 14 PIN	2630015-00	3
XU6		CONN, SOCKET, DIP, 20 PIN	2630018-00	3
XU7		NOT USED		
XU8	XU6			
XU9		CONN, SOCKET, DIP, 24 PIN	2630020-00	3
XU10	XU9			
XU11		CONN, SOCKET, DIP, 28 PIN	2630021-00	3
XU12	XU11			
XU13	XU11			
XU14	XU5			
XU15	XU6			
XU16	XU9			
XU17	XU5			
XE1	XU3			
XE2	XU3			

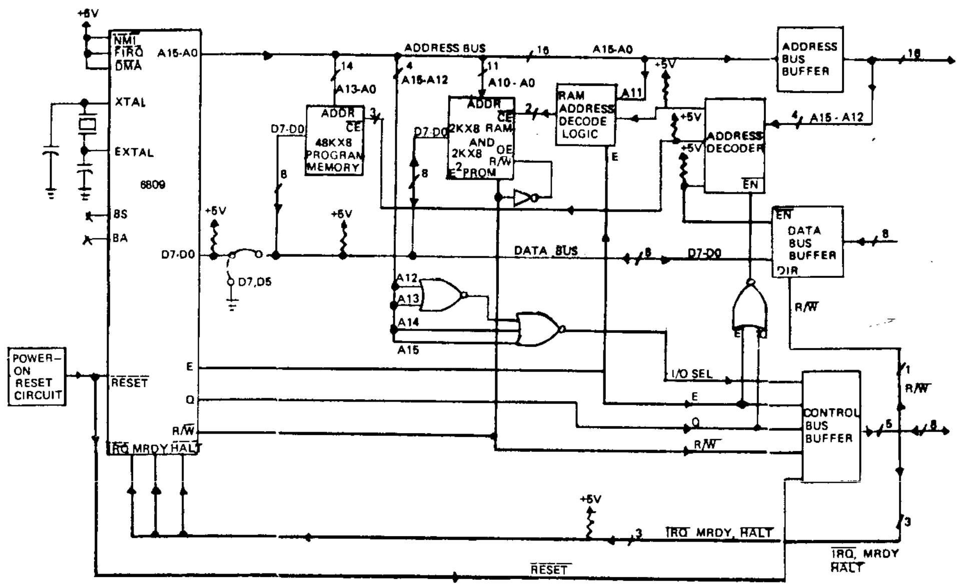


Figure 8A3-1. Functional Block Diagram, Microprocessor

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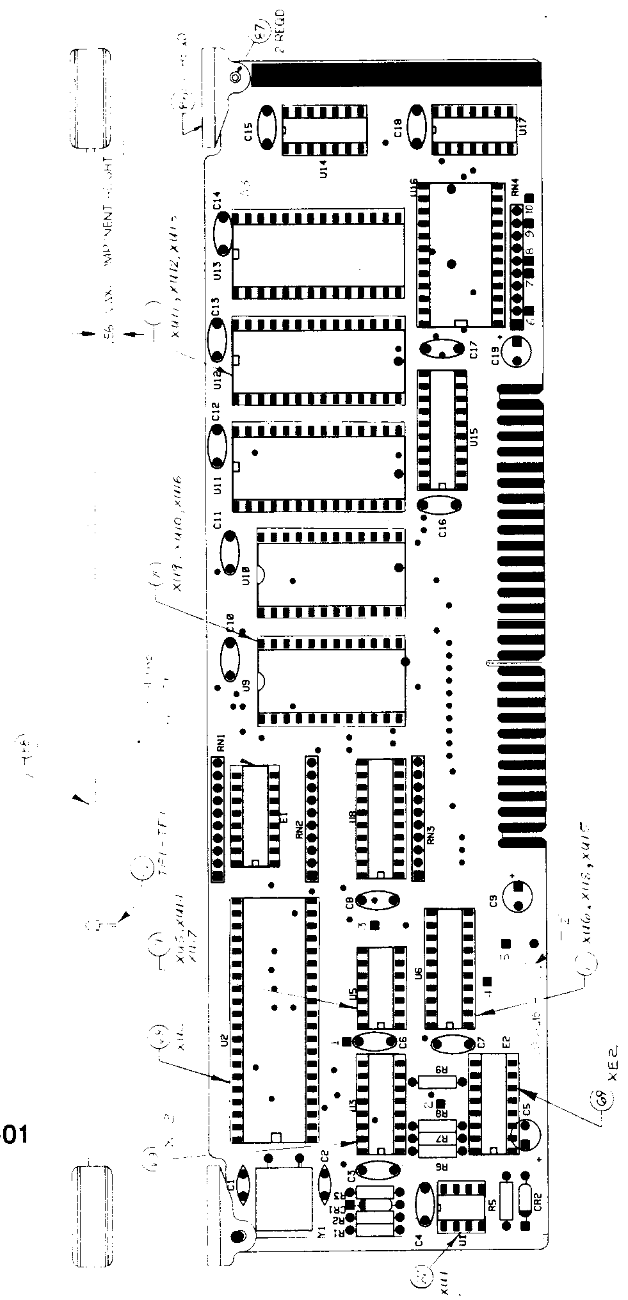

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Figure 8A3-2. Component Locator, Microprocessor

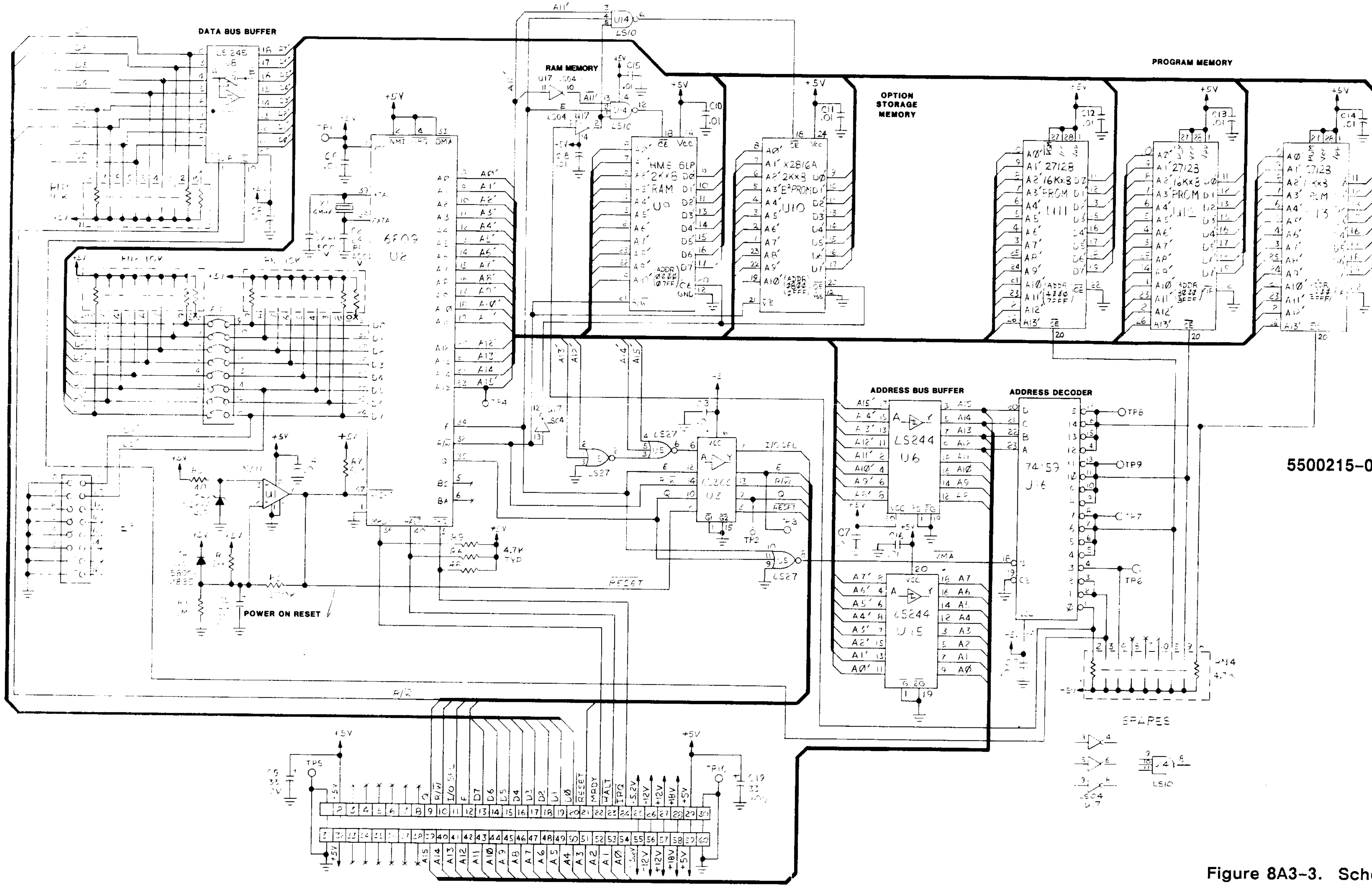

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Figure 8A3-3. Sch

A5 GENERAL PURPOSE INTERFACE BUS (GPIB)/ MICROWAVE (BAND 2) POWER DISCRIMINATOR (2020218-01)

The GPIB board performs two major functions:

- GPIB interface
- Band 2 amplitude determination, in conjunction with the Detector/Video Amplifier in the Band 2 converter module.

GPIB INTERFACE

The GPIB interface makes the 58X counter fully compatible with IEEE 488-1978. The functions implemented are:

- Basic talker with talk only
- Basic listener
- Remote/local with local lockout
- Device clear
- Device trigger
- Service request

The address decoder consists of U5 and U6. They enable the TI9914 GPIB interface adapter (GPIA) at hexadecimal addresses 1C00 through 1C07 and the 8-bit DAC at hexadecimal address 2A00.

Transceivers U2 and U3 provide the required bus buffering and termination for the GPIB. They are driven directly from the GPIA.

U1 is the TI9914 GPIB interface adapter. It performs all the bus functions and protocols according to commands from the microprocessor. All data and messages between the microprocessor and the GPIB are transferred through this IC.

BAND 2 AMPLITUDE DETERMINATION

The amplitude determination circuit converts the analog signals at J1 and J2 into digital information for the microprocessor. The signals at J1 are derived from video amplifiers driven by a square law detector. The signal amplitude at J2 is 40 times the amplitude at J1.

The A/D converters (U14, U15, U16, and U17) perform a fast conversion of the signal at J1 and J2 into digital signals for the microprocessor. Dynamic range is 30 dB and resolution is 1.25 dB.

The A/D converters, consisting of eight comparators arranged in two sets of four comparators each, compare video inputs at J1 and J2 to reference levels. The comparator reference levels are set by resistive voltage dividers at 5 dB apart and are driven by the eight-bit DAC (U7).

The eight-bit DAC is driven directly from the microprocessor and provides the reference signal for the A/D converters. The DAC output varies from 2.5 to 8 volts (6 dB) and is stepped in 1.25 dB increments.

The latches consist of eight cross-coupled NAND gates (U12 and U13) that hold the comparator outputs for the microprocessor through the PIA (U8) and NAND gate U9A.

The rear panel INHIBIT INPUT connector is connected to J3. The inhibit signal passes through ECL-to-TTL converter U11 to U9C and U10. The output of U10, a TTL-to-ECL converter, goes to the Gate Generator board and disables the gate signal while inhibit is true. The inhibit signal from U10 can be disabled by the microprocessor through U9D.

A5 GPIB/BAND 2 POWER DISCRIMINATOR 2020218-01

REF DES.	SAME AS	DESCRIPTION				EIP NO.	UNITS PER ASSY
C1		CAP,CER	.01µF	20%	100V	2150003-00	13
C2	C1						
C3		CAP,DISC,CER	33PF	10%	100V	2150069-00	1
C4	C1						
C5	C1						
C6	C1						
C7	C1						
C8	C1						
C9	C1						
C10	C1						
C11	C1						
C12	C1						
C13		CAP,TANTALUM	33µF		10V	2300015-00	2
C14		CAP,TANTALUM	10µF	20%	25V	2300029-00	2
C15	C14						
C16	C13						
C17	C1						
C18	C1						
R1		RES,M/OX	1K	1/4W	2%	4130102-00	1
R2		RES,M/OX	270	1/4W	2%	4130271-00	3
R3		RES,M/OX	560	1/4W	2%	4130561-00	3
R4		RES,M/OX	100	1/4W	2%	4130101-00	1
R5	R2						
R6	R2						
R7		RES,M/OX	160	1/4W	2%	4130161-00	3
R8	R7						
R9	R3						
R10	R7						
R11		RES,M/OX	68	1/4W	2%	4130680-00	1
R12		RES,M/OX	33	1/4W	2%	4130330-00	1
R13		RES,M/OX	20	1/4W	2%	4130200-00	1
R14	R3						
R15		RES,M/OX	51	1/4W	2%	4130510-00	2
R16		RES,M/OX	180	1/4W	2%	4130181-00	1
R17		RES,M/OX	62	1/4W	2%	4130620-00	1
R18		RES,M/OX	22	1/4W	2%	4130220-00	1
R19		RES,M/OX	10	1/4W	2%	4130100-00	1
R20	R15						

A5 GPIB/BAND 2 POWER DISCRIMINATOR (Continued) 2020218-01

REF DES.	SAME AS	DESCRIPTION	EIP NO.	UNITS PER ASSY
U1		IC,TMS9914A,GPIB CONTROLLER	3059914-00	1
U2		OC.BIS DRVR	3055161-00	1
U3		IC,75160A,GP INTERFACE BUS XCVR	3055160-00	1
U4		IC,LM398A,OPNL AMP/BUFFER	3040308-00	1
U5		IC,74LS32	3087432-00	1
U6		IC,74LS00	3087400-00	2
U7		IC,AD7524J,DAC,8-BIT,1/2 LSB	3057524-00	1
U8		IC,6820,PERIPHERAL INTFC ADAPTER	3086820-00	1
U9	U6			
U10		IC,10124,ECL 10K,TRANSLATOR	3110124-00	1
U11		IC,10125,ECL 10K,TRANSLATORS	3110125-00	1
U12		IC,74LS279	3084279-00	2
U13	U12			
U14		IC,521,DUAL DIFF COMPARATOR	3050521-00	4
U15	U14			
U16	U14			
U17	U14			
CR1		DIODE,5082-2835,PSVT SCHOTTKY	2710004-00	2
CR2	CR1			
Q1		XSTR,2N4124,NPN,GP	4704124-00	1
J1		CONN,COAX PC RCPT,SNAP NANOHEX	2610038-00	3
J2	J1			
J3	J1			

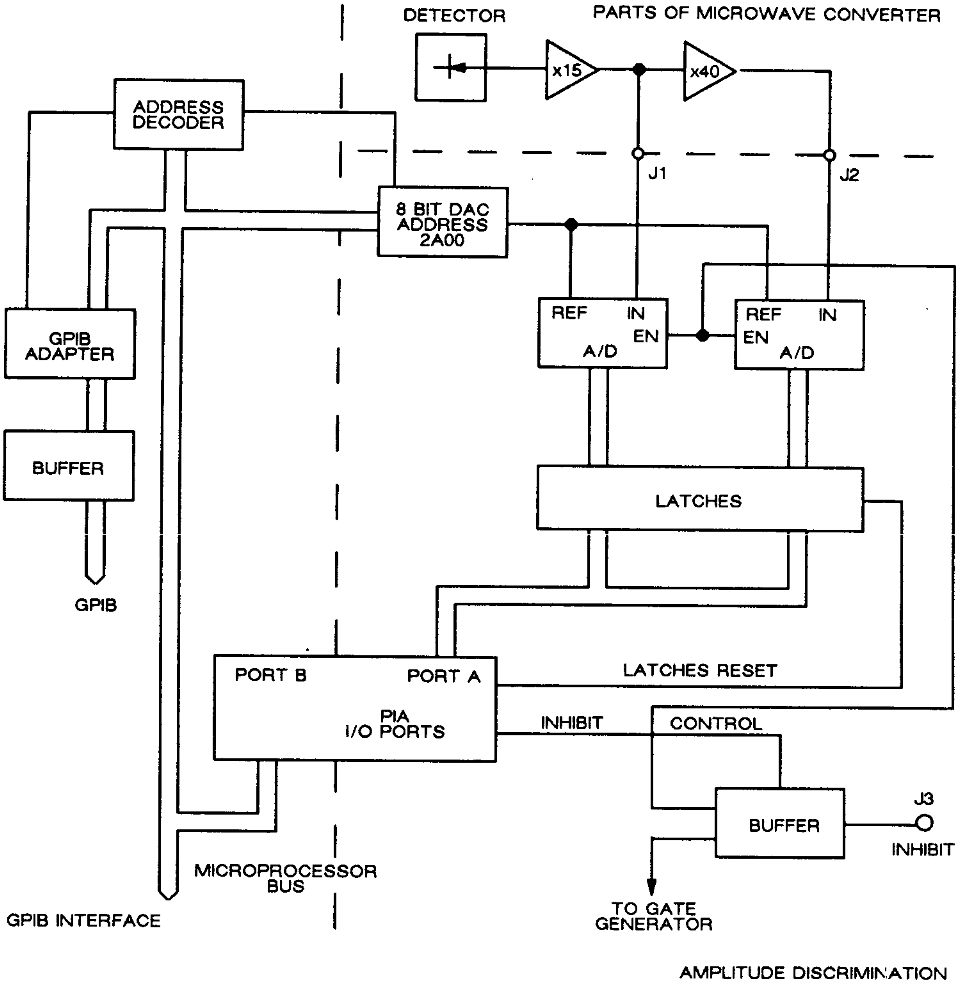

Figure 8A5-1. Functional Block Diagram, GPIB/Band 2 Power Discrimination

2020218-01

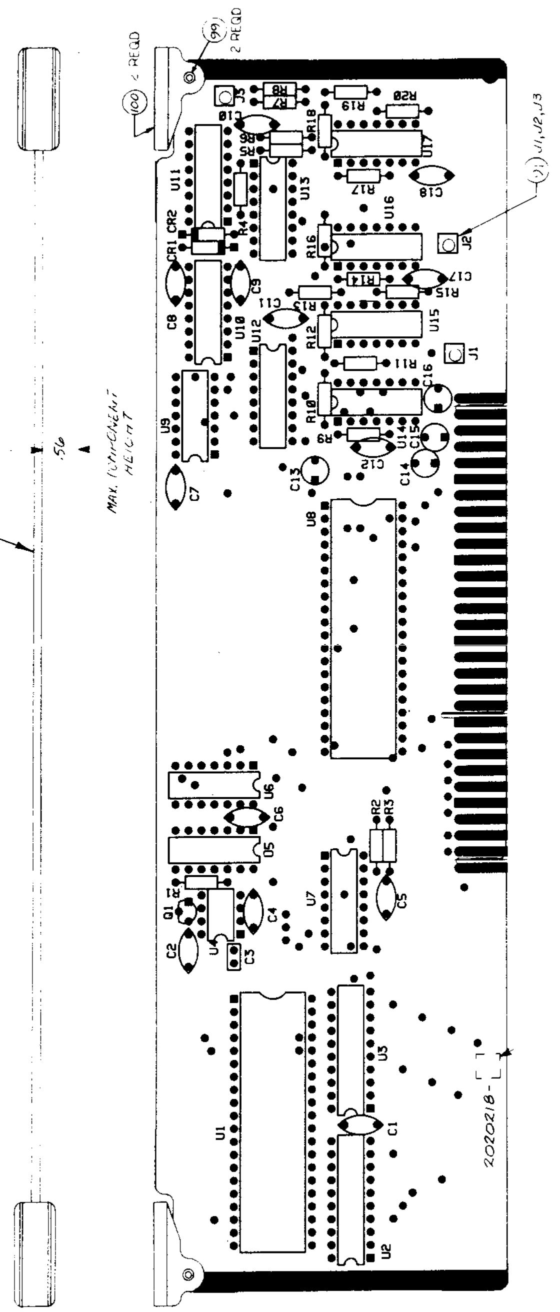

Figure 8A5-2. Component Locator, GPIB/Band 2 Power Discriminator

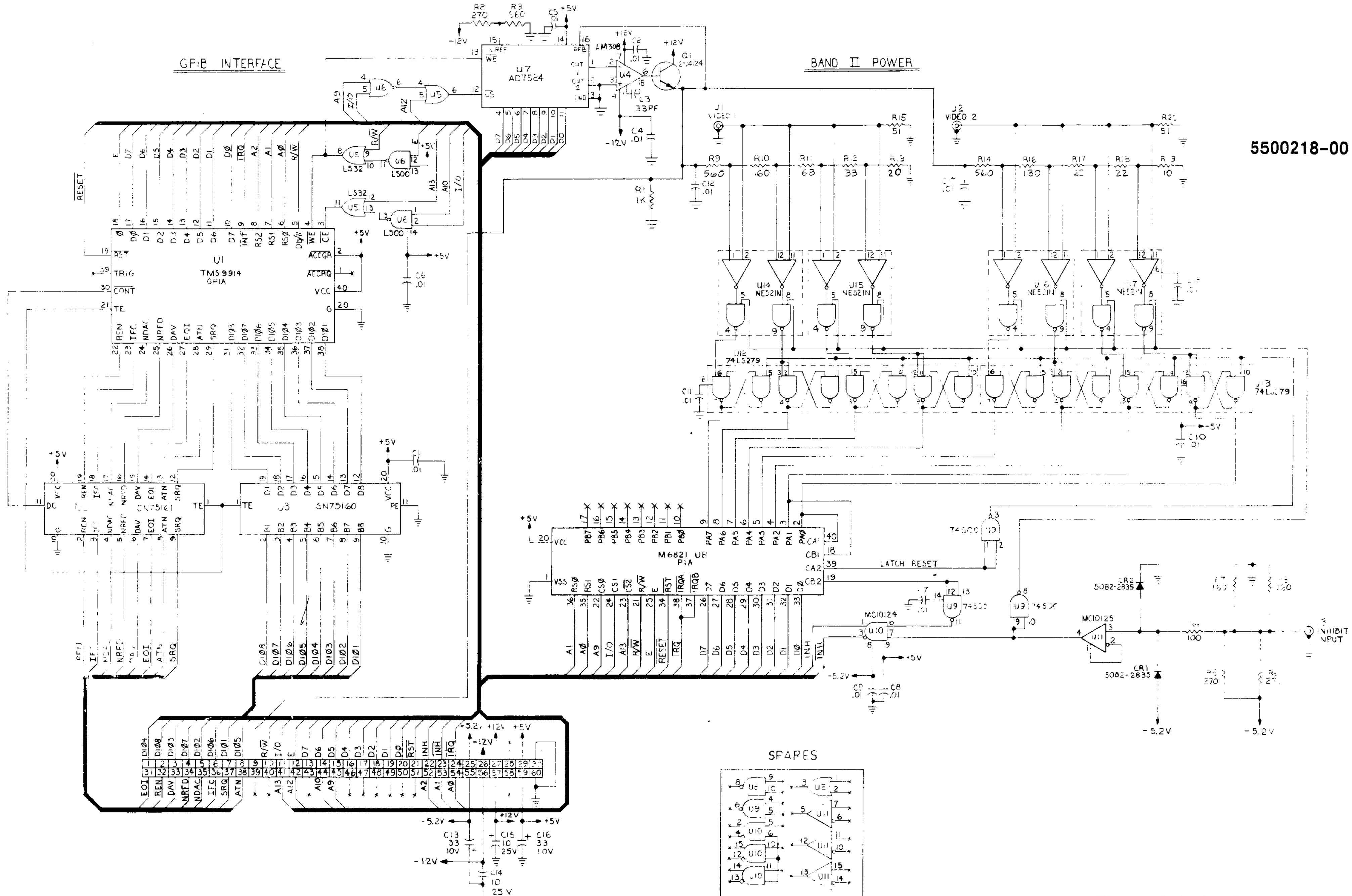

Figure 8A5-3. Schematic Diagr

A6 COUNT CHAIN (2020219-01)

The primary function of this board is to count the number of zero crossings of an input signal in a given period of time, called the gate. The input signal may be the IF of the measured signal in the frequency mode, or the signal output by the VCO in the pulse parameter measurement and self test modes.

A second function is to detect the Band 2 IF, and a third function is to provide the real-time clock for the counter.

The Count Chain assembly consists of following functional blocks:

- IF Delay Circuit
- Divide-by-Four Prescaler
- Band 2 IF Detector
- IF Pulse-Shaping Network
- Gate Width Adjustment
- IF Frequency Measurement
- Real-Time Clock

In addition, there are two switches:

- IF/Prescaler Selector - selects between the IF signal and the Divide-by-Four Prescaler.

- Detected Signal Selector - selects between the Band 2 and the Band 1 or 3 detected signal.

Control and timing of the Count Chain board signals are performed by the microprocessor through a peripheral interface adapter (PIA).

SIGNAL PATH

The IF signal is distributed between the IF Delay circuit and the Band 2 IF Detector. The IF Delay Circuit delays the signal in order to adjust its timing to that of the gate signal. The Detected Signal Selector transfers the appropriate detected IF band to the Gate Generator board. The detected IF is processed by the Gate Generator board and brought back to the Gate Width Adjustment block. There it is compensated for gate error and for minor changes in the gate width caused by passing the signal through the digital gates and the lines on the Interconnect board.

When the counter is in the frequency measurement mode, the IF signal coming from the delay line passes through the IF/Prescaler Selector to the Pulse-shaping Network. The waveform at this input consists of very short pulses (0.5 ns) at the point of zero crossing.

The Pulse-shaping Network output is connected to the gate input of the BCD counter (the IF Frequency Measurement block).

When the counter is in the pulse parameter measurement mode, the gate signal input to the IF/Frequency Measurement block is the width or the period of the signal. The IF/Prescaler Selector is connected to the Divide-by-Four Prescaler. Therefore the counter measures a known frequency of the VCO output divided by four, that is, 100 to 125 MHz. The counter then computes the parameters according to the number of cycles it counts.

When the counter is in the test mode, both switches cause the detected signal channel to have a constant threshold and the IF signal is fed from the Divide-by-Four Prescaler at a constant frequency of 100 MHz.

IF DELAY CIRCUIT

The Band 2 IF signal (through connector J3) or the Band 1 or 3 signal (through connector J2) is passed to the input of U2C pins 12 or 13 respectively. U2 is an ECL line receiver used here as a differential amplifier. The microprocessor ensures that the two signals do not exist simultaneously. The output is connected to a 45-ns delay line (approximately 30 feet of coax cable) terminated with 50 ohms of resistance (R7 and R9 in parallel).

DIVIDE-BY-FOUR PRESCALER

The input to the Divide-by-Four, U1 pin 3, (through J1 connector) is the output of the VCO, a 400- to 505-MHz CW signal that exists only in the self-test and pulse parameter modes of operation. The prescaler U1 divides the frequency by four, and sends its output to U3 pin 10. Since U1 oscillates without any input, it is disabled by Q1 and R3. This resistor is floating when the counter is in either the self-test or the pulse parameter modes and Q1 is off, permitting U1 to divide.

When the counter is in the frequency measurement mode, R3 is connected to +12 volts via Q1, changing the bias condition of the Divide-by-Four Prescaler and disabling the oscillation. It takes the divider approximately 10 microseconds to pass from an idle to a dividing state. The switching command is sent from the PIA (pin 39) through U5A, an open-collector TTL inverter.

The Band 2 IF signal (connector J3) is distributed to U2C and U2A. The latter (with R90 and C21) forms a peak-positive detector. The output of this detector is a video signal corresponding to the envelope of the IF signal. This video signal goes through a Schmitt trigger circuit (U4), which shapes the analog signal to ECL levels with fast rise and fall times. The circuit uses all three U4 line receivers to provide more than 30 dB gain.

Band 2 IF detector uses R22 as the feed-back resistor, giving the circuit the necessary amount of hysteresis to be immune to noise and spikes. U2B provides a reference voltage of VBB, which precisely tracks the bias voltage of the detector.

IF PULSE-SHAPING NETWORK

The IF from either the IF Delay Circuit or the Divide-by-Four Prescaler is input to the line receiver/differential amplifier U3 (pins 10 or 9 respectively). The output differentially drives a wide-band high-speed differential amplifier (Q3 and Q4). The differential outputs of this amplifier drive current switch Q5. The resulting current square wave from Q5 drives inductor L2, producing a series of positive pulses when Q5 turns on and negative pulses when it turns off. These pulses are input to a pulse inverter, Q7. Q7 acts as a high-speed zero-crossing amplifier, because it is biased at cut-off by Q9. (Q9 performs as a diode. It is the same type of transistor as Q7, used for precise tracking over temperature). The Q7 amplifier inverts the positive pulses and removes the unwanted negative pulses. The output of the pulse inverter drives the input of the IF Frequency Measurement block (BCD counter).

IF FREQUENCY MEASUREMENT

The IF Frequency Measurement block consists of three major parts:

1. A divide-by-ten unit with binary coded decimal outputs (U7) and a surrounding bias circuit
2. An asynchronous four-bit decade counter (U11)
3. A six-decade up-counter with eight-decade latches and multiplexed BCD output (U12).

The IF Frequency Measurement block gets its input frequency at U7 pin 14 from the Pulse-shaping Network, its gate at U7 pin 16 from the Gate Width Adjustment block, and, in response to the microprocessor commands, outputs the frequency readings at U12, pins 17, 18, 19, and 20.

The bias point for U7 pin 14 input is established by a tracking bias circuit (U9 and Q6) whose output is equal to the voltage on U7 pin 1, plus a fixed dc voltage offset selected by resistors R62 and R63. This bias determines the threshold voltage of a U7 internal comparator.

The divide-by-ten output of the U7 decade counter is a 40/60 duty cycle ECL-level signal. It is converted to TTL by U10, an ECL-to- TTL translator, which in turn drives a second decade counter, U11.

The BCD outputs of U7 and U11 are connected to a VLSI counter, IC U12, which derives its clock information at pin 28 (B8) directly from the D output of U11 (Pin 11). The TTL-compatible BCD outputs of U7 are very slow compared to the carry output (pin 9). As a result, these outputs will only settle to a defined state when the gate signal is removed.

When a count cycle is completed, eight decades of BCD data are read by the microprocessor (through the PIA U13) by a time multiplex process. The U12 multiplexer (set to the first digit by the end of the previous reset clock) loads the multiplex latches with the load clock (pin 21), and steps to the remaining seven digits with seven pulses on the scan clock line. A single reset line resets all count stages to zero before the next count cycle begins.

GATE WIDTH ADJUSTMENT

The Gate Width Adjustment circuitry compensates for minute errors in the gate signal width caused by the digital circuitry. This is especially important in Band 1 and Band 3, where the higher frequency of the IF allows for greater frequency error. The gate signal enters the board on differential lines at the edge connector pins 6 and 36. The signal is input to U8A, a line receiver. Its output drives another line receiver acting as a differential inverting amplifier. The threshold signal for this second line receiver is derived from operational amplifier U15. Its output tracks the reference voltage on U8 pin 11 plus a fixed offset supplied by the voltage divider and digital-to-analog converter (DAC), consisting of U14 and U16. This accommodates slight changes in threshold that produce a change in gate width. The output of this circuit, consisting of U8 and U15, drives the clock enable input of U7 pin 16.

The function of the DAC is to change the bias in such a way that correction of gate error can be done by software control. The error correction factors are stored in non-volatile RAM. This enables automatic calibration of the gate signal.

REAL-TIME CLOCK

The Real-time Clock, U17, delivers a 100-Hz square wave to the PIA, U13 pin 18. It is used for timing the flashing of the annunciators and for timing the intervals between loss of IF threshold checks.

IF/PRESCALER SELECTOR

When the IF signal is counted, the PIN diode CR1 is forward biased with 10 mA of current supplied by Q2. At the same time, Q1, through R3, changes the bias conditions at U3 pin 3 so it will not oscillate. At these times, an IF signal reaches U3 pin 9 while no signal is present at pin 10.

When the VCO output is counted, Q1 and Q2 are cut off. Diode CR1 is isolated and attenuates the IF channel by approximately 20 dB. R3 is floating and U1 is enabled to divide the VCO input. Q1 and Q2 are controlled by the microprocessor through U5A.

DETECTED SIGNAL SELECTOR

This circuit selects either the Band 2 detected IF signal or the Band 1 or 3 detected IF signal and sends it through U6 pins 6 and 7 on differential lines to the Gate Generator board. The Band 2 detected IF signal is connected to U6 pin 4. The Band 1 or 3 detected IF enters the board differentially on the edge connector pins 8 and 38. It is then converted to an unbalanced signal by line receiver U3B, which delivers it to U6 pin 12. U6 is used as a multiplexer and is controlled by the microprocessor through U5B and U5F.

When U6 pin 5 is low and U6 pin 13 is high, the Band 2 detected IF is sent to the Gate Generator board on the edge connector pins 4 and 34. When U6 pin 13 is low and pin 5 is high, the Band 1 or 3 detected IF is sent to the Gate Generator board, and when both U6 pins 5 and 13 are high, the Gate Generator receives a constant IF threshold (for the 100-MHz self test).

A6 COUNT CHAIN 2020219-01

REF DES.	SAME AS	DESCRIPTION				EIP NO.	UNITS PER ASSY
C1		CAP,ML CER	.01μF	10%	100V	2150014-00	12
C2	C1						
C3		CAP,ML CER	.001μF	10%	100V	2150015-00	24
C4	C3						
C5	C1						
C6	C3						
C7	C3						
C8	C1						
C9	C1						
C10	C1						
C11	C3						
C12	C3						
C13		CAP,DISC,CER,X7R	.1μF	10%	50V	2150028-00	3
C14	C3						
C15	C3						
C16		CAP,DISC,CER	6.8PF	10%	100V	2150087-00	1
C17	C1						
C18	C3						
C19	C3						
C20	C3						
C21		CAP,DISC,CER	100PF	10%	100V	2150056-00	1
C22		CAP,SMD,CER,X7R	.01μF	10%	50V	2100040-00	4
C23	C1						
C24	C1						
C25	C22						
C26	C22						
C27		CAP,CHIP	.001μF	20%	50V	2100002-00	3
C28	C22						
C29	C27						
C30		CAP,TANTALUM	10μF	20%	25V	2300029-00	4
C31	C30						
C32	C3						
C33	C1						
C34		CAP,DISC,CER	33PF	10%	100V	2150069-00	3
C35	C3						
C36	C3						
C37	C13						
C38	C13						
C39	C1						
C40	C3						

A6 COUNT CHAIN (Continued) 2020219-01

REF DES.	SAME AS	DESCRIPTION				EIP NO.	UNITS PER ASSY
C41	C3						
C42	C34						
C43	C3						
C44	C3						
C45	C34						
C46	C3						
C47	C3						
C48	C3						
C49	C3						
C50	C1						
C51	C3						
C52		CAP,TANTALUM	33μF		10V	2300015-00	4
C53	C52						
C54	C30						
C55	C30						
C56	C3						
C57		NOT USED					
C58	C52						
C59	C27						
C60	C52						
C61		CAP,CER	220PF	10%	100V	2150047-00	1
C62		CAP,CER	33PF	10%	100V	2150037-00	1
CR1		DIODE,MA47123,PIN				2710024-00	1
CR2		DIODE,1N5234,ZENER 6.3V				2705234-00	1
CR3		DIODE,1N5231,ZENER 5.1V				2705231-00	1
CR4		DIODE,5082-2835,PSVT SCHOTTKY				2710004-00	1
J1		CONN,COAX PC RCPT,SNAP NANOHEX				2610038-00	6
J2	J1						
J3	J1						
J4	J1						
J5	J1						
J6	J1						
L1		INDUCTOR,1.0μH				3510003-00	1
L2		PART OF PC BOARD					
L3		INDUCTOR,.33μH				3510007-00	1

A6 COUNT CHAIN (Continued) 2020219-01

REF DES.	SAME AS	DESCRIPTION				EIP NO.	UNITS PER ASSY
Q1		XSTR,2N4126,PNP,GP				4704126-00	2
Q2	Q1						
Q3		XSTR,NE02137,NPN,MICROWAVE				4710032-00	5
Q4	Q3						
Q5		XSTR,MRF536,PNP,RF				4710044-00	2
Q6	Q3						
Q7	Q3						
Q8	Q5						
Q9	Q3						
R1		RES,M/OX	51	1/4W	2%	4130510-00	3
R2		RES,M/OX	1K	1/4W	2%	4130102-00	15
R3		RES,M/OX	10K	1/4W	2%	4130103-00	5
R4		RES,M/OX	330	1/4W	2%	4130331-00	10
R5		RES,CC	5.6	1/4W	5%	4010569-00	8
R6	R3						
R7		RES,M/OX	100	1/4W	2%	4130101-00	5
R8		RES,M/OX	510	1/4W	2%	4130511-00	5
R9	R7						
R10	R7						
R11	R2						
R12	R3						
R13	R2						
R14		RES,M/OX	43	1/4W	2%	4130430-00	1
R15	R1						
R16	R4						
R17		RES,M/OX	150	1/4W	2%	4130151-00	3
R18	R7						
R19		NOT USED					
R20	R4						
R21	R8						
R22		RES,M/OX SEE NOTE 1	3.9K	1/4W	2%	4130392-00	1
R23		RES,M/OX	620	1/4W	2%	4130621-00	1
R24		RES,M/OX	130	1/4W	2%	4130131-00	2
R25		RES,M/OX	56	1/4W	2%	4130560-00	2
R26	R24						

NOTE 1 - SAT AS FOLLOWS: 1.5K OHMS MIN-4.7K OHMS MAX

A6 COUNT CHAIN (Continued) 2020219-01

REF DES.	SAME AS	DESCRIPTION				EIP NO.	UNITS PER ASSY
R27		RES,M/OX	430	1/4W	2%	4130431-00	1
R28	R5						
R29	R25						
R30	R4						
R31	R4						
R32		RES,M/OX	2K	1/4W	2%	4130202-00	2
R33		RES,M/OX	1.5K	1/4W	2%	4130152-00	2
R34	R2						
R35	R2						
R36	R2						
R37	R2						
R38	R5						
R39		RES,M/OX	39	1/4W	2%	4130390-00	2
R40	R4						
R41	R2						
R42		NOT USED					
R43		RES,M/OX	10	1/4W	2%	4130100-00	1
R44	R8						
R45		RES,M/OX	47	1/4W	2%	4130470-00	2
R46	R39						
R47	R5						
R48	R2						
R49	R33						
R50	R2						
R51	R32						
R52	R8						
R53	R8						
R54		NOT USED					
R55	R2						
R56		RES,M/OX	220	1/4W	2%	4130221-00	1
R57	R7						
R58		RES,M/OX	20K	1/4W	2%	4130203-00	4
R59	R58						
R60	R58						
R61	R58						
R62	R2						
R63		RES,M/OX	33	1/4W	2%	4130330-00	1
R64	R2						
R65		RES,M/OX	240	1/4W	2%	4130241-00	2

A6 COUNT CHAIN (Continued) 2020219-01

REF DES.	SAME AS	DESCRIPTION				EIP NO.	UNITS PER ASSY
R66	R65						
R67	R3						
R68	R4						
R69	R2						
R70	R3						
R71	R5						
R72		NOT USED					
R73		NOT USED					
R74	R2						
R75		NOT USED					
R76	R5						
R77	R5						
R78		RES,M/OX	8.2K	1/4W	2%	4130822-00	1
R79		RES,M/OX	750K	1/4W	2%	4130754-00	1
R80	R5						
R81	R1						
R82	R17						
R83	R4						
R84		RES,M/OX	270	1/4W	2%	4130271-00	1
R85	R17						
R86		NOT USED					
R87		RES,CC	2.4K	1/4W	5%	4010242-00	1
		SEE NOTE 2					
R88	R4						
R89	R4						
R90	R45						
R91		RES,M/OX	82	1/4W	2%	4130820-00	2
R92	R91						
R93		RES,M/OX	300	1/4W	2%	4130301-00	1
R94		RES,M/OX	18	1/4W	2%	4130180-00	1
RN1		RES,NTWK	7X330		2%	4170010-00	2
RN2	RN1						
RN3		RES,NTWK	5X330		2%	4170012-00	1
RN4		RES,NTWK	7X10K	0.3W	2%	4170004-00	1

NOTE 2 - SAT AS FOLLOWS: 1.5K OHMS MIN-3.3K OHMS MAX

A6 COUNT CHAIN (Continued) 2020219-01

REF DES.	SAME AS	DESCRIPTION	EIP NO.	UNITS PER ASSY
TP1		CONN,PCB,.040D PIN,GOLD	2620032-00	9
TP2-5	TP1			
TP7-10	TP1			
U1		IC,3199E,VHF/UHF,4 PRESCALER	3043199-00	1
U2		IC,10H116,ECL 10KH,LINE RCVRS	3118116-00	2
U3	U2			
U4		IC,10216,ECL 10K,HI SP LINE RCVR	3110216-00	2
U5		IC,7406	3007406-00	1
U6		IC,10H105,ECL 10KH,2-3-2 IN OR/NOR	3118105-00	1
U7		IC,HIGH SP DEC COUNTER	3018634-00	1
U8	U4			
U9		IC,LM308A,OPNL AMP/BUFFER	3040308-00	3
U10		IC,10125,ECL 10K,TRANSLATORS	3110125-00	1
U11		IC,74LS160	3084160-00	1
U12		IC,7031,CNTR,6-DECADE,UP,PMOS	3057031-00	1
U13		IC,6820,PERIPHERAL INTFC ADAPTER	3086820-00	1
U14		IC,AD7524J,DAC,8-BIT,1/2 LSB	3057524-00	1
U15	U9			
U16	U9			
U17		IC,555,TIMER	3040555-00	1
XU1		CONN,SOCKET,DIP,8 PIN	2630014-00	5
XU2		CONN,SOCKET,DIP,16 PIN	2630016-00	9
XU3	XU2			
XU4	XU2			
XU5		CONN,SOCKET,DIP,14 PIN	2630015-00	1
XU6	XU2			
XU7	XU2			
XU8	XU2			
XU9	XU1			
XU10	XU2			
XU11	XU2			
XU12		CONN,SOCKET,DIP,40 PIN	2630022-00	2
XU13	XU12			
XU14	XU2			
XU15	XU1			
XU16	XU1			
XU17	XU1			

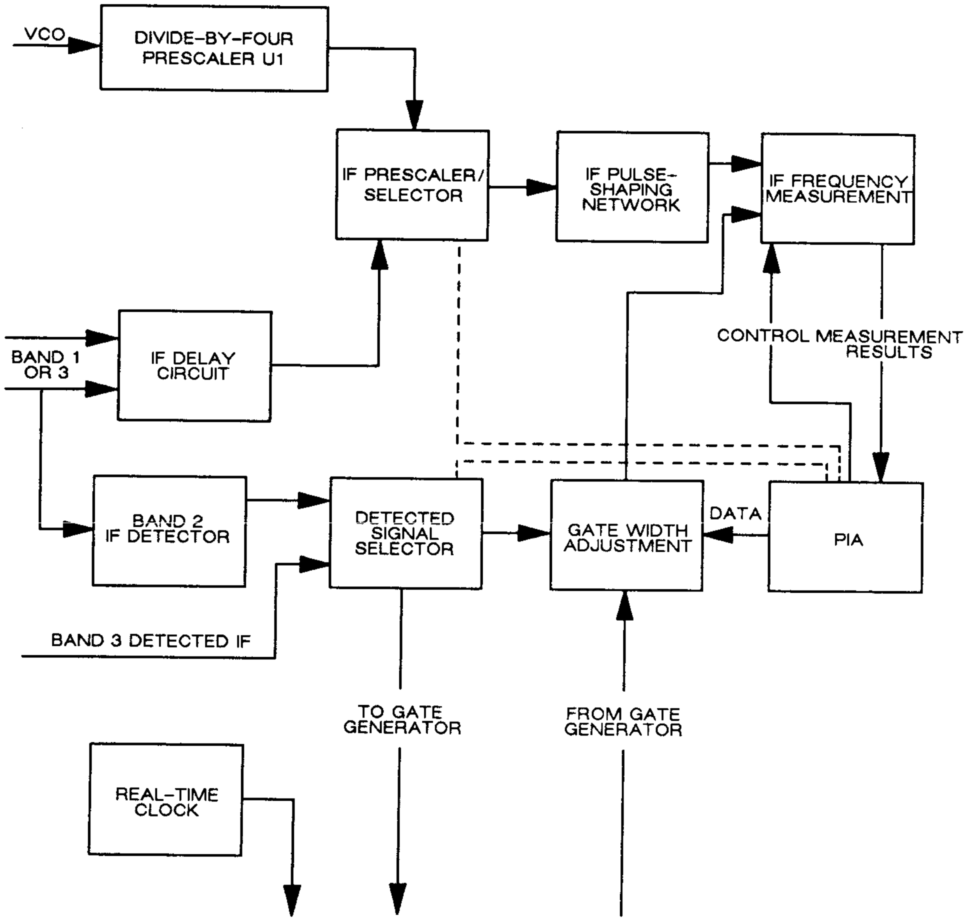

Figure 8A6-1. Functional Block Diagram, Count Chain

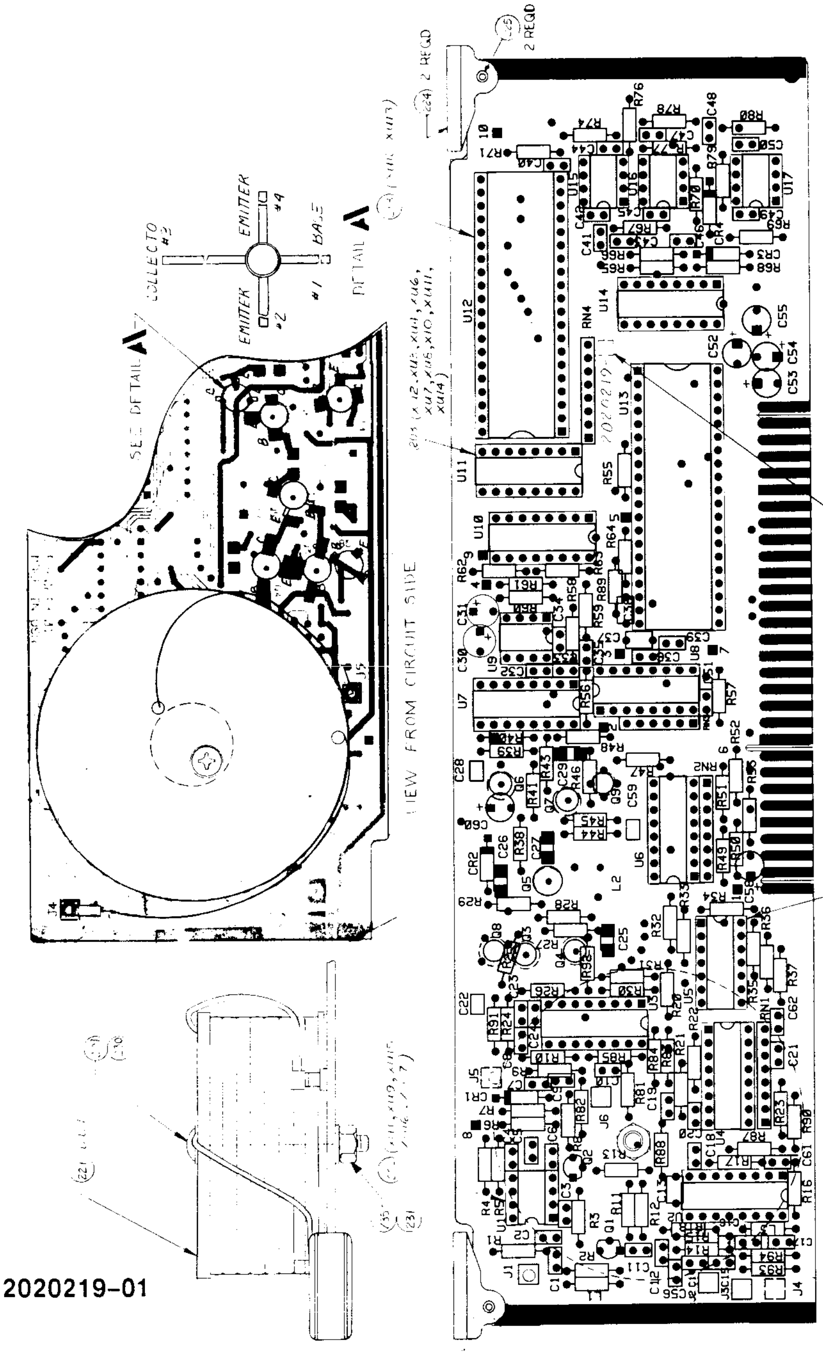

Figure 8A6-2. Component Locator, Count Chain

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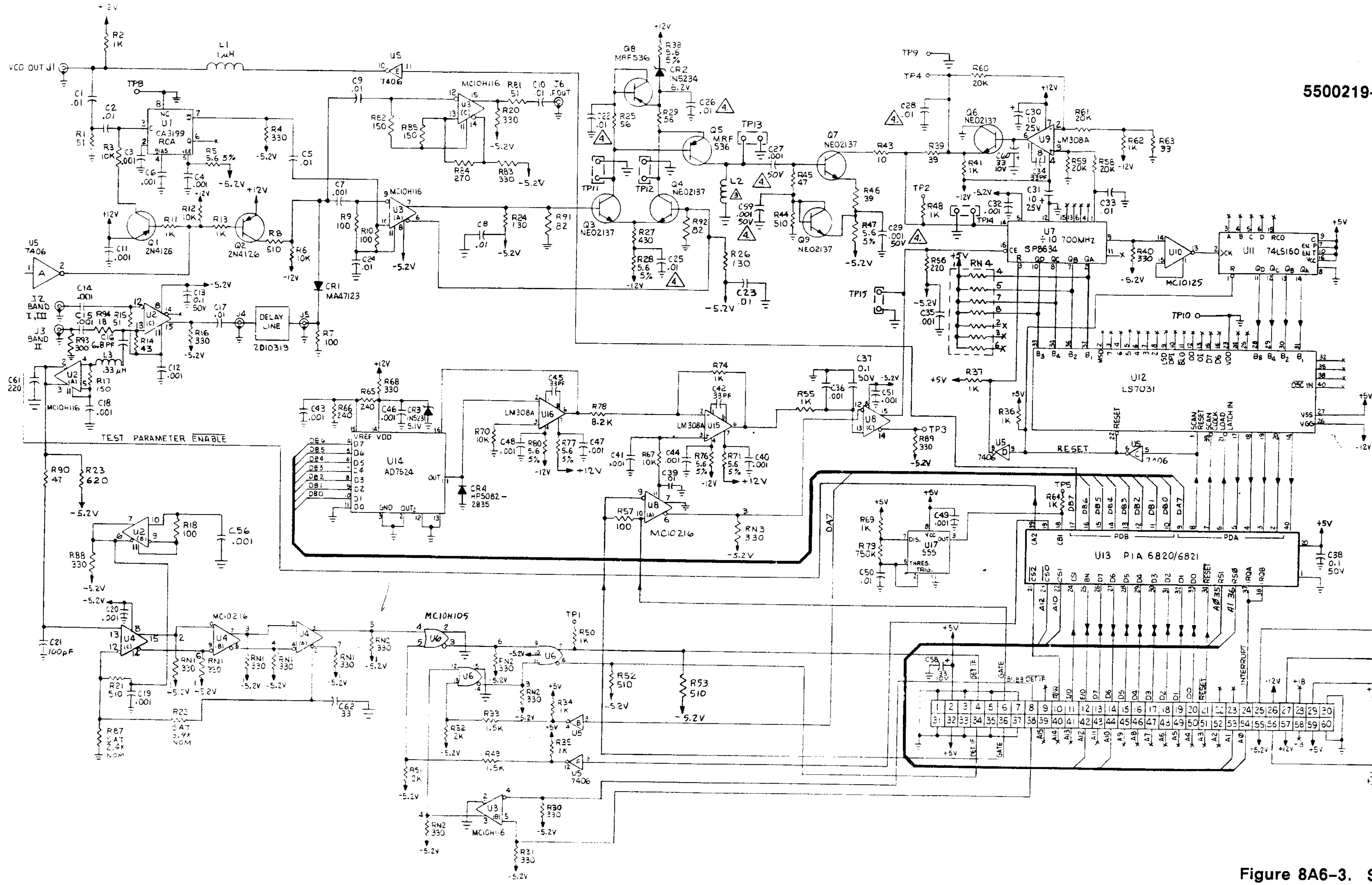

Figure 8A6-3. S

A7 GATE GENERATOR (2020217-01)

The Gate Generator assembly generates the gate signal for frequency, pulse width, and pulse period measurements. In the frequency mode, it controls the time interval needed for the required resolution.

The Gate Generator assembly consists of the following functional blocks:

- 10-MHz Reference Oscillator
- 80-MHz Phase Lock Loop (PLL) Source
- Frequency Gate Processor
- Parameter Gate Processor
- Accumulator
- Reject Gate Circuit
- Loss-of-Lock Detector

Control and timing of the Gate Generator board signals are managed by the microprocessor through a peripheral interface adapter (PIA).

SIGNAL PATH

The gate signal input from the Count Chain board (A6) is applied to the Reject Gate circuit, which partially or completely suppresses the gate signal if (1) the gate signal arrives in less than 200 ns from the trailing edge of the preceding gate thus eliminating the possibility of triggering on noise input, or (2) it is prohibited by an active inhibit signal.

Next, the gate signal is distributed to the Parameter Gate Processor, the Frequency Gate Processor, and a buffered output. The Parameter Gate Processor puts out two pulses that indicate the beginning and the end of the signal. The Frequency Gate Processor shortens the leading edge of the gate signal so the gate signal input to the IF Frequency Measurement on the Count Chain board occurs at the middle of the IF pulse.

Both outputs are applied to the Accumulator. During the frequency measurement mode, the gate signal is sampled by the 80-MHz clock, so that its output gate width is a multiple of 12.5-ns time intervals. The output is divided between the Count Chain board and the Accumulator. The accumulator counts the clock for one or more gate periods and terminates the current measurement cycle whenever it accumulates the total gate time necessary to achieve the requested resolution.

In the parameter measurement mode, the output of the Accumulator is equal to the width or the period of the input pulse. It is applied only to the Count Chain board. In this mode, the clock is shut off and the Accumulator is disconnected. In both modes, the gate has a third buffered output at the rear panel of the counter.

The 80-MHz clock is provided by a Phase Locked Source that receives a 10-MHz reference signal from the 10-MHz Reference Clock. This 10-MHz clock can be the internal crystal oscillator or an external source provided through the rear panel. The 10-MHz reference is also routed to the Converter Control.

10-MHZ REFERENCE OSCILLATOR

The 10-MHz reference oscillator is the time base for the counter. It uses for a reference either an internal 10-MHz TCXO oscillator or an external reference source at rear panel connector J3. The operator uses the INT/EXT switch on the rear panel to select the required reference source. The selection is input from U18 (PIA) pin 2 to pins 5 and 8 of dual comparator U25. A low TTL logic level from U18 means the TCXO input is selected. U25 squares the sine wave input and delivers TTL output levels through U24C as a frequency reference to two PLL circuits: to pin 1 of U8 (the 80-MHz PLL), and through connector J4 to the Converter Control board. When an internal reference source is chosen, this signal is also available at the rear panel through U23C, Q6, and J3.

When an external reference is used, pin 4 of U25 is high and causes Q6 to be off, so that the external 10-MHz signal reaches U25 pin 12 through J3, a two-way (input-output) connector.

80-MHz PHASE-LOCKED LOOP

This PLL circuit provides an accurate 80-MHz clock for the Accumulator block. The voltage controlled oscillator (VCO) consists of U1 and the varactor CR1. The VCO delivers its output to a divide-by-18 consisting of U13 and U14. This 10-MHz ECL output is ac coupled through C17 and translated to TTL levels by Q5. The phase detector U8 compares this signal (applied to pin 3) with the 10-MHz reference (pin 1) and generates a dc signal proportional to the phase difference. Deviation from 80-MHz causes voltage change at the VCO input in a direction that will return the frequency to 80 MHz. The output is applied to the Accumulator block via a switch during frequency measurement only. The switch consists of pin 4 of U4, which serves as an input, pin 3 of U4, which acts as an output, and pin 5 of U4, which is the control. In parameter measurement mode, pin 5 of U4 is high and shuts off the switch.

FREQUENCY GATE PROCESSOR

The Frequency Gate Processor block is enabled when the pulse width and pulse period lines are both low. The Frequency Gate Processor receives a gate signal, an inverted pulse, from U9A pin 7 in the Reject Gate Circuit block. It then generates a gate the width of which is a multiple of 12.5 ns time intervals. This gate is shortened by approximately 30 ns from the original gate in the following manner: a capacitor to ground, C14, slows the fall time of the inverted gate signal without greatly affecting the rise time.

The signal is squared up again by a Schmitt trigger consisting of U15, R26, and R27. After passing through U9B, which is enabled by its other input being low, the gate signal reaches pin 7 of the gate flip-flop U11A. This is a fast ECL D flip-flop. This clock, at pin 9, comes from the 80-MHz PLL Source through U4A, provided the enable signal at pin 5 is low.

When the gate signal reaches the input of the gate flip-flop, the gate flip-flop is triggered by the next 80-MHz clock pulse. When the gate period ends or when the accumulator is full (U9C pin 14 is high), the next 80-MHz clock pulse turns the gate flip-flop back to the preceding state. The gate flip-flop puts out the gate signal to the Accumulator, at U11B pin 11, and to the Count Chain board on differential lines through U10C to pins 6 and 36 of the edge connector. The reset signal from U18 pin 10 is applied at U11A pin 5 from U12C Pin 2 and causes the gate flip-flop U11A to be set at the beginning of the measurement cycle.

PARAMETER GATE PROCESSOR

The purpose of this block is to put out to the Count Chain board a gate signal equal to the pulse width or the pulse period of the input signal. The Parameter Gate Processor gets its input from the Reject Gate Circuit and shares its output with U11A and U10A in the Gate Frequency Processor block. During the parameter measurement mode, the gate flip-flop U11A is used as a set-reset flip-flop; during frequency measurement, it is used as a D flip-flop.

The Parameter Gate Processor is enabled only when pulse width or pulse period measurement is selected. The gate signal is input at the junction of U3C pin 6 and U6A pin 6. U3 is an inverter used during pulse width measurement and enabled at pin 7 when the pulse width line is low. U6 functions as a divide-by-two counter (pin 3 is connected to pin 7). It is a positive edge triggered flip-flop that is enabled at pin 4 (reset) when the pulse-period line is low. U6 divides the frequency of the pulse-train by two, forming a square wave signal with its width equal to the original gate period. The signal at U3B pin 13 is a pulse whose width is equal to either the pulse width or the pulse period, depending on the selected parameter.

The circuit consisting of U7, U3B, U12A, and U12B is a pulse-forming network. It has input at U3B pin 13 and puts out two very short pulses on two different lines. The pulse input to U12 pin 3 marks the beginning of the pulse or period gate signal; the pulse input to U12 pin 15 points at the termination of the pulse or period gate. These signals serve as the set-reset signal to the input of U11A.

Before the measurement cycle begins, the flip-flop U11 must be reset. The flip-flop is reset by the board reset signal provided by U18 pin 10 through U23A, U2A, and U12C. The 80-MHz clock at U11A pin 9 that exists during the frequency mode is inhibited by a high logic signal at U4A pin 5.

Since U11A is in the set state, only a short pulse on the reset line (pointing to the leading edge of the pulse) at pin 4 switches its state, and the next short pulse on the set line, pin 5, returns it to the original state. The negative-going change on U11 pin 2 and pin 11 causes U11B to switch states and terminate this measurement cycle by placing a high logic signal at U3B pin 12. The gate signal at U11A pin 3 is delivered to the Count Chain board through U10C and pin 6 and 36 at the edge connector.

ACCUMULATOR

The accumulator is a high-speed binary up-counter. It counts the 80-MHz clock during the measurement cycle and stops count when its state is equal to a preset value. This value is one of five predefined maximum clock counts that the 80-MHz clock translates to total gate time of 0.1 µs, 1 µs, 10 µs, 100 µs, or 1 ms.

The Accumulator input comes from the 80-MHz clock at U11B pin 9. It has two outputs. The first, at U18 pin 12, tells the microprocessor that the measurement is over. The second output, at U9C pin 14, is an inhibit signal to the gate flip-flop, pin 7 (wire-ORed with U9B), which delivers the gate signal. The Accumulator counts only when U11B pin 13 (the clock enable) is low. The control lines of the Accumulator are the reset and gate time lines.

There are five phases of accumulator operation:

1. **Pre-measurement.** No gate signal is present. The gate flip-flop input D, U11A (pin 7) is high. As a result, its Q output is high and the Accumulator is disabled.

2. **Beginning of the gate.** Input D of the gate flip-flop changes state to low. The next 80-MHz clock signal triggers the gate flip-flop, forcing the Q output to change to low level. This enables the Accumulator. Because of the inherent delay of this IC, the Accumulator does not count this clock.

3. **Measurement.** The Accumulator begins count on the next clock and continues until it is disabled again at the enable input.

4. **End of the gate.** The gate flip-flop D, U11A pin 7, input changes state to high. On the next clock, its Q output follows the input and disables the Accumulator. Because of the inherent delay of this IC, the accumulator counts this clock.

During pulse measurement, phases 2, 3, and 4 repeat until the sum of the total gate time approaches that of the preset gate time.

5. **End of Measurement.** After the nth count, the Accumulator inhibit output (U9C pin 14) issues a high signal to the wired-OR junction of the D input of the gate flip-flop. On the next clock, the gate flip-flop outputs a change of state (if it is not in CW, the change occurs at the middle of the current gate), preventing continuation of measurement.

The Accumulator comprises a divide-by-eight ECL counter (U11B, U5, and U6B) followed by four TTL-level decade counters (U19 and U21). The count capacity of this group is 80,000 clock pulses, which at a 80-MHz (12.5 ns) clock rate is 1ms total. The last three decade counters (U19B, U21A, and U21B) may be removed from the string to permit the shorter gate times mentioned previously. This is done by putting a high level on the set line of the decade counters (pin 4 or 12). In addition, a divide-by-four unit (U22), which may be switched into or out of the chain, is included between the binary and the decade counter. The divide-by-four circuit is included when the counter is operating in Band 1 or 3 to increase the gate time by a factor of four. The output of those bands is prescaled by four, so the gate time must be extended to cause the counter to read the input frequency directly. The control is done by pin 7 of the PIA. In Band 2, the divide-by-four circuit is disabled and the gate U23B provides a path for the input signal around the stage.

A coincidence detector (U20) produces a low output when all the decade counters are in state 9 and the divide-by-four is in state 3. A second coincidence detector (U4B) produces a high level output when U5A, U5B, and U6B are in the 1 position. A third coincidence detector (U9C) produces the inhibit signal of the Accumulator. It uses the outputs of the two previous coincidence detectors, U20 and U4B, to produce a coincidence after n clock pulses. A fourth coincidence detector (U10B) sends the end-of-measurement message to the PIA through pin 7 and prevents any further counting by putting a high level on the set pin 12 of U11B.

It is important to remember that the gate signal itself consists of n+1 clock pulses, since the first pulse is not taken into account by the Accumulator.

To repeat the measurement, a reset signal is sent by the PIA. The reset causes the coincidence detector U9C to release the inhibit. Since this occurs last in the series of Accumulator counting operations, invalid data is not generated.

REJECT GATE CIRCUIT

This block inhibits the gate when:

1. the signal is input less than 200 ns from the trailing edge of the preceding gate (in which case it may be noise or high PRF that is out of specification and should therefore eliminated). This is implemented by U16, a D flip-flop. U16 pin 7 is driven high by R36 and R35. When the gate signal ends, the negative transition triggers the flip-flop, forcing the Q output, pin 2, high and disabling U9A at pin 11. The capacitor C24 is charged to a high level through R39; when it reaches the appropriate voltage, after approximately 200 ns it resets the flip-flop and enables U9A.

2. an inhibit signal is received from the rear panel.

LOSS-OF-LOCK DETECTOR

The purpose of this circuit is to indicate to the microprocessor whether there is a signal or not. The circuit consists of a set- reset flip-flop (U16B). The microprocessor resets the flip-flop through the PIA pin 16, and after a period of time set by the MIN PRF function, checks to ascertain whether any gate signal has set it. If the flip-flop is not set, the microprocessor assumes the signal has been removed and initiates the converter search procedure.

A7 GATE GENERATOR 2020217-01

REF DES.	SAME AS	DESCRIPTION				EIP NO.	UNITS PER ASSY
C1		NOT USED					
C2		CAP,SMD,CER,NPO	.001μF	5%	50V	2100050-00	1
C3		CAP,ML CER	.01μF	10%	100V	2150014-00	13
C4		CAP,DISC,CER,X7R	.1μF	10%	50V	2150028-00	9
C5	C4						
C6		CAP,MICA	560PF	5%	500V	2250036-00	1
C7		CAP,TANTALUM	33μF		10V	2300015-00	5
C8	C4						
C9	C3						
C10	C4						
C11	C4						
C12		NOT USED					
C13	C7						
C14		CAP,CER SEE NOTE 1 SEE NOTE 2	220PF	10%	100V	2150047-00	1
C15	C3						
C16	C3						
C17	C3						
C18	C3						
C19	C4						
C20	C3						
C21	C7						
C22	C3						
C23	C4						
C24		CAP,MICA	100PF	5%	500V	2260034-00	1
C25	C3						
C26	C3						
C27	C7						
C28		CAP,TANTALUM	10μF	20%	25V	2300029-00	1
C29	C7						
C30	C4						
C31	C4						
C32	C3						

NOTE 1 - SAT AS FOLLOWS: 100PF MIN-470PF MAX
NOTE 2 - DO NOT STUFF

A7 GATE GENERATOR (Continued) 2020217-01

REF DES.	SAME AS	DESCRIPTION				EIP NO.	UNITS PER ASSY
C33	C3						
C34	C3						
L1		INDUCTOR,.1µH				3510001-00	1
CR1		DIODE,MV109,VARIABLE CAP				2710012-00	1
RN1		RES,NTWK	7X330		2%	4170010-00	3
RN2	RN1						
RN3		RES,NTWK	9X330		2%	4170011-00	2
RN4	RN1						
RN5	RN3						
R1		RES,M/OX	51	1/4W	2%	4130510-00	2
R2		RES,M/OX	330	1/4W	2%	4130331-00	15
R3		RES,M/OX	1K	1/4W	2%	4130102-00	10
R4	R3						
R5		RES,M/OX	36K	1/4W	2%	4130363-00	1
R6		RES,M/OX	150	1/4W	2%	4130151-00	5
R7		RES,CC	2.7	1/4W	5%	4010279-00	3
R8		RES,M/OX	300	1/4W	2%	4130301-00	3
R9		RES,M/OX	680	1/4W	2%	4130681-00	1
R10		RES,M/OX	4.3K	1/4W	2%	4130432-00	2
R11		RES,M/OX	510	1/4W	2%	4130511-00	1
R12	R2						
R13	R7						
R14	R3						
R15	R6						
R16	R6						
R17	R8						
R18	R6						
R19	R2						
R20	R3						
R21	R6						
R22		NOT USED					
R23	R1						
R24		RES,M/OX	2K	1/4W	2%	4130202-00	1
R25	R2						
R26		RES,M/OX	390	1/4W	2%	4130391-00	2

A7 GATE GENERATOR (Continued) 2020217-01

REF DES.	SAME AS	DESCRIPTION				EIP NO.	UNITS PER ASSY
R27	R26						
R28	R2						
R29	R2						
R30		RES,M/OX	100	1/4W	2%	4130101-00	1
R31	R2						
R32		NOT USED					
R33	R2						
R34	R2						
R35	R10						
R36		RES,M/OX	820	1/4W	2%	4130821-00	1
R37	R2						
R38	R2						
R39	R3						
R40	R7						
R41		RES,M/OX	1.8K	1/8W	2%	4130182-00	2
R42		RES,M/OX	1.2K	1/4W	2%	4130122-00	1
R43	R41						
R44	R2						
R45		RES,M/OX	10K	1/4W	2%	4130103-00	3
R46	R45						
R47	R45						
R48	R2						
R49	R8						
R50		RES,M/OX	30	1.8W	2%	4130300-00	1
R51	R3						
R52	R3						
R53		RES,CC	5.1	1/4W	5%	4010519-00	2
R54	R3						
R55	R53						
R56	R3						
R57	R2						
R58	R2						
R59	R3						
Q1		XSTR,2N5179,PNP,RF GRADED-RED				4710011-00	4
Q2	Q1						
Q3	Q1						
Q4	Q1						
Q5		XSTR,WN4124,NPN,GP				4704124-00	1
Q6		XSTR,2N4126,PNP,GP				4704126-00	1

A7 GATE GENERATOR (Continued) 2020217-01

REF DES.	SAME AS	DESCRIPTION	EIP NO.	UNITS PER ASSY
TP1		CONN,PCB,.040D PIN,GOLD	2620032-00	6
TP2-6	TP1			
J1		CONN,COAX PC RCPT,SNAP NANOHEX	2610038-00	3
J2	J1			
J3	J1			
J4		CONN,PCB,RT ANGLE,3 PIN	2620132-00	1
Y1		OSC,TCXO	2030002-00	1
U1		IC,MC1648,OSC,VOLTAGE CONTROLLED	3011648-00	1
U2		IC,10124,ECL 10K,TRANSLATOR	3110124-00	1
U3		IC,10102,ECL 10K,2-INP NORS	3110102-00	2
U4		IC,0105,ECL 10K,OR/NOR GATES	3110105-00	3
U5		IC,10131,ECL 10K,M-S FF	3110131-00	5
U6	U5			
U7		IC,10107,ECL 10K,2-IN EXCL OR/NOR	3110107-00	1
U8		IC,MC4044,PHASE FREQ DET	3014044-00	1
U9	U4			
U10	U4			
U11	U5			
U12	U3			
U13	U5			
U14		IC,10231,ECL 10K,M-S FF	3110231-00	1
U15		IC,0116,ECL 10K,LINE RCVRS	3110116-00	1
U16	U5			
U17		IC,10125,ECL 10K,TRANSLATORS	3110125-00	1
U18		IC,6820,PERIPHERAL INTFC ADAPTER	3086820-00	1
U19		IC,74LS490	3084490-00	2
U20		IC,74S133	3070019-00	1
U21	U19			
U22		IC,74LS76A	3087476-00	1
U23		IC,74LS11	3087411-00	1
U24		IC,74LS00	3087400-00	1
U25		IC,521,DUAL DIFF COMPARATOR	3050521-00	1
XU1		CONN,SOCKET,DIP,14 PIN	2630015-00	5
XU2		CONN,SOCKET,DIP,16 PIN	2630016-00	18
XU3	XU2			

A7 GATE GENERATOR (Continued) 2020217-01

REF DES.	SAME AS	DESCRIPTION	EIP NO.	UNITS PER ASSY
XU4	XU2			
XU5	XU2			
XU6	XU2			
XU7	XU2			
XU8	XU1			
XU9	XU2			
XU10	XU2			
XU11	XU2			
XU12	XU2			
XU13	XU2			
XU14	XU2			
XU15	XU2			
XU16	XU2			
XU17	XU2			
XU19	XU1			
XU20	XU1			
XU21		CONN,IC PIN(MINISERT)	2620054-00	16
XU22	XU2			
XU23	XU1			
XU24	XU1			
XU25	XU1			

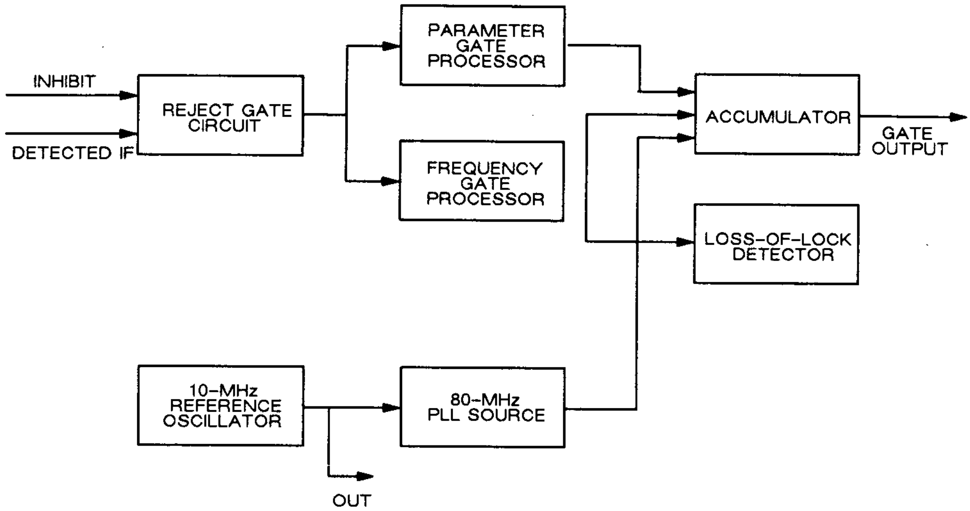

Figure 8A7-1. Functional Block Diagram, Gate Generator

2020217-01

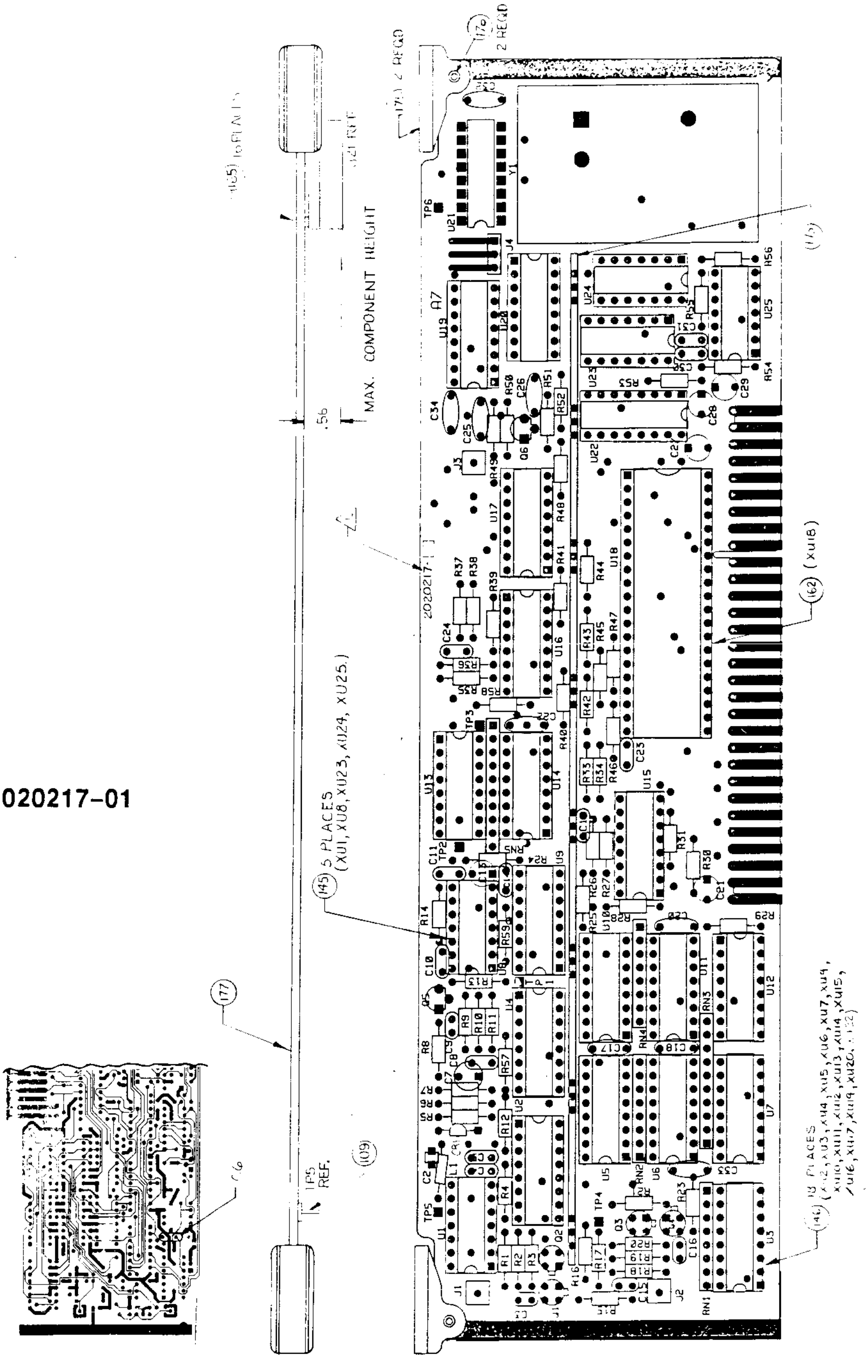

Figure 8A7-2. Component Locator, Gate Generator

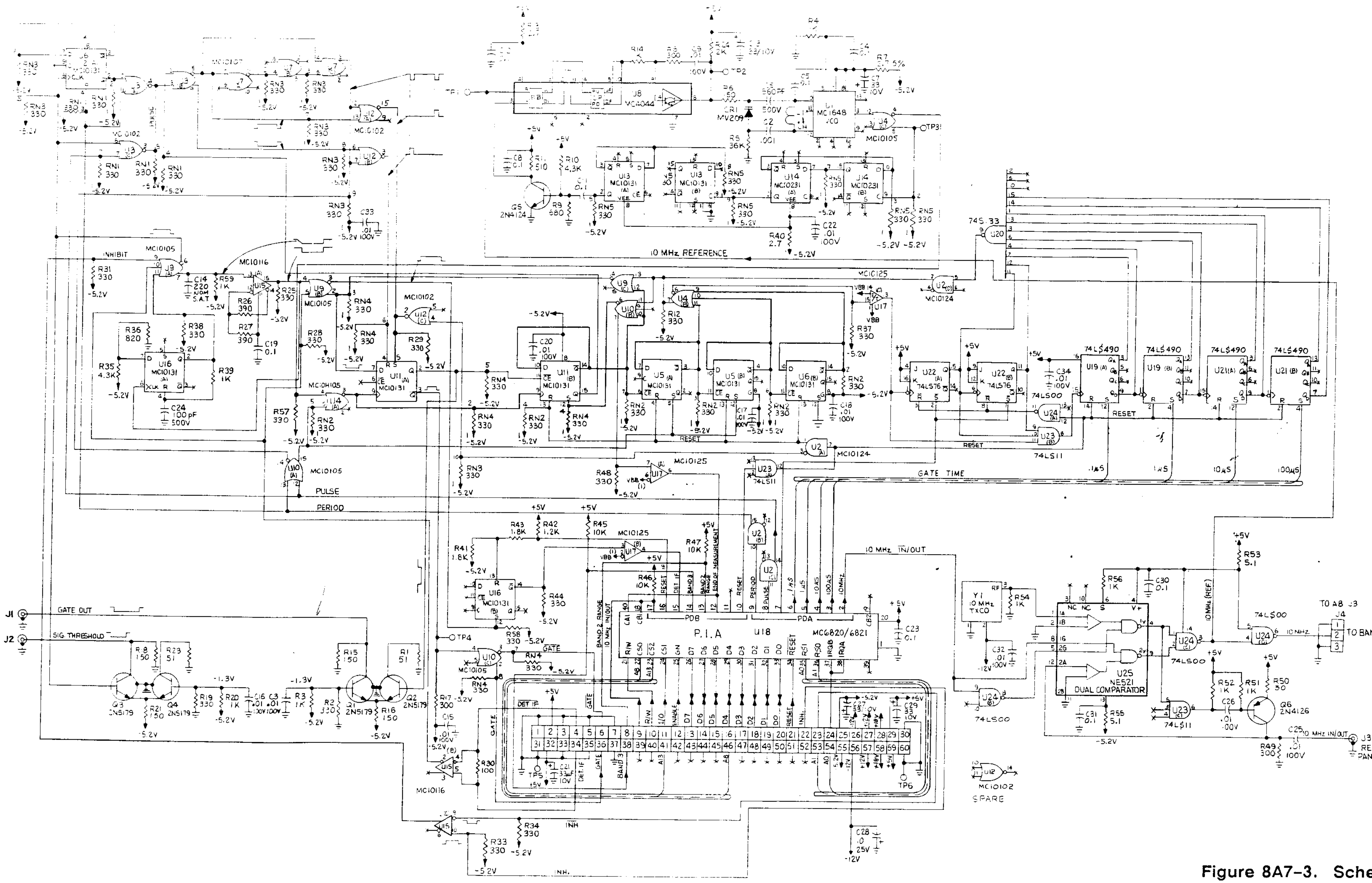

Figure 8A7-3. Sche

A8 CONVERTER CONTROL (2020200-05)

The Converter Control board performs two major functions. One of the functions is to provide a precise YIG tuning current that is controlled by the microprocessor via the Peripheral Interface Adapter (PIA) U4. The other function is to phase lock the VCO in the Microwave Converter to provide a synthesized local oscillator (LO) signal. The converter control also enables the microprocessor to control the LO power amplifier and provides the microprocessor input for the IF threshold signal.

YIG FREQUENCY CONTROL DAC AND DRIVERS

The YIG tuning current is supplied by the YIG driver (U3, Q1, Q2, and Q3), which is controlled by the DAC. The DAC is composed of a 12-bit monolithic DAC (U2), a summing amplifier (U1), and resistors; it provides a total resolution of 14 bits. Ports 0 and 1 of the PIA (U4) are used to drive the two least significant bits of the DAC directly. A change in the least significant bit of the DAC corresponds to a YIG frequency change of 2 MHz. An analog voltage to the YIG current appears across R25 and is compared to the DAC output at the summing junction of U3, with resistors R1 and R19.

The slope and the offset of YIG current vs. DAC voltage are by DAC Data Correction stored in non-volatile RAM during Special Function 91 calibration.

VCO CONTROL

The VCO control, together with the VCO, form a phase-locked-loop frequency synthesizer with a range of 400 to 505 MHz.

The output of the VCO from A10-J6 is applied to the programmable frequency divider. The programmable frequency divider is programmed by the microprocessor via PIA U7. The output of the programmable frequency divider is compared to the 50-kHz reference derived from a 10-MHz clock on the Gate Generator board, in the phase dectector U14. A phase difference between the divided-down VCO and the 50 kHz reference results in an output from the phase detector.

The phase detector has two output ports, a pump-up port and a pump-down port. Pump-down is U14, pin 2. Pump-down is normally high and goes low to reduce the VCO frequency. Pump-up is U18, pin 3. Pump-up is normally low and goes high to increase the VCO frequency. The outputs of the phase detector go to the charge pump, which converts them to a single tri-state output. The charge pump output is open with no pump command, sources current with pump-up, and sinks current with pump-down. The output of the charge pump is connected to the input of the loop amplifier U19 and U17. The loop amplifier provides the proper gain and filtering to achieve the desired loop response. The output of the loop amplifier is the VCO tuning voltage. The VCO tuning voltage from A8-J2 goes to A10-J4.

PROGRAMMABLE FREQUENCY DIVIDER

The programamble frequency divider uses a two-modulus (divide number) prescaler (U5, U6) and two programmable counters (A and B). The prescaler is used to divide the VCO frequency down to a lower frequency that can be handled by low-power Schottky TTL-programmable counters. The two-modulus prescaler permits prescaling without loss of resolution.

At the start of the programmable frequency divider cycle, the prescaler is set to divide by the larger modulus (41), and both programmable counters are loaded with their respective program numbers from the PIA. The programmable counters each decrement one count for each output pulse from the prescaler. When programmable counter B (U12, U13) reaches the count of zero, the 40/41 control flip-flop (part of U11) changes state and causes the prescaler to divide by the lower modulus (40). When programmable counter A (U8, U9, and U10) reaches the count of two, the D input of the PL period flip-flop (part of U11) goes high, so that on the count of one the flip-flop changes state. This causes both programmable counters to be reloaded with their respective program numbers and the 40/41 control flip-flop to reset the prescaler in the 41 state. The very next count causes the PL period flip-flop to reset, starting the programmable frequency divider cycle over again. The equation for the divide ratio of the programmable frequency divider N_d is:

$$N_d = 40\ (N_{counter\ A}) + N_{counter\ B}$$

with the condition that :

$N_{counter\ B}$ must not exceed $N_{counter\ A}$

The weighting of the command bits is:

U9 P_1	-- 400 MHz	U10 P_1	-- 4 MHz
U9 P_0	-- 200 MHz	U10 P_0	-- 2 MHz
U8 P_3	-- 160 MHz	U13 P_3	-- 1.6 MHz
U8 P_2	-- 80 MHz	U13 P_2	-- 0.8 MHz
U8 P_1	-- 40 MHz	U13 P_1	-- 0.4 MHz
U8 P_0	-- 20 MHz	U13 P_0	-- 0.2 MHz
U10 P_3	-- 16 MHz	U12 P_1	-- 100 kHz
U10 P_2	-- 8 MHz	U12 P_0	-- 50 kHz

A8 CONVERTER CONTROL 2020200-05

REF DES.	SAME AS	DESCRIPTION				EIP NO.	UNITS PER ASSY
C1		CAP,DISC,CER	.005μF	20%	100V	2150008-00	1
C2		CAP,CER	.01μF	20%	100V	2150003-00	14
C3		CAP,DISC,CER,X74	.047μF	10%	50V	2150090-00	1
C4		CAP,TANTALUM	1μF		35V	2300008-00	3
C5	C4						
C6	C2						
C7		CAP,CER	.001μF	20%	100V	2150001-00	3
C8	C4						
C9		CAP,TANTALUM	33μF		10V	2300015-00	2
C10	C7						
C11		CAP,SMD,Z5U	.1μF	20%	50V	2100046-00	1
C12	C7						
C13	C2						
C14	C2						
C15	C2						
C16	C2						
C17	C2						
C18		CAP,TANTALUM	10μF	20%	25V	2300029-00	4
C19	C18						
C20	C9						
C21	C18						
C22	C2						
C23	C2						
C24	C2						
C25		CAP,DISC,CER,COG	560PF	5%	100V	2150029-00	2
C26		CAP,TANTALUM	.47μF		35V	2300005-00	1
C27		CAP,CER	.022μF	15%	50V	2350027-00	1
C28	C18						
C29	C2						
C30		CAP,DISC,CER,COG	330PF	10%	100V	2150030-00	1
C31		CAP,TANTALUM	2.2μF	20%	16V	2300012-00	1
C32		CAP,MICA	82PF	5%	500V	2260032-00	2
C33	C2						
C34		CAP,MICA SEE NOTE 1	470PF	5%	500V	2250018-00	2
C35	C34						

NOTE 1 - SAT AS FOLLOWS: 430PF MIN-470PF MAX

A8 CONVERTER CONTROL (Continued) 2020200-05

REF DES.	SAME AS	DESCRIPTION				EIP NO.	UNITS PER ASSY
C36		CAP,MICA SEE NOTE 2 SEE NOTE 3	300PF	5%	300V	2260045-00	1
C37		CAP,DISC,CER,X7R	.1µF	10%	50V	2150028-00	1
C38	C2						
C39		CAP,ML CER	2200PF	5%	100V	2150026-00	1
C40	C25						
C41	C2						
C42	C32						
CR1		DIODE,5082-2835,PSVT SCHOTTKY				2710004-00	1
CR2		DIODE,1N4758,ZENER 56V				2704758-00	1
CR3		DIODE,1N4148,FAST SWITCHING,GP				2704148-00	14
CR4		DIODE,1N827,ZENER,6.2V				2700827-00	1
CR5		CIODE,1N4001,PWR RECT				2704001-00	1
CR6	CR3						
CR7	CR3						
CR8	CR3						
CR9	CR3						
CR10	CR3						
CR11	CR3						
CR12	CR3						
CR13	CR3						
CR14	CR3						
CR15	CR3						
CR16	CR3						
CR17	CR3						
CR18	CR3						
L1		INDUCTOR,100UH				3520007-00	1
L2		INDUCTOR,1UH				3510018-00	1
L3		INDUCTOR,4700UH				3510017-00	2
L4	L3						
Q1		XSTR,MJE350,PNP PWR				4710009-00	1
Q2		XSTR,MPSL51,PNP,RF AMPLIFIER				4710018-00	1
Q3		XSTR,2N4124,NPN,GP				4704124-00	1

NOTE 2 - SAT AS FOLLOWS: 82PF MIN-300PF MAX
NOTE 3 - DO NOT STUFF

A8 CONVERTER CONTROL (Continued) 2020200-05

REF DES.	SAME AS	DESCRIPTION				EIP NO.	UNITS PER ASSY
R1		RES,PRCN	7.23K	1/10W	1%	4120021-00	1
R2		RES,CC	4.7K	1/4W	5%	4010472-00	1
R3		RES,CC	1K	1/4W	5%	4010102-00	6
R4		NOT USED					
R5		RES,M/OX	390	1/4W	2%	4130391-00	2
R6		NOT USED					
R7		NOT USED					
R8	R3						
R9		NOT USED					
R10		NOT USED					
R11		NOT USED					
R12		NOT USED					
R13	R5						
R14		RES,CC	750	1/4W	5%	4010751-00	1
R15		RES,CC	820K	1/4W	5%	4010824-00	1
R16	R3						
R17		RES,M/OX	1.6K	1/4W	2%	4130162-00	1
R18		RES,CC	160K	1/4W	5%	4010164-00	1
R19		RES,PREC	3.01K	1/10W	1%	4120020-00	1
R20		RES,CC	10K	1/4W	5%	4010103-00	3
R21		RES,CC	82K	1/4W	5%	4010823-00	1
R22	R20						
R23	R20						
R24	R3						
R25		RES,WW	5	7W	1%	4110003-00	1
R26		RES,CC	2.7K	1/4W	5%	4010272-00	1
R27		RES,SMD	1K	1.8W	1%	4220009-00	1
R28		RES,CC	390	1/4W	5%	4010391-00	3
R29	R28						
R30	R28						
R31	R3						
R32		RES,CC	100	1/4W	5%	4010101-00	3
R33	R3						
R34		RES,CC	2.4K	1/4W	5%	4010242-00	1
R35	R32						
R36		RES,CC	220K	1/4W	5%	4010224-00	1
R37	R32						
R38		RES,CC SEE NOTE 4	4.3K	1/4W	5%	4010432-00	1

NOTE 4 - SAT AS FOLLOWS: 3.9K MIN-4.7K MAX

A8 CONVERTER CONTROL (Continued) 2020200-05

REF DES.	SAME AS	DESCRIPTION				EIP NO.	UNITS PER ASSY
R39		RES,CC	2K	1/4W	5%	4010202-00	1
R40		RES,CC	51	1/4W	5%	4010510-00	1
R41		RES,CC	1.5M	1/4W	5%	4010155-00	1
R42		RES,CC	300	1/4W	5%	4010301-00	1
R43		RES,CC	8.2K	1/4W	5%	4010822-00	1
R44		RES,CC	51K	1/4W	5%	4010513-00	2
R45		RES,CC	5.1K	1/4W	5%	4010512-00	1
R46	R44						
R47		RES,CC	3.3K	1/4W	5%	4010332-00	1
R48		RES,SMD	51.1	1.8W	1%	4220002-00	1
S1		SWITCH,DIP,SPDT		1	POSN	4540007-00	1
U1		IC,OP-16F,OPNL AMPL,JFET INP,TO-0-99				3041016-00	1
U2		IC,7541C-2,12-BIT MULTIPLYING DAC				3050012-00	1
U3		IC,LM741C,OP AMP				3040741-00	1
U4		IC,6820,PERIPHERAL INTFC ADAPTER				3086820-00	2
U5		IC,12013,ECL 2-MODULOUS PRESCALER				3112013-02	1
U6		IC,10131,ECL 10K,M-S FF				3110131-00	1
U7	U4						
U8		IC,74LS192				3084192-00	4
U9	U8						
U10	U8						
U11		IC,12014,COUNTER CONTROL LOGIC				3112014-00	1
U12		IC,74LS193				3084193-00	1
U13	U8						
U14		IC,MC4044,PHASE FREQ DET				3014044-00	1
U15		IC,74LS175				3084175-00	1
U16		IC,74LS490				3084490-00	1
U17		IC,TL071C,OPNL AMPL,LOW NOISE				3040071-00	2
U18		IC,74LS00				3087400-00	1
U19	U17						
TP1-4, 6, 7, 9-16		CONN,PCB,.040D PIN,GOLD				2620032-00	14
J1		CONN,COAX PC RCPT,SNAP NANOHEX				2610038-00	2
J2	J1						
J3		CONN,PCB,RT ANGLE,3 PIN				2620132-00	1

A8 CONVERTER CONTROL (Continued) 2020200-05

REF DES.	SAME AS	DESCRIPTION	EIP NO.	UNITS PER ASSY
XU1		CONN,IC PIN (MINISERT)	2620054-00	11
XU2		CONN,SOCKET,DIP,18 PIN	2630017-00	1
XU3		CONNKSOCKET,DIP,8 PIN	2630014-00	3
XU4		CONN,SOCKET,DIP,40 PIN	2630022-00	2
XU6		CONN,SOCKET,DIP,16 PIN	2630016-00	10
XU7	XU4			
XU8	XU5			
XU9	XU6			
XU10	XU6			
XU11	XU6			
XU12	XU6			
XU13	XU6			
XU14		CONN,SOCKET,DIP,14 PIN	2630015-00	2
XU15	XU6			
XU16	XU6			
XU17	XU3			
XU18	XU14			
XU19	XU3			

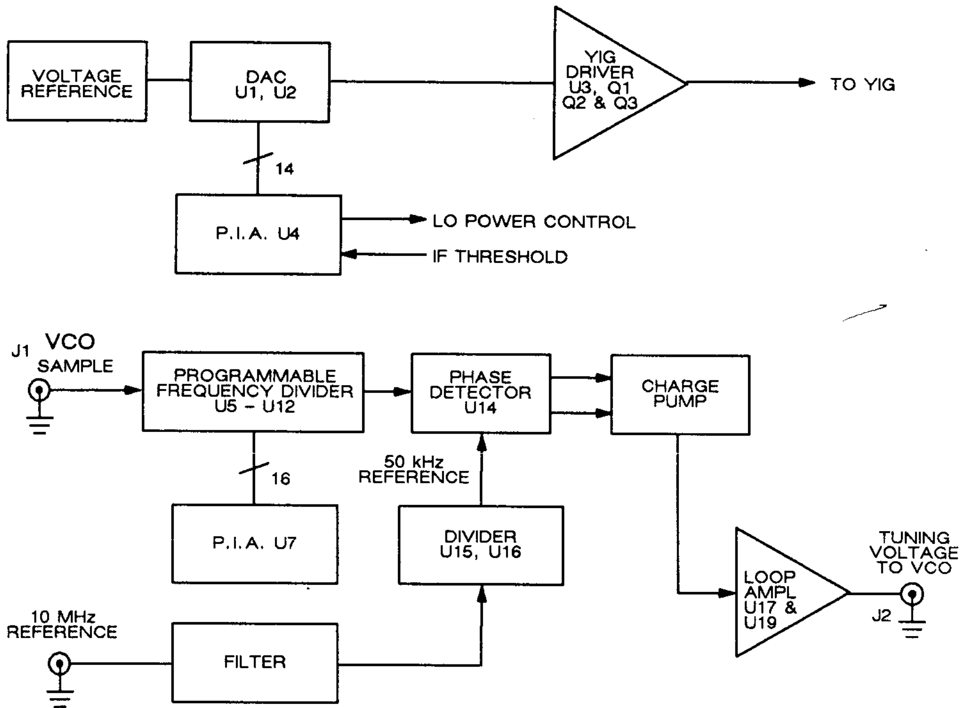

Figure 8A8-1. Functional Block Diagram, Converter Control

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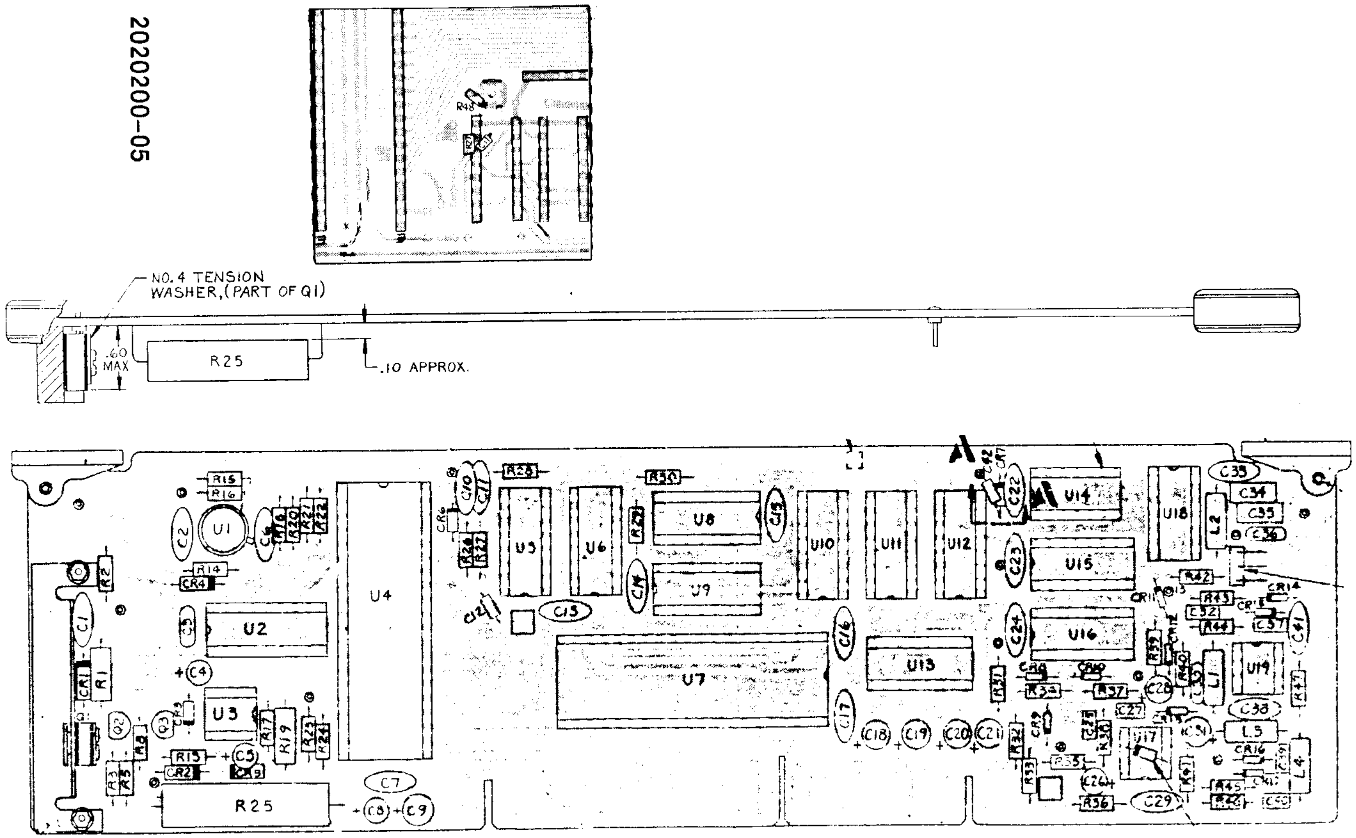

2020200-05

Figure 8A8-2. Component Locator, Converter Control

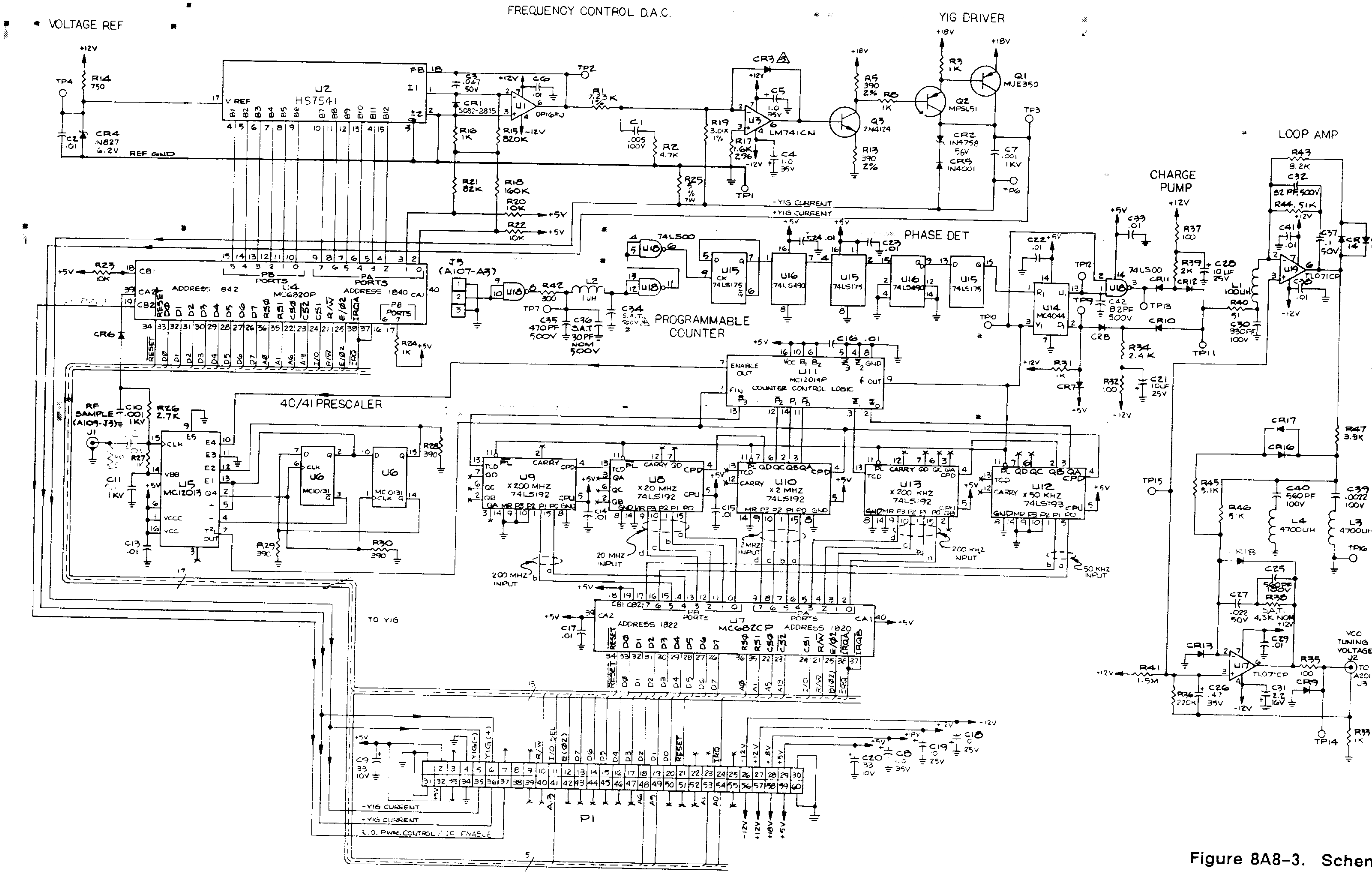

Figure 8A8-3. Schen

A9 BAND 1 CONVERTER (2020224-02)

This board receives signal inputs from either the Band 1 input or the Band 3 IF. The board outputs two signals: a detected signal and the input signal divided by four. Both signals are sent to the Count Chain board.

The Band 1 Converter consists of the following functional blocks:

- Band 1 Amplifier/attenuator
- Band 1 or 3 Selector/amplifier
- RF Detector
- Divide-by-four Prescaler
- Digital Attenuator/controller

Control and timing of the Band 1 Converter board signals are performed by the microprocessor through a peripheral interface adapter (PIA).

SIGNAL PATH

When the counter is operating in Band 1, the signal input to this board is applied to the Band 1 Amplifier/attenuator block. This block outputs the signal at a constant power level by the following process. The Loss-of-lock Detector on the Gate Generator board detects the presence of the input signal through the associated signal threshold line. The microprocessor prompts the Digital Attenuator/controller to attenuate the signal until the Loss-of-lock Detector can no longer detect it, then reduces the attenuation until the amplitude of the signal is at a level that can be detected at the signal threshold line.

When the counter is operating in Band 3, Band 1 Converter performs the same process using the Band 3 Amplifier/attenuator located in the Millimeter Wave (Band 3) Converter module.

The constant power signal from either Band 1 or Band 3 is amplified by the Selector/amplifier and then divided between the RF detector and Divide-by-four prescaler blocks.

BAND 1 AMPLIFIER/ATTENUATOR

The Band 1 Amplifier/attenuator consists of five sub-blocks:

1. Protection circuits that protect the input from high dc voltage or high power signals. The decoupling capacitor C7 eliminates high dc voltage and the 3-dB attenuator (R12, R13, and R15) and the two Schottky diodes (CR3 and CR4) protect the amplifier from high power input signals. The 3- dB attenuator also improves the input VSWR.

2. A high-pass filter (C9, L1, C10, L2, and C11) that eliminates out-of-band signals.

3. A linear amplifier (U6).

4. A switch that controls the 12-volt supply to the amplifier U6 at pin 1. This switch consists of U1A, U5, and Q3. When the output of U5 pin 14 goes low, the output of U1A, an open collector/inverter gate, goes high, and causes Q3 to turn off. When the +12-volt signal to the amplifier U6 is cut off, it causes U6 to attenuate, rather then amplify the signal, increasing the isolation between the Band 1 input and the Selector/amplifier while the counter is operating in Band 3.

5. An attenuator that consists of four PIN diodes, CR6, CR7, CR8, and CR12. The control line delivers the input signal to the junction of C52 and R60. The control line voltage varies between 0 volts minimum attenuation and 8 volts maximum attenuation.

BAND 1 OR 3 SELECTOR AMPLIFIER

This block consists of a selector that selects Band 1 or Band 3 and an amplifier.

When the counter is in Band 3, the output of U1B is low and the PIN diode CR5 in series with it conducts, presenting a low attenuation to Band 3 signals. The attenuation of signals in the Band 1 range is about 50 dB maximum.

When the counter is in Band 1, the output of U1B is high; since it is an open collector gate, it does not sink current. As a result, there is no voltage drop on R19 and the PIN diode CR5 is reverse biased, adding 20 dB of attenuation to signals in the Band 3 range.

The gain of the amplifier (U7 and U8) is about 20 dB. Since the input signal is always at the same power level, the output is about 0 dBm.

RF DETECTOR

This block comprises a detector, a Schmitt trigger, a delay circuit, and a line driver.

The RF output from U8 reaches a detector consisting of Schottky diode CR9, resistor R64, and capacitor C25. The diode CR9 is forward biased by a current of 100 μA delivered by U10, pin 11 (the reference voltage source, VBB, of the ECL line receiver) through inductor L5. This signal is applied to the input, pin 5, of comparator U10A. The reference voltage of the comparator U10A, pin 4, is derived from the same voltage source (VBB) that feeds the detector and uses the same circuit and component values to establish this voltage. CR10 is in this case equivalent to CR9 and R40 to R37. R41, R42, U13, R54, and R51 form a unity gain amplifier with the offset generated by R53 and R50. As a result, the voltage difference between the inputs is temperature compensated.

The output of the comparator, U10A, is connected to a Schmitt trigger circuit consisting of U10B, U9A, and U9B, which gives about 3 dB of hysteresis. The Schmitt trigger circuit has two feedback loops: one feedback loop, from the output of the circuit to its input, uses R63; the second, around U10, uses R24, C44. This configuration overcomes the through put delay problem that would result in noise and oscillation during the pulse rise and fall time.

To equalize the timing of the Band 1 detector circuit to that of the Band 2 detector (on the Count Chain board), the Band 1 detected signal is delayed. C17, at the output of the Schmitt trigger circuit, delays the detected pulse on the leading edge. The capacitor slows the fall time without greatly affecting the rise time. C45, at the output of an inverter amplifier (U9C, pin 6), delays the trailing edge of the pulse and restores it to the original pulse width. If the delays are matched, the net effect is to delay the pulse.

The line driver U10C serves as a buffer to C17 and delivers its output through a differential line to the Count Chain board.

DIVIDE-BY-FOUR PRESCALER

In order to have a frequency range at the Band 1 output that can be measured by the Count Chain board, the original input frequency must be scaled down. This is done by a divide-by-four prescaler, U11. The input impedance of U11 is a function of frequency and can significantly load the source, amplifier U8. The matching is improved by inserting a 3-dB pad (R34, R35, and R36) between U8 and U11.

In the absence of an input signal, U11 is self-oscillating; while the counter is operating in Band 2, this interference will distort the frequency measurement (the Count Chain will receive both the correct signal from Band 2 and the oscillation at the same time). To prevent oscillation, the bias point of U11 pin 2 is changed by pushing Q4 from cut-off (R33 floating) to saturation. U12, following U11, is a line driver that delivers the signal through J3 to the Count Chain board.

DIGITAL ATTENUATOR/CONTROLLER

This block controls the attenuators on the Band 1 Converter board and the Band 3 (Millimeter Wave) Converter module. U4 is an eight-bit DAC controlled by the microprocessor through the PIA. U3 is an operational amplifier.

When the counter is operating in Band 1, U2C and U2A, parts of quad analog switch U2, are closed and U2D and U2B are open. In this case, Q2 drives the Band 1 Amplifier/attenuator and the feedback is supplied to U4, pin 16 via U2A. Q1 is turned off, setting the Band 3 attenuator to maximum attenuation (0 volts).

When the counter is operating in Band 3, U2D and U2B are closed and current is delivered to the Band 3 (Millimeter Wave) Converter. U2C is open and as a result, Q2 is saturated, which drives the Band 1 Amplifier/attenuator to maxmum attenuation.

A9 BAND 1 CONVERTER 2020224-02

REF DES.	SAME AS	DESCRIPTION				EIP NO.	UNITS PER ASSY
C1		CAP,ML CER	.01μF	10%	100V	2150014-00	11
C2	C1						
C3	C1						
C4	C1						
C5	C1						
C6		CAP,DISC,CER	47PF	10%	100V	2150039-00	1
C7		CAP,ML CER	.001μF	10%	100V	2150015-00	20
C8	C7						
C9		CAP,DISC,CER	6.8PF	10%	100V	2150087-00	3
C10	C9						
C11	C9						
C12		CAP,CHIP	150PF		100V	2100005-00	2
C13	C12						
C14		CAP,DISC,CER	100PF	10%	100V	2150056-00	8
C15	C7						
C16		NOT USED					
C17		CAP,CER SEE NOTE 1	120PF	5%	100V	2100124-00	1
C18	C7						
C19	C14						
C20		CAP,TANTALUM	33μF		10V	2300015-00	2
C21	C14						
C22	C14						
C23	C7						
C24	C14						
C25		CAP,DISC,CER	4.7PF	10%	100V	2160086-00	1
C26	C7						
C27	C7						
C28	C20						
C29		CAP,TANTALUM	10μF	20%	25V	2300029-00	2
C30	C29						
C31	C1						
C32	C1						
C33	C14						
C34	C1						
C35		CAP,DISC,CER	33PF	10%	100V	2150069-00	1
C36	C1						

NOTE 1 - SAT AS FOLLOWS: 15PF MIN-220PF MAX

A9 BAND 1 CONVERTER (Continued) 2020224-02

REF DES.	SAME AS	DESCRIPTION				EIP NO.	UNITS PER ASSY
C37	C14						
C38	C7						
C39	C7						
C40	C14						
C41	C7						
C42	C7						
C43	C1						
C44		CAP,DISC,CER	22PF	10%	100V	2150067-00	1
C45		CAP,DISC,CER,COG SEE NOTE 2	560PF	5%	100V	2150029-00	1
C46	C7						
C47	C7						
C48	C7						
C49	C7						
C50	C7						
C51	C7						
C52	C7						
C53	C7						
C54	C7						
C55	C1						
CR1		DIODE,5082-2835,PSVT SCHOTTKY				2710004-00	5
CR2		NOT USED					
CR3	CR1						
CR4	CR1						
CR5		DIODE,MA47123,PIN				2710024-00	5
CR6	CR5						
CR7	CR5						
CR8	CR5						
CR9	CR1						
CR10	CR1						
CR11		DIODE,1N5231,ZENER 5.1V				2705231-00	1
CR12	CR5						
CR13		DIODE,1N914				2700914-00	1
L1		PART OF BOARD					
L2	L1						

NOTE 2 - SAT AS FOLLOWS: 330PF MIN-820PF MAX

A9 BAND 1 CONVERTER (Continued) 2020224-02

REF DES.	SAME AS	DESCRIPTION				EIP NO.	UNITS PER ASSY
L3		INDUCTOR,1.2µH				3510010-00	2
L4	L3						
L5		INDUCTOR,.47µH				3510006-00	1
Q1		XSTR,2N4124,NPN,GP				4704124-00	2
Q2	Q1						
Q3		XSTR,2N4126,PNP,GP				4704126-00	2
Q4	Q3						
R1		NOT USED					
R2		RES,M/OX	2K	1/4W	2%	4130202-00	7
R3		RES,M/OX	1K	1/4W	2%	4130102-00	9
R4		RES,M/OX	680	1/4W	2%	4130681-00	1
R5		RES,CC	5.6	1/4W	5%	4010569-00	5
R6	R5						
R7		RES,M/OX	10K	1/4W	2%	4130103-00	5
R8		RES,M/OX	360	1/4W	2%	4130361-00	1
R9	R3						
R10	R3						
R11	R7						
R12		RES,CC	8.2	1/4W	5%	4010829-00	3
R13		RES,M/OX	150	1/4W	2%	4130151-00	2
R14	R3						
R15	R12						
R16		RES,M/OX SEE NOTE 3	33	1/4W	2%	4130330-00	2
R17		RES,M/OX SEE NOTE 4	20	1/4W	2%	4130200-00	1
R18	R16						
R19	R7						
R20	R3						
R21	R2						
R22		RES,M/OX	270	1/4W	2%	4130271-00	3
R23		RES,M/OX SEE NOTE 5	8.2K	1/4W	2%	4130822-00	2

NOTE 3 - SAT AS FOLLOWS: 24 MIN-33 MAX
NOTE 4 - SAT AS FOLLOWS: 20 MIN-36 MAX
NOTE 5 - SAT AS FOLLOWS: 3K MIN-10K MAX

A9 BAND 1 CONVERTER (Continued) 2020224-02

REF DES.	SAME AS	DESCRIPTION				EIP NO.	UNITS PER ASSY
R24	R3						
R25	R3						
R26		RES,M/OX	330	1/4W	2%	4130331-00	9
R27	R26						
R28	R26						
R29	R26						
R30		RES,M/OX	47	1/4W	2%	4130510-00	2
R31	R7						
R32	R3						
R33	R7						
R34		RES,M/OX	47	1/4W	2%	4130470-00	1
R35	R12						
R36	R13						
R37	R2						
R38	R26						
R39	R22						
R40	R2						
R41		RES,M/OX	51K	1/4W	2%	4130513-00	4
R42	R41						
R43	R5						
R44	R3						
R45		RES,M/OX	620	1/4W	2%	4130621-00	2
R46	R26						
R47	R45						
R48	R5						
R49	R26						
R50		RES,M/OX SEE NOTE 6	82	1/4W	2%	4130820-00	1
R51	R41						
R52	R5						
R53		RES,M/OX	8.2K	1/4W	2%	4130822-00	1
R54	R41						
R55	R26						
R56		RES,M/OX	24K	1/4W	2%	4130243-00	1
R57	R23						
R58	R2						
R59		RES,M/OX	12K	1/4W	2%	4130123-00	1

NOTE 6 - SAT AS FOLLOWS: 39 MIN-120 MAX

A9 BAND 1 CONVERTER (Continued) 2020224-02

REF DES.	SAME AS	DESCRIPTION	EIP NO.	UNITS PER ASSY
R60	R2			
R61	R26			
R62	R22			
R63	R2			
R64	R30			
R65		RES,M/OX 750 1/4W 2%	4130751-00	1
U1		IC,7406	3007406-00	1
U2		IC,4066B,ANALOG SWITCH	3034066-00	1
U3		IC,LM308A,OPNL AMP/BUFFER	3040308-00	2
U4		IC,AD7524L,DAC,8-BIT,1/8 LSB	3057525-00	1
U5		IC,6820,PERIPHERAL INTFC ADAPTER	3086820-00	1
U6		IC,GPD-1003/1063,CASCADABLE AMPL	3041063-00	3
U7	U6			
U8	U6			
U9		IC,0116,ECL 10K,LINE RCVRS	3110116-00	1
U10		IC,10H116 ECL 10KH,LINE RCVRS	3118116-00	2
U11		IC,311993,VHF/UHF,4 PRESCALER	3043199-00	1
U12	U10			
U13	U3			
J1		CONN,COAX PC RCPT,SNAP NANOHEX	2610038-00	3
J2	J1			
J3	J1			
XU1		CONN,SOCKET,DIP,14 PIN	2630015-00	2
XU2	XU1			
XU3		CONN,SOCKET,DIP,8 PIN	2630014-00	2
XU4		CONN,SOCKET,DIP,16 PIN	2630016-00	4
XU5		CONN,SOCKET,DIP,0 PIN	2630022-00	1
XU6		NOT USED		
XU7		NOT USED		
XU8		NOT USED		
XU9	XU4			
XU10	XU4			
XU11		CONN,IC PIN(MINISERT)	2620054-00	8
XU12	XU4			
XU13	XU3			

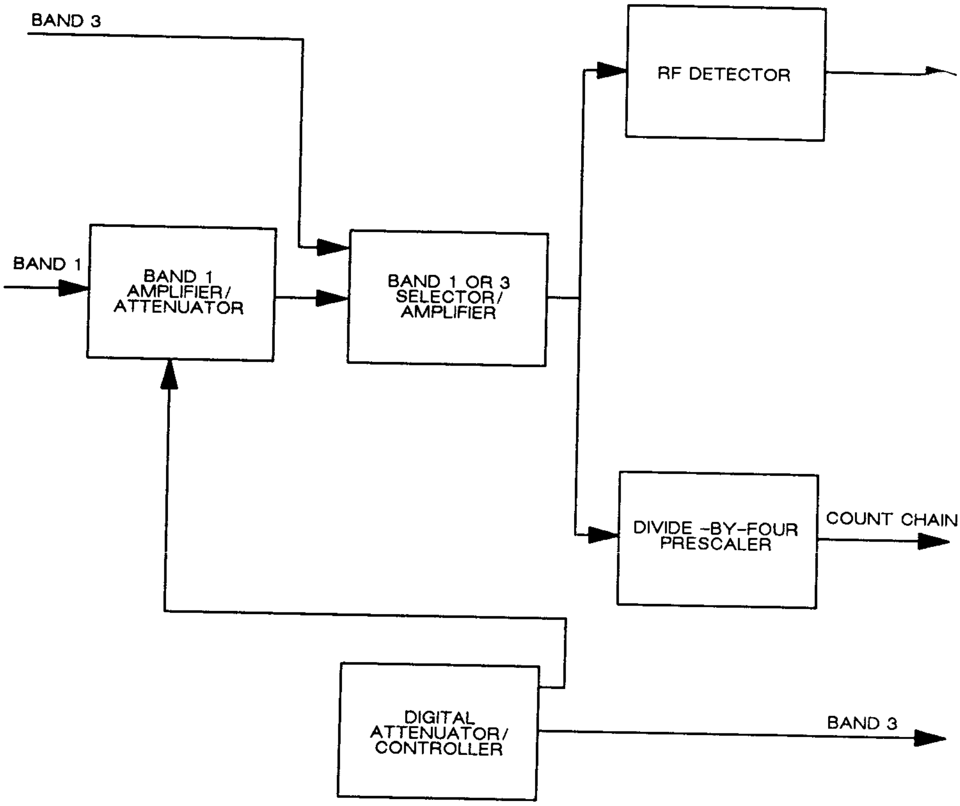

Figure 8A9-1. Functional Block Diagram, Band 1 Converter (Option)

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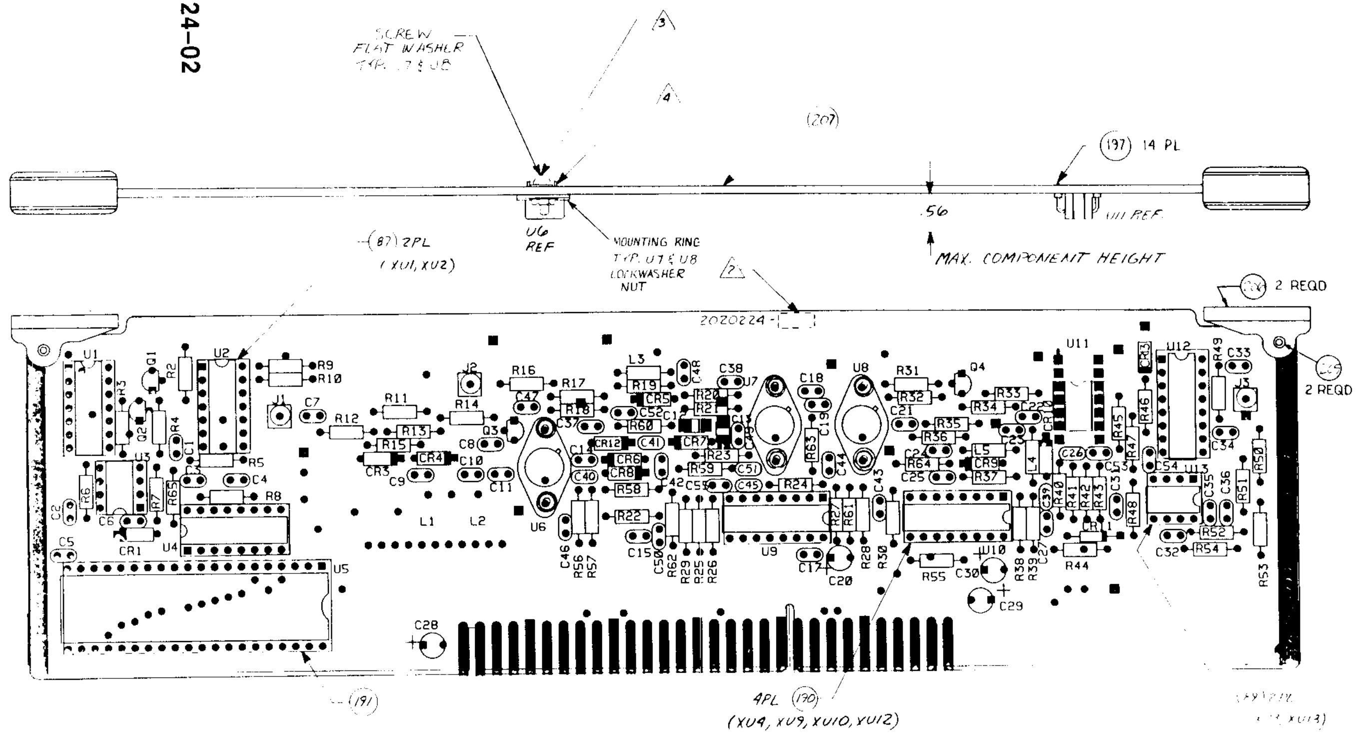

Figure 8A9-2. Component Locator, Band 1 Converter (Option)

2020224-02

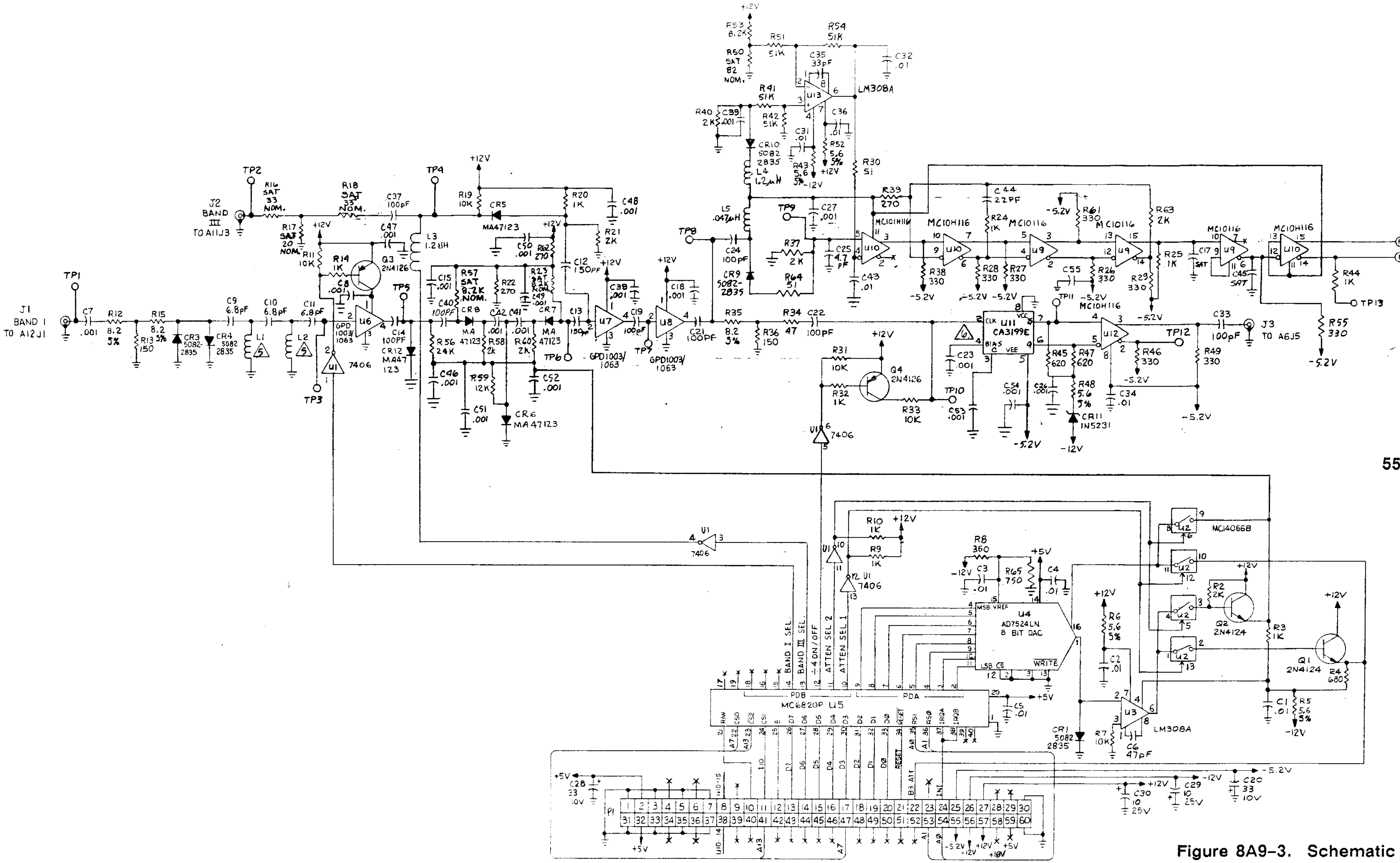

Figure 8A9-3. Schematic D

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A10 BAND 2 MICROWAVE CONVERTER (2010296-01)

GENERAL

The Band 2 Microwave Converter is a complete microwave subsystem consisting of three printed circuit assemblies: the IF/Video Amplifier, the VCO, and the VCO Buffer. It converts an input signal in the range of 0.95 GHz to 18 GHz/26.5 GHz down to an IF of 110 MHz. Down conversion is achieved in this heterodyne system by combining the input signal with a harmonic of a precisely known reference signal, F_{VCO}. The mixer then produces a signal, F_{IF}, equal to the difference between the input and reference harmonic. If this difference is close to 110 MHz, it is amplified to a level of about 0 dBm and then counted. The input signal is then determined for the equation

$$F_{IN} = NF_{VCO} \pm F_{IF}$$

F_{VCO} is set by the instrument program via a phase-locked loop located on the Converter Control board (A8) and is thus known exactly.

Harmonics of the VCO are produced by the comb generator and coupled to the mixer. The frequency ranges of the VCO and IF are such that for any VCO frequency and any input frequency, only one harmonic can produce an IF frequency. The YIG filter located between the RF input and the mixer is used to determine the input frequency approximately. From this information the desired values of N, F_{VCO}, and mix side are determined.

NOTE

Due to the extensive test equipment and special processes required to test and repair this assembly, it is not recommended that any field repair be attempted. For this reason the manual does not contain detailed information on the circuitry contained in this assembly. Exchange modules are available from EIP. Please consult the factory for pricing.

A11 MILLIMETER WAVE CONVERTER (2020238-01)

The Band 3 Millimeter Wave Converter is a heterodyne harmonic downconverter, employing millimeter wave harmonic mixers in the various waveguide bands from 26.5 to 110 GHz. These mixers are external to the instrument.

Local oscillator frequency (LO) is created by multiplying the VCO input frequency to the Millimeter Wave Converter by 12. This LO signal is channeled to the external mixer through a coaxial cable. The resulting IF signal, returning through the same cable, is separated and processed in the converter.

The major parts of the converter are the following:

- Power Amplifier
- Multiplier
- IF Amplifier

POWER AMPLIFIER

The power amplifier consists of three bipolar transistor stages, preceded by a high-pass filter to reduce the wide-band noise entering the amplifier. The first stage is operated linearly (class A), and does not require tuning. The second and third stages are turned on by the RF power, and need to be adjusted for best performance.

MULTIPLIER

The Multiplier, consisting of the X3 Multiplier, the X4 Multiplier, and the LO Amplifier/Diplexer, multiplies the incoming VCO frequency by 12 to supply the LO power to an external mixer. The LO amplifier doubles the output power while providing buffering between the mixer and the multiplier chain.

The IF signal, separated in the diplexer, is amplified and filtered in the variable gain IF amplifier strip.

IF AMPLIFIER

The IF amplifier increases the amplitude of the IF signal generated by a harmonic mixer to approximately -5 dBm while suppressing all other signals, such as harmonics of the VCO, that are present at the input at levels far exceeding that of the desired IF signal.

Since the amplifier processes pulsed signals, it must always be kept in the linear operating range, regardless of the IF input level. This is done by varying the bias current of two of the amplifier stages by microprocessor control, according to output level, to keep the output level constant at approximately -5 dBm.

NOTE

Due to the extensive test equipment and special processes required to test and repair this assembly, it is not recommended that any field repair be attempted. For this reason the manual does not contain detailed information on the circuitry contained in this assembly. Exchange modules are available from EIP. Please consult the factory for pricing.

A12A1 FRONT PANEL DISPLAY and KEYBOARD (2020140-02)

The Front Panel Display and Keyboard assembly is divided into two functional sections:

- Numeric display and annunciators
- Keyboard

NUMERIC DISPLAY AND ANNUNCIATORS

This section of the assembly contains 12 common-anode, seven- segment numeric display units (DS1-DS12), 2 green LEDs (DS37 and DS38), and 24 yellow LEDs (DS13-DS36).

The seven-segment LEDs are mounted side by side, with space between each third digit from the right. The corresponding cathode segments of the seven-segment LEDs are connected, and the drive signals come from the segment drivers Q3 through Q10. The signals to drive the digits come from the digit drivers located on the Front Panel Logic board.

The two green LEDs (DS37 and DS38) are driven by Q1 and Q2. When these LEDs light, they indicate that the GATE and CONVERTER SEARCH modes are in operation.

The yellow LEDs (DS13-DS36) are divided into three groups of eight each. The anodes of all LEDs in each group are connected. The cathode of each grouped LED is connected to one of the segment drivers (Q3 through Q10). With this arrangement, each group of annunciator lights can be regarded as similar to one seven-segment LED. The digit drives for the three groups of annunciator lights also come from the Front Panel Logic board.

KEYBOARD

This section of the assembly contains 21 single-pole, double- throw switches. The switches are arranged in a four-row by six- column matrix, with the extra switch taking the row 4, column 7 position. The columns are connected to +5 volts through the resistor network (RN1) on the Front Panel Logic board.

The keyboard is continuously scanned. The signals scanning the keyboard are derived from the Front Panel Logic board. When the keyboard is being scanned, the four rows are grounded sequentially. When a row is grounded, and a key in that row is pressed, one of the columns will be grounded. This information is sent to the Front Panel Logic board, where key debouncing is performed.

A12A1 FRONT PANEL DISPLAY AND KEYBOARD 2020140-02

REF DES.	SAME AS	DESCRIPTION				EIP NO.	UNITS PER ASSY
Q1		XSTR,2N4402,PNP,RF AMPLIFIER				4710019-00	10
Q2	Q1						
Q3	Q1						
Q4	Q1						
Q5	Q1						
Q6	Q1						
Q7	Q1						
Q8	Q1						
Q9	Q1						
Q10	Q1						
R1		RES,CC	4.7K	1/4W	5%	4010472-00	2
R2		RES,CC	130	1/4W	5%	4010131-00	2
R3	R1						
R4	R2						
R5		RES,CC	240	1/4W	5%	4010241-00	8
R6		RES,CC	18	1/4W	5%	4010180-00	8
R7	R5						
R8	R6						
R9	R5						
R10	R6						
R11	R5						
R12	R6						
R13	R5						
R14	R6						
R15	R5						
R16	R6						
R17	R5						
R18	R6						
R19	R5						
R20	R6						
DS1 thru DS12		LAMP,LED,NUMERIC INDICATOR				2800024-01	12
DS13 thru DS36		LAMP,LED,YELLOW,RECT .15X.26				2800020-00	24
DS37		LAMP,LED,GREEN,.12 OD				2800018-00	2
DS38	DS37						

A12A1 FRONT PANEL DISPLAY AND KEYBOARD (Continued) 2020140-02

REF DES.	SAME AS	DESCRIPTION	EIP NO.	UNITS PER ASSY
S1		SWITCH,MOM SPDT	4500013-00	21
S2		NOT USED		
S3		NOT USED		
S4		NOT USED		
S5		NOT USED		
S6 thru S25	S1			
P1		CONN,PCB RCPT,9 PIN	2620065-00	1
P2		CONN,PCB RCPT,17 PIN	2620067-00	1
P3		CONN,PCB RCPT,13 PIN	2620066-00	1
XDS1 thru XDS12		CONN,SOCKET,DIP,14 PIN	2630015-00	12
XDS13 thr XDS36		CONN,IC PIN(MINISERT)	2620054-00	48

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2020140-02

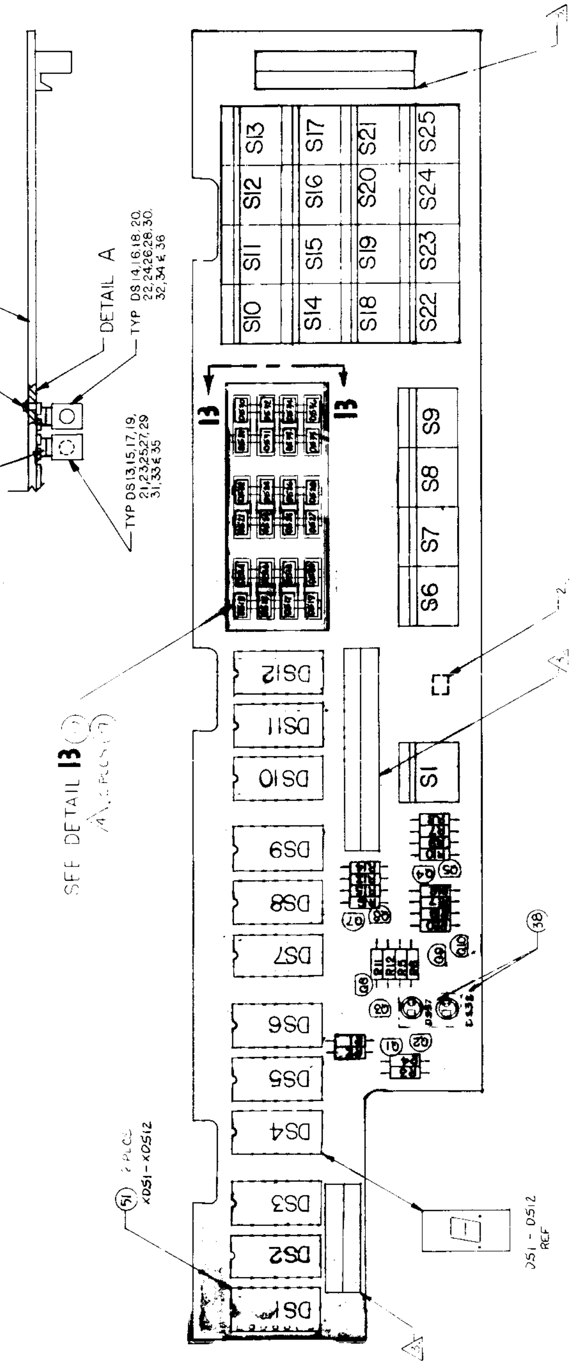

Figure 8A12A1-1. Component Locator, Front Panel Display/Keyboard

5500140-00

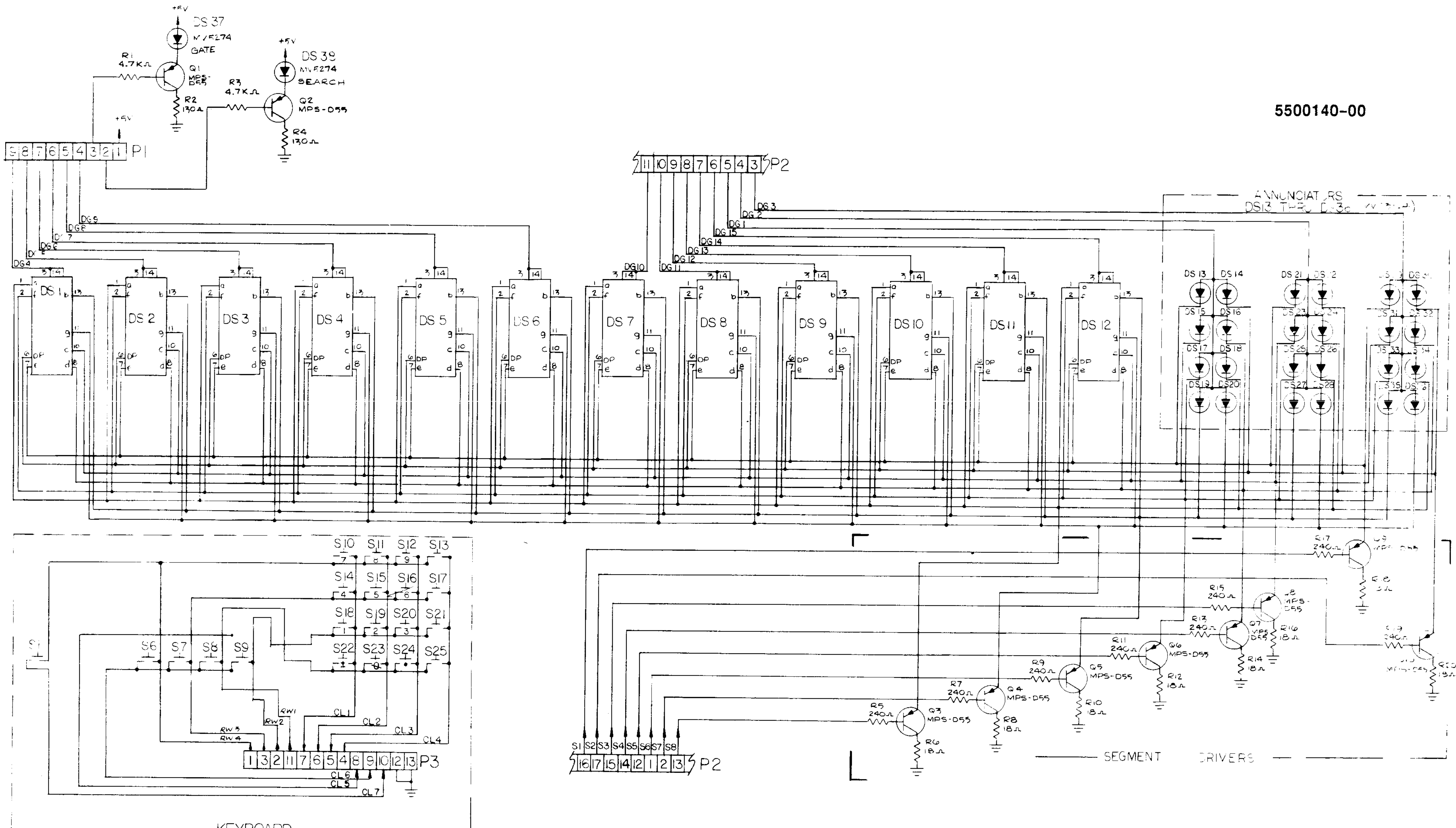

Figure 8A12A1-2. Schematic Diagram, Fr

A12A2 FRONT PANEL LOGIC (2020191-01)

The Front Panel Logic assembly contains logic circuitry for control of two functions:

- Display control
- Keyboard control

The +5 volt power supply to the front panel assemblies is regulated by a voltage regulator that is located behind the Front Panel Logic board. For heat-sinking purposes, this voltage regulator is mounted on the chassis as shown in Front Panel Logic Functional Block Diagram.

DISPLAY CONTROL

The signals input to the twelve 7-segment LEDs and the three groups of annunciator lights on the Front Panel Display are multiplexed. To turn on a particular segment in a digit, both the digit driver for that digit and the segment driver for that segment must be on.

The display logic is in constant operation in either the self-scan mode or the memory update mode.

SELF-SCAN MODE

This is the normal operating mode. In this mode, the display scan clock is clocking the display counter (U6). The state of the display counter determines which digit will be turned on.

The state of the display counter is decoded by a 4-to-16-line multiplexer (U2), and the appropriate digit driver is turned on. At this time, the display memory (U7 and U8) is read, and the on/off information (stored in the display memory for that specific digit) turns the segment drivers on the Front Panel Display board on or off.

The display intensity is controlled by varying the duty cycle of the multiplexer. This is done by varying the resistance of the potentiometer (R4) which, in turn, varies the length of time the decoder (U2) and the display memories (U7, U8) are disabled between each scan clock cycle.

At the start of each gate operation, the GATE LED control is triggered, and the GATE LED lights for the length of the gate time.

MEMORY UPDATE MODE

In this mode, the display scan/$\overline{\text{update}}$ control line (PA4) is set to logic, disabling the multiplexer. The microprocessor-controlled clock (PA1) is used to clock the display counter (U6).

The microprocessor sets the clear/load control line (PA5) to logic 1 and clocks the clock input of U6, which clears the display counter and updates the display memory (U7 and U8). Update mode timing is illustrated in Figure 8A12A2-1.

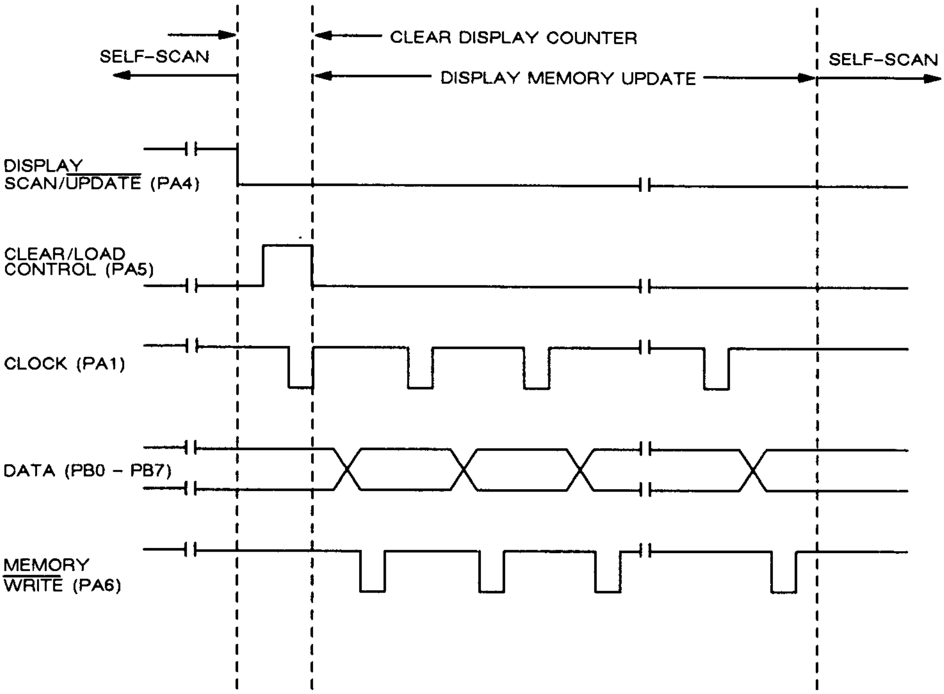

Figure 8A12A2-1. Update Mode Sequence

KEYBOARD CONTROL

When the keyboard is not being read by the microprocessor, the keyboard read/$\overline{\text{scan}}$ control line (PAO) is at logic 0. All the outputs of the shift register are at logic 0. If no key on the keyboard is pressed, all the inputs to the 8-input NAND gate (U13) are at logic 1 level. When a key is pressed, the column containing that key is grounded. The output of U13 goes to logic 1 and C7 (in the debounce circuit) starts to discharge. When the voltage across C7 reaches approximately +0.7 volts above ground, the debounce circuit will trigger the interrupt input of the PIA (U11, pin 18), indicating that a key is being pressed.

READ KEYBOARD

When the microprocessor needs to read the keyboard, a logic 1 signal is put on the keyboard read/$\overline{\text{scan}}$ control line (PA0). This enables the data buffer (U9). A 0111 is then loaded into the shift register (U3) by putting a logic 1 on the clear/load control line (PA5) and clocking the clock input of U3. The logic 0 at the output of the shift register (U3) is shifted through the shift register once. The microprocessor reads the keyboard row and column information with the logic 0 at each of the four outputs of U3 to determine the coordinate of the key pressed. After the keyboard is read, the keyboard read/scan line is returned to logic 0.

A12A2 FRONT PANEL LOGIC 2020191-01

REF DES.	SAME AS	DESCRIPTION				EIP NO.	UNITS PER ASSY
C1		CAP,TANTALUM	.1µF		35V	2300020-00	1
C2		CAP,DISC,CER	.002µF	20%	1KV	2150005-00	2
C3	C2						
C4		NOT USED					
C5		CAP,TANTALUM	47µF		16V	2300025-00	1
C6		CAP,TANTALUM	2.2µF	20%	16V	2300012-00	1
C7		CAP,TANTALUM	22µF	20%	16V	2300030-00	1
C8		CAP,TANTALUM	.33µF		10V	2300031-00	1
C9		CAP,TANTALUM	33µF		10V	2300015-00	1
C10		CAP,CER	.01µF	20%	100V	2150003-00	6
C11	C10						
C12	C10						
C13	C10						
C14	C10						
C15	C10						
CR1		DIODE,1N4148,FAST SWITCHING,GP				2704148-00	1
J1		CONN,PCB,PLUG,9 PIN				2620062-00	1
J2		CONN,PCB,PLUG,17 PIN				2620064-00	1
J3		CONN,PCB,PLUG,13 PIN				2620063-00	1
J4		CONN,FRICT LK .100,4 PIN				2620068-00	1
J5		CONN,FRICT LK .100,3 PIN				2620121-00	1
P2		CONN,PCB,RT ANGLE,26 PIN				2620131-00	1
Q1		XSTR,MPSD54,PNP,DALINGTON				4710027-00	15
Q2	Q1						
Q3	Q1						
Q4	Q1						
Q5	Q1						
Q6	Q1						
Q7	Q1						
Q8	Q1						
Q9	Q1						
Q10	Q1						
Q11	Q1						
Q12	Q1						

A12A2 FRONT PANEL LOGIC (Continued) 2020191-01

REF DES.	SAME AS	DESCRIPTION				EIP NO.	UNITS PER ASSY
Q13	Q1						
Q14	Q1						
Q15	Q1						
Q16		XSTR,2N4124,NPN,GP				4704124-00	2
Q17	Q16						
R1		RES,CC	10K	1/4W	5%	4010103-00	2
R2		RES,CC	220	1/4W	5%	4010221-00	1
R3		RES,CC	75K	1/4W	5%	4010753-00	1
R4		POT,CERMET	200	KT05	0.5W	4250022-00	1
R5		RES,CC	120K	1/4W	5%	4010124-00	1
R6		RES,CC	2.4K	1/4W	5%	4010242-00	1
R7		RES,CC	1K	1/4W	5%	4010102-00	16
R8	R7						
R9	R7						
R10	R7						
R11	R7						
R12	R7						
R13	R7						
R14	R7						
R15	R7						
R16	R7						
R17	R7						
R18	R7						
R19	R7						
R20	R7						
R21	R7						
R22		NOT USED					
R23		RES,CC	15K	1/4W	5%	4010153-00	1
R24		RES,CC	390	1/4W	5%	4010391-00	1
R25		RES,CC	200	1/4W	5%	4010201-00	1
R26	R7	SEE NOTE 1					
R27	R1						
R28		NOT USED					
R29		RES,CC	2.2K	1/4W	5%	4010222-00	1
R30		NOT USED					
R31		RES,CC	27K	1/4W	5%	4010273-00	1

NOTE 1 – R26 SAT AS FOLLOWS: 820 OHMS MIN-1.2K OHMS MAX

A12A2 FRONT PANEL LOGIC (Continued) 2020191-01

REF DES.	SAME AS	DESCRIPTION				EIP NO.	UNITS PER ASSY
R32		RES,CC	39K	1/4W	5%	4010393-00	3
R33	R32R34	R32					
RN1		RES,NTWK	9X10K	0.2W	2%	4170003-00	2
RN2	RN1						
RN3		RES,NTWK	7X10K	0.3W	2%	4170004-00	1
TP1		CONN,PCB,.040D PIN,GOLD				2620032-00	9
TP2	TP1						
TP3	TP1						
TP4	TP1						
TP5	TP1						
TP6	TP1						
TP7		NOT USED					
TP8	TP1						
TP9	TP1						
TP10	TP1						
U1		IC,74LS123				3084123-00	2
U2		IC,74154				3074154-00	1
U3		IC,SR,PRL ACCESS,4-BIT,TI ONLY				3084195-01	1
U4		IC,74LS51				3087451-00	1
U5		IC,74LS132				3084132-00	1
U6		IC,74LS163				3084163-00	1
U7		IC,74LS189				3057489-00	2
U8	U7						
U9		IC,74LS244				3084244-00	1
U10	U1						
U11		IC,6820,PERIPHERAL INTFC ADAPTER				3086820-00	1
U12		IC,74LS14				3087414-00	1
U13		IC,74LS30				3987430-00	1
XU2		CONN,SOCKET,DIP,24 PIN				2630020-00	1
XU3		CONN,SOCKET,DIP,16 PIN				2630016-00	1
XU11		CONN,SOCKET,DIP,40 PIN				2630022-00	1

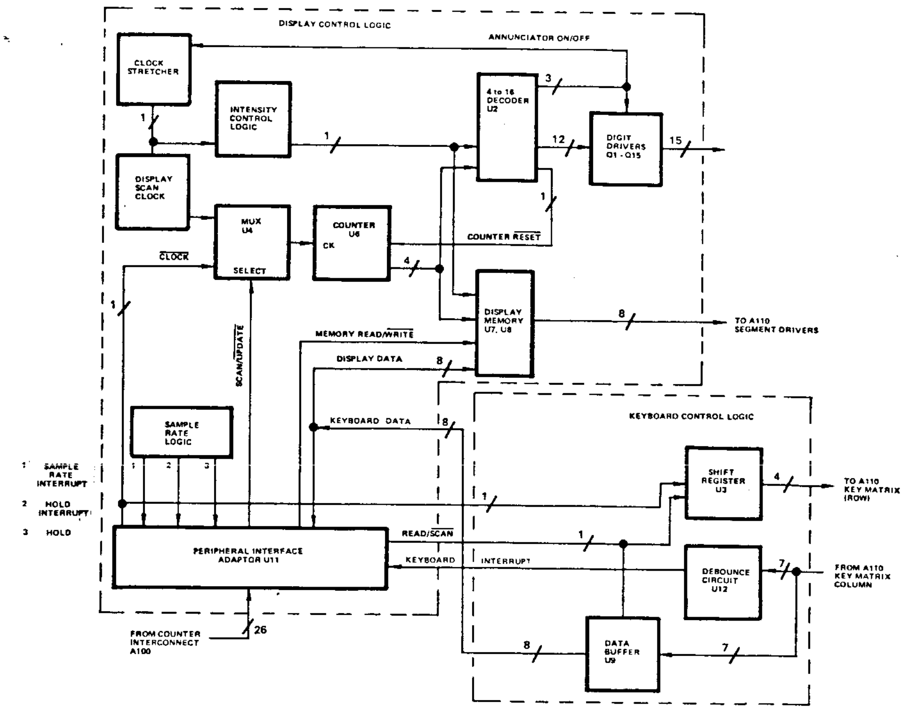

Figure 8A12A2-2. Functional Block Diagram, Front Panel Logic

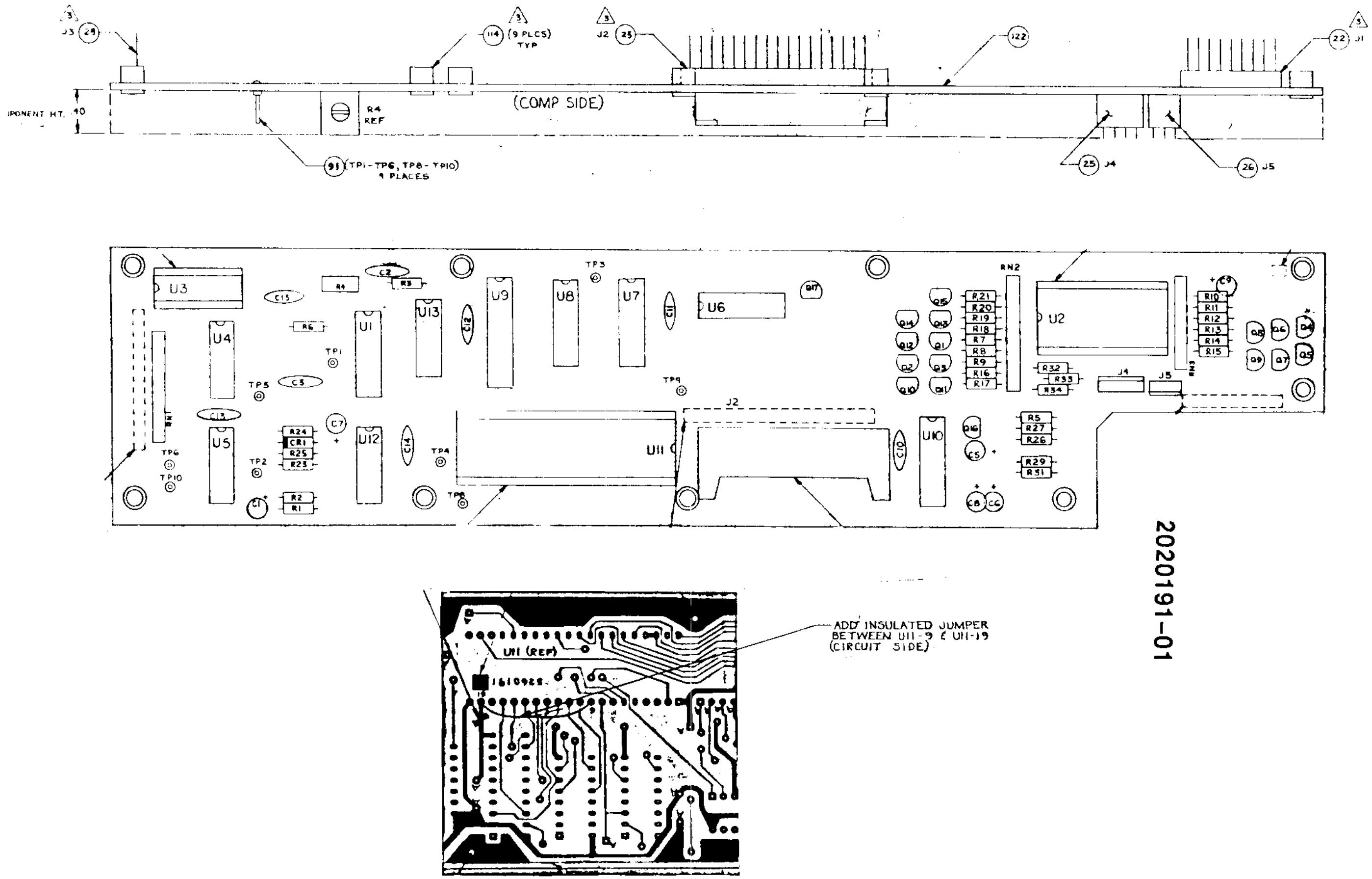

Figure 8A12A2-3. Component Locator, Front Panel Logic

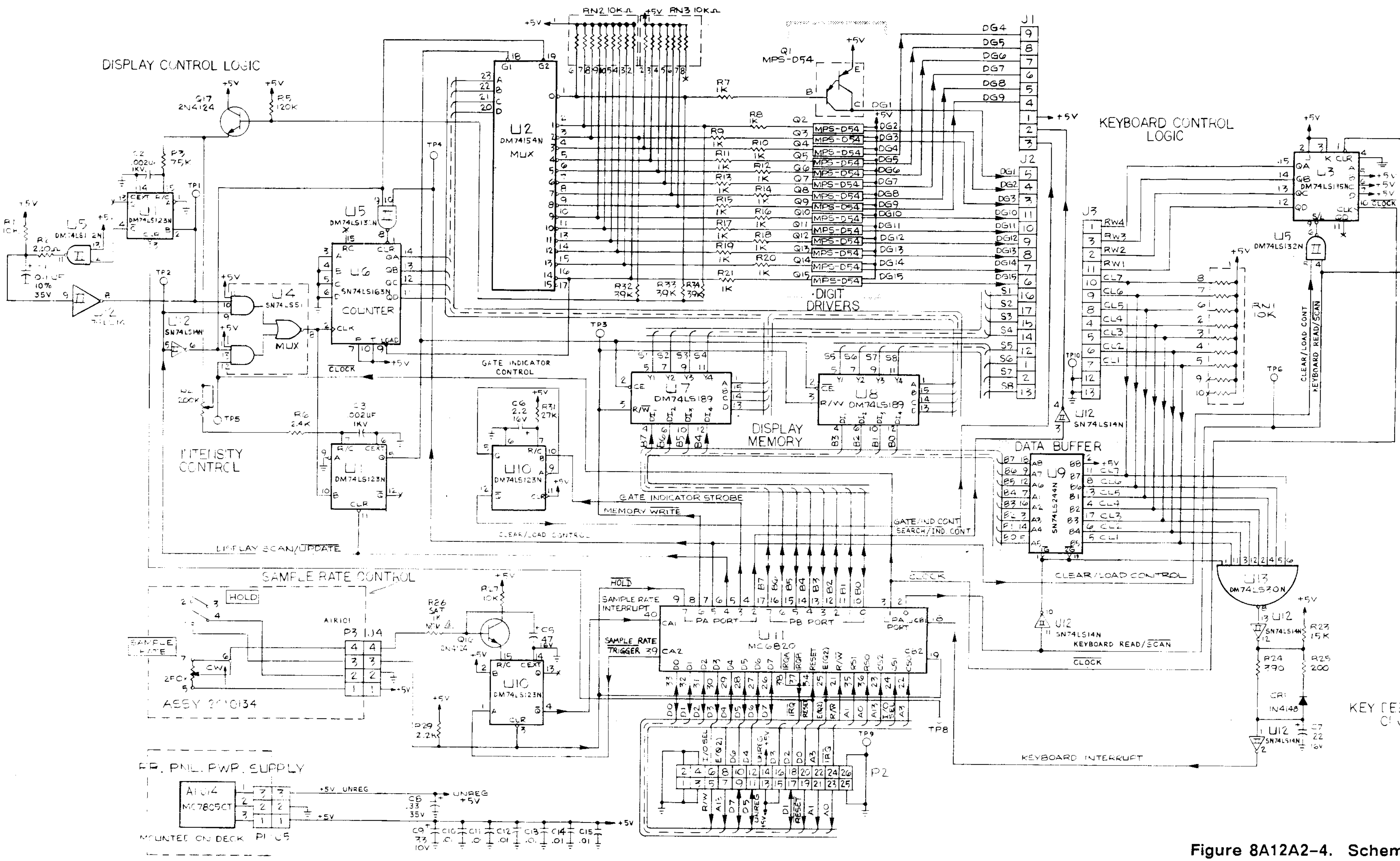

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Figure 8A12A2-4. Schematic Di

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Operations

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Manual Assembly Part Number: 5585023-03
Manual Text Part Number: 5580023-06
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585: CCN 2704
588: CCN 2804

Warranty

EIP Microwave warrants this counter to be free from defects in material and workmanship for one year from the date of delivery. Damage due to accident, abuse, or improper signal level is not covered by the warranty. Removal, defacement, or alteration of any serial or inspection label, marking, or seal may void the warranty. EIP Microwave will repair or replace, at its option, any components of this counter which prove to be defective during the warranty period, provided the entire counter is returned PREPAID to EIP or an authorized service facility. In-warranty counters will be returned freight prepaid; out-of-warranty units will be returned freight COLLECT. No other warranty other than the above warranty is expressed or implied.

Certification

EIP Microwave certifies that this instrument was thoroughly inspected and tested, and found to be in conformance with the specifications noted herein at time of shipment from the factory.

Manual Change Information

As EIP continually improves and updates its products, changes to the material covered by the manual will occur. When a part or assembly in an EIP instrument is changed to the extent that it is no longer interchangeable with the earlier part, the Change Control Number (CCN) of the instrument, shown on the title page of the manual, will change and a new edition of the manual will be published. A new edition not involving a CCN change will show the new date on the front page and on each changed page.

Sometimes, due to printing and shipping requirements, changes cannot be incorporated into the printed manual immediately. In these cases, dated change pages will be shipped with the manual. Please insert these pages in your manual and remove the obsolete pages, if any.

Customer Suggestion Form

A mail-in form at the end of this manual provides an easy way for you to tell us about any additions, corrections, or changes that would improve this publication. We appreciate your taking the time to help us provide the best possible service to you and to all of our customers.

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Section 1
General Information

DESCRIPTION

The Model 585 and Model 588 Microwave Pulse Counters are microprocessor-based multifunction instruments used for both CW and pulsed microwave measurements. They automatically measure pulse widths as narrow as 50 ns and pulse periods up to 250 ns. The 585 and 588 also measure input signal pulse width or pulse period to a 10-ns resolution. Additionally, through the INHIBIT INPUT connector, the 585 and 588 can profile pulsed or chirped CW signals with gates down to 15 ns. The range of pulse parameter measurements is 15 ns (when profiling) to 9.99 seconds. No manual switching is required to measure CW or pulsed signals.

The frequency range of the 585 is 0.95 to 18 GHz, and is extendible, by option, down to 300 MHz. The frequency range of the 588 is 0.95 to 26.5 GHz, and is extendible, by option, down to 300 MHz and up to 110 GHz.

All major functions are controlled through the 21-button, functionally grouped keyboard. Information is presented for viewing on a 9-digit sectionalized frequency display, a 3-digit floating point pulse parameter display, and a 20-message annunciator bank.

Microprocessor control and the unique architecture employed offer all the major counter functions, such as frequency offsets, frequency range limits, and averaging capabilities, plus a variety of special functions including internal diagnostics, calibration and test aids, and sophisticated operational enhancements.

All front panel controls (except the ON/OFF switch) and all background functions are externally programmable via the IEEE 488-1978 standard GPIB (General Purpose Interface Bus) port. The instrument output status and all displayed information are accessible via the GPIB.

SAFETY

The Model 585/588 is a Safety Class I instrument. This instrument has been designed and tested according to international safety requirements.

This manual contains information, cautions, and warnings that must be followed by the service person to ensure safe operation and to retain the instrument in safe condition.

SAFETY SYMBOLS

WARNING The WARNING sign denotes a hazard. It calls attention to a procedure or practice, which, if not correctly performed or adhered to, could result in personal injury.

CAUTION The CAUTION sign denotes a hazard. It calls attention to an operating procedure or practice, which, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the product.

OVERALL SAFETY CONSIDERATIONS

WARNING

Before this instrument is switched on, the protective earth terminals of this instrument must be connected to the protective conductor of the (mains) power cord. The mains plug shall only be inserted in a socket outlet provided with a protective earth contact. The protective action must not be negated by the use of an extension cord (power cable) without a protective earth (grounding) conductor.

WARNING

Only fuses with the required rated current voltage and specified type should be used. Do not use repaired fuses or short-circuited fuseholders. To do so could cause a shock or fire hazard.

WARNING

Whenever it is likely that the protection has been impaired, the instrument must be made inoperative and be secured against any unintended operation.

WARNING

All protective earth terminals, extension cords, autotransformers, and devices connected to this instrument should be connected to a socket outlet provided with a protective earth contact. Any interruption of the protection will cause a potential shock hazard that could result in personal injury.

PERIODIC MAINTENANCE

No periodic preventive maintenance is required. To maintain accuracy, it is recommended that the counter be recalibrated every six months. See Section 5, Adjustments and Calibration.

If the following assemblies are repaired or replaced, the counter may require recalibration for proper operation.

- Power Supply
- Gate Generator
- Converter Control
- Microwave Converter
- Microprocessor
- Band 1 Converter
- Count Chain

Care should be taken when removing any assemblies to prevent damage to components or cables.

CAUTION

Do not attempt repair or disassembly of the Microwave Converter, Millimeter Wave Converter, or Time Base Oscillator assemblies. Such action will void the warranty of the counter. Contact EIP or your sales representative.

OPERATING CONDITIONS

This instrument is designed to be operated at temperatures not exceeding 0° to 50°C at relative humidity not to exceed 95% (75% over 25°C; 45% over 40°C). This instrument will perform to specifications at altitudes not exceeding 3050 in (10,000Ft.) and will tolerate vibration not exceeding 2 g. It is fungus resistant. The chassis is not designed to provide protection from mechanical shock or falling water particles and is intended for normal bench use in an environmentally uncontaminated area.

VENTILATION

Air circulates through the vents in the rear panel of the counter. These vents must not be obstructed or the temperature inside the counter may increase enough to reduce counter stability and shorten component life.

STORAGE

Store the instrument in an environment that is protected from moisture, dust, and other contaminants. Do not expose the instrument to temperatures below -55°C or above 75°C, nor to altitudes above 12,000 m (40,000 ft).

CAUTION

Check current rating of counter fuse and setting of rear panel Vac selector switch before applying power to counter.

FUSE REPLACEMENT

The counter uses one fuse. It is located on the rear panel above the line voltage plug. The following fuses must be used:

Line Voltage	Fuse Type
110/120 Vac	1.5-A Slow-blow MDL
220/240 Vac	0.75-A Slow-blow FST

To release the fuse, use a screwdriver to rotate the slotted cap counter-clockwise. To reinstall the fuse, press the fuse and slotted cap assembly into the fuse cavity and turn it clockwise until it locks into place.

VOLTAGE SELECTION

The voltage select switch should be set to the proper line voltage. To change line voltage:

1. Disconnect the counter from the power line.

2. Use a screwdriver to turn the slotted voltage indicator to the desired position.

INSTALLATION

No special installation instructions are required. The counter is a self-contained bench or rack mounted unit, and only requires connection to a standard, 100/120/220/240-volts, 50/60-Hz power line for operation.

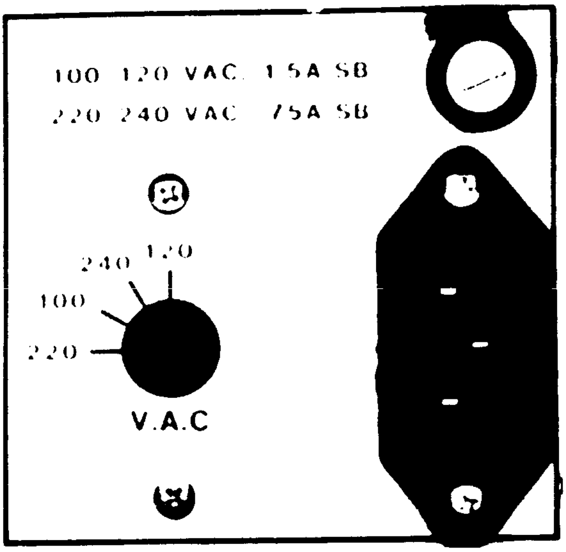

Figure 1-1. Rear Panel Fuse and Voltage Select Locations

CAUTION

Always be sure that the fuse is the type and value specified, and that the voltage select switch is set to correspond to the ac power input voltage; otherwise, the counter may be damaged.

PERFORMANCE CHECKOUT PROCEDURE

The following procedure can be done without special tools or equipment.

1. Turn counter POWER switch off. Check fuse rating and setting of AC POWER switch on the rear panel.

2. Connect the power cord to 100/120 or 220/240-V, 50/60-Hz single-phase power source. The ground terminal on the power cord plug should be grounded.

3. Turn the POWER switch on. All LEDs and annunciators will light for about 2 seconds, then the model number will be displayed for about 1 second, then all zeros will be displayed. This indicates that the automatic self-check has been completed.

4. Press: [9] (SPECIAL/FUNC) [0] [1] Display should read 100 000 ±1 (100 MHz).

5. Press: [9] (SPECIAL/FUNC) [0] [2] Display should read all 8's and all annunciators should be lit.

6. Press: [9] (SPECIAL/FUNC) [0] [3] Each display segment should light in turn (adjustable by the front panel SAMPLE RATE).

7. Press: [9] (SPECIAL/FUNC) [0] [4] Each digit should light in turn (adjustable by the front panel SAMPLE RATE).

8. This completes the performance checkout procedure.

SERVICE INFORMATION

COUNTER IDENTIFICATION

This counter is identified by three sets of numbers: the model number 585 or 588, a serial number, and a Configuration Control Number (CCN). They are located on a label affixed to the rear panel. All three numbers must be mentioned in any correspondence regarding your counter.

REPLACEABLE ASSEMBLIES

EIP has an assembly exchange program. Selected plug-in assemblies and modules may be exchanged. Consult with the factory for the current listing.

After identifying the faulty assembly, call EIP with the assembly number and shipping information. A replacement can be shipped within 24 hours. After the replacement assembly has been received, return the faulty assembly to EIP for credit.

FACTORY SERVICE

If the counter is being returned to EIP for service or repair, be sure to include the following information with the shipment.

- Name and address of owner.
- Model, complete serial number, and CCN of the counter.
- A complete description of the problem (Under whant conditions did the problem occur? What was the signal level? What equipment was attached or connected to the counter? Did that equipment experience failure symptoms?)
- Name and telephone number of someone familiar with the problem that may be contacted by EIP for any further information if necessary.
- Shipping address to which the counter is to be returned. Include any special shipping instructions.

Pack the counter for shipping as detailed below.

SHIPPING INSTRUCTIONS

Wrap the counter in heavy plastic or kraft paper, and repack in original container if available. If the original container cannot be used, use a heavy (275 pound test) double-walled carton with approximately four inches of packing material between the counter and the inner carton. Seal carton with strong filament tape or strapping. Mark the carton to indicate that it contains a fragile electronic instrument. Ship to the EIP address on the title page of this manual.

OPTIONS AND ACCESSORIES

This section provides descriptions for the options and accessories available on the EIP Model 585/588 Counters.

OPTIONS	DESCRIPTION
5801	50 to 400 Hz Operation
5802	Band 1 (300 MHz to 1 GHz)
5803	Rear Input
5804	Band 3 (Frequency Extension to 110 GHz, available on Model 588 only - unit must have Option 5802)
5805	MATE CIIL Interface

ACCESSORIES	DESCRIPTION
890	Frequency Extension Cable Kit
91	Remote Sensor 26.5 - 40 GHz (WR-28)
92	Remote sensor 40 - 60 GHz (WR-19)
93	Remote Sensor 60 - 90 GHz (WR-12)
94	Remote sensor 90 - 110 GHz (WR-10)
95	Remote Sensor 50 - 75 GHz (WR-15)
96	Remote Sensor 33 - 50 GHz (WR-22)

The accessories above listed are used in conjunction with Option 5804.

101	Chassis Slides with Handles (includes Rack Mount Kit)
102	Chassis Slides without Handles (includes Rack Mount kit)
010	Transit Case
021	Rack Mount Kit with Handles
022	Rack Mount Kit without Handles
031	Operations Manual (one supplied with each instrument)
032	Maintenance and Service Manual (one supplied with each instrument)
050	Sof-Pac Carrying Case

Option 5801
50 to 400 Hz Input Power

Units equipped with this option are modified to operate properly on AC power with a line frequency from 50 to 400 Hz.

Option 5802
Band 1 (300 MHz to 1 GHz)

This option enables the counter to measure pulse and CW frequencies from 300 MHz to 1 GHz. The electrical specifications for Band 1 are contained in Section 2 of the Operations manual.

Option 5803
Rear Input

This option relocates the front panel input connectors to the rear panel of the counter. It is usually used for ATE, rack mounted, applications that required the test signal be applied at the rear panel of the counter.

Option 5804
Band 3

This option extends the potential frequency range of the EIP Model 588 from 26.5 GHz to 110 GHz. Option 5802 is required with this option. In addition, a Frequency Extension Cabling Kit (Model 890) and one or more of the Remote Sensors are necessary for operation. Electrical specifications for Band 3 are contained in Section 2 of the Operations manual.

Option 5805
MATE CIIL Interface

This option was developed for the MATE program of the United States Air Force. The acronym MATE stands for Modular Automatic Test Equipment. Instruments with this option communicate through a TMA (Test Module Adapter) which translates the instruments commands into a language common to all instruments called CIIL (Control Interface Intermediate Language).

Option 5805 provides a TMA built into the counter. This enables the counter to communicate in either CIIL or its native language. For more information on the use of this option refer to Section 3 (GPIB) of the Operations manual.

Section 2 Specifications

GENERAL

HEIGHT	3.5 in (89 mm)
WIDTH	16.75 in (425 mm)
DEPTH	14.0 in (356 mm)
WEIGHT	35 lb (15.9 kg)
SHIPPING WEIGHT	41 lb (18.6 kg)
OPERATING TEMPERATURE	0 to 50° C
POWER	110/120, 220/240 Vac ±10% 50-60 Hz, 100 VA typ.
MINIMUM PULSE WIDTH	50 ns
MAXIMUM PULSE WIDTH	CW
MINIMUM PULSE PROFILE	15 ns
MINIMUM PRF	1 Hz (0 Hz for pulse profile)
MINIMUM OFF TIME	200 ns (will count CW)
MINIMUM ON/OFF RATIO	15 dB
RESOLUTION	1 kHz to 1 GHz
GATE TIME	1 ms to 1 µs (dependent upon resolution)

PULSE PERIOD

ACCURACY	±(20 ns + time base error x PW)
DISPLAY RESOLUTION	3 digits, floating point, 10 ns maximum (Special function available for 10 ns
RESOLUTION TO GPIB	10 ns
MIN/MAX PULSE PERIOD	10 ns / 9.99 s
MEASUREMENT POINTS	3 to 6 dB below peak

TIME BASE

CRYSTAL FREQUENCY	10 MHz (TCXO)
STABILITY: AGING RATE	<1 x 10 [illegible] /mo.
SHORT TERM	<1 x 10^{-9} RMS for one second averaging time
TEMPERATURE	<1 x 10^{-6} over the range 0 to 50° C
LINE VARIATION	±10% change in line voltage produces frequency shift <1 x 10^{-7}
WARM-UP TIME	None required
OUTPUT FREQUENCIES	10 MHz, square wave, 1 V peak-to-peak minimum into 50 ohms
EXTERNAL TIME BASE	Requires 10 MHz, 1 V peak-to-peak minimum into 300 ohm
PHASE NOISE	-95 dBc/Hz at 10 Hz from carrier

PULSE WIDTH

ACCURACY	±(20 ns + time base error x PW)
DISPLAY RESOLUTION	3 digits, floating point. 10 ns maximum (Special function available for 10 ns on all measurements)
RESOLUTION TO GPIB	10 ns
MIN/MAX PULSE WIDTH	50 ns / 9.99 s
MEASUREMENT POINTS	3 to 6 dB below peak

Specifications subject to change without notice.

	BAND 1 (OPTION)
MINIMUM FREQUENCY	300 MHz
MAXIMUM FREQUENCY	1 GHz
SENSITIVITY	-15 dBm
CONNECTOR	BNC
MAXIMUM INPUT	+7 dBm peak
DAMAGE LEVEL	+27 dBm peak
AMPLITUDE DISCRIMINATION	10 dB when signals are separated by >100 MHz
MAXIMUM VIDEO VIDEO FREQUENCY <300 MHz VIDEO FREQUENCY >300 MHz SL FREQUENCY >300 MHz	 MV = SL - [10 LOG (300 MHZ/FV)^4] -20 dBm MV = SL - 20 dB
MAXIMUM FM/CHIRP	Carrier frequency cannot be <300 MHz or >1000 MHz.
GATE ERROR	GE = (±0.07) / (GW)
DISTORTION ERROR	DE = (±0.03 / (PW - 3 X 10^{-9} seconds)
AVERAGING JITTER	AJ = ±2 x $\sqrt{\text{[RES / ((GW)(AVE))]}}$
FREQUENCY LIMITS	N/A
CENTER FREQUENCY	N/A

BAND 2	BAND 3 (OPTION)
950 MHz	26.5 GHz
18 GHz (585) / 26.5 GHz (588)	110 GHz
-20 dBm (950 MHz to 12.4 GHz) -15 dBm (12.4 to 18 GHz) -10 dBm (18 to 26.5 GHz)	26.5 to 60 GHz -20 dBm (-25 dBm typ.) 60 to 110 GHz -15 dBm (-20 dBm typ.)
Precision N (585) / APC 3.5 (588)	Kwik Jack (accepts 890 cabling kit)
+7 dBm peak	+5 dBm peak
+40 dBm peak (10 watts)	+10 dBm peak
10 dB if separated $\geq$50 MHz, if <10 dB, will count one signal accurately if separated by >200 MHz.	20 dB when signals are separated by >100 MHz
MV = SL -20 dB	MV = 15 mV peak-to-peak max

MV is the maximum video amplitude in dBm. SL is the input signal level in dBm. FV is the frequency component of the video in Hz.

20 MHz peak to peak	Auto Mode: 20 MHz peak to peak Center Frequency Mode: 150 MHz peak to peak

Measured Frequency is a function of Average Frequency and Geometric Center Frequency when FM / chirp is greater than 150 MHz and nonsymmetrical.

GE = ($\pm$0.01) / (GW)	GE = ($\pm$.03) / (GW)

GE is the gate error in Hz. GW in seconds is the logical AND of inhibit and pulse width -3×10^{-9} seconds

DE = ($\pm$0.03) / (PW - 3×10^{-9} seconds)	DE = ($\pm$0.02) / (PW) - 3×10^{-9} seconds

DE is distortion error in Hz. PW is pulse width in seconds.

$AJ = \pm \sqrt{[RES / ((GW)(AVE))]}$	$AJ = \pm 2 \times \sqrt{[RES / ((GW)(AVE))]}$

AJ is the RMS averaging jitter in Hz. RES is the specified instrument resolution in Hz. (This is true up to 1 MHz resolution. Above 1 MHz resolution RES is 10^6 Hz.) GW in seconds is the logical AND of inhibit and pulse width -3×10^{-9} seconds. AVE is the number of specified count averages.

Instrument will ignore signals outside of frequency limits. 10 MHz resolution, $\pm$50 MHz accuracy. Unwanted signals must be greater than 200 MHz from either limit and 50 MHz from desired signal.	N/A
Will lock on signals $\pm$40 MHz from the entered frequency at sensitivity 10 MHz resolution	Instrument assumes any signals present to be in the range $\pm$2 GHz from the specified center frequency and calculates the harmonic number based on this assumption

	BAND 1(OPTION)
ACQUISITION TIME (PULSE)	$AQ = 1/PRF + 50 \times 10^{-3}$ seconds
ACQUISITION TIME (CW)	$AQ = 1/PRF + 50 \times 10^{-3}$ seconds
TOTAL ACCURACY (PULSE)	ACC = ±GE ±DE ±AJ ±Time Base Error
TOTAL ACCURACY (CW)	ACC = Time Base Error ± 1 count * *(Based on measurement average)
MEASUREMENT TIME	MT = [(4)(PP)] / [(GW)(RES)]

BAND 2	BAND 3 (OPTION)
(Freq Limits): AQ = (FH) [(4×10^{-12}) + (4×10^{-8} / PRF)] + 60 / PRF + [(2×10^{-5})(PP)] / GW + .1 (Center Freq): AQ = 72 / PRF + [(2×10^{-5})(PP)] / GW + .1	(Automatic): AQ = 70 / PRF + [(6×10^{-3})(PP)] / GW + 0.2 (Center Freq): AQ = 70 / PRF + [(8×10^{-4})(PP)] / GW + 0.2 AQ = 70 / PRF + 0.2
(Freq Limits): AQ = [FH] [(4×10^{-12}) + (4×10^{-8} / PRF)] + 60 / PRF + .1 (Center Freq): AQ = 72 / PRF + .1	

AQ is the acquisition time in seconds. FH is the difference between frequency limit high and frequency limit low in Hz. PRF is the specified instrument PRF in Hz. PP is the period of the input signal in seconds. GW in seconds is the logical AND of inhibit and pulse width - 3×10^{-8} seconds.

ACC = ±GE ±DE ±AJ ±Time Base Error	ACC = ±GE ±DE ±AJ ±Time Base Error
ACC = Time Base Error ± 1 count * *(Based on measurement average)	ACC = Time Base Error ±N^2 counts N = Freq / 20 GHz (Based on measurement averaging)
MT = (PP) / [(GW)(RES)]	MT = [(4)(PP)]) [(GW)(RES)]

MT is the measurement time in seconds. GW in seconds is the logical AND of inhibit and pulse width - 3×10^{-8} seconds. PP is the period of the input signal in seconds. RES is the specified instrument resolution in Hz. (This is true up to 1 MHz resolution. Above 1 MHz resolution RES is 10^6 Hz.)

Section 3
Operation

Figure 3-1. 585/588 Microwave Pulse Counters

INTRODUCTION

The operations section of this manual consists of a listing of the controls, connectors, and indicators featured on the Model 58X Pulse Counter, followed by an explanation of how each counter function operates, plus some general measurement considerations. Sample GPIB commands, included for each function, are in the format used by the HP-85™ controller; for formats used by other controllers, see page 3-62 A more thorough discussion of GPIB operation follows, along with a discussion of the special functions available to the operator and a list and explanation of possible error messages.

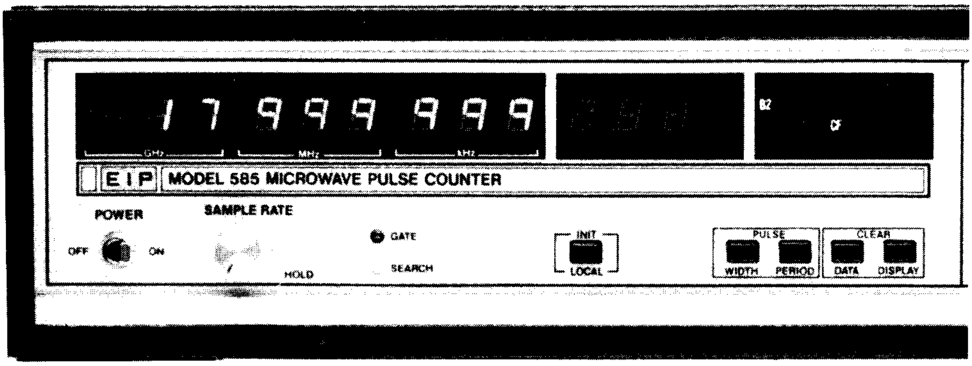

Figure 3-2. Front Panel, Model 585

FRONT PANEL CONTROLS AND INDICATORS

1. POWER switch - turns counter on.
2. SAMPLE RATE/HOLD - varies time between measurements from 0.1 to 10 seconds (nominal). The last reading is retained indefinitely in HOLD.
3. GATE - lights when the signal gate is open and a measurement is being made.
4. SEARCH - lights when the counter is not locked to an input signal.
5. DATA DISPLAY - 12-digit LED display provides a direct numerical readout of a measurement. The frequency information is displayed on the nine left-most digits in a fixed position format that is sectionalized in GHz, MHz, and kHz. Pulse parameters (pulse width and pulse period) are displayed in a three-digit floating point format to the right of the frequency display.
6. STATUS DISPLAY - The operating status of the counter is indicated by a series of annunciators. When the counter is displaying input data instead of a measurement, the appropriate status indicator will flash.
7. KEYBOARD - Both data entry and function choice are controlled through through the keyboard (see Keyboard section on page 3-8).

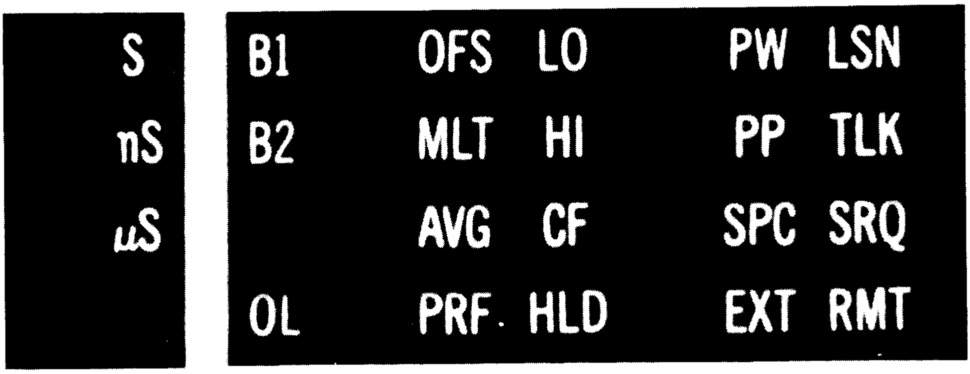

Figure 3-3. Status Indicators

STATUS INDICATORS

- B1 (Band 1) - lights when the optional 300 MHz-1 GHz range is selected.
- B2 (Band 2) - lights when the 950 MHz-18/26.5 GHz range is selected.
- B3 (Band 3) - lights when the optional 26.5-110 GHz range is selected.
- OL (Overload) - indicates that the input signal level is in excess of the optimum counting range. (Overload does not indicate improper operation, only that the input amplitude is greater than optimum.)
- OFS (Frequency Offset) - lights when a frequency offset is stored in the counter memory.
- MLT (Frequency Multiplier) - lights when a frequency multiplier other than 1 is stored in the counter memory.
- AVG (Average) - lights when an average other than 1 is stored in the counter memory.

- PRF (Minimum Pulse Repetition Frequency) - lights when a PRF other than 2.0 kHz is stored in memory.
- LO (Frequency Limit Low) - lights when a low limit other than the default value is stored in memory. (See page 3-10).
- HI (Frequency Limit High) - lights when a high limit other than the default value is stored in memory. (See page 3-10).
- CF (Center Frequency) - lights when the Center Frequency mode of operation is enabled.
- HLD (Hold) - lights when the SAMPLE RATE control is placed in the HOLD position.
- PW (Pulse Width) - lights when the counter is in the pulse width measurement mode.
- PP (Pulse Period) - lights when the counter is in the pulse period measurement mode.
- SPC (Special Function) - lights when a special function is enabled.
- EXT (External Reference) - lights when the counter is set to an external time base reference.

NOTE

For proper operation, a 10 MHz external reference must be applied to the rear input panel when INT/EXT switch is set to the external position.

GPIB STATUS INDICATORS

- LSN (Listen) - lights when the counter is addressed as a listener by the GPIB.
- TLK (Talk) - lights when the counter is addressed as a talker by the GPIB.
- SRQ (Service Request) - lights when the counter is sending a service request.
- RMT (Remote) - lights to indicate that the front panel controls are disabled and the counter is being controlled by the GPIB.

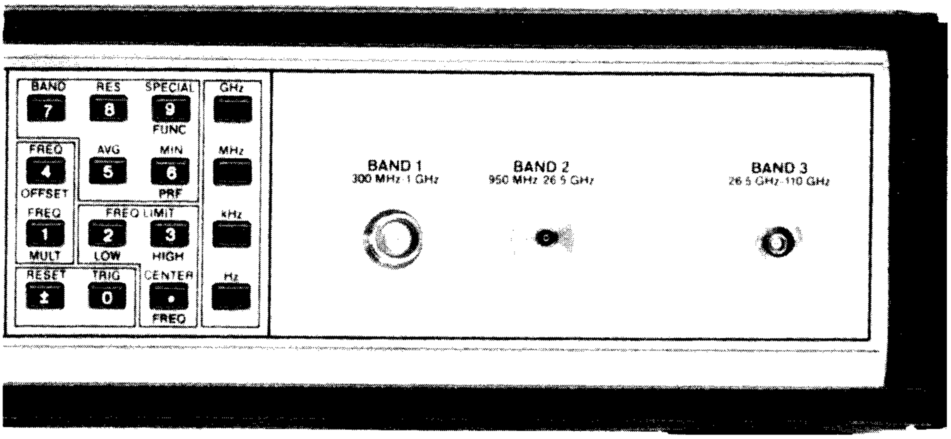

Figure 3-4. Front Panel, Model 588

SIGNAL INPUT CONNECTORS

1. BAND 1 INPUT CONNECTOR (BNC female) - has a nominal input impedance of 50 ohms, shunted by 20 pF. It is used for measurements in the range of 300 MHz to 1 GHz. (Model 585 and 588)
2. BAND 2 INPUT CONNECTOR (APC 3.5 female for 588, precision N for 585) - has a nominal input impedance of 50 ohms. It is used for measurements in the range of 950 MHz to 26.5 GHz (18 Ghz for 585).
3. BAND 3 INPUT CONNECTOR – (on the Model 588 only) is a Sealectro Quick-Connect. It is used for counter operation in the range of 26.5 to 110 GHz in conjunction with Frequency Extension Option 5804, the Model 890 Frequency Extension Cabling Kit, and a remote sensor.

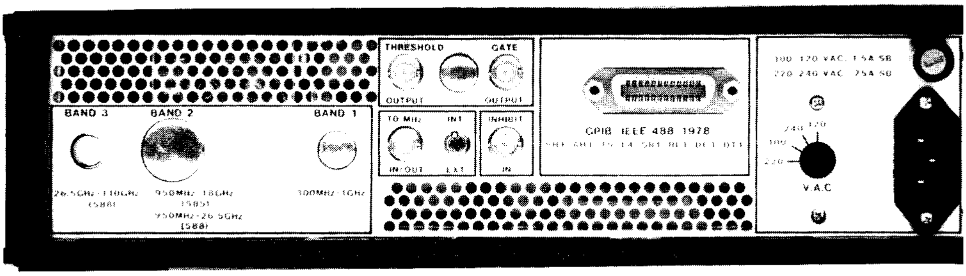

Figure 3-5. Rear Panel, Models 585/588

REAR PANEL CONTROLS AND CONNECTORS

1. REAR PANEL INPUT HOLES - provided for rear panel input option. For Bands 2 and 3, the rear panel input is achieved by turning the individual modules around. For Band 1, the input cable is routed to the back of the instrument.
2. THRESHOLD OUTPUT - is the digitized pulse envelope. It is true when the counter has a converter lock and a signal is present. The output is 0 volts when false, and -0.75 volts into 50 ohms when true.
3. GATE OUTPUT - represents the gate to the Count Chain board. The gate output follows the actual gate, not the gate enable. The output is 0 volts when false, and -0.75 volts into 50 ohms when true.
4. 10 MHz INT/EXT Switch - references the counter to its internal time base, a 10-MHz TCXO, when the switch is in the internal position. When the switch is in the external position, it references the counter to an external 10 MHz reference applied to the 10 MHz IN/OUT connector.

NOTE

For proper operation, a 10 MHz external reference must be applied to the rear input panel when INT/EXT switch is set to the external position.

5. 10 MHz IN/OUT - provides a 10-MHz square wave, 1 volt peak to peak, ac coupled into 50 ohms, when the 10 MHz INT/EXT switch is in the internal position. Accepts a 10-MHz, 1-volt peak-to-peak signal into 300 ohms when the 10 MHz INT/EXT switch is in the external position.

6. INHIBIT INPUT - causes the counter to perform as if the input signal were turned off. The counter ignores any signal that is present while inhibit is true during all phases of operation. An input of -1 volt inhibits the counter. An input of -2 volts enables the counter. The inhibit input impedance is 50 ohms to -2 volts so that the counter can be driven by either an ECL signal or a 0 to -1 volt, 50-ohm source.

NOTE

The INPUT INHIBIT is designed to be compatible with either a 50 ohm impedance pulse generator, or emitter-coupler-logic (ECL) devices. An internal termination of 50 ohms returned to -2 volts makes this dual compatibility possible. An ECL high level signal (-0.8 to -1.1 volts) will inhibit measurement. ECL devices are designed to drive 50-ohm lines without reflections when the lines are terminated with 50 ohms returned to -2 volts. The direct compatibility with a 50-ohm pulse generator results from the fact that zero volts from a 50-ohm source will produce -1 volts at the INPUT INHIBIT (inhibiting the counter) while a -1 volt signal into 50 ohms will produce 1.5 volts at the INPUT INHIBIT, thus enabling the counter.

7. GPIB CONNECTOR - used to connect the instrument to the IEEE 1978-488 bus.

8. FUSE - provides overload protection. Use a 1.5-A slow-blow MDL-type fuse for 100/120 V operation. Use a 0.75-A slow- blow FST-type fuse for 220/240 V operation.

9. VAC SWITCH - sets the operating voltage of the counter to match the power line. There are four settings: 100, 120, 220, and 240 Vac. The counter will operate at voltages within ±10% of selected line voltage, at frequencies of 50 to 60 Hz (50 to 400 Hz for Option 5801).

CAUTION

Switch setting and fuse rating must match power line voltage.

10. AC POWER CONNECTOR - accepts the power cord supplied with the counter.

11. FAN - blows air out of the instrument. Air flow is from the holes in the left side (viewed from the rear), through the instrument, and out through the fan. Obstruction of these air passages will cause the temperature inside the counter to increase, which reduces the counter's operating stability and shortens component life.

KEYBOARD OPERATION

KEYBOARD

The keyboard consists of 21 push button keys that control the major functions of the counter. Twelve keys are used for numerical data entry – the digits 0 through 9, the decimal point, and the change sign (±). Four keys (GHz, MHz, kHz, and Hz) act as terminators for the input of frequency parameters. The CLEAR ENTRY and CLEAR DATA keys are also considered terminator keys.

Ten of the keys, the parameter call keys, are also used to select the measurement parameters. Five of these, BAND (which also calls subband), SPECIAL FUNCTION, FREQUENCY MULTIPLIER, RESOLUTION, and AVERAGE, are used without terminators, while the other five, MINIMUM PRF, FREQUENCY LIMIT LOW, FREQUENCY LIMIT HIGH, CENTER FREQUENCY, and FREQUENCY OFFSET, are used with the terminator keys. The parameter call keys overlap the numeric entry keys.

The remaining keys are called one-shot action keys; they include INIT/LOCAL, PULSE PERIOD, PULSE WIDTH, RESET, and TRIGGER.

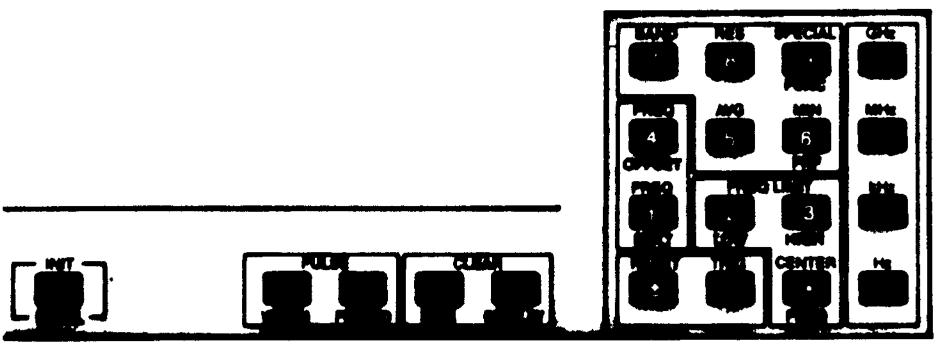

Figure 3-6. Keyboard

NUMERIC ENTRY KEYS

The numeric entry keys are:

- Digits 0 Through 9
- (±) Sign Change Key
- (.) Decimal Point Key

TERMINATOR KEYS

The terminator keys are:

- GHz
- MHz
- kHz
- Hz

CLEAR DISPLAY and CLEAR DATA

These are also considered terminator keys. At any point inside a key sequence the user has the option to:

- Press CLEAR DISPLAY to abort the sequence and return to normal operation without changing the value of the called parameter.

- Press CLEAR DATA to abort the sequence and assign the default value to the called parameter.

ONE-SHOT ACTION KEYS

INIT/LOCAL - initiates two different actions. When the counter is in local mode, this key causes the counter to be initialized to the power-up state. When the counter is in remote mode, the INIT/LOCAL key causes a return to local mode (unless a GPIB local lockout is active).

PULSE WIDTH - turns the pulse width measurement on or off. The result is displayed in the pulse parameter display.

PULSE PERIOD - turns the pulse period measurement on or off. The result is displayed in the pulse parameter display.

When the counter is in local mode, it cannot display both pulse width and pulse period simultaneously; in remote operation, however, both parameters can be output to the controller.

NOTE

See Special Functions section, page 3-29, for higher resolution or for PRF measurements.

RESET - resets the converter and restarts the signal acquisition process. If a signal is found, a measurement will be taken, even if the counter is in HOLD.

TRIGGER - begins a new measurement cycle. If a measurement cycle is in progress, it will be aborted.

PARAMETER CALL KEYS

The operation of the counter is controlled by the values of the measurement parameters. These parameters have default values on power-up, and can be changed by the user through the keyboard or the GPIB. The parameters are:

Parameter	Default Value
Band	2 (Microwave Band)
Sub-Band	1
Resolution	3 (1 kHz)
Special Function	00 (All cleared)
Average	01
Frequency Multiplier	01
Frequency Offset	0 kHz
Minimum PRF	2 kHz
Frequency Limit Low	900 MHz
Frequency Limit High	26.7 GHz (Model 588) 18.5 GHz (Model 585)
Center Frequency	0 kHz (not active)

PARAMETER CALL KEYS USED WITHOUT TERMINATORS

BAND

This parameter controls the frequency measurement range. Select the appropriate band according to:

Band	Range
1	300 MHz to 1 GHz (Optional)
2	950 MHz to 26.5 GHz/Model 588 950 MHz to 18 GHz/Model 585
3	26.5 GHz to 110 GHz (Optional) 588 only

Default: 2

Example:

Press: [BAND] [2] to select Band 2

GPIB example:

Enter: OUTPUT 718; "BAND 2" to select Band 2

SUB-BAND (Called using BAND key)

This parameter controls the frequency measurement range of Band 3. It is set according to the mixer being used. Select the appropriate sub-band according to:

Sub-Band	Range	Microwave Band Letter Designation
1	26.5 GHz to 40 GHz	Ka
2	33 GHz to 50 GHz	Q
3	40 GHz to 60 GHz	U
4	50 GHz to 75 GHz	V
5	60 GHz to 90 GHz	E
6	75 GHz to 110 GHz	W

Default: 1

Examples:

Press: [BAND] [CLEAR DATA] to default to Band 2

Press: [BAND] [3] [CLEAR DATA] to default to sub-band 1

Press: [BAND] [2] to select Band 2

Press: [BAND] [3] [4] to select Band 3, sub-band 4

Press: [BAND] [CLEAR DISPLAY] to examine the band without changing it

Press: [BAND] [3] [CLEAR DISPLAY] to examine the sub-band without changing it

GPIB examples:

Enter: OUTPUT 718;"BAND 3, SUBBAND 6" to select Band 3, subband 6

Enter: OUTPUT 718; "SUBBAND 3" to select subband 3 (if counter is already in Band 3.) This command does not automatically set counter to Band 3.

RESOLUTION

This parameter controls the frequency measurement resolution. Select the appropriate resolution according to table below.

Resolution	Frequency	Gate Time
3	1 kHz	1 ms
4	10 kHz	100 μs
5	100 kHz	10 μs
6	1 MHz	1 μs
7	10 MHz	1 μs
8	100 MHz	1 μs
9	1 GHz	1 μs

Default: 3

Examples:

Press: [RES] [CLEAR DATA] to select resolution 3 (1 kHz)

Press: [RES] [2] to select resolution 2 (1 kHz)

Press: [RES] [9] to select resolution 9 (1GHz)

GPIB example:

Enter: OUTPUT 718;"RESOLUTION 4" to select resolution 4 (10 kHz)

SPECIAL FUNCTIONS

This key is used to call any of the special functions listed in the table below. These functions are also listed on the keyboard operation label on the cover of the counter. For more details on special functions, see page 3-29.

Default: 00 (Clears all special functions previously activated).

01 100 MHz self test
02 Light all segments and annunciators
03 Scan segments test
04 Scan digits test
05 Keyboard test
06 PROM test
07 Display model (identify)
20 Band 2 Detected RF

40 Sweep YIG DAC
41 Sweep VCO, power amp on
42 Sweep VCO, power amp off
44 Disable normal operations
45 Restart normal operations
46 Memory read/alter
47 Measure IF frequency only

61 Disable track
62 Enable track
63 Disable sample rate control
64 Enable sample rate control
65 Disable results display
66 Enable results display
67 Display PRF as pulse period
68 Display PRF as pulse width
69 Display pulse parameters only

70 Display frequency and pulse parameters
72 Store instrument setup
73 Recall instrument setup
74 Relative freq measurement (freq offset = actual freq)
75 Display current IF freq (freq offset = LO freq)
76 Test and initialize EEPROM (Destructive test, see page 3-43)
90 GPIB address read/alter
91 YIG DAC auto calibration
92 Gate accuracy calibration

Examples:

Press:	[SPECIAL FUNC] [CLEAR DATA]	to clear all activated special functions.
Press:	[SPECIAL FUNC] [6] [2]	to activate special function 62, enable track function.
Press:	[SPECIAL FUNC] [4] [4]	to activate special function 44, disable normal operations of counter.

GPIB example:

Enter: OUTPUT 718;"SPECIAL 01" To activate special function 01, 100-MHz self test

AVERAGE

This parameter controls the number of measurements to be averaged on frequency and pulse parameters. Select AVERAGE in the range of 1 to 99.

Default: 1

Examples:

Press: [AVG] [CLEAR DATA] to select average factor of 1

Press: [AVG] [0] [2] to average 2 readings before displaying the result

Press: [AVG] [2] [7] to average 27 readings before displaying the result

GPIB example:

Enter: OUTPUT 718;"AVERAGE 27" to average 27 readings before displaying the result

FREQUENCY MULTIPLIER

This parameter controls the value of the constant M in the math generation of:

Display frequency = (M x measured frequency) + B

that can be performed by the counter. Select FREQUENCY MULTIPLIER in the range of 1 to 99.

Default: 1

Examples:

Press: [FREQ MULT] [CLEAR DATA] to select a multiplier value of 1.

Press: [FREQ MULT] [0] [7] to select a multiplier value of 7.

Press: [FREQ MULT] [3] [1] to select a multiplier value of 31.

GPIB example:

Enter: OUTPUT 718;"MULTIPLIER 31" to select a multiplier value of 31

PARAMETER CALL KEYS USED WITH TERMINATORS

FREQUENCY OFFSET

Frequency offset allows the entry of a negative or positive frequency (to 1 Hz resolution) into the offset frequency register. This parameter controls the constant B in the math generation of:

Displayed frequency = (M x measured frequency) ±B

where M is the frequency multiplier and B is the frequency offset. Select FREQUENCY OFFSET in the range of -99.999 999 GHz to +99.999 999 GHz. The number can be entered in any fixed-point format, with the units terminator that determines the scale of the input number.

Default: 0

Examples:

Press: [FREQ OFFSET] [CLEAR DATA] — to select a 0 value

Press: [FREQ OFFSET] [1] [2] [.] [3] [4] [MHz] — to select a 12.34 MHz value

Press: [FREQ OFFSET] [±] [0] [.] [1] [2] [MHz] — to select a -0.12 GHz value

GPIB example:

Enter: OUTPUT 718;"OFFSET 12.34 MHZ" — to select a 12.34 MHz value.

MINIMUM PULSE REPETITION FREQUENCY (PRF)

This parameter controls the minimum PRF of the pulsed signals that can be acquired and measured by the counter. For example, if a minimum PRF of 2 kHz is selected, the counter will measure a signal with a PRF of 2 kHz or greater. This parameter affects the acquisition speed indirectly by affecting two internal processes: the time of waiting for a pulse at each frequency step in the frequency range search, and the time of waiting for a pulse when taking measurements before declaring a "signal lost" condition.

Select MIN PRF in the range of 0 to 100 kHz. A zero value will disable the possibility of a "signal lost" condition. The search will continue using a 1-Hz value. Thus zero value can be selected to prevent the counter from re-searching when a signal is acquired.

Default: 2 kHz

The number can be entered in any fixed-point format, with the units terminator that determines the scale of the input number.

Examples:

Press: [MIN PRF] [CLEAR DATA] — to select a 2 kHz value

Press: [MIN PRF] [3] [7] [.] [5] [kHz] — to select a 37.5 kHz value

Press: [MIN PRF] [.] [0] [1] [2] [MHz] — to select a 0.012 MHz (12 kHz) value

GPIB example:

Enter: OUTPUT 718;"MINPRF 3.75 KHZ" — to select a MIN PRF value of 3.75 kHz.

FREQUENCY LIMIT LOW

This parameter controls the low end of the frequency window that is searched for a signal in Band 2. Select FREQUENCY LIMIT LOW in the range of 900 MHz to 26.7 GHz for Model 588, and in the range of 900 MHz to 18.5 GHz for Model 585.

Value entered by the user is truncated to 10 MHz resolution. This function is only available in Band 2. The FREQUENCY LIMIT LOW must always be less than the FREQUENCY LIMIT HIGH. The number can be entered in any fixed-point format, with the units terminator that determines the scale of the input number.

Default: 900 MHz

Examples:

Press: [FREQ LIMIT / LOW] [CLEAR / DATA] to select a 900 MHz value

Press: [FREQ LIMIT / LOW] [2] [.] [3] [5] [GHz] to select a 2.35 GHz value

Press: [FREQ LIMIT / LOW] [3] [1] [3] [6] [.] [3] [MHz] to select a 3130.0 MHz (3.13 GHz) value (truncated to 10 MHz resolution)

GPIB example:

Enter: OUTPUT 718;"**LOLIMIT** 2.356 GHZ" to select a 2.35 GHz value

CENTER FREQUENCY

This parameter controls the center frequency mode of operation, in which the counter looks for a signal in the vicinity of the CENTER FREQ value. This mode can be used when speed of acquisition or a multiple-signal environment is a consideration. This mode is available in either Band 2 or Band 3.

Select Band 2 CENTER FREQ in the range of 950 MHz to 26.5 GHz for Model 588 and in the range of 950 MHz to 18 GHz for Model 585. The counter will lock on signals at least ±50 MHz from the entered signal, depending on its power and frequency. The locking frequency is determined by the band pass width of the YIG filter at the input to Band 2.

Select Band 3 CENTER FREQ in the range of the sub-band currently selected. The counter will lock on signals ±1 GHz from the entered frequency. The counter will NOT reject signals outside this range. If a signal more than 1 GHz from the entered frequency is applied, and erroneous reading may result.

The value entered by the user is truncated to 10 MHz resolution. The number can be entered in any fixed-point format, with the units terminator that determines the scale of the input number.

Default: 0

Examples:

Press:	[CENTER FREQ] [CLEAR DATA]	to select a center frequency value of 0 and return to the limits mode of operation.
Press:	[CENTER FREQ] [2] [2] [.] [5] [GHz]	to select a center frequency value of 22.5 GHz (for Model 588, Band 2, only)
Press:	[CENTER FREQ] [2] [1] [7] [5] [MHz]	to select a center frequency value of 2170 MHz (2.17 GHz, truncated to 10 Mhz resolution)

GPIB example:

Enter: OUTPUT 718;"CENTERFREQ 22.5 GHZ" to select a center frequency of 22.5 GHz.

FREQUENCY LIMIT HIGH

This parameter controls the high end of the frequency window that is searched for a signal in Band 2. Select the high frequency limit in the range of 900 MHz to 26.7 GHz for Model 588, and in the range of 900 MHz to 18.5 GHz for Model 585.

The value entered by the user is truncated to 10 MHz resolution. This function is only available in Band 2. FREQUENCY LIMIT LOW must always be less than FREQUENCY LIMIT HIGH.

The number can be entered in any fixed-point format, with the units terminator that determines the scale of the input number.

Default: 18.5 GHz - Model 585
26.7 GHz - Model 588

Examples:

Press: [FREQ LIMIT HIGH] [CLEAR DATA] to select a value of 18.5 GHz for Model 585 or a value of 26.7 GHz for Model 588

Press [FREQ LIMIT HIGH] [3] [.] [2] [GHz] to select a 3.2 GHz value

Press: [FREQ LIMIT HIGH] [2] [1] [0] [9] [8] [MHz] to select a 21,090 MHz (21.09 GHz) value (truncated to 10 Mhz resolution)

GPIB example:

Enter: OUTPUT 718;"HIGHLIMIT 13.2 GHZ" to select a 13.2 GHz value

SIGNAL MEASUREMENT WITH THE 585/588

PULSE MEASUREMENT

Automatic pulse measurements can determine the average frequency of a pulse. In some cases, however, additional information may be necessary. For example, a pulsed magnetron may exhibit substantial frequency shift near the leading and trailing edges of the pulse, or a pulsed Gunn diode oscillator may exhibit frequency shift during a pulse due to peak power thermal effects. Measurements of these characteristics are easily made with only the 585/588 and a delaying pulse generator (See Figure 3-7).

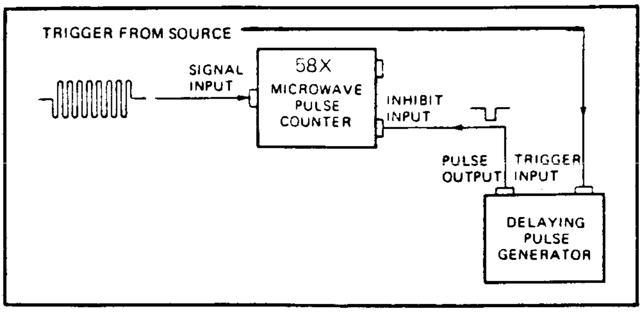

Figure 3-7. Pulse Profile Measurement Test Set-Up.

The output pulse of the signal generator is used as an enable input to the 585/588. As the pulse delay is varied, the measurement window can be "walked" through the pulse. A plot of frequency-versus-delay gives the frequency-versus-time profile of the pulse directly, as shown in Figure 3-8. The width of the measurement window is determined by the width of the pulse generator output. Measurement windows as narrow as 15 ns can be used, although wider windows yield higher accuracy.

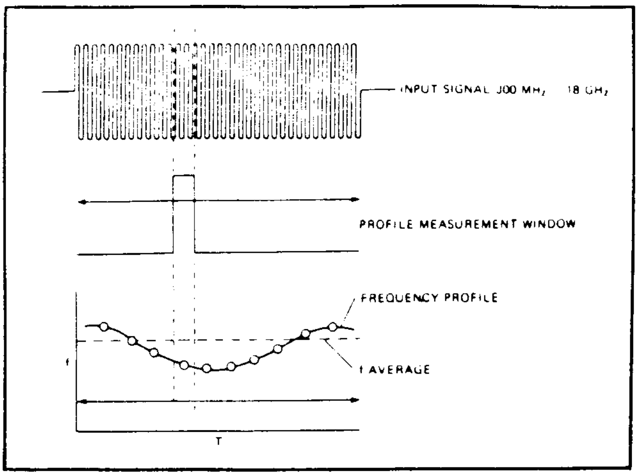

Figure 3-8. Pulse Profile Measurement

TIME VARYING SIGNALS

Many complex signals are not pulsed at all, but simply continuous signals that have frequency variations repetitively with time. One example is the measurement of the response of a VCO. A square wave applied to the tuning voltage will produce a response curve of frequency-versus-time, allowing measurement of linearity and amplitude for frequency modulated radar altimeter signals. Figure 3-9 shows a test set-up designed to make measurements on time varying signals. It is similar to the pulse profile test set-up, except that there is always a signal present.

MULTIPLE SIGNAL MEASUREMENTS

Another type of measurement is that of a repetitive sequence of pulses that differ in frequency. In this case, it is desirable to measure the frequency of each pulse in the sequence separately. The same test set-up as shown in Figure 3-9 is required, with the trigger pulse synchronous with the sequence. In this measurement, the input inhibit function is used to discriminate between pulses. The enabling pulse can be slightly wider than the pulse to be measured. By shifting the delay time of the enabling pulse, the user can measure each input pulse of the sequence separately.

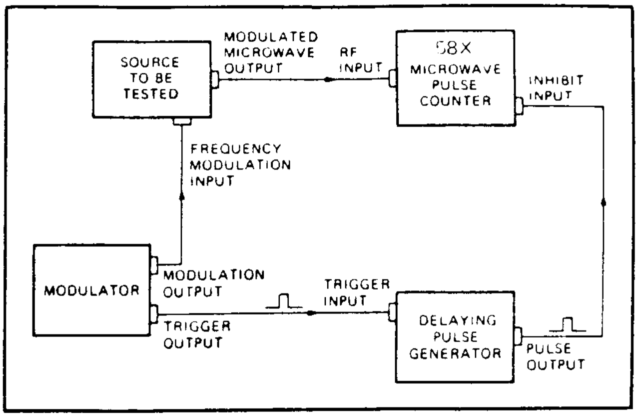

Figure 3-9. Time Varying Signal Measurement Test Set-up

TIMING CONSIDERATIONS

The internal timing usually should be of no concern to the user. However, in applications where a few nanoseconds are significant, some details of internal operation are important. These involve two areas. One area is the measurement window width, and the other is the internal timing delays.

MEASUREMENT WINDOW WIDTH

The measurement window is the period during which the gate is actually open to enable the counting of a signal. This gate width will be typically 30 nanoseconds narrower than the pulse applied to the INPUT INHIBIT connector. The width of the gate is always an integral number of clock periods (12.5 ns). For applications where the measurement window needs to be known to an accuracy better than 20 ns, it is recommended that the gate output on the rear panel be observed on a high speed oscilloscope. The desired gate width may be set by varying the input inhibit pulse width. For accurate pulse representation, the oscilloscope input should be terminated in a 50-ohm load.

INTERNAL TIMING DELAYS

When it is necessary to measure the signal frequency at a precise point in time, the internal delays of the measuring instrument can be significant. In the 585/588, the total delay between the time a signal is applied to an input connector and the time it is available to be counted is nominally 60 ns. The signal threshold output on the rear panel typically occurs 20 ns after the signal is applied. The gate signal at the rear panel occurs at the measurement time with virtually no delay. In other words, when absolute time positioning of a signal is required, it is necessary to consider that the gate signal (representing the measurement period) is actually making a measurement of the signal which appeared at the input connector 60 ns earlier. If the signal threshold output is used as an indication of input signal, then it occurs 40 ns prior to measurement. Figure 3-10 shows the relative timing of these signals for a pulsed input signal. Timing, however, is not a function of input signal characteristics.

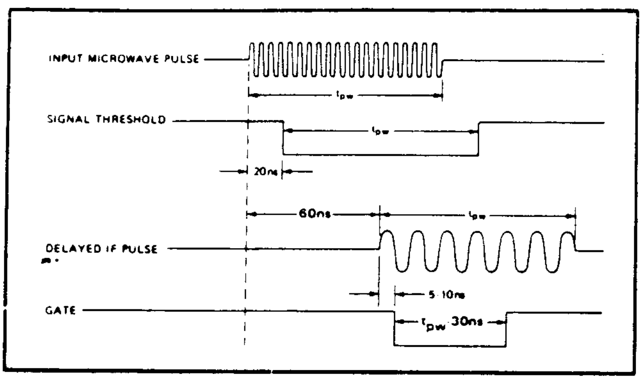

Figure 3-10. Internal Timing Delays

ACCURACY

CW MEASUREMENT ACCURACY

When measuring CW signals the measurement accuracy is specified as:

Total error = Time Base Error +/− 1 Count
(Based on measurement averaging)

Time Base Error causes an error in the measured frequency of the same percentage as the error in the time base oscillator. For example, if the 10 MHz oscillator is off frequency by 3 Hz the corresponding measurement error on a 1 GHz signal would be 300 Hz. For an 18 GHz signal, the same 3 Hz error in the time base would cause a measurement error of 5.4 kHz. The maximum error in the time base is the sum of the various possible errors, such as aging rate and temperature stability.

The second type of error, +/- 1 count, is due to the lack of phase coherence between the gate and the signal. Simply stated, if an event occurs every 400 mS (F = 2.5 Hz), a counter could measure either 2 or 3 events in a one second interval.

The note "Based on measurement averaging" is included due to a random instrumentation error in the counter. This error can be virtually eliminated by averaging measurements.

PULSE MEASUREMENT ACCURACY

Each of the sources of CW measurement error contribute to the overall error in pulsed frequency measurements along with gate error and distortion error. For narrow pulses the averaging error and gate error can become the dominant sources of error for pulse measurements.

AVERAGING ERROR

In order to obtain high resolution, the frequency of a number of measurements is averaged. Each individual measurement has a ±1 count uncertainty as previously noted. If N measurements are made, then an uncertainty of ±N counts is possible, but very unlikely. The resultant averaged measurement follows the rules of statistics, in that successive measurements will vary randomly to a certain degree. In fact, most of the readings (63%) will fall between $\pm\sqrt{N}$ counts. This is called the RMS averaging error. N is the number of gates required to accumulate the required gate time. The gate is typically 30 nanoseconds narrower than the input pulse, so the RMS averaging error (in Hz) is:

Band 1/3: Averaging Error (RMS) = $\pm 2 \times \sqrt{\text{RES} / ((\text{GW})(\text{AVE})}$

Band 2: Averaging Error (RMS) = $\pm\sqrt{\text{RES} / ((\text{GW})(\text{AVE}))}$

Where RES is the specified instrument resolution in Hz (up to 1 MHz resolution). Above 1 MHz resolution, RES is 10^6 Hz. GW in seconds is the logical AND of inhibit and pulse width - 3 x 10^{-8} in seconds. AVE is the number of measurements averaged.

GATE ERROR

When narrow pulses are counted, the gate is opened many times in order to obtain a high resolution measurement. Each time the gate opens and closes, there will be a small but finite error. The total error is proportional to the number of times the gate is cycled during a measurement, and is thus inversely proportional to the gate width. This error is also related to both temperature and input frequency. In the 585/588, the worst case error, including all variables, is specified as:

Band 1: Gate Error = ±0.07 / GW

Band 2: Gate Error = ±0.01 / GW

Band 3: Gate Error = ±0.03 / GW

where GW in seconds is the logical AND of inhibit and pulse width - 3 x 10^{-8} seconds. Unlike averaging error, which is random, gate error is systematic, and is not reduced by frequency averaging.

DISTORTION ERROR

During the first and last few nanoseconds of a pulse phase, distortion that is caused by impedance mismatches or video effects can occur, which results in shifts in time of the zero crossing. On wide pulses, distortion error is insignificant; however, on narrow pulses it may become the dominant source of error.

TECHNIQUES FOR IMPROVING ACCURACY

In most cases, specified accuracy of the 585/588 will be more than sufficient to meet measurement requirements. If greater accuracy is required, all three sources of error can be minimized by a combination of error calibration and long term averaging.

TIME BASE CALIBRATION

A frequency error in the time base oscillator results in the same percentage error in the frequency reading for either CW or pulsed signals. By directly measuring the 10 MHz time base frequency at the 10 MHz OUTPUT connector using a standard of known accuracy, this error can be determined and corrected. As an example, suppose the measured time base output is 10,0001 MHz, the time base is thus 1 x 10^{-6} high in frequency, and all readings will be 1 x 10^{-6} low in frequency: a reading at 10 GHz will be 10 kHz low. Instead of correcting the reading for this error, a better technique is to set the time base oscillator precisely on frequency.

MEASUREMENT AVERAGING

Averaging jitter, as noted previously, is simply the result of a random statistical process. As in all such processes, taking a larger number of samples reduces the averaging jitter. A larger number of samples may be taken in two ways: increasing resolution or averaging several readings.

The 585/588 allows 1 kHz maximum resolution and averaging up to 99 measurements internally. With the GPIB (IEEE-488) and a controller, the user can average a large number of samples to virtually eliminate averaging jitter.

CORRECTING FOR GATE ERROR

Gate error at any given frequency and pulse width can also be virtually eliminated. This can be done by simulating a pulsed input and determining the gate error. This calibration factor can then be added to, or subtracted from, the indicated measurement to obtain the correct frequency. First, determine the time base error using a CW source at approximately the same frequency (within 25 MHz) as the indicated measurement. Then simulate an input by applying an ENABLE signal (of the same width as the pulse to be measured) to the INPUT INHIBIT connector. Gate error is the difference in reading between the pulsed and non-pulsed measurement of the same CW signal. This procedure provides the true gate error, and avoids error associated with any possible pulling of the signal source. It should be noted that gate error can be calibrated out of the system for a given pulse width and frequency. However, this calibration procedure may result in additional error for other pulse widths or frequencies. (See Special Function 92).

REDUCTION OF DISTORTION ERROR

Since distortion error is most significant on the edges of the pulse, it may be reduced by using the inhibit to measure only in the middle of the pulse. However, since measuring only the middle of the pulse requires narrowing the gate, the gate error will increase. For pulses less than 70 to 80 nanoseconds, this may add more error than it removes.

SPECIAL FUNCTION DIRECTORY

DEFINITION

The special functions of the 58X counters can be divided into three categories:

1. Counter operation verification

2. Calibration/troubleshooting aids

3. Counter capability enhancements

The special functions discussed in the next section are grouped according to the above categories. Further information about how each one works is summarized at the end of each discussion. The summary covers the following features.

* ONE-SHOT OR CONTINUOUS ACTION

  1. **One-shot action functions** automatically revert the counter to its normal operation after a specific action has been taken. These special functions are designated ONE-SHOT.

  2. **Continuous action functions** stop all normal operations of the counter and cause it to stay in the special function mode until the user terminates the function. Most continuous action functions can be terminated by pressing any key on the keyboard or entering any function command through the GPIB interface. After the special function is terminated, the function corresponding to the key pressed or the command entered will be serviced and a reset will be generated. Exceptions to the above termination sequence will be stated in the individual special function descriptions. These functions are designated STOP/RESET or STOP/NO RESET as applicable.

- ★ STATUS INDICATOR ON OR OFF

  LED:ON/OFF at the end of a special function description indicates whether the SPC status indicator on the front panel is on or off during this function.

- ★ SPECIAL STATUS BIT ON OR OFF

  SPECIAL SB: ON/OFF indicates whether the special on/off status bit is on or off during this function.

ACTIVATION OF SPECIAL FUNCTIONS

Special functions can be activated through both the front panel keyboard and the GPIB interface. To activate a special function through the keyboard, press the SPECIAL FUNC key followed by two digit keys. To activate a special function through the GPIB interface, enter the word SPECIAL followed by a two-digit number. Activating special functions will not alter any previously entered parameters unless specifically stated. Pressing the SPECIAL FUNC, 00 or SPECIAL FUNC, CLEAR DATA keys will take the counter out of all previously activated special functions.

OPERATION VERIFICATION FUNCTIONS

Special function numbers 01 through 19 provide the user with a means of verifying that the counter is operational.

SPECIAL FUNCTION 01 — 100 MHz Self Test

This function is used to verify that the Count Chain, Gate Generator, and the VCO are operational.

When this function is entered, the counter will do the following:

1. Exit the current band.
2. Set the hardware to the self-test mode.
3. Set the VCO to 400 MHz.
4. Set the counter to take frequency measurements only.
5. Start measurement cycles.

The display will show the frequency measurement results. These results will be output to the GPIB interface when frequency readings are requested. The measurement result should be 100 MHz ±1 count.

★STOP/RESET LED:ON SPECIAL SB:ON ★

SPECIAL FUNCTION 02 — Light Display Segments

This function verifies that all the digit segments and annunciator LEDs are operational. When this function is activated, all digit segments and all annunciators will be turned on. The GATE and the SEARCH annunciators will both be on for the duration of the special function.

*STOP/RESET LED:ON SPECIAL SB:ON *

SPECIAL FUNCTION 03 — Scan Display Segments

Each segment in all the digits and bank of annunciators is turned on sequentially by this function to test the display segment drivers. The scan rate is determined by the current sample rate.

*STOP/RESET LED:ON SPECIAL SB:ON *

SPECIAL FUNCTION 04 — Scan Display Digits

Each digit and each bank of annunciators is turned on sequentially by this function to check the display digit driver. The scan rate is determined by the current sample rate.

*STOP/RESET LED:ON SPECIAL SB:ON *

SPECIAL FUNCTION 05 — Keyboard Test

This function is used to verify the operation of the keyboard.

After this function is activated, the counter will stop normal operations. The display will show the key code of the last key pressed. When a new key is pressed, the display will be updated to show the code of the new key. When the GPIB controller requests a key code, the code of the last key pressed will be output. (If the controller requests a key code, the counter will output to the GPIB interface the code of the last key pressed even if Special Function 05 is not activated). If the counter is in LOCAL, this function must be terminated by the CLEAR DISPLAY key. If it is in remote, this function can be terminated by any device-dependent command.

*STOP/RESET LED:ON SPECIAL SB:ON

*

SPECIAL FUNCTION 06 — PROM Check Sum Test

This function generates the check sum for each PROM in the counter and compares it with the check sum table stored in the firmware. If all the check sums generated are correct, the counter will display the word **PASSED** on the front panel. If any one of the check sums is incorrect, an error message corresponding to that particular check sum will be output to the display. At the same time, the Error Condition status bit in the GPIB serial poll status byte will be set. During check sum generation, **SPECIAL 06** will be displayed.

*ONE-SHOT LED:ON SPECIAL SB:ON *

SPECIAL FUNCTION 07 — Display counter model number

This function enables the user to find out whether the counter is configured as a 585 or 588 counter.

After the appropriate model number is displayed on the front panel, the counter will return to the measurement mode. No RESET will be generated.

*ONE-SHOT LED:ON SPECIAL SB:ON *

CALIBRATION/TROUBLESHOOTING AIDS

Special functions number 20 through 59 and 90 through 99 aid the user in calibrating and/or troubleshooting the counter.

SPECIAL FUNCTION 20 — Band 2 Detected RF Level

This function verifies coarse calibration of the Band 2 YIG DAC offset and YIG DAC slope adjustments.

When this function is activated, the counter will wait for the user to enter the new YIG calibration frequency. The previously entered frequency number and **FR** is displayed in the frequency section and the pulse parameter section of the display respectively. The special function will stop in this state until the user enters a new frequency number; or, if the previously entered frequency number is the required frequency, the kHz key can be pushed to tell the special function to continue.

After the number has been entered, the YIG DAC is set to the entered frequency number. The display will show **CAL DAC** plus a number from 1 to 8 corresponding to the information on the Band 2 power discrimination circuitry. The counter will output the power discrimination circuitry information when requested by the GPIB to output LEVEL.

For more calibration information, see Section 6.

*STOP/RESET LED:ON SPECIAL SB:ON *

SPECIAL FUNCTION 40 — Sweep YIG DAC

When this function is activated, the counter will wait for the user to enter the start frequency of the YIG sweep. The previously entered start frequency and **F1** will be displayed in the frequency section and the pulse parameter section of the display respectively. The special function will stop in this state until the user enters a new start frequency or, if the previously entered frequency is the required start frequency, the user presses the kHz key to tell the special function to continue.

After the start frequency is entered, the counter will wait for the user to enter the stop frequency of the YIG sweep. The previously entered stop frequency and **F2** will be displayed in the frequency section and the pulse parameter section of the display respectively. The special function will stop in this state until the user enters a new stop frequency or, if the previously entered frequency is the required stop frequency, the user presses the kHz key to tell the special function to continue.

When both the start and stop frequencies have been entered, the display will revert to displaying **SPECIAL 40**. The YIG DAC will be swept continuously from F1 to F2 in 2-MHz steps until the function is terminated. The sweep rate is controlled by the sample rate. Maximum sweep rate may be obtained by disabling the sample rate (Special Function 63) before calling this function. If F1 and F2 are equal, the YIG DAC will be set to that particular frequency.

To activate this function in remote, the user programs the controller to output SPECIAL 40. The start and stop frequencies used will be the frequencies specified in the GPIB commands Y1FREQ and Y2FREQ (where Y1FREQ and Y2FREQ correspond to F1 AND F2 respectively). If the start or stop frequency required is different from that specified in Y1FREQ or Y2FREQ respectively, the number in that frequency register has to be updated before Special Function 40 is activated.

*STOP/RESET LED:ON SPECIAL SB:ON *

SPECIAL FUNCTION 41 — Sweep VCO with VCO Power Amplifier On

After this function is activated, the counter will wait for the user to enter the start frequency of the VCO sweep. The previously entered start frequency and **F1** will be displayed in the frequency section and the pulse parameter section of the display respectively. The special function will stop in this state until the user enters a new start frequency or, if the previously entered frequency is the required start frequency, the user presses the kHz key to tell the special function to continue.

After the start frequency is entered, the counter will wait for the user to enter the stop frequency of the VCO sweep. The previously entered stop frequency and **F2** will be displayed in the frequency section and the pulse parameter section of the display respectively. The special function will stop in this state until the user enters a new stop frequency or, if the previously entered frequency is the required stop frequency, the user presses the kHz key to tell the special function to continue.

When both the start and stop frequencies have been entered, the display will revert to displaying **SPECIAL 41**. The VCO will be swept continuously from F1 to F2 in 50-kHz steps until the function is terminated. The sweep rate is controlled by the sample rate. Maximum sweep rate may be obtained by disabling the sample rate (Special Function 63) before calling this function. If F1 and F2 are equal, the VCO will be set to that particular frequency. The VCO power amplifier is turned on during this function.

To activate this function in remote, the user instructs the controller to output SPECIAL 41. The start and stop frequencies used will be the frequencies specified in the GPIB commands V1FREQ and V2FREQ (where V1FREQ and V2FREQ correspond to F1 and F2 respectively). If the start or stop frequency required is different from that specified in V1FREQ or V2FREQ, the number in that frequency register must be updated before SPECIAL 41 is activated.

*STOP/RESET LED:ON SPECIAL SB:ON *

SPECIAL FUNCTION 42 — Sweep VCO with VCO Power Amplifier Off

After this function is activated, the counter will wait for the user to enter the start frequency of the VCO sweep. The previously entered start frequency and **F1** will be displayed in the frequency section and the pulse parameter section of the display respectively. The special function will stop in this state until the user enters a new start frequency or, if the previously entered frequency is the required start frequency, the user presses the kHz key to tell the special function to continue.

After the start frequency is entered, the counter will wait for the user to enter the stop frequency of the VCO sweep. The previously entered stop frequency and **F2** will be displayed in the frequency section and the pulse parameter section of the display respectively. The special function will stop in this state until the user enters a new stop frequency or, if the previously entered frequency is the required stop frequency, the user presses the kHz key to tell the special function to continue.

When both the start and stop frequencies have been entered, the display will revert to displaying **SPECIAL 42**. The VCO will be swept continuously from F1 to F2 in 50-kHz steps until the function is terminated. The sweep rate is controlled by the sample rate. Maximum sweep rate may be obtained by disabling the sample rate (Special Function 63) before calling this function. If F1 and F2 are equal, the VCO will be set to that particular frequency. The VCO power amplifier is turned off during this function.

To activate this function in remote, the user instructs the controller to output SPECIAL 42. The start and stop frequencies used will be the frequencies specified in the GPIB commands V1FREQ and V2FREQ (where V1FREQ and V2FREQ correspond to F1 and F2 respectively). If the start or stop frequency required is different from that specified in V1FREQ or V2FREQ, the number in that frequency register must be updated before SPECIAL 42 is activated.

*STOP/RESET LED:ON SPECIAL SB:ON *

SPECIAL FUNCTION 44 — Disable Normal Operations

This function, when activated, will prevent the counter from performing the normal converter lock and measurement cycles. It will freeze the counter in the state it was in at the moment the function was activated. The display will show **PAUSE** and the Stop On/Off status bit will be set when this function is active. Special Function 44 remains activated until terminated through Special Function 45 or SPC CLEAR DATA or SPC [0] [0]

★STOP/RESET LED:ON SPECIAL SB:ON ★

SPECIAL FUNCTION 45 — Enable Normal Operations

This function provides the means to reverse the action taken when Special Function 44 is activated. The function enables the counter to return to normal operation again. A reset is generated and the Stop On/Off status bit is cleared when this function is activated.

★STOP/RESET LED:OFF SPECIAL SB:ON ★

SPECIAL FUNCTION 46 — Display and/or Alter Memory

This function provides the user with a means to display and/or alter any memory location. The counter will continue its normal operations when it is performing this function unless Special Function 44 has previously been activated.

After this function is activated, the counter will wait for a memory address to be entered. During this time, **Addr ____** will be displayed. When the address is being entered, the hexadecimal digits keyed in will replace each blank (-) sequentially. After the memory address is entered, the content of that memory location is displayed in the pulse parameter section of the display.

At this point the user can do one of the following five things:

1. Exit the function by issuing a CLEAR DISPLAY command.
2. Alter the content of the memory location by entering a two-digit hexadecimal number.
3. Display the next memory location by issuing an INCREMENT command (pressing the PULSE WIDTH key).
4. Display the previous memory location by issuing a DECREMENT command (Pressing the PULSE PERIOD key).

5. Enter another memory address by first issuing an ADDRESS command (pressing the CLEAR DATA key).

If the content of a memory is altered, the new content of that memory location will be displayed in the pulse parameter section of the display. If the ADDRESS command is issued, the display will change to show Addr _ _ _ _. This function MUST BE terminated by the CLEAR DISPLAY command.

CAUTION

Care must be used when operating Special Function 46. Although the counter cannot be damaged by this function, improper operation of it can affect the counter calibration, possibly rendering the counter unusable until it can be recalibrated. Do not call this function unless familiar with its operation.

In the local mode, the keys on the keyboard will take on different meanings after Special Function 46 is activated. The following are the definitions of the keys when the counter is this function.

1. All number keys remain number keys.
2. GHz key = hexadecimal digit A
3. MHz key = hexadecimal digit B
4. kHz key = hexadecimal digit C
5. Hz key = hexadecimal digit D
6. "." key = hexadecimal digit E
7. "±" key = hexadecimal digit F
8. PULSE WIDTH key = INCREMENT command.
9. PULSE PERIOD key = DECREMENT command.
10. CLEAR DATA key = ADDRESS command.
11. CLEAR DISPLAY and INIT keys remain the same.

In the remote mode, a memory content can be interrogated by using the OUTPUT MEMORY command. When the counter is addressed to talk, the last memory address accessed will be output. A memory location can be accessed using the MEMORY 0HHHH command (where H is a hexadecimal digit). The content of a memory location can be altered using the MEMORY 0HHHH 0HH command. In the remote mode, Special Function 46 does not need to be activated when accessing and altering memory locations. Those operations can be done by the controller in the background.

*STOP/RESET LED:ON SPECIAL SB:ON *

SPECIAL FUNCTION 47 — Measure IF Frequency Only

This function provides the user with the means to measure the frequency of the signal present at the input of the Count Chain board without having the counter converter locked on the signal. The counter will not measure pulse parameters when it is in this function.

When this function is activated, the counter will stop the normal converter lock and measurement cycles. The VCO, YIG, and all the microprocessor-controlled hardware switches will be left at the state they were in when the function was activated. The counter will then start measuring the frequency of the signal present at the input to the Count Chain board. The measurement results will be displayed on the front panel. The result will also be output to the GPIB interface if frequency readings are requested. This function does not check periodically for the presence of a signal as in the normal operation of the counter.

⋆STOP/RESET LED:ON SPECIAL SB:ON ⋆

CAPABILITY ENHANCEMENT FUNCTIONS

Special functions number 60 through 76 provide to sophisticated users those functions that are not required in normal use of the counter.

SPECIAL FUNCTION 61 — Disable Input Signal Tracking

This function allows the user to configure the counter not to perform the input signal tracking function after every measurement cycle. This function will shorten the measurement cycle time, but the counter will not be able to track a moving signal.

The action taken with this function can be reversed by activating Special Function 62.

⋆ONE-SHOT LED:ON SPECIAL SB:ON ⋆

SPECIAL FUNCTION 62 — Enable Input Signal Tracking

This function provides the user with a means to reverse the action taken with Special Function 61.

⋆ONE-SHOT LED:OFF SPECIAL SB:OFF ⋆

SPECIAL FUNCTION 63 — Disable Sample Rate Control

This function allows the user to configure the counter to ignore the local and the remote sample rate controls. The counter will start a new measurement cycle as soon as the last one is finished. This function will shorten the measurement cycle time.

The action taken with this function can be reversed by activating Special Function 64.

*ONE-SHOT LED:ON SPECIAL SB:ON *

SPECIAL FUNCTION 64 — Enable Sample Rate Control

This function provides the user with a means to reverse the action taken with Special Function 63.

*ONE-SHOT LED:OFF SPECIAL SB:OFF *

SPECIAL FUNCTION 65 — Disable Results Display

This function allows the user to configure the counter not to output the measurement results to the front panel display. During the measurement cycles, the front panel will display a row of dots. When the user enters parameters through the keyboard, the display will react normally. This function shortens the measurement cycle time and provides security in systems used with classified frequencies.

The action taken with this function can be reversed by activating Special Function 66.

*ONE-SHOT LED:ON SPECIAL SB:ON *

SPECIAL FUNCTION 66 — Enable Results Display

This function is used to reverse the action taken by Special Function 65. When this function is activated, the display will immediately be updated with the last measurement results.

*ONE-SHOT LED:OFF SPECIAL SB:OFF *

SPECIAL FUNCTION 67 — Display PRF as Frequency

This function configures the counter to display the pulse period measurements as a frequency. It has no effect on pulse width measurements.

After this function is turned on, the frequency measurements will **not** be displayed on the front panel. The pulse period will be displayed to the maximum available resolution, using the pulse parameter display as the 100 Hz, 10 Hz and 1 Hz digits. Since the PRF is derived mathematically from the period, the resolution will be a function of the period measurement resolution per the formula:

$$\text{Resolution (Hz)} = 1 \times 10^{-10} \ / \ [\text{Period (seconds)}]^2$$

For example:

Period	Frequency	Resolution
200 ns	5 MHz	250 kHz
100 μs	10 kHz	1 Hz
1 ms	1 kHz	1 Hz (maximum resolution)

When requested by the GPIB bus controller to output a period measurement, the counter will output the period measurement instead of the PRF of the input signal.

If the Pulse Period function is on, this special function has a higher priority than Special Function 69. That is, the front panel will be configured according to Special Function 67 if both Special Function 67 and Special Function 69 are activated.

This function is terminated when Special Function 68 is activated.

*ONE-SHOT LED:ON SPECIAL SB:ON *

SPECIAL FUNCTION 68 — Display PRF as Period

This function provides the user with a means to reverse the action taken with Special Function 67.

*ONE-SHOT LED:OFF SPECIAL SB:OFF *

SPECIAL FUNCTION 69 — Display Pulse Parameter Measurements Only

When this function is activated, the frequency measurements are not displayed on the front panel. Instead, the twelve digits on the front panel are devoted to displaying pulse parameter measurements to 10 ns resolution.

If the Pulse Period function is on, this special function has a lower priority than Special Function 67. That is, the front panel will be configured according to Special Function 67 if both Special Function 67 and Special Function 69 are activated.

This function is terminated when Special Function 70 is activated.

*ONE-SHOT LED:ON SPECIAL SB:ON *

SPECIAL FUNCTION 70 — Display Frequency and Pulse Parameter Measurement

This function returns the counter to the normal mode of displaying measurement results, reversing the action taken by Special Function 69.

If no other special function is active, the SPC LED and the Special On/Off status bit will be turned off when this function is activated.

*ONESHOT LED:OFF SPECIAL SB:OFF *

SPECIAL FUNCTION 72 — Store Counter Setup

This function stores the present counter setup in the storage register specified.

When this function is activated, the counter requests the user to enter the register number by displaying **REG --** on the front panel. The counter will remain in this state until the user enters a number between 0 and 9 inclusively. After the register number is entered, the function will proceed to store the current counter setup in the register specified. During this time, **REG N** will be displayed on the front panel (where N is the register number entered).

*ONE-SHOT LED:OFF SPECIAL SB:OFF *

SPECIAL FUNCTION 73 — Recall Counter Setup

This function recalls the counter setup stored in the storage register specified.

When this function is activated, the counter requests the user to enter the register number by displaying **REG** — on the front panel. The counter will remain in this state until the user enters a number between 0 and 9 inclusively. After the register number is entered, the function will proceed to set up the counter according to the information stored in the register specified. During this time, **REG N** will be displayed on the front panel (where N is the register number entered).

When the counter finishes setting up, a reset will be generated.

⋆ONE-SHOT/RESET LED:OFF SPECIAL SB:OFF ⋆

SPECIAL FUNCTION 74 — Relative Frequency Readings

When this function is activated, the counter assigns a negative value to the last input frequency reading and enters it into the frequency offset register (overwriting any previously entered frequency offset). The last input frequency in this case means the actual frequency of the input signal, not the frequency displayed on the front panel, which may be affected by a frequency multiplier or another special function. The counter displays the relationship, i.e., the difference between the last input frequency and the current one, subject to any other functions activated. It will continue to do so until the FREQ OFFSET and CLEAR DATA keys *are pressed. The Frequency Offset LED is turned on.

⋆ONE-SHOT LED: OFF SPECIAL SB:ON ⋆

SPECIAL FUNCTION 75 — Display IF Frequency Readings

When this function is activated, the counter will assign a negative value to the local oscillator (LO) frequency and enter it into the frequency offset register (overwriting any previously entered frequency offset). The counter will subtract the LO frequency from the input frequency and display the resulting IF frequency. It will continue to do so until the FREQUENCY OFFSET and CLEAR DATA keys are pressed. The FREQUENCY OFFSET annunciator will be turned on.

⋆ONE-SHOT LED:OFF SPECIAL SB:ON ⋆

SPECIAL FUNCTION 76 — Test and Initialize EEPROM

This function provides the means for the user to test the EEPROM option.

This function performs write and read tests on each location on the EEPROM. If any one location on the EEPROM fails the write and read tests, **ERROR 94** will be displayed. If all memory locations pass the tests, **PASSED** will be displayed.

CAUTION

Care must be used when operating Special Function 76. Although the counter cannot be damaged by this function, using this will affect the counter calibration, rendering the counter unusable until it can be recalibrated. Do not call this function unless familiar with its operation.

This function requires approximately 2 minutes to complete. During those 2 minutes, the counter will not respond to any key entry from the keyboard.

*ONE-SHOT LED:ON SPECIAL SB:ON *

SPECIAL FUNCTION 77 — Not implemented

SPECIAL FUNCTION 78 — Not implemented

SPECIAL FUNCTION 90 — Display and/or Alter GPIB Address

When this function is activated, the counter displays the current address of the GPIB interface. If the address does not need to be changed, the function may be terminated by pressing the CLEAR DISPLAY or CLEAR DATA keys.

After this function has been activated, the GPIB address can be changed by entering a two-digit number between 01 and 99 inclusively. The function will be terminated and the display returned to displaying measurement results after the second digit key is released.

(Refer to the GPIB interface section, page 3-69 for meanings of GPIB addresses above 31.)

*ONE-SHOT LED:ON SPECIAL SB:ON *

SPECIAL FUNCTION 91 --- YIG DAC Automatic Calibration

This function permits the user to calibrate the Band 2 YIG DAC through the front panel.

When this function is activated, the counter will display **F1** and measure a user-supplied 2-GHz input. Then it will display **F2**, wait for the user to change the input to 18 GHz, and measure it. The counter then calculates and stores (in non-volatile memory) the correction factors that it uses to compensate for any YIG DAC error.

CAUTION:

Care must be used when operating Special Function 91. Although the counter cannot be damaged by this function, improper operation of it can affect the counter calibration, possibly rendering counter unusable until it can be recalibrated. Do not call this function unless familiar with its operation.

To calibrate the YIG DAC:

1. Apply a signal at 2 GHz ±2 MHz at approximately 0 dBm to the Band 2 input connector.
2. Call Special Function 91 and press the TRIG key.
3. When the display changes from F1 to F2, apply a signal at 18 GHz ± 2 MHz, at approximately 0 dBm and press the TRIG key.
4. When the display returns to normal, the counter YIG DAC is calibrated.

NOTE

For more calibration information, refer to Section 5 in the Service manual.

*ONE-SHOT/RESET LED:ON SPECIAL SB:ON *

SPECIAL FUNCTION 92 --- Gate Accuracy Calibration

This function permits the user to calibrate the counter gate error through the front panel.

Before activating this function, the user must apply a valid synthesized (or phase-lock) CW input and a 50-ns inhibit input to the counter. When this function is activated, the counter measures the frequency with inhibit disabled, then measures the frequency with inhibit enabled and compares the readings. Based on the result, it adjusts the gate width and repeats until the gate is calibrated. It stores the correction factors in non-volatile memory.

This function stores separate corrections for each band to permit each band to be calibrated independently. Band 3 sub-bands do not have independent corrections.

CAUTION

Care must be used when operating Special Function 92. Although the counter cannot be damaged by this function, improper operation of it can affect the counter calibration, possibly rendering the counter unusable until it can be recalibrated. Do not call this function unless familiar with its operation.

To calibrate the counter gate:

Band 1

1. Set the counter to Band 1.
2. Apply a synthesized CW signal at 900 MHz ± 5 MHz at -10 to 0 dBm.
3. Apply an inhibit signal at approximately 50 ns.
4. Adjust the inhibit width until the average gate width is 20 ns.
5. Enter Special Function 92 and press the TRIG key to start calibration.
6. When the display returns to normal, (this may take from 1 to 5 minutes), Band 1 is calibrated.

Band 2

1. Set the counter to Band 2.
2. Apply a synthesized CW signal in the Band 2 range to the Band 2 input connector.
3. Apply an inhibit signal at approximately 50 ns.
4. Adjust the inhibit width until the average gate width is 20 ns.
5. Enter Special 92, and press the TRIG key to start calibration.
6. When the display returns to normal (this may take from 1 to 2 minutes), Band 2 is calibrated.

Band 3

1. Set the counter to Band 3 and the appropriate sub-band.
2. Apply a synthesized CW signal in the range of the selected sub-band to the Band 3 input connector.
3. Apply an inhibit signal at approximately 50 ns.
4. Adjust the inhibit width until the average gate width is 20 ns.
5. Enter Special 92 and press the TRIG key to start calibration.
6. When the display returns to normal (this may take from 1 to 5 minutes). Band 3 is calibrated.

NOTE

For more calibration information, refer to Section 5.

*ONE-SHOT/RESET LED:ON SPECIAL SB:ON *

ERROR MESSAGES

When an error occurs, an error number will be displayed. The probable cause of each error is listed below.

01 KEY PRESSED NOT FUNCTION KEY
02 LOWER LIMIT HIGHER THAN HIGH LIMIT
03 LIMITS ENTRY ONLY IN BAND 2
04 CENTER FREQUENCY ENTRY ONLY IN BAND 2 OR BAND 3
05 CENTER FREQUENCY ENTRY OUTSIDE CURRENT BAND RANGE
06 NO VALID DATA IN STORAGE REGISTERS FOR RECALL FEATURE
07 CONVERTER UNABLE TO LOCK ON SIGNAL DURING SPECIAL
09 ILLEGAL REGISTER ENTRY

10 ILLEGAL BAND ENTRY
11 ILLEGAL SUB-BAND ENTRY
12 ILLEGAL RESOLUTION ENTRY
13 ILLEGAL SPECIAL FUNCTION ENTRY
14 ILLEGAL AVERAGE ENTRY
15 ILLEGAL MULTIPLIER ENTRY
16 ILLEGAL FREQUENCY OFFSET ENTRY
17 ILLEGAL CENTER FREQUENCY ENTRY
18 ILLEGAL MIN PRF ENTRY
19 ILLEGAL LOW LIMIT ENTRY

20 ILLEGAL HIGH LIMIT ENTRY
21 ILLEGAL SAMPLE RATE ENTRY
22 ILLEGAL SRQ NUMBER ENTRY
23 ILLEGAL GPIB ADDRESS
24 ILLEGAL VCO FREQUENCY 1 ENTRY
25 ILLEGAL VCO FREQUENCY 2 ENTRY
26 ILLEGAL YIG FREQUENCY 1 ENTRY
27 ILLEGAL YIG FREQUENCY 2 ENTRY
28 ILLEGAL YIG DAC FREQUENCY ENTRY
29 FREQUENCY OVERFLOW DUE TO MULTIPLIER

30 PULSE PARAMETERS MEASUREMENTS GREATER THAN SPECIFIED MIN PRF
31 GPIB INPUT MESSAGE TOO LONG
32 GPIB MESSAGE STARTS WITH A NUMBER
33 GPIB MESSAGE STARTS WITH A WRONG NUMBER
34 UNIDENTIFIED WORD FOUND
35 WORD MISSPELLED
36 MISSING SPACE
37 WRONG MODE ARGUMENT

40 NON-NUMERIC PARAMETER VALUE
41 WRONG FREQUENCY TERMINATOR
42 WRONG TIME TERMINATOR
43 WRONG OUTPUT ARGUMENT
44 NUMERIC ARGUMENT SYNTAX ERROR
45 NUMERIC MANTISSA HAS TOO MANY DIGITS
46 NUMERIC EXPONENT HAS TOO MANY DIGITS
47 HEX DATA SHOULD PRECEDE WITH A ZERO
48 NO HEX MEMORY ADDRESS SPECIFIED
49 ILLEGAL HEX DATA ENTRY

50 ILLEGAL HEX ADDRESS ENTRY
51 ACTIVATE SPC 72 AND 73 through STORE AND FETCH

60 RAM FAULT
61 ROM CHECK SUM ERROR: ADDR 4000 TO 7FFF
62 ROM CHECK SUM ERROR: ADDR 8000 TO BFFF
63 ACTIVATE SPC 72 AND 73 THRU STORE AND FETCH

71 GPIB/AMPLITUDE DISCRIMINATION BOARD MISSING
72 COUNT CHAIN BOARD MISSING
73 GATE GENERATOR BOARD MISSING
74 CONVERTER CONTROL BOARD MISSING
75 FRONT PANEL LOGIC BOARD MISSING

90 NO KEY RELEASE DETECTED
91 OPTION DOES NOT EXIST
92 BAND 3 OPTION IN A 585 UNIT
93 BAND 3 WITH NO BAND 1 BOARD
94 NON-VOLATILE MEMORY FAILURE
99 NO IF DETECTED

GENERAL PURPOSE INTERFACE BUS (GPIB) OPERATIONS

The GPIB interface of the 585/588 counters conforms to the IEEE Code and Format conventions and the IEEE 488-1978 Standards. With the GPIB interface, the counter can respond to remote control instructions and can output measurement results via the IEEE 488-1978 bus interface. At the simplest level, the counter can output data to other devices, such as a thermal printer. In more sophisticated systems, a calculator or other system controller can program the counter remotely, trigger measurements, and read results. Of course, a calculator or computer adds other benefits to a GPIB-based measurement system. The calculator can manipulate data to compute the mean and standard deviation, check for linearity, and compare results to limits.

GPIB FUNCTIONS IMPLEMENTED

The following GPIB interface function subsets are implemented.

INTERFACE FUNCTION	SUBSET	DESCRIPTION
Source Handshake	SH1	complete capability
Acceptor Handshake	AH1	complete capability
Talker	T5	basic talker, serial poll, Talk Only mode, unaddress if MLA
Listener	L3	basic listener, Listen Only mode, unaddress if MTA
Service request	SR1	complete capability
Remote/Local	RL1	complete capability
Device Clear	DC1	complete capability
Device Trigger	DT1	complete capability

The 585/588 counters thus have the capacity to provide the following capabilities in remote operation to the user:

1. Acceptance of device-dependent messages to set the instrument measurement mode and parameters. The input buffer can store up to 256 characters accepted from the bus. Execution of the device-dependant messages starts after the first message separator is accepted. Input of more characters will interrupt the execution so that the additional characters are accepted and stored for fast bus response (unless buffer is full).

2. Output of measurement results or any parameter value or instrument mode on demand from the system controller.
3. Configuration of the output format in several ways to accommodate different system controllers and speed requirements.
4. Implementation of Device Clear and Selected Device Clear to configure the instrument to the power-up state. See page 3-10 for the instrument power-up configuration.
5. Implementation of Group Execute Trigger (GET) message to start a new measurement cycle.
6. Implementation of Serial Poll functions to allow the system controller to get a status byte from the instrument that gives status information for various functions. The instrument can also be instructed to interrupt (SRQ) the controller on any ORed combination of the status events.
7. Implementation of Remote/Local transitions. While the counter is in remote, all the front and rear panel keys and switches are disabled (except the ON/OFF switch). Remote/Local transitions will not change any instrument configuration (except the INT/EXT rear switch, and the sample rate settings, which will override in a remote-to-local transition). When the counter changes from local to remote functioning, or vice-versa, all stored information is retained. The counter will operate in the same state as it was in before the change. The only exception is that when the counter is performing a special function, the special function will be terminated.
8. Implementation of Local Lockout, with the INIT/LOCAL key disabled accordingly. When the counter is in remote, and Local Lockout is not active, the INIT/LOCAL key on the front panel keyboard acts as the return-to-local key.
9. Availability of instrument configuration information, in addition to the status events available in the status byte, by means of a special OUTPUT CONFIGURATION command. When the instrument is configured as a talker, it will output five bytes that contain the current configuration.
10. Recognition of all three bus terminators: CR LF, NL, EOI.
11. Availability of front panel annunciators for REMOTE, TALKER, LISTENER, and SRQ that continuously show the interface state.
12. Implementation of talk-only modes for no-controller applications.

DEVICE-DEPENDENT MESSAGES (LISTENER FEATURES)

A device-dependent message generally consists of reserved words and numbers. The message structure depends on the type of message, and can be:

- header only
- header and argument
- header and argument and terminator

Where the header is a reserved word, the argument is a number or a reserved word, and the terminator is a reserved word.

Messages can be concatenated with a comma (,) or semicolon (;) as separators. A message chain can be terminated with CR LF or NL or EOI. Any device-reserved word will be recognized by at least two first characters with the exception of RESET which requires the first four letters. These first two characters are printed in boldface type in the following command lists and in program examples to promote user familiarity with the shortened form of the command. Spelling of more characters (Up to the full word) is optional for user program readability.

Example: INITIALIZE
INITIAL — are all recognized equivalently
INIT
IN

A <number> can be sent in any of the defined IEEE formats (NR1, NR2, NR3).

Example: 12000
12000.00 — are all recognized equivalently
001.2e4
.12000E+5

The reserved word DEFAULT can replace a numeric argument for default value assignment.

The terminator in the parameter messages group is optional, and defaults to Hz or seconds.

A message with more than one word (like PERIOD ON) should have a space between the words. This is optional if the second word is a number (OFFSET4.3e9 and OFFSET 4.3e9 are recognized equivalently). Additional spaces in front of words, between words, or after a message are optional, and will be ignored. Nulls and CRs are ignored anywhere. Both upper case and lower case characters are equally acceptable.

The following tables list the possible GPIB messages for the 58X series counters.

CONTROL MESSAGES

Control, mode, and parameters messages are all used with the controller in the listener mode to enter instructions and data.

Header	Argument	Terminator	Description
INITIALIZE	None	None	Reconfigures the instrument to power-up state. (Equivalent to front panel key.)
RESET	"	"	Resets converter to restart a new signal acquisition. (Equivalent to front panel key.)
TRIGGER	"	"	Triggers a new measurement cycle. (Equivalent to front panel key.)
CLEARDISPLAY	"	"	Returns the display to normal measurement results display, clear error. (Equivalent to front panel key.)

MODE MESSAGES

Header	Argument	Terminator	Description
PERIOD	ON or OFF	None	Turns pulse period or 0 or 1 measurement on or off or DEFAULT. (Equivalent to front panel key.)
WIDTH	"	"	Turns pulse width measurement on or off. (Equivalent to front panel key.)
HOLD*	"	"	Holds the last result if on. (Equivalent to front panel HOLD.)
EXTERNAL*	"	"	Controls the INT/EXT time base reference.
HEADER	"	"	Adds an alpha header and terminator for talker.
SCIENTIFIC	"	"	Selects scientific notation for talker.
DYNAMIC	"	"	Suppresses blanks when counter is configured in talker mode for faster free-field data transfer.
SEPARATE	"	"	Replaces the commas with CR LF between multinumber results.

NOTE

These functions are controlled by hardware switches in local mode. In remote, HOLD defaults to sample rate and EXT defaults to internal. A GPIB command must be sent when in remote to change from the default setting.

PARAMETERS MESSAGES

Header	Argument	Terminator	Description
BAND	<number>	None	Select a specific band (1 to 3) or DEFAULT.
SUBBAND	"	"	Selects a specific Band 3 subband (1 to 6)
RESOLUTION	"	"	Sets the frequency measurement resolution (0 to 9).
SPECIAL	"	"	Activates a specific special function (0 to 99).
AVERAGE	"	"	Inputs an averaging value (1 to 99).
MULTIPLIER	"	"	Inputs a multiplier value (1 to 99).
SRQMASK	"	"	Selects the combination of status events to cause a service request.
OFFSETFREQ	"	(Hz or kHz or MHz or GHz)	Sets a frequency offset value.
HIGHLIMIT	"	"	Sets a frequency high limit value.
LOWLIMIT	"	"	Sets a frequency low limit value.
MINPRF	"	"	Sets a minimum PRF value.
CENTERFREQ	"	"	Sets a center frequency value and mode.
Y1FREQ	"	"	Sets a start frequency for YIG sweep (Special Function 40).
Y2FREQ	"	"	Sets a stop frequency for YIG sweep (Special Function 40).

PARAMETERS MESSAGES

Header	Argument	Terminator	Description
V1FREQ	"	"	Sets a start frequency for VCO sweep (Special Functions 41, 42).
V2FREQ	"	"	Sets a stop frequency for VCO sweep (Special Functions 41, 42).
STORE	<number>	None	Store current counter setup in specified storage register (0 to 9).
FETCH	"	"	Recall counter setup stored in specified storage register (0 to 9).
SAMPLERATE	"	(sec or msec)	Sets a delay between measurement values (0 to 100 sec, 10 ms resolution).
MEMORY	<hex adrs>	<hex data>	Accesses a memory location and alters it, (altering is optional).
MEMORY	INCREMENT	"	Accesses the next location and alters it, (altering is optional).
MEMORY	DECREMENT	"	Accesses the previous location and alters it, (altering is optional).

OUTPUT CONTROL MESSAGES

These commands are used with the controller in the talker mode to request the output of data.

Command	Description
OUTPUT RESOLUTION	Outputs the last specified frequency measurement resolution.
OUTPUT BAND	Outputs the number of the last specified band.
OUTPUT SUBBAND	Outputs the number of the last specified sub-band.
OUTPUT AVERAGE	Outputs the last specified averaging value.
OUTPUT MULTIPLIER	Outputs the last specified multiplier value.
OUTPUT ERRORNUMBER	Outputs the number of the last error. See listing of error numbers on page 3-47.
OUTPUT SRQMASK	Outputs the combination of status events required to cause a service request. See page 3-66.
OUTPUT CONFIGURATION	Outputs current configuration of instrument. See page 3-67.
OUTPUT IDENTIFICATION	Outputs "EIP58n GPIB dd", where n is 5 or 8 and dd is the GPIB address.
OUTPUT LOWLIMIT	Outputs the low frequency limit last specified.
OUTPUT HIGHLIMIT	Outputs the high frequency limit last specified.
OUTPUT OFFSETFREQ	Outputs the offset frequency last specified.
OUTPUT CENTERFREQ	Outputs the center frequency last specified.
OUTPUT MINPRF	Outputs the minimum PRF last specified.
OUTPUT V1FREQ	Outputs the last specified start frequency for VCO sweep (Special Function 41).
OUTPUT V2FREQ	Outputs the last specified stop frequency for VCO sweep.

Command	Description
OUTPUT Y1FREQ	Outputs the last specified start frequency for YIG sweep (Special Function 40).
OUTPUT Y2FREQ	Outputs the last specified stop frequency for YIG sweep.
OUTPUT SAMPLERATE	Outputs the last specified delay time between measurement values.
OUTPUT DEFAULT	Outputs results according to displayed results.
OUTPUT FREQUENCY (AND WIDTH) (AND PERIOD)	Controls which measurement results to output. **(Note: More than one measurement result is optional. The order of the results is preserved in the output. Output frequency, width and period can be used in any combination.)**
OUTPUT KEYCODE	Outputs the code of the last key pressed.
OUTPUT MEMORY	Outputs the content of the memory in the last accessed location.
OUTPUT LEVEL	Outputs the rough amplitude measurement result (Special Function 20).
OUTPUT DATE	Outputs a 42-character string that shows the revision level and date.
OUTPUT SETUP	Outputs a 142-character string that describes the current setup.

SYNTAX DEFINITION

In the instructions that follow, | means "or" and N|S means "null or space." The format used for the examples is that used for the HP85™ controller. Sample formats for other controllers are given in the following section.

DEVICE DEPENDENT MESSAGE:: = <message><N|S><message terminator>|<message><message separator><message><message terminator>

---

message:: = <control message>|<mode message>|<parameters message>|<output control message>

message separator:: = ,|;

message terminator:: = CR LF|NL|EOI

---

1. CONTROL MESSAGE:: = INITIALIZE|RESET|TRIGGER|CLEAR DISPLAY

Example: To instruct the instrument to begin a new signal acquisition process, the operator enters:

```
OUTPUT 718; "INITIALIZE"
```

---

2. MODE MESSAGE:: = <mode name><space><mode position>

---

mode name:: = WIDTH|PERIOD|HOLD|EXTERNAL|SCIENTIFIC|SEPARATE|HEADER|DYNAMIC

mode position:: = ON|OFF|1|0|DEFAULT

Example: To instruct the instrument to accept an external reference, the operator enters:

```
OUTPUT 718;"EXTERNAL ON"
```

3. PARAMETERS MESSAGE:: = <parameter message 1>| <parameter message 2>|<parameter message 3>|<parameter message 4>|<parameter message 5>

PARAMETERS MESSAGE 1:: = <parameter 1><N|S> <argument>

---

parameter 1:: = BAND|SUBBAND|RESOLUTION|SPECIAL|
AVERAGE|MULTIPLIER|SQRMASK|
GPIBADDRESS

argument:: = DEFAULT|<number>

number:: = <NULL|+|><mantissa><exponent>

mantissa:: = <digit>|<digit string>|<digit|digit string, digit|
digit string>

exponent:: = NULL|E<NULL|+|><digit|digit string>

Example: To instruct the instrument to accept an averaging value, the operator enters:

```
OUTPUT 718,"AVERAGE 70"
```

PARAMETERS MESSAGE 2:: = <parameter 2><N|S>
<argument>N|S<frequency terminator>

---

parameter 2:: = OFFSET FREQ|HIGHLIMIT|LOWLIMIT|MINPRF|
CENTERFREQ|Y1FREQ|Y2FREQ|Y3FREQ|
V1FREQ|V2FREQ

frequency terminator:: = NULL|Hz|kHz|MHz|GHz

Example: To instruct the instrument to accept a frequency high limit value, the operator enters:

```
OUTPUT 718;"HIGHLIMIT 12.3 GHz" or
             "HIGHLIMIT 12.3E6 kHz"
```

PARAMETERS MESSAGE 3:: = SAMPLERATE<N|S> <argument><N|S><time terminator>

---

time terminator:: = NULL|SEC|MSEC

Example: To instruct the instrument to accept a sample rate value, the operator enters:

```
OUTPUT 718;"SAMPLERATE 100 MSEC"
```

PARAMETERS MESSAGE 4:: = MEMORY<N|S><memory instruction><N|S><memory data>

---

memory instruction:: = INCREMENT|DECREMENT|<memory location>

memory location:: = O<hex digit><hex digit><hex digit> <hex digit>

hex digit:: = <digit>|A|B|C|D|E|F

memory data:: = NULL|O<hex digit><hex digit>

Example: To instruct the instrument to change memory location 99AF to 3B, the operator enters:

```
OUTPUT 718;"MEMORY 099AF  03B"
```

PARAMETERS MESSAGE 5:: = STORE|FETCH<N|S> <NUMBER>

Example: To instruct the instrument to store a counter setup in a specified storage register, the operator enters:

```
OUTPUT 718;"STORE 03"
```

4. OUTPUT CONTROL MESSAGE:: = OUTPUT<SPACE> <output parameter>

output parameter:: = <single parameter>|<result parameter>

single parameter:: = RESOLUTION|BAND|SUBBAND|AVERAGE|
MULTIPLIER|ERRORNUMBER|SQRMASK|
CONFIGURATION|LEVEL|MEMORY|
IDENTIFICATION|LOWLIMIT|HIGHLIMIT|
OFFSETFREQ|CENTERFREQ|MINPRF|
SAMPLERATE|KEYCODE|SETUP

result parameter:: = DEFAULT|<result list>

result list:: = <result name>|<result name><SPACE>
AND<SPACE><result name>|<result name>
<SPACE>AND<SPACE><result name><SPACE>
AND<SPACE><result name>

result name:: = FREQUENCY|WIDTH|PERIOD

Example: To request the controller to display the width and frequency, in that order, the operator enters:

```
OUTPUT 718;"OUTPUT WIDTH AND FREQUENCY"
ENTER 718; A$
DISP A$
```

OUTPUT AND FORMAT EXAMPLES

The following programs illustrate how controllers function with the counter and how different kinds of controllers give instructions. These programs set the counter up in a sample configuration and program it to make a series of measurements of a 12.5-GHz pulsed signal with 13.258 μs period. The Talk and Listen address of the counter is assumed to be 18.

Hewlett Packard 85

```
10 DIM A$[36]
20 OUTPUT 718;"IN"
30 WAIT 4000
40 OUTPUT 718;"PE ON,RE 4"
50 OUTPUT 718;"HI 17.5 GHZ,LO 1.1 GHZ"
60 WAIT 1000
70 OUTPUT 718;"OUTPUT WI AND FR"
80 WAIT 1000
90 ENTER 718;A$
100 DISP A$
110 END
```

This program initiates the counter, provides a resolution value and a high and low frequency limit, and instructs it to output pulse width to the counter display and pulse width and frequency to the controller display. The controller display would appear like this:

```
0.0000132580 12500000000,
```

Hewlett Packard 9825A

```
0: dim A(10)
1: rem 7
2: wrt 718,"BA 2,RE 4,OF-4.55 MHZ"
3: wait 300
4: For I = 1 to 10
5: red 718, A(1)
6: prt A(1)
7: next I
8: end
```

The 9825A program will cause the counter to take a series of ten readings, print them on the 9825A paper tape, and stop. Notice that an offset of 4.55 MHz is subtracted from each reading.

Hewlett Packard 9845A

```
10: OUTPUT 718,"BA 3, RE 4, OF -4.55 MHZ"
15: WAIT 300
20: INPUT 718,A
30: PRINT "Frequency minus offset equals,"A
40: GO TO 20
```

Tektronix 4051

```
10: PRINT @ 18:"BA 3,RE 4, OF -4.55 MHZ"
20: INPUT @ 18:A
30: PRINT "Frequency minus offset equals,"A
40: GO TO 20
```

The programs shown for the Hewlett Packard 9845A and Tektronix 4051 cause the counter to make a frequency measurement and print that measurement. To end the program, initiate a STOP command. This is accomplished on the 9845A with the key labeled STOP. On the Tektronix 4051, use the key labeled BREAK. To restart the program, enter the RUN statement followed by the line number that is printed in the INTERRUPT message.

OUTPUT MESSAGES (TALKER FEATURES)

After receiving a talk address, the GPIB will output the current configuration or any parameter value or measurement result, in response to the appropriate output control message. After power-up or device-clear, the controller outputs the displayed measurement results (as it does after the OUTPUT DEFAULT command).

The controller can be instructed to output any ordered combination of the three possible measurements, no matter what is displayed on the front panel.

Examples: OUTPUT FREQ AND WIDTH
OUTPUT WIDTH AND PERIOD
OUTPUT WIDTH AND FREQUENCY AND PERIOD

The format of each output message can be controlled by the following features:

- SCIENTIFIC - provides exponential notation with engineering exponents when SCIENTIFIC is ON. Default is OFF.
- DYNAMIC - suppresses blanks and trailing zeros for faster data transfers when DYNAMIC is ON. Default is OFF.
- HEADER - provides an alpha header and terminator around each numeric data item for clarity, (useful for printers) when HEADER is ON. Default is OFF.

NOTE

Terminator takes over the exponential role if both SCIENTIFIC and HEADER are ON.

- SEPARATE - substitutes CR LF for the comma between results of one measurement (freq,period) when SEPARATE is ON. Default is OFF.
- DEFAULT - outputs data in default format. The fixed fields are 16 characters long for the header and argument, and 5 long for the terminator. When none of the output-formatting features above are turned on, numbers are right justified, letters are left justified, blanks are filled.

Example: The counter is measuring a 12.34 GHz pulsed signal with 98 ns width and 14.567 μs period. The operator enters the following messages through the controller:

RESOLUTION 6
OUTPUT FREQ AND WIDTH AND PERIOD

The output will be as follows (b is for blank):

Parameter	Output
Default:	bbbbb12340000000,bbbbb0.000000100,bbbbb0.000014570 CR LF
SCIENTIFIC on:	bbbbbbbb12.340E+9,bbbbbbbbbb100E-9, bbbbbbbb14.57E-6 CR LF
DYNAMIC on:	.34E9,100E-9,14.57E-6 CR LF
SEPARATE on:	2.34E9 CR LF 100E-9 CR LF 14.57E-6 CR LF
HEADER on:	FREQUENCY 12.34 GHz CR LF WIDTH 100 NSEC CR LF PERIOD 14.57 USEC CR LF

If the counter is searching, zero data will be output to the controller on all results once every search loop.

If the counter has found a signal, a measurement result will be output only once; thus when the instrument is in HOLD, the user must trigger the counter before sending another talk address or the counter will hold indefinitely, since it has no data to output.

STATUS (SERIAL POLL FEATURES)

Instrument status information can be accessed by the system controller through a serial poll. The interface will respond by displaying the ASCII symbol for the decimal equivalent of the setting of the status byte. The status byte is structured as follows:

bit 7 (128)	6 (64)	5 (32)	4 (16)	3 (8)	2 (4)	1 (2)	bit 0 (1)
Input buffer empty	Request to send (RQS)*	Error condition	Overload	Gate on	Search on	Signal found	Valid measurement result (data) ready

*One or more bits in the status byte of this instrument have been set).

The interface can be instructed to interrupt the bus (by setting SRQ line true) on any ORed combination of the above events.

Examples:		
	SRQMASK 33	SRQ if data ready or error condition
	SRQM 4	SRQ if search on (signal lost)
	SRQ 130	SRQ if input buffer empty or signal found

CONFIGURATION INFORMATION

Instrument configuration information is accessible through five special configuration bytes. After receiving the OUTPUT CONFIGURATION message and then being addressed to talk, the controller will output five ASCII characters, the symbols for the decimal equivalents of the setting of the status bytes. The bytes are structured as follows:

	bit 7	6	5	4	3	2	1	bit 0
Byte 1 Options and Measurement Mode	PERIOD on/ off	WIDTH on/ off	CURRENT BAND		EEPROM opt.	BAND3 opt.	BAND1 opt.	585 or 588

	bit 7	6	5	4	3	2	1	bit 0
Byte 2 Parameters Condition		MIN PRF	AVG	FREQ MULT	FREQ OFST	CENTER FREQ	HIGH LIMIT	LOW LIMIT

	bit 7	6	5	4	3	2	1	bit 0
Byte 3 Specials State		PP ONLY on/ off	PRF on/ off	STOP on/ off	SAMPL on/ off	TRACK on/ off	DISP on/ off	SPECIAL on/ off

	bit 7	6	5	4	3	2	1	bit 0
Byte 4 Interface and Switch State				SAMPLE DELAY	EXT	HOLD	SRQ	REMOTE

	bit 7	6	5	4	3	2	1	bit 0
Byte 5 Format Configuration					DYNAM on/ off	SEPAR on/ off	HEADR on/ off	SCIEN on/ off

The program below is an example of how to query the status bytes for configuration information. The counter model number is determined by checking Byte 1, bit 0.

```
10 OUTPUT 718; "OUTPUT CONFIGURATION"
20 ENTER 718; A$
30 PRINT "CONFIGURATION STRING = ";A$
40 B$=A$[1,1]
50 PRINT "FIRST BYTE = ";B$
60 Y=NUM(A$)
70 IF BIT (Y,0) THEN C=588 ELSE C=585
80 PRINT "COUNTER IS EIP"; C
90 END
```

The controller would output:

```
CONFIGURATION STRING = +%x-[
FIRST BYTE = *@t//
COUNTER IS EIP 588
```

DEFAULT STATE (DEVICE CLEAR FEATURES)

The instrument default state takes place after power-up, Initialize, Device Clear, or Selected Device Clear (general bus commands). Note that after power-up and Initialize, self-check and hardware initialization functions are activated that are not activated by Device Clear.

The default state is as follows:

Clear display action taken.
Period function off.
Width function off
Hold function off (only if in remote)
Display enabled
External reference off (only if in remote)
Band 2 (Sub-band 1 if in Band 3.)
Resolution 3 (1 kHz)
Special functions off
Average and multiplier set to 1
Srqmask set to 0
Offset set to 0
Lowlimit set to 900 MHz

DEFAULT STATE (CONTINUED)

Highlimit set to 26.7 GHz (588) or 18.5 GHz (585)
PRF set to 2 kHz.
Center frequency set to 0 (off)
Remote sample rate set to 40 ms
Talker format: header off, scientific off, dynamic off, separate off (unless in a talk-only mode)
Output: talker talks the displayed results.
Keyboard and GPIB parsing states return to their start positions
All buffer pointers reset
Listener, talker, and SRQ active states switched to passive (unless in a talk-only mode)
Converter reset

TALKER ONLY MODE

The instrument can be configured to be a talker-only by selecting one of the following decimal addresses.

NOTE

Address is composed of the binary value of the choices +32.

SCIENTIFIC	SEPARATE	HEADER	DYNAMIC	ADDRESS
off	off	off	off	32
off	off	off	on	33
off	off	on	off	34
off	off	on	on	35
off	on	off	off	36
off	on	off	on	37
off	on	on	off	38.
off	on	on	on	39
on	off	off	off	40
on	off	off	on	41
on	off	on	off	42
on	off	on	on	43
on	on	off	off	44
on	on	off	on	45
on	on	on	off	46
on	on	on	on	47

**ADDRESS CHARACTERS		ADDRESS CODES					
Listen	Talk	binary					decimal
		5	4	3	2	1	*
SP	@	0	0	0	0	0	00
!	A	0	0	0	0	1	01
"	B	0	0	0	1	0	02
#	C	0	0	0	1	1	03
$	D	0	0	1	0	0	04
%	E	0	0	1	0	1	05
&	F	0	0	1	1	0	06
'	G	0	0	1	1	1	07
(	H	0	1	0	0	0	08
)	I	0	1	0	0	1	09
*	J	0	1	0	1	0	10
+	K	0	1	0	1	1	11
,	L	0	1	1	0	0	12
-	M	0	1	1	0	1	13
.	N	0	1	1	1	0	14
/	O	0	1	1	1	1	15
0	P	1	0	0	0	0	16
1	Q	1	0	0	0	1	17
2	R	1	0	0	1	0	18
3	S	1	0	0	1	1	19
4	T	1	0	1	0	0	20
5	U	1	0	1	0	1	21
6	V	1	0	1	1	0	22
7	W	1	0	1	1	1	23
8	X	1	1	0	0	0	24
9	Y	1	1	0	0	1	25
:	Z	1	1	0	1	0	26
;	[	1	1	0	1	1	27
<	/	1	1	1	0	0	28
=	]	1	1	1	0	1	29
>	^	1	1	1	1	0	30

* Decimal Talk/Listen Address is provided as a cross reference for those controllers which use decimal address.

** Address characters in ASCII code.

Figure 3-11. Allowable Address Codes

DATA INPUT AND OUTPUT SPEED

OUTPUT SPEED

Several options have been provided in the GPIB interface for the user who wants to increase the output speed of the counter. Each of the following conditions decreases the measurement cycle time. The fastest measurement cycle time is achieved with all of the following conditions set:

HEADER OFF: Outputs the numeric results without header or terminator. (default).

SCIENTIFIC OFF: Outputs fixed point results which are shorter than exponential notations, (default).

DYNAMIC ON: Suppresses leading blanks. NOTE: The controller has to have free field capability.

SPECIAL 61: Disables the tracking feature, thus saving the time required for YIG and VCO corrections.

SPECIAL 63: Disables sample rate control, thus deleting any delay between gates. (For counter in LOCAL.)

SPECIAL 65: Disables the LED results display, thus saving the time required for display, formatting, and output.

SAMPLERATE 0: Same as SPECIAL 63 for counter in REMOTE.

INPUT SPEED

It takes a specific amount of time for the counter to process input data (error checking, formatting, changing the mode of operation, etc.). To prevent the data rate of the bus from slowing down while the counter is doing input data processing, the data is accepted as soon as it is available on the bus and is temporarily stored in a 256-character storage memory.

The users of the GPIB interface need to be aware of the difference between accepting data and complying with it. If the counter is asked to output a reading before it is finished processing the input data, the output will not reflect the newly entered data. To prevent this, sufficient programmed delays must be provided (see the sample program formats on page 3-64). The user can also make use of the counter's Service Request status byte. Bit 7 in the status byte can be used to determine if the counter has completed the processing of the messages. Refer to the section on the Instrument Status (Serial Poll).

READING MEASUREMENTS

To read a measurement from the counter to a calculator, the user must first address the counter to talk and the calculator to listen. The examples below indicate how a calculator may read a measurement from the counter.

Hewlett Packard 9825A

```
10 red 718,A
20 prt A
```

Hewlett Packard 9845A

```
10 ENTER 718,A
20 PRINT A
```

Tektronix 4051A

```
10 INPUT @ 18:A
20 PRINT A
```

The EIP counter user has a choice of method for taking readings. When the command HOLD is ON, the counter takes one reading then waits for a RESET command or a Device Trigger GPIB command. In this condition, the counter is sent a RESET command or a Device Trigger and (when addressed to talk) outputs a new reading to the bus. The counter will hold that particular reading on the display until another RESET command or Device Trigger is received.

When the HOLD command is OFF, data is read out to the bus in the normal way. The display is automatically updated according to the specified sample rate, and the counter can output successive readings without requiring a RESET command or Device Trigger each time.

Section 4
Performance Verification Tests

INTRODUCTION

This section describes the performance verification test procedures for the EIP Model 585 or 588 Microwave Pulse Counter, referred to throughout the rest of this section as the counter. These procedures are described in Table 4-1 below.

Table 4-1. Performance Verification Test Methods

INSTRUMENT CHARACTERISTIC	CONDITIONS	PERFORMANCE	TEST METHOD SPECIFICATIONS
Frequency Range			
Band 1		300 MHz to 1 GHz	Checked by verifying that counter displays accurate reading of frequency input from synthesized signal generator.
Band 2		(585) 950 MHz to 18 GHz (588) 950 MHz to 26.5 GHz	Checked by verifying that counter displays accurate reading of frequency input from synthesized signal generator.
Band 3 Minimum Frequency		Band 3-1: 26.5 GHz Band 3-2: 33 GHz Band 3-3: 40 GHz Band 3-4: 50 GHz Band 3-5: 60 GHz Band 3-6: 75 GHz	Checked by verifying that counter displays accurate reading of frequency input from millimeter wave sources (see Special Equipment Section, Table 4-2).
Band 3 Maximum Frequency	Band 3-1: 40 GHz Band 3-2: 50 GHz Band 3-3: 60 GHz Band 3-4: 75 GHz Band 3-5: 90 GHz Band 3-6: 110 GHz		Checked by verifying that counter displays accurate reading of frequency input from millimeter wave sources (see Special Equipment Section, Table 4-2).

INSTRUMENT CHARACTERISTIC	CONDITIONS	PERFORMANCE SPECIFICATIONS	TEST METHOD
Sensitivity			
Band 1	300 MHz to 1 GHz	-15 dBm	Checked by verifying that counter set to Resolution 3 displays a measurement within 1 kHz of signal input from signal generator at -15 dBm
Band 2	0.95 to 12.4 GHz 12.4 to 18.0 GHz 18.0 to 24.0 GHz 24.0 to 26.5 GHz	-20 dBm -15 dBm -10 dBm -5 dBm	Checked by verifying that counter displays a measurement within 1 kHz of signal input from signal generator at specified power levels
Band 3	26.5 to 60.0 GHz 60.0 to 110.0 GHz	-20 dBm -15 dBm	Checked by verifying that counter displays a reading within 1 kHz of signal input from signal generator at specified power level.
Maximum Input			
Band 1	300 MHz to 1 GHz	+7 dBm	Checked by verifying that counter displays a measurement within 1 kHz of input signal at maximum power level.
Band 2	950 MHz to 26.5 GHz	+7 dBm	Checked by verifying that counter displays a measurement within ±1 kHz of input signal at maximum power level.
Band 3	26.5 GHz to 110 GHz	+5 dBm	Checked by verifying that counter displays a measurement within ±1 kHz of input signal at maximum power level.

INSTRUMENT CHARACTERISTIC	CONDITIONS	PERFORMANCE SPECIFICATIONS	TEST METHOD
Amplitude Discrimination			
Band 1	300 MHz to 1 GHz	10 dB	Checked by verifying that counter measures the higher power signal of two signals input from signal generators.
Band 2	950 MHz to 18 GHz (Model 585) 950 MHz to 26.5 GHz (Model 588)	15 dB 15 dB	Checked by verifying that counter measures the higher power signal of two signals input from signal generators.
Band 3	26.5 GHz to 110 GHz	20 dB	Checked by verifying that the counter measures the highest power signal of the signals input from signal generators.
Gate Error			
Band 1	300 MHz to 1 GHz	Gate Error (in Hz)= ±0.07/ Gate Width	Checked by verifying that the counter displays measurement within the limits of the gate error when appropriate inhibit input and signal are applied.
Band 2	950 MHz to 18 GHz (Model 585) 950 MHz to 26.5 GHz (Model 588)	Gate Error (in Hz) +0.01/ Gate Width	Checked by verifying that the counter displays measurement within the limits of the gate error when appropriate inhibit input and signal are applied.
Band 3	26.5 GHz to	Gate Error (in Hz) + ±0.01/ Gate Width	Checked by verifying that the counter displays a measurement within the limits of the gate error when appropriate inhibit input and signal are applied.

INSTRUMENT CHARACTERISTIC	CONDITIONS	PERFORMANCE SPECIFICATIONS	TEST METHOD
Distortion Error			
Band 1	300 MHz to 1 GHz	Distortion Error (in Hz) = (±0.03)/ Pulse Width (in seconds) -3 x 10^{-9}	Checked by calculating the distortion error by subtracting the gate error from the frequency of a pulsed signal input from a signal generator and verifying that it falls within the specification
Band 2	950 MHz 26.5 GHz	Distortion Error (in Hz)= (±0.03) Pulse Width (in seconds) -3 x 10^{-9}	Checked by calculating the distortion error by subtracting the gate error from the frequency of a pulsed signal input from a signal generator and verifying that it falls within the specification
Band 3	26.5 GHz to 110 GHz	Distortion Error (in Hz)= (±0.01)/ Pulse Width (in seconds) 3 x 10^{-9}	Checked by calculating the distortion error by subtracting the gate error from the frequency of a pulsed signal input from a signal generator and verifying that it falls within the specification.
Averaging Jitter			
Band 1	300 MHz to 1 GHz	Averaging Jitter = ±(2) $\sqrt{[RES / (GW)(AVE)]}$ *	Checked by using the displayed frequency of a number of measured pulsed signals input from a signals generator to calculate the sample variance and then verifying that it is within the specified limits
Band 2	950 MHz to 18.0 GHz (26.5 GHz for Model 588)	Averaging Jitter = ± $\sqrt{[RES / (GW)(AVE)]}$*	Checked by using the displayed frequency of a number of measured pulsed signals input from a signal generator to calculate the sample variance and then verifying that it is within the specified limits.

INSTRUMENT CHARAC-TERISTIC	CONDITIONS	PERFORMANCE	TEST METHOD SPECIFICATIONS
Band 3	26.5 GHz to 110 GHz	Averaging = $\pm(2)\sqrt{[RES / (GW)(AVE)]}$ *	Checked by using the displayed frequency of a number of measured pulsed signals input from a signal generator to calculate the sample variance and then verifying that it is within the specified limits.

*RES is the specified instrument resolution in Hz (This is true up to 1 MHz resolution. Above 1 MHz resolution RES = 10^6 Hz). GW in seconds is the logical AND of inhibit and pulse width minus 3 x 10^{-8} seconds. AVE is the number of specified count average.

Frequency Limits	950 MHz to 18.0 GHz (for Model 585) 26.5 GHz (for Model 588)	Instrument will ignore signals greater than 100 MHz outside the specified limit. 10 MHz resolution ±50 MHz accuracy	Checked by applying a signal 70 MHz from the entered frequency and verifying that it is not read, and applying a signal 50 MHz from the entered frequency and verifying that it is read.
Center Frequency	950 MHz to 18.0 GHz (for Model 585) 26.5 GHz (for Model 588)	Counter locks a signal ±50 MHz from entered frequency at 10 MHz resolution	Checked by applying a signal 70 MHz from the entered frequency and verifying that it is not read, and applying a signal 50 MHz from the entered frequency and verifying that it is read.
Maximum Video			
Band 1	950 MHz to 18.0 GHz (for Model 585) 26.5 GHz (for Model 588)	Counter maintains accuracy in presence of video signal 20 dB or more below RF signal	Checked by applying a video pulse to the inhibit input and verifying that it does not change the accuracy of the counter reading.
Band 2	950 MHz to 18.0 GHz (for Model 585) 26.5 GHz (for Model 588)	Counter maintains accuracy in presence of video signal 20 dB or more below RF signal	Checked by applying a video pulse to the inhibit input and verifying that it does not change the accuracy of the counter reading.

EQUIPMENT REQUIREMENTS

Equipment required for testing the EIP 585 or 588 Microwave Pulse Counter is listed in the Table 4-2.

NOTE

Minimum use specifications are the principal parameters required for performance of the procedures, and are included to assist in the selection of alternate equipment. Satisfactory performance of alternate items should be verified prior to use. All applicable equipment must bear evidence of current calibration.

Table 4-2. Equipment Requirements

DESCRIPTION	CRITICAL PARAMETERS	MANUFACTURER	MODEL
Synthesized Sweeper (2)	10 MHz to 26.5 GHz	Hewlett Packard	8340A
Power Meter	950 MHz to 26.5 GHz	Pacific Measurements	1045
20-dB Directional Coupler	10 to 1000 MHz	Anzac	CH132
16-B Directional Coupler (2)	1 to 18 GHz	Narda	4222-16
10-dB Directional Coupler	18 to 26 GHz	Narda	4017B-10
Low-Attenuation Coaxial Cable (3)		Gore	P2S01S01036.0
10-dB Directional Coupler	300 MHz to 1 GHz	Merrimac	CR-15-500
Spectrum Analyzer	100 Hz to 22 GHz 10 Hz resolution band width	Hewlett Packard	8566A
Pulse Generator (2)	5 Hz to 50 MHz	Wavetek	801
Oscilloscope	100 MHz Bandwidth	Tektronix	475
PIN Modulator	800 MHz to 2.4 GHz	Hewlett Packard	8731B

Table 4-2. Equipment Requirements (Continued)

DESCRIPTION	CRITICAL PARAMETERS	MANUFACTURER	MODEL
Pulse Modulator	2 to 18 GHz	Hewlett Packard	11720A
Pulse Modulator	18-26 5 GHz	MilliMeter Products	7-42-231
6-dB Attenuator (2)	dc to 1 GHz	Texscan	FP-50
3-dB Attenuator (3)	dc to 26.5 GHz	Weinschel	9-3
Dual-directional Coupler	10 dB	Narda	3022
Detector	10 MHz to 18 GHz	Hewlett Packard	8473B
Frequency Extender	26 5 to 60 GHz	Watkins Johnson	1204-42
Frequency Counter	300 MHz to 110 GHz	EIP	578/06
Remote Sensors	26.5 to 110 GHz	EIP	590/91/92 /93/94
Gunn Diode Oscillator	94 GHz	Hughes	R486A
Power Meter	26.5 to 110 GHz	HP	432
Power Meter Sensor	26.5 to 40 GHz	HP	R486A
Power Meter Sensor	40 to 60 GHz	Hughes	4577UH-1000
Power Meter Sensor	60 to 90 GHz	Hughes	4577EH-1000
Power Meter Sensor	90 to 100 GHz	Hughes	4577WH-1000/95
Power Meter Sensor	100 to 110 GHz	Hughes	4577WH-1000/105
Power Meter Sensor	90 to 110 GHz	Hughes	5776H-1400

SPECIAL EQUIPMENT

Because of the lack of adequate equipment for testing narrow pulses below 0.8 GHz, and pulses above 60 GHz, special equipment must be fabricated to test the counter accurately in these ranges. In cases where full capability testing is not necessary, the instrument may be tested using substitute equipment.

Modulator, 0.3 to 1 GHz (For Option 5802)

Used for testing Band 1 pulsed capabilities. If it is not necessary to test pulse widths less than 100 ns, the pulse modulation capabilities of the HP 8340A will be sufficient to test the 58X. If another modulator is used, extreme care must be taken to prevent phase distortion of the pulse by the modulator.

All resistors are in ohms.
Double balanced Mixer is Mini Circuits TFM-2

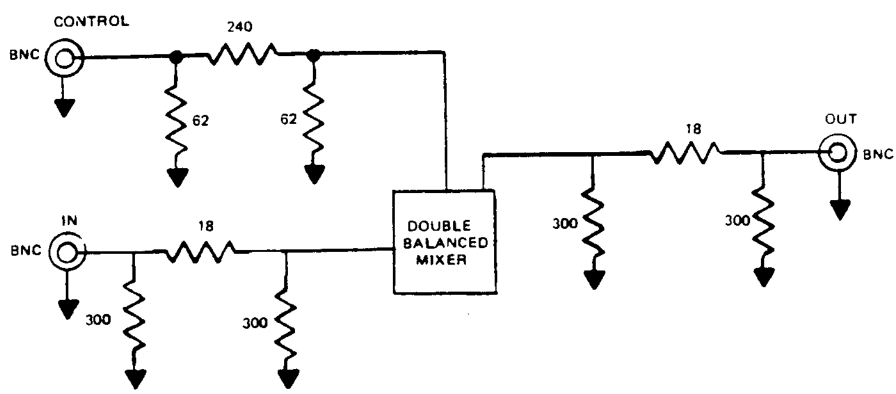

Figure 4-1. Pulse Modulator

Upconverter, 60 to 110 GHz (For Option 5804)

Used for testing Band 3 pulsed and CW capabilities above 60 GHz. Each upconverter covers a 10-GHz bandwidth and is constructed as shown in the following block diagram (Figure 4-2.) The Gunn diode oscillator frequency is set to 8 GHz below the minimum frequency, i.e., for a 90 to 100 GHz upconverter, the oscillator would be set to 82 GHz. If CW testing is sufficient, the unit may be tested with the Hughes millimeter wave synthesizer.

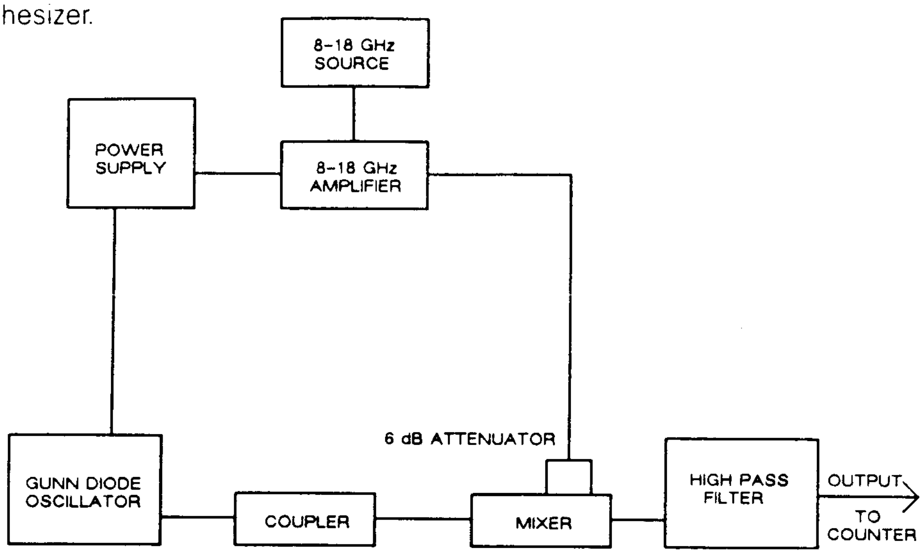

Figure 4-2. Upconverter

Power Supply	Acopian
Gunn Diode Oscillator	Central Microwave Company
Coupler	Hughes
Mixer	Honeywell Spacecom Microwave Center
High Pass Filter	Gamma-F Corporation
8 to 18 GHz Amplifier	Avantek
8 to 18 GHz Source	HP 8340A Synthesized Sweeper

PRELIMINARY OPERATIONS

Review the entire procedure before starting the verification testing process. Verify that the line voltage selection switch is set properly for the intended single-phase line voltage.

TEST PROCEDURES

MINIMUM AND MAXIMUM FREQUENCY/BAND 1 (Option 5802 only)

DESCRIPTION

This test verifies that the counter operates at the Band 1 minimum frequency of 300 MHz and the Band 1 maximum frequency of 1 GHz.

EQUIPMENT

Synthesized Sweeper (signal generator)	Hewlett Packard 8340A
Power Meter	Pacific Measurements 1045

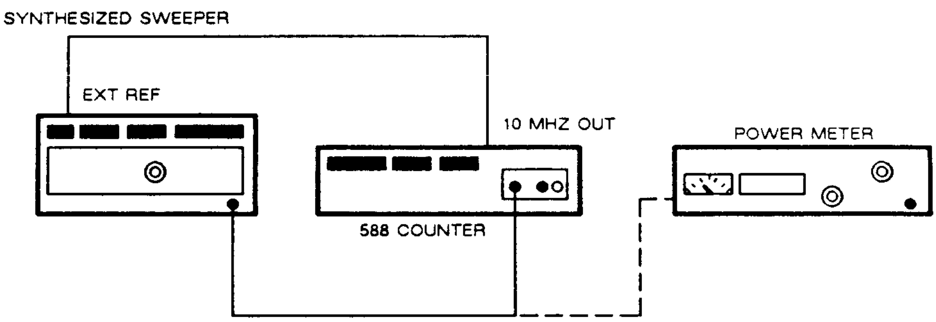

Figure 4-3. Band 1 Minimum and Maximum Frequency Test Setup

PROCEDURE

1. Connect equipment as shown in Figure 4-3.
2. Set the counter for Band 1. Set measurement averaging to 10. Set the signal generator frequency at 300 MHz and power at -15 dBm
3. Vary the signal level from -15 dBm to +7 dBm and verify from the counter display that the reading is 300 MHz ±1 kHz.
4. Set the counter for Band 1. Set the signal generator frequency at 1 GHz and power at -15 dBm.
5. Vary the signal level from -15 dBm to +7 dBm and verify that the counter displays 1 GHz ±1 kHz.

MINIMUM AND MAXIMUM FREQUENCY/BAND 2

DESCRIPTION

This test verifies that the counter operates at the Band 2 minimum frequency of 950 MHz and the Band 2 maximum frequency of 18 GHz for Model 585 and 26.5 GHz for Model 588.

EQUIPMENT

Synthesized Sweeper	Hewlett Packard 8340A
Power Meter	Pacific Measurements 1045

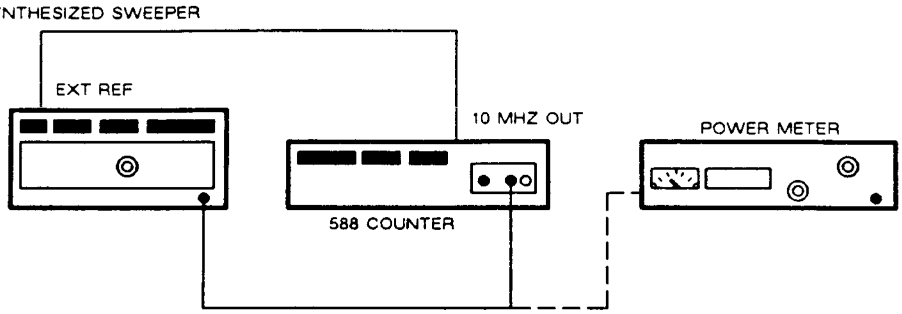

Figure 4-4. Band 2 Minimum and Maximum Frequency Test Setup

PROCEDURE

1. Connect equipment as shown in Figure 4-4.
2. Set the counter to Band 2. Set measurement averaging to 10. Set the signal generator frequency at 950 MHz and power at -20 dBm
3. Vary the amplitude from -20 dBm to +7 dBm and verify from the counter display that the reading is 950 MHz ±1 kHz.
4. Set the counter to Band 2. Set the signal generator frequency to 18 GHz (26.5 GHz for Model 588) and power to - 15 dBm (-10 dBm for Model 588).
5. Vary the power up to +7 dBm and verify that the counter displays 18 GHz (26.5 GHz for Model 588).

MINIMUM AND MAXIMUM FREQUENCY/BAND 3 (Option 5804 only)

NOTE

Band 3 is operated in conjunction with Model 890 and one or more remote sensors. The Band 3 tests are designed to test the entire band and it is assumed the proper remote sensors are connected for each sub-band. Because of the complicated test setups required for Band 3, the user may wish to test only specific sub-band(s).

DESCRIPTION

This test verifies that the counter operates at the Band 3 minimum and maximum frequencies for each sub-band.

EQUIPMENT

Synthesized Sweeper	Hewlett Packard 8340A
Frequency Extender	Watkins Johnson 1204-42
Upconverters, 60 to 110 GHz	See "Special Equipment"
Frequency Counter	EIP 578
Remote Sensors	EIP 891-895

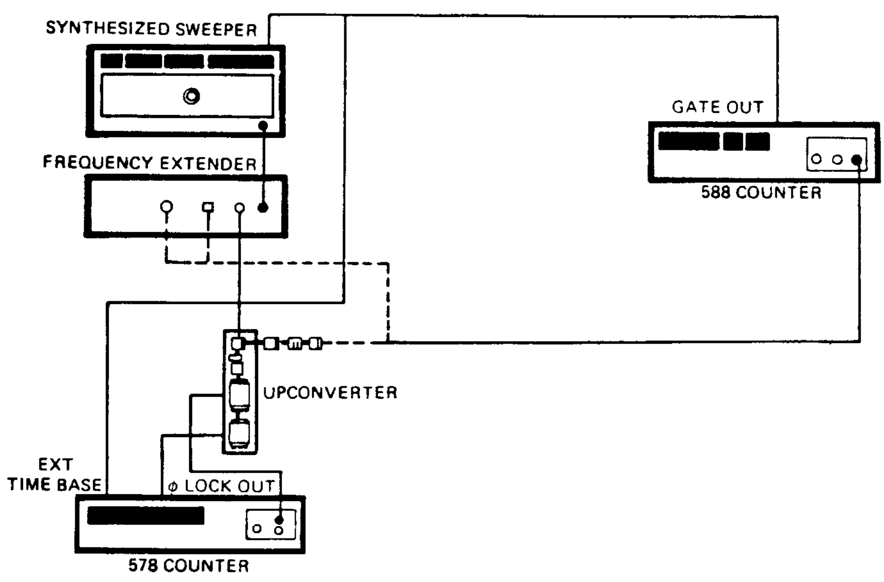

Figure 4-5. Band 3 Minimum and Maximum Frequency Setup

PROCEDURE

1. Connect equipment as shown in Figure 4-5.
2. For each sub-band, per Table 4-3:
   a. Set the frequency to the minimum specified frequency. Set measurement averaging to 10.
   b. Vary the power from the specified minimum to the specified maximum and verify that the counter measures accurately.
   c. Set the frequency to the maximum specified frequency.
   d. Vary the power from the specified minimum to the specified maximum and verify that the counter measures accurately.

Table 4-3. Maximum and Minimum Frequency and Power

BAND	MINIMUM FREQUENCY (GHz)	MAXIMUM FREQUENCY (GHz)	MINIMUM POWER (dBm)	MAXIMUM POWER (dBm)
3-1 (Ka)	26.5	40	-20	+5
3-2 (Q)	33	50	-20	+5
3-3 (U)	40	60	-20	+5
3-4 (V)	50	75	-20/-15	+5
3-5 (E)	60	90	-15	+5
3-6 (W)	75	110	-15	+5

SENSITIVITY/BAND 1 (Option 5802 only)

DESCRIPTION

This test verifies that the counter measures a -15 dBm signal within the Band 1 range of 300 MHz to 1 GHz with an accuracy of ±1 kHz of the input frequency.

EQUIPMENT

Synthesized Sweeper	Hewlett Packard 8340A
Power Meter	Pacific Measurements 1045

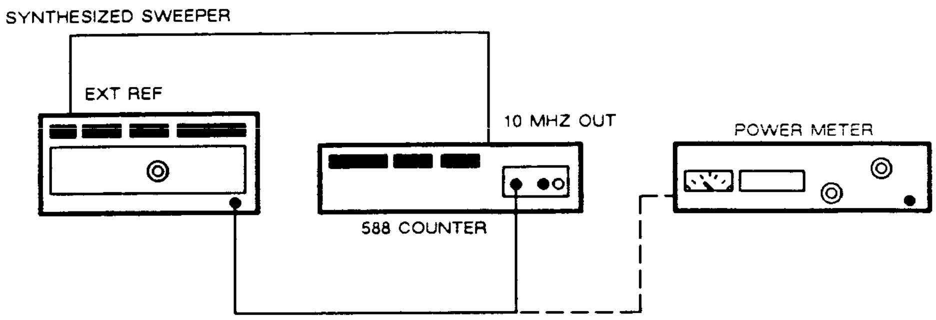

Figure 4-6. Band 1 Sensitivity Test Setup

PROCEDURE

1. Connect equipment as shown in Figure 4-6.
2. Set the counter to Band 1. Set measurement averaging to 10. Set the signal generator for an input power of -15 dBm
3. Vary the signal generator frequency in 100-MHz steps from 300 MHz to 1 GHz. Verify from the counter display that the reading is within ±1 kHz of the signal generator input frequency.

SENSITIVITY/BAND 2

DESCRIPTION

This test verifies that the counter measures a Band 2 signal at the specified power level with an accuracy of ±1 kHz of the input frequency. The sensitivity of Band 2 is listed in Table 4-4.

Table 4-4. Band 2 Sensitivity

POWER LEVEL (dBm)	BAND 2 FREQUENCY RANGE (GHz)
-20	0.95 - 12.4
-15	12.4 - 18
-10	18 - 26.5 (588 only)

EQUIPMENT

Synthesized Sweeper	Hewlett Packard 8340A
Power Meter	Pacific Measurements 1045
Low-Attenuation Coaxial Cables (2)	Gore P2S01S01036.0

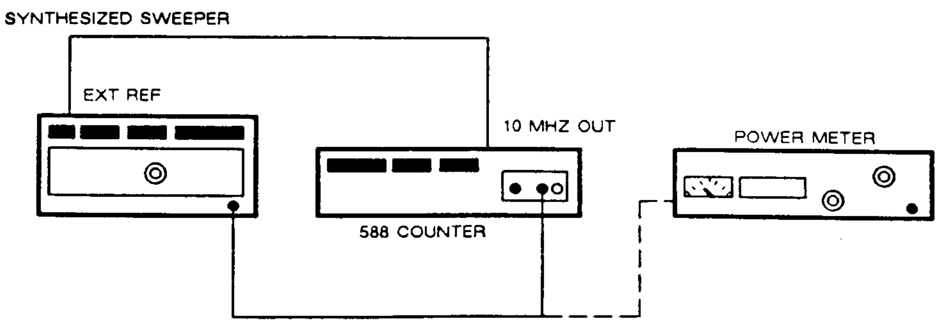

Figure 4-7. Band 2 Sensitivity Test Setup

PROCEDURE

1. Connect equipment as shown in Figure 4-7.
2. Set the signal generator frequency to 950 MHz and the power level so that the input signal to the counter is -20 dBm Set measurement averaging to 10.
3. Verify from the counter display that the frequency measurement reading of the input signal is within ±1 kHz of the input signal.
4. Repeat step 3 every 500 MHz up to 12.4 GHz. Adjust the signal generator power output as necessary to keep the power at -20 dBm.
5. Set the signal generator power level so that the input signal to the counter is -15 dBm.
6. Repeat step 3 up to 18 GHz. Adjust the signal generator power output as necessary to keep the power at -15 dBm.
7. Set the signal generator power level so that the input signal to the counter is -10 dBm.
8. Repeat step 3 up to 26.5 GHz. Adjust the signal generator power output as necessary to keep the power at -10 dBm.

NOTE

Steps 7 and 8 are only for Model 588.

SENSITIVITY/BAND 3 (Option 5804 only)

NOTE

Band 3 is operated in conjunction with Model 890 and one or more remote sensors. The Band 3 tests are designed to test the entire band and it is assumed the proper remote sensor(s) are connected for each sub-band. Because of the complicated test setups required for Band 3, the user may wish to test only specific sub-band(s).

DESCRIPTION

This test verifies that the counter measures a Band 3 signal at the specified power level with an accuracy of ±1 kHz of the input frequency. The sensitivity of Band 3 is listed in Table 4-5.

Table 4-5. Band 3 Sensitivity

POWER LEVEL (dBm)	FREQUENCY RANGE (GHz)
-20	26.5 - 60
-15	60 - 110

EQUIPMENT

Synthesized Sweeper	Hewlett Packard 8340A
Frequency Extender	Watkins Johnson 1204-42
Upconverters, 60 to 110 GHz	See "Special Equipment"
Frequency Counter	EIP 578
Remote Sensors	EIP 891-895

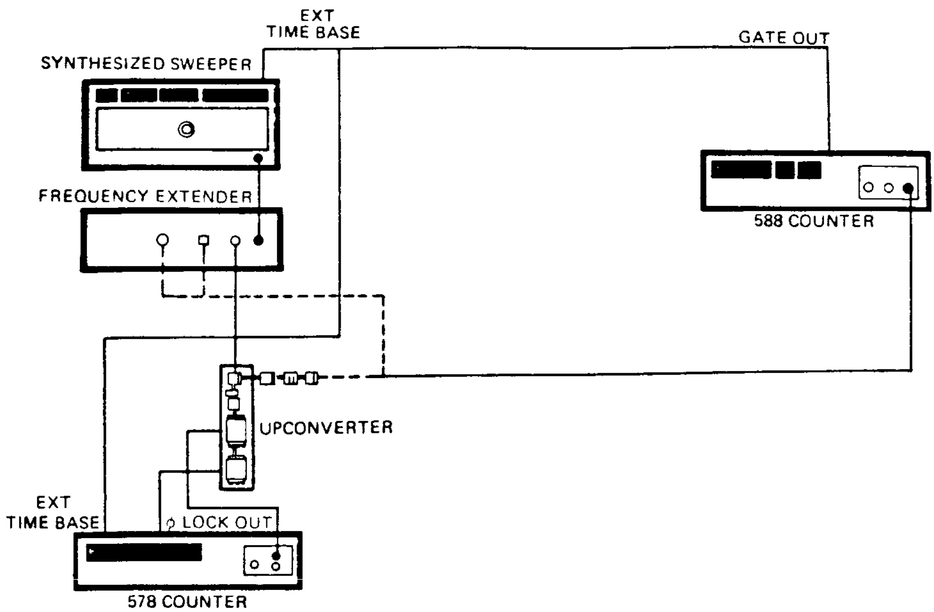

Figure 4-8. Band 3 Sensitivity Test Setup

PROCEDURE

1. Connect equipment as shown in Figure 4-8.
2. Set the input frequency to the counter [illegible].5 GHz. Set the counter to Band 3-1. Set measurement averaging to [illegible]0.
3. Set the power level to -20 dBm.
4. Verify from the counter display that the measurement reading of the input signal is correct.
5. Repeat steps 3 and 4 every 500 MHz up to 60 GHz, changing sources, Band 3 sub-bands, and remote sensors as necessary.
6. Set the power level to -15 dBm.
7. Verify from the counter display that the measurement reading of the input signals is correct.
8. Repeat steps 6 and 7 every 500 MHz up to 110 GHz, changing sources, Band 3 sub-bands, and remote sensors as necessary.

MAXIMUM INPUT/BAND 1 (Option 5802 only)

DESCRIPTION

This test verifies that the counter measures a Band 1 signal at the maximum specified power level within ±1 kHz of the input frequency.

EQUIPMENT

Synthesized Sweeper	Hewlett Packard 8340A
Power Meter	Pacific Measurements 1045

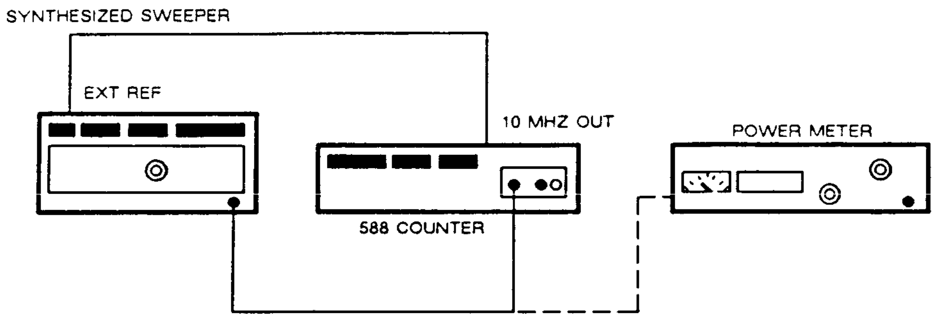

Figure 4-9. Band 1 Maximum Power Level Test Setup

PROCEDURE

1. Connect equipment as shown in Figure 4-9.
2. Set the frequency of the synthesized signal generator to 300 MHz and the power level to +7 dBm Set the counter to Band 1. Set measurement averaging to 10.
3. Verify from the counter display that the reading is within ±1 kHz of the input frequency.
4. Repeat step 3 every 100 MHz up to 1 GHz.

MAXIMUM INPUT/BAND 2

DESCRIPTION

This test verifies that the counter measures a Band 2 signal at the maximum specified power level within ±1 kHz of the input frequency.

EQUIPMENT

Synthesized Sweeper	Hewlett Packard 8340A
Power Meter	Pacific Measurements 1045
Low Attenuation Coaxial Cable	Gore P2S01S01036.0

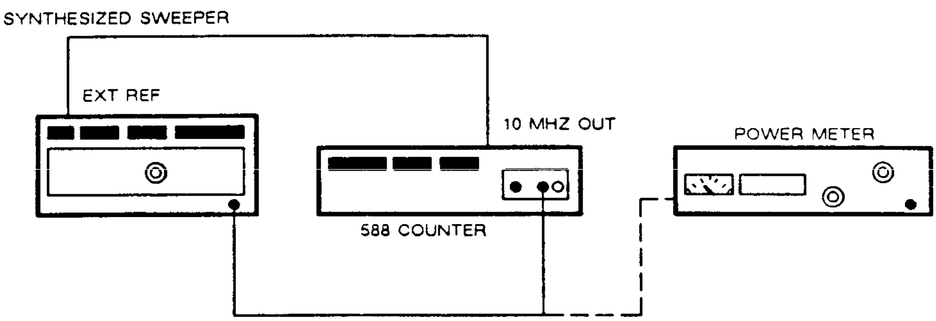

Figure 4-10. Band 2 Maximum Power Level Test Setup

PROCEDURE

1. Connect equipment as shown in Figure 4-10.
2. Set the synthesized signal generator frequency to 950 MHz and the power level so that the input signal to the counter is +7 dBm.
3. Set the counter to Band 2. Set measurement averaging to 10.
4. Verify from the counter display that the frequency measurement reading is within ±1 kHz of the input signal.
5. Repeat step 3 every 500 MHz up to 18 GHz (26.5 GHz for Model 588). Adjust the signal generator power output as necessary to keep the power at +7 dBm.

MAXIMUM INPUT/BAND 3 (Option 5804 only)

DESCRIPTION

This test verifies that the counter measures a Band 3 signal at the maximum specified power level within ±1 kHz of the input frequency.

EQUIPMENT

Synthesized Sweeper	Hewlett Packard 8340A
Frequency Extender	Watkins Johnson 1204-42
Upconverters, 60 to 110 GHz	See "Special Equipment"
Frequency Counter	EIP 578
Remote Sensors	EIP 591-595
Power Meter	Hewlett Packard 432

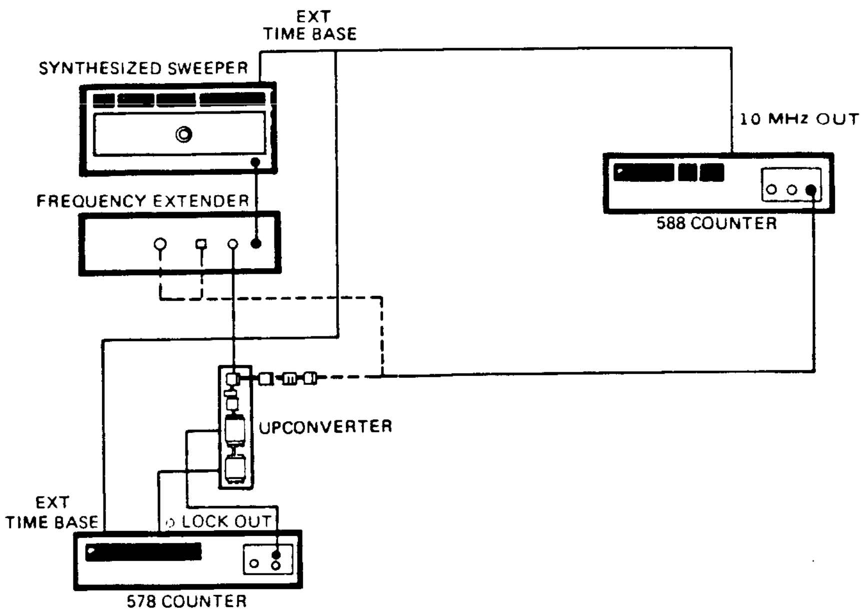

Figure 4-11. Band 3 Maximum Power Level Test Setup

PROCEDURE

1. Connect equipment as shown in Figure 4-11.
2. Set the frequency input to the counter at 26.5 GHz. Set measurement averaging to 10.
3. Set the power level to +5 dBm, or the maximum available power, whichever is lower.
4. Verify from the counter display that the measurement reading of the input signal is correct.
5. Repeat steps 3 and 4 up to 110 GHz, changing bands, sources and remote sensors as necessary.

AMPLITUDE DISCRIMINATION/BAND 1 (Option 5802 only)

DESCRIPTION

This test verifies that the counter will measure accurately the larger of two signals differing in amplitude by more than 10 dB.

EQUIPMENT

Synthesized Sweepers (2)	Hewlett Packard 8340A
10-dB Directional Coupler	Merrimac CR-15-500
Spectrum Analyzer	Hewlett Packard 8566A

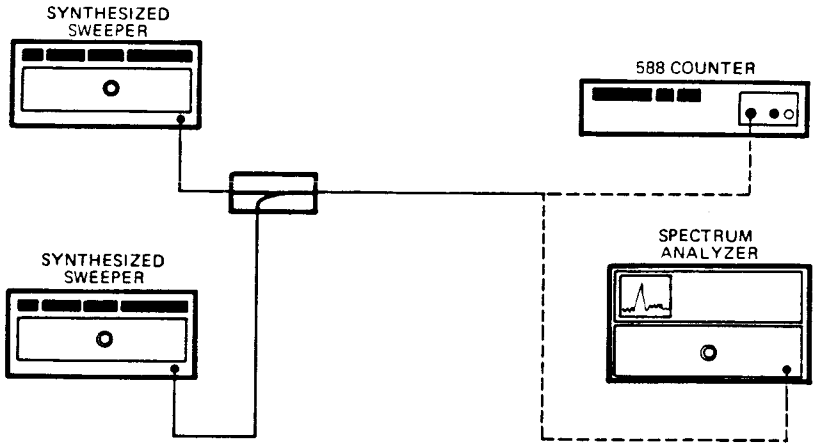

Figure 4-12. Band 1 Amplitude Discrimination Test Setup

PROCEDURE

1. Connect equipment as shown in Figure 4-12.
2. Set the first signal generator to 300 MHz at 0 dBm. Set the second signal generator to 400 MHz at 0 dBm (to provide -10 dBm at the output of the coupler).
3. Verify that the counter correctly measures the frequency of the higher power signal source.
4. Repeat steps 2 and 3 with the signal generators at 900 MHz and 1 GHz.

AMPLITUDE DISCRIMINATION/BAND 2

DESCRIPTION

This test verifies that the counter will measure accurately the larger of two signals differing in amplitude by 10 dB or more.

EQUIPMENT

Synthesized Sweepers (2)	Hewlett Packard 8340A
16-dB Directional Coupler	Narda 4222-16
Low-Attenuation Coaxial Cables (3)	Gore P2S01S01036.0
Spectrum Analyzer	Hewlett Packard 8566A

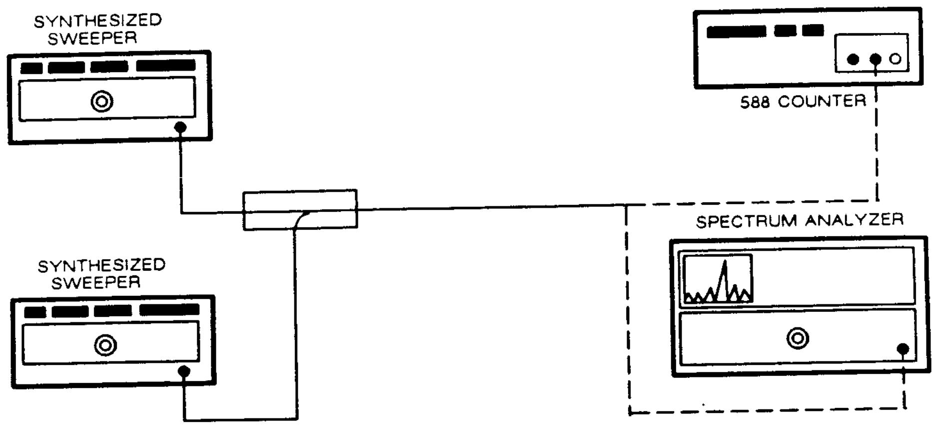

Figure 4-13. Band 2 Amplitude Discrimination Test Setup

PROCEDURE

1. Connect equipment as shown in Figure 4-13.
2. Set first signal generator to 3.000 GHz at 0 dBm and second signal generator to 3.2 GHz at +6 dBm.
3. Adjust the power level so that the difference is 10 dB.
4. Verify that the counter correctly measures the frequency of the higher power signal source.
5. Repeat steps 2 to 4 at 12 and 12.2 GHz and at 17.8 and 18 GHz.

AMPLITUDE DISCRIMINATION/BAND 3 (Option 5804 only)

DESCRIPTION

This test verifies that the counter will accurately measure the larger of two signals differing in amplitude by more than 20 dB.

EQUIPMENT

Synthesized Sweeper	Hewlett Packard 8340A
Upconverter, 90-100 GHz	See "Special Equipment"
Gunn Diode Oscillator, 94 GHz	Hughes 47226H-1600
10-dB Coupler	Hughes 45326H-1010
Power Meter	Hewlett Packard 432A
Sensor for Power Meter, 90-110 GHz	Hughes 45776H-1400

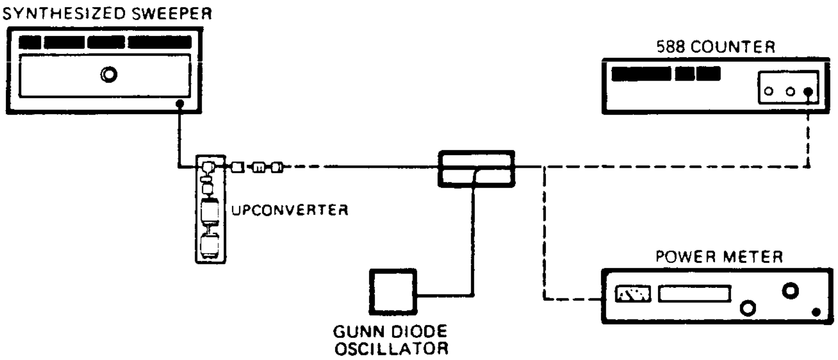

Figure 4-14. Band 3 Amplitude Discrimination Test Setup

PROCEDURE

1. Connect equipment as shown in Figure 4-14.
2. Turn the Gunn diode oscillator on. Measure the frequency on the counter and the power on the power meter.
3. Turn the Gunn diode oscillator off, and the synthesizer on. Set the synthesizer power to 20 dB below the Gunn diode oscillator and set the frequency 100 MHz away.
4. Turn the Gunn diode oscillator on. Connect the signal to the counter and verify that the counter measures accurately.

GATE ERROR/BAND 1 (Option 5802 only)

DESCRIPTION

This test verifies that the gate error in Band 1 is within the limits defined by the equation:

$$GE = (\pm 0.07) \ / \ (GW)$$

where GE is the gate error in Hz
GW in seconds is the logical AND of inhibit and pulse width minus 30 ns

The measurement is performed with a CW input signal and inhibit signal.

EQUIPMENT

Synthesized Sweeper	Hewlett Packard 8340A
Pulse Generator	Wavetek 801
Oscilloscope	Tektronix 475

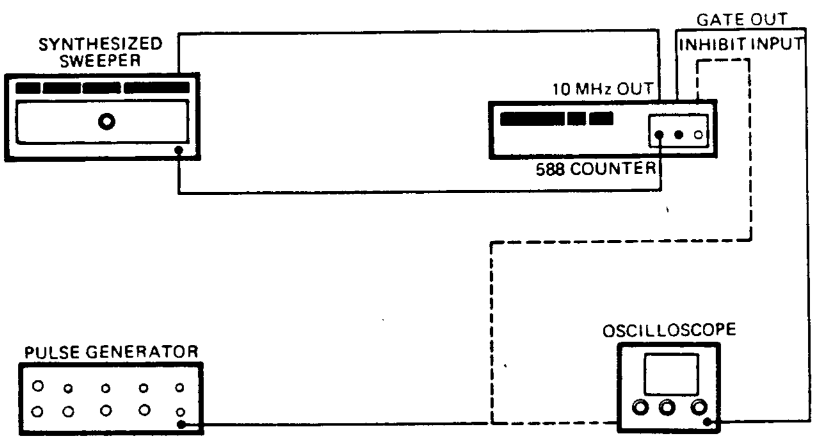

Figure 4-15. Band 1 Gate Error Test Setup

PROCEDURE

1. Connect equipment as shown in Figure 4-15.
2. Set the pulse generator to complementary mode, 0 volt to -1 volt pulse amplitude measured with 50 ohms load, 1 MHz PRF, and 50 ns pulse width.
3. Set the counter to Band 1; set the averaging feature to 99.
4. Set the synthesized sweeper frequency to 300 MHz and power to 0 dBm. The CW reading on the counter display should be equal to the input frequency ± 1 kHz.
5. Connect the pulse generator output to the inhibit input of the counter. Connect the gate output from the counter to the oscilloscope. Adjust the inhibit pulse width until the average gate width is 20 ns. Verify that the reading on the counter display is within the limits of the gate error.
6. Repeat step 4 and 5 with 100 ns and 1 μs gate width while keeping the duty cycle (the ratio of the pulse width to pulse period) constant.
7. Repeat the measurements at 650 MHz and 1 GHz.

GATE ERROR/BAND 2

DESCRIPTION

This test verifies that the gate error in Band 2 is within the limits defined by the equation:

$$GE = (\pm 0.01) / (GW)$$

where GE is the gate error in Hz
GW in seconds is the logical AND of inhibit and pulse width minus 30 ns

The measurement is performed with a CW input signal and inhibit signal.

EQUIPMENT

Synthesized Sweeper	Hewlett Packard 8340A
Pulse Generator	Wavetek 801
Oscilloscope	Tektronix 475
Low-Attenuation Coaxial Cable	Gore P2S01S01036.0

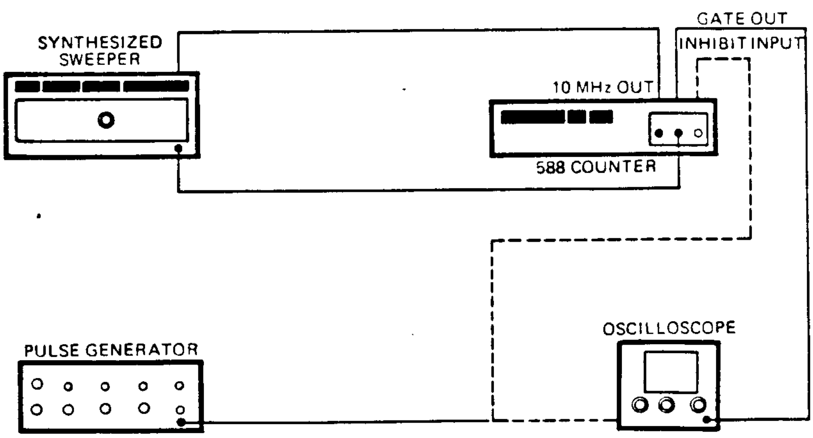

Figure 4-16. Band 2 Gate Error Test Setup

PROCEDURE

1. Connect equipment as shown in Figure 4-16 and turn equipment on.
2. Set the pulse generator to complementary mode, 0 volt to -1 volt pulse amplitude measured with 50 ohms load, 1 MHz PRF, and 50 ns pulse width.
3. Set the counter to Band 2; set the averaging feature to 99.
4. Set the synthesized signal generator frequency to 3 GHz. Set the power so that the input signal at Band 2 is 0 dBm. The CW reading on the counter display should be equal to the input frequency ±1 kHz.
5. Connect the pulse generator output to the inhibit input of the counter. Connect the gate output from the counter to the oscilloscope. Adjust the inhibit pulse width until the average gate width is 20 ns. Verify that the reading on the counter display is within the limits of the gate error.
6. Repeat step 4 and 5 with 100 ns and 1 μs gate width while keeping the duty cycle (the ratio of the pulse width to pulse period) constant.
7. Repeat the measurements every 3 GHz up to 18 GHz (26.5 GHz for 588).

GATE ERROR/BAND 3 (Option 5804 only)

DESCRIPTION

This test verifies that the gate error in Band 3 is within the limits defined by the equation:

$$GE = (\pm 0.03) / (GW)$$

where: GE is the gate error in Hz
GW in seconds is the logical AND of inhibit and pulse width minus 30 ns

The measurement is performed with a CW input signal and inhibit signal.

EQUIPMENT

Synthesized Sweeper	Hewlett Packard 8340A
Frequency Extender	Watkins Johnson 1204-42
Upconverters, 60 to 110 GHz	See "Special Equipment"
Frequency Counter	EIP 578
Remote Sensors	EIP 591-595
Pulse Generator	Wavetek 801
Oscilloscope	Tektronix 475

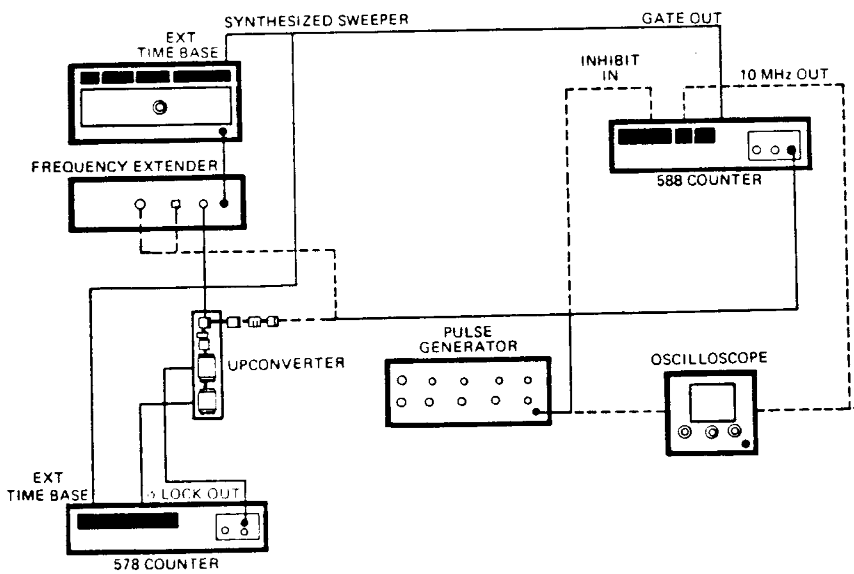

Figure 17. Band 3 Gate Error Test Setup

PROCEDURE

1. Connect equipment as shown in Figure 4-17.
2. Set the pulse generator to complementary mode, 0 volt to -1 volt pulse amplitude into a 50-ohm load, 1 MHz PRF, and 50 ns pulse width.
3. Set the counter to Band 3-1. Set the averaging feature to 99.
4. Set the input frequency to the counter to 26.5 GHz, and the power to approximately -10 dBm. The CW reading on the counter should be equal to the input frequency.
5. Connect the pulse generator output to the inhibit input of the counter. Connect the gate output from the counter to the oscilloscope. Adjust the inhibit pulse width until the average width is 20 ns. Verify that the reading on the counter is within the limits of the gate error.
6. Repeat steps 4 and 5 with 100 ns and 1 μs gate width while keeping the duty cycle (the ratio of pulse width to pulse period) constant.
7. Repeat the measurements at 30 GHz and every 5 GHz to 110 GHz, changing sources and Band 3 sub-bands as necessary.

DISTORTION ERROR/BAND 1 (Option 5802 only)

DESCRIPTION

This test verifies that the distortion error in Band 1 is within the limits defined by the equation:

$$DE = (\pm 0.03) / (PW - 3 \times 10^{8})$$

where DE is distortion error in Hz
PW is pulse width in seconds

The measurement is performed by counting the frequency of a pulsed signal and subtracting the gate error from the result.

NOTE

Gate error must be known (See Gate Error test in this section) before performing this test.

EQUIPMENT

Synthesized Sweeper	Hewlett Packard 8340A
Pulse Generator	Wavetek 801
Pulse Modulator (300 MHz to 1 GHz)	See "Special Equipment"
Oscilloscope	Tektronix 475
6-dB Attenuator (dc to 1 GHz)	Texscan FP-50

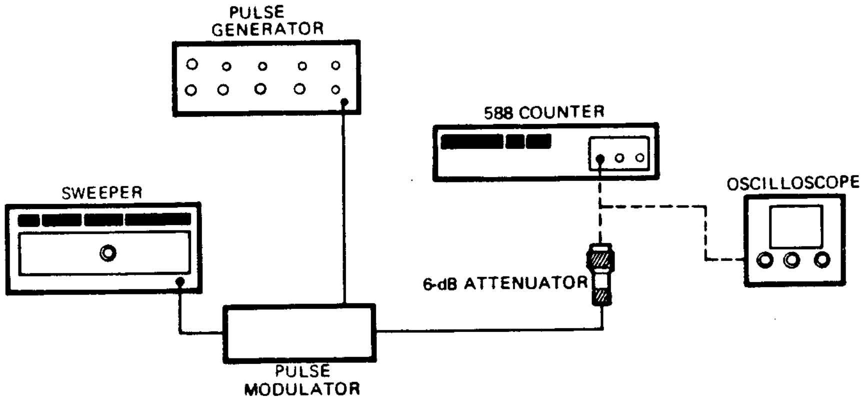

Figure 4-18. Band 1 Distortion Error Test Setup

PROCEDURE

1. Connect equipment as shown in Figure 4-18. The 6-dB attenuator should be at the input of the the counter.
2. Set the counter to Band 1. Set average to 99.
3. Connect the signal to the oscilloscope as shown. Set the synthesized sweeper frequency to 100 MHz and power to +10 dBm.
4. Set the pulse generator to 1 MHz PRF, 50 ns pulse width, and +3.0 to -0.5 volts.
5. Adjust the pulse width and voltage levels slightly until the pulsed RF signal is 50 ns wide and has a good on/off ratio.
6. Take one measurement.
7. Calculate:

   Distortion Error = (Current Measurement) - (Gate Error)

   Gate error is the error measured by the Gate Error Test in this section.
8. Verify that the distortion error is within the specification.
9. Repeat steps 4 to 8 with 100 ns, and 1 μs pulse width while keeping the duty cycle (the ratio of the pulse width to pulse period) constant.
10. Repeat steps 4 to 9 every 100 MHz up to 1 GHz.

DISTORTION ERROR/BAND 2

DESCRIPTION

This test verifies that the distortion error in Band 2 is within the limits defined by the equation:

$$DE = (\pm 0.03) / (PW - 3 \times 10^{-8})$$

where DE is distortion error in Hz
PW is pulse width in seconds

The measurement is performed by counting the frequency of a pulsed signal and subtracting the gate error from the result.

EQUIPMENT

Synthesized Sweeper	Hewlett Packard 8340A
Pulse Modulator	Hewlett Packard 11720A
Pulse Generator	Wavetek 801
Oscilloscope	Tektronix 475
3-dB Attenuators (3) (up to 26.5 GHz)	Weinschel 9-3
Low-Attenuation Coaxial Cable	Gore P2S01S01036.0
Detector	Hewlett Packard 8473B

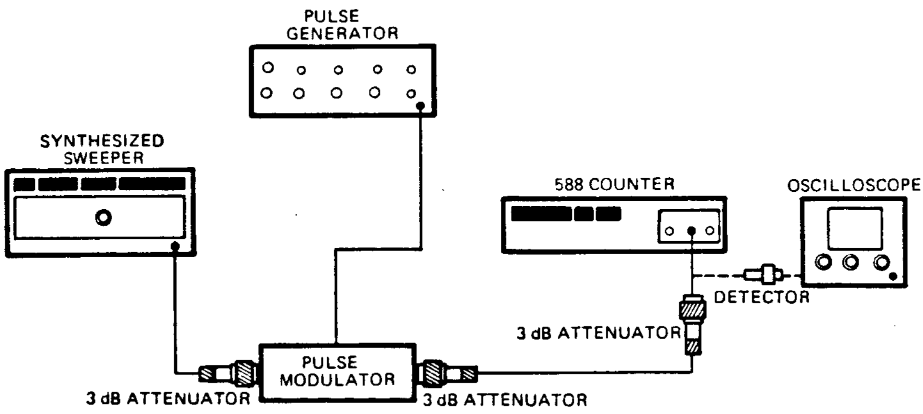

Figure 4-19. Band 2 Distortion Error Test Setup

PROCEDURE

1. Connect equipment as shown in Figure 4-19. The 3-dB attenuators should be at the IN and OUT ports of the pulse modulator, and at the input to the counter.
2. Set the counter to Band 2. Set the averaging feature to 99.
3. Connect the signal through the detector to the oscilloscope as shown. (The detector must be terminated in a low- impedance device, such as a 50-ohm feedthrough, to detect the narrow pulses adequately). Set the synthesized sweeper frequency to 2 GHz and power to +10 dBm.
4. Set the pulse generator to 1 MHz PRF, 50 ns pulse width, and +3.0 to -0.5 volts.
5. Adjust the pulse width and voltage levels slightly until the pulsed RF signal is 50 ns wide and has a good on/off ratio.
6. Take one measurement.
7. Calculate:

   Distortion Error = (Current Measurement) - (Gate Error)

   Gate error is the error measured by the Gate Error Test in this section.
8. Verify that the distortion error is within the specification.
9. Repeat steps 4 to 8 with 100 ns, and 1 μs pulse width while keeping the duty cycle (the ratio of the pulse width to pulse period) constant.
10. Repeat steps 5 through 9 at 10 GHz and 18 GHz.

DISTORTION ERROR/BAND 3 (Option 5804 only)

DESCRIPTION

This test verifies that the distortion error in Band 3 is within the limits defined by the equation:

$$DE = (\pm 0.03) / (PW - 3 \times 10^{8})$$

where DE is distortion error in Hz
PW is pulse width in second

The measurement is performed by counting the frequency of a pulsed signal and subtracting the gate error from the result.

NOTE

Gate error must be known (See Gate Error test in this section) before performing this test.

EQUIPMENT

Synthesized Sweeper	Hewlett Packard 8340A
Pulse Generator	Wavetek 801
Pulse Modulator (300 MHz to 1 GHz)	See "Special Equipment"
Oscilloscope	Tektronix 475
6-dB Attenuator (dc to 1 GHz)	Texscan FP-50

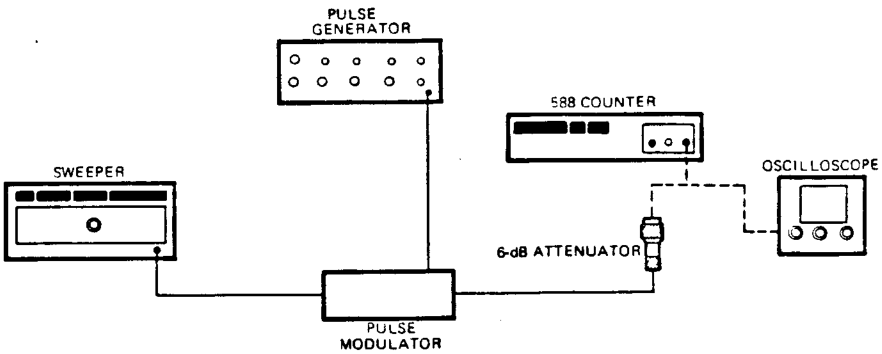

Figure 4-20. Band 3 Distortion Error Test Setup

PROCEDURE

1. Connect equipment as shown in Figure 4-20.
2. Set the counter to Band 3. Set the average to 99.
3. Connect the signal through the remote sensor (using it as a detector) to the oscilloscope as shown. Set the synthesized sweeper frequency to 26.5 GHz and power to +10 dBm.
4. Set the pulse generator to 1 MHz PRF and 50 ns pulse width at +3.0 to -0.5 volts.
5. Adjust the pulse width and voltage levels slightly until the pulsed RF signal is 50 ns wide and has a good on/off ratio.
6. Take one measurement.
7. Calculate:

   Distortion Error = (Current Measurement) - (Gate Error)

   Gate error is the error measured by the Gate Error Test in this section.
8. Verify that the distortion error is within the specification.
9. Repeat steps 4 to 8 with 100 ns and 1 μs pulse width while keeping the duty cycle (the ratio of the pulse width to pulse period) constant.
10. Repeat steps 4 through 9 every 5 GHz up to 110 GHz.

AVERAGING JITTER/BAND 1 (Option 5802 only)

DESCRIPTION

This test verifies that the averaging jitter in Band 1 is within the limits defined by the equation:

$$AJ = \pm (2) \sqrt{[RES / (GW)(AVE)]}$$

where AJ is the RMS averaging jitter in Hz.

RES is the specified instrument resolution in Hz. (This is true up to 1 MHz resolution. Above 1 MHz resolution, RES is 10^6 Hz.)

GW in seconds is the logical AND of inhibit and pulse width minus 3×10^{-8} seconds.*
*For this test, gate width will be set to 20 ns.

AVE is the number of specified count average.

The measurement is performed by counting the frequency of n pulsed signals and calculating the sample variance given as:

$$S = \sqrt{\sum_{I=0}^{I=n-1} (F_I - F_{ave})^2 / (n-1)}$$ (standard deviation)

where F_{ave} is the average frequency measurement minus the gate error and the distortion error and F_I is the current reading.

EQUIPMENT

Synthesized Sweeper	Hewlett Packard 8340A
Pulse Generator	Wavetek 801
Oscilloscope	Tektronix 475

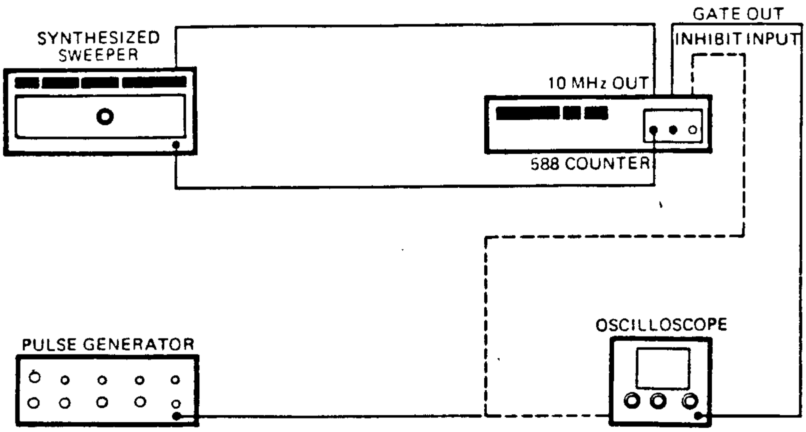

Figure 4-21. Band 1 Averaging Jitter Test Setup

PROCEDURE

1. Connect equipment as shown in Figure 4-21.
2. Set the pulse generator to complementary mode, 0 volt to -1 volt pulse amplitude measured with 50 ohms load, 1 MHz PRF, and 50 ns pulse width.
3. Set the counter to Band 1; set the averaging feature to 99.
4. Set the synthesized sweeper frequency to 300 MHz and power to 0 dBm. The CW reading on the counter display should be equal to the input frequency ±1 kHz.
5. Connect the pulse generator output to the inhibit input of the counter. Connect the gate output from the counter to the oscilloscope. Adjust the inhibit pulse width until the average gate width is 20 ns.
6. Take one frequency measurement. This reading is F_{ave}.
7. Turn the averaging function off. Turn the SAMPLE RATE knob on the front panel to the HOLD position.
8. Take ten measurements by pressing the TRIG key ten times.
9. Calculate:

$$S = \sqrt{\sum_{i=0}^{i=n-1} (F_i - F_{ave})^2 \ (9)}$$

10. Calculate:

$$AJ = \pm (2) \sqrt{(RES / (GW)(AVE))}$$

11. Verify that S < AJ
12. Set the signal generator to 1 GHz. Repeat steps 4 through 11.

AVERAGING JITTER/BAND 2

DESCRIPTION

This test verifies that the averaging jitter in Band 2 is within the limits defined by the equation:

$$AJ = \pm \sqrt{[RES\ (GW)(AVE)]}$$

where AJ is the RMS averaging jitter in Hz.

RES is the specified instrument resolution in Hz. (This is true up to 1 MHz resolution. Above 1 MHz resolution, RES is 10^6 Hz.)

GW in seconds is the logical AND of inhibit and pulse width minus 3×10^{-8} seconds.

AVE is the number of specified count average.

The measurement is performed by counting the frequency of n pulsed signals and calculating the sample variance given as:

$$S = \sqrt{\sum_{i=0}^{i=n-1} (F_i - F_{ave})^2 / (n-1)} \qquad \text{(standard deviation)}$$

where F_{ave} is the average frequency measurement minus the gate error and the distortion error and F_i is the current reading.

EQUIPMENT

Synthesized Sweeper	Hewlett Packard 8340A
Pulse Generator	Wavetek 801
Oscilloscope	Tektronix 475
Low-Attenuation Coaxial Cable	Gore P2S01S01036.0

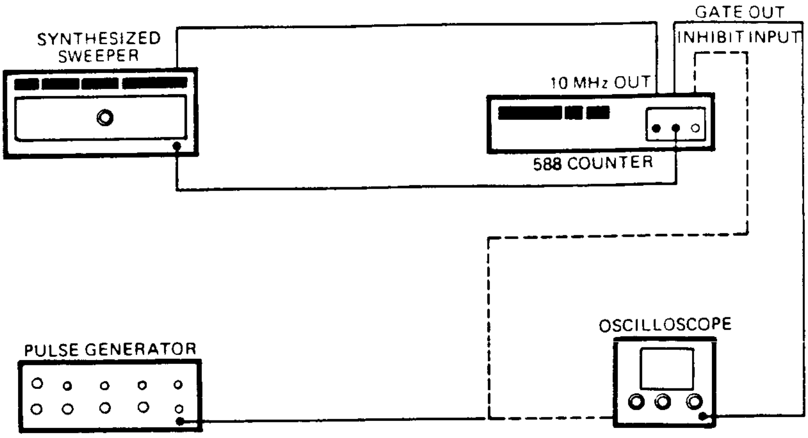

Figure 4-22. Band 2 Averaging Jitter Test Setup

PROCEDURE

1. Connect equipment as shown in Figure 4-22 and turn equipment on.
2. Set the pulse generator to complementary mode, 0 volt to -1 volt pulse amplitude measured with 50 ohms load, 1 MHz PRF, and 50 ns pulse width.
3. Set the counter to Band 2; set the averaging feature to 99.
4. Set the synthesized signal generator frequency to 3 GHz. Set the power so that the input signal at Band 2 is 0 dBm. The CW reading on the counter display should be equal to the input frequency ±1 kHz.
5. Connect the pulse generator output to the inhibit input of the counter. Connect the gate output from the counter to the oscilloscope. Adjust the inhibit pulse width until the average gate width is 20 ns.
6. Take one frequency measurement. This reading is F_{ave}.
7. Turn the averaging function off. Turn the SAMPLE RATE knob on the front panel to the HOLD position.
8. Take ten measurements by pushing the TRIG function key ten times.
9. Calculate:

$$S = \sqrt{\sum_{i=0}^{i=n-1} (F_i - F_{ave})^2 / (9)}$$

10. Calculate:

$$AJ = \pm \sqrt{[RES / (GW)(AVE)]}$$

11. Verify that $S < AJ$

AVERAGING JITTER/BAND 3 (Option 5804 only)

DESCRIPTION

This test verifies that the averaging jitter in Band 3 is within the limits defined by the equation:

$$\pm (2) \sqrt{[RES / (GW)(AVE)]}$$

AJ is the RMS averaging jitter in Hz.

RES is the specified instrument resolution in Hz. (This is true up to 1 MHz resolution. Above 1 MHz resolution, RES is 10^6 Hz.)

GW in seconds is the logical AND of inhibit and pulse width minus $3x10^{-8}$ seconds.

AVE is the number of specified count average.

The measurement is performed by counting the frequency of n pulsed signals and calculating the sample variance given as:

$$S = \sqrt{\sum_{i=0}^{i=n-1} (F_i - F_{ave})^2 / (n-1)} \qquad \text{(standard deviation)}$$

where F_{ave} is the average frequency measurement minus the gate error and the distortion error and F_i is the current reading.

EQUIPMENT

Synthesized Sweeper	Hewlett Packard 8340A
Frequency Extender	Watkins Johnson 1204-42
Upconverters, 60 to 110 GHz	See "Special Equipment"
Frequency Counter	EIP 578
Remote Sensors	EIP 591-595
Pulse Generator	Wavetek 801
Oscilloscope	Tektronix 475

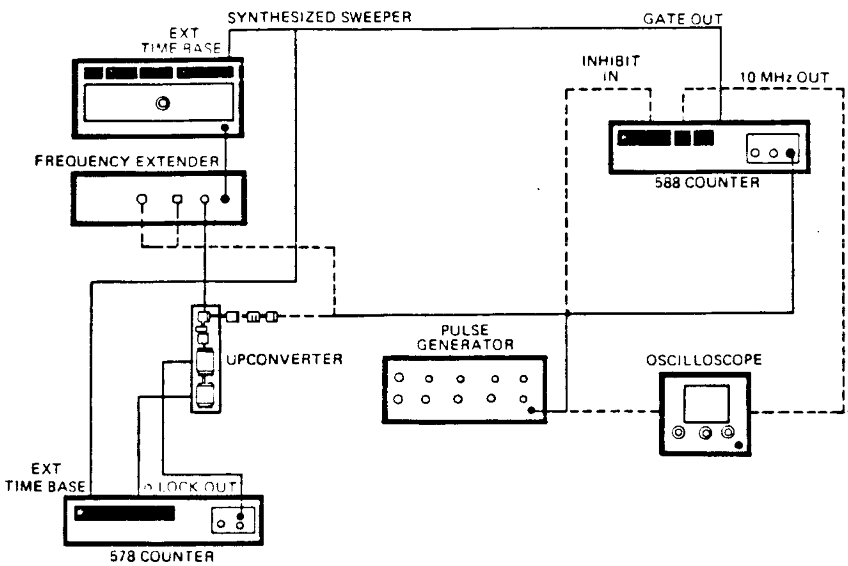

Figure 4-23. Band 3 Averaging Jitter Test Setup

PROCEDURE

1. Connect equipment as shown in Figure 4-23.
2. Set the pulse generator to complementary mode, 0 volt to -1 volt pulse amplitude into a 50 ohm load, 1 MHz PRF, and 50 ns pulse width.
3. Set the counter to Band 3-1. Set the averaging feature to 99.
4. Set the input frequency to the counter to 33 GHz and the power to approximately -10 dBm. The CW reading on the counter should be equal to the input frequency.
5. Connect the pulse generator output to the inhibit input of the counter. Connect the gate output from the counter to the oscilloscope. Adjust the inhibit pulse width until the average width is 20 ns.
6. Take one frequency measurement. This reading is F_{ave}.
7. Turn the averaging function off. Turn the SAMPLE RATE knob on the front panel to the HOLD position.
8. Take ten measurements by pressing the TRIG key ten times.
9. Calculate:

$$S = \sqrt{\sum_{i=0}^{i=n-1} (F_i - F_{ave})^2 / (9)}$$

10. Calculate:

$$AJ = \pm (2) \sqrt{[RES / (GW)(AVE)]}$$

11. Verify that S < AJ
12. Repeat steps 5 through 11 changing sources as necessary at the following frequencies:

Band 3-2 41 GHz
Band 3-3 50 GHz
Band 3-4 62 GHz
Band 3-5 75 GHz
Band 3-6 92 GHz

FREQUENCY LIMITS/BAND 2

DESCRIPTION

This test verifies that the instrument will ignore signals outside of frequency limits.

EQUIPMENT

Synthesized Sweeper	Hewlett Packard 8340A
Low-Attenuation Coaxial Cable	Gore P2S01S01036.0

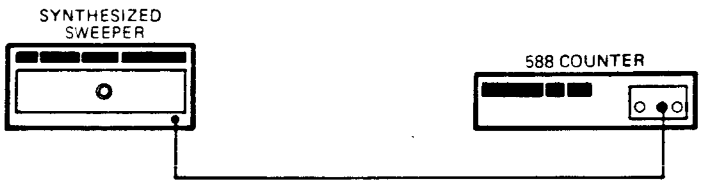

Figure 4-24. Band 2 Frequency Limits Test Setup

PROCEDURE

1. Connect equipment as shown in Figure 4-24.
2. Set the counter to Band 2 and press keys for FREQ LIMIT LOW, 3 GHz.
3. Set the signal generator to the low frequency limit minus 150 MHz. Set the power level to +7 dBm at the input to Band 2.
4. Increase the signal generator frequency until a frequency reading appears on the display. Verify that this frequency is between the low frequency limit minus 100 MHz and the low frequency limit plus 50 MHz.
5. Clear the frequency limit low. Set the frequency limit high to 3 GHz.
6. Set the signal generator to the high frequency limit plus 150 MHz.
7. Decrease the signal generator frequency until a frequency reading appears on the display. Verify that this frequency is between the high frequency limit plus 100 MHz and the high frequency limit minus 50 MHz.

CENTER FREQUENCY/BAND 2

DESCRIPTION

This test verifies that the counter locks on a signal ±50 MHz from the center frequency.

EQUIPMENT

Synthesized Sweeper	Hewlett Packard 8340A
Low-Attenuation Coaxial Cable	Gore P2S01S01036.0

Figure 4-25. Band 2 Center Frequency Test Setup

PROCEDURE

1. Connect equipment as shown in Figure 4-25.
2. Set the counter to Band 2 and press the keys for CENTER FREQUENCY 3 GHz.
3. Set the signal generator to the center frequency minus 50 MHz. Set the power level to the sensitivity level. Verify that the reading on the counter display is accurate.
4. Set the signal generator to the center frequency plus 50 MHz. Verify that the reading on the counter display is accurate.

MAXIMUM VIDEO/BAND 1 (Option 5802 only)

DESCRIPTION

This test verifies that frequency measurement accuracy is maintained in the presence of a video signal in excess of 20 dB below the RF signal.

EQUIPMENT

Synthesized Sweeper	Hewlett Packard 8340A
Dual-directional Coupler	Narda 3022
Pulse Generators (2)	Wavetek 801
6-dB Attenuator	Texscan FP-50

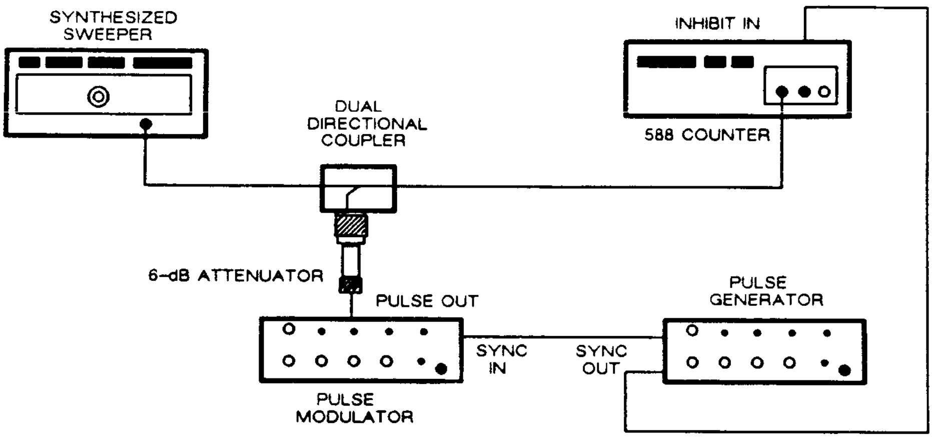

Figure 4-26. Band 1 Maximum Video Test Setup

PROCEDURE

1. Set the first pulse generator to complementary mode, 0 to -1 volt pulse amplitude measured with a 50-ohm load, 1 MHz PRF, and 50 ns pulse width. This signal will be applied to the INHIBIT input connector on the rear panel of the counter.
2. Synchronize the second pulse generator to the first. Set the pulse amplitude at 0 to 1 volt. Set the time delay and the pulse width so that the pulses of both pulse generators overlap. Disable the output of the second pulse generator. This signal will be applied to the coupled port of the dual- directional coupler.
3. Connect equipment as shown in Figure 4-26.
4. Set the counter to Band 1 and set the averaging feature to 99 pulses.
5. Set the synthesized sweeper frequency to 300 MHz and power to +10 dBm at the input to Band 1. Since the CW signal is inhibited, the reading on the counter display includes some gate error.
6. Enable the second pulse generator. Verify that there is no change (besides that caused by jittering error) in the frequency reading.
7. Reverse the pulse generator polarity and repeat step 6.

MAXIMUM VIDEO/BAND 2

DESCRIPTION

This test verifies that frequency measurement accuracy is maintained in the presence of a video signal in excess of 20 dB below the RF signal.

EQUIPMENT

Synthesized Sweeper	HP 8340A
Dual-directional Coupler	Narda 3022
Two Pulse Generators	Wavetek 801
6-dB Attenuator	Texscan FP-80

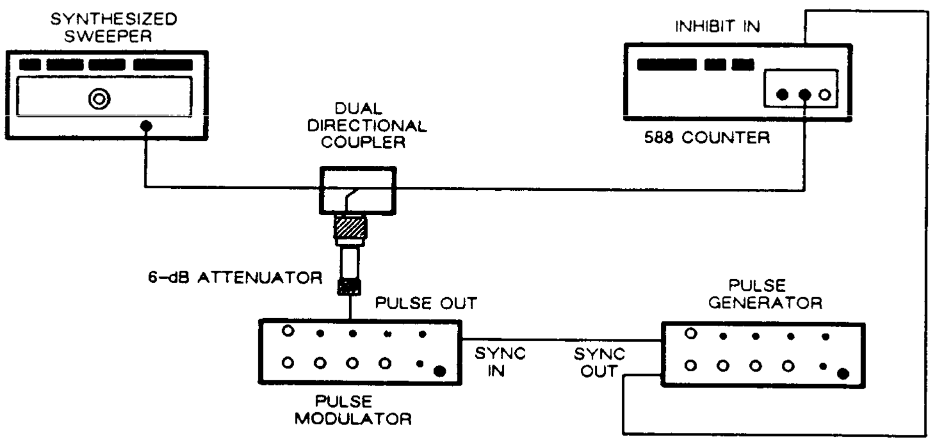

Figure 4-27. Band 2 Maximum Video Test Setup

PROCEDURE

1. Set the first pulse generator to complementary mode, 0 to -1 volt pulse amplitude measured with a 50-ohm load, 1 MHz PRF, and 50 ns pulse width. This signal will be applied to the INHIBIT input connector on the rear panel of the counter.
2. Synchronize the second pulse generator to the first. Set the pulse amplitude at 0 to 1 volt. Set the time delay and the pulse width so that the pulses of both pulse generators overlap. Disable the output of the second pulse generator. This signal will be applied to the coupled port of the dual- directional coupler.
3. Connect equipment as shown in Figure 4-27.
4. Set the counter to Band 2 and set the averaging feature to 99 pulses.
5. Set the synthesized sweeper frequency to 3 GHz and power to +10 dBm at the input to Band 2. Since the CW signal is inhibited, the reading on the counter display includes some gate error.
6. Enable the second pulse generator. Verify that there is no change (besides that caused by jittering error) in the frequency reading.
7. Reverse the pulse generator polarity and repeat step 6.

PULSE PARAMETERS

PULSE WIDTH ACCURACY

This test verifies that the pulse width accuracy is within ±20 ns.

EQUIPMENT

Synthesized Sweeper	Hewlett Packard 8340A
Pulse Modulator	Hewlett Packard 11720A
Pulse Generator	Wavetek 801
Oscilloscope	Tektronix 475
3-dB Attenuator (up to 26.5 GHz) (3)	Weinschel 9-3
Low-Attenuation Coaxial Cable	Gore P2S01S01036.0
Detector	Hewlett Packard 8473B

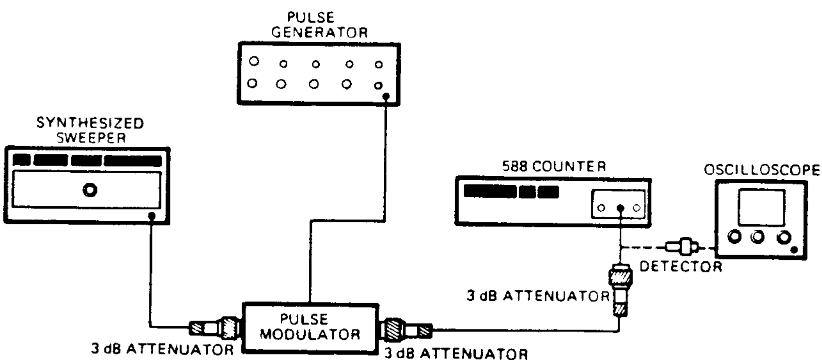

Figure 4-28. Pulse Width Accuracy

PROCEDURE

1. Connect equipment as shown in Figure 4-28. The 3-dB attenuators should be at the IN and OUT ports of the pulse modulator, and the input to the counter.
2. Set the counter to Band 2. Set the averaging feature to 99.
3. Connect the signal through the detector to the oscilloscope as shown. The detector must be terminated in a low-impedance device such as a 50-ohm feedthrough to detect the narrow pulses adequately . Set the synthesized sweeper frequency to 2 GHz and power to +10 dBm.
4. Set the pulse generator to 1 MHz PRF, 50 ns pulse width, and +3.0 to -0.5 volts.
5. Connect the signal to the counter. Turn pulse width on. Verify that the pulse width is 0.05 μs ±0.02 μs.

PULSE PERIOD ACCURACY

This test verifies that the pulse period accuracy is within ±20 ns.

EQUIPMENT

Synthesized Sweeper	Hewlett Packard 8340A
Pulse Modulator	Hewlett Packard 11720A
Pulse Generator	Wavetek 801
Oscilloscope	Tektronix 475
3-dB Attenuators (up to 26.5 GHz) (3)	Weinschel 9-3
Low-Attenuation Coaxial Cable	Gore P2S01S01036.0
Detector	Hewlett Packard 8473B

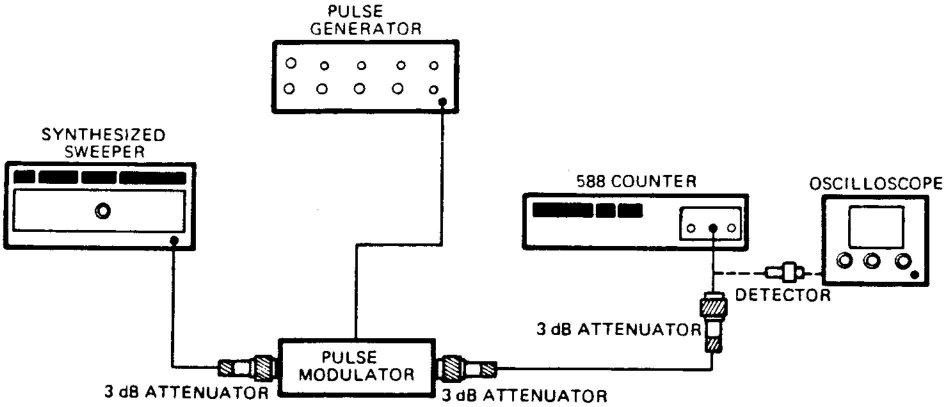

Figure 4-29. Pulse Period Accuracy

PROCEDURE

1. Connect equipment as shown in Figure 4-29. The 3-dB attenuators should be at the IN and OUT ports of the pulse modulator, and the input to the counter.
2. Set the counter to Band 2. Set the averaging feature to 99.
3. Connect the signal through the detector to the oscilloscope as shown. The detector must be terminated in a low- impedance device, such as a 50-ohm feedthrough, to detect the narrow pulses adequately . Set the synthesized sweeper frequency to 2 Ghz and power to +10 dBm.
4. Set the pulse generator to 1 MHz PRF, 50 ns pulse width, and +3.0 to -0.5 volts.
5. Connect the signal to the counter. Turn pulse period on. Verify that the pulse period is 1 μs ±0.02 μs.

SPECIAL FUNCTIONS

00	Clear all active special functions
01	100 MHz self test
02	Light all segments and annunciators
03	Scan digits test
04	Scan segments test
05	Keyboard test
06	PROM test
07	Display model (identify)
20	Band 2 Detected RF
40	Sweep YIG DAC
41	Sweep VCO, power amp on
42	Sweep VCO, power amp off
44	Disable normal operations of counter
45	Restart normal operations of counter
46	Memory read/alter
47	Measure IF frequency only
61	Disable track
62	Enable track
63	Disable sample rate control
64	Enable sample rate control
65	Disable results display
66	Enable results display
67	Display PRF as pulse period
68	Display PRF as pulse width
69	Display pulse parameters only
70	Display frequency and pulse parameters
71	Store instrument setup
72	Recall instrument setup
74	Relative freq measurement (freq offset = actual freq)
75	Display current IF freq (freq offset = LO freq)
76	Test and initialize EEPROM
90	GPIB address read/alter
91	YIG DAC auto calibration
92	Gate error auto calibration

ERROR MESSAGES

01	KEY PRESSED NOT FUNCTION KEY
02	LOWER LIMIT HIGHER THAN HIGH LIMIT
03	LIMITS ENTRY ONLY IN BAND 2
04	CENTER FREQUENCY ENTRY ONLY IN BAND 2 OR BAND 3
05	CENTER FREQUENCY ENTRY OUTSIDE CURRENT BAND RANGE
06	NO VALID DATA IN STORAGE REGISTERS FOR RECALL FEATURE
07	CONVERTER UNABLE TO LOCK ON SIGNAL DURING SPECIAL
09	ILLEGAL REGISTER ENTRY
10	ILLEGAL BAND ENTRY
11	ILLEGAL SUB-BAND ENTRY
12	ILLEGAL RESOLUTION ENTRY
13	ILLEGAL SPECIAL FUNCTION ENTRY
14	ILLEGAL AVERAGE ENTRY
15	ILLEGAL MULTIPLIER ENTRY
16	ILLEGAL FREQUENCY OFFSET ENTRY
17	ILLEGAL CENTER FREQUENCY ENTRY
18	ILLEGAL MIN PRF ENTRY
19	ILLEGAL LOW LIMIT ENTRY
20	ILLEGAL HIGH LIMIT ENTRY
21	ILLEGAL SAMPLE RATE ENTRY
22	ILLEGAL SRQ NUMBER ENTRY
23	ILLEGAL GPIB ADDRESS
24	ILLEGAL VCO FREQUENCY 1 ENTRY
25	ILLEGAL VCO FREQUENCY 2 ENTRY
26	ILLEGAL YIG FREQUENCY 1 ENTRY
27	ILLEGAL YIG FREQUENCY 2 ENTRY
28	ILLEGAL YIG DAC FREQUENCY ENTRY
29	FREQUENCY OVERFLOW DUE TO MULTIPLIER

30 PULSE PARAMETERS MEASUREMENTS GREATER THAN SPECIFIED MIN PRF
31 GPIB INPUT MESSAGE TOO LONG
32 GPIB MESSAGE STARTS WITH A NUMBER
33 GPIB MESSAGE STARTS WITH A WRONG NUMBER
34 UNIDENTIFIED WORD FOUND
35 WORD MISSPELLED
36 MISSING SPACE
37 WRONG MODE ARGUMENT

40 NON-NUMERIC PARAMETER VALUE
41 WRONG FREQUENCY TERMINATOR
42 WRONG TIME TERMINATOR
43 WRONG OUTPUT ARGUMENT
44 NUMERIC ARGUMENT SYNTAX ERROR
45 NUMERIC MANTISSA HAS TOO MANY DIGITS
46 NUMERIC EXPONENT HAS TOO MANY DIGITS
47 HEX DATA SHOULD PRECEDE WITH A ZERO
48 NO HEX MEMORY ADDRESS SPECIFIED
49 ILLEGAL HEX DATA ENTRY

50 ILLEGAL HEX ADDRESS ENTRY
51 ACTIVATE SPC 72 AND 73 THRU STORE AND FETCH

60 RAM FAULT
61 ROM CHECK SUM ERROR: ADDR 4000 TO 7FFF
62 ROM CHECK SUM ERROR: ADDR 8000 TO BFFF
63 RAM FAULT

71 GPIB/AMPLITUDE DISCRIMINATION BOARD MISSING
72 COUNT CHAIN BOARD MISSING
73 GATE GENERATOR BOARD MISSING
74 CONVERTER CONTROL BOARD MISSING
75 FRONT PANEL LOGIC BOARD MISSING

90 NO KEY RELEASE DETECTED
91 OPTION DOES NOT EXIST
92 BAND 3 OPTION IN A 585 UNIT
93 BAND 3 WITH NO BAND 1 BOARD
94 NON-VOLATILE MEMORY FAILURE

QUICK REFERENCE LIST OF GPIB COMMANDS

PARAMETERS MESSAGES

Header	Argument	Terminator	Description
BAND	(number) or DEFAULT	None	Selects specific band (1 to 3).
SUBBAND	"	"	Selects specific Band 3 sub-band (1 to 6)
RESOLUTION	"	"	Sets frequency measurement resolution (0 to 9).
SPECIAL	"	"	Activates specific special function (0 to 99).
AVERAGE	"	"	Inputs averaging value (1 to 99).
MULTIPLIER	"	"	Inputs multiplier value (1 to 99).
SRQMASK	"	"	Selects combination of status events to cause a service request.
OFFSETFREQ	"	(Hz/kHz/ MHz/GHz)	Sets frequency offset value.
HIGHLIMIT	"	"	Sets frequency high limit value.
LOWLIMIT	"	"	Sets frequency low limit value.
MINPRF	"	"	Sets minimum PRF value.
CENTERFREQ	"	"	Sets center frequency value and mode.
Y1FREQ	"	"	Sets start frequency for YIG sweep (Special Function 40).
Y2FREQ	"	"	Sets stop frequency for YIG sweep.
Y3FREQ	"	"	Sets calibration frequency for YIG sweep.
V1FREQ	"	"	Sets start frequency for VCO sweep (Special Functions 41, 42).
V2FREQ	"	"	Sets stop frequency for VCO sweep.
STORE	(number)	None	Store current counter setup in specified storage register (0 to 9).
FETCH	"	"	Recall counter setup stored in specified storage register (0 to 9).
SAMPLERATE	"	(s/ms)	Sets delay between measurement values (0 to 100 sec, 10 ms resolution).
MEMORY	(hex adrs)	(hex data)	Accesses memory location — alters it, (altering is optional).
MEMORY	INCREMENT	"	Accesses next location — alters it, (altering is optional).
MEMORY	DECREMENT	"	Accesses previous location — alters it, (altering is optional).

CONTROL MESSAGES

Header	Argument	Terminator	Description
INITIALIZE	None	None	Reconfigures the instrument to power-up state.
RESET	"	"	Resets converter to restart a new signal acquisition.
TRIGGER	"	"	Triggers new measurement cycle.
CLEARDISPLAY	"	"	Returns display to normal measurement results display, clear error.

MODE MESSAGES

Header	Argument	Terminator	Description
PERIOD	on/off	None	Turns pulse period measurement on or off.
WIDTH	"	"	Turns pulse width measurement on or off
HOLD	"	"	Holds last result if on.
EXTERNAL	"	"	Controls INT/EXT time base reference.
HEADER	"	"	Adds alpha header and terminator for talker
SCIENTIFIC	"	"	Selects scientific notation for talker.
DYNAMIC	"	"	Suppresses blanks when counter is configured in talker mode for faster free-field data transfer.
SEPARATE	"	"	Replaces commas with CR LF between multinumber results.

OUTPUT CONTROL MESSAGES

Command	Description
OUTPUT RESOLUTION	Outputs last specified frequency measurement resolution
OUTPUT BAND	Outputs number of last specified band.
OUTPUT SUBBAND	Outputs number of last specified sub-band.
OUTPUT AVERAGE	Outputs last specified averaging value.
OUTPUT MULTIPLIER	Outputs last specified multiplier value.
OUTPUT ERRORNUMBER	Outputs number of last error.
OUTPUT SRQMASK	Outputs status events required to cause service request.
OUTPUT CONFIGURATION	Outputs current configuration of instrument.
OUTPUT IDENTIFICATION	Outputs EIP58n (5 or 8) and GPIB address.
OUTPUT LOWLIMIT	Outputs low frequency limit last specified.
OUTPUT HIGHLIMIT	Outputs high frequency limit last specified.
OUTPUT OFFSETFREQ	Outputs offset frequency last specified.
OUTPUT CENTERFREQ	Outputs center frequency last specified.
OUTPUT MINPRF	Outputs minimum PRF last specified.
OUTPUT V1FREQ	Outputs last specified start frequency for VCO sweep (Special Function 40).
OUTPUT V2FREQ	Outputs last specified stop frequency for VCO sweep.
OUTPUT Y1FREQ	Outputs last specified start frequency for YIG sweep (Special Function 41).
OUTPUT Y2FREQ	Outputs last specified stop frequency for YIG sweep.
OUTPUT Y3FREQ	Outputs last specified calibration frequency for YIG sweep.
OUTPUT SAMPLERATE	Outputs last specified delay time between measurement values.
OUTPUT DEFAULT	Outputs results according to displayed results.
OUTPUT FREQUENCY (AND WIDTH (AND PERIOD))	Controls which measurement results to output.
OUTPUT KEYCODE	Outputs code of last key pressed
OUTPUT MEMORY	Outputs content of memory in last accessed location.
OUTPUT LEVEL	Outputs rough amplitude measurement result.
OUTPUT DATE	Outputs 42-character string showing revision level and date.
OUTPUT SETUP	Outputs 142-character string describing current instrument setup.

Dear Customer,

EIP welcomes any suggestions you may have for changes, additions, or corrections that would improve the usefulness of this manual. Your suggestions are a valuable part of the input used in revising our manuals and developing the structure and format of new ones.

Please send us your comments on the detachable, postage-paid card below. Your contributions help us attain our goal of providing you with the best possible service for your instrument.

Marketing and Sales
EIP Microwave, Inc.

Name ______________________________

Title ______________________________

Company ______________________________

Address ______________________ Mail Sta. ____________

City ______________________ State ________ Zip ________

Phone (_____) ______________________ Ext. ________

Instrument Model Number ______________________________

Manual Publication Date ______________________________

Comments ______________________________

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______________________________ Date ____________

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MANUAL ADDENDUM
MODEL 585-Y16

The following information applies to this special configuration of the Counter and does not include other changes due to the additional modifications.

Specifications and technical information contained in this document supersedes the information contained in the manual.

In any correspondence or parts orders relating to this Counter be sure to specify the complete model number, serial number, options, and specials.

Description

The Y16 Special designates the EIP Model 585 Pulse Microwave Frequency Counter with the following:

- 300 MHz-18GHz Frequency Coverage
- Operation at 50-400 Hz Line Frequencies
- Convenient Accessory Pouch
- Full GPIB Programmability
- Compliance with Mil-Std-461 and Mil-T-28800 Environmental Standards

For Serial Numbers 2702-2000 through 2702-2039, refer to 5585023-01 Operations Section and 5585023-02 Service Section. For Serial Numbers 2703-2040 and above, refer to 5585023-01 Operations Section and 5586012-00 Service Addendum.

Note: The AC Voltage selections and fuse call-outs have been changed as follows:

WAS	IS
100/120 VAC 1.5A SB	100/120/140 VAC 1.5A SB
220/240 VAC .75A SB	200/220/240 VAC 0.8A SB

Please change the information on pages 1-4, 1-5, 2-1, 3-6, and 3-7 of your Operations Manual (5585023-01) to reflect these changes.