

XL MICROWAVE
Models 3600
3500A
3460A
3400A
Standard
and Battery Option
Millimeter Wave
Frequency
Counters

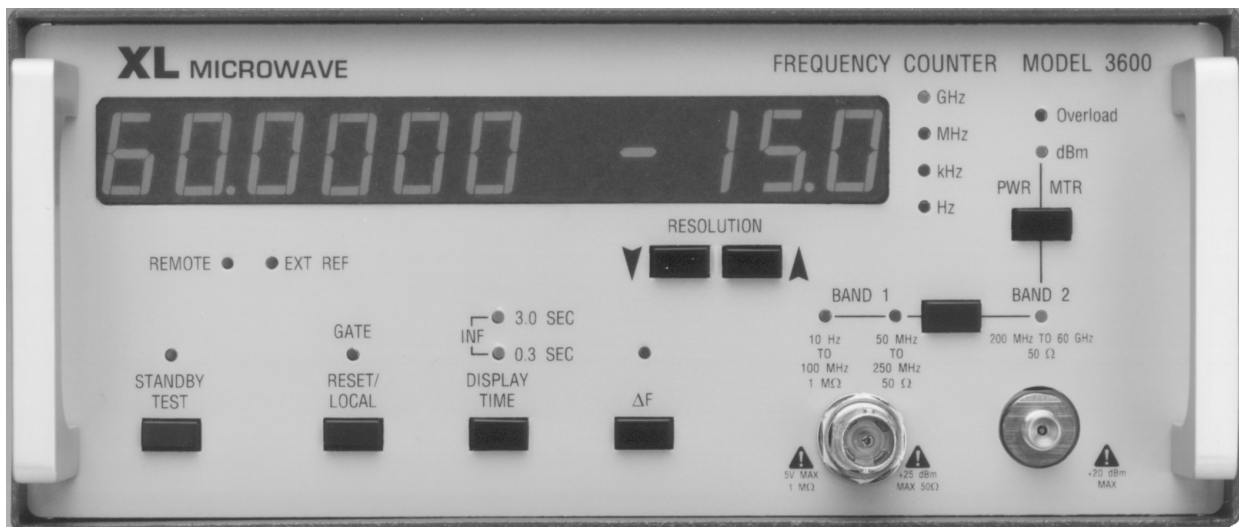


ISO 9001 CERTIFIED

Model No./Serial No. _____ / _____

XL MICROWAVE, Inc.

OPERATING AND MAINTENANCE MANUAL



XL MICROWAVE
Millimeter Wave Frequency Counters
Model 3600 10 Hz to 60 GHz
Model 3500A 10 Hz to 50 GHz
Model 3460A 10 Hz to 46 GHz
Model 3400A 10 Hz to 40 GHz
(including Battery Option Counters)

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XL MICROWAVE, Inc.

Manufactured by XL Microwave, Inc.
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Note: This CD Manual is an “Operation Manual” only and not an “Operation & Maintenance Manual” as stated in some of the pages contained herein.

These pages are identical to the equivalent Operation & Maintenance Manual pages through Chapter 3 and the Maintenance and Calibration sections of Chapter 5. A paper version of the full Operation & Maintenance Manual for this instrument is available from the Factory.

XL MICROWAVE, Inc.

QUALITY POLICY

XL Microwave is committed, at all levels, to:

- deliver products on time, that are of high quality, reliability and superior value to our customers;
- meet or exceed our published or contractual specifications;
- meet customer, regulatory and statutory requirements;
- provide the necessary resources;
- pursue continual quality improvement; and,
- deliver outstanding customer support... all with the aim of enhancing customer satisfaction.

Richard Phillips, President

Our Quality System has been established to implement and maintain the requirements of ISO 9001:2000 and its equivalent ANSI/ASQC Q9001:2000.

XL MICROWAVE, Inc.

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Reference Information on CE Certification of XL Microwave Frequency Counters

The XL Microwave, Inc. Equipment noted below has been tested at ERA Ltd. In England and conforms with the essential requirements of the European Directive 89/336/EEC relating to EMC, as transposed to the relevant European and National Standards.

For Model 3400 and Model 3401 Counters



CE Certified
EN 55022 Class B
EN 50082-1
VDE 0871/6.78 Class B

Tested 15–17 February 1993 by ERA Technology, Ltd., Surrey, England
Test Report 5044/6N2

Certificate No. 93/002, dated 23 March 1993

The EMC Division at ERA is accredited by NAMAS as a Test Laboratory.

ERA is registered as a Competent Body in the European Union.

Report reissued 29 April 1996 to add EN 55022 Class B certification to the report.

Models Tested:

Model 3400, S/N 930235304

Model 3401, S/N 930236326

The following XL Microwave models are CE approved via the Technical Construction File Route as Derivative Variants of the referenced tested models.

Derivative Variants of the

Tested Model 3400

40 GHz CW Counter:

Model 3600, 60 GHz CW Counter
Model 3500A, 50 GHz CW Counter
Model 3460A, 46 GHz CW Counter
Model 3400A, 40 GHz CW Counter
Model 3260, 26.5 GHz CW Counter
Model 3200, 20 GHz CW Counter
Model 3120, 12.4 GHz CW Counter
Model 3080, 8 GHz CW Counter
Model 3030, 3 GHz CW Counter

Derivative Variants of the

Tested Model 3401

40 GHz Source Locking Counter:

Model 3601, 60 GHz Source Locking Counter
Model 3261, 26.5 GHz Source Locking Counter
Model 3201, 20 GHz Source Locking Counter

RWTÜV USA INC.

CERTIFICATE

RWTÜV USA INC. hereby certifies that

XL Microwave, Inc.

5811 Racine Street
Oakland, CA 94609 USA

has established and applies
a management system for

**Design and Manufacture of Millimeter Wave, Microwave, and RF Control,
Test, and Measurement Equipment.**

Further clarifications regarding the scope of this certificate and the applicability of
ISO 9001:2000 requirements may be obtained by consulting the organization

Proof has been furnished that the requirements according to

ISO 9001:2000

are fulfilled.

This Certificate is valid until

January 26, 2007

Certificate Registration Number

03-1328

Clifton, New Jersey, U.S.A.
Date Issued: January 27, 2004



RWTÜV
Subsidiary of RWTÜV
Systems GMBH Germany

USA INC.

Quality Systems Division

PROPRIETARY NOTICE

The information contained in this manual is derived in part from proprietary and patent data of XL Microwave, Inc. This information has been prepared for the express purpose of assisting operating and maintenance personnel in the efficient use of the instrument, and the publication of this information does not convey any rights to reproduce it or to use it for any purpose other than in connection with the installation, operation, and maintenance of the equipment described herein. Reproduction for non-military use of the information or illustrations contained in this publication is not permitted. The policy for military use reproduction is established for the US Army in AR 380-4, for the US Navy and Marine Corps in OPNAVINST 5510.1B, and for the US Air Force in AFR 205-1.

5-YEAR LIMITED WARRANTY

XL MICROWAVE Frequency Counters are warranted during a period of **FIVE YEARS** from date of shipment to original purchaser to be free from defects in material and workmanship. The liability of XL MICROWAVE under this warranty is limited to replacing or repairing any instrument or component thereof which is returned by Buyer and is proven to be defective.

This warranty does not apply to Batteries, Carrying Bags/Cases, and/or Accessories, nor does it apply to defects caused by: Improper installation, misuse, neglect, customer supplied software interface devices, unauthorized repair or alteration or accident. XL MICROWAVE shall have the right of final determination as to the existence and cause of a defect. In no event shall XL MICROWAVE be liable for collateral or consequential damages. In the case where the instrument must be returned for repair, the instrument must be returned, prepaid, to XL MICROWAVE. When the instrument is repaired, it will be returned by the best way, prepaid. This warranty is in lieu of any other warranty, expressed, implied, or statutory and no agreement extending or modifying it will be binding upon XL MICROWAVE unless in writing and signed by a duly authorized officer.

RECEIVING INSPECTION

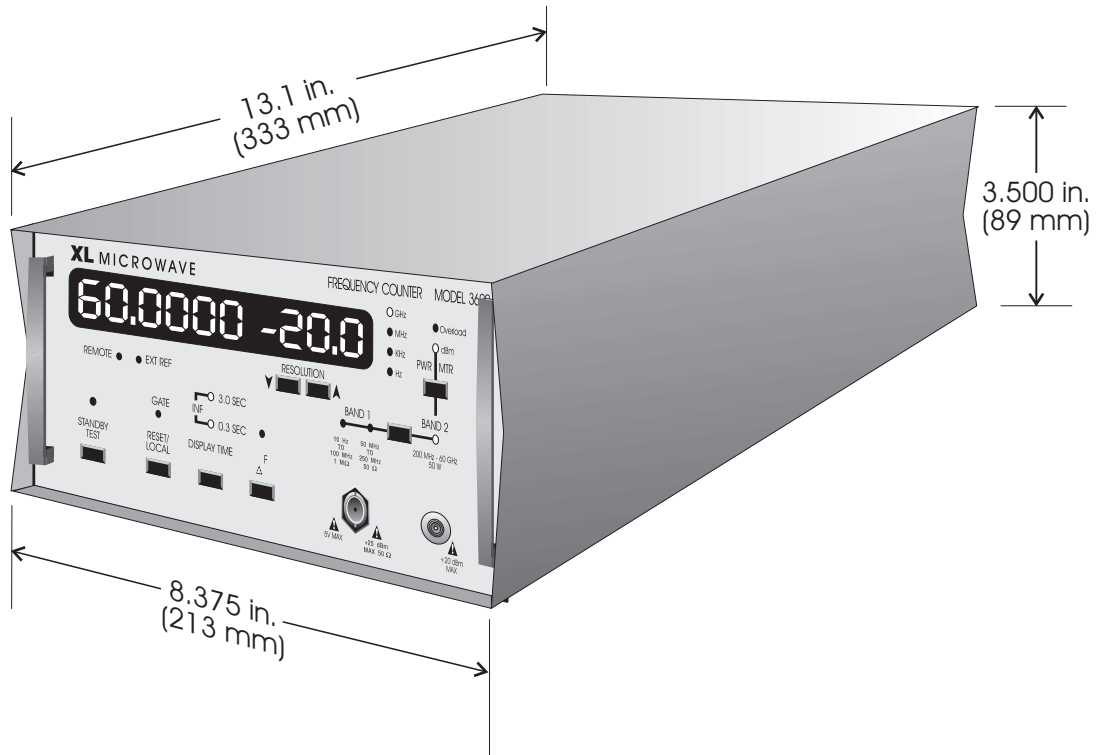
Every XL MICROWAVE instrument is carefully inspected and is in perfect working order at the time of shipment. Each instrument should be checked as soon as received. If the instrument is damaged in any way, a claim should immediately be filed with the transportation company. In any case where damage occurs in transit with the instrument in its packing case, XL MICROWAVE's obligations under the warranty are dependent on the customer immediately notifying the carrier so that inspection can be made and a claim filed.

REPAIR SERVICE

Experienced service personnel and special test equipment are available at the factory to perform any necessary repairs. Every effort will be made to expedite the repair of instruments returned for servicing. Repair work will be performed only upon receipt of a written purchase order or authorization. Utilize the same procedure for returning an instrument for service as for warranty return. After receipt of the unit, the Customer Service Department will issue a quotation of repair costs for your approval.

XL MICROWAVE

Millimeter Wave CW Counters



Model 3600 Dimensioned Drawing

LIST OF EFFECTIVE PAGES (Revision/Configuration Control Document)

The XL Microwave mm-Series millimeter wave Frequency Counter's Operating and Maintenance manual is a revision/configuration controlled document. Original pages are dated 3600/97NOV01; pages changed in the future will be indicated according to respective revision date(s).

The total number of pages in this publication is 56, consisting of the following:

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Quality Policy	04JAN01
CE Reference Information	97NOV01
ISO 9001 Certificate	04JAN26
Proprietary Notice	97NOV01
Warranty	97NOV01
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CHAPTER 1

GENERAL INFORMATION

1-1. INTRODUCTION

1-1.1. This manual contains information pertaining to the specifications, installation, operation, and maintenance of XL Microwave millimeter wave Frequency Counters models 3400A, 3460A, 3500A and 3600. The four models discussed in this manual are referred to as the mm-Series. Their upper frequency ranges are: 40 GHz (3400A); 46 GHz (3460A); 50 GHz (3500A); and 60 GHz (3600). Included information pertains to both the standard mm-Series CW Counters and the Battery Option mm-Series CW Counters. All of the Battery Option Counters are capable of battery operation via an internal 12 VDC/2.3 Ah battery.

1-1.2. The information contained in this manual is arranged in the following manner.

Front Matter: Includes Title Page, Quality Policy, CE Reference Information, ISO 9001 Certificate, Proprietary Notice, Warranty, Dimensioned Drawing, List of Effective Pages, and Table of Contents with List of Tables, and List of Figures.

Chapter 1, *General Information:* Describes the manual format, manual effectivity, safety practices, a brief functional description of the mm-Series, and provides a specifications table including a description of the standard options.

Chapter 2, *Installation:* Discusses the receiving inspection, installation criteria, initial turn-on, confidence check, system interfaces via the GPIB (IEEE Std 488 General Purpose Interface Bus), and preparation for reshipment.

Chapter 3, *Operation:* Describes the front panel and the rear panel controls, indicators, connectors, general instrument operating procedures of each mode and function, and instrument operation both local front panel control and remote control via GPIB.

Chapter 4, *Theory of Operation:* Provides a detailed functional/circuit description of the mm-Series to guide technical personnel in troubleshooting, maintenance, and calibration.

Chapter 5, *Maintenance:* Contains the procedure for performance verification, calibration, preventative maintenance, corrective maintenance/troubleshooting and disassembly/reassembly instructions.

Chapter 6, *Parts List:* Provides information for ordering parts, manufacturers code-to-name conversion, listings for recommended spare parts, manufacturers' part numbers, and assembly and component location diagrams.

Chapter 7, *Schematic Diagrams:* Contains Schematic Diagrams for maintenance and troubleshooting.

Chapter 8, *Option Information:* Contains Schematic Diagrams, Parts Lists, and Theory of Operation that pertain to options for mm-Series CW Microwave Counters, including Battery Option and Oscillator Options.

1-2. EFFECTIVITY OF MANUAL

1-2.1. Information contained in this manual is date-coded at the bottom of each page (for example: 3600/97NOV01). A summary of these date codes is given in the list of effective pages provided in the front of this manual. Changes made to instruments after the printing of this manual will be documented by change supplements and inserted in the front of future printings. Change supplement information may also include the correction of errors which were not yet determined at the date of this publication. Any future changes of this manual will be reflected by the date code on the effected pages and in the List of Effective Pages.

1-3. SAFETY PRACTICES

1-3.1. Personnel assigned to the operation or maintenance of the mm-Series Microwave Frequency Counters are encouraged to review the safety practices given in this section. These are recommended procedures which may prevent a serious accident, save a life, or protect the counter from damage.

1-3.2. Whenever the safety of operating or maintenance personnel is involved, special safety instructions are inserted in the text as "WARNINGS". Instructions concerning the safety of the counter are inserted as "CAUTIONS".

1-3.3. The following recommended procedures should be understood and applied during any phase of operation or maintenance of the instrument.

1-3.4. Chassis Grounding. Prior to applying power to the counter, determine that the internal protective power ground is connected to the protective ground conductor of the power cord. This ground, in turn, must be connected through the external power cord to the grounded power outlet. (Verify ground continuity using an ohmmeter with power totally removed from the instrument).

1-3.5. Any interruption of the protective ground conductor, inside or outside of the instrument will create a potentially hazardous condition due to possible voltage differences between the frequency counter and any other equipment. When the counter is connected into a system with other units, all power grounds should connect via a common bus to optimize circuit breaker (fuse) response in the event of a ground fault. Intentional interruption of the grounding system by use of two-wire plug adapters or two-wire extension cords must be considered an unsafe practice.

1-3.6. Whenever it is determined that the protective ground system has been impaired, the equipment must be made inoperative or be secured against inherent operation until the deficiency is corrected.

1-3.7. Removal of the top or bottom covers while the counter is operating exposes personnel to potential dangers. Only allow qualified personnel to maintain this instrument.

1-3.8. Under certain conditions, dangerous potentials may still exist when power is removed from the unit due to charges retained by capacitors. To avoid injury, always remove power; then discharge or ground any large capacitors prior to replacing components or making repairs. Also, when the power cord is not disconnected from the AC mains, AC voltage is always present on the Power Supply PCBA3!

1-3.9. To avoid potential damage to the counter, always remove power from the instrument before extracting or installing any circuit boards and/or discrete components.

1-3.10. Troubleshooting, repair or adjustments of the counter with power applied to the circuits should be minimized whenever possible. However, when instrument manual procedures so dictate, these should be performed only by skilled technical personnel who are aware of the various hazards involved.

1-3.11. *Do Not Service or Adjust Alone.* Under no circumstances should any person service or adjust equipment unless in the presence of another person who is capable of rendering first aid/resuscitation services in the event of an accident.

1-3.12. Defective Parts Replacement. To avoid possible damage or degrading of instrument performance, technical personnel are cautioned to replace defective components only with new factory replacement items, or, in certain cases, cross-referenced, direct-substitute items. Be certain that only the correct power fuse with required rating (voltage/current) and specified type (slow blow/fast blow etc.) is used for replacement purposes. The use of repaired fuses or short-circuiting of the fuse holder is considered an unsafe practice.

1-3.13. Safety Summary. The following safety symbols are used on all XL mm-Series instruments and/or in this manual.



Instruction manual symbol. The instrument will be marked with this symbol when it is necessary to refer to the instruction manual.



Indicates Protective Conductor terminal (earth ground). (IEC 417, No. 5019)

WARNING

The WARNING sign denotes a personnel hazard. It highlights an essential operating or maintenance procedure, practice, condition, statement, etc, which, if not strictly observed, could result in injury to, or death of, personnel or long term health hazards. Do not proceed beyond a WARNING sign until the indicated conditions are fully understood and met.

CAUTION

The CAUTION sign denotes an instrument hazard. It highlights an essential operating or maintenance procedure, practice, condition, statement, etc, which, if not strictly observed, could result in damage to, or destruction of, equipment or loss of mission effectiveness. Do not proceed beyond a CAUTION sign until the indicated conditions are fully understood and met.

1-3.14. Battery Safety. The following information concerning the Battery Option should be observed.

1. Important safety considerations:

- Do not incinerate battery, may exploded if disposed of in fire.
- Do not directly connect the negative and positive terminals.
- Do not use other than the instrument's internal charger to recharge battery.

2. To prevent deterioration or damage to battery:

- Do not drop or subject to strong physical shock.
- Do not use to power equipment other than specified.
- Do not use below -10°C (14°F) or above + 40°C (104°F). If the temperature exceeds this upper limit, a safety device will automatically prevent operation of the battery.

3. To ensure long battery life:

- ***Do not discharge completely.***
- ***Recharge battery immediately after use.***



Recycling Battery. The sealed Lead/Acid battery, shipped with the millimeter Battery Option counters, contain Lead (Pb) and ***must*** be recycled or disposed of properly after its useful life is exhausted. Do not incinerate this battery or dispose of in garbage container.

1-4. GENERAL DESCRIPTION

1-4.1. The mm-Series Millimeter wave Frequency Counters are high-performance, system-oriented, bench or rack mounted microprocessor-based counters. Frequency measurements to 40, 46, 50, and 60 GHz (model dependent) and input power (amplitude) measurements are operational at the front panel or via the rear panel GPIB interface.

1-4.2. The mm-Series counters are continuous wave millimeter wave frequency counters with measurement ranges of 10 Hz to 40, 46, 50, and 60 GHz. Band 1 provides a frequency range from 10 Hz to 250 MHz via a front panel BNC (1-megohm/50-ohm impedance) connector. Band 1 is split into two separate sub-bands...10 Hz to 100 MHz with 1-megohm impedance, and 50 MHz to 250 MHz with a 50-ohm impedance. The 10 Hz to 100 MHz range (Band 1/1 M Ω) is measured by reciprocal counting and the 50 MHz to 250 MHz range (Band 1/50 Ω) is measured by prescaling the input frequency by two, and then reciprocally counting the result. Band 2 provides a frequency range of 200 MHz to 40 GHz, 46 GHz, 50 GHz, or 60 GHz (model dependent) via a front panel mounted female sparkplug connector: 2.92 mm 'K' (models 3400A & 3460A); 2.4 mm (model 3500A); or 1.85 mm 'V' (model 3600). Band 2 input impedance is 50 Ω . Band 2 inputs are down-converted to an IF by a harmonic-heterodyne down-conversion technique. The IF is added to or subtracted from a multiple of the local oscillator to determine the input frequency.

1-4.3. Frequencies above 200 MHz are measured with automatic amplitude discrimination. A power meter provides amplitude measurements from -35 dBm or the minimum sensitivity of the counter...whichever is greater, to + 10 dBm [-30 dBm to 26.5 GHz; -25 dBm to 40 GHz; -20 dBm to 46 GHz; -15 dBm to 50 & 60 GHz].

1-4.4. Resolution and display storage time are selected in steps via front panel controls. An internal microprocessor performs all measurement calculations, taking into account the selected resolution. Measurements are displayed with correctly placed decimal point and unit of measurement on the front panel display.

1-4.5. The front panel is self-explanatory, with well-defined controls and indicators for selecting power, bands, and resolution using push-button toggle switches. Remote GPIB operation is also indicated on the front panel.

1-5. SPECIFICATIONS

1-5.1. Table 1-1 lists the mm-Series counter specifications; procedures for acceptance testing and calibration make reference to these specifications as a tolerance guide.

Table 1-1. Specifications

INPUT:	BAND 1 / 1 MΩ	BAND 1 / 50 Ω	BAND 2
Frequency Range:	10 Hz to 100 MHz	50 MHz to 250 MHz	200 MHz to 40 GHz (Model 3400A) 200 MHz to 46 GHz (Model 3460A) 200 MHz to 50 GHz (Model 3500A) 200 MHz to 60 GHz (Model 3600)
Sensitivity:	25 mVrms	-25 dBm	-30 dBm to 26.5 GHz, -25 dBm to 40 GHz, -20 dBm to 46 GHz, -15 dBm to 50/60 GHz. (-20 dBm @ 50/60 GHz typical)
Dynamic Range:	25 mVrms to 1 Vrms	-25 dBm to + 10 dBm	minimum sensitivity to + 10 dBm
Overload Indicator:			ON at + 10 dBm nom. to 26.5 GHz, increasing to + 15 dBm at 40 GHz, to + 20 dBm at 50/60 GHz
Coupling:	AC	AC	AC
Impedance:	1 megohm/25 pF	50 Ω nom.	50 Ω nom.
Damage Level:	250 VAC+DC to 440 Hz decreasing to 5 V at 1 MHz; 5 V from 1 MHz to 100 MHz	+ 25 dBm	+ 25 dBm (+ 23 dBm/Model 3600)
Automatic Amplitude Discrimination:			10 dB separation between 2 signals within 30 MHz, 20 dB otherwise. (30 dB otherwise/Model 3600).
Integrated Kickback Noise:			-50 dBm typical
AM Tolerance:			Any modulation index, provided the minimum signal is not less than the sensitivity spec.
FM Tolerance: (worst case)			20 MHz P-P to 40 GHz, decreasing to 10 MHz at 60 GHz.
VSWR:			3:1 typical.
Connectors:	BNC female	BNC female	2.92 mm female 'K' sparkplug, 2.4 mm female sparkplug (3500), 1.85 mm female 'V' sparkplug (3600)
Signal Acquisition Time:	N/A	N/A	< 100 milliseconds.

GENERAL SPECIFICATIONS:

Accuracy:	± 1 count, \pm time base accuracy.
Gate Time:	10 sec, 1 sec, 0.1 sec, .01 sec., 1.0 ms.
Resolution:	1 MHz, 100 kHz, 10 kHz, 1 kHz, 100 Hz, 10 Hz, 1 Hz, 0.1 Hz, & * 0.01 Hz. (0.1 dBm: Power Meter).
Display Time:	0.3 sec, 3.0 sec, Infinite & Min.
Self-Test:	All digit segments, all LED's and 10 MHz clock.
Display:	11 digits, LED 0.5" high, Overload, decimal point, sign.
Display Legend:	Hz, kHz, MHz, GHz, dBm.
Status Indicators:	BAND 1/1M Ω , BAND 1/50 Ω , BAND 2, EXT REF, GATE, DISPLAY TIME (2), REMOTE, ΔF , OVERLOAD (band 2 only), STANDBY/TEST, dBm (band 2 only: Power Meter).
DF:	Difference between stored reading and current reading displayed. *(Note: 0.01 Hz resolution is frequency dependent)

POWER METER (Band 2 only):

Frequency Range:	200 MHz to 40 GHz (Model 3400A) 200 MHz to 46 GHz (Model 3460A), 200 MHz to 50 GHz (Model 3500A), 200 MHz to 60 GHz (Model 3600).
Power Range:	-35 dBm or counter sensitivity, whichever is greater to +10 dBm max.
Damage Level:	+ 25 dBm (+ 20 dBm/model 3500A and Model 3600)
Accuracy:	± 1 dBm to 26.5 GHz, typical, ± 2 dBm 26.5-40 GHz, typical, ± 2.5 dBm 40-46 GHz, typical, ± 3 dBm at 50/60 GHz, typical.
Resolution:	0.1 dBm
Measurement Time:	Frequency measuring time + 15 ms.
Display:	Simultaneously displays Frequency (with 0.1 MHz resolution) and Power.

TIME BASE, Standard TCXO (See Options 112, 120, and 125 for other):

Frequency:	10 MHz
Aging Rate/second:	$\leq \pm 5$ parts in $10^{-9}/\sqrt{\tau}$ (root Allen variance).
Aging Rate/year:	$\leq \pm 7.6$ parts in 10^{-7} .
Retrace:	$\leq \pm 5$ parts in 10^{-7} after 24 hrs. ON, 24 hrs. OFF, 3 hrs. ON.
Temperature stability:	$\leq \pm 1$ part in 10^{-6} (0°C to 50°C).
MAINS change ($\pm 10\%$):	$\leq \pm 4$ parts in 10^{-7} .
Calibration Schedule:	One (1) year.

INTERNAL/EXTERNAL REFERENCE OSCILLATOR:

10 MHz REF OSC OUT:	10 MHz, 1 Vrms into 50 Ω , AC coupled.
Connector:	BNC female (rear panel).
EXT REF OSC IN:	External time base accepts 1 MHz, 2 MHz, 5 MHz, or 10 MHz time base signal, 0.2 Vrms to 5 Vrms. Automatically disconnects internal time base if external signal is > 0.2 Vrms.
Connector:	BNC female (rear panel); 1 k Ω impedance.

GPIB / IEEE 488:

Programmable Functions/Controls:	BAND 1/1 M Ω , BAND 1/50 Ω , BAND 2, RESET, STANDBY, POWER METER, ΔF , ΔF REFERENCE, TEST, DISPLAY TIME, RESOLUTION.
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General Specifications contd.

ENVIRONMENTAL: Designed to meet MIL-PRF-28800F Type III, Class 3, Style E and EN 61010-1 (IEC 1010-1), Specifically:

Operating Temperature: 0°C to 50°C.(standard CW) / 0°C to 40°C (Battery Option)
 Storage Temperature: -40°C to 71°C (w/o battery) / -10°C to 40°C (w/battery).
 Relative Humidity: 95% ± 5% 10°C to 30°C;
 75% ± 5% to 40°C;
 45% ± 5% above 40°C.
 Altitude: 4600 m (15,092 ft.)
 Vibration (random): 5–500 Hz.
 Burn In: Failure-free burn in of no less than 100 hours at 40°C (w/o battery).
 Pollution Degree: 1 (no pollution)(EN 61010-1/3.7).
 Transient Overvoltage: Installation Category II (EN 61010-1/J)

The XL mm-wave CW counters do not contain nor require a cooling fan.

RELIABILITY:

MTBF: Mean Time Between Failure = > 32,000 hours (MIL-HDBK-217E).
 MTTR_{ACM}: Mean Active Corrective Maintenance Time = 30.92 minutes (MIL-HDBK-472).

SUPPLEMENTAL SPECIFICATIONS:

ISO 9001: XL Microwave's Quality System for design and manufacture is registered and certified by TÜV Essen to ISO 9001-1994.

Montreal Protocol: Nil Return.

EC (European Union):

EMC Emissions: Certified to EN 55022:1987 Class B
 EMC Immunity: Certified to EN 50082-1:1992
 Low Voltage Directive: complies with EN 61010-1.

VDE (Germany):

EMC Emissions: Certified to VDE 0871/6.78 Class B.

BS (United Kingdom):

Complies with BS 4743:1979 (IEC 348) (Safety Requirements) and Defense Standard 59-41/Issue 3 (EMC) for the following classes:
 Ship use: parts 1, 2, and 3 for Type 1 equipment (Below Decks)
 Land Service use: Class F.

This Equipment complies with the environmental requirements of British Defense Standard 66-31/2 for Category III equipments.

BATTERY CHARACTERISTICS (Battery Option Counters only):

Manufacture: Panasonic.
 Manuf. Part No.: LC-SA122R3U, Rechargeable Lead/Acid Battery.
 Nominal Voltage: 12 VDC.
 Nominal Capacity: 2.3 Ah.
 Capacity affected by Temperature:

40°C (104°F)	102%
25°C (77°F)	100%
0°C (32°F)	85%
-15°C (5°F)	65%

Self-Discharge
 25°C (77°F):

Capacity after 3 month storage-	90%
Capacity after 6 month storage-	80%
Capacity after 12 month storage-	60%

General Specifications contd.

MECHANICAL:

Power: DC: 11 VDC to 28 VDC; 20 VA (18 VDC to 28 VDC; 20 VA, Option 125 only).
Battery Option: 12 VDC/2.3 Ah Rechargeable Sealed Lead/Acid Battery (Panasonic part number LCS-2312NC).
Battery power operating time on full charge: approx. 3 hours.

AC MAINS: 90/132 VAC or 180/265 VAC, 45 Hz to 440 Hz; 25 VA.

AC MAINS Fuse: (115 V) 1/2 A/250 V SLO-BLO (3AG)(1/4" x 1-1/4").
(230 V) 1/4 A 'T'/250 V (IEC 127-III-T Time-lag)(5 x 20 mm).

Weight: Net: Standard CW: 3.6 kg (8 lbs.)
Battery Option: 5 kg (11 lbs.)(including battery and Instrument Back-Pack).

Shipping: Standard CW: 5.5 kg (12 lbs.)
Battery Option: 6.8 kg (15 lbs).

Dimensions (HxWxD): 89 mm x 213 mm x 333 mm (3.5 in. x 8.375 in. x 13.1 in.).

ACCESSORIES FURNISHED:

One (1) Operating/Maintenance Manual.
One (1) AC power cord, 2 meters (6 ft.)
(conforms to IEC 320-3:1987/EN 60 320 and CEE color coding)
UL listed type SVT, 3 conductor Vinyl with NEMA, type 5-15p plug and
IEC 320-3:1987/EN 60 320 end termination.

Battery Option only: One (1) Weather-Resistant Instrument Back-Pack with Field Reference Card.
One (1) Panasonic LCS-2312NC, 12 VDC/2.3 Ah, Rechargeable,
Sealed Lead/Acid Battery.

1.6. OPTIONS

1-6. Table 1-2 lists the options that are available for the mm-Series counters.

Table 1-2. Options

Oscillator Options Available:

OPTION:	112 OCXO	120 OCXO	125 RUBIDIUM (see Note)
Aging/second:	$5 \times 10^{-10}/\sqrt{\tau}$ root Allan variance	$5 \times 10^{-12}/\sqrt{\tau}$ root Allan variance	$1.4 \times 10^{-11}/\sqrt{\tau}$ root Allan variance
Aging/day:	3×10^{-9} after 30 days	4×10^{-10}	2×10^{-11} after 60 min.
Aging/year:	5×10^{-7}	5×10^{-8}	2×10^{-9}
Warm-up (time): @ 25°C	1×10^{-8} in 30 min.	5×10^{-8} in 30 min.	5×10^{-10} in 4 min.
Retrace: @ 25°C	2×10^{-8} after 72 hrs. ON, 24 hrs. OFF, 12 hrs. ON	5×10^{-9} after 72 hrs. ON, 24 hrs. OFF, 2 hrs. ON	5×10^{-11} after 72 hrs. ON, 24 hrs. OFF, 1 hr. ON
Temperature: (0°C to 50°C)	2×10^{-8}	7×10^{-9} (2×10^{-8} , -30°C to 70°C)	3×10^{-11}
MAINS change: (± 10%)	5×10^{-9}	2×10^{-9}	N/A
Calibration Schedule:	1 year	1 year	1 year

Note : Election of Rubidium Osc. Option 125 extends counter chassis depth from 13.1 in. (333 mm) to 14.5 in. (368 mm). Rubidium oscillator, option 125, is not available with Battery Option 150 counters.

Other Options:

150: Battery Option. AC MAINS and Internal Battery Powered CW counter. This option includes a Weather-Resistant Instrument Back-Pack and a 12 VDC/2.3 Ah Rechargeable sealed Lead/Acid Battery (approx. 3-hour operating time per full charge). The battery will recharge whenever the counter is connected to AC Mains.

Note: In addition to the standard TCXO oscillator, both the OCXO oscillators (Option 112 & 120) are also available with the Battery Option. Rubidium Oscillator Option 125 is not available with Battery Option 150 counters. Battery and Back pack are excluded from instrument's warranty.

160: OCXO Oven Always ON. Provides constant power to OCXO oven circuitry with Battery operation (shortens battery operating time)(requires Options 150 & 112 or 120 OCXO).

170: Rack Ears: 3.5 in. x 19 in. (88.9 mm x 482.6 mm) (H x W) (EIA RS-310).

NOTE: ALL OPTIONS ARE INSTALLED BY FACTORY ON ORIGINAL INSTRUMENT ORDER.

1.7. ACCESSORIES AND SERVICES

1-7. Table 1-2 lists the accessories and services that are available for the mm-Series counters.

Table 1-3. Accessories & Services

Accessories

- 302:** Case: Hard Shell.
- 326:** Case: Watertight, airtight, corrosion proof, dust proof, crush proof, for severe environmental conditions.
- 336:** Back-Pack: Custom Weather-Resistant Instrument Back-Pack.
- 320:** Battery: Spare, 12 VDC / 2.3 Ah Rechargeable Sealed Lead/Acid.
- 305:** Manual: Spare Operating and Maintenance Manual.

Services

- 214:** Factory Calibration: All Instruments (includes report per ISO 9001).

CHAPTER 2 INSTALLATION

2-1. INTRODUCTION

2-1.1. This chapter outlines the procedure for initial inspection and installation of the XL mm-Series Millimeter Wave Frequency Counters. The subject matter includes receiving inspection, initial turn-on, installation criteria, and information on the IEEE Std-488 GPIB system. Instructions for preparing an instrument for reshipment are also included.

2-2. RECEIVING INSPECTION

2-2.1. Prior to accepting the unit from the shipper, inspect the condition of the shipping container for any evidence of freight damage. Any damage should be noted by both the shipper and the receiving customer and reported to the insurance investigator.

2-2.2. Immediately after removing the instrument from the shipping carton, inspect it for any possible physical damage that may have been incurred in shipment. Check for surface scratches and dents; note the condition of switches, buttons, and connectors (carrying bag and battery if Battery Option). Should any damage be detected, notify XL Microwave. ***DO NOT USE THE INSTRUMENT UNTIL INSTRUCTED TO DO SO BY THE XL MICROWAVE FACTORY.***

2-3. POWER REQUIREMENTS

2-3.1. The mm-Series counters are provided with a detachable three-conductor power cord, type IEC 320-3:1987/EN 60 320. This power cord conforms to the CEE Color Coding Standards (Light Blue: Neutral; Brown: Live; Green/Yellow: Protective Ground). The power cord grounds the instrument chassis when connected through a compatible power receptacle. Battery Option counters can be operated, and the battery recharged, over the MAINS line voltage (external DC source not available with battery option). The counter operates over a MAINS line voltage of 90/132 VAC/25 VA or 180/265 VAC/25 VA (rear-panel switchable), 45 Hz to 440 Hz. Standard CW counters may also be operated from an external DC source of 11 to 28 VDC/20 VA (NOTE: Option 125 requires a minimum of **18** VDC External power).

WARNING

This is a safety Class 1 product and is provided with a protective grounding terminal. The detachable (IEC 320-3:1987/EN 60 320) three-conductor power cord couples this grounding terminal to the power source uninterruptible safety earth terminal. Do not use the unit if the safety ground is broken. An Adapter which provides a chassis ground should be used whenever the power cord is mated to a two-terminal outlet.

2-4. BATTERY INFORMATION (Battery Option counters only)

2-4.1. The mm-Series Battery Option counters are provided with a Panasonic LCS-2312NC, 12 VDC/2.3 Ah rechargeable Lead/Acid battery for portable power. The Battery Option counters contain a built-in recharging power supply that automatically recharges the battery whenever the battery is placed into the instruments battery compartment and the AC MAINS power cord is attached to an appropriate AC MAINS source (90/132 VAC/25 VA or 180/265 VAC/25 VA, 45 Hz to 440 Hz).

2-4.2. CAUTION: *The following information concerning the battery should be observed.*

1. Important safety considerations:

- Do not incinerate battery, may exploded if disposed of in fire.
- Do not directly connect the negative and positive terminals together.
- Do not use other than the instrument's internal charger to recharge battery.

2. To prevent deterioration or damage to battery:

- Do not drop or subject to strong physical shock.
- Do not use to power equipment other than this counter.
- Do not use below -10°C (15°F) or above + 40°C (105°F). If the temperature exceeds this upper limit, a safety device will automatically prevent operation of the battery.

3. To ensure long battery life:

- **Do not discharge completely.**
- **Recharge battery immediately after use.**

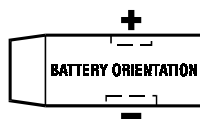
2-4.3. Recycling battery. The sealed Lead/Acid battery, shipped with the 3000 Battery Option counters, contain Lead (Pb) and **must** be recycled or disposed of properly after its useful life is exhausted (consult your local Waste Disposal Authority). Do not incinerate this battery or dispose of in garbage container.



2-5. INSTALLATION

2-5.1. When operated as a bench mounted unit, the rear panel must remain unobstructed to allow cable connection and switch operation. Standard CW instruments are supplied with a swing-down-type bail, mounted on the front of the bottom cover. When extended, this stand will tilt-up the front panel to a comfortable operating and viewing angle. With Battery Option counters, the battery may be removed or left in the counter when used as bench mounted units.

2-5.2. (Battery Option only) The battery should first be placed into the counter's battery compartment through the battery rear panel door, and the door secured with the thumb screw. When inserting the battery into its compartment, orient the battery so that the positive terminal is **up** and the **end with the**



terminals is inserted first (note: the battery cannot be fully inserted into its compartment if it is incorrectly oriented). The counter (with battery) can now be placed into the soft shoulder carrying bag and used within this bag. The counter may be recharged while it is in the carrying bag by opening the flap at the bottom of the bag and plugging the AC MAINS cord into the IEC MAINS connector at the

rear of the counter, the other end being connected to an appropriate AC source. **NOTE: The battery must be charged before first use!**

2-6. MATING CONNECTORS

2-6.1. The 10 Hz to 100 MHz/1 M Ω /25 pF and 50 MHz to 250 MHz/50 Ω Band 1 input is a coaxial type BNC connector. The 200 MHz to 40, 46, or 60 GHz (model dependent) Band 2 input is either a 2.92 mm female 'K' sparkplug connector (SMA and 3.5 mm compatible; Models 3400A & 3460A), a 2.4 mm female sparkplug connector (Model 3500), or a 1.85 mm female 'V' sparkplug connector (2.4 mm compatible/Model 3600) with a 50 Ω nominal impedance (*see Cautions below*). The input connector is front-panel mounted. The rear panel 10 MHz time base connectors are coaxial type BNC. The IEEE-488 Interface connector is 24-pin (metric-dimensioned) in accordance with IEEE Std-488 1978; it is compatible with an Amphenol 57-30204 mating connector.

Note: Using a 3.5 mm terminated cable with the counter's 2.92 mm front panel connector (models 3400A & 3460A) will mate properly but the physical difference in construction between these two different size connectors will slightly degrade the VSWR specification. The same is true when using a 2.4 mm terminated cable with the 1.85 mm front panel connector (model 3600).

2-6.2. Replacing the Band 2 sparkplug connector. The Band 2 female sparkplug connector (2.92 mm or 1.85 mm) is "field replaceable" if damaged or lost during use. A special toolkit, available from Anritsu Wiltron Co., must be used when replacing this connector. The Wiltron part number for this kit is *toolkit # 01-105*. Caution must be exercised when removing and replacing this 'sparkplug' connector to ensure that the center conductor of the internal coax is not bent. The following instructions should be followed when replacing the sparkplug connector:

- 1- Remove the old sparkplug connector from the mixer block and check to see that the coax center conductor (inside the block) is centered and has not been bent.
- 2- Carefully screw the new sparkplug connector into the mixer block, by hand, until finger tight.
- 3- Tighten, using the referenced toolkit adapter and torque wrench, per enclosed instructions in the toolkit.

Note: If the center conductor of the internal coax (inside the mixer block) is found to be bent, the entire counter must be returned to the factory for repair. Attempting to straighten this center conductor will only deform it and correct mating with the sparkplug will no longer occur.

Model 3500A & 3600 CAUTION Do Not Use 'SMA' Connectors!!!

Caution 1- The Band 2 connectors on the model 3500A (2.4 mm) and the 3600 (female 'V', 1.85 mm) are not compatible with a 'SMA' type connector! Attempting to directly connect a 'SMA' terminated cable to either type connector will deform the connector's center conductor and render the connector unusable.

Caution 2- A 2.4 mm coax connector will mate with a 1.85 mm connector (on model 3600) but the transition is not the same and an impedance mismatch will occur. Always use a 1.85 mm terminated coax cable connector when connecting to the model 3600.

2-7. GPIB SYSTEM CONNECTION, REMOTE PROGRAMMING

2-7.1. The General Purpose Interface Bus (GPIB) permits operation of the mm-Series counters from a data bus which conforms to the IEEE Standard Digital Interface for Programmable Instruments (IEEE Std-488 1978). To implement the GPIB, a 24-pin connector and a 5-bit address switch are provided on the rear panel of the instrument.

2-7.2. See Chapter 3 for a detailed description of the GPIB. Table 2-1 below provides the pin assignments for the rear panel GPIB interface.

Table 2-1. GPIB Interface Connector

PIN NO.	IEEE-488 MNEMONIC	PIN NO.	IEEE-488 MNEMONIC
1	DIO1	13	DIO5
2	DIO2	14	DIO6
3	DIO3	15	DI07
4	DIO4	16	DI08
5	EOI	17	REN
6	DAV	18	GND (Return)
7	NRFD	19	GND (Return for NRFD)
8	NDAC	20	GND (Return for NDAC)
9	IFC	21	GND (Return for IFC)
10	SRQ	22	GND (Return for SRQ)
11	ATN	23	GND (Return for ATN)
12	GND	24	GND (Logic Return)

Levels: *True* (1) state is 0.0 to 0.8 VDC *False* (0) state is + 2.5 to + 5.0 VDC
Mating Connector: Amphenol 57-30240

2-8. INCOMING CONFIDENCE CHECK

2-8.1. Prior to packaging the instrument for shipment, extensive operational, alignment, and calibration procedures were performed by XL Microwave to verify that the instrument is operating to specifications. To ensure the electronic integrity of the instrument on your receiving bench, you must perform the following confidence check. **Battery Option Note:** If it is desired to perform this confidence check on battery power, it is necessary to first completely charge the battery. This may be accomplished by placing the battery in the instrument and connecting the AC cord to the instrument and an appropriate MAINS supply.

1. Ascertain that the operating voltage and line fuse are appropriate, then connect the AC power cord to the MAINS.
2. Turn on power, the display turns on, and each digit displays an "8" with decimal points, and all annunciator LEDs on the front panel illuminate.
3. Next, the front panel digital display indicates "10.000000 MHz, followed by the GPIB address (buss) set with the rear panel GPIB ADDRESS switch", the TEST LED extinguishes, the GATE LED illuminates (blinking at the recycle rate), the 0.3 SEC DISPLAY TIME LED illuminates, and the display indicates 0.0 kHz.

4. Insert jumper cable from rear panel 10 MHz REF OUT to Band 1/1 M Ω input. Display indicates 10.000 MHz. Press DISPLAY TIME twice to the "INF" setting (both 0.3 SEC and 3.0 SEC LEDs illuminate). GATE LED remains steadily "OFF". Press RESET-LOCAL and observe that GATE LED blinks, then remains steadily "OFF".

5. This completes the incoming confidence check. The instrument can now be placed in service.

2-9. FIRMWARE RELEASE

2-9.1. To see what the firmware release in your particular instrument (PROMS) is, use the following procedure:

1. Push and hold the [DISPLAY TIME] button while plugging the instruments AC cord into the AC MAINS. The instrument will now display the release number in the format "rEL = CX.X" where X.X is the release number (see Figure 2-1 below).

2. When done, press and release any button to continue the power-up self-test, which, when done, will set the counter into normal operation.

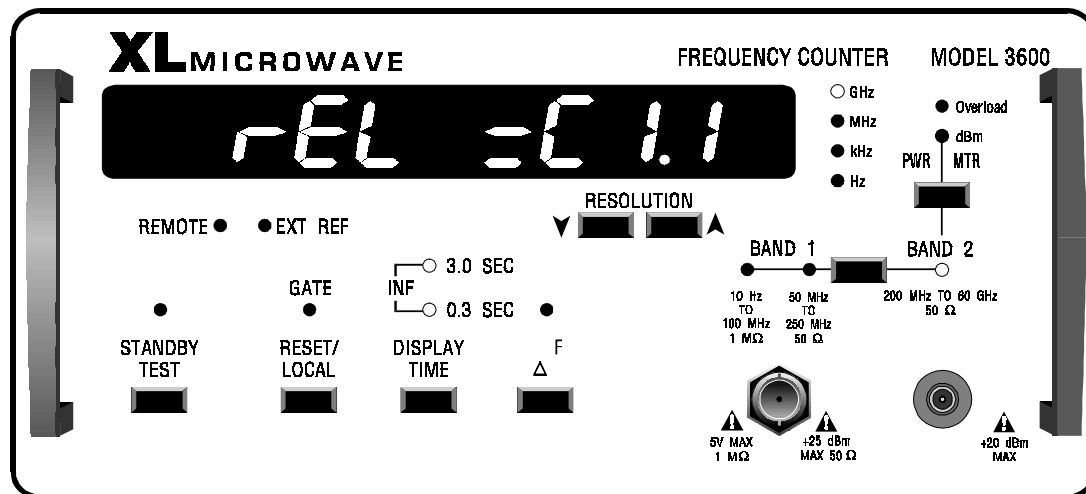


Figure 2-1. Firmware Release

2-10. PREPARATION FOR RESHIPMENT

2-10.1. When packing the instrument for reshipment, use the original packing materials that the instrument was shipped in.

2-10.2. Pack the instrument using the following package procedures:

1. Attach an identification tag to the unit indicating model number, serial number, name and address of instrument owner, and a summary of the service or repairs required.

Battery Option Note: Do not reship the battery, carrying case or accessories to the factory, as these items are not covered by the warranty and XL Microwave does not repair these items.

2. Wrap the instrument in heavy paper or plastic prior to placing it in the shipping container.

3. Select a strong carton or wooden box as a shipping container.

4. Use an adequate layer of shock-absorbing materials on all six sides of the unit. Protect the instrument front panel with added layers of cardboard. Ensure that the unit does not move in the container.

5. Seal the shipping container with strong tape or metal bands; attach a packing list to the outside surface.

6. Mark the shipping container "**FRAGILE-DELICATE INSTRUMENT**," and also affix appropriate handling symbols to the carton to ensure maximum care in transit.

7. Be certain that all correspondence relating to the service or repair of the instrument includes the information contained on the instrument identification tag.

2-11. STORAGE

2-11.1. There are no special storage instructions. The instrument should be shelved in a reasonably clean environment and protected from dirt and moisture. Do not wrap air-tight with plastic. Place the instrument in a cardboard container and seal it from dirt and moisture.

2-11.2. For extended storage (periods in excess of one year), the shelf life of electrolytic capacitors must be considered. The shelf life of electrolytic capacitors is governed by the storage temperature. At a storage temperature of 25°C to 30°C the shelf life will be two years or more. At temperatures below 25°C the shelf life will be several years. When storage conditions are unknown, capacitors should be reconditioned every six months or before they are put in service. Capacitors stored for long periods, especially at high temperatures, may show significantly increased DC Leakage (DCL). The DCL can usually be decreased to original limits (capacitor restored to normal operating specifications) by application of voltage, increasing in steps to the capacitor's working voltage.

2-11.3. To recondition the instrument's electrolytic capacitors: At six-month intervals, bench mount the instrument and apply appropriate AC power, turn the instrument on and allow it to cook for one hour. After reconditioning, return the instrument to storage.

CHAPTER 3 OPERATION

3-1. INTRODUCTION

3-1.1. This chapter describes the operation of the Models 3600/3500A/3460A/3400A mm-Series Frequency Counters. First, the front and rear panel controls, indicators, display and connectors are depicted and described as to their function and operational use. Next, remote procedures are presented for IEEE-488 GPIB operation to show system application of the counter, and, finally, the failure messages and error signals output from the internal microprocessor are discussed.

3-2. FRONT PANEL CONTROLS, INDICATORS, DISPLAY, AND CONNECTORS

3-2.1. Figure 3-1 depicts a typical 3600 Series Front Panel (for an illustration of the Battery Option front panel, see Chapter 8).

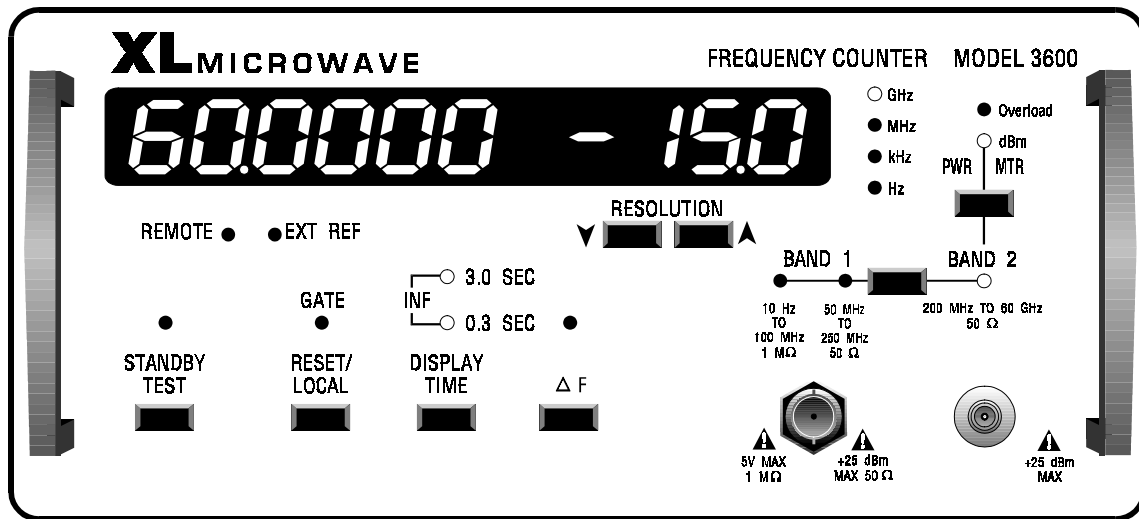


Figure 3-1. Model 3600 Front Panel

3-3. FRONT PANEL MODE SELECTIONS

3-3.1. The following modes of operation are selectable by pressing the appropriate switch [XXX] or switches. Appropriate LED indicators light (where provided) to indicate selection or operation of a function.

NAME	FUNCTION
STANDBY/TEST	Pushing [STANDBY/TEST] switch puts the counter in the Standby mode, lighting the STANDBY LED indicator. When the [STANDBY/TEST] switch is pressed again, it toggles the counter status, initiating a self-test sequence which displays 10.000000 MHz, then displays the GPIB address that has been set on the rear panel, and then restores the instrument to normal operation. Note: In Battery Option counters, this switch is an [ON/OFF] switch which toggles the instrument's power ON and OFF, lighting

the LED indicator when ON. When the counter is powered-up the above self-test sequence is initiated.

RESET/LOCAL

Pushing [RESET/LOCAL] will reset the instrument, initiate a new measurement and return the instrument to local control. When pressed while operating in local mode, restarts program, immediately initiating a new measurement. All user settings are retained. If in *remote* mode when pressed, returns instrument to local control and initiates a new measurement. This function is locked out by "LLO" if it has been issued by the GPIB controller. Reset also loads in the GPIB address as set on the switches on the rear panel.

DISPLAY TIME

[DISPLAY TIME] is a toggle pushbutton that increments the time between measurements (recycle rate). The illuminated LED's denote the selection of 0.3 seconds or 3.0 seconds between displays. When both LED's are OFF it indicates a zero display time, and when both LED's are ON it indicates infinite display time. Each push of the button toggles the next function.

 ΔF

Push [ΔF] to toggle the Delta Frequency function ON and OFF. When ON, the ΔF function will cause the counter to display the difference between the current frequency and the first measurement after the function was turned ON. The ΔF reference may be loaded via the GPIB (see GPIB program section). ΔF and 0.01 Hz resolution are mutually exclusive. If Band 1 resolution was set to 0.01 Hz and ΔF is then selected, ΔF will automatically set the Band 1 resolution to 1 Hz. **Note:** if the reference measurement fails when initiating ΔF , the counter will attempt to remeasure the reference five times. If the reference cannot be successfully measured in five attempts the ΔF LED will be turned OFF and normal measurements will resume.

RESOLUTION

Push to activate switches. The UP [\uparrow] arrow will increase the resolution to a maximum of 0.01 Hz (Band 1)/1 Hz (Band 2) and the DOWN arrow [\downarrow] will decrease the resolution to a minimum of 100 Hz (Band 1)/1 MHz (Band 2).

BAND

Push [BAND 1/BAND 2] to toggle the instrument from BAND 1/1 M Ω to BAND 1/50 Ω to BAND 2 and back to BAND 1/1 M Ω . If the power meter was ON in BAND 2, it will be ON when BAND 2 is reselected. The LED's illuminate to indicate which band is active.

PWR MTR

Push [PWR MTR] to toggle the power meter ON and OFF. An LED indicates operation of the power meter. When active, display indicates both frequency and input power level in dBm (Power meter operable only in Band 2).

3-4. FRONT PANEL FREQUENCY/POWER DISPLAY

3-4.1. The 11-digit display shows the measured frequency and input power level.

NAME

FUNCTION

DIGITAL DISPLAY

The mm-Series of XL counters all have an 11-digit, 0.5 inch high numerical in-line display with decimal point. The display shows 11 digits of frequency measurement information. Appropriate LED annunciators denote frequency in Hz, kHz, MHz, or GHz. When power mode is selected the display is split, with the six most-significant digits representing frequency (to 100 kHz resolution), and the three least-significant digits representing the input power level in dBm. Positive dBm indications are displayed *without* sign, whereas negative dBm indications are displayed with the minus (–) symbol.

3-5. CONNECTORS

3-5.1. This section identifies the front panel connectors.

NAME

FUNCTION

BAND 1

BNC type connector accepts input frequencies in the Band 1 range, from 10 Hz to 100 MHz/1 M Ω /25 pF and 50 MHz to 250 MHz/50 Ω .



CAUTION: 5 V rms (1 M Ω). Damage may be sustained by the counter if greater than 5 V rms is applied when in the 10 Hz to 100 MHz/1 M Ω mode. Damage level is frequency-dependent (see pg. 1-5).



CAUTION: + 25 dBm (50 Ω). Damage may be sustained by the counter if greater than + 25 dBm is applied when in the 50 MHz to 250 MHz/50 Ω mode.

BAND 2

2.92 mm female (SMA compatible) sparkplug connector (model 3460A & 3400A) accepts input frequencies in the Band 2 range from 200 MHz to 46 GHz (model 3460A) or to 40 GHz (model 3400A). A 1.85 mm 'V' sparkplug female connector (model 3600) accepts input frequencies in the Band 2 range from 200 MHz to 60 GHz. Band 2 input impedance is for all three models is 50 Ω .



CAUTION: Do not use SMA terminated cable with the model 3600 Band 2 'V' connector.



CAUTION: + 25 dBm. Damage may be sustained by the counter if greater than + 25 dBm is applied... + 20 dBm for Model 3600.

3-6. LED INDICATORS AND ANNUNCIATORS

3-6.1. This section identifies the mm-Series front panel indicators and annunciators.

NAME	FUNCTION
STANDBY	Red LED. Illuminates when counter is in the standby mode (in Battery Option counters this LED is an ON/OFF indicator and illuminates when the counter is ON).
REMOTE	Red LED. Illuminates when counter is in remote operation via the GPIB IEEE interface.
EXT REF	Red LED. Illuminates when an external reference oscillator is in use for the counter's time base (switchover is automatic if the external input falls below minimum level requirements).
GATE	Red LED. Illuminates when the count gate is active.
0.3 SEC, 3.0 SEC, INF	Red LEDs. Illuminate to display measurement hold time. 0.3 SEC illuminated indicates 300 millisecond hold time is in effect. 3.0 SEC illuminated indicates 3.0 seconds hold time is in effect. Both LEDs illuminate to indicate infinite hold time. Both LEDs extinguished denote minimum hold time.
ΔF	Red LED. Illuminates when the ΔF function has been turned on by either the front panel [ΔF] switch or by GPIB command.
GHz	Red LED. Illuminates to indicate that the frequency displayed is in GHz.
MHz	Red LED. Illuminates to indicate that the frequency displayed is in MHz.
kHz	Red LED. Illuminates to indicate that the frequency displayed is in kHz.
Hz	Red LED. Illuminates to indicate that the frequency displayed is in Hz.
OVERLOAD	Red LED. Illuminates when Band 2 input signal level exceeds + 10 dBm nominal.
dBm	Red LED. Illuminates to indicate that the counter is in the power measurement mode and the display indicates frequency in MHz and power in dBm.
BAND 1/1 MΩ	Red LED. Illuminates when Band 1/1 M Ω is selected.
BAND 1/50Ω	Red LED. Illuminates when Band 1/50 Ω is selected.
BAND 2	Red LED. Illuminates when Band 2 is selected.

3-7. REAR PANEL

3-7.1. Figure 3-2 depicts the mm-Series rear panel connectors, fuse, and address switch (for an illustration of the Battery Option rear panel, see Chapter 8)

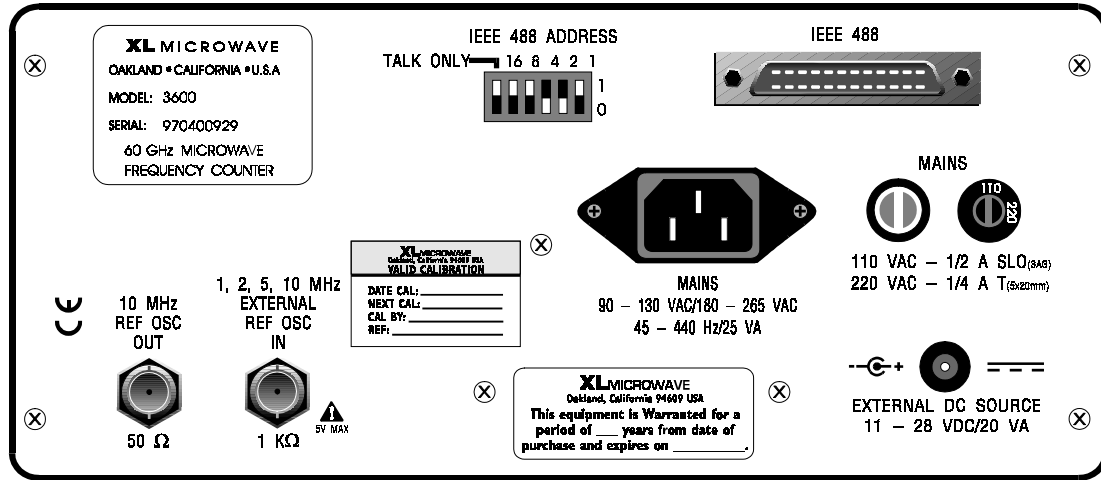


Figure 3-2. mm-Series Rear Panel

NAME	FUNCTION
10 MHz REF OSC OUT	BNC connector. The 10 MHz REF OSC OUT connector provides an output of 10 MHz from the time base being used.
EXT REF OSC IN	BNC connector. The EXT REF OSC IN connector provides for input of the external time base oscillator signal of 1 MHz, 2 MHz, 5 MHz or 10 MHz. Automatically disconnects internal time base.
IEEE 488 ADDRESS	Six-bit switch assembly. Selects instrument address. The five 0/1 switches (# 2-6) provide for the specific 5-bit GPIB address for the counter. The sixth switch (# 1) selects a TALK ONLY mode.
POWER CONNECTOR	Mains power receptacle. Male plug suitable for connection to the detachable (IEC 320-3:1987/EN 60 320) three-conductor power cord, houses 3-prong RF/EMI filter.
IEEE-488	A 24-pin female connector whose pinouts are defined in Table 2-1. Provides for remote interface of the counter with the GPIB. A standard IEEE-488 interface cable may be connected here.
MAINS LINE FUSE	1/2-amp SLO (115 VAC) or 1/4-amp 'T' (230 VAC) Slo Blo line fuse.
MAINS LINE VOLTAGE SWITCH	Selects either 115 VAC/25 VA (90-132 VAC) or 230 VAC/25 VA (180-265 VAC) operation.
DC POWER CONNECTOR	Type 2.5 mm, two-terminal battery power connector. Connect an external 11-28 VDC/20 VA source to this port (18-28 VDC/Option 125)(center pin is positive). An internal sensing circuit automatically selects AC or DC power source (Note: Battery Option counters do not contain an external DC connector).

3-8. MEASUREMENT CONSIDERATIONS

3-8.1. When the counter is used to make critical measurements, several factors that may cause errors in a measurement must be considered. The following paragraphs describe significant error producing factors, and explain how the counter's specifications and characteristics affect measurement accuracy.

3-8.2. When discussing measurement accuracy, *accuracy* must be defined as a measurement as close as possible to an accepted standard. The basic unit for frequency and time measurements is the second. The second is defined as the duration of 9, 191, 631, 770 periods of the transition within the cesium atom. The two most-accepted national standards have been established by the National Institute of Standards and Technology (NIST), Colorado, and the U.S. Naval Observatory (USNO), Washington, D.C. NIST and USNO use cesium beam atomic clocks for primary measurement standards.

3-9. MEASUREMENT ERRORS

3-9.1. There are four categories of measurement errors:

1. Gating ambiguity
2. Time base
3. Trigger
4. System

3-9.2. Systematic errors are not typical to frequency counters and the detrimental effect is insignificant.

3-10. GATING AMBIGUITY ERRORS

3-10.1. The counter is subject to an irreducible plus or minus one-count error in the LSD of the display when operating in the normal gate mode. This error is present because of a noncoherence between the signal being measured and the time base oscillator that controls opening and closing of the main count gate. The first or last pulse of the signal being counted may or may not be gated into the count register during the selected count gate *on* interval. As the frequency measured is increased, the percent of error is reduced because it becomes less significant as compared to the total count. Thus, the percent of error is a function of the frequency (rate) being measured and the number of pulses counted, that is, the gate count time selected. While normally insignificant at higher frequencies, this error becomes more important at lower frequencies. For this reason the reciprocal mode is automatically selected to obtain greater accuracy when measuring low frequencies.

3-10.2. Reciprocal counting provides two major advantages: (1) the ± 1 count quantization error is independent of the input signal frequency being counted (hence, for noiseless inputs and assuming negligible trigger and time base error, the resolution of reciprocal counting is also independent of the input signal frequency); (2) the reciprocal technique provides control of the count gate in real time.

3-10.3. For a given time, the ± 1 count quantization error for frequency counting is inversely proportional to the input frequency. In reciprocal counting, for the same gate time, the quantization error is constant and is determined by the period of the counted clock. Thus, the quantization error is less when the reciprocal technique is used for all input frequencies that are less than the clock frequency. The difference in the ± 1 count quantization error between frequency counting and reciprocal counting is shown in Figure 3-3.

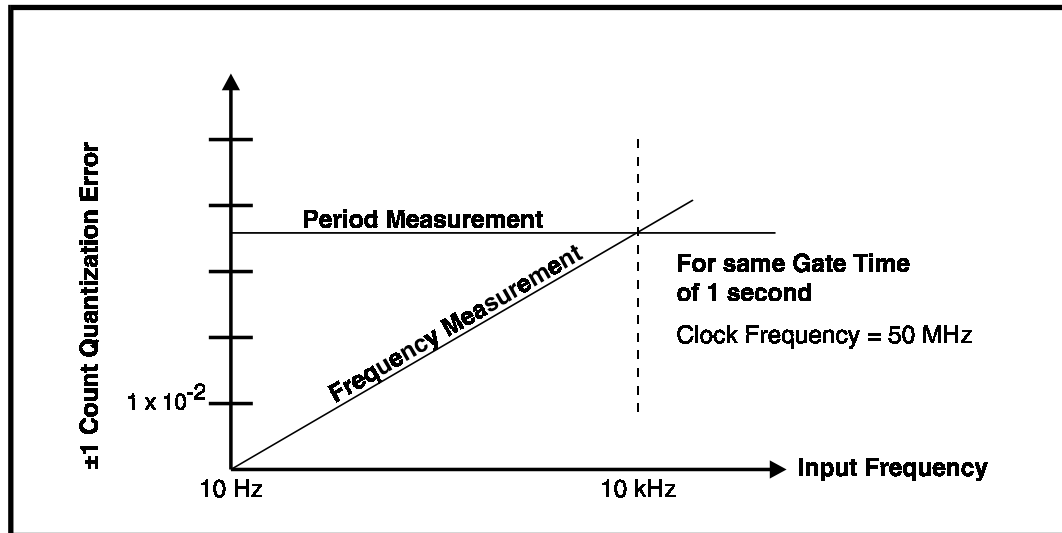


Figure 3-3. Gating Ambiguity Error, Reciprocal Counting versus Direct Counting

3-11. TIME BASE ERROR

3-11.1. The gating precision, and, therefore, the accuracy of measurement, depends on the stability of the time base oscillator frequency.

3-11.2. The stability of the time base oscillator may be stated as the maximum fractional frequency change due to all error sources (for example, aging, temperature, and line voltage). The actual error in any particular measurement can be found by multiplying the total Δ/f of the time base oscillator (or Δ/t which equals Δ/f by the measured quantity). For example, if the standard time base oscillator is specified as:

Frequency: 10 MHz
Aging Rate: ± 3 parts in 10^{-7} /month; ± 1 part in 10^{-6} /year
Temperature: ± 5 parts in 10^{-7} /month; over 0 to 50°C
Line Voltage: ± 5 parts in 10^{-8} /month; for 10% change from nominal

3-11.3. What is the time base error in the measurement of 5 MHz input signal if the counter has not been calibrated for one month and the temperature change from when it was calibrated to time of measurement is 7°C at the most.

$$\Delta F / F_{\text{Aging}} = \pm 3 \times 10^{-7}$$

$$\Delta F / F_{\text{Temperature}} = \pm 5 \times 10^{-7} \times 7^{\circ}\text{C} / 50^{\circ}\text{C} = \pm 7 \times 10^{-8}$$

$$\Delta F / F_{\text{Line Voltage}} = \pm 5 \times 10^{-8}$$

$$\Delta F / F_{\text{Total}} = \pm 3 \times 10^{-7} \pm 7 \times 10^{-8} \pm 5 \times 10^{-8} = \pm 4.2 \times 10^{-7}$$

$$\Delta F / F_{\text{Error}} = F \times \Delta F / F = \pm 5 \times 10^6 \times \pm 4.2 \times 10^{-7} = \pm 2.1 \text{ Hz}$$

3-12. TRIGGER ERROR

3-12.1. When reciprocal measurements are made, the input signal controls the opening and closing of the count gate. Small noise spikes on the input signal can cause the count gate to open and close either early or late, allowing the accumulation of too few or too many counts. Figure 3-4 shows an input signal passing through the hysteresis window of the input amplifier trigger circuit. In the absence of noise, the count gate would open at point A. The noise spike has sufficient amplitude to cross the upper hysteresis limit and cause a trigger error, because the count gate opened early at point B.

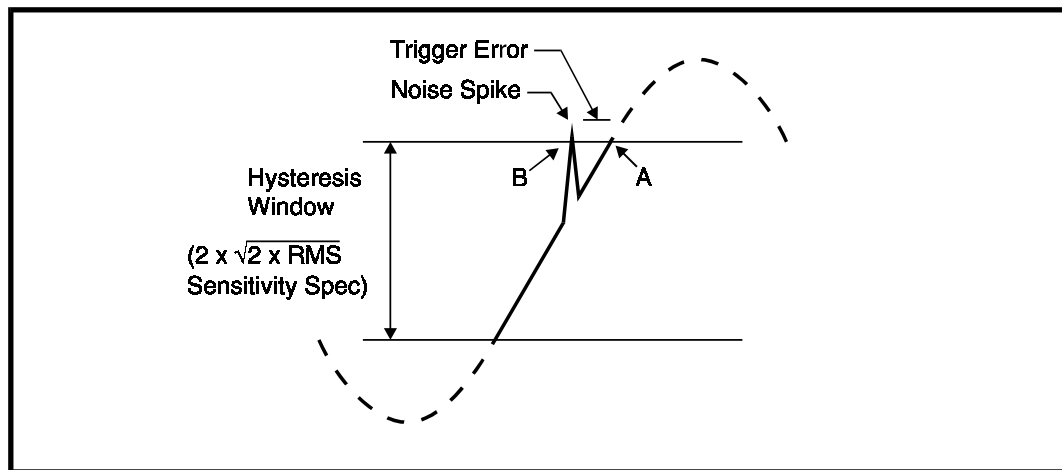


Figure 3-4. Trigger Error

3-12.2. The hysteresis band is determined by the sensitivity specification while the trigger responds to a peak-to-peak signal.

3-13. OPERATING CHARACTERISTICS

3-13.1. The following paragraphs describe the operating range, resolution, FM tolerance, dynamic range, and overload characteristics of the mm-Series CW Counters.

3-13.2. Operating Ranges. There are three operating ranges available: Band 1/1M Ω : 10 Hz to 100 MHz; Band 1/50 Ω : 50 MHz to 250 MHz; and Band 2: 200 MHz to end of band. Frequencies in the Band 1 range are input to the Band 1 BNC connector and manually selected as 10 Hz to 100 MHz/1M Ω or 50 MHz to 250 MHz/50 Ω . Frequencies in the Band 2 range (200 MHz to 40 GHz, 46 GHz, or 60 GHz, model dependent) are input to the 50 Ω female sparkplug connector [2.92 mm (SMA compatible)/model 3460A & 3400A, 2.4 mm/3500A or 1.85mm 'V'/model 3600].

3-13.3. Band 1 Resolution. Resolution is defined as the value represented by the least significant digit (LSD) displayed. The Frequency resolution in Band 1 is a function of both **the resolution selected and the actual input frequency**. This is true for both manually selected Band 1 resolution (using the resolution up and down arrows on the front panel—one to five zeros displayed) and for Band 1 resolution set over the GPIB buss (via 488 commands, G1–G5, one to five zeros displayed). The accompanying chart, Figure 3-5, cross-referencing Maximum Resolution (Hz); Band 1 Input Frequency; and GPIB Band 1 Resolution Command (Minimum Gate Time); is an attempt to illustrate the resolution (in Hertz) of Band 1 frequencies for various gate lengths selected either manually or over the GPIB buss. The gate length number (e.g. G3) corresponds to the number of zeros displayed when there is no input frequency. For example, without an input signal in Band 1, push the resolution arrows till four (4) zeros are displayed—this is the G4 gate setting (1.090 sec. minimum gate time). If a 10 MHz signal is then connected to the Band 1 input, the counter will display 10000000.0 Hz (10 MHz with a 0.1 Hz resolution at a minimum gate time of 1.090 sec.). To compute the actual resolution for a selected gate time and measured frequency use the formula $(1/(1.2^8 \times \text{GATE TIME})) \times \text{FREQUENCY} = \text{RESOLUTION}$ (or 0.01 Hz, whichever is larger); where GATE TIME is in seconds and RESOLUTION is in Hertz. Resolution of 0.001 Hz to 1 Hz is given automatically for frequencies less than 10 kHz.

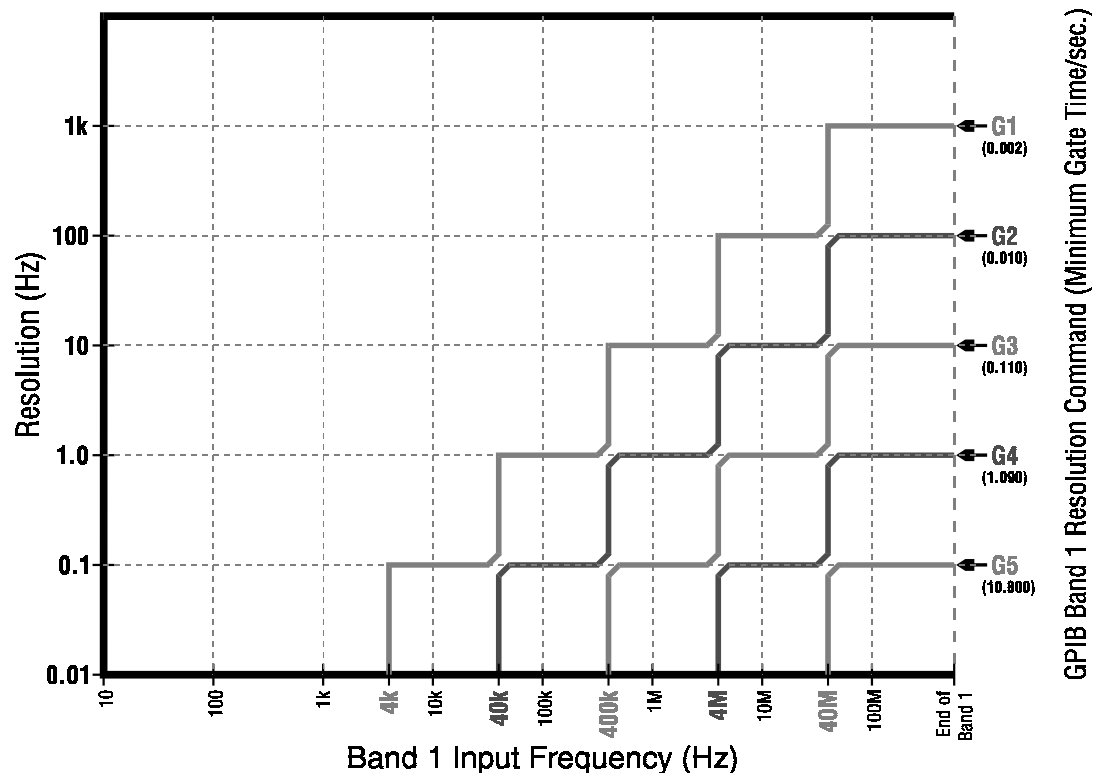


Figure 3-5. Band 1 Resolution Chart.

3-13.4. Band 2 Resolution and Blanking. Resolution of 1 Hz to 1 MHz, in decade steps, is available in Band 2. Resolution once selected is stored in memory until changed or power is removed. If 0.01 Hz or 0.1 Hz resolution is selected in Band 1 and you enter Band 2, the resolution will default to 1 Hz in Band 2...but when you return to Band 1, the previously selected resolution will be active. **Note:** Selecting 0.01 Hz or 0.1 Hz resolution in Band 1 may require up to a 10 second gate time to measure the signal (see figure 3-5). During this gating time-out, the display will read "0" until measurement is achieved.

3-13.5. FM Characteristics. The Band 2 measuring technique provides measurement of microwave carrier frequencies in the presence of high levels of frequency modulation, phase modulation and residual noise. The FM characteristics are a function of the modulation rate and the carrier frequency as shown in Figure 3-6.

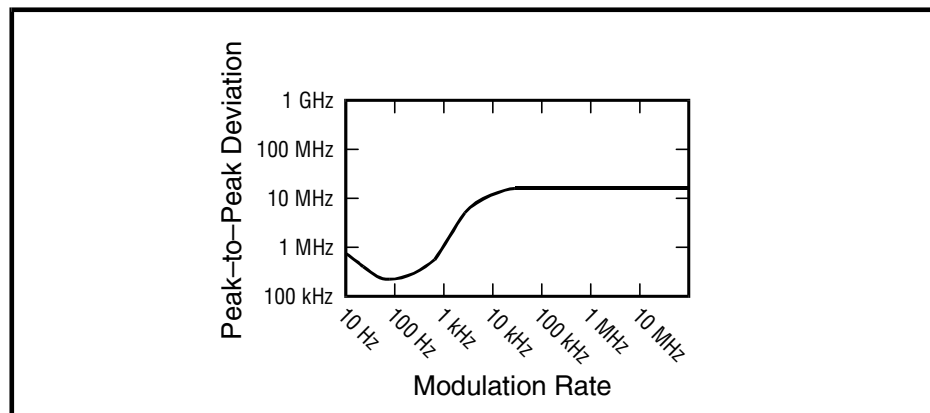


Figure 3-6. FM Characteristics

3-13.6. Dynamic Range and Overload Protection. The Band 2 microwave measuring technique provides excellent sensitivity for low-level signals and high-power protection. *Operative dynamic range* is the term used to define the parameters that determine the range of input power levels, maximum power without damage, and pending overload indication.

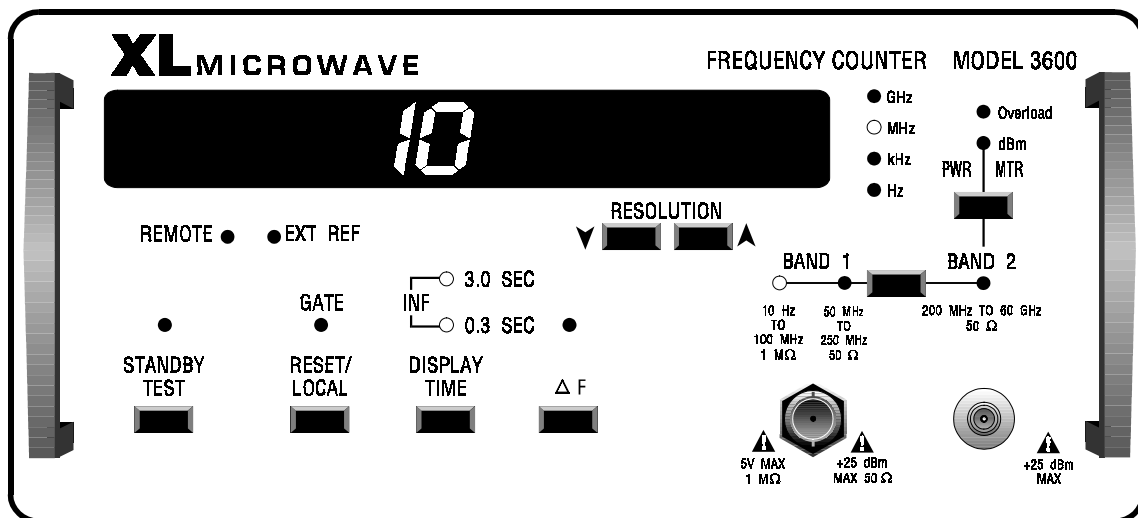
3-13.7. The front panel LED indicators and the digital display provide a constant display of signal strength. When the input signal level is equal to or above the counter's sensitivity, the display reads the frequency. When the input signal level is below the counter's sensitivity, the display reads all zeros. At approximately + 10 dBm (100 mW) the red **Overload** light flashes a warning of a potential overload (+ 10 dBm nom./200 MHz to 26.5 GHz, increasing to + 15 dBm at 40 GHz, to+ 20 dBm at 50 GHz & 60 GHz).

3-14. OPERATING PROCEDURES

3-14.1. Prior to operation, establish the line voltage and be sure that the appropriate fuse has been installed. If a high-stability oscillator is installed, allow at least a one-hour warm-up. Check the time base oscillator output on the rear panel to be sure the oscillator has been properly calibrated. If an external time base is used, be sure that it is turned on and connected to the 10 MHz **IN** connector on the rear panel as indicated by the **EXT REF** light.

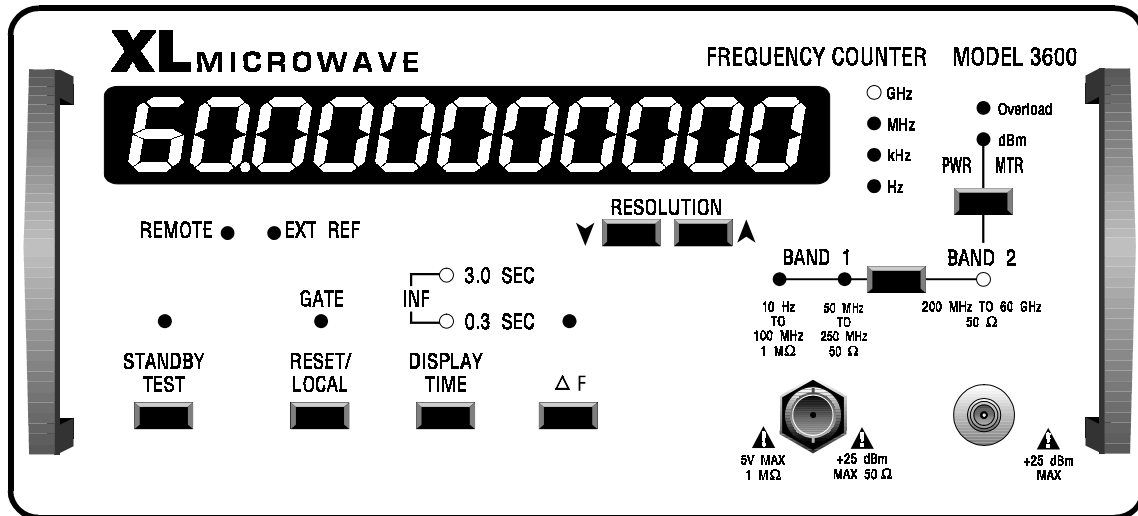
3-14.2. Receiving Inspection Initial Turn-on. The following procedure performs an operational check on the instrument and may be used as a confidence check for maintenance purposes, incoming inspection, trouble shooting, and so on.

1. When connected to power, the instrument wakes, does an LED test where all LEDs light for one second, then enters the test mode and displays **10.000000** with the MHz annunciator turned on.
2. Press [DISPLAY TIME] and select **0.3 SEC**, or as appropriate.
3. Connect a suitable signal source, 10 Hz to 100 MHz, to the Band 1/1 M Ω BNC input. Maximum signal 1 V rms (damage level= 5 V rms), minimum signal 25 mV rms.
4. With an input frequency of approximately 100 Hz, press RESOLUTION UP [\uparrow] and RESOLUTION DOWN [\downarrow] arrows; observe the display for blanking and appropriate decimal placement. This will show the automatic decimal and resolution when measuring frequencies below 10 kHz.
5. Increase the input frequency to greater than 10 kHz and press RESOLUTION DOWN [\downarrow]; notice the display's blanking and decimal placement, like that shown below.

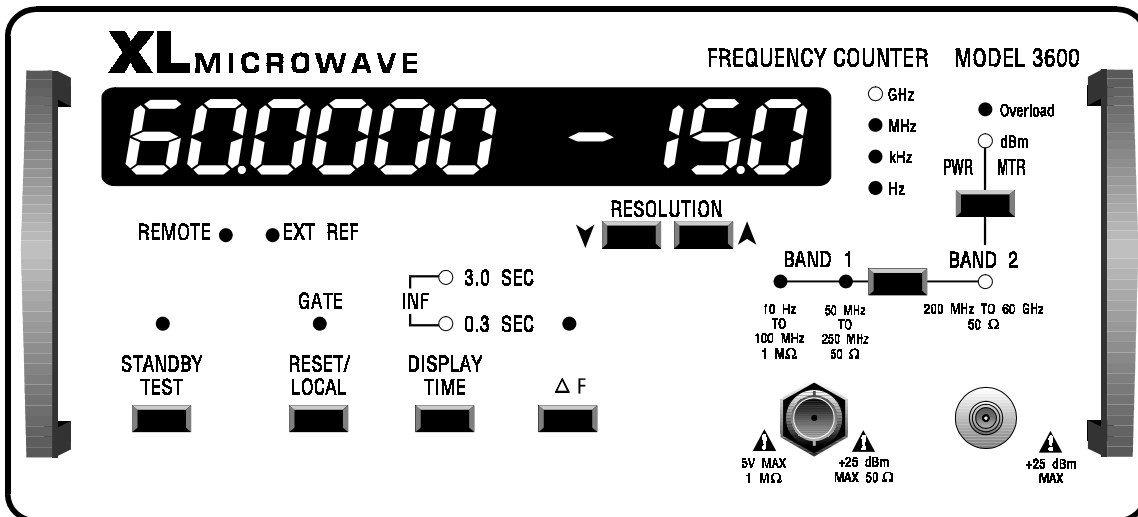


6. Remove the Band 1 input signal. Connect a suitable signal source (200 MHz to 40 GHz, 46 GHz, 50 GHz, or 60 GHz, model dependent) to the 50 Ω Band 2 input connector. Maximum signal + 10 dBm (damage level = + 25 dBm, + 20 dBm/model 3600), minimum signal: - 30 dBm to 10 GHz; -25 dBm to 40 GHz; -15 dBm to 50/60 GHz. **Caution:** Do not use SMA terminated cable with model 3600 Band 2 'V' connector.

7. Press the [BAND] switch to select Band 2; with an appropriate input frequency, press the [\downarrow] and [\uparrow] RESOLUTION switches; notice the display's blanking, decimal point, and annunciator LED, like that shown below.



8. Press [PWR MTR]; observe how the display splits, showing frequency in the 5 MSDs with decimal point and the MHz, or GHz, annunciator and the 3 LSDs with the minus (-) symbol (if appropriate), decimal, and dBm annunciator.



9. Press [RESET/LOCAL]. The instrument resets, and then immediately initiates a new measurement.

10. Cycle [DISPLAY TIME] to the **INF** setting and press [RESET/LOCAL]. The instrument initiates a new measurement and locks up in the infinite hold mode. To make a new measurement, toggle [DISPLAY TIME] to other than **INF**, or press [RESET/LOCAL].

3-15. REMOTE OPERATING PROCEDURES GPIB

3-15.1. The mm-Series counters can be remotely operated using the General Purpose Interface Bus (GPIB). This interface permits control and status reporting of the instrument from a data bus that conforms to IEEE STD-488. The instrument may be used on-line or off-line (remote or local). When used in the remote mode (instrument connected to the interface bus and commanded to remote), it can be programmed by sending device-dependent commands during the instrument's *listen* mode of operation. Device-dependent commands are received by the instrument at any time during its operation.; it will ignore any device-dependent or independent command to which it has not been designed or programmed to respond. When the instrument is addressed to *talk*, data is transferred in compliance with the IEEE STD-488 *Handshake* process to those devices that are addressed to *listen*.

3-16. IEEE STD-488 IMPLEMENTED INTERFACE FUNCTION SUBSETS

3-16.1. Incorporated into the mm-Series counters are the interface function subsets for implementation of IEEE STD-488 GPIB (see Table 3-1). For a more complete description of these subsets refer to *IEEE STD-488 1978, Appendix C*.

SUBSET	DESCRIPTION	CAPABILITY
SH1	Source Handshake	Complete
AH1	Acceptor Handshake	Complete
T5	Talker	Basic talker, Serial Poll, does unaddress if addressed to listen
TE0	Extended Talker	None
L4	Listener	Basic listener, does unaddress if addressed to talk
LE0	Extended Listener	None
SR1	Service Request	Complete, flags controller when measurement is done
RL1	Remote Local	Local lockout
PP0	Parallel Poll	None
DC1	Device Clear	Complete (RESET-LOCAL equivalent)
DT1	Device Trigger	Complete
C0	Controller	None
E1	Tri-State Bus Interface Logic	

3-17. GPIB CHARACTERISTICS

3-17.1. For GPIB electrical and mechanical specifications, see the referenced IEEE standard. The interface system contains a set of 16 signal lines to carry all information, interface messages, and device-dependent messages. These messages may be coded on one, or on a set, of signal lines, as determined by the particular message content.

3-17.2. The bus structure consists of three sets of signal lines. (See Figure 3-7 for bus management information.)

1. Data bus—8 signal lines
2. Data byte transfer control bus—3 signal lines
3. General interface management bus—5 signal lines

3-17.3. The mnemonics, DIO1 to DIO8, are assigned by IEEE STD-488 data input/output lines. Message bytes are transferred on the DIO signal lines in a bit-parallel, byte serial format, asynchronously, and, usually, bidirectionally.

3-17.4. A set of 3 interface signal lines effect transfer of each byte of data on the DIO signal lines, from an addressed talker to all addressed listeners:

1. **DAV (data valid)** indicates the condition (availability and validity) of information on DIO signal lines.
2. **NRFD (not ready for data)** indicates the readiness condition of device(s) accepting data.
3. **NDAC (not data accepted)** indicates the condition of acceptance of data by device(s).

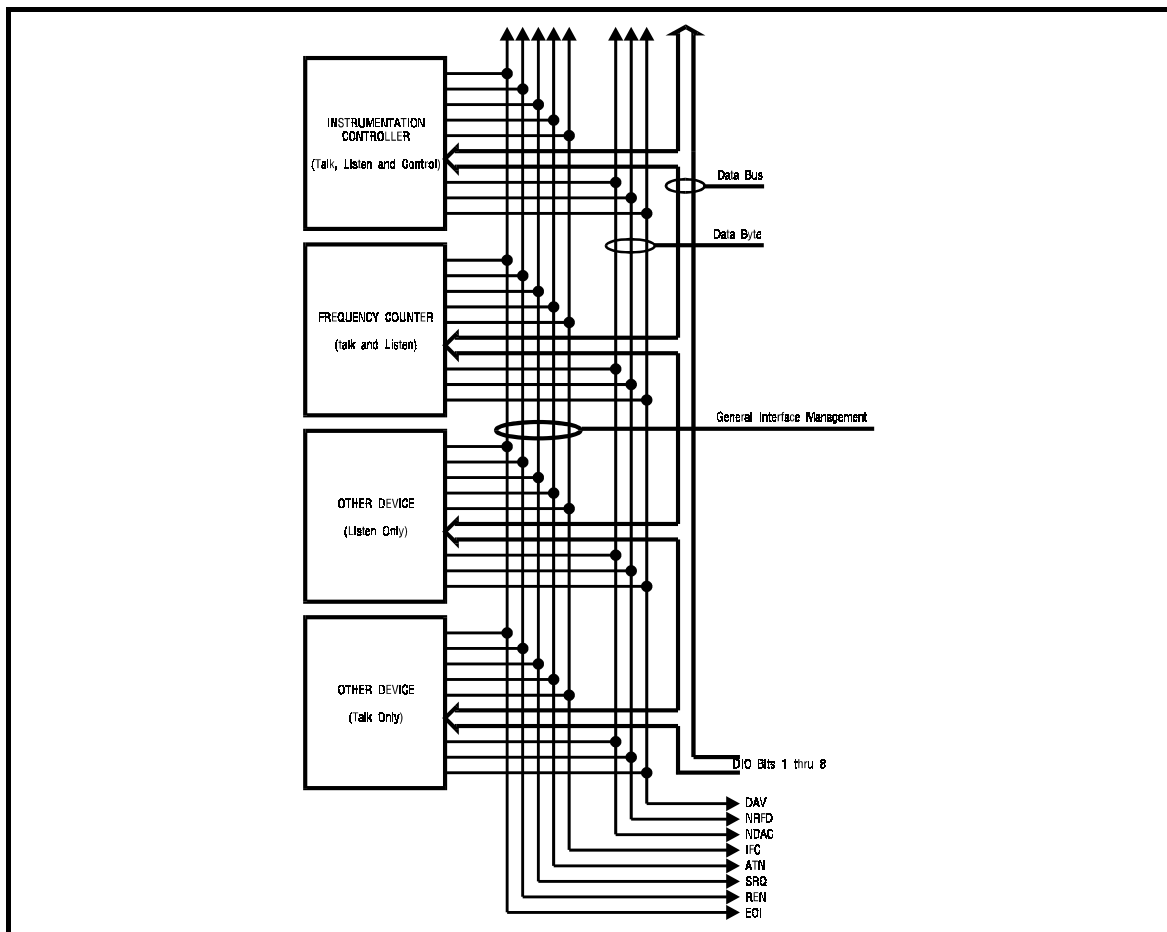


Figure 3-7. GPIB Interface Capabilities and Bus Structure

3-17.5. The **DAV**, **NRFD**, and **NDAC** signal lines operate in what is called a *3-wire (interlocked) handshake process* to transfer each data byte across the interface.

3-17.6. Five interface signal lines are used to manage an orderly flow of information across the interface.

- 1. ATN (attention)** specifies how data on the DIO signal lines are to be interpreted and which devices must respond to the data.
- 2. IFC (interface clear)** resets the interface system, portions of which are contained in all interconnect devices, into a known quiescent state.
- 3. SRQ (service request)** is used by a device to indicate the need for attention and to request an interruption of the current sequence of events.
- 4. REN (remote enable)** is used (in conjunction with other messages) to select between two alternate sources of device programming data.
- 5. EOI (end or identify)** indicates the end of a multiple-byte transfer sequence or, in conjunction with **ATN**, the execution of a polling sequence.

3-18. ADDRESS ASSIGNMENT PROCEDURE

3-18.1. The GPIB address is selected manually using the rear panel 16-8-4-2-1 ADDRESS switches. The setting of the five bits to either the 1 or 0 position determines which talk address (and corresponding listen address) is assigned to the counter. Thirty different talk/listen addresses can be assigned. The address selected on the ADDRESS switches is loaded into memory, displayed during self-test, and displayed at power-up as Buss-6. During operation, the address may be changed and then activated by pressing the [RESET/LOCAL] button on the front panel (See Table 3-2 for the Talk/Listen Address-to-ASCII/decimal code format).

NOTE: In *Battery Option Counters*, The GPIB Address Switch on the rear panel has been set at the factory to all 1's (address 31), an illegal address. This setting turns power to the GPIB chips off, extending battery operation time. For GPIB operation it is necessary to change this switch setting (see Table 3-2).

Table 3-2. Talk/Listen Address

ADDRESS SWITCH SETTINGS					CHARACTER		DECIMAL CODE
					LISTEN	TALK	
0	0	0	0	0	SP	@	00
0	0	0	0	1	!	A	01
0	0	0	1	0	"	B	02
0	0	0	1	1	#	C	03
0	0	1	0	0	\$	D	04
0	0	1	0	1	%	E	05
0	0	1	1	0	&	F	06
0	0	1	1	1	'	G	07
0	1	0	0	0	(H	08
0	1	0	0	1)	I	09
0	1	0	1	0	*	J	10
0	1	0	1	1	+	K	11
0	1	1	0	0	'	L	12
0	1	1	0	1	—	M	13
0	1	1	1	0	.	N	14
0	1	1	1	1	/	O	15
1	0	0	0	0	0	P	16
1	0	0	0	1	1	Q	17
1	0	0	1	0	2	R	18
1	0	0	1	1	3	S	19
1	0	1	0	0	4	T	20
1	0	1	0	1	5	U	21
1	0	1	1	0	6	V	22
1	0	1	1	1	7	W	23
1	1	0	0	0	8	X	24
1	1	0	0	1	9	Y	25
1	1	0	1	0	:	Z	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

NOTE: A 11111 (decimal 31) address must not be assigned to any device interfacing the bus, since this listen and talk address is reserved for the UNL (unlisten) ASCII (?) and UNT (untalk) ASCII () commands.

3-18.2. To address the instrument's talk or listen capability, set the BIT switches 1 through 5 to a valid talk or listen address. Connect an IEEE STD-488 24-pin cable to rear panel IEEE remote connector. Program the controller to set ATN line to **1**, and send a **UNL** command to inhibit all current listeners, and then send the listener or talk address of the instrument. When ATN goes to **0**, the instrument is in a *listener active/talker active* state. To enter a program, set the ATN line to **1** again, then send the program data.

3-19. PROGRAMMING PROCEDURE

3-19.1. The counter is programmed via device commands. A device command is a string of two or more ASCII-coded bytes followed by a separator. The separator is an ASCII comma, space, semicolon, carriage return, line feed, or EOI (eg 1: B1L, //eg 2: R3, B2, M_?,). The counter can accept up to 80 characters via its input buffer. The device commands are interpreted by the counter to generate a control function after receiving a line feed, EOI, or whenever the counter exits its listener active state. Any unrecognized characters or commands will cause the counter to enter its error mode. The error mode must be cleared with either a device clear message (DCL), a device trigger message (DT), a reset device command (RE); or else, press the front panel [RESET-LOCAL] key to clear the error mode. When the error mode is cleared, a new measurement cycle is initiated. The counter converts lower-case characters to uppercase when in the listener state.

3-20. COMMAND SET AND FORMAT

3-20.1. The following list describes the command syntax for GPIB control of the mm-Series counters. All command lines are required to be terminated with either a carriage return/line feed pair, a line feed character, or assertion of EOI on the last character transmitted (EOI may be asserted with a line feed character [eg: R4, PWR1, ?; where the controller terminates the transmitted line with a carriage return/line feed]). **Note:** If command 'B1' is sent without a 'L' or 'H', Counter will default to 'B1L'.

COMMAND	INSTRUMENT ACTION
B1L	Selects Band 1/10 MΩ (10 Hz to 100 MHz)(see Note above).
B1H	Selects Band 1/50Ω (50 MHz to 250 MHz)(see Note above).
B2	Selects Band 2 (200 MHz to 40, 46, 50, or 60 GHz).
M	Performs a measurement.
?	Outputs last measurement result.
C	Outputs Composite Status BYTE (1 if TRUE; 0 if FALSE).
	BIT 8: Ouch
	BIT 7: Overload
	BIT 6: External Reference
	BIT 5: Power Meter
	BIT 4: Band 2
	BIT 3: Band 1
	BIT 2: Not Used (always a 0)
	BIT 1: Local Lock-Out

NOTE: A "?" OR "C" MUST BE FOLLOWED BY A "REQUEST FOR DATA".

Band 1 Resolution	Gate Length (see paragraph 3-13.3. and chart, Figure 3-5, pg. 3-9 for explanation)
G5	Selects 10.850 second minimum gate time.
G4	Selects 1.0865 second minimum gate time.
G3	Selects 110 millisecond minimum gate time.
G2	Selects 12 millisecond minimum gate time.
G1	Selects 2 millisecond minimum gate time.
Band 2 Resolution	LSB Displayed
R1	Selects 1 Hz resolution.
R2	Selects 10 Hz resolution.
R3	Selects 100 Hz resolution.
R4	Selects 1 kHz resolution.
R5	Selects 10 kHz resolution.
R6	Selects 100 kHz resolution.
R7	Selects 1 MHz resolution.
PWR0	Turns Power Meter OFF .
PWR1	Turns Power Meter ON and switches to Band 2 input.
TEST	Initiates Self-Test mode.
HOLD0	Sets measurement hold time to 0.
HOLD1	Sets measurement hold time to Infinite.
DISP0	Allows normal result display.
DISP1	Suppresses front panel frequency/power display.
RE	Reset Instrument. (WARNING! see Note on next page).
DF0	Turns Delta frequency (ΔF) OFF .
DF1	Turns Delta frequency (ΔF) ON ; places instrument in ΔF mode, using the next answer as reference and then displaying the difference between the reference and the current measurement. Note: ΔF and 0.01 Hz are mutually exclusive. If, during remote initiation of ΔF , the measurement of the reference frequency fails, the counter will attempt to remeasure the reference five times. If unsuccessful, the counter will still initiate ΔF measurements, but the ΔF reference will be forced to zero.

F	Inputs Delta Reference Frequency; input must be in the following format: Band 1: F_XXXXXX.XXXXXE+ 03 where X represents any decimal digit (0 through 9). Band 2: F_XXXXX.XXXXXE+ 06 where X represents any decimal digit (0 through 9).
ID	Returns a string consisting of model number, software rev level, and special oscillator option (if any). The string will be terminated with a CR/LF pair with the GPIB EOI, set on the LF character. eg: 3600,2.1,RB indicating a model 3600, firmware rev. 2.1, with Rubidium oscillator.

Note: Sending **RE** *within a string* resets the counter and *clears the GPIB buffer!* This will clear any stored GPIB commands and *can lock-up the counter and transmitting device.* To prevent this, *don't use RE within a command string* (its use is normally unnecessary). We recommend sending **M** (take another measurement). This will clear the measurement section and take a new measurement without completely resetting the counter. If you need to send an **RE** command, do so by itself, outside a command string.

GPIB OPERATION

INSTRUMENT RESPONSE

LLO	(Local Lock-Out); Initiates Local Lock-Out.
GET	(Group Execute Trigger); initiates a measurement.
DC	(Device Clear); resets the counter ([RESET/LOCAL] switch equivalent).

3-21. OUTPUT DATA FORMAT

3-21.1. After a measurement the counter must receive a '?' command to output measurement data via the GPIB (eg: R2, B2, ?. Note that the '?' must be followed by a "request for data" from the controller). This format is shown in Figure 3-8.

3-21.2. The Alpha Character is one of two single characters that precedes the measurement data and which specifies the type of measurement.

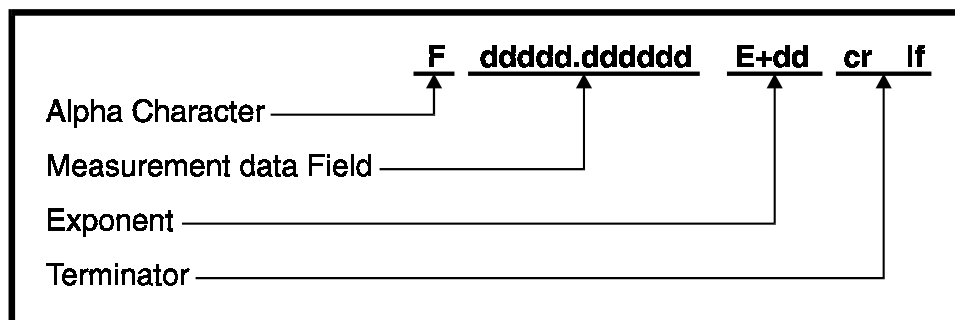


Figure 3-8. Measurement Data Output Strings Format

Frequency and power measurement data consists of a fixed length ASCII data string. The format is as follows:

F = Frequency measurement in Hz or MHz
P = Amplitude measurement in dBm

Frequency only (Band 2 and Band 1 above 10 kHz):

F xxxxx.xxxxxxE+ 06 cr lf (with EOI) where X indicates the measured frequency as displayed in Hz.

Frequency only (Band 1 only, 0.1 Hz resolution, above 10 kHz):

F xxxxx.xxxxxxE+ 06 cr lf (with EOI) where X indicates the measured frequency as displayed in 0.1 Hz.

Frequency only (Band 1 only, below 10 kHz):

F xxxx.xxxE+ x cr lf (with EOI) where X represents the frequency measured in Hz with the proper exponent applied.

Band 2 frequency and power:

F xxxxx.xxE+ 06 P sxx.xE+ 0 cr lf (with EOI) where xx represents the measured frequency in MHz and sxx represents the power level in dBm.

If no valid result can be obtained on a measurement, the string **NULL cr lf** is returned.

In Delta F mode:

Band 1: DF_SXXXXXX.XXXXXXE+ 03 cr lf. S is the sign; blank if positive and minus if negative.

Band 2: DF_SXXXXXX.XXXXXXE+ 06 cr lf. S is the sign; blank if positive and minus if negative.

Status byte—"1" if TRUE; "0" if FALSE

Bit 8—Ouch

Bit 7—Overload

Bit 6—External Reference

Bit 5—Power Meter

Bit 4—Band 2

Bit 3—Band 1

Bit 2—Not used (always a 0)

Bit 1—Local lockout

Note: A **?** or **C** must be followed by a "request for data."

3-22 . ERROR MESSAGES

The following Error messages will result in disabling the counter until the failure is corrected.

Error 1: Indicates a failure of the "A" count chain.

Error 2: Indicates a failure of the "B" count chain.

Error 3: "Talk Only" mode enabled (switch on rear panel set to "1")
but there is no listening device connected to the IEEE 488 port.

Error 4: No internal oscillator and no external oscillator.

Error 5: Internal Stack Error. Results in disabling counter.
Counter must be reset.

Error 6: Local Oscillator margin test failure at hi-frequency end.
Results in disabling counter until failure is corrected.

Error 7: Local Oscillator margin test failure at low-frequency end.
Results in disabling counter until failure is corrected.

Error 8: Oscillator cold (OCXO options only).

Error 9: N/A

Error 10: Stuck [DISPLAY TIME] key.

Error 11: N/A

Error 12: Stuck [↓] key.

Error 13: Stuck [ΔF] key.

Error 14: Stuck [↑] key.

Error 15 to 36: N/A

Error 37: Stuck [BAND SELECT] key.

Error 38: Stuck [PWR MTR] key.

Error 39: Unused key position.

CHAPTER 5

MAINTENANCE

5-1. INTRODUCTION

5-1.1. This chapter describes the adjustments required to maintain the mm-Series counter (models 3400A / 3460A / 3500A / 3600) operating within specifications. Adjustments should be made when performance or parts replacement indicate they may be necessary.

5-2. EQUIPMENT REQUIRED

5-2.1. The recommended test equipment for the adjustment procedure is listed in Table 5-1, "Recommended Test Equipment". Substitute test equipment may be used if it meets or exceeds the recommended characteristics.

Table 5-1. Recommended Test Equipment

INSTRUMENT MODEL	CHARACTERISTICS	RECOMMENDED
Oscilloscope	100 MHz Bandwidth	Tektronix 2236
Oscilloscope Probe (2 required)	High Impedance (10 Megohm)	Tektronix P6121
Synthesized Microwave Generator	10 MHz to 40 GHz -50 dBm to + 10 dBm	Wiltron 6769A
Frequency Standard (NIST traceable)	Accuracy of $\geq \pm 1 \times 10^{-9}$	XL Microwave 500
Microwave Frequency Counter	10 Hz to 40 GHz	XL Microwave 3400A
Power Meter	100 MHz to 40 GHz	HP 432A
Power Sensor	100 MHz to 18 GHz	HP 478A
Power Sensor	18 GHz to 26.5 GHz	HP K486A
Power Sensor	26.5 GHz to 40 GHz	HP R486A
Power Sensor	40 GHz to 60 GHz	millitech 45773H-1100
Signal Generator	10 Hz to 10 MHz	HP 652A

5-3. CLEANING

5-3.1. Accumulated dirt on the exterior of the instrument may be removed with a soft cloth or a small soft brush dampened with a mild detergent-and water solution. Abrasive cleanser should never be used.

5-4. SAFETY CONSIDERATIONS

WARNING!

Maintenance is performed with power supplied to the instrument and protective covers removed. Only trained service personnel who are aware of the hazards involved should perform any maintenance on these instruments. Before any repair is completed be sure that all necessary parts are connected to their protective grounding. Electronic components and assemblies can be permanently degraded or damaged by electrostatic discharge during maintenance. Be sure that all maintenance is performed at a static-safe work station.

5-5. PERFORMANCE VERIFICATION

5-5.1. This section outlines the performance verification procedure and may be used as a confidence check for incoming inspection and to verify the need for recalibration or maintenance.

Allow the counter and all test equipment to warm-up for 24 hours.

5-5.2. REFERENCE OSCILLATOR Verification. Connect a traceable reference frequency standard to the 'external sync' input of a 100 MHz oscilloscope and set the oscilloscope to external sync. Connect the counters' rear panel '10 MHz REF OSC OUT' signal to the 'Channel A' Input of the oscilloscope. Observe the 10 MHz REF OSC OUT signal on the oscilloscope display for signal movement. The signal should not drift more than one cycle in ten minutes. If the drift exceeds this limit, then proceed to the 'Reference Oscillator Adjustment' section of this Manual (paragraph 5-8).

5-5.3. BAND 1 Verification. Place the counter in Band 1/50Ω (50 MHz–250 MHz) and apply a signal of 120 MHz at – 19 dBm to the 'Band 1' input connector of the counter. Verify that the front panel display reads the correct frequency count. Reduce the amplitude of the signal until the instrument fails to count correctly (typically around – 28 dBm). *NOTE: Do not exceed +25 dBm, as damage could occur to the instrument!*

5-5.4. BAND 2 and POWER METER Verification. Place the counter in Band 2 and apply a signal of 200 MHz to 400 MHz at 0 dBm to the 'Band 2' input connector of the counter. Verify that the front panel display reads the correct frequency count. Place the counter in Power Meter and verify the correct power reading (± 1.5 dBm). Reduce the input signal to – 30 dBm and re-check the frequency and power measurements as described above.

NOTE: Do not exceed +25 dBm (+ 20 dBm/model 3600), as damage could occur to the instrument!

5-5.5. OVERLOAD Verification. Place the counter in Band 2 and apply a signal of 200 MHz to 400 MHz at 0 dBm to the 'Band 2' input connector of the counter. Increase the signal level until the Overload LED lights (at approx. +10 dBm). *Carefully* increase the input signal until "OUCH" appears on the front panel display (typically between +13 dBm and +15 dBm).

NOTE: Do not exceed +25 dBm (+ 20 dBm/models 3500/3600), as damage could occur to the instrument!

This Completes The Performance Verification Check.

5-6. MAINTENANCE SCHEDULE

5-6.1. The mm-Series counters do not require any regular maintenance except for the recommended annual calibration of the internal oscillator.

VERY IMPORTANT!

The "P" number marked on the Mixer Label and stamped on the Mixer Block *MUST MATCH* the "P" number printed on the PROM label(s) U20 (& U18).

5-7. REFERENCE OSCILLATOR ADJUSTMENT

5-7.1. XL Microwave recommends that your mm-Series counter has its internal reference oscillator (TCXO standard or OCXO Options 112 or 120) calibrated annually to a traceable reference frequency standard (such as NIST) in order to maintain the counter's guaranteed specifications.

5-7.2. Allow the instrument to warm for three (3) hours for the TCXO, 24 hours for the OCXO. The instrument's reference oscillator time base can be adjusted, via a ten-turn trim pot (RA1), through a 'Reference Oscillator Adjustment' access hole located on the instrument's bottom cover.

5-7.3. Two ways are given to calibrate the counter's internal reference oscillator. The first way (analog) is simpler, requiring only a scope and a traceable frequency standard. It also offers instant visual feedback of the result of the tuning adjustment. The second way (digital) requires more equipment but is faster and yields a more accurate number.

5-7.4. Analog. You will need the following test equipment from Table 5-1: a 100 MHz Oscilloscope and a traceable 10 MHz Frequency Standard. Connect the equipment as illustrated below in Figure 5-1.

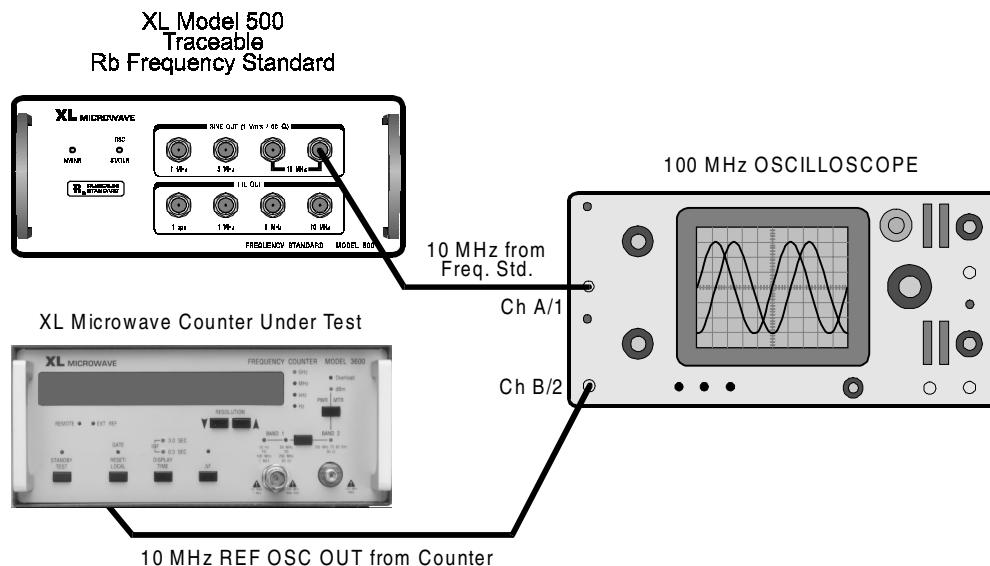


Figure 5-1. Reference Oscillator Test Setup, analog version.

5-7.5. Set the scope to show 1 to 5 cycles of a 10 MHz signal. Connect the 10 MHz signal from the Frequency Standard to Channel 'A/1' of the scope and trigger on Channel 'A/1'. Connect channel 'B/2' of the scope to the 'REF OSC OUT' BNC connector on the back of the counter. Watch the scope's display and note the time it takes for one complete cycle of channel 'B/2' to drift one cycle compared to channel 'A/1'. On the Oscillator CCA (5999-45561, figure 6-6) adjust the 'Oscillator Trimpot' (RA1) for minimum drift of the signal on the oscilloscope display using a nonconductive tuning tool (remove the tool when noting drift as the tool will affect the observation). Accuracy = (for a one-cycle drift) 1 second drift/cycle = 10^{-7} ; 10 second drift/cycle = 10^{-8} ; 100 second drift/cycle = 10^{-9} .

5-7.6. Digital. You will need the following test equipment from Table 5-1: a 40 GHz Frequency Counter; a traceable 10 MHz Frequency Standard; and a 40 GHz Synthesized Signal Generator.

5-7.7. Connect the equipment as illustrated below in Figure 5-2. The 10 MHz signal from the traceable Frequency Standard is connected to the Synthesizer's external reference input. Set the Synthesizer to 40 GHz (or the highest frequency that the test counter can count). Connect the output of the Synthesizer (40 GHz) to the microwave input of the test counter. Connect the Internal Reference Oscillator 10 MHz signal from the Counter Under Test, to the external reference oscillator input on the test counter. Set the resolution on the test counter to display the greatest resolution possible.

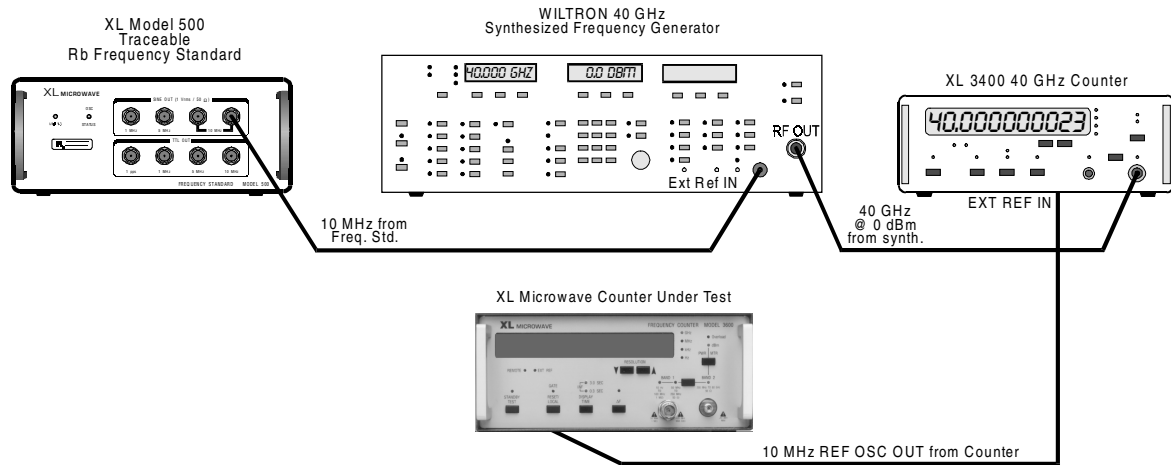


Figure 5-2. Reference Oscillator Test Setup, digital version.

5-7.8. On the Oscillator CCA (5999-45561, figure 6-6) of the Counter Under Test, adjust the 'Oscillator Trimpot' (RA1) for the closest possible reading to 40.000000000 GHz on the test counter's display. Use a nonconductive tuning tool (remove the tool when noting reading as the tool will affect the observation).

5-7.9. This method effectively multiplies up the traceable Frequency Standard's 10 MHz to a traceable 40 GHz signal (with the accuracy of the frequency standard) to the test counter's microwave input. The accuracy of the test counter's readout of this 40 GHz signal is now dependant on the accuracy of the 10 MHz internal oscillator in the Counter Under Test which you are adjusting. To read the accuracy of the adjustment of the internal oscillator, a Reading on the test counter of:

40.000 000 023 GHz is equivalent to 5 parts in 10^{-10}
 40.000 000 040 GHz is equivalent to 1 part in 10^{-9}
 40.000 000 800 GHz is equivalent to 2 parts in 10^{-8}
 40.000 006 000 GHz is equivalent to 1.5 parts in 10^{-7}

5-8. A2, MMW-ANALOG CCA ADJUSTMENT LOCATIONS

5-8.1. Analog CCA, A2 (5999-45498), adjustment locations are identified in Figure 5-3. All adjustments are made with the top and bottom covers removed.

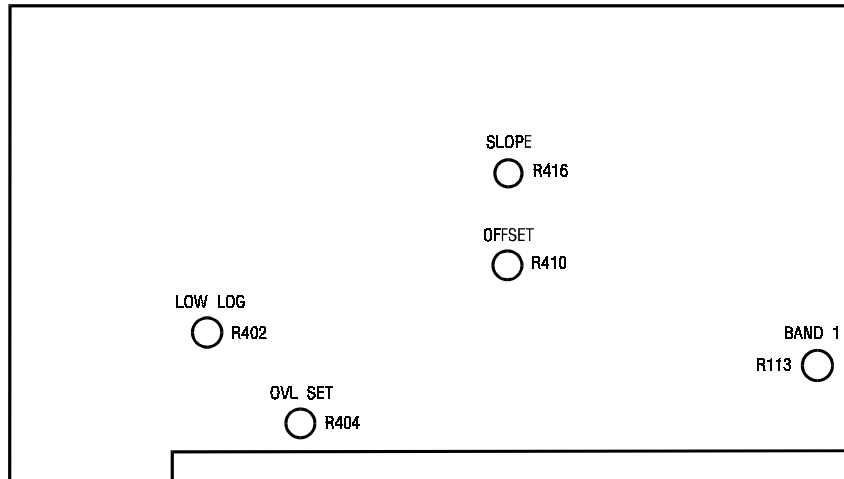


Figure 5-3. Analog Board Cover

5-9. POWER METER ADJUSTMENT

5-9.1. Center all adjustment pots R402 (LOW LOG), R404 (OVL SET), R410 (OFFSET), and R416 (SLOPE).

5-9.2. Apply a + 10 dBm signal to the Band 2 input at a frequency between 200 to 400 MHz. Adjust R404 until the OVERLOAD light comes on. Raise and lower the signal level and adjust R404 so that the OVERLOAD indicator turns on and off at + 10 dBm \pm 0.5 dBm.

5-9.3. Switch the instrument to Band 2, turn Power Meter on. Reduce the input to 0 dBm and note the display reading. Reduce the input level to -10 dBm and note the change in displayed power. If the change is more or less than 10 dB, R416, the SLOPE pot, must be adjusted. The "SLOPE" pot changes the gain of the log amp system. Continue adjusting the slope while changing the input power by 10 dB until the display changes 10 dB.

5-9.4. Return the input to 0 dBm and adjust R410 (the OFFSET pot) for 0.0 displayed power.

5-9.5. Reduce the input to -34 dBm and adjust R402 (the LOW LOG pot) for correct reading.

5-9.6. Check the log accuracy at 0, -5, -10, -15, -20, and -25 dBm.

5-9.7. If there is a slope error, readjust R416, the SLOPE pot, to improve tracking. Readjust R410, the OFFSET pot, at 0 dBm for correct reading.

5-9.8. Recheck R402 (the LOW LOG pot) for -34 dBm display with -34 dBm input.

5-9.9. Increase the signal level to + 10 dBm and note the display should be greater than + 9 dBm.

5-9.10. Increase the signal level until the **OUCH** display appears; the signal level should be between + 13 dBm and + 15 dBm.

5-10. BAND 1 SENSITIVITY ADJUSTMENT

5-10.1. Place the instrument in Band 1/50Ω (50 MHz–250 MHz) and apply a signal of 120 MHz at – 19 dBm.

5-10.2. Reduce the amplitude of the signal until the instrument fails to count correctly. Then adjust R113 (the Band 1 threshold pot) for correct counting with minimum signal level in.

5-11. 10 MHz BUFFER ADJUSTMENT, POWER SUPPLY CCA (L10 or L204)

Note: *This is a Factory adjustment should only be done if components have failed and been replaced within the 10 MHz Buffer section of the Power Supply.*

5-11.1. Disconnect AC power from counter and remove the bottom cover. Locate the 10 MHz Buffer section of the Power Supply located just behind the two BNC connectors on the rear panel (REF OSC OUT & EXTERNAL REF OSC IN) and remove the three # 4-40 screws attaching the metal cover over the Buffer section and remove the cover.

1. Using a BNC/BNC coax cable, connect the Counter Under Test's '10 MHz REF OSC OUT' BNC to a test bench frequency counter.
2. Power-up the Counter Under Test and note 10 MHz displayed on the bench counter.
3. Disconnect the internal oscillator from the 10 MHz Buffer/Power Supply CCA (J4) just behind the 10 MHz Buffer section.
4. Adjust the FREQ ADJ inductor (L10, std p/s; or L204, battery p/s) for a reading of 10.00xxxxx MHz on the bench counter. Use a nonconductive tuning tool and remove the tool when noting reading as the tool will affect the observation.
5. Reattach the internal oscillator (J4). The reading on the bench counter should be 10 MHz, within the tolerance of the internal oscillator.
6. Verify buffer circuit operation by inserting a 1, 2, 5 & 10 MHz reference signal into the '1, 2, 5, 10 MHz EXTERNAL REF OSC IN' BNC jack and confirm that a 10 MHz reading is displayed on the bench counter. The 'EXT REF' LED on the front panel of the counter under test should be illuminated to confirm automatic switching to external reference in the presence of an appropriate signal.
7. Verify REF OSC signal input levels of 0.2–5.0 Vrms (as given in the Specifications section of Chapter 1) automatically switch to EXT REF when applied (front panel REF OSC LED).
8. Adjustment is complete. Reattach Buffer section cover and screws and bottom cover of counter.

5-12. mm-DIGITAL CCA BAND 2 SENSITIVITY ADJUSTMENT, RA1

5-12.1. On the mm-Digital Circuit Card Assembly (5999-45502) the Band 2 Sensitivity pot, RA1, is adjusted as follows:

Connect a synthesized signal of 270 MHz at -50 dBm to the front panel Band 2 input connector. Set RA1 fully clockwise. Increase the signal amplitude, in 1 dB steps, until the counter begins to count—with the lower digits unstable. Adjust RA1 until the counter reaches a stable count—or no count. If there is no count, increase the signal amplitude until the counter counts. Repeat this procedure until the count is stable.

5-13. mm-DIGITAL CCA PHASE DETECTOR BALANCE ADJUSTMENT, RA2

5-13.1. On the mm-Digital CCA, A4 (5999-45502), the Phase Detector Balance pot, RA2, is adjusted as follows:

Connect a synthesized signal, set to 10 GHz at -20 dBm, to the front panel Band 2 input connector. Connect a Spectrum Analyzer to the mm-Digital CCA, A4—JW4, Phase-Lock IF signal input. Adjust the analyzer so the IF frequency is centered (approx. 130 MHz) and the analyzer displays a 200 kHz span per division. Adjust RA2 for minimum 200 kHz sidebands (typically ≥ 30 dBc).