EIP's unique Model 371 Source Locking Microwave Counter combines in one instrument, a premium automatic microwave counter **PLUS** a broadband lockbox. Never before has the microwave counter user been afforded the additional capability and versatility of multiple functions that now exists in this single device. Utilizing the heterodyne technique and advanced solid state YIG and thin film technology, the microwave counter function offers premium performance specifications. This includes: frequency coverage from 20 Hz to 18 GHz, -30 dBm sensitivity, > 40 MHz FM tolerance, 2-watt burnout protection, and multiple signal discrimination. The built-in lockbox function provides the capability to automatically phase-lock virtually any swept signal source over the range of 10 MHz to 18 GHz in 100 kHz increments. Featuring a microprocessor-based keyboard input combined with automatic bandwidth and polarity control, this source locking mode highlights simplicity of use and ease of operation. Now the EIP Model 371 provides a unique, cost-effective solution to the complete range of microwave counting **PLUS** frequency stabilizing applications.

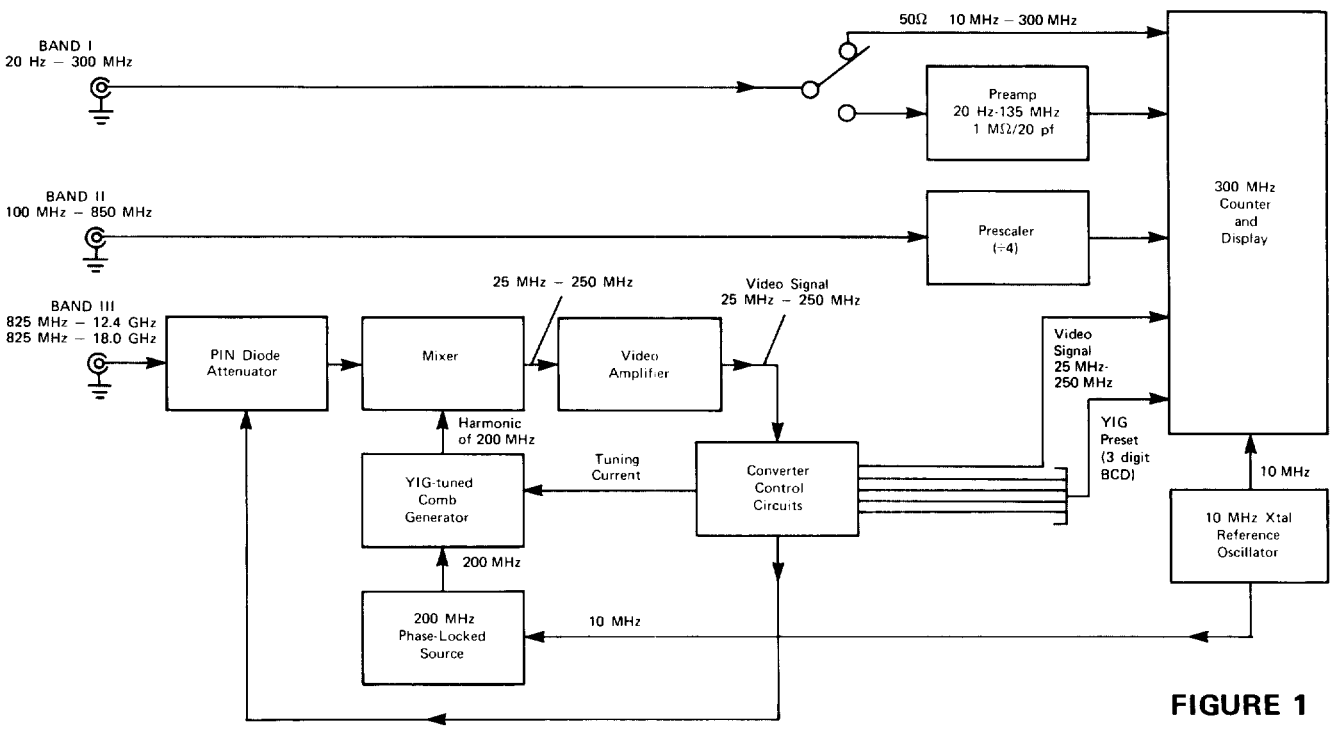


FIGURE 1

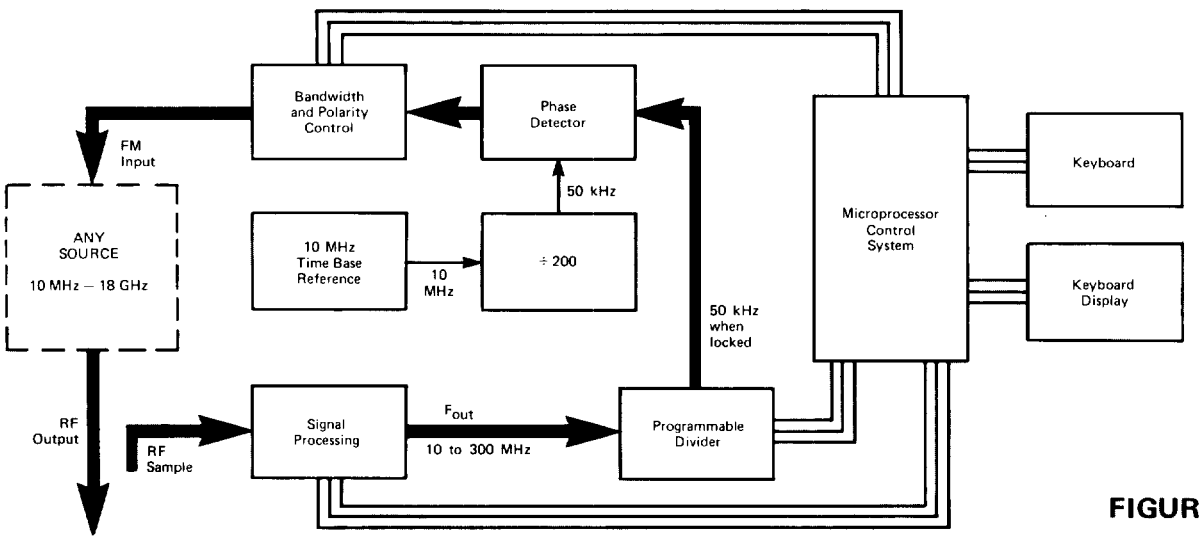


FIGURE 2

Figure 1 shows a simplified block diagram of the Model 371 Autohet Microwave Counter. Measurements in Band I (20 Hz to 300 MHz) are made directly with a high speed direct digital counter. This band is further broken down into two channels. Channel A covers the range 20 Hz to 135 MHz, and has an input impedance of 1 megohm shunted by 20 pf. Channel B is the 50 ohm impedance channel, and operates from 10 MHz to 300 MHz. Band II contains a prescaler which divides the input frequency by four. It operates over the range of 100 MHz to 850 MHz, with an input impedance of 50 ohms.

Band III covers the microwave range from 825 MHz to 18 GHz. In this band an Autohet microwave converter translates the input frequency downward into the frequency range of the direct counter.

This is accomplished by mixing the input with a selected harmonic of the YIG-tuned comb generator. The 200 MHz source is phase-locked to the 10 MHz crystal reference, and thus retains the stability and accuracy of the counter time base over the entire frequency range. The converter control circuits perform the function of locking the YIG-tuned comb generator to the correct harmonic of 200 MHz and presetting the harmonic frequency into the counter. The difference in frequency between the incoming signal and the harmonic is then counted directly and added to the preset information, resulting in a direct readout of the input frequency.

The block diagram of Figure 2 shows in simplified form, the technique used to phase-lock a signal source to the time base reference oscillator. The incoming signal is processed by the counter circuitry to produce a signal in the range of 10 MHz to 300 MHz. This is accomplished by an Autohet Converter (Band III), a prescaler (Band II), or directly (Bands 1A/1B). The microprocessor control system then calculates an appropriate division ratio to produce an output of 50 kHz from the programmable divider when the input frequency is equal to the desired frequency. This output is compared to the 50 kHz signal derived from the time base reference in the phase detector. The output of the phase detector contains a dc component which can be used to alter the frequency of the source. This signal is then passed through the bandwidth and polarity control circuits before being fed as an error correction signal to the source. The microprocessor then controls the overall loop response by systematically varying the bandwidth and polarity parameters until a phase-lock is achieved at a nominal bandwidth of 2 kHz. If the loop cannot be locked at this bandwidth — due to very low inherent bandwidth in the source — the microprocessor will try again at a nominal bandwidth of 500 Hz.

Once phase-lock is achieved, the Lock Indicator will light, and the counter will display the source frequency, thus providing an additional check.

Mechanical tuning or adjustments are unnecessary with this automatic heterodyne counter. Simply electronically select the desired band and apply the signal — the counter does the rest. For added convenience, the 371 features an 11-digit sectionalized display. Confusing shifting decimal points, annunciators, and digit overflow are completely eliminated.

The Model 371 is one of the fastest microwave counters available. Speed is defined as the sum of the acquisition time plus the gate time. Band III acquisition time is 10 ms/GHz plus 50 ms nominal. Standard gate times are 1 sec through 1 msec. For example, measurement of an 18 GHz signal to 1 Hz resolution can be made in approximately 1.2 seconds. After acquisition, subsequent measurements can be made at rates up to 900 readings per second with 1 kHz resolution.

Creative technical design has been employed in the Model 371 resulting in -30 dBm sensitivity. This has been achieved by utilizing computer-aided design, and advances in thin film microwave integrated circuitry, to improve mixer efficiency and output power from the YIG-tuned comb generator. All of the advantages of the heterodyne technique of microwave frequency measurement are now available with sensitivity previously associated only with the transfer oscillator approach.

High sensitivity, coupled with broad frequency coverage, and a 50 dB typical dynamic range, open new areas of microwave frequency measurement. In microwave design, lossy cables no longer present a problem. Test points in microwave systems may easily be monitored using 10 or 20 dB couplers. Band I sensitivity now allows the measurement of low level intermediate frequencies or local oscillators often encountered in microwave systems applications.

The General Purpose Interface Bus (Option 17) provides both the counter and lockbox functions of the 371 with the capability of being operated on the IEEE Standard Digital Interface Bus for Programmable Instruments (IEEE STD 488-1975). The GPIB incorporates the functions of Remote Programming, Digital Output, and YIG Preset.

Full BCD output and programming is also available in the Model 371. This provides output information in parallel 1248 format of all 11 digits, and programming of everything on the front panel except Sample Rate, Power, and lockbox function. Standard parallel 1248 coding and TTL levels are easily interfaced to a wide line of printers, plotters and computers.

Frequency Range:	20 Hz to 18.0 GHz
Accuracy:	± 1 count ± time base error
Resolution:	Selectable, 1 Hz to 1 MHz
Gate Time:	1 sec (1 Hz), 0.1 s (10 Hz), 10 ms (100 Hz), 1 ms (1 kHz); other resolutions 1 ms. Band II gate times expanded by four
Display:	11-digit LED sectionalized to read GHz, MHz, kHz, and Hz
Operation:	Completely automatic after band selection
Acquisition Time (Band III):	10 ms/GHz plus 50 ms nom. Once locked, readings can be taken at rate determined by Sample Rate control and selected gate time
Controls:	
Sample Rate:	Controls time between measurements. Variable from 100 ms typ to 10 sec. Switchable Hold position retains display indefinitely
Band Select:	Select Band IA, IB, II, or III
Resolution:	Blanking of up to 6 least significant digits
Gate Time:	1 sec through 1 ms. (Band II: 4 sec – 4 ms)
Reset:	Resets display to zero; initiates new reading
Test:	Counts/displays internal 10 MHz time base
Int/Ext Time Base:	Rear panel switch selects time base reference. INT position typically used. EXT allows use of external 10 MHz reference
Power:	Applies line power to counter
Operating Temp:	0° to + 50° C
Power:	115/230 VAC ± 10%, 50-60 Hz, 90 W nom.
Weight (kg):	Net: 29 lbs (13.2); Shipping: 38 lbs (17.3)
Dimensions (HWD):	3.5" x 16.75" x 19.63" incl. handles (89 x 425 x 499 mm incl. handles.)
Accessories Furnished:	Detachable power cord 8 ft (241 cm) long, with International plug. Operating & Service Manual. PCB Extender Card

Crystal Frequency:	10 MHz (No warm-up required)
Stability:	
Aging Rate:	$< \lvert 3 \times 10^{-7} \rvert$ / month
Short Term:	$< 1 \times 10^{-9}$ RMS for 1 sec averaging time
Temperature:	$< \lvert 2 \times 10^{-6} \rvert$ over range of 0° to +50° C
Line Variation:	± 10% change in line voltage produces frequency shift $< \lvert 1 \times 10^{-7} \rvert$
Output Frequency:	10 MHz, 1 V min sq wave into 50 Ω
External Time Base:	Requires 10 MHz, 1 V p-p min into 300 Ω

Frequency Coverage:	20 Hz to 135 MHz	10 MHz to 300 MHz
Minimum Sensitivity:	25 mV RMS	-20 dBm (22 mV RMS)
Input Impedance:	1 meg/ 20 pf	50 Ω nominal
Maximum Input:	120 V RMS*	+ 10 dBm (.7 V RMS)
Maximum Input Without Damage:	150 V RMS*	+ 27 dBm (5 V RMS)
Coupling:	AC	AC
Connector:	BNC female	BNC female

*Above 1 kHz, max input decreases at 6 dB/octave to 3.0 V RMS.

Frequency Coverage:	100 MHz to 850 MHz
Minimum Sensitivity:	100 to 150 MHz: - 15 dBm 150 to 850 MHz: - 20 dBm
Maximum Input:	+ 10 dBm (0.7 V RMS)
Maximum Input Without Damage:	+ 27 dBm (5.0 V RMS)
Input Impedance:	50 Ω nominal
Coupling:	AC
Connector:	BNC female

Frequency Coverage:	825 MHz to 18.0 GHz
Minimum Sensitivity:	825 MHz to 1.1 GHz: - 25 dBm 1.1 GHz to 12.4 GHz: - 30 dBm 12.4 GHz to 18.0 GHz: - 25 dBm
Maximum Input:	+ 7 dBm; + 20 dBm typical
Maximum Input Without Damage:	+ 33 dBm (2 Watts)
Input Impedance:	50 Ω nominal
Coupling:	AC
Connector:	Type N Precision female
VSWR:	2.5 : 1 typical
FM Tolerance:	40 MHz peak-to-peak worst case for modulation rates from DC to 10 MHz
YIG Preset:	
Selection:	Front panel keyboard input; indicated on 6-digit LED display
Settability:	Set ≥ 400 MHz below lowest frequency to be measured. YIG sweep begins at preset and measures only frequencies ≥ 400 MHz above preset frequency
Operation:	Preset desired frequency on keyboard in MHz (or GHz) at 200 MHz increments. Press Preset button; indicator will light

The source locking mode of the Model 371 provides the capability to phase-lock virtually any swept signal source to the same long-term accuracy and stability as the time base oscillator in the counter. This is achieved over a broad frequency range from 10 MHz to 18 GHz in 100 kHz steps.

Utilizing innovative technical design and state-of-the-art components, the lockbox function highlights extreme simplicity of operation. Only two interconnections are required between the 371 and the source. One is a sample of the source output, the other is the FM input to the source.

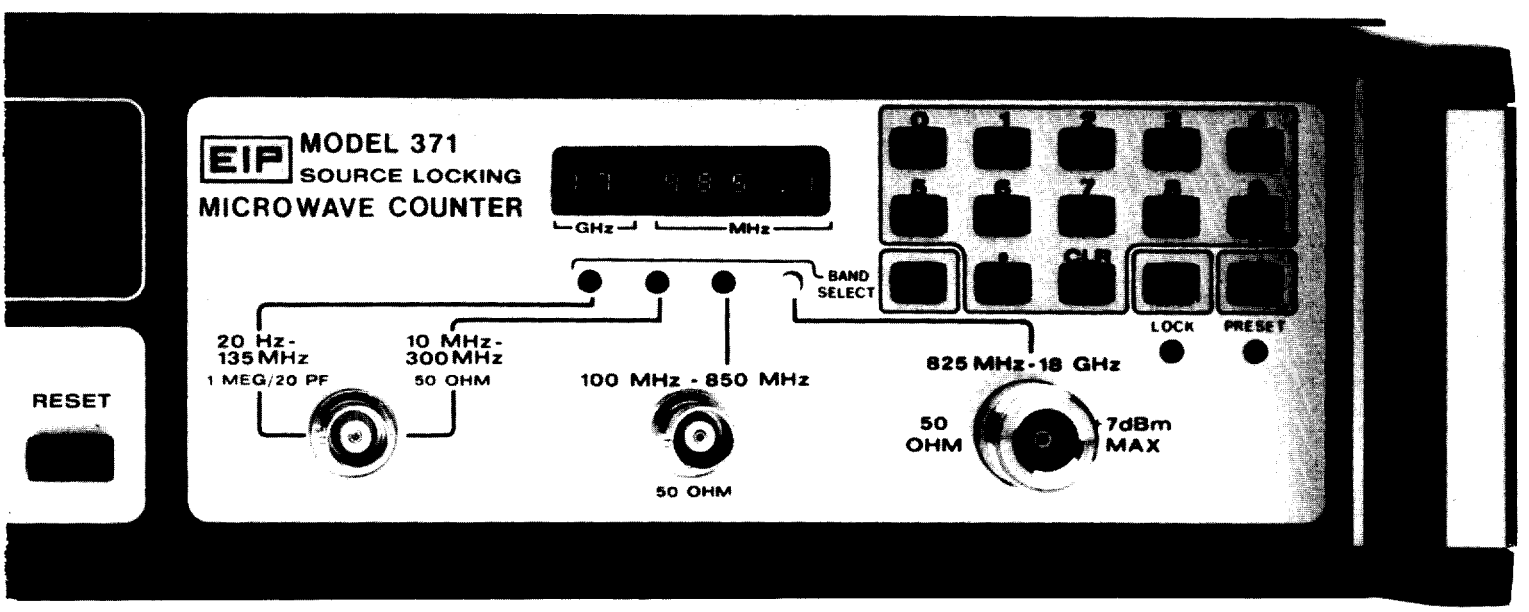
To lock a signal, simply tune the source to within 20 MHz of the desired output frequency, using the counter's 11-digit sectionalized display to check the exact frequency. The desired lock frequency is then entered on the microprocessor-controlled front panel keyboard, and displayed on a separate 6-digit readout. Then by simply depressing the Lock button, the 371 will automatically stabilize the source to the desired frequency – as evidenced by illumination of the Lock indicator. The main counter display also indicates the desired stabilized frequency, and provides a check that lock has indeed occured. Once locked, the source will exhibit the same long term accuracy and stability as the time base oscillator in the counter.

One of the truly unique features of the 371 is its automatic bandwidth and polarity control. The frequency modulation inputs of various commercial sweepers and sources have differing modulation sensitivities and polarities.

Utilizing a microprocessor, the 371 has the capability to automatically provide the correct input to sources of either polarity, with modulation sensitivities between 2 and 200 MHz/volt. No adjustments or controls need be set by the user.

A common problem at microwave frequencies is the reproducibility of a measurement. An additional benefit of the 371 is the ability to not only precisely select a given frequency, but also to precisely repeat that signal at any future time. This inherent capability eliminates the frequency uncertainty which can be a significant source of error in many microwave measurements.

The Model 371 features plug-in board design. Boards are laid out to facilitate fault isolation to the assembly level. EIP's Exchange Board Program may then be used, at the customer's discretion, to replace the faulty board for a completely operational one. This service is free of charge during the 12 month warranty period, and available for a low fixed fee afterward.



A counter's ability to measure a modulated signal is determined by the FM tolerance specification. FM tolerance is specified in terms of the maximum deviation than can be tolerated at a given modulation rate. As an example, a microwave communication system is described in terms of the number of voice channels that can be transmitted. An 1800 channel system (three master groups) requires approximately 8 MHz baseband width (3.4 kHz per channel plus bandwidth for multiplexing). Thus the maximum FM modulation frequency is 8 MHz. The deviation is selected to optimize the noise performance of the system – in practice, this optimum deviation is 4 to 5 MHz.

The EIP Model 371 Source Locking Microwave Counter will measure the center frequency in the presence of 40 MHz peak-to-peak modulation, worst case. In the best case – when the counter's IF is centered in the counter's IF bandwidth, the counter can measure with as much as 200 MHz peak-to-peak deviation. This capability offers obvious advantages to communications and systems manufacturers, and end users.

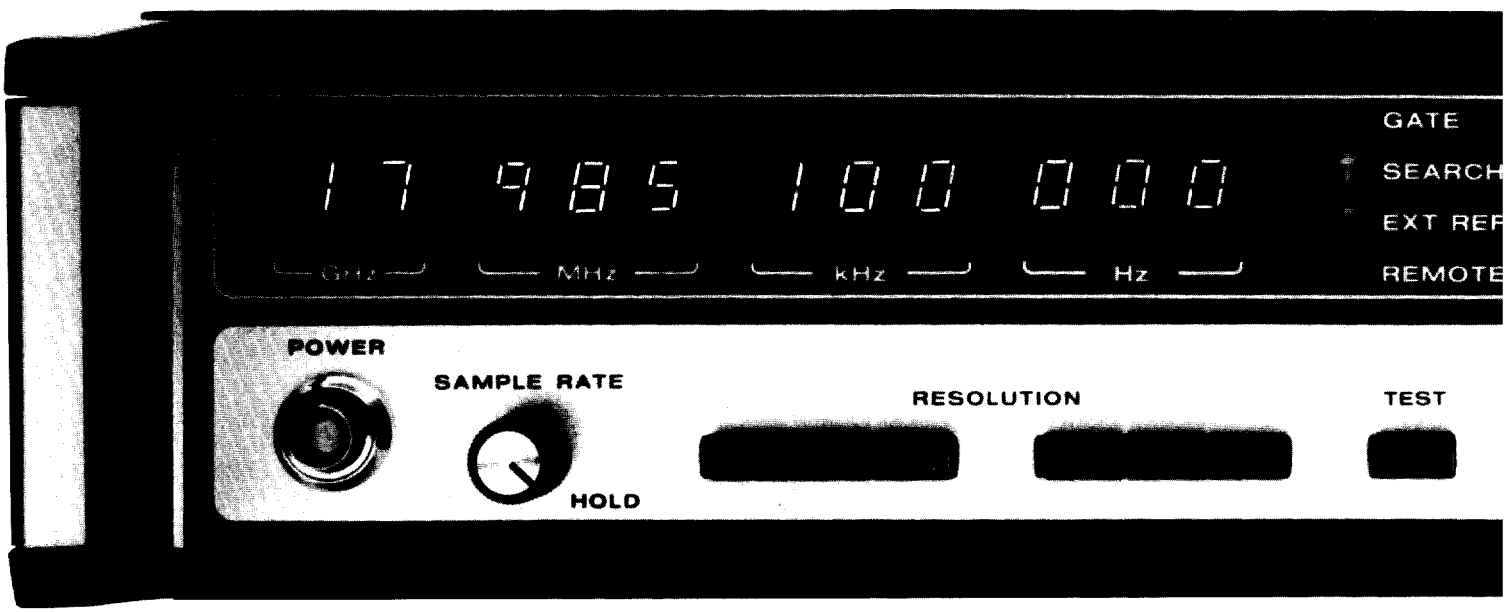
In most microwave frequency measurement applications, the source to be measured does not provide the counter with a single, clean, clearly defined signal, but rather with an input signal spectrum containing harmonics, sub-harmonics, noise, and possibly multiple signals of equal or near-equal amplitude. Such an input spectrum can cause considerable measurement problems in counters employing simple "amplitude discrimination" circuitry.

EIP's unique Automatic Input Level Control combined with YIG Preset, provides Multiple Signal Discrimination by incorporating the ability to pre-determine, in 200 MHz steps, the start frequency from which the counter will sweep upward until it encounters a signal within its sensitivity range. Once that frequency is measured and recorded, the counter can then be preset above that frequency to a new start sweep frequency for measurement of the next higher signal present. For example, with an input spectrum of equal amplitude signals at 2 GHz, 4 GHz, and 6 GHz, the 371 would first lock to and display 2 GHz. Then, by setting the YIG Preset to 3 GHz and 5 GHz, respectively, accurate frequency measurement of the 4 GHz and 6 GHz signals would be achieved.

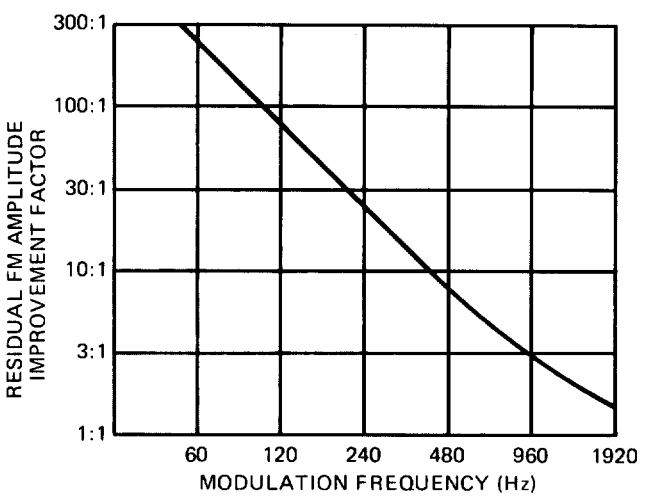
In normal Band III operation, the YIG-tuned comb generator begins its sweep at 0 frequency. Manually programming the front panel keyboard allows starting the YIG at a preselected frequency. Selecting the start frequency for the YIG makes possible the individual measurement of multiple frequencies, and eliminates the limitation of measuring only the highest level signal or first encountered frequency. YIG Preset is also very helpful in high speed applications, resulting in considerable reduction in acquisition time.

Receiver applications typically deal with received signal levels far lower (-80 to -90 dBm) than the sensitivity of microwave frequency counters. Option 06 allows the direct readout of received frequencies limited only by receiver sensitivity.

This is accomplished by offsetting the counter display by the IF of the receiver and measuring the LO of the receiver. These two quantities are then automatically totalized on the counter display, yielding the ultra low level received frequency.



Frequency Coverage:	10 MHz to 18 GHz
Resolution (Settability):	100 kHz (400 kHz in Band II)
Long Term Stability:	Equal to counter time base oscillator
Minimum Lock Level:	Equal to counter sensitivity
Lock Time:	0.1 to 3 sec; dependent upon source
Accuracy:	Equal to counter
Capture Range:	± 20 MHz min; ± 50 MHz typical unless limited by source characteristics or output current capability
Bandwidth & Polarity:	Fully automatic selection
Output Drive Capability:	± 10 V into 5 KΩ minimum, or ± 40 mA into 10 Ω maximum
Output Connector:	Rear panel BNC female
Residual FM Reduction:	See graph below for typical response
Required Source Input Characteristics:	
Bandwidth:	4 kHz min for specified performance
Modulation Sensitivity:	Voltage input ($R_{in} > 5$ KΩ): 2 to 200 MHz/V. Current input ($R_{in} < 10$Ω): 0.1 to 10 MHz/mA



Mode of Operation:	Any frequency reading within counter's range may be increased or decreased by any number in 100 kHz increments. Positive offsets are made by presetting the desired number in BCD format. Negative offsets require preset of the nines complement of the desired number
Offset Selection:	Ground contact closure (TTL/DTL compatible); parallel BCD format
Programming Connector:	Amphenol 57-40500, 50-pin female. Mating conn: Amphenol 57-30500, 50-pin male

Function:	Provides rear panel programming of all front panel controls except Sample Rate, Power, and lockbox function
Selection:	Ground contact closure (TTL/DTL compatible). Requires one control line per function
Connector:	Same types as Option 06

BCD Code:	1248 "1" state positive
Format:	11 data digits in parallel form
"0" State Level:	0 to 0.4 V, 5 mA current sink capability
"1" State Level:	+5 V, 2K Ω source impedance
Negative Reference:	Ground
Positive Reference:	+5 V, 22 Ω source impedance
Print Command:	+5 V to 0 V step; fall time: 1 ms; width: 20 ms; 2 K Ω source impedance
Hold Off Requirem't:	Maximum: 50 V; minimum: 2 V
Output Connector:	Same types as Option 06

Function:	**Utilizing IEEE STD 488-1975 format, Option 17 provides remote programming of essential counter and lockbox functions plus data output in ASCII format.**

OPTION	AGING RATE PER 24 HRS. (After 72 hour warm-up)	SHORT TERM STABILITY (1 second average)	0° to +50° C Temp Stability	± 10% Line Voltage Chg
03	$< \lvert 5 \times 10^{-9} \rvert$	$< 1 \times 10^{-10}$ RMS	$< \lvert 6 \times 10^{-8} \rvert$	$< \lvert 5 \times 10^{-10} \rvert$
04	$< \lvert 1 \times 10^{-9} \rvert$	$< 1 \times 10^{-10}$ RMS	$< \lvert 3 \times 10^{-8} \rvert$	$< \lvert 2 \times 10^{-10} \rvert$
05	$< \lvert 5 \times 10^{-10} \rvert$	$< 1 \times 10^{-10}$ RMS	$< \lvert 3 \times 10^{-8} \rvert$	$< \lvert 2 \times 10^{-10} \rvert$

* All Time Base Options utilize a proportional control oven which is energized whenever line cord is connected to AC source.

371 Microwave Counter
ACCESSORIES:
Calibration Kit
Carrying Case
Rack Mount Kit

03 5×10^{-9} Oscillator
04 1×10^{-9} Oscillator
05 5×10^{-10} Oscillator
06 Programmable IF Offset
07 Programming
09 Digital Output

10 Rear Inputs
11 No Band II
17 GPIB (IEEE STD 488-1975)
S-02 Band III to 20.0 GHz

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