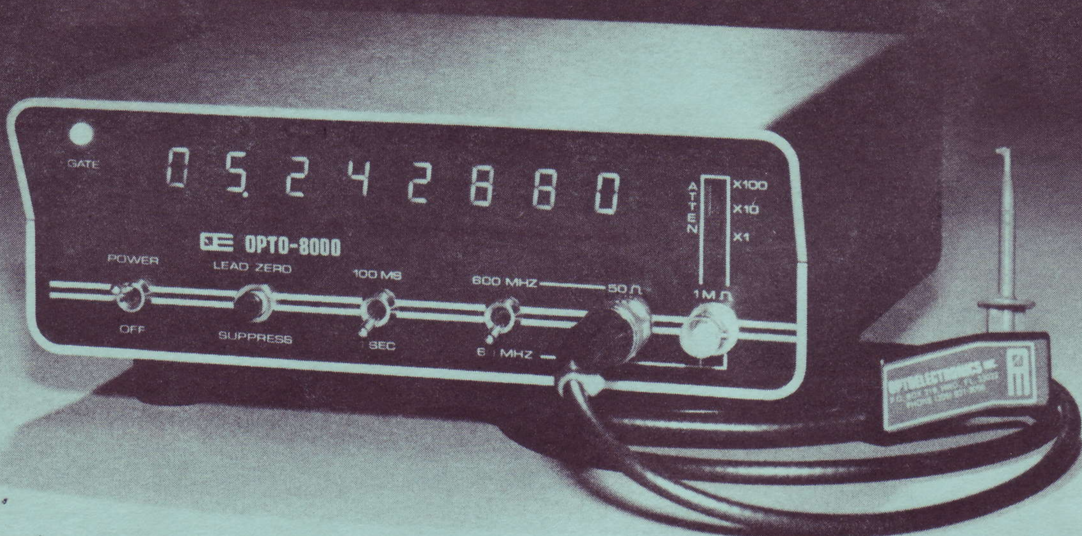
$3.95

10 Hz TO 600 MHz

FREQUENCY COUNTER

±0.1 PPM TCXO



OPTOELECTRONICS, inc.

MODEL OPTO-8000.1A

Owners Manual

OPTO-8000.1A
FREQUENCY COUNTER

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OPTOELECTRONICS, INC.

5821 N.E. 14th Avenue
Ft. Lauderdale, Florida 33334
(305) 771-2050

OPTO-8000.1A FREQUENCY COUNTER SPECIFICATIONS

The OPTO-8000 series frequency counters are a no compromise, professional quality line of instruments at affordable prices. Thanks to new CMOS LSI technology, size, power and cost have shrunk while performance improved.

The OPTO-8000 combines this new technology with careful circuit design and unique packaging for a state-of-the-art counter that sets the pace.

FEATURES AND SPECIFICATIONS

RANGE	10 Hz to 600 MHz in two over lapping ranges.
	1 Meg Ohm input - 10 Hz to 60 MHz.
	50 Ohm input - 20 MHz to 600 MHz.
GATE TIMES	1 second and 100 miliseconds, switch selectable.
RESOLUTION	1 Hz to 60 MHz, 10 Hz to 600 MHz.
DISPLAY	8 LED digits with floating decimal point. Flashing LED gate period indicator.

TIME BASE DATA MODEL OPTO-8000.1A

Frequency:	5.242880 MHz.
Type:	TCXO (Temperature Compensated Crystal Oscillator)
Stabability:	less than .1 ppm from 17° to 40° C.
	less than 1.0 ppm from 0° to 60° C.
Aging:	less than 1.0 ppm first year. (less than 1.0 ppm first three years typical)
	less than 0.5 ppm per year thereafter.
Initial set accuracy:	less than 0.5 Hz at 25° C.
External adjustment range:	± 10 ppm.

TIME BASE DATA MODEL OPTO-8000A

Frequency:	5.242880 MHz.
Type:	Crystal, AT cut, HC-18 holder.
Typical Stabability:	less than 1.0 ppm, 17° to 40° C.

INPUT CHARACTERISTICS

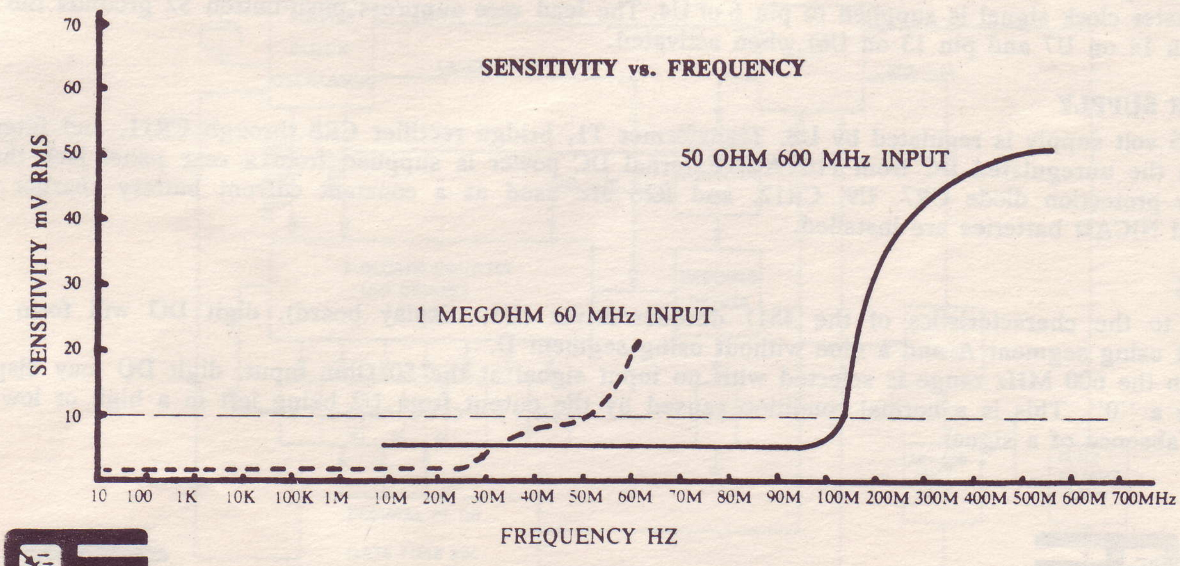
Impedance:	1 Meg Ohm shunted by 20pF, DC coupled (10 Hz to 60 MHz).
	50 Ohm, AC coupled (20 MHz to 600 MHz).
Connectors:	BNC type.
Typical Sensitivity:	2 - 10 MV RMS below 150 MHz,
	10 - 50 MV RMS below 600 MHz.
Max Input Signal:	1 Meg input - 100 V peak to peak up to 10 MHz,
	50 V peak to peak up to 60 MHz.
	50 Ohm input - 2 V peak to peak max.

GENERAL

Power:	105 to 130, 117 VAC nominal, 60 Hz, 2 Watts.
	8 to 16 VDC, 300 MA.
Dimensions:	3¼" H x 7¼" W x 6¾" D.
Weight:	Approximately 2.5 pounds.

OPTO-8000.1A CONTROLS

POWER	**ON -**	"on" position applies power to the circuit.
	OFF -	"Off" position removes circuit power and charges internal NI-CADS if option #NI-CAD-80 has been installed.
60 MHz/600 MHz		In 60 MHz position signals between 10 Hz and 60 MHz that are coupled to the 1 megohm input connector are counted. In "600 MHz" position, signals between 10 MHz and 600 MHz that are coupled to the "50 ohm" input connector are counted.
100 MS/1 SEC		Gate Control selects the period of time in which the counter counts the input signal. In the "100 MS" position a new count is displayed every 200 miliseconds. In the "1 sec" position a new count is displayed every two seconds. Maximum resolution is obtained with the 1 sec gate time while the 100 MS gate allows changes in frequency to be more quickly displayed.
ATTENUATOR		The decade input attenuator works in conjunction with the 1M ohm input to provide 1X, 10X and 100X reduction in signal amplitude.
LEAD ZERO		When depressed for two gate time periods the counter resets to "000". After its released additional higher order digits will appear in pairs when required to display a count.
50 OHM INPUT		BNC connector for input signals between 10 MHz and 600 MHz. Input is active only when range switch is in "600 MHz" position.
1M OHM INPUT		BNC connector for input signals between 10 Hz and 60 MHz. Input is active only when range switch is in "60 MHz" position.
GATE LITE		The gate is on for a period equal to the selected gate time. When gate lite is off the gate is open and the internal counters count pulses from the amplifier. If the input signal is interrupted when the gate lite is out then an incorrect count will be displayed when the gate lite is next on.
DC POWER INPUT JACK		Rear panel jack for 8 to 16 volts DC. A mating plug and cord is provided. An internal diode protects against reversed polarity. When the counter is operated from a DC source the AC line cord should be disconnected.



CIRCUIT DESCRIPTION

1 MEG OHM INPUT

A signal to be counted between 10 Hz and 60 MHz is connected to the 1 Meg Ohm input and is amplitude attenuated or passed by the switchable voltage divider. The signal is then passed through R1 and C1 and past back to back protection diodes CR1 and CR2 to the gate of FET Q1. Q1 in conjunction with bipolar Q2 forms a high input impedance, low output impedance, unity gain amplifier. The collector of Q2 is directly coupled to the input of amplifier U1. Trimmer R2 controls the bias voltage on pin 9 and is adjusted for a 2.5 VDC reading at TP#1. U1 contains two amplifiers with negative feedback followed by a positive feedback stage that acts as a Schmitt trigger. Transistors Q3 and Q4 convert the U1 output into acceptable logic levels for U3. TP#2 is provided to monitor the amplifier output signal.

50 OHM INPUT

A high frequency signal from 10 MHz to 600 MHz is applied to the 50 Ohm input and then coupled to the wide band UHF amplifier through C8. The amplifier's first stage consists of Q5 (2N2857) in a common base configuration. High frequency signal paths utilize microstrips on the PC board which exhibit characteristic impedance. The second stage of amplification consists of Q7 (2N2857) in a common emitter configuration. The amplified signal is connected through C24 to input pins 15 and 16 of the prescaler IC, U2 (11C90). U2 further amplifies the signal amplitude and divides its frequency by 10. The output signal from pin 11 of U2 is at an acceptable logic level for gate U3.

GATING, COUNTING, AND DISPLAY

The position of switch S3 determines which input circuit is powered and also selects the appropiate gate in U3 to transmit the signal. A gate period signal of either 1 second or 100 mili-seconds is applied to pin 9 of U3 and controls the length of time in which the input signal is presented to the counter stages. The gate signal is produced by U4, inverted by Q6 and selected by S4. Trimmer R24 is used to equalize the rise and fall times of the gate signal (approx. .5 usec.) by changing the bias on transistor Q6. R24 is accurately set when there is no difference between a signal read on the 1 second and 100 mili-second gate times.

The amplified and gated input signal is applied to pin 8 of U6 which counts the frequency and provides BCD coded data on its four output lines. Two of the output lines are ORed together by U5 to produce a 60/40 duty cycle square wave having 1/10 the input signal frequency at pin 8. This signal is presented to pin 12 of U7 where up to seven additional decades of counting is performed. The count data from U6 is decoded by U1 (display board) which then drives LED digit DO. The digit drive data for D1 through D7 is generated by U7. U4 generates a latch pulse (pin 2) that is fed to U7 pin 11 and to U1 (display board) pin 5. A reset pulse generated at U4 pin 14 and buffered by U5 is fed to U6 pin 13 and U7 pin 14. A multiplex timing signal produced at U4 pin 12 is fed to U7 pin 19.

Gate time LED indicator CR7 is switched by the gate signal through Q8. The four combinations of switch S3 and S4 activate the appropiate decimal points on D6, D5, and D4. The master clock frequency is produced by a TCXO oscillator module or by crystal Y1 and its associated network C12, C13, C14 and R22. The master clock signal is supplied to pin 6 of U4. The lead zero suppress push-button S2 grounds the reset line (pin 14 on U7 and pin 13 on U6) when activated.

POWER SUPPLY

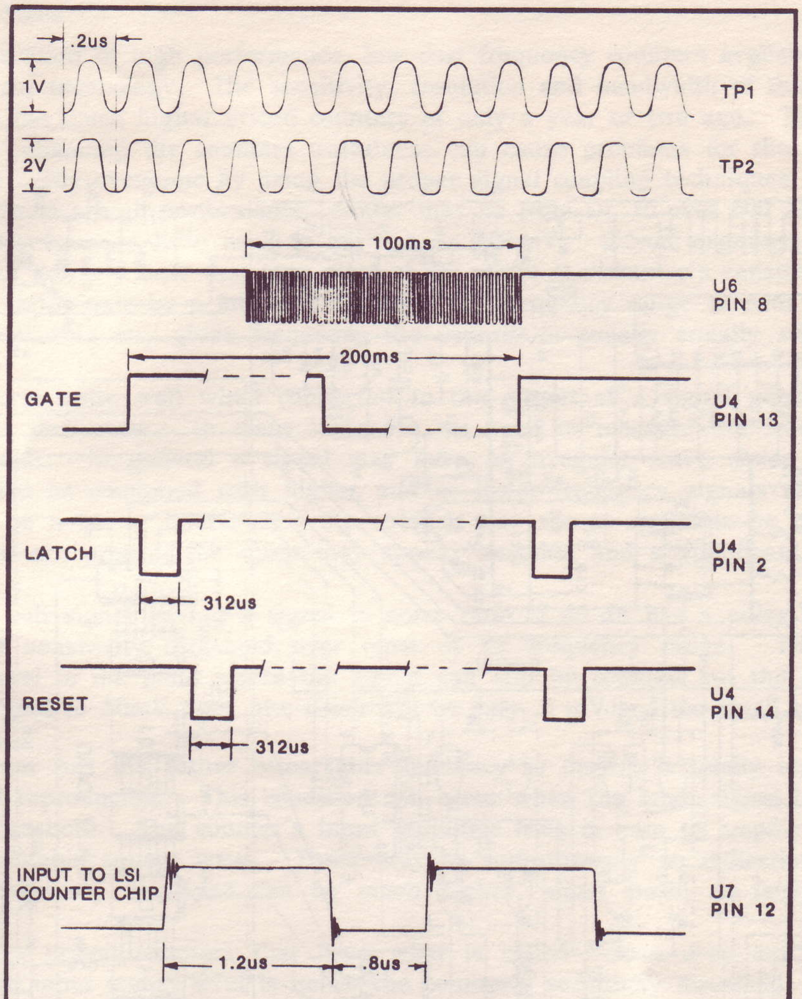
The 5 volt supply is regulated by U8. Transformer T1, bridge rectifier CR8 through CR11, and filter C18 provide the unregulated DC from 110VAC. External DC power is supplied from a rear panel jack through polarity protection diode CR7. U9, CR12, and R28 are used as a constant current battery charger when optional NICAD batteries are installed.

NOTES

Due to the characteristics of the 4511 decoder/driver (U1, display board), digit DO will form a six without using segment A and a nine without using segment D.

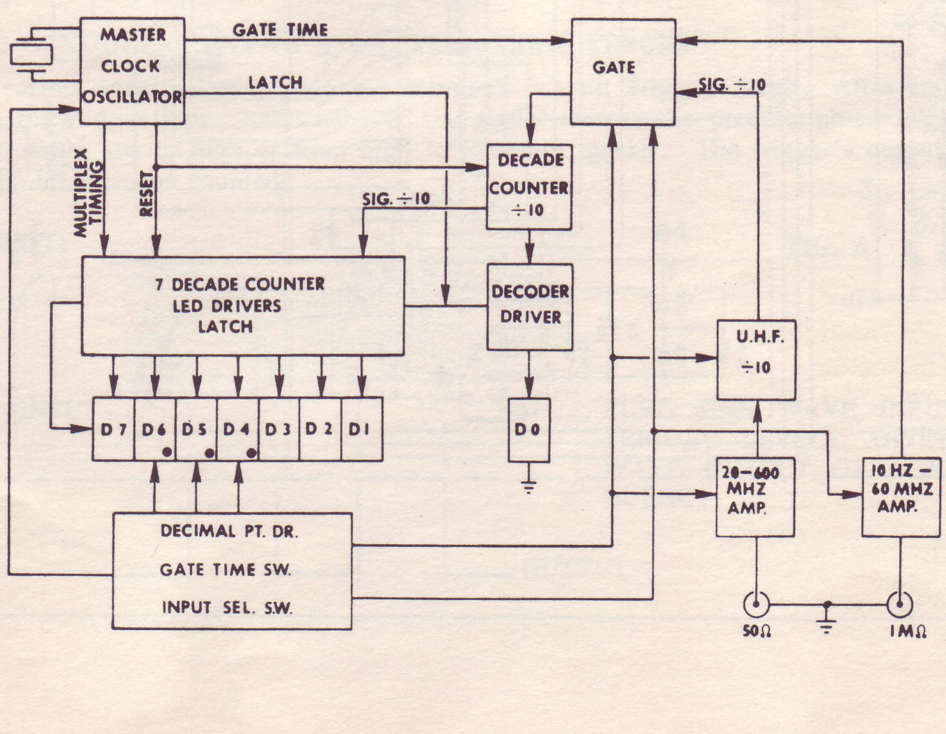
When the 600 MHz range is selected with no input signal at the 50 Ohm input, digit DO may display a "1" or a "0". This is a normal condition caused by the output from U2 being left in a high or low state in the absence of a signal.

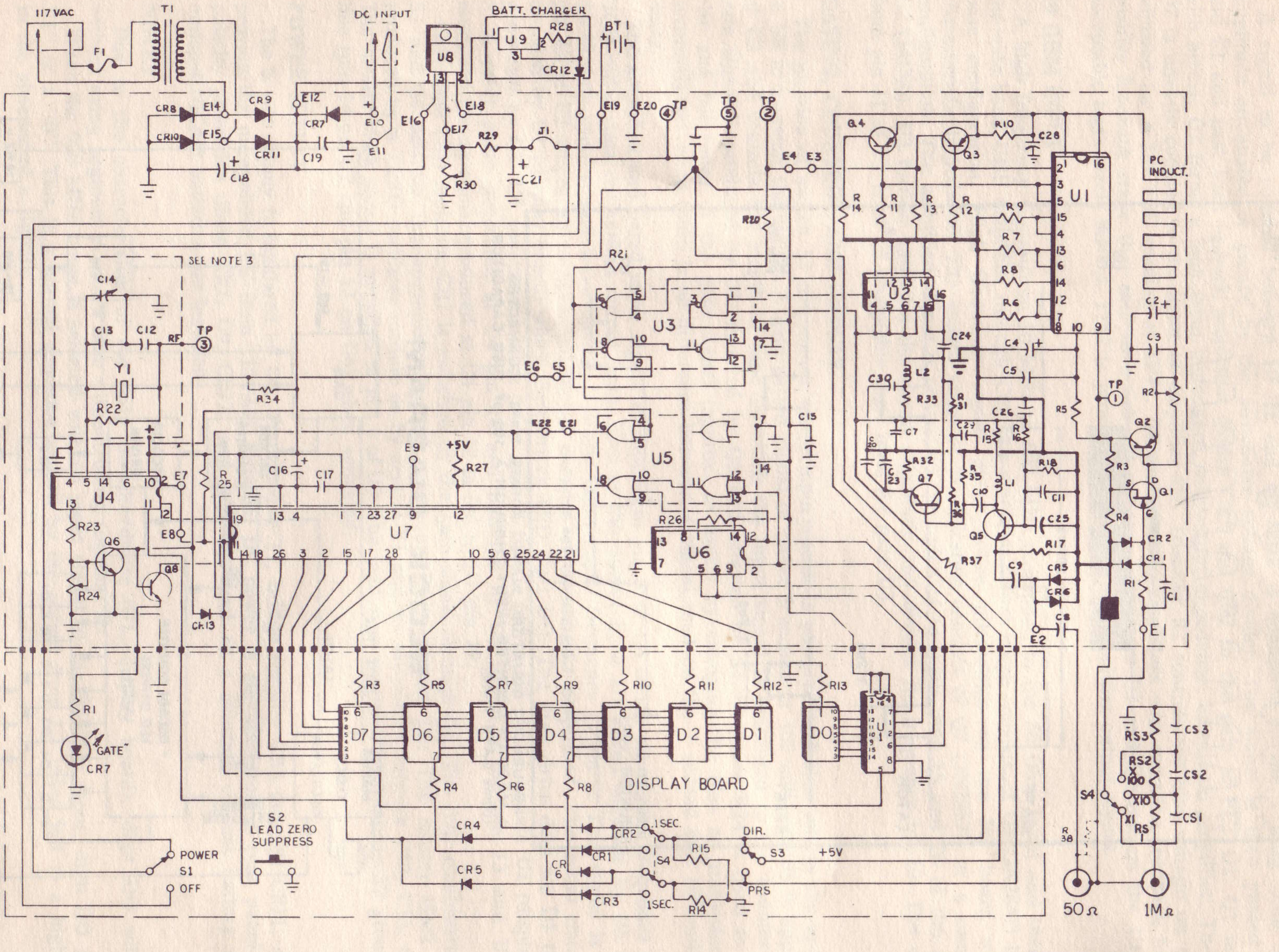
COUNTER WAVE FORMS



FREQUENCY COUNTER WAVE FORMS. TP3 CONNECTED TO 1 MEGOHM COUNTER INPUT THROUGH A 100 pF DISC CAPACITOR. 100ms GATE TIME.

BLOCK DIAGRAM





NOTES

1. R38 MAY BE NECESSARY TO PREVENT SELF-OSCILLATION.
2. C29 & C30 INSTALLED BOTTOM OF PC BOARD.
3. OPTO-8000 USES COMPONENTS SHOWN WITHIN DOTTED LINE. OPTO-8000.1 A REPLACES COMPONENTS WITHIN DOTTED LINE WITH A PRECISION TCXO (SEALED UNIT).

CONTRACT NO		OPTOELECTRONICS, INC.	
APPROVALS	DATE		
DRAWN G. Colburn	10/10/78	SCHEMATIC, OPTO-8000.1 A REV. I	
CHECKED W P Lua			
SIZE D	CODE IDENT NO	DRAWING NO 6301003	
SCALE N.A.			SHEET 1 OF 1

AVOIDING FREQUENCY COUNTING PITFALLS

What We Consider Noise

There is a new generation of high performance, low cost frequency counters available today as the result of advances in LSI circut technology. The sensitivity, resolution and bandwidth of these new counters is as good or better than in the much higher priced counters of only a year or two ago. These high performance features while greatly enhancing the counters usefulness can cause problems for the unwarry. Fortunately these problems can be easily overcome by using the proper signal coupling techniques.

The typical bandwidth of a high performance counter may be from DC to over 600 MHZ. Over this range the sensitivity may vary from as little as 2 to as high as 80 mV. If you examine the log/linear plot of sensitivity vs. frequency you will note that over most of the range the counter's sensitivity is quite uniform. In fact the sensitivity varies only by a factor of 10 while the frequency range extends over 8 decades. The point is that when measuring any given frequency the counter is usually equally sensitive to many other frequencies.

A counter will perform quite well when connected to the output of a signal generator that produces a rather pure and stable sine wave. In many instances we need to measure the frequency of much more complex electrical signals. In general a signal may have an irregular wave shape containing noise and harmonics. It may also be combined with higher and or lower frequency signals of reduced amplitude. What we consider to be noise or interference the counter may see as signal to be counted. When noise spikes and interference are present the count may appear unstable and a significant amount of error can result.

As an example a 5 volt signal having a signal to noise ratio of 40 db has a noise level of 50 mV which exceeds the counter's sensitivity threshold over most of its frequency range. The answer here is to attenuate the signal level to the point where the signal can still be counted but the noise can not. If we attenuate our 5 volt signal to 50mV then the noise will be only .5 mV and too small to be counted.

The frequency counter has the rather remarkable tendency to display a totally inaccurate count that is remarkably stable and reproducible. This condition can occur when the input signal level is just below the counter's sensitivity threshold. The counter's input amplifier tries in vain to amplify and convert this low level signal into a countable square wave. There may be unfortunately no indication when this condition occurs because the frequency displayed can be much higher, much lower, or fairly close to the actual frequency.

There are some high priced counters that have what is called "clean drop out" where all zeros are displayed whenever the input signal level is below the counter's sensitivity threshold. This problem can be avoided however by those of us who can not afford the luxuary of a counter in the thousand dollar plus price range. When ever making a frequency measurement it is advisable to know as much as possible about the charisterics of the signal. Ask yourself, "What is the expected frequency of the signal and how sensitive is my counter to it?". Check for the same frequency at different locations in the circut especially where the signal level may be present with greater amplitude. Above all, when making a measurement, be skeptical and don't take for granted any reading that doesn't make sense to you.

SIGNAL COUPLING CONSIDERATIONS TO AVOID TRIGGERING ERRORS

Fig. A Shows the correct operation of a frequency counter's Schmitt Trigger Circuit. After amplification the signal is applied to the trigger input and whenever the signal crosses the predetermined trigger levels the output changes state from low to high or from high to low very quickly. The trigger's output square wave is at the proper logic levels to be counted.

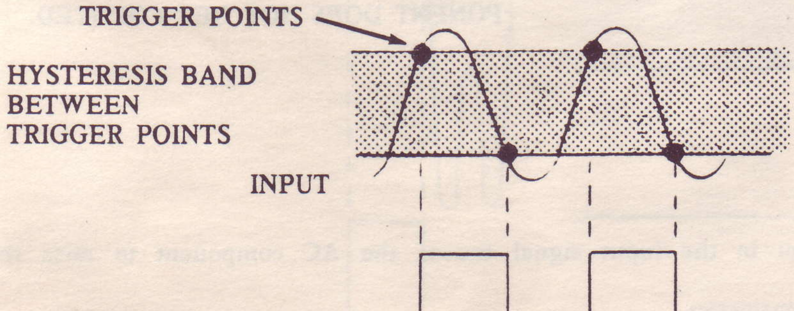
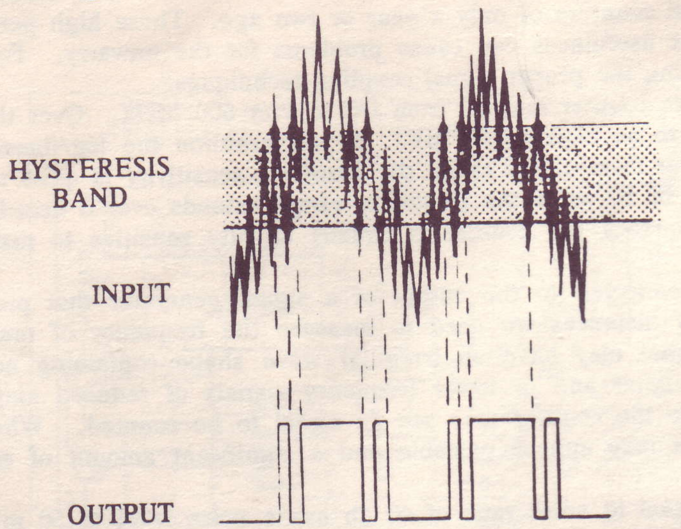


FIG. A

PURE SINE WAVE INPUT CROSSES TRIGGER LEVELS, GIVING SQUARE WAVE OUTPUT OF CORRECT FREQUENCY.

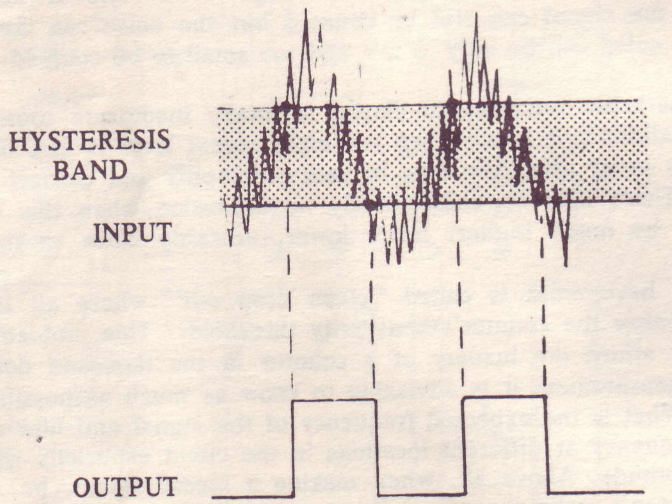
Fig. B Shows the false triggering that occurs when a noisy input signal is counted. The false triggering is caused when noise spikes transit the hysteresis band. When the signal is attenuated, (Fig. C), the noise spikes become smaller in relationship to the hysteresis band. A 10X oscilloscope probe is useful for attenuation and has the added advantage of reducing the circuit loading. A 10 megohm pot in series with the counter's input will allow continuously variable attenuation from 1X to 100X.

FIG. B



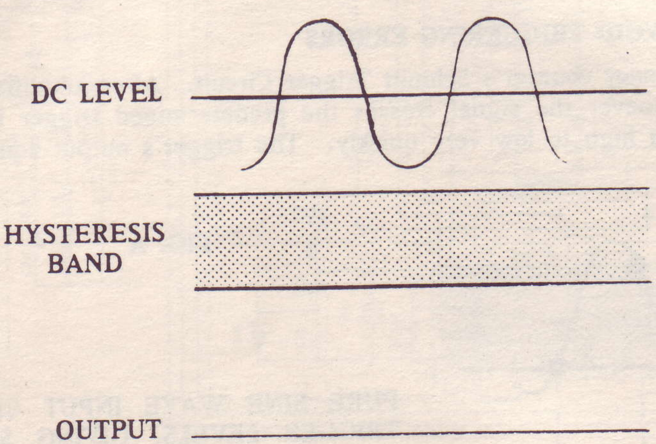
NOISY SIGNAL CROSSES HYSTERESIS BAND SEVERAL TIMES DURING PERIOD, CAUSING FALSE TRIGGERING, GIVING INCORRECT SQUARE WAVE FREQUENCY OUTPUT.

FIG. C



ATTENUATION OF NOISY SIGNAL REDUCES SIZE OF NOISE COMPARED TO HYSTERESIS BAND. CORRECT TRIGGERING NOW OCCURES, GIVING SQUARE WAVE OUTPUT OF CORRECT FREQUENCY.

FIG. D



AC SIGNAL WITH LARGE DC COMPONENT DOES NOT GET COUNTED.

Fig. D The presence of a DC component in the input signal causes the AC component to miss the hysteresis band.

Fig. E Shows the effect of a blocking capacitor in series with the input. Depending upon the input signal frequency, the blocking capacitor should be chosen with as small a value of capacitance as possible that permits sufficient signal amplitude to be counted. Sprague 5GA series ceramic disc caps are ideal because they have low self inductance.

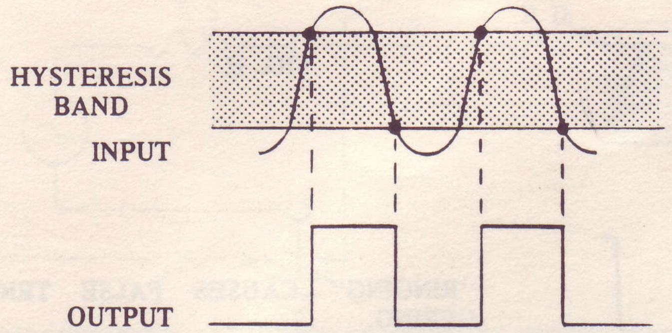


FIG. E

USE OF COUPLING CAPACITOR BLOCKS DC COMPONENT, ALLOWS AC COMPONENT TO CROSS HYSTERESIS BAND.

Harmonic distortion in the signal in Fig. F causes double counting. Increased signal amplitude prevents the double counting as shown in Fig. G.

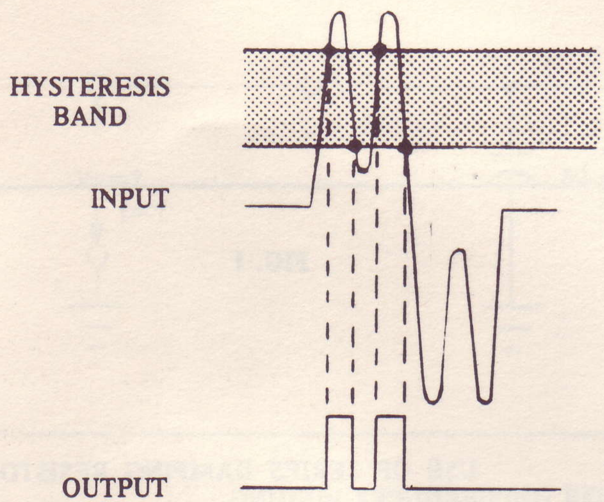


FIG. F

FIRST HARMONIC CONTENT CAUSES DOUBLE COUNTING.

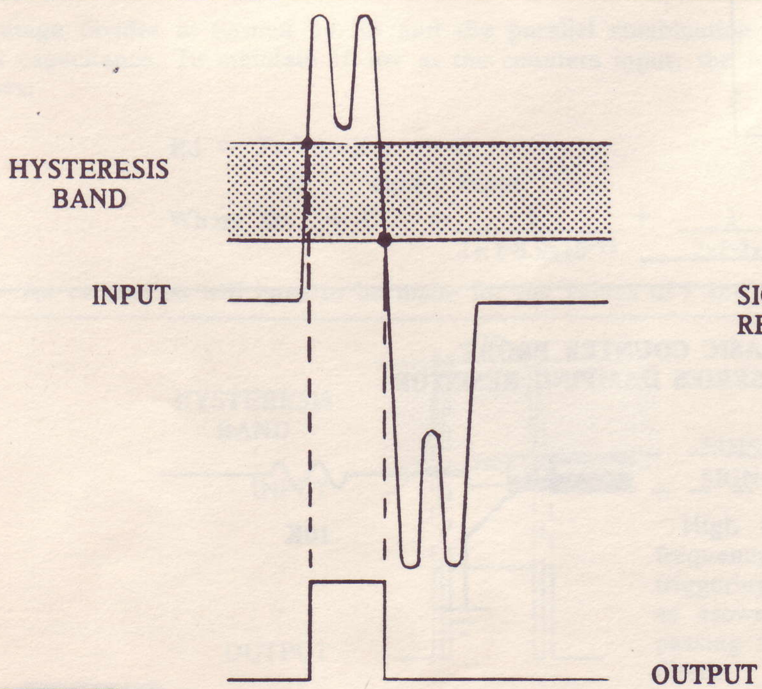


FIG. G

SIGNAL AMPLITUDE INCREASED TO REMOVE DOUBLE COUNTING.

Ringing can cause false triggering as shown in Fig. H. Fig. I shows the effect of a series damping resistor. The HI—Z frequency counter probe can be used because of its series resistance or the DC (50 Ω) probe can be used with a suitable resistor in series with the input. A 10 K ohm series damping resistor works well in many applications.

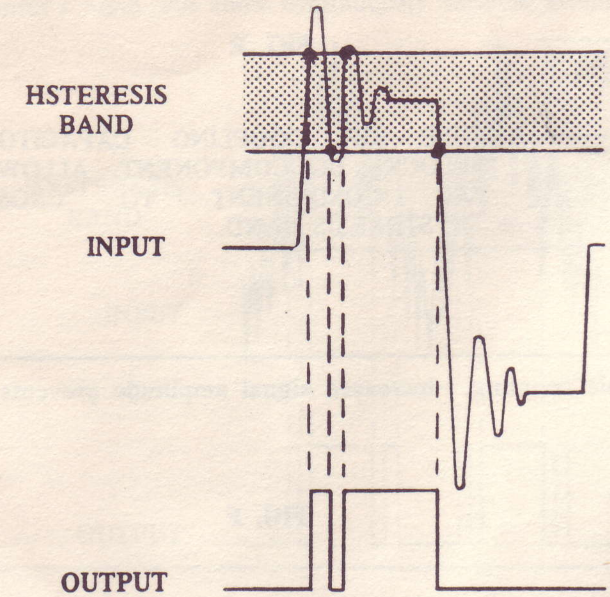


FIG. H

"RINGING" CAUSES FALSE TRIGGERING.

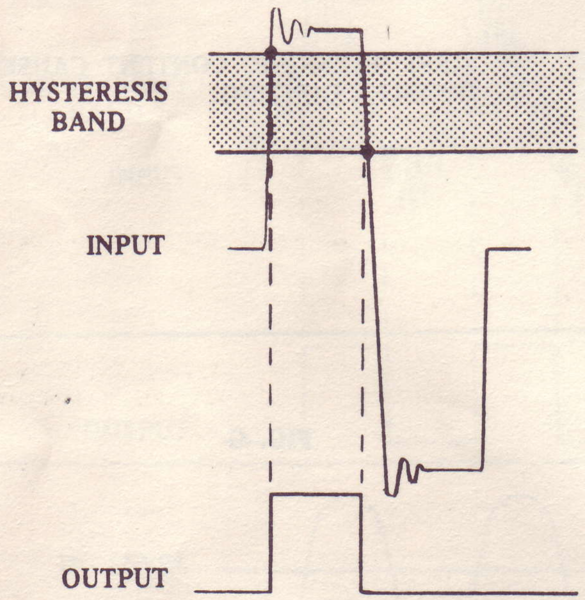
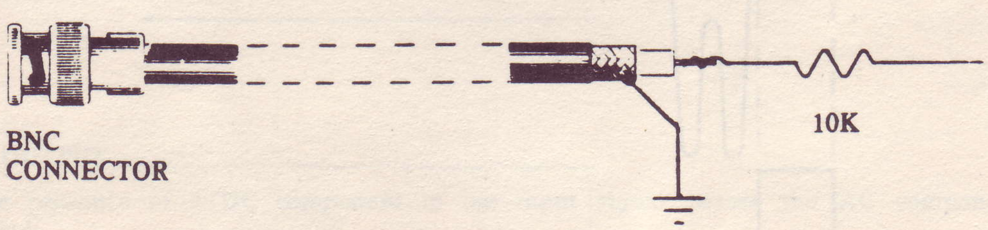


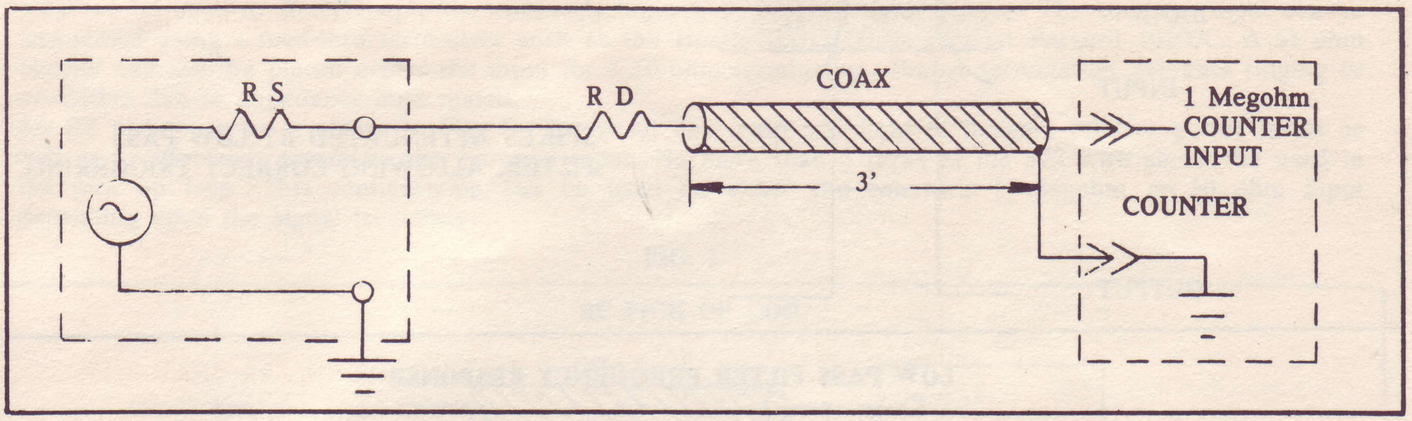
FIG. I

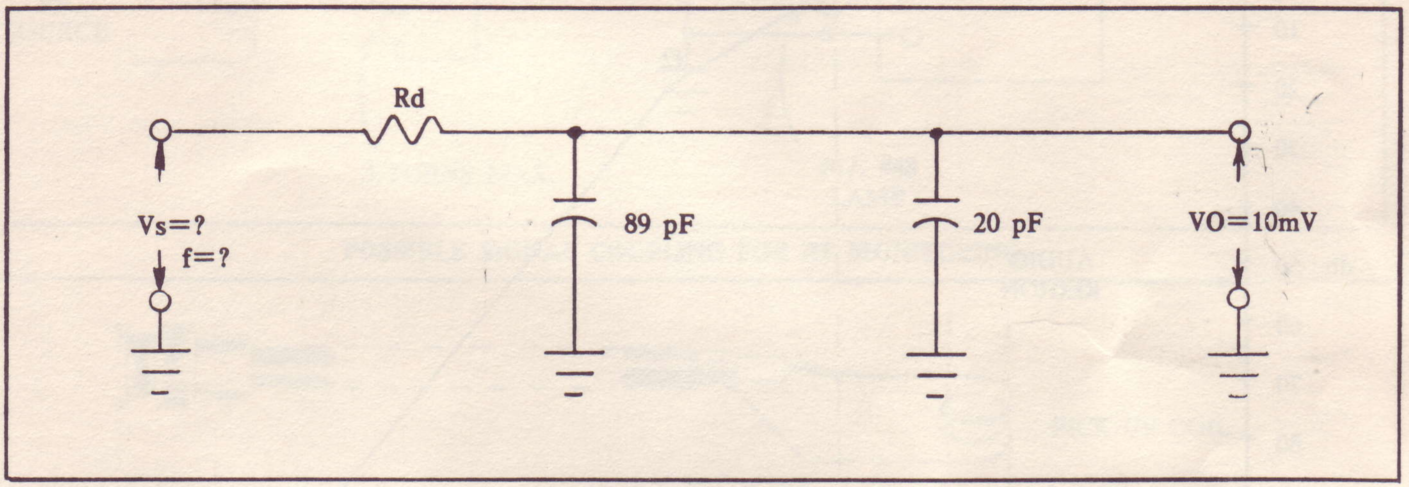
USE OF SERIES DAMPING RESISTOR REDUCES RINGING.

BASIC COUNTER PROBE WITH SERIES DAMPING RESISTOR



USE OF SERIES DAMPING RESISTOR





SERIES DAMPING RESISTOR CALCULATIONS

A voltage divider is formed by Rd and the parallel combination of the coax capacitance and the counters input capacitance. To maintain 10 mv at the counters input, the maximum value for Rd can be computed as follows:

$$Rd = \frac{Vs-Vo}{Vo} \; Xc_{coax} + C_{Input}$$

$$\text{Where } Xc_{coax} + C_{Input} = \frac{1}{2\pi f \cdot 8.9x10^{-11}} + \frac{1}{2\pi f \cdot 2x10^{-11}}$$

An estimation will have to be made for the values of f and Vs.

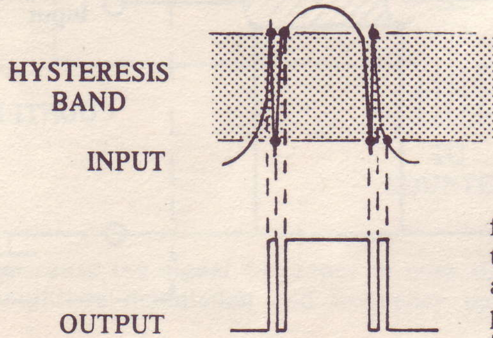


FIG. J

NOISE SPIKES ON LOW FREQUENCY AUDIO SIGNAL CAUSE FALSE TRIGGERING.

High frequency noise spikes present in low frequency (Audio) signals can cause false triggering when they transit the hysteresis band as hsown in Fig. J. Fig. K shows the result of passing the signal through a two stage low pass filter.

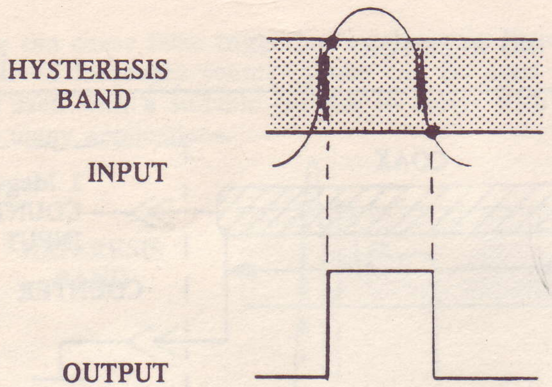
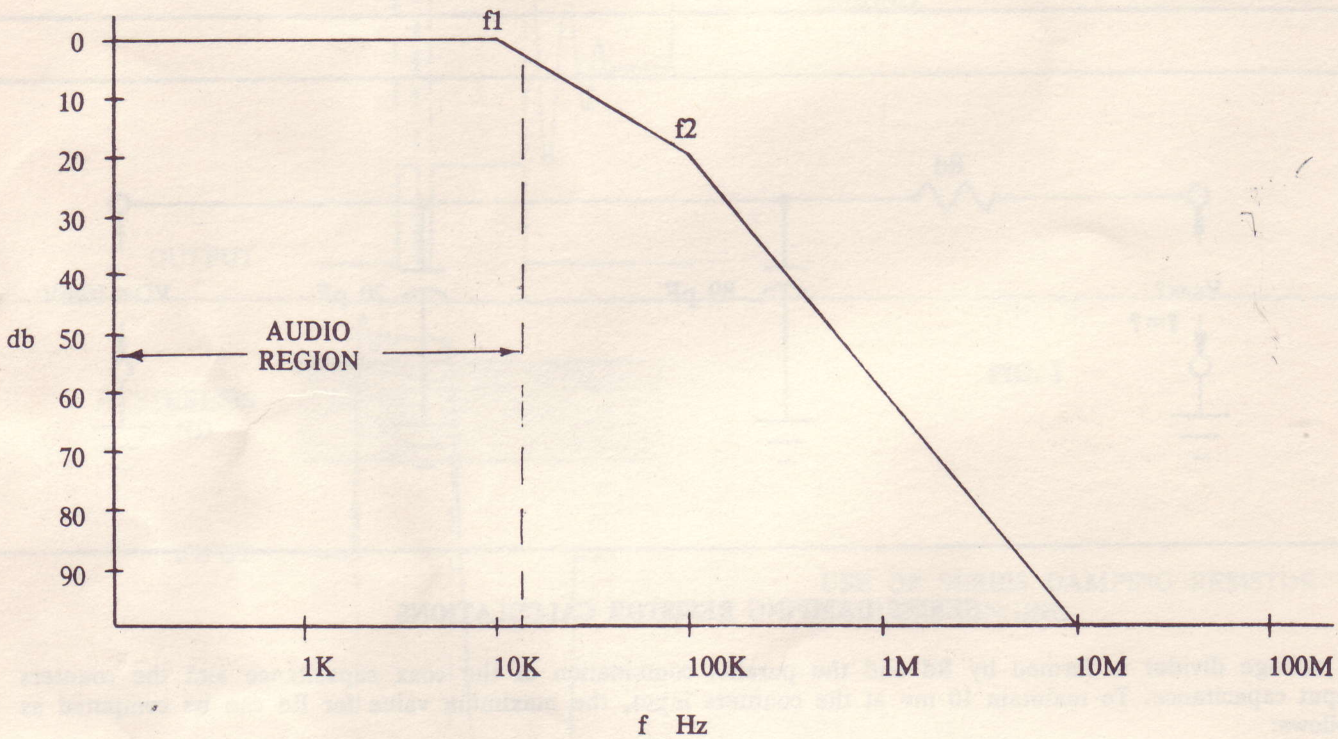


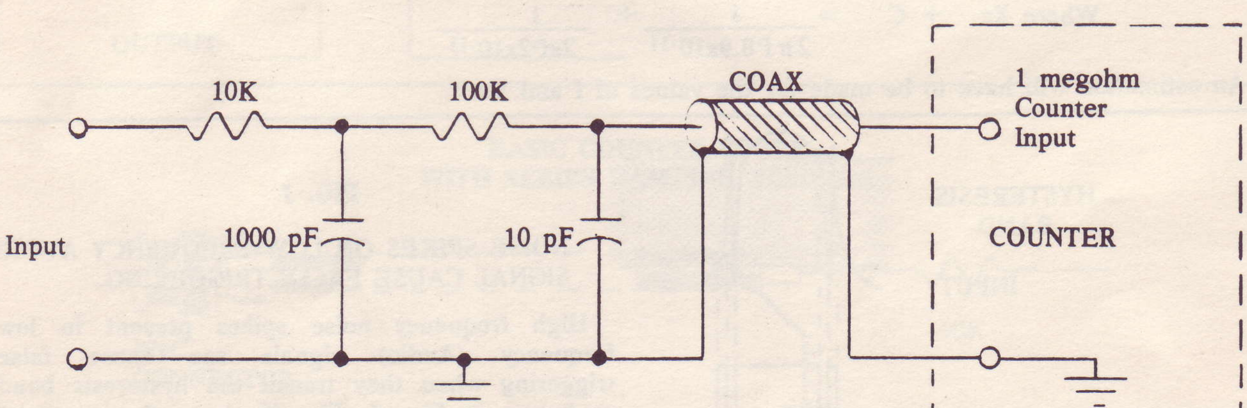
FIG. K

SPIKES ATTENUATED BY LOW PASS FILTER, ALLOWING CORRECT TRIGGERING.

LOW PASS FILTER FREQUENCY RESPONSE

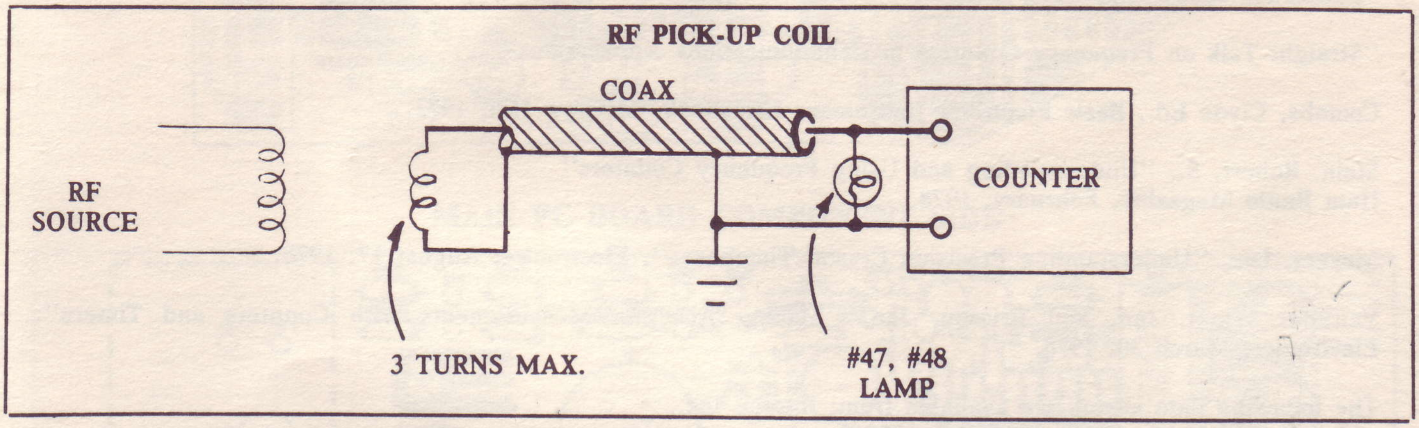


LOW PASS PROBE SCHEMATIC

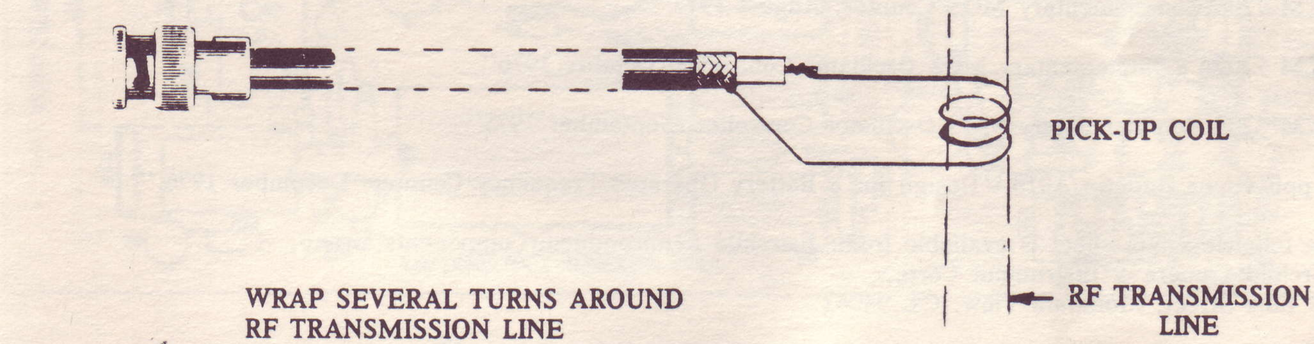


The frequency counter's input should be terminated with the characteristic impedance of the signal source when a cable is used to direct couple to the source. 50 ohms is a common value in RF work and RG58U coax can be used to direct couple the counter's input to a 50 ohm signal source. The counters input can be terminated using a feed-thru terminator such as the Heath SU511500 or Hewlett Packard 10100C. A 51 ohm resistor can also be placed across the input for a 50 ohm termination. Proper termination prevents ringing or oscillation due to impedance miss match.
An RF pickup probe is shown in Fig. L. The small #48 lamp will light to indicate relative power levels as well as to effectively terminate the counters input. No more than 3 turns of the #22 wire should be used in the pick up loop. This configuration can be used on either the counter's 1 megohm or 50 ohm input depending upon the signal frequency.

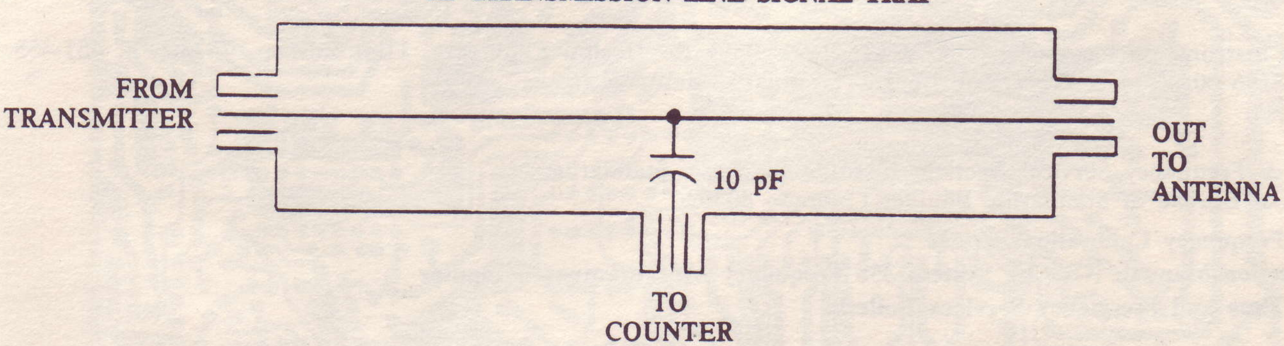
FIG. L



POSSIBLE SIGNAL COUPLING FOR RF MONITORING



RF TRANSMISSION LINE SIGNAL TRAP



AM modulation can cause the signal frequency to miss the hysteresis band as the % of modulation changes. When possible, amplitude modulation and frequency modulation should be avoid when making frequency measurements.

BIBLIOGRAPHY OF FREQUENCY COUNTER THEORY AND APPLICATIONS INFORMATION

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"ICM 7207A Complementary MOS Oscillator Controller, October 1976"

"ICM 7207 Complementary MOS Oscillator Controller, September 1975"

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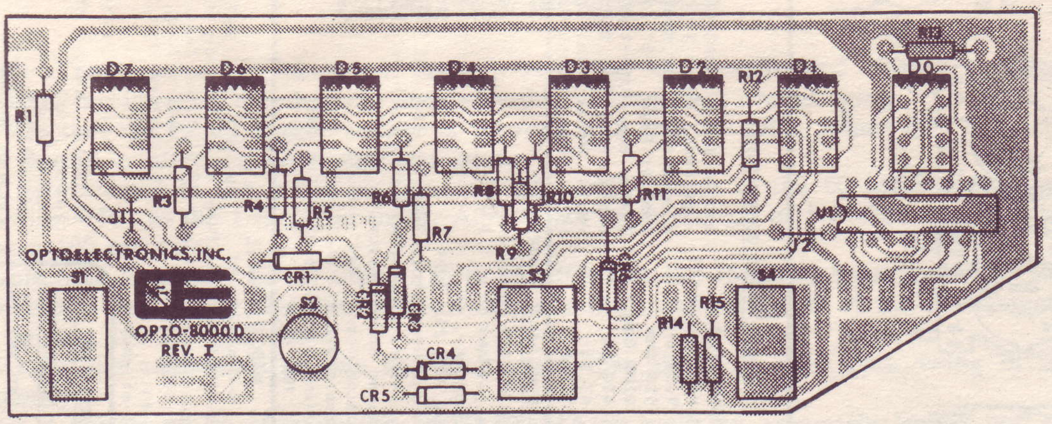
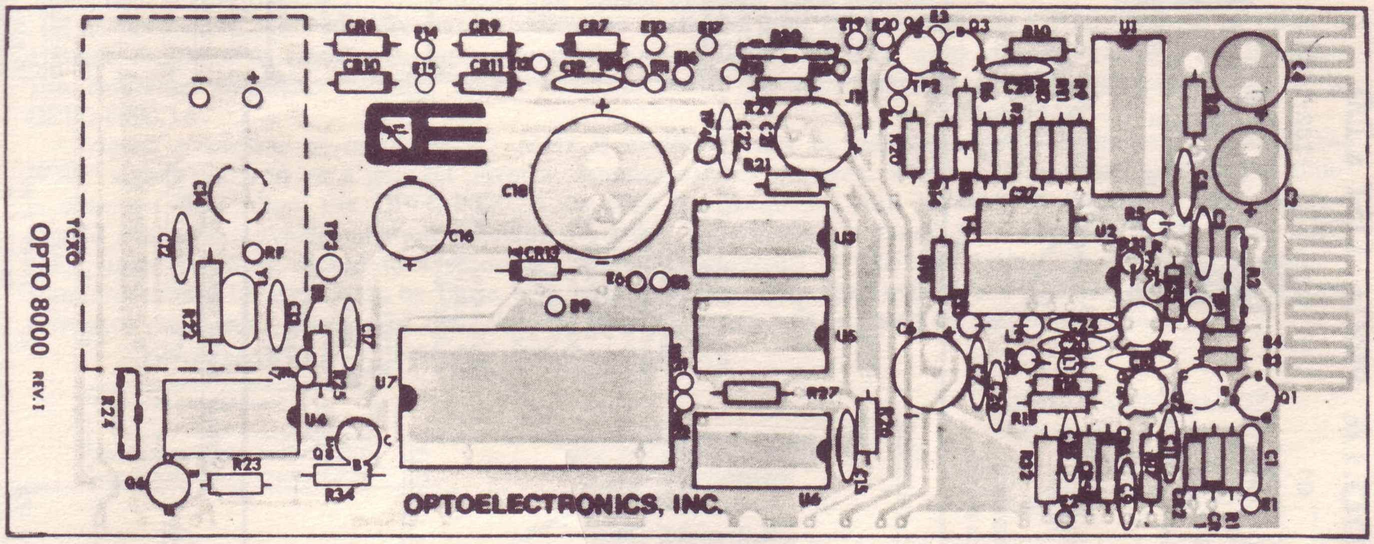
Time & Frequency Services Section, Institute for Basic Standards,
National Bureau of Standards, Boulder Colorado 80302

New Frequency Calibration Service
Instruction Manual: NBS TV System 358 Frequency Measurement Computer
NBS Time and Frequency Services Bulletin

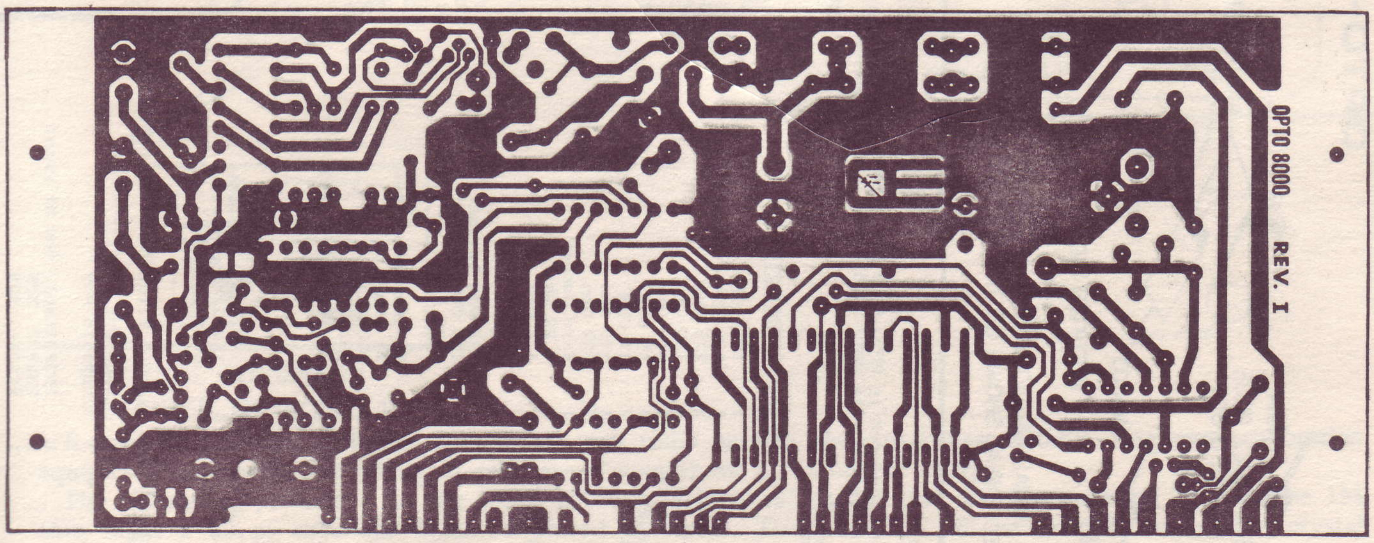
PC BOARD COMPOSITE DRAWINGS



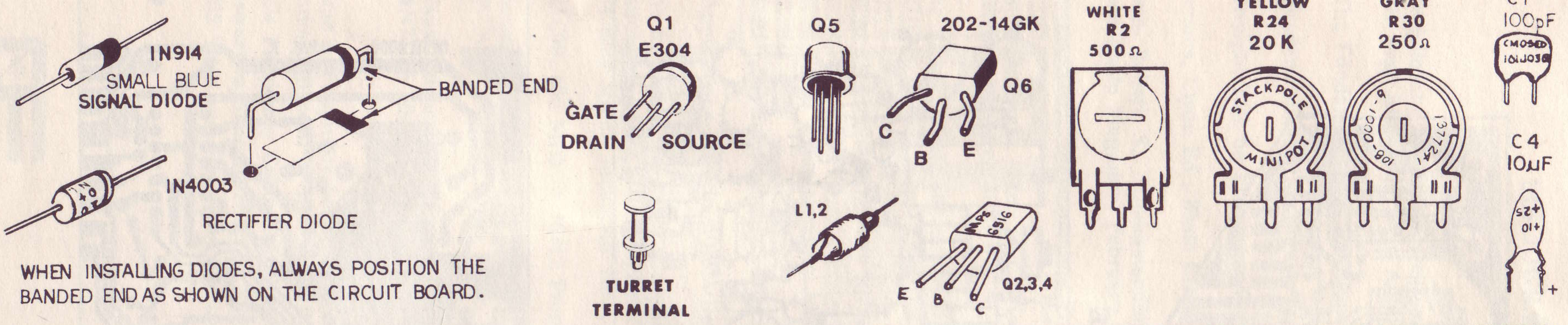
MAIN PC BOARD COMPONENT SIDE



MAIN PC BOARD SOLDER SIDE



OPTO-8000.1A PARTS LIST & I.D.



WHEN INSTALLING DIODES, ALWAYS POSITION THE BANDED END AS SHOWN ON THE CIRCUIT BOARD.

MAIN BOARD

* Parts included in OPTO-8000 REV.I only.
** Parts included in OPTO-8000.1 REV.I only.

RESISTORS

REF.	QTY	DESCRIPTION
R1	1	100K Ohm
R2	1	500 Ohm trimmer
R3,35	2	270 Ohm
R4,13,14,33	4	150 Ohm
R5,8,9,11,12	5	510 Ohm
R6,7,16,27	4	1K Ohm
R10,31	2	47 Ohm
R17	1	180 Ohm
R18	1	620 Ohm
R19	1	Wire Jumper
R20	1	1.2K Ohm
R21,36,38	3	470 Ohm
* R22	1	10 Meg Ohm
R24	1	20K Ohm trimmer
R25,23	2	12K Ohm
R26,29	2	2.2K Ohm
R30	1	250 Ohm trimmer
R32	1	15 Ohm
R15	1	110 Ohm
R34	1	680 Ohm
R37	1	19 Ohm (see text)

DIODES

CR1,2,5,6,13	5	1N914 Small Signal
CR7,8,9,10,11	5	1N4003 (or equiv.) Rectifier

TRANSISTORS (see parts I.D. for lead identification)

Q1	1	E304 FET
Q2,3,4	3	MPS6516 PNP
Q6	1	2N3904(sel. for Hi gain)
Q7,5	2	2N2857 NPN
Q8	1	2N2369 NPN

MAIN BOARD continued

REF.	QTY.	DESCRIPTION
INDUCTORS		
L1,2	2	8.2 uHy
CAPACITORS		
C1	1	100pF(101J03) Dipped Mica
C6,16,21	3	100uF PC Mount
C3,5,7,9,10,20,24,25,26,28,30-11		.001uF Disc
C4	1	10uF Tantalum
C11	1	470pF Disc
*C12	1	30-to-33pF Disc
*C13	1	20-to-22pF Disc
*C14	1	2-30pF Trimmer
C15	1	.1uF Disc
C17,19,22,8	4	.01uF Disc
C18	1	2200uF PC Mount
C27	1	47uF Axial Lead
C29	1	5pF Axial Lead
C2	1	47uF PC Mount
INTEGRATED CIRCUITS		
U1	1	MC10116
U2	1	11C90
U3	1	74LS00
U4	1	7207A
U5	1	7432 or 74LS32
U6	1	74196
U7	1	7208

DISPLAY BOARD COMPONENTS

RESISTORS	QTY	DESCRIPTION
R1,13	2	100 Ohm
R3 thru R12	10	10 Ohm
R14,15	2	1K Ohm
DIODES		
CR1 thru CR6	6	1N914 Type. Small Sig.

DISPLAY BOARD CONTINUED

DISPLAYS	QTY	DESCRIPTION
D0 thru D7	8	FND 357/359
I.C.'s		
U1	1	CD4511

MISCELLANEOUS

16 PIN SOCKET
OPTO-8000-D REV. I PC Board

FRONT PANEL COMPONENTS

1 —— Switch, DP3T Slide
2 —— Machine Screws, 4-40x1/8
1-RS3-Resistor, 9.1K Ohm
1-RS2-Resistor, 91K Ohm
1-RS1-Resistor, 910K Ohm
1-CS3-Disc Cap, 470 pf
1-CS2-Disc Cap, 47 pf
1-CS1-Disc Cap, 2.0pF
1 Jumbo Red Discrete LED
1 LED Panel Mount (2 Pcs.)
2 Connectors, BNC #UG1094
2 Solder Lugs, 3/8"
3 Nuts, Hex, Mini-toggle
2 Nuts, Hex, Push Button
3 Nuts, Dress, Mini-toggle
1 Nut, Dress, Pushbutton

REAR PANEL COMPONENTS

1	Fuse Holder, 3AG
1	Fuse, 1 AMP
1	Recepticle, AC
1	Jack, DC, Pin Type
1	Voltage Regulator, 7805 UC, Ref. U8
1	Insulator, Mica w/heat sink compound
1	Machine Screw, Nylon, 6-32 x ½"
2	Machine Screw, Self-tap, #2
1	Transformer 117 VAC 10VAC
4	Machine Screws, 6-32 x 3/8" Blk
5	Nut, Hex 6-32

MISCELLANEOUS

6 Mach. Screw, 4-40x1/2", FH
1 AC Line Cord w/Molded input Plug
16 Mach. Screw, 4-40x1/4" blk, FH
4 Mach. Screw, 6-32x5/8"
6 Nut, Hex, 4-40
1 Bumper, Self-stick
4 Nut, Hex, 6-32
4 Lockwasher, #6
2 Cabinet Feet, Rear
1 Cabinet Foot, LF
1 Cabinet Foot, RF
1 Bail
1 Disc Cap, 82pF (KIT ONLY)
2 Brackets, Cabinet R&L
1 Panel, Front
1 Panel, Rear
1 Cabinet Top
1 Cabinet Bottom
18" Stranded Hook-up Wire
2" Small Heat-shrink Tubing
1½" Large Heat-shrink Tubing
1 Plug, Male, DC PIN Type
3' 2 Conductor Power Cord
5 Turret Terminal

OPTO-8000.1A FREQUENCY COUNTER

CALIBRATION INSTRUCTIONS

The TCXO (Temperature Compensated Crystal Oscillator) is precalibrated during the manufacturing process. In time recalibration may become necessary due to long term crystal aging.

Check to see that the circuit supply voltage is between 5.25 and 5.9 volts. Adjust R30 if necessary but do not readjust during or after the calibration sequence.

With the gate control in the 1 sec position and the range switch in the 60 MHz position, connect the oscillator output, TP3, to the 1 megohm input. Adjust R24 for a display of 5.242880 with a 1 sec gate and 5.24288 with a 100 ms gate.

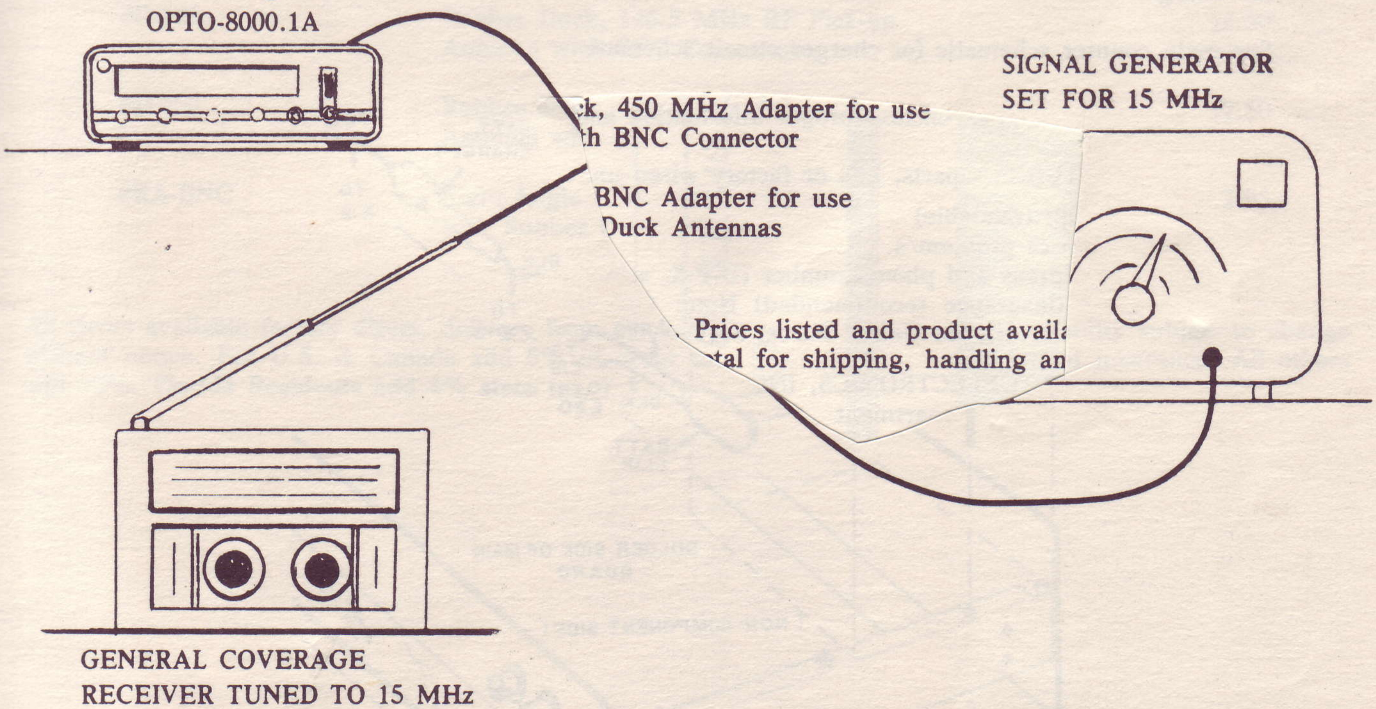
Use a stable high frequency signal source (15 to 60 MHz into the 1M Ohm input or 150 to 600 MHz into the 50 Ohm input) and adjust R24 for identical displays (with the exception of the least significant digit) with the 1 sec and 100 ms gate times.

The TCXO has an adjustment on one end of its case that allows a + 10 ppm swing in the oscillator output frequency.

Calibration is performed by allowing the OPTO-8000.1A to count an accurately known and stable signal (preferable between 3 MHz and 50 MHz) and adjusting the TCXO until the known frequency is displayed. The 1 Megohm/60 MHz input and the 1 sec gate position should be used for maximum resolution. A nonmetalic screwdriver or TV alignment tool should be used when adjusting.

If an accurately calibrated frequency counter is available then allow it and the OPTO-8000.1A to measure a stable oscillator or signal generator output. Adjust the OPTO-8000.1A until identical reading are obtained. The reference frequency counter should have at least the same number of digits of resolution as the OPTO-8000.1A.

A signal generator or oscillator (15 MHz if available) can be adjusted for a "zero beat" against the WWV signal received on a general purpose communications receiver. When a "zero beat" or "meter null" is obtained then allow the OPTO-8000.1A to read the frequency and adjust C14 for the correct display. Figure 2 shows a typical calibration setup. A color TV set that is tuned to a network (CBS, NBC, ABC) color signal is phase locked to a secondary frequency standard of 3.579545 MHz. The colorburst frequency standard should be used only by those who have experience working with live TV set chassis. An additonal reference concerning the use of the color TV frequency standard is listed in the bibliography.



It may be possible to locate a local two-way radio service shop that has suitable frequency calibration equipment and would be willing to calibrate a counter for a reasonable charge.

The calibration procedure for the OPTO-8000.1A is identical except that when connecting TP-3 to the 1M ohm input a 82 pf capacitor must be placed in series. Trimmer C14 will be used to adjust the crystal oscillator.

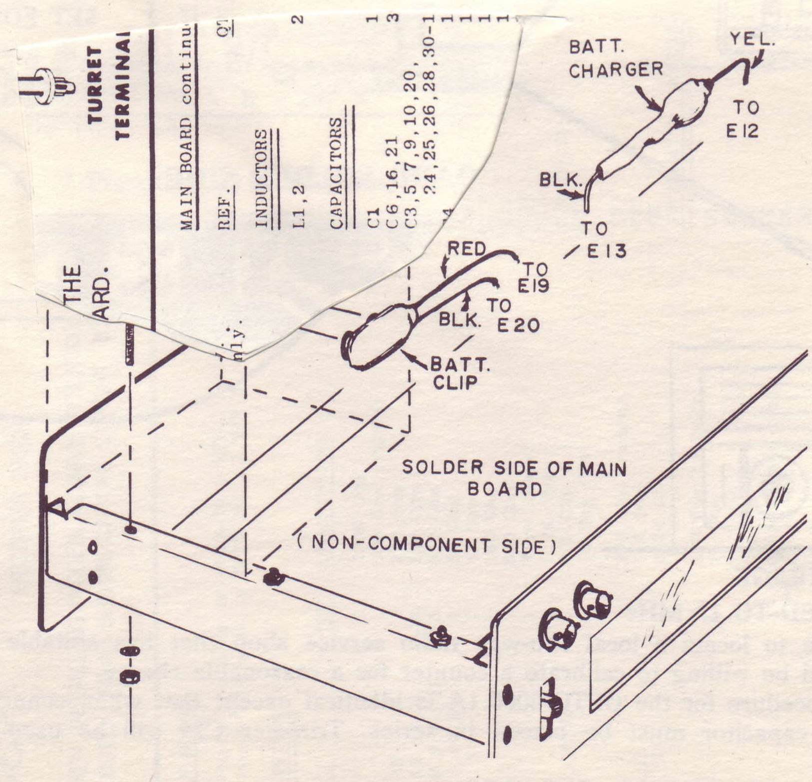
NI-CAD-80
BATTERY PACK AND CHARGER CIRCUIT INSTALLATION

INSTALLATION:

1. Remove (4) screws from each side of the unit and remove the top and bottom covers.
2. Referring to the illustration below, install the #2 machine screw through the battery holder so that the head is on the inside of the holder. It is recommended to place a piece of plastic electrical tape over the screw head and a piece around the battery that will be installed over the screw. This is a precaution against any possibility of the screw head shorting to the battery case.
3. Now install the batteries as indicated inside the holder, making sure the taped battery is over the screw head.
4. Wrap the battery pack with strong tape, such as filament tape, to ensure positive battery contact at all times. (see illustration)
5. Install the battery pack as shown, inserting the screw up through the bottom of the side rail and applying the washer and hex nut. **DO NOT OVER-TIGHTEN!**
6. If the battery holder supplied has wire leads, instead of snaps as shown, solder the red wire in main board location "E19" and the black wire in "E20". If a battery clip is supplied, solder it's red and black wires as just stated. (see illustration)
7. Install the battery charger circuit as shown. Charger circuit may be mounted on either the component side or the solder side of the main board. Solder both leads.
8. Remove R29 from the main PC board.
9. If battery clip was supplied, snap it to the battery pack at this time.
10. Replace top and bottom covers and secure with (8) F.H. screws removed.

NOTE: Batteries will charge from AC or DC input power when counter is turned off. Full charge will take from 12 to 16 hours and should power the counter for up to two hours of continuous operation from full charge.

See main counter schematic for charger circuit schematic.



OPTO-8000.1A FREQUENCY COUNTERS, ACCESSORIES AND OPTIONS

#OPTO-8000.1A	Factory Assembled Counter	$329.95
#OPTO-8000.1A K	Counter Kit	279.95
OPTIONS		
#Ni-Cad-80	Rechargeable Battery Pack (with charge Circuitry)	19.95
220VAC	Optional Transformer for 220VAC or 110VAC 50/60 Hz Operation	10.00
ACCESSORIES:		
#P-100	Probe, 1X Direct Connection 50 Ohm	13.95
#P-101	Probe, Lo-Pass Attenuates RF Noise	16.95
#P-102	Probe, HI-Z 2X General Usage	16.95
#P-103K	Probe Kit, BNC to Mini - Gator Clips	3.95
#D-146	Rubber Duck, 146.5 MHz RF Pick-up Antenna with BNC Connector	12.50
#D-450	Rubber Duck, 450 MHz Adapter for use Antenna with BNC Connector	12.50
#RA-BNC	Right-Angle BNC Adapter for use with Rubber Duck Antennas	2.95

All items available factory direct, delivery from stock. Prices listed and product availablity subject to change without notice. For U.S. & Canada add 5% of order total for shipping, handling and insurance. All others add 10%. **Florida Residents add 4% state tax.**