Models 585/588 Microwave Pulse Counters

Operations

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585: CCN 2701
588: CCN 2801

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 m (10,000 ft.) 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.

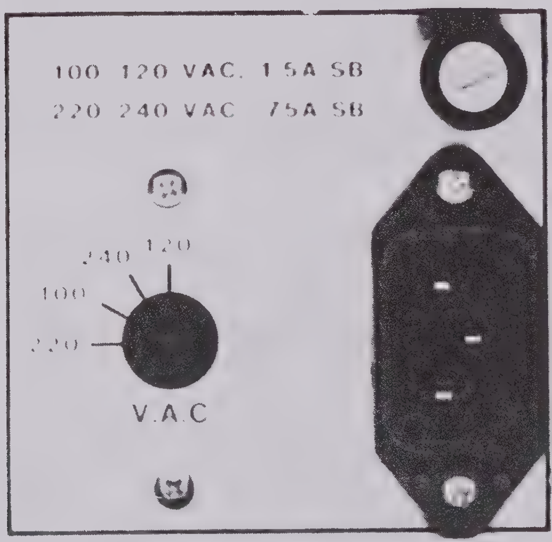

Figure 1-1. Rear Panel Fuse and Voltage Select Locations

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

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

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

7. Press: SPECIAL [9] 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. All plug-in assemblies, modules, and the front panel assembly may be exchanged.

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 what 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	$<1 \times 10^{-7}$ / mo.
SHORT TERM	$<1 \times 10^{-9}$ RMS for one second averaging time
TEMPERATURE	$<1 \times 10^{-6}$ over the range 0 to 50° C
LINE VARIATION	±10% change in line voltage produces frequency shift $<1 \times 10^{-7}$
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
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^{-8} seconds)
AVERAGING JITTER	AJ = ±2 x $\sqrt{[RES / ((GW)(AVE))]}$
FREQUENCY LIMITS	
CENTER FREQUENCY	

BAND 2	BAND 3 (OPTION)
950 MHz	26.5 GHz
18 GHz (Model 585) / 26.5 GHz (Model 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 (Model 585) / APC 3.5 (Model 588)	Kwik Jack (accepts 890 cabling kit)
+7 dBm peak	+5 dBm peak
+40 dBm peak (10 watts)	+10 dBm peak
15 dB	20 dB
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 = (±0.01) / (GW)	GE = (±.03) / (GW)

GE is the gate error in Hz. GW in seconds is the logical AND of inhibit and pulse width - 3×10^{-8} seconds

DE = (±0.03) / (PW - 3×10^{-8} seconds)	DE = (±0.02) / (PW) - 3×10^{-8} 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^{-8} seconds. AVE is the number of specified count averages.

Instrument will ignore signals outside of frequency limits. 10 MHz resolution, ±50 MHz accuracy. Unwanted signals must be greater than 100 MHz from either limit.	
Will lock on signals ±50 MHz from the entered frequency at sensitivity 10 MHz resolution.	Instrument assumes any signals present to be in the range ±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 x 10^{-3} seconds.
ACQUISITION TIME (CW)	AQ = 1 / PRF + 50 x 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 x 10^{-12}) + (4 x 10^{-8} / PRF)] + 60 / PRF + [(2 x 10^{-5})(PP)] / GW + .1 (Center Freq): AQ = 72 / PRF + [(2 x 10^{-5})(PP)] / GW + .1 (Freq Limits): AQ = [FH] [(4 x 10^{-12}) + (4 x 10^{-8} / PRF)] + 60 / PRF + .1 (Center Freq): AQ = 72 / PRF + .1	(Automatic): AQ = 70 / PRF + [(6 x 10^{-3})(PP)] / GW + 0.2 (Center Freq): AQ = 70 / PRF + [(8 x 10^{-4})(PP)] / GW + 0.2 AQ = 70 / PRF + 0.2

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 x 10^{8} seconds.

ACC = ±GE ±DE ±AJ ±Time Base Error ACC = Time Base Error ± 1 count * *(Based on measurement average)	ACC = ±GE ±DE ±AJ ±Time Base Error 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 x 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.

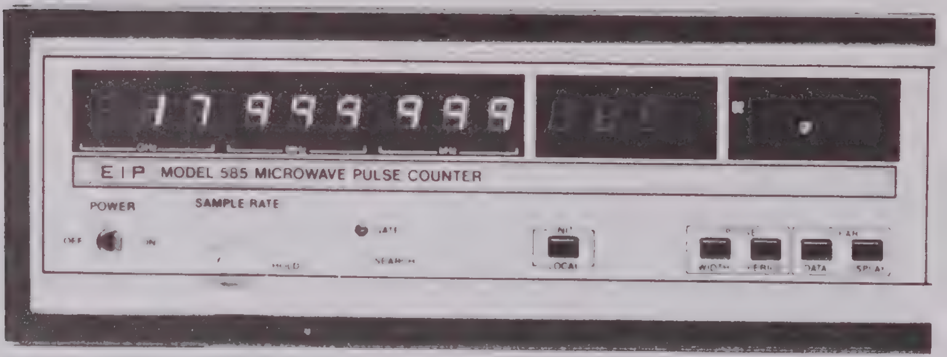

Figure 3-2. Front Panel, Model 585

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).

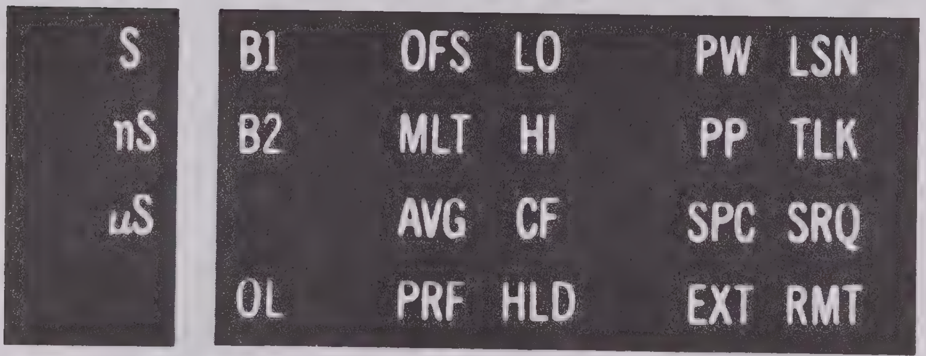

Figure 3-3. Status Indicators

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.

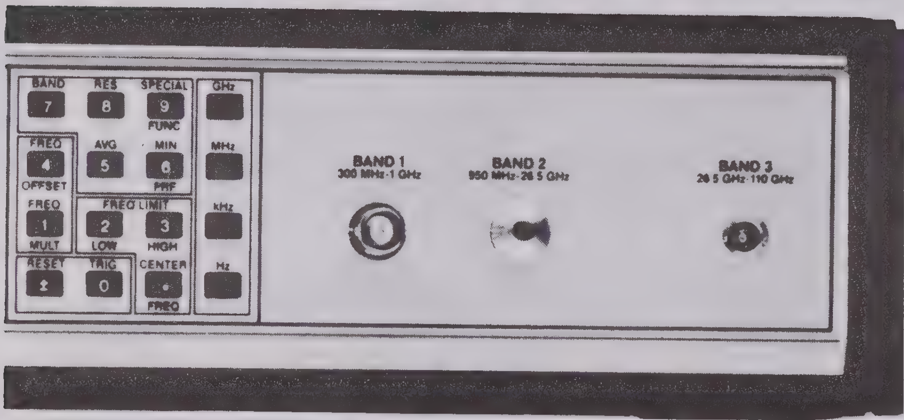

Figure 3-4. Front Panel, Model 588

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.

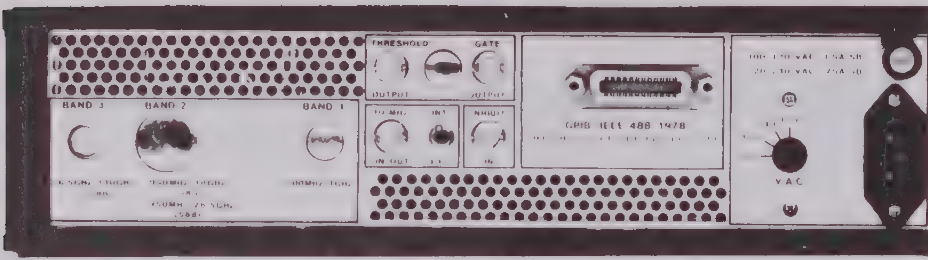

Figure 3-5. Rear Panel, Models 585/588

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 sub-band), 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.

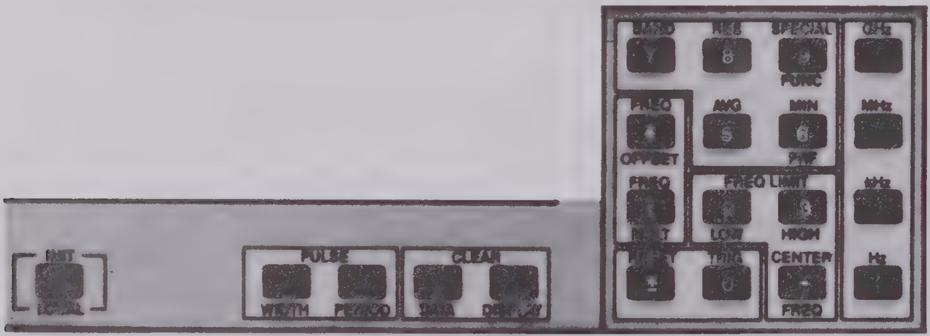

Figure 3-6. Keyboard

NUMERIC ENTRY KEYS

The numeric entry keys are:

- Digits O 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;"**BA**ND 3, **SU**BBAND 6" to select Band 3, subband 6

Enter: OUTPUT 718; "**SU**BBAND 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;"**RES**OLUTION 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;"**LO**LIMIT 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).

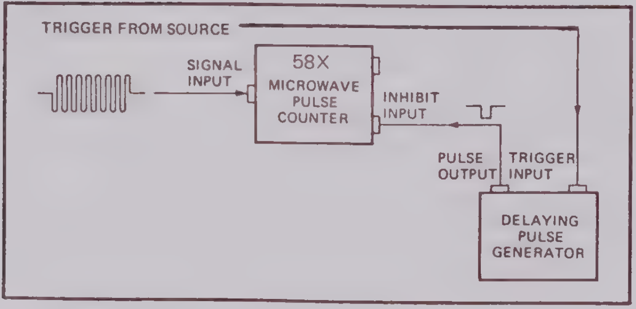

Figure 3-7. Pulse Profile Measurement Test Set-Up.

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.

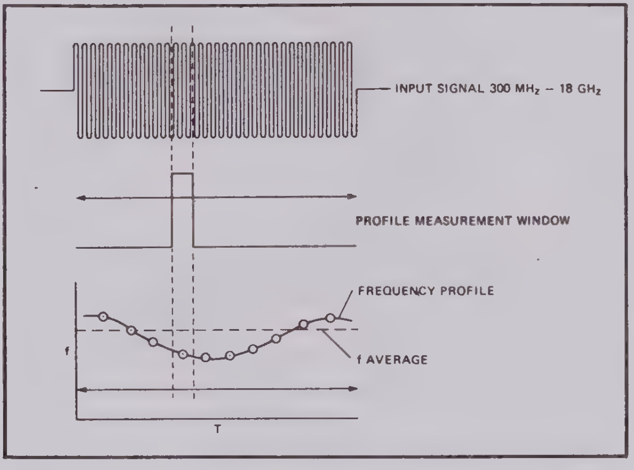

Figure 3-8. Pulse Profile Measurement

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.

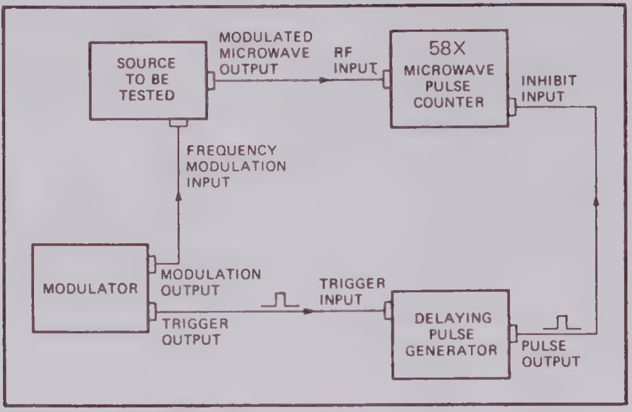

Figure 3-9. Time Varying Signal Measurement Test Set-up

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.

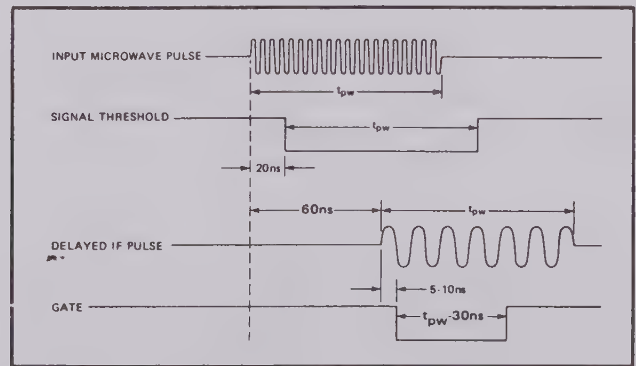

Figure 3-10. Internal Timing Delays

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 - 3×10^{-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 - 3×10^{-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 1×10^{-6} high in frequency, and all readings will be 1×10^{-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 92. 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.

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 accuracy 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 ±5MHz at -10 to 0dBm
3. Adjust the inhibit width until the average gate width is 20 ns.
4. Enter Special Function 92 and press the TRIG key to start calibration.
5. 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 5 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 6.

★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 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 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

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 sub-band (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,bbbbbbbbb100E-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)	Input buffer empty
6	(64)	Request to send (RQS)*
5	(32)	Error condition
4	(16)	Overload
3	(8)	Gate on
2	(4)	Search on
1	(2)	Signal found
bit 0	(1)	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 = *@†//
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) -3×10^{-8}	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) -3×10^{-8}	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) 3×10^{-8}	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 = $\pm(2)\ \sqrt{[RES\ /(GW)(AVE)]}$ *	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 = $\pm\ \sqrt{[RES\ /\ (GW)(AVE)]}$*	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 CHARACTERISTIC	CONDITIONS	PERFORMANCE SPECIFICATIONS	TEST METHOD
Band 3	26.5 GHz to 110 GHz	Averaging Jitter = $\pm(2)\sqrt{[RES / (GW)(AVE)]}$*	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.

INSTRUMENT CHARACTERISTIC	CONDITIONS	PERFORMANCE SPECIFICATIONS	TEST METHOD
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 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 above 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

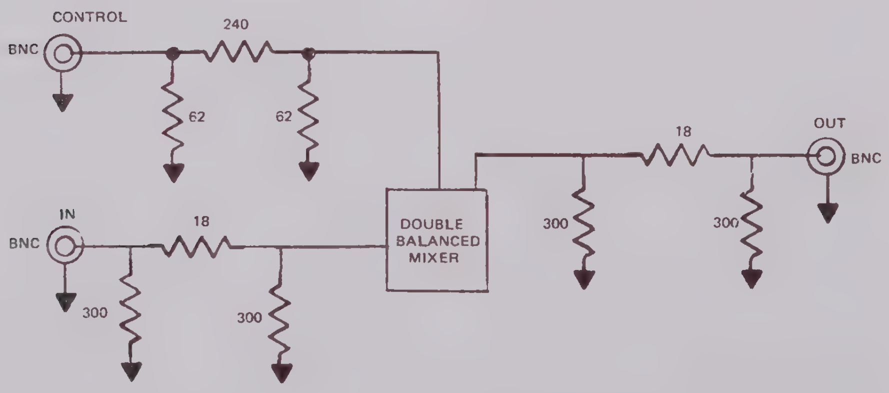

Figure 4-1. Pulse Modulator

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.

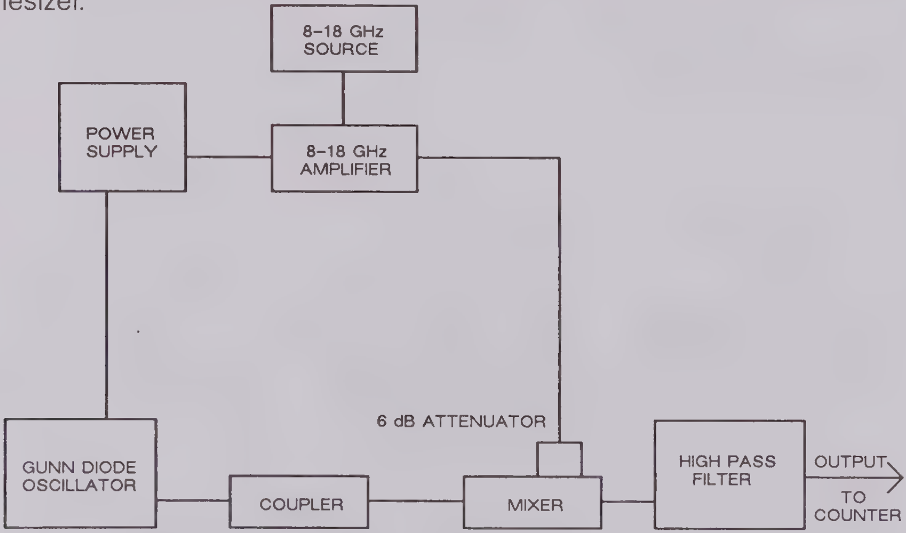

Figure 4-2. Upconverter

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

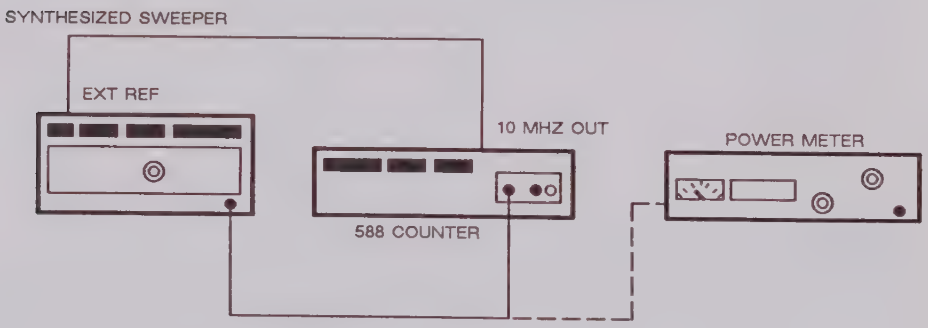

Figure 4-3. Band 1 Minimum and Maximum Frequency Test Setup

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

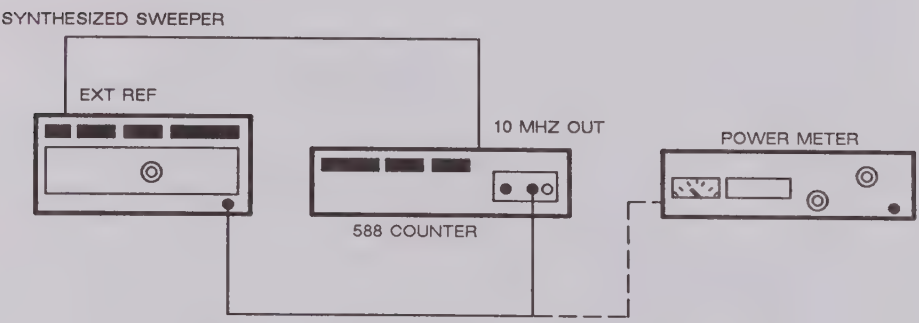

Figure 4-4. Band 2 Minimum and Maximum Frequency Test Setup

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 fréquency 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

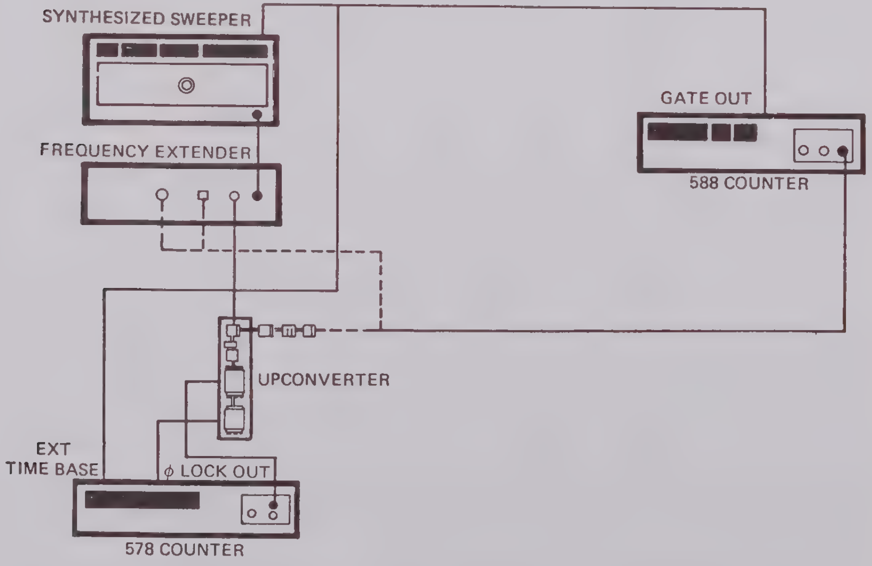

Figure 4-5. Band 3 Minimum and Maximum Frequency Setup

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

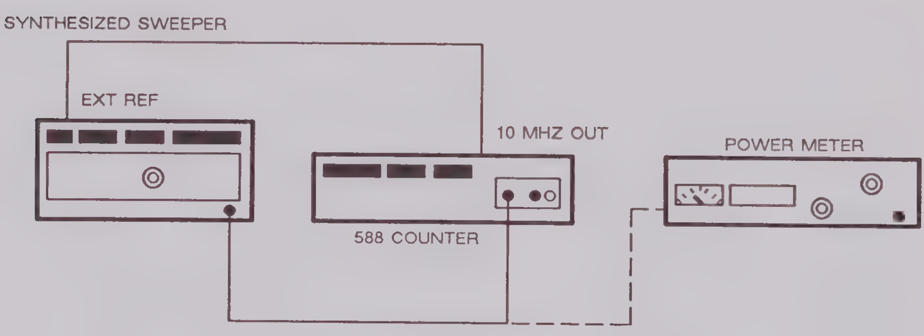

Figure 4-6. Band 1 Sensitivity Test Setup

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

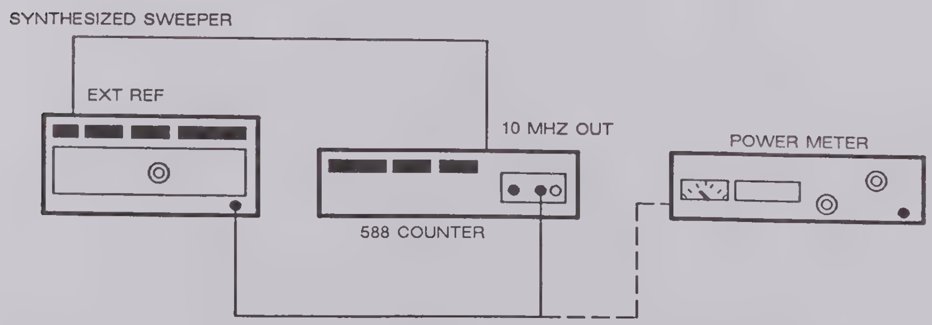

Figure 4-7. Band 2 Sensitivity Test Setup

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

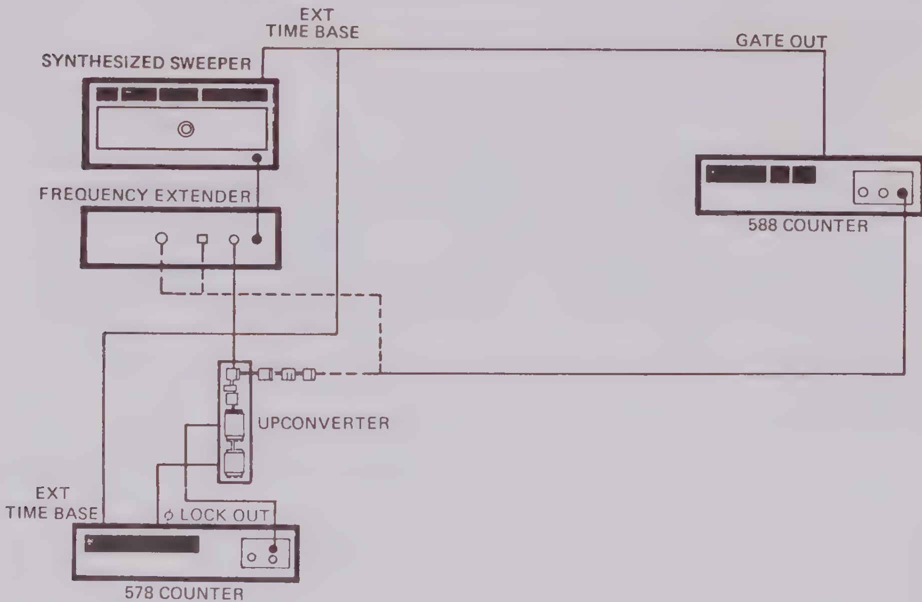

Figure 4-8. Band 3 Sensitivity Test Setup

PROCEDURE

1. Connect equipment as shown in Figure 4-8.
2. Set the input frequency to the counter to 26.5 GHz. Set the counter to Band 3-1. Set measurement averaging to 10.
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

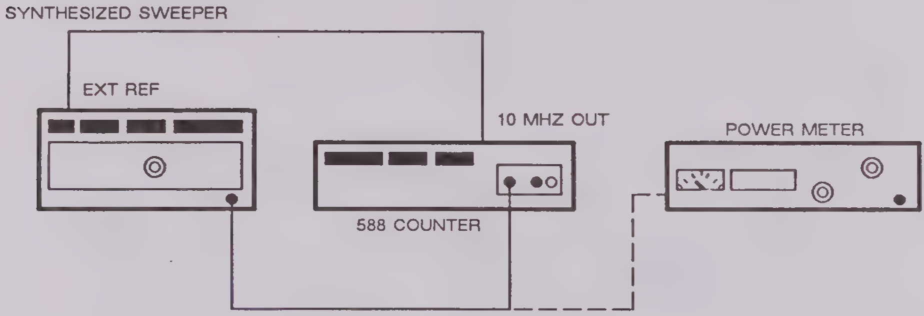

Figure 4-9. Band 1 Maximum Power Level Test Setup

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

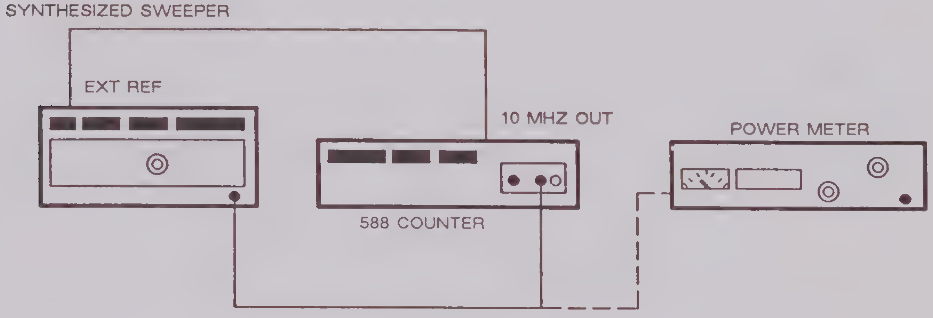

Figure 4-10. Band 2 Maximum Power Level Test Setup

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

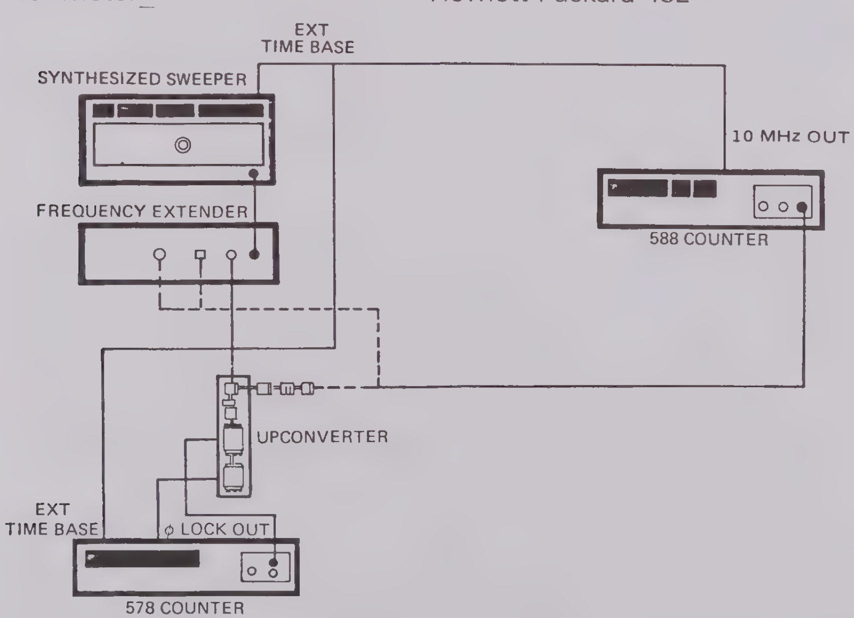

Figure 4-11. Band 3 Maximum Power Level Test Setup

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

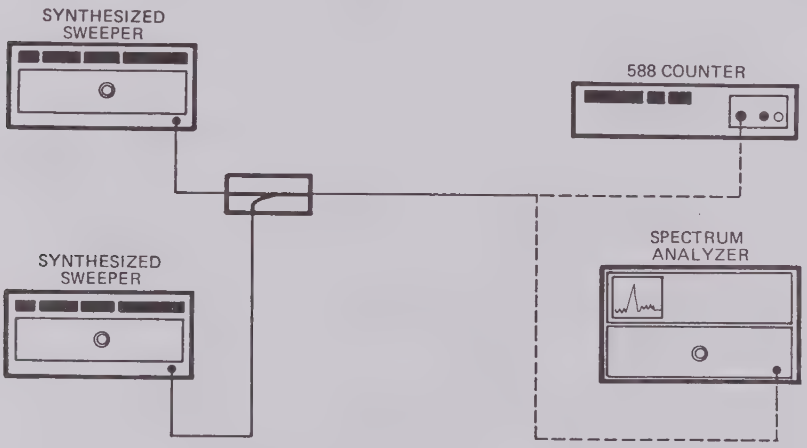

Figure 4-12. Band 1 Amplitude Discrimination Test Setup

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 more than 15 dB.

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

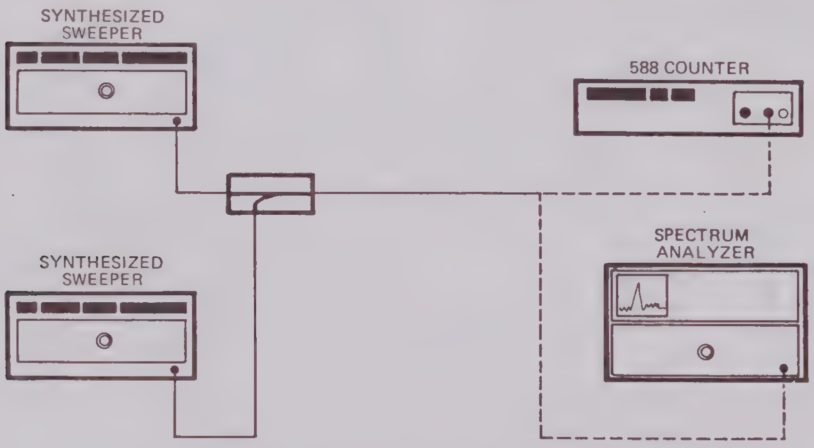

Figure 4-13. Band 2 Amplitude Discrimination Test Setup

PROCEDURE

1. Connect equipment as shown in Figure 4-13.
2. Set the first signal generator to 3.000 GHz at 0 dBm and the second signal generator to 3.1 GHz at +1 dBm.
3. Adjust the power level so that the difference is 15 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 12.1 GHz and at 17.9 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

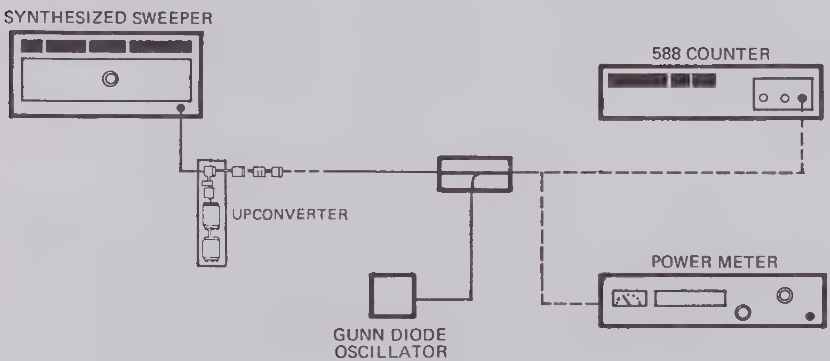

Figure 4-14. Band 3 Amplitude Discrimination Test Setup

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

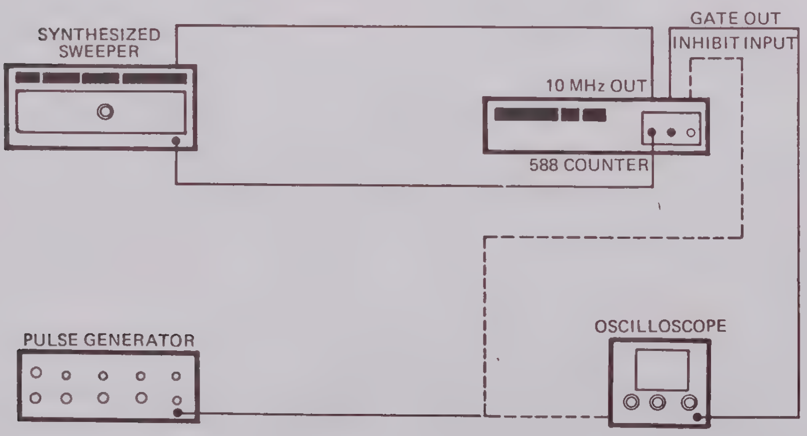

Figure 4-15. Band 1 Gate Error Test Setup

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

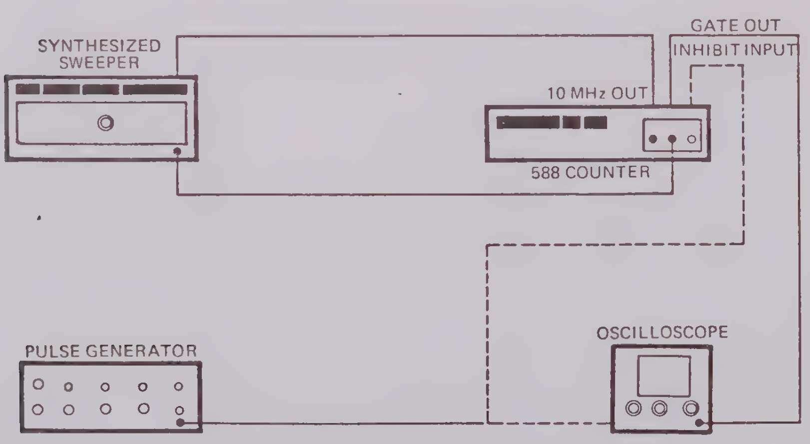

Figure 4-16. Band 2 Gate Error Test Setup

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

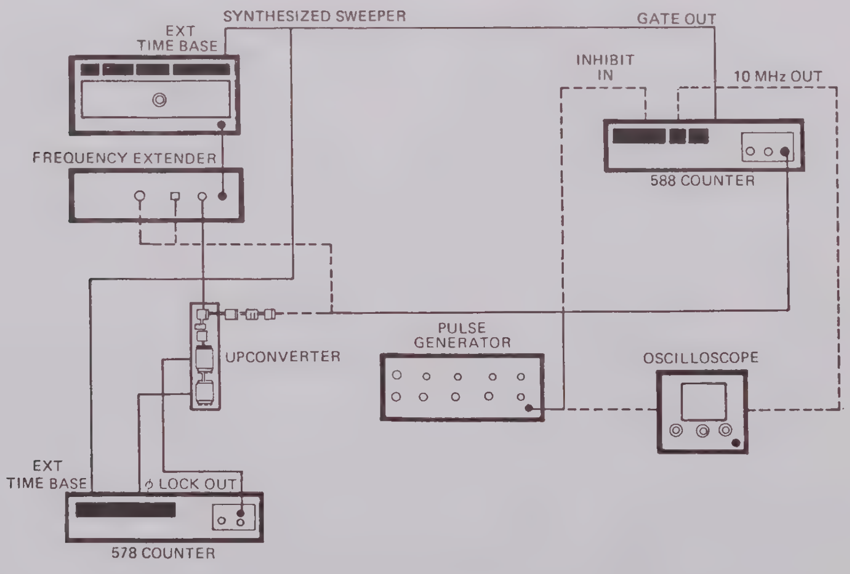

Figure 17. Band 3 Gate Error Test Setup

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

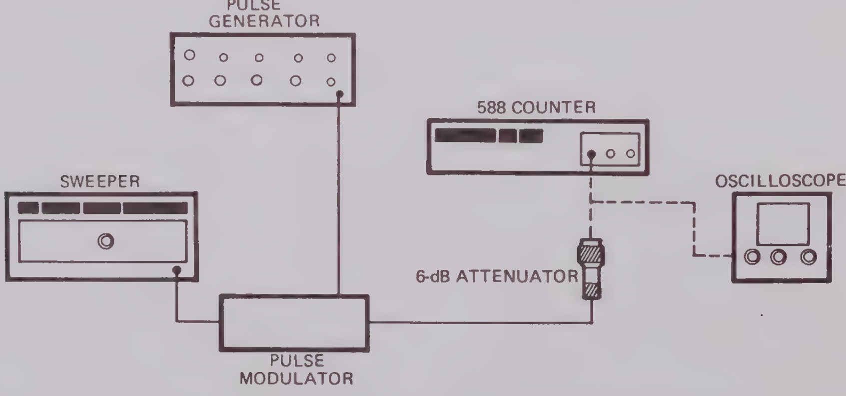

Figure 4-18. Band 1 Distortion Error Test Setup

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

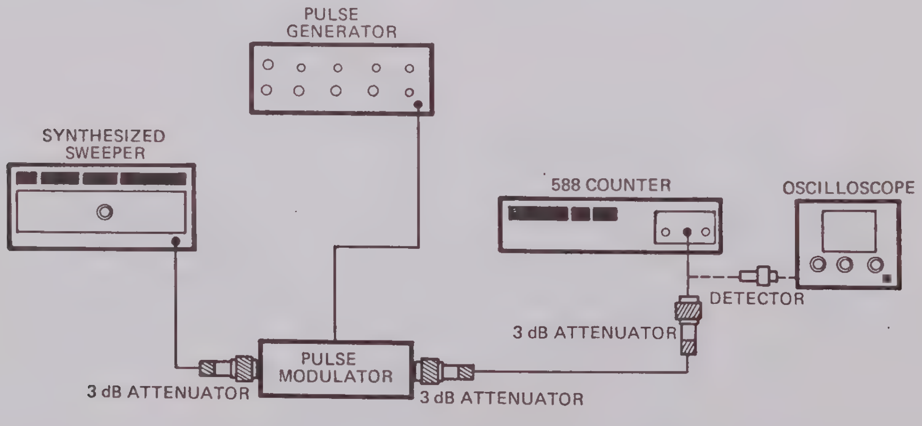

Figure 4-19. Band 2 Distortion Error Test Setup

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

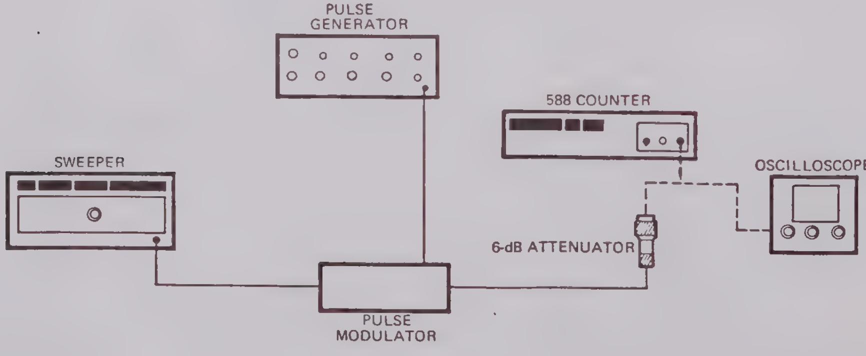

Figure 4-20. Band 3 Distortion Error Test Setup

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:

$$S = \sqrt{\sum_{i=0}^{i=n-1} (F_i - F_{ave})^2 / (n-1)} \qquad \text{(standard deviation)}$$

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

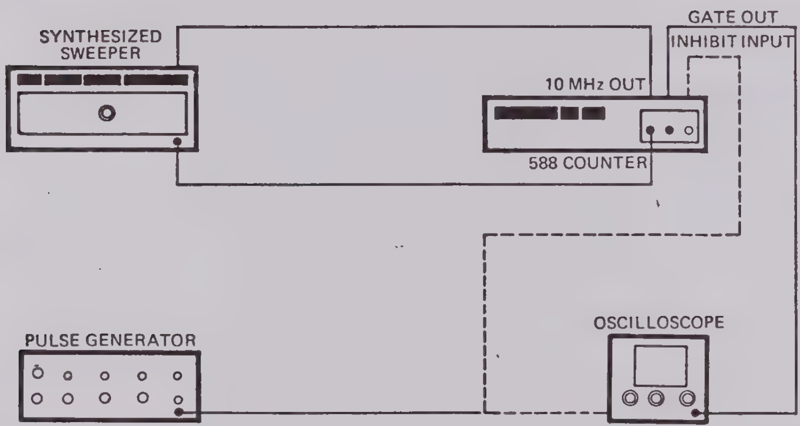

Figure 4-21. Band 1 Averaging Jitter Test Setup

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

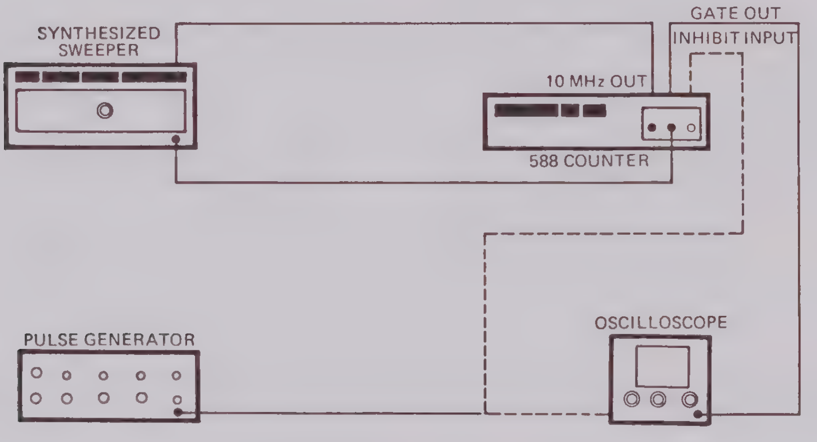

Figure 4-22. Band 2 Averaging Jitter Test Setup

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:

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

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.

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

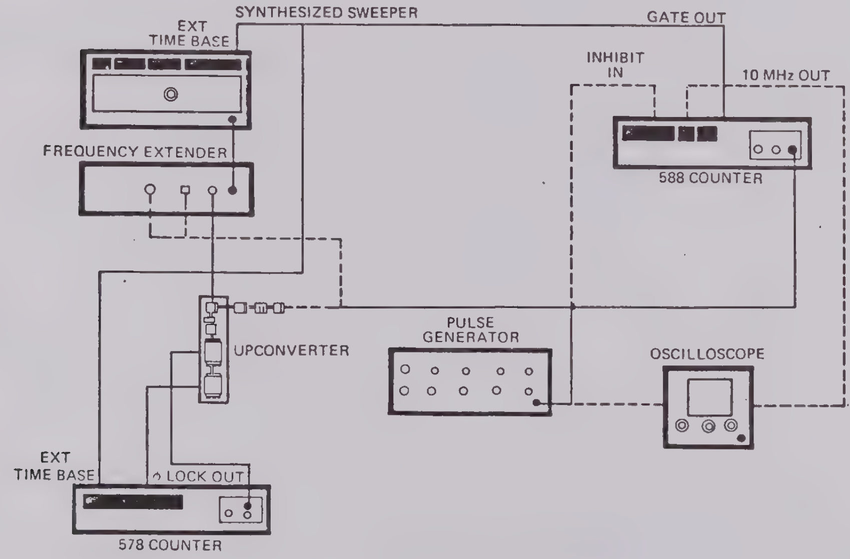

Figure 4-23. Band 3 Averaging Jitter Test Setup

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 above 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

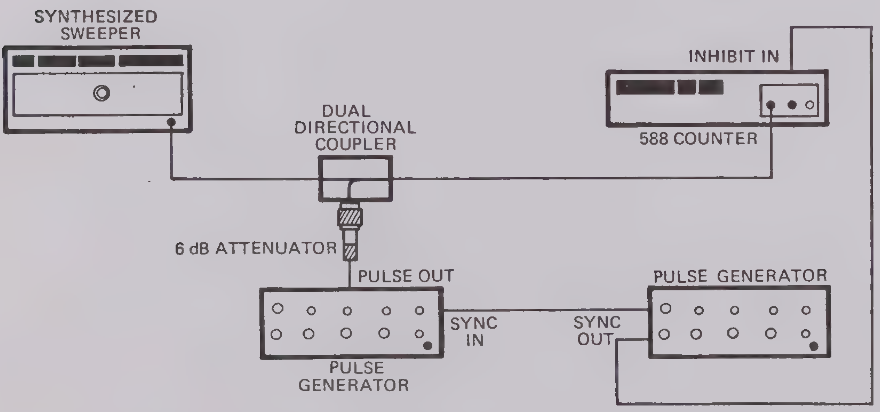

Figure 4-26. Band 1 Maximum Video Test Setup

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 above the RF signal.

EQUIPMENT

Synthesized Sweeper	HP 8340A
Dual-directional Coupler	Narda 3022
Two Pulse Generators	Wavetek 801
6-dB Attenuator	Texscan FP-80

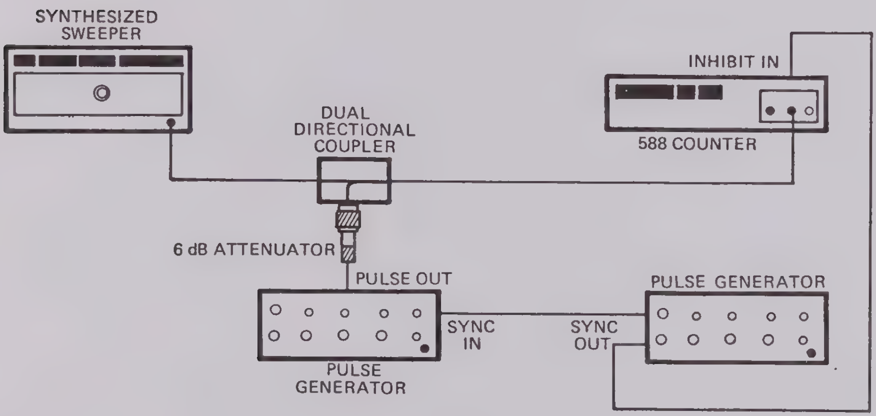

Figure 4-27. Band 2 Maximum Video Test Setup

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

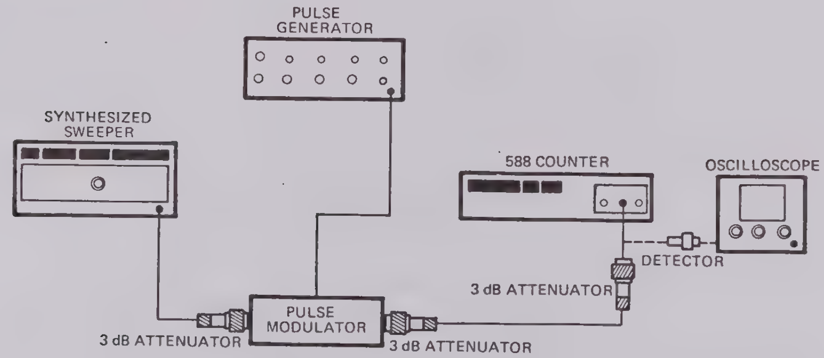

Figure 4-28. Pulse Width Accuracy

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 $\pm$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

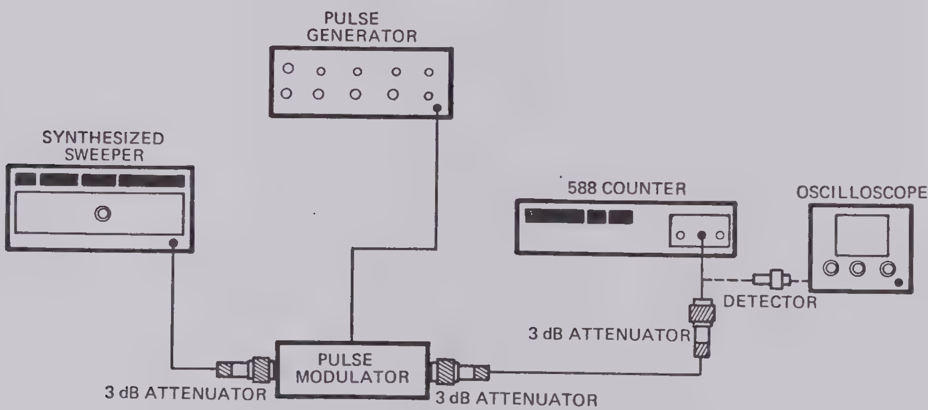

Figure 4-29. Pulse Period Accuracy

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.

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.

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

-A-

-B-

-C-

-C- (continued)

-D-

-D- (Continued)

-E-

-F-

-F- (Continued)

-G-

-G- (Continued)

-H-

-I-

-K-

-L-

-M-

-M- (Continued)

-N-

-O-

-P-

-R-

-R- (continued)

-S-

-T-

-T- (continued)

-U-

-V-

-Y-

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