MODELS 350D/351D AUTOHET™ MICROWAVE FREQUENCY COUNTERS

EIP Microwave

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Features

- ☐ 20 Hz to 12.4 GHz, 18 GHz and 20 GHz
- ☐ −30 dBm Sensitivity
- ☐ +33 dBm (2 watt) Overload Protection
- ☐ 40 MHz to 200 MHz FM Tolerance
- ☐ Multiple Signal Discrimination
- ☐ 1 Hz Resolution in 1 Sec
- ☐ 11 Digit Sectionalized LED Display
- ☐ Plug-In Exchange Board Construction

Introduction

The EIP 350D/351D Automatic Microwave Frequency Counters, utilizing the heterodyne technique, offer a microwave instrument with both sensitivity of -30 dBm and wide band FM tolerance of greater than 40 MHz peak-to-peak. The combination of these two key specifications is unsurpassed in any other automatic microwave counter. Using improved solid state YIG and thin film technology, EIP has developed an innovative frequency measuring technique yielding the FM tolerance advantage of heterodyning and the sensitivity previously associated with transfer oscillator approaches. The 350D Series provides these capabilities in one completely solid state unit which automatically measures frequencies from 20 Hz to 12.4 (350D) or 18 GHz (351D) with optimal coverage to 20 GHz. Now the overall balance of the EIP 350D Series provides a unique solution to the complete range of microwave frequency counter applications.

Model 350D/351D Autohet Microwave Counters

Complementing the high FM tolerance and sensitivity of the EIP 350D Series are a wide range of unique features which make these counters ideally suited for many frequency measuring applications including communications, radar, ECM systems, telemetry production test systems, calibration labs and R&D.

Dynamic Range – 50 dB typical (-30 dBm to +20 dBm) minimizes the need for external amplifiers or attenuators.

Overload Protection -- +33 dBm (2 watts) burn out protection is provided by Automatic Input Level Control which attenuates the microwave input signal to the optimum level.

Speed – EIP heterodyne counters offer 1 Hz resolution in 1 second.

YIG Preset – Provides multiple signal discrimination and minimum signal acquisition time for high speed applications.

IF Offset – Provides direct frequency measurements in ultra low level receiver applications.

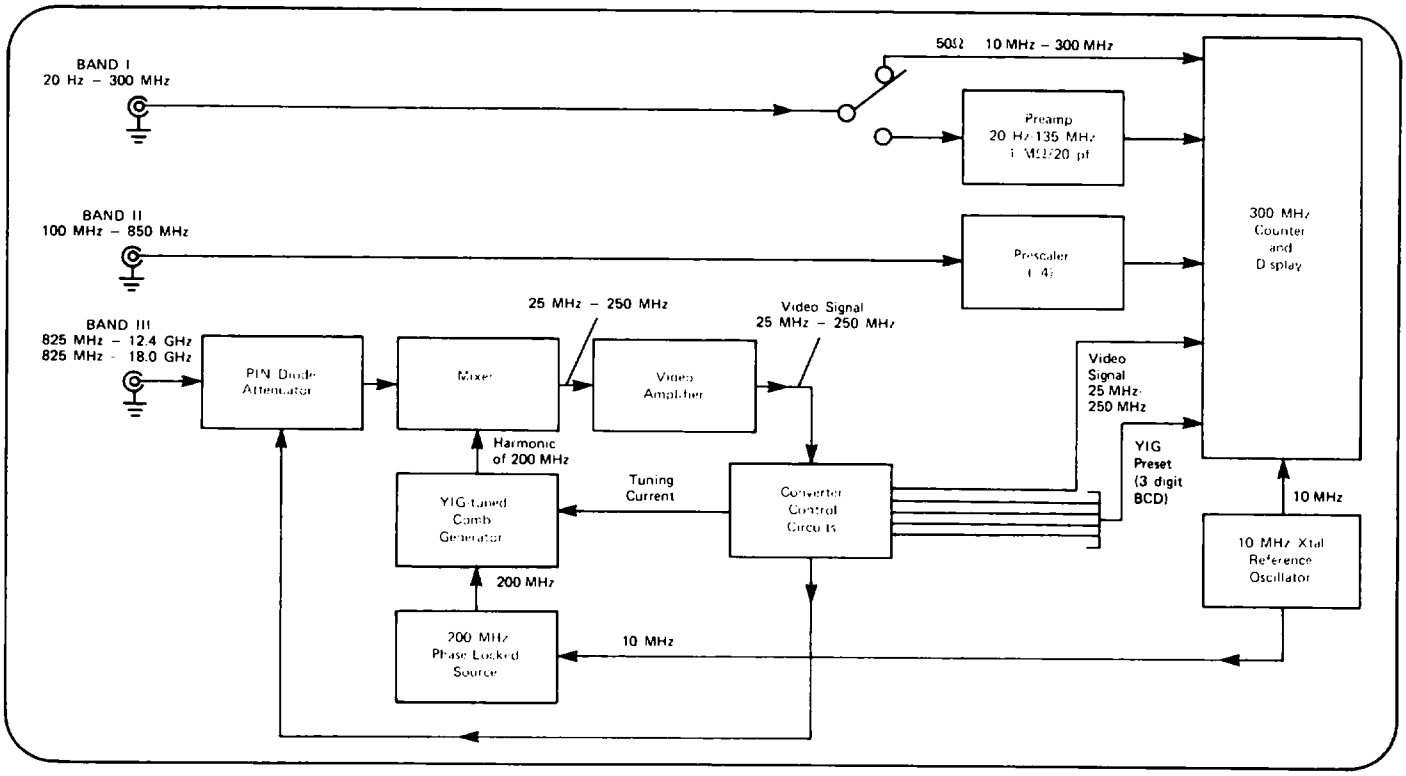
Rear Input – All input connectors are available on the rear panel for rack mounted applications.

Three Isolated Bands – Measure 3 separate signals simultaneously by simply moving the band select switch.

Systems Compatible – General Purpose Interface Bus (IEEE STD 488-1975) or parallel digital output and programming available for systems applications.

Plug-In Boards – Isolate problems easily and eliminate downtime with the EIP Exchange Board program.

Reliability – Reliability is enhanced with the completely solid state design. Based on over 4 years of warranty repair data, actual Mean Time Between Failure (MTBF) has exceeded 60 months.



Autohet Operation

Figure 1 is a simplified block diagram of the Autohet 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 to 300 MHz. Band II contains a prescaler which divides the input frequency by 4. It operates over the frequency range of 100 MHz to 850 MHz with an input impedance of 50 ohms.

Band III covers the microwave frequencies from 825 MHz to 12.4 or 18 GHz (350D or 351D). In this band an Autohet microwave converter translates the input frequency downward into the frequency range of the direct counter.

This is done 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.

Sensitivity

Creative technical design has been employed in the 350D/351D Microwave Counters 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 the sensitivity previously achieved only in the transfer oscillator approach.

High sensitivity, coupled with wide 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 also now makes possible the measurement of low level intermediate frequencies or local oscillators often encountered in microwave systems applications.

FM Tolerance

All microwave counters will measure a cw signal; however, there are many communication and electronic warfare applications which necessitate the measurement of a modulated signal; for example, monitoring the carrier frequency of a microwave radio while the modulation is on. Essentially, this measurement is made with a frequency counter by averaging the positive and negative deviations over the gate time of the counter.

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 that can be tolerated at a given modulation rate. As an example, a microwave communications 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 modulation frequency, FM, 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 Series 350D Microwave Counters will measure the center frequency in the presence of 40 MHz peak-to-peak modulation, worst case. In the best case, when the IF frequency of the counter is in the center of 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.

Other frequency measuring techniques utilizing phase lock loops may be adversely affected by signal FM. The phase lock loop in a transfer oscillator, for example, is limited in bandwidth and thus a signal with high modulation rate or wide deviation may break lock. In fact, some transfer oscillator microwave counters are so susceptible to FM that measurements cannot be made on signals containing incidental FM found in some BWO sources. The EIP Series 350D offers tolerance of 40 MHz or more peak-to-peak deviation without restrictions on signal level, residual FM products, noise or spectral density.

Multiple Signal Discrimination

In most microwave frequency measurements 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.

Amplitude discrimination implies that the counter will always measure the strongest signal. What if the input consists of multiple widely-spaced signals of equal amplitude? Which signal, if any, will the counter measure?

EIP's unique Automatic Input Level Control combined with optional 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 up to a new start sweep frequency for measurement of the next higher frequency signal present. For example, with an input spectrum of equal amplitude signals at 2 GHz, 4 GHz, and 6 GHz the 350D/351D 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.

Only EIP provides this Multiple Signal Discrimination feature.

350D/351D Features

–30 dBm Sensitivity

New thin film microwave integrated circuitry now makes –30 dBm sensitivity available in a heterodyne counter. Low level signals no longer complicate frequency measurement. Measurement of test points after directional couplers and lossy devices is greatly facilitated. The 50 dB typical dynamic range and broad frequency coverage also allows a wide range of signal inputs without external signal conditioning.

40 MHz FM Tolerance

Only a heterodyne converter can offer the FM tolerance required for signal measurements with high residual FM or communications, radar and other microwave systems where FM is used for information transfer. The Series 350D provides a 40 MHz peak-to-peak deviation specification worst case regardless of RF frequency, signal level, modulation rate or other limitations. Best case conditions allow a deviation of over 200 MHz peak-to-peak.

Speed

The Series 350D is the fastest microwave counter available. Speed is defined as the sum of the acquisition time plus the gate time. Acquisition time on Band III is 10 ms/GHz plus 50 ms nominal. Standard gate times are 1 second 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.

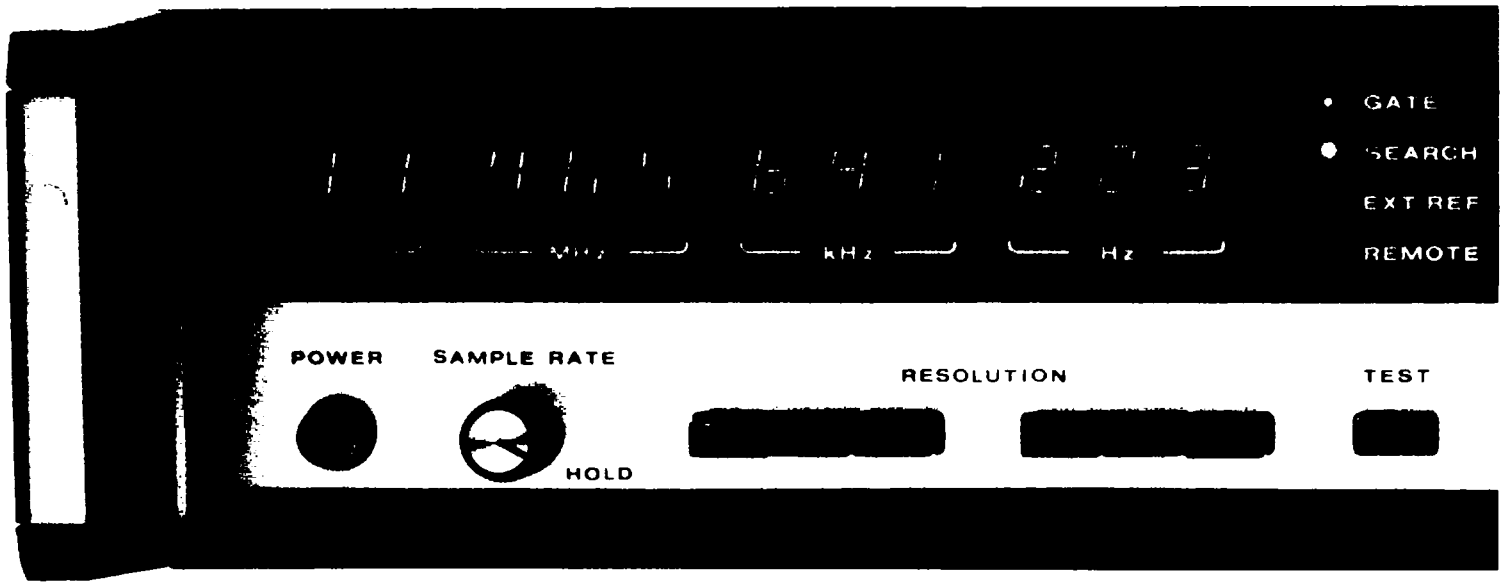
Easy to Use

Mechanical tuning or adjustments are unnecessary with this automatic heterodyne counter. Simply set the input selector switch to the desired band and apply the signal, the counter does the rest. The three connector input also allows multiple inputs to the counter. Readings over a wide frequency range are then automatically obtained by manually setting or automatically programming the input selector switch.

Systems Oriented

The General Purpose Interface Bus (Option 16) provides complete systems capability of being operated on the IEEE Standard Digital Interface Bus for Programmable Instruments (IEEE STD 488-1975). The GPIB incorporates the functions of YIG Preset, IF Offset, Remote Programming, and Digital Output options.

Full BCD output and programming is also available in the EIP 350D Series. This provides output information in parallel 1248 format of all 11 digits and programming of everything on the front panel except sample rate, Band I mode select and power. Standard parallel 1248 coding and TTL levels are easily interfaced to a wide line of printers, plotters and computers.



Display

The Series 350D Counters feature an 11 digit LED display sectionalized into GHz, MHz, kHz, and Hz. Confusing shifting decimal points, annunciators and digit overflow are completely eliminated. The display is instantly clear, even for relatively unskilled operators. For further convenience the 6 least significant digits may be individually blanked by depressing the pushbutton directly below the digit. Four gate times are provided from 1 sec to 1 msec according to the resolution selected. All segments of the LED display may be tested by depressing the test and reset pushbuttons.

YIG Preset

In normal Band III operation the YIG-tuned comb generator begins its sweep at 0 frequency. A thumbwheel front panel switch (Option 02) or rear panel programmable connector (Option 01) allows starting the YIG at a preselected frequency. Selecting the start frequency for the YIG makes possible the individual measurement of multiple frequencies. This eliminates the limitation of measuring only the highest level signal or the first encountered frequency. YIG Preset is also very helpful in high speed applications. If, for example, frequencies are above 6 GHz, the YIG may be preset to begin sweeping at 5.6 GHz, resulting in considerable reduction in acquisition time.

Programmable IF Offset

Receiver applications typically deal with received signal levels far lower (-80 to -90 dBm) than the sensitivity of microwave frequency counters. The Option 06 allows the direct readout of received frequencies limited only by the sensitivity of the receiver. This is accomplished by offsetting the counter display by the IF of the receiver and measuring the receiver LO. These two quantities are then automatically totalized on the counter display yielding the ultra low level received frequency. A wide range of IF frequency offsets are available and each can be automatically selected.

Exchange Board Program

The 350D Series features plug-in board design. Boards are laid out to facilitate fault isolation to the board level. EIP's exchange board program may then be used, at the customers 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 after warranty.

EIP 350D/351D Specifications

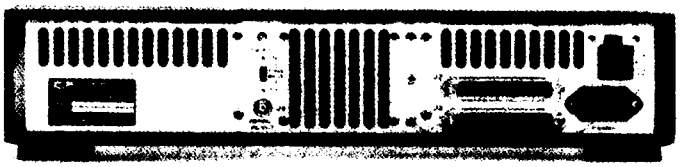
BAND I	A	B
Frequency Coverage:	20 Hz to 135 MHz	10 MHz to 300 MHz
Minimum Sensitivity:	25mv RMS	-20 dBm (22mv RMS)
Input Impedance:	1 megohm/20 pf	50 ohm nominal
Maximum Input:	120V RMS*	+10 dBm (.7V rms)
Maximum Input Without Damage:	150V RMS*	+27 dBm (5.0V RMS)
Coupling:	AC	AC
Connector:	Type BNC Female	

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

BAND II	
Frequency Coverage:	100 MHz to 850 MHz
Minimum Sensitivity:	100-150 MHz: -15 dBm; 150-850 MHz: -20 dBm
Maximum Input:	+10 dBm (.7V RMS)
Maximum Input Without Damage:	+27 dBm (5.0V RMS)
Input Impedance:	50 ohm nominal
Coupling:	AC
Connector:	Type BNC Female

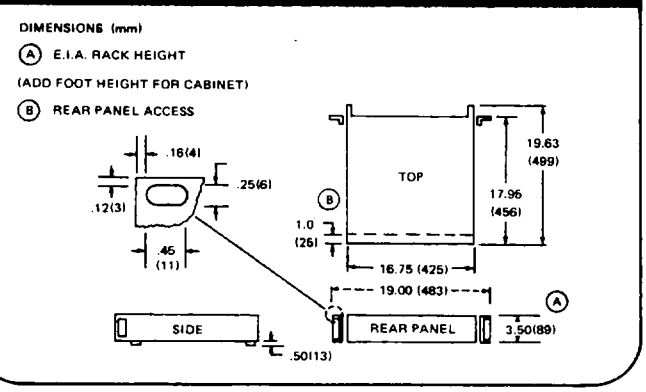
BAND III	
Frequency Coverage:	825 MHz to 12.4 GHz (Model 350D) 825 MHz to 18.0 GHz (Model 351D)
Minimum Sensitivity:	825 MHz to 1.1 GHz -25 dBm 1.1 GHz to 12.4 GHz -30 dBm 12.4 GHz to 18.0 GHz -25 dBm
Maximum Input:	+7 dBm; +20 dBm typical
Maximum Input Without Damage:	+33 dBm (2 Watts)
Input Impedance:	50 ohms 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.

TIME BASE (Standard)	
Crystal Frequency:	10 MHz
Stability: Aging Rate: Short Term: Temperature: Line Variation:	 $< \lvert 3 \times 10^{-7} \rvert$ / mo. $< 1 \times 10^{-9}$ RMS for one second averaging time $< \lvert 2 \times 10^{-6} \rvert$ over the range 0° to 50°C ±10% change in line voltage produces frequency shift $< \lvert 1 \times 10^{-7} \rvert$
Warm-up Time:	None Required
Output Frequency:	10 MHz, square wave, 1V peak-to-peak minimum into 50 ohms
External Time Base:	Requires 10 MHz, 1V peak-to-peak minimum into 300 ohms



GENERAL SPECIFICATIONS	
Frequency Range:	20 Hz to 12.4 GHz (Model 350D) 20 Hz to 18.0 GHz (Model 351D)
Accuracy:	±1 count ± time base error.
Resolution:	Selectable 1 Hz to 1 MHz
Gate Time:	1 sec (1 Hz), .1 sec (10 Hz), 10 msec (100 Hz), 1 msec (1 kHz); Other resolutions are 1 msec gate time. Band II gate times are expanded by 4.
Display:	11 digit LED sectionalized to read GHz, MHz, kHz, and Hz.
Operation:	Completely automatic after band selection.
Acquisition time (Band III):	10 msec/GHz plus 50 msec nominal. Once locked, readings can be taken at rate determined by Sample Rate Control and selected gate time.
Controls: SAMPLE RATE: BAND SELECT: RESOLUTION: Gate Time: RESET: TEST:	 Controls time between measurements. Variable from 100 msec typical to 10 seconds. Switchable HOLD position holds display indefinitely. Select Band IA, IB, II, or III. Pushbutton blanking of up to six least significant digits. 1 sec through 1 msec. Band II expands gate time by 4. Resets display to zero and initiates new reading. Counts and displays internal 10 MHz time base.
INT/EXT TIME BASE Switch:	Rear panel switch selects time base reference. INT position typically used. EXT position allows use of externally supplied 10 MHz reference.
POWER Switch:	On/Off control applies line power to the instrument.
Operating Temperature:	0°C to 50°C
Power:	115 or 230VAC ±10%, 50 to 60 Hz, 80 watts
Weight:	Net: 25.5 lbs. (11.6 kg) Shipping: 30.0 lbs. (13.6 kg)
Accessories Furnished:	Detachable power cord, 8 ft. (241 cm) long, with International plug. Operating and Instruction Manual and Extender Card

DIMENSIONS



350D/351D Options

MODELS	OPTIONS	
350D 20 Hz – 12.4 GHz	01 YIG Preset Programmable	09 Digital Output
351D 20 Hz – 18.0 GHz	02 YIG Preset Thumbwheel	10 Rear Inputs
	03 $5x10^{-9}$ oscillator	11 No Band II
	04 $1x10^{-9}$ oscillator	12 Band III 13.5 GHz (350D)
	05 $5x10^{-10}$ oscillator	13 Rack Mount/Chassis Slides
	06 Programmable IF Offsets	16 GPIB (IEEE STD 488-1975)
	07 Programming	S02 Band III 20.0 GHz (351D)

TIME BASE OPTIONS*

OPTION	AGING RATE PER 24 HRS. (After 72 hours warm-up)	SHORT TERM STABILITY 1 Sec. Avg.	0°C to +50°C Temperature Stability	±10% LINE Voltage Change
03	$<\lvert 5x10^{-9} \rvert$	$<1x10^{-10}$ rms	$<\lvert 6x10^{-8} \rvert$	$<\lvert 5x10^{-10} \rvert$
04	$<\lvert 1x10^{-9} \rvert$	$<1x10^{-10}$ rms	$<\lvert 3x10^{-8} \rvert$	$<\lvert 2x10^{-10} \rvert$
05	$<\lvert 5x10^{-10} \rvert$	$<1x10^{-10}$ rms	$<\lvert 3x10^{-8} \rvert$	$<\lvert 2x10^{-10} \rvert$

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

OPTION 01/02: YIG PRESET

Selection:	Front panel 3 digit thumbwheel switch (02) Rear Panel Programmable Ground Contact Closure (01)
Settability:	Set at least 400 MHz below lowest frequency to be measured. YIG sweep begins at preset frequency and will measure only frequencies 400 MHz or more above the preset.
Operation:	Preset desired frequency on thumbwheels (02). or rear panel connector (01). On Option 01 preset frequency set by ground contact closure (T^2L compatible) of up to 8 parallel input lines.

OPTION 06: PROGRAMMABLE IF OFFSETS

Mode of Operation:	The readings of any frequency within the range of the counter may be increased or decreased by any number in 100 kHz increments. Positive offsets are achieved 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 (T^2L and DTL compatible) at rear panel programming connector utilizing parallel BCD format.
Programming Connector:	Amphenol 57-40500 50-pin, female. Mating connector Amphenol 57-30500 50-pin, male.

ACCESSORIES:

Calibration Kit	P/N: 2000005
Rack Mount Kit	P/N: 2010008
Carrying Case	P/N: 5700001

OPTION 07: REMOTE PROGRAMMING

Function:	Provides rear panel programming of all front panel controls except SAMPLE RATE and POWER.
Selection:	Ground Contact closure (T^2L and DTL compatible) at rear panel connector. Requires one control line per function.
Connector:	Amphenol 57-40500 50-pin female. Mating connector Amphenol 57-30500 50-pin male.

OPTION 09: DIGITAL OUTPUT

BCD Code:	1248 "1" state positive
Format:	11 data digits in parallel form
"0" State Level:	0 to 0.4V, 5 mA current sink capability
"1" State Level:	+5V, 2 kohm source inpedance
Negative Reference:	Ground
Positive Reference:	+5V, 22 ohm source impedance
Print Command:	+5V to 0V step, fall time 1 microsec, 20 microsec. width; 2 kohm source impedance
Hold Off Requirement:	Maximum: 50 volts Minimum: 2 volts
Output Connector:	Amphenol 57-40500 50-pin female. Mating connector, Amphenol 57-30500 50-pin, male.

OPTION 16: GPIB

Function:	GPIB utilizes IEEE STD 488-1975 format and provides the functions of YIG Preset, IF Offset, Remote Programming, and Digital Output.

Worldwide

EIP products are sold through sales representative organizations located throughout the world. For information on countries, contact an EIP representative at the telephone number listed below nearest your location. If no office is listed for your country, contact EIP directly.

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