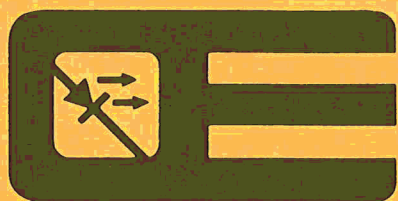


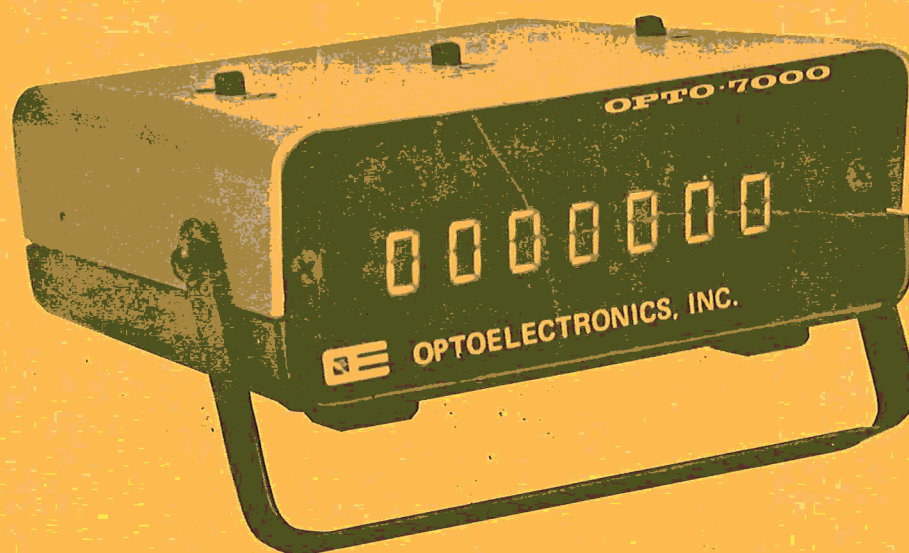
\$3⁹⁵



OPTOELECTRONICS, inc.

MODEL OPTO-7000

Owners Manual

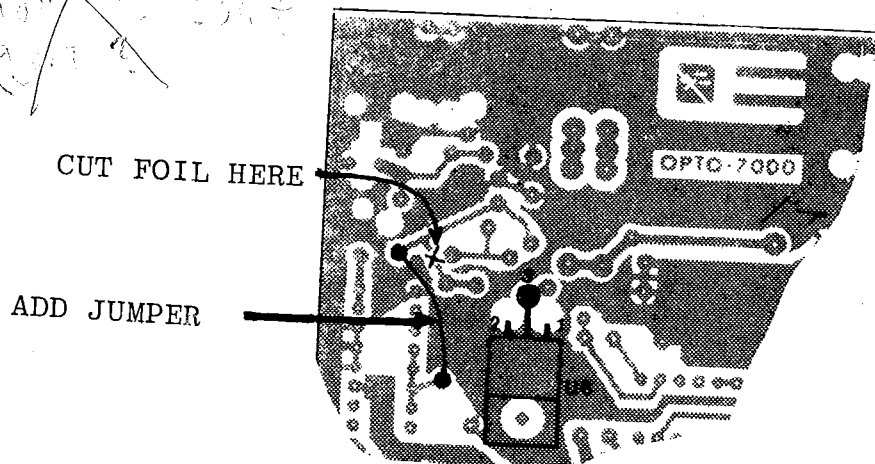


**MINIATURE 600 MHz
FREQUENCY COUNTER**

AC • DC • PORTABLE

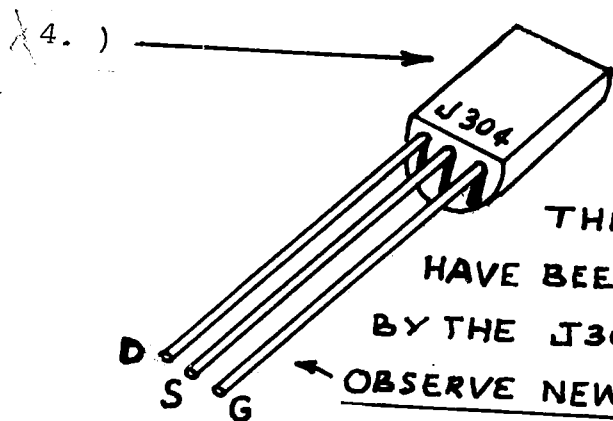
OPTO-7000 ERRATA SHEET

- 1.) Cut the PC foil where indicated in the diagram below and add the jumper wire as shown.



- 2.) The schematic has an "E1" as the input connection from the 1M Ω connector, this should be labeled "E2".

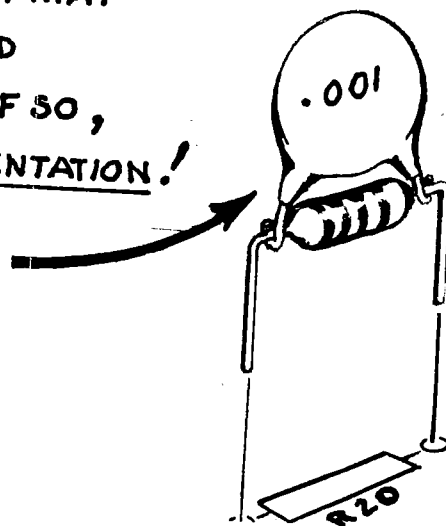
- 3.) Transistor Q1 (2N2857) may be substituted by a 2N5179 in the parts supplied.



NOTE:

THE E304 FET MAY
HAVE BEEN REPLACED
BY THE J304 FET. IF SO,
OBSERVE NEW LEAD ORIENTATION!

- 5.) Your kit has been supplied with an extra .001 mF disc capacitor. Before installing R20 (Step 4.3), solder the extra capacitor to R20.



OPTO-7000 FREQUENCY COUNTER

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OPTOELECTRONICS, INC.

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

OPTO-7000 FREQUENCY COUNTER SPECIFICATIONS

Frequency Range: (Switch Selectable)	10 Hz to 60 MHz (65 MHz Typical) 10 MHz to 600 MHz Guaranteed (10 MHz to 700 MHz Typical)
Input Impedance:	1 megohm shunted by 20 pf (60 MHz input) 50 ohm (600 MHz input)
Input Protection:	1 megohm/60 MHz input - 100V up to 10 MHz 50V up to 60 MHz 50 ohm/600 MHz input - 2V max.
Gate Times: (Switch Selectable)	100 milisecond (1/10 second) 1 second
Resolution:	* 1 Hz (10 Hz to 6 MHz) with switch (S4) Option 10 Hz (10 Hz to 60 MHz) 100 Hz (10 MHz to 600 MHz)
Sensitivity:	<10 mV to 60 MHz 25 mV to 150 MHz 50 mV 450 MHz typ. (<75 mV Guaranteed)
Time Base:	Quartz Crystal, 5.24288 MHz, TCXO, first order linear compensation
Counter Accuracy:	± 1 count, Temperature stability and aging
Temp. Stability:	.08PPM/C° (< ± 1 PPM 20° to 40°C, Typ.)
Aging:	<2 PPM/year
Display:	7, .4" Red LED Digits
Decimal Point:	Auto Placement
Power Requirement:	1.5 Watts 7.5 - 15V AC/DC < 250 ma
Batteries:	* 4 - AA Ni-Cad, Constant Current Charger
Size:	1-3/4"H x 4-1/4"W x 5-1/4"D
Weight:	14 oz. (17 oz. with batteries & charger)

* Optional - not included with basic unit

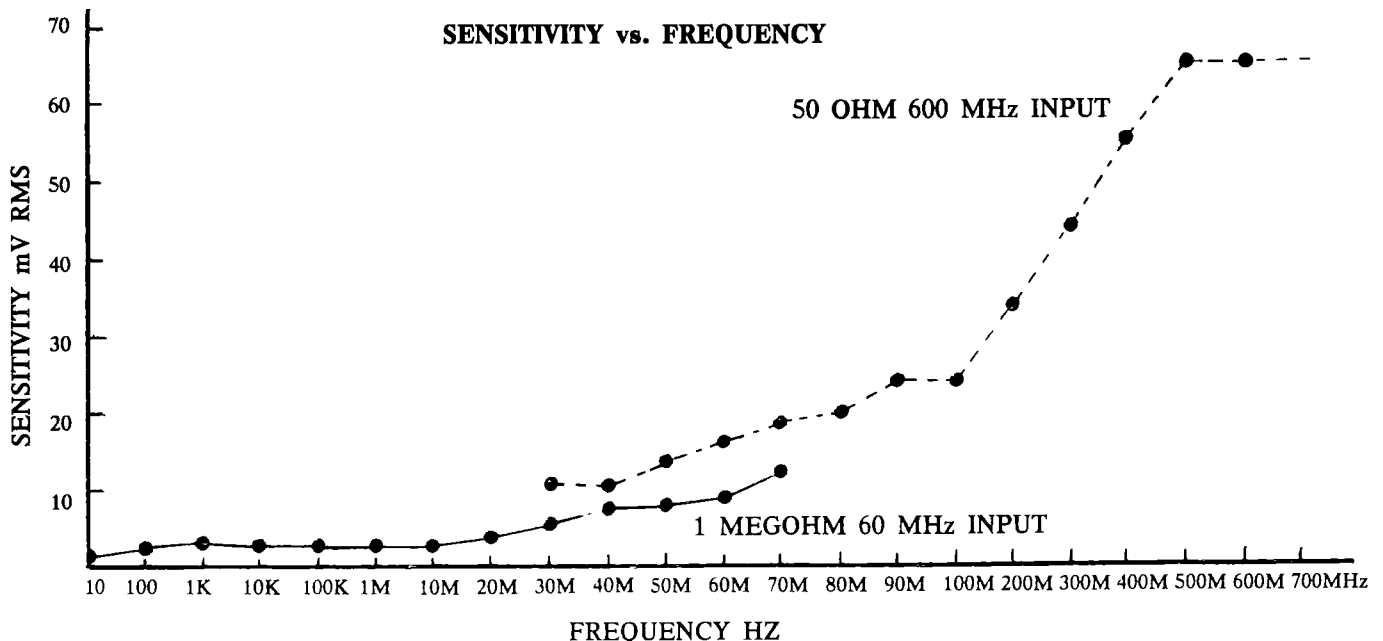


OPTO-7000

CONTROLS

POWER	ON OFF	<p>“On” position applies power to circuit. “Off” position removes circuit power and charges internal Ni-Cads if option #NI-CAD-70 has been installed.</p>
RANGE	60 MHz 600 MHz	<p>In “60 MHz” position, signals between 10 Hz and 60 MHz that are coupled to the “1 MEG 60 MHz” input connector are counted. In “600 MHz” position, signals between 10 MHz and 600 MHz that are coupled to the “50 OHM 600 MHz” input connector are counted.</p>
GATE	1 SEC 100 MS	<p>Gate refers to the period of time in which the counter counts the input signal. In the “1 SEC” position a new count is displayed every two seconds. In the “100 MS” position a new count is displayed every 200 milliseconds. Maximum resolution is obtained with the 1 SEC gate time while the 100 MS gate allows changes in frequency to be more quickly displayed.</p>
REAR PANEL POWER INPUT CONNECTOR		<p>7.5 to 15 volts AC or DC can be applied through the power connector to power the OPTO-7000. The bridge rectifier input makes it unnecessary to observe polarity. A 1/2 AMP inline fuse should be used when operating from automotive 12V systems. A mating pin type power plug and cord is supplied with the OPTO-7000.</p>
OPTIONAL Hz/MHz SWITCH [S-4]		<p>Rear panel switch allows 1 Hz resolution on signals between 10 Hz and 6 MHz applied to the “1 Megohm, 60 MHz input”.</p>

Decimal point in display should be disregarded when operated in the “Hz” position.



THEORY OF OPERATION

HOW IT WORKS

The unit of frequency measurement is the Hertz which is equivalent to cycles per second. The basic digital frequency counter employs a precisely generated gate interval in conjunction with an electronic counter which counts cycles of the input signal during the period of time in which the gate is open. If the gate period is 1 second then the number displayed is cycles per second. If the gate period is .1 seconds then we correct the count by multiplying the number displayed by 10 (move the decimal point one position to the right).

THE COUNTER

The OPTO-7000 block diagram is shown in Fig. 1. The gate and the decade counter are located inside the 7208 I.C. The gate signal is generated by the 7207A I.C. which divides the crystal oscillator frequency to obtain either a 2 second or .2 second square wave. The gate signal is low for either 1 second or .1 second which enables the gate to transmit the input signal to the counter. As the gate signal goes from low to high to close the gate, a store pulse is generated by the 7207A which causes the contents of the counter to be transferred to the latch and then displayed. A reset pulse follows the store pulse to reset the counters to zero to be ready for the next negative gate interval.

PRESCALER

The maximum signal frequency which the 7208 can handle is between 6 and 7 MHz. In order to count higher frequencies the input signal must be prescaled or divided. The 74196 I.C. generates a BCD output and we utilize the 2² bit to drive transistor inverter Q5 (see schematic) to obtain a 60/40 duty cycle square wave that the 7208 counter likes.

In order to count frequencies as high as 600 MHz the 11C90 ÷ 10 UHF prescaler is used so that the input signal is divided by 100 before reaching the 7208 counter. The decimal point location is switched to indicate the 1 MHz position when the input signal is divided by 10 or 100 and the gate period is 1 second or .1 second.

INPUT AMPLIFIERS

Dual inputs and amplifiers are used for the 10 Hz to 60 MHz and the 10 MHz to 600 MHz ranges. Both inputs utilize back to back signal diode clamps for over voltage protection.

The 1 megohm (60 MHz) input employs an FET/Bi-Polar pair to achieve high input impedance, low output impedance, with a small amount of voltage gain. Resistor Rx is matched with the FET to set the voltage at Pin 9 to ½ the supply (2.3 to 2.7 volts). The MC10116 is an ECL (Emitter Coupled Logic) triple line receiver. The first two stages are connected as differential input/output amplifiers while the third stage has positive feedback to act as a Schmitt trigger to square up the wave form. Q4 (MPS6516) converts the ECL logic levels to TTL.

Several low cost frequency counters on the market today economize by having less than 1 megohm input impedance on their low frequency (less than 60 MHz) range. The advantages of having 1 megohm input impedance are well worth the additional parts cost. The counter's input impedance is seen as a load by the circuit being measured. An oscillator may shift frequency or stop when loaded by only a few thousand ohms. Oscilloscope accessories such as 10:1 probes and terminators can be used because most scopes have 1 megohm inputs. The counters input impedance can always be lowered to match source impedance by using a terminator or adding shunt impedance but it is not as easily increased.

The 11C90 prescaler IC has good sensitivity (typically about 200 mV) without preamplification. Foregoing once again the dictates of economy, it was decided that the OPTO-7000 should have at least one stage of preamplification in order to meet a wider range of applications. A 2N5179 (or 2N2857) NPN RF amplifier is used in a common base configuration to provide voltage gain all the way to 600 MHz. The PC layout is critical at high frequencies and good soldering techniques are important. The ceramic disc capacitors used should have low self inductance such as the Sprague 5GA series. Component leads must be kept as short as possible to prevent attenuation due to lead inductance.

If you don't expect to be counting frequencies above say 450 MHz then additional sensitivity and significant power savings can be achieved by lowering the supply voltage to the 11C90. Resistor R6 can be increased until the counter will count 450 MHz but no higher. The 11C90 will operate with as little as 3.5 volts and the only sacrifice is band width.



At very high frequencies, a high input impedance can not be maintained. The reactance of shunt capacitances in coax input cables is low at high frequencies (80 ohm for 20 pf shunt capacitance at 100 MHz). A nominal 50 ohm input impedance is therefore used on the 600MHz input.

TIME BASE

A frequency counter's accuracy is a function of its time base stability. The quality of the quartz crystal used is of paramount importance. The cheap and readily available color burst T.V. crystal (3.579545 MHz) was found unsuitable as a counter time base. Color burst crystals are manufactured to a very loose specification (in a T.V. set they are phase locked to the network signal). While suitable color burst crystals can be outsourced they still have what crystal manufacturers refer to as "glitches". When temperature cycled they behave erratically and depart from a smooth temperature/frequency curve.

The 7207A time base generator is designed to use a 5.24288 MHz crystal. This frequency falls within the inherently stable 4 to 10 MHz range for quartz crystals. The crystal used in the OPTO-7000 counter is guaranteed to meet or exceed 5ppm stability from 20° to 60°C. The industry spec for the color burst crystal is 30 ppm from 20° to 60°C. Over the more realistic range of 20° to 40°C the typical stability of the OPTO-7000's crystal is on the order of 1 ppm and .5 ppm close to room temperature. The oscillator employs first order linear temperature compensation in order to improve temperature stability over the crystal specs. Each crystal's temperature frequency curve is plotted and a pair of temperature compensating caps are selected to provide compensation. Good long term stability is achieved by pre-aging the crystal. The color burst crystal is not pre-aged and will drift typically 1 ppm/month. The 7207A generates all clock signals as well as the display multiplex frequency, thus saving at least two additional I.C.'s that would be required with the color burst crystal.

POWER SUPPLY

The power supply input is a full wave bridge rectifier and can handle 7.5 to 15 volts AC or DC. The bridge output is filtered with a 2200 uf capacitor (no economy here either) and regulated by a 7805 IC. R1 adjusts the regulator output to 5.25 volts. The internal Ni-Cads are charged when the power switch is in the "OFF" position. The 50 ma charger consists of a 78L05 voltage regulator IC in a constant current source configuration. The supply is bypassed in critical circuit areas with ceramic disc or electrolytic capacitors.

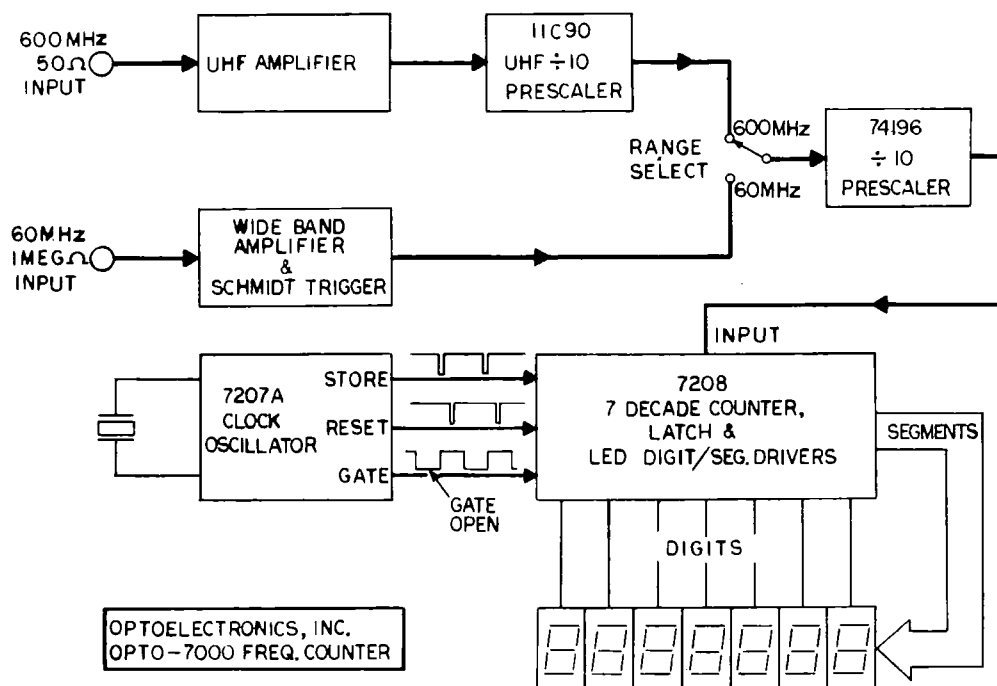
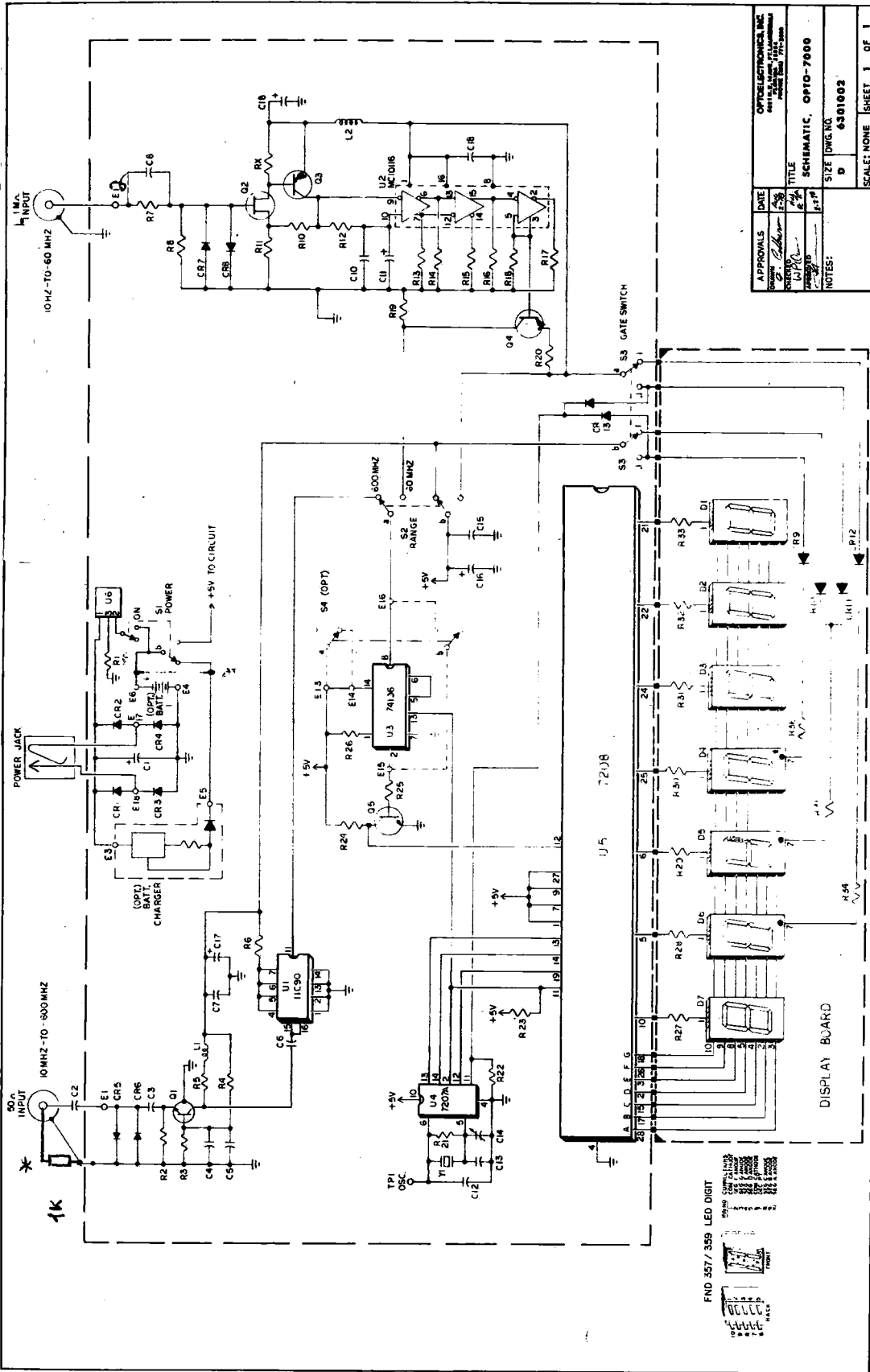


FIG. 1
BLOCK DIAGRAM



* Monterat pga. ustabilitet i VHF-ingångströmmen



APPROVALS	DATE	BY	TITLE
			SCHEMATIC, OPTO-7000
			SIZE DWG. NO.
			D 6301002
NOTES:			SCALE: NONE SHEET 1 OF 1

Q3 o3 04 er PNP transistorer (MPS 6516)



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 circuit 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 unwary. 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 luxury 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 characteristics 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 circuit 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.

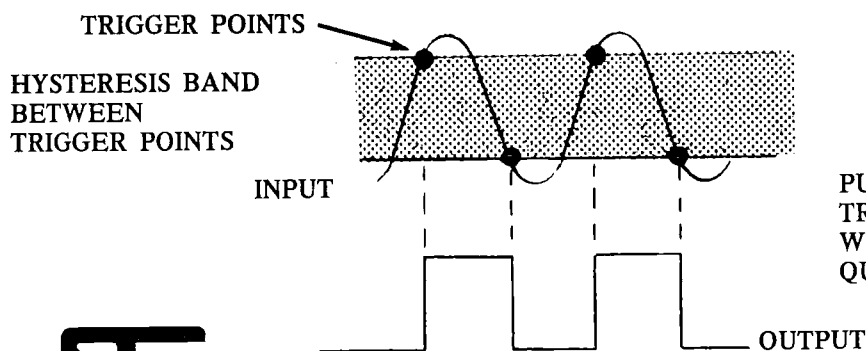


FIG. A

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.

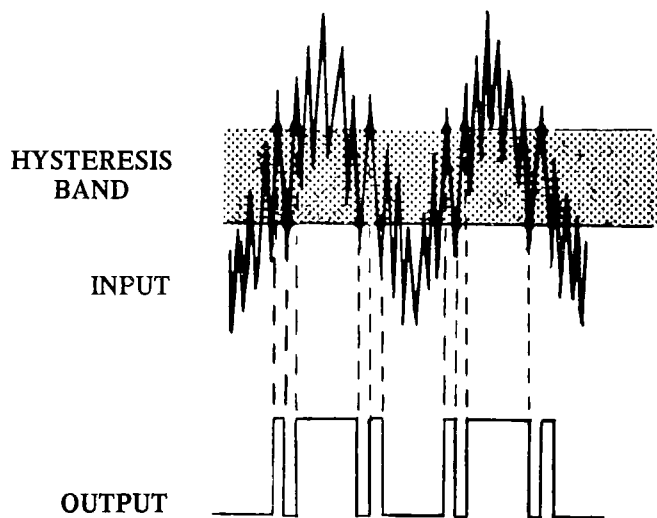


FIG. B

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

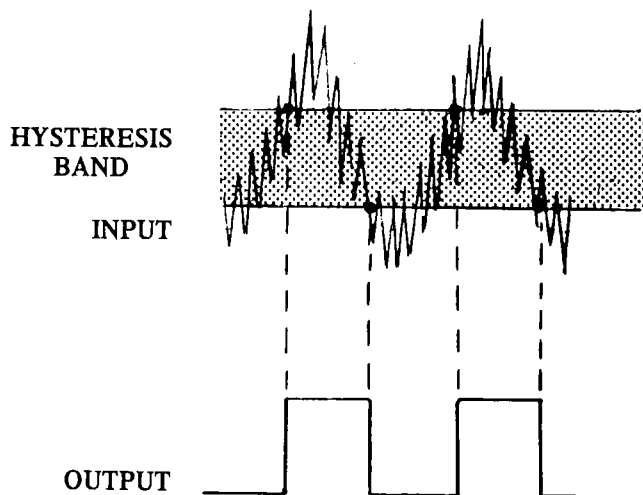


FIG. C

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

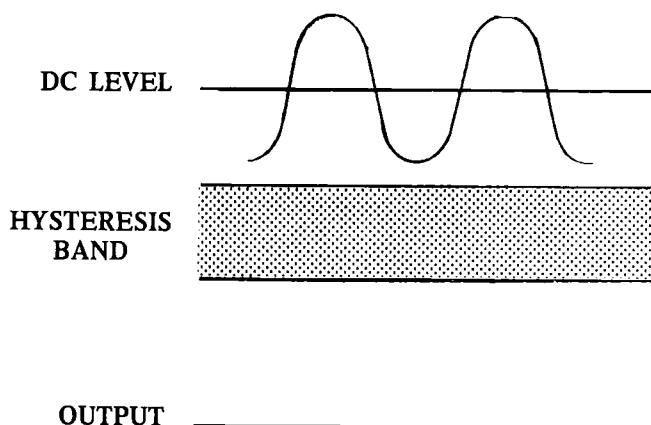


FIG. D

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.

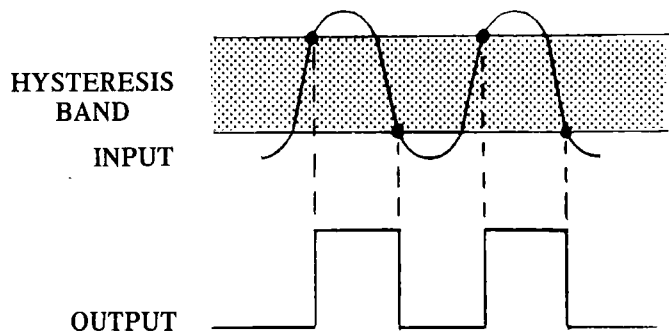


FIG. E

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.

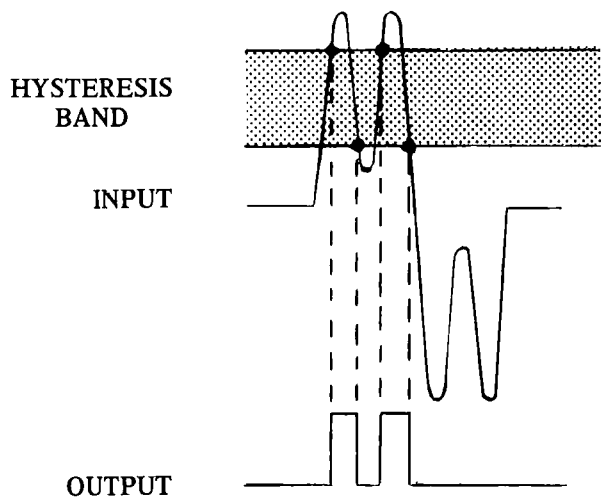


FIG. F

FIRST HARMONIC CONTENT CAUSES DOUBLE COUNTING.

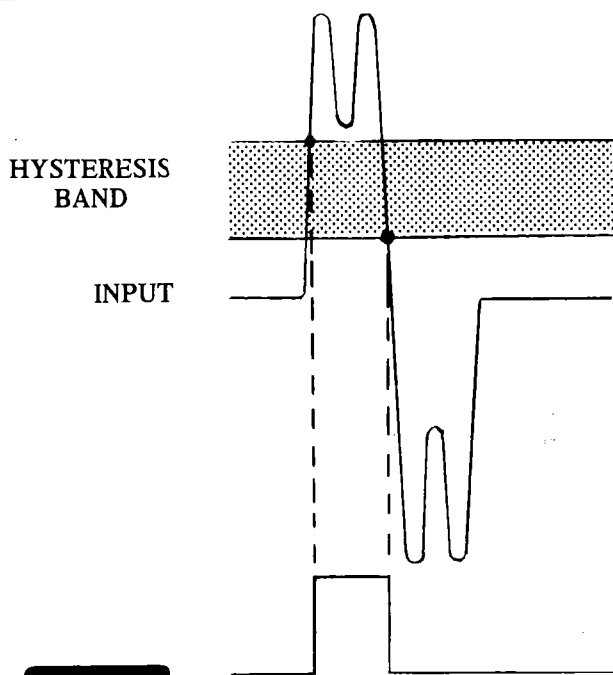


FIG. G

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.

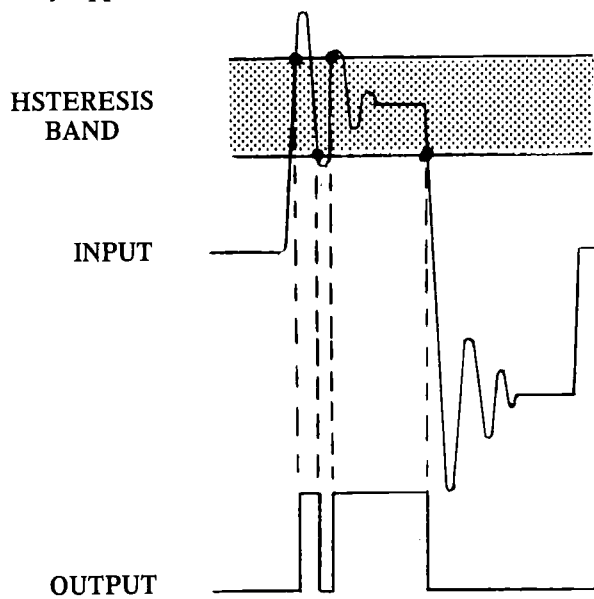


FIG. H

"RINGING" CAUSES FALSE TRIGGERING.

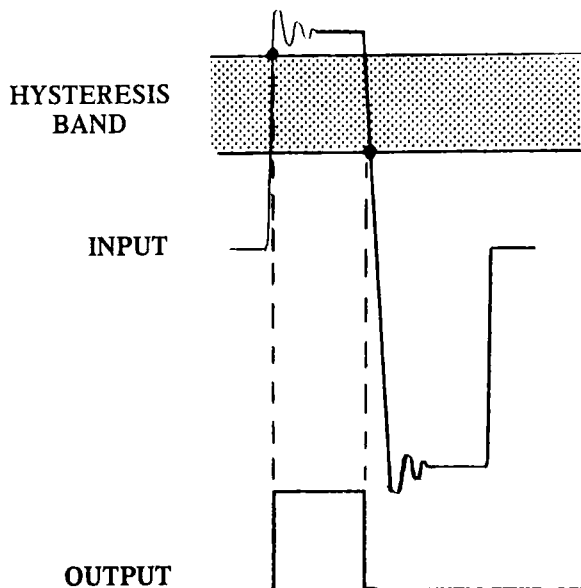
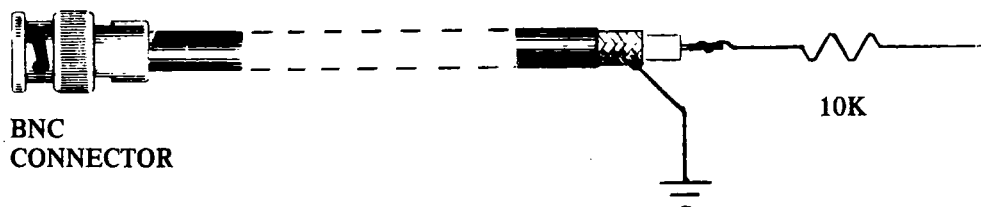


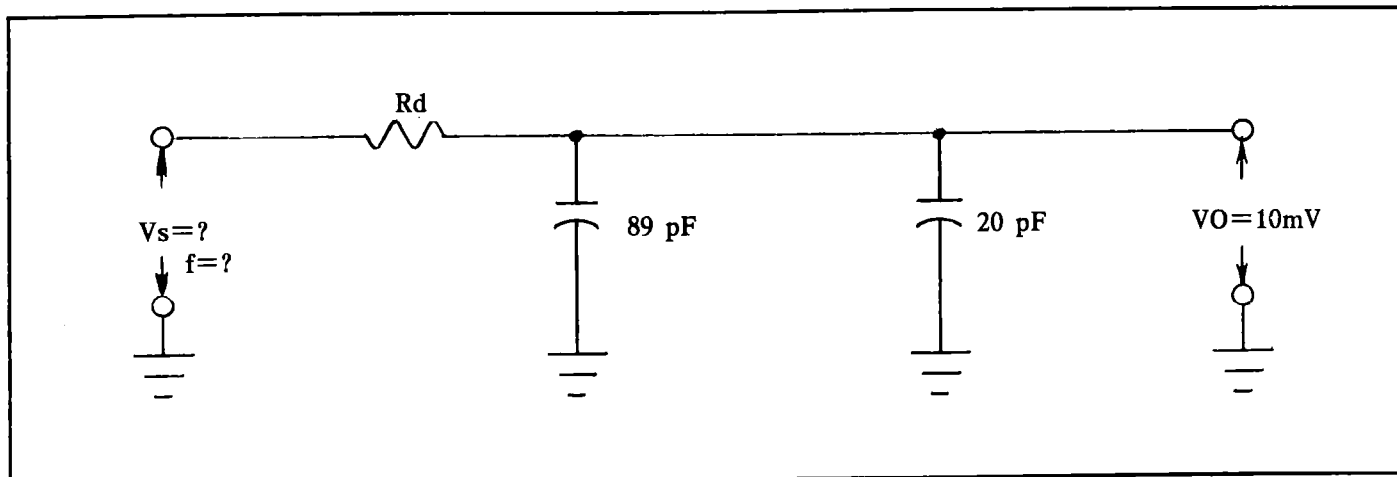
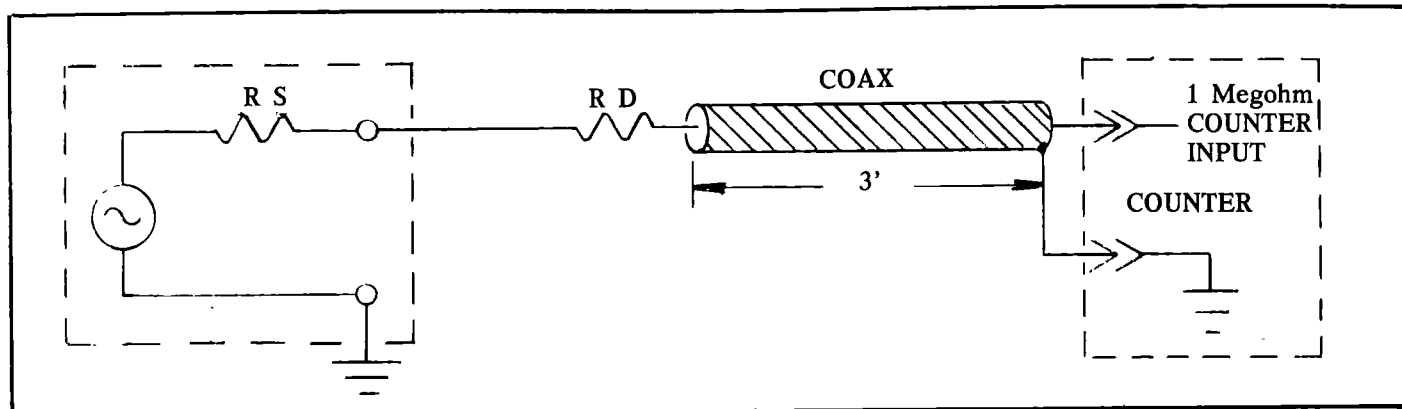
FIG. I

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 R_d 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 R_d can be computed as follows:

$$R_d = \frac{V_s - V_o}{V_o} \times \left(C_{\text{coax}} + C_{\text{Input}} \right)$$

$$\text{Where } X_c + C = \frac{1}{2\pi f \cdot 8.9 \times 10^{-11}} + \frac{1}{2\pi f \cdot 2 \times 10^{-11}}$$

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

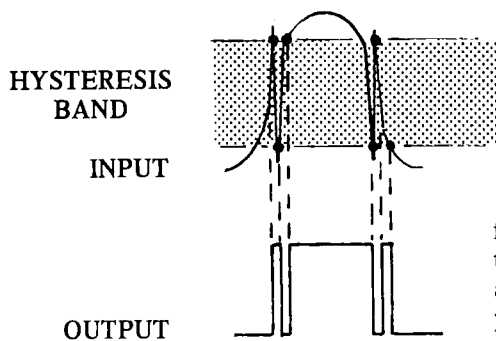


FIG. J

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 shown in Fig. J. Fig. K shows the result of passing the signal through a two stage low pass filter.



HYSTERESIS BAND

INPUT

OUTPUT

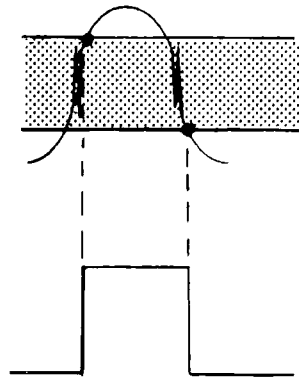
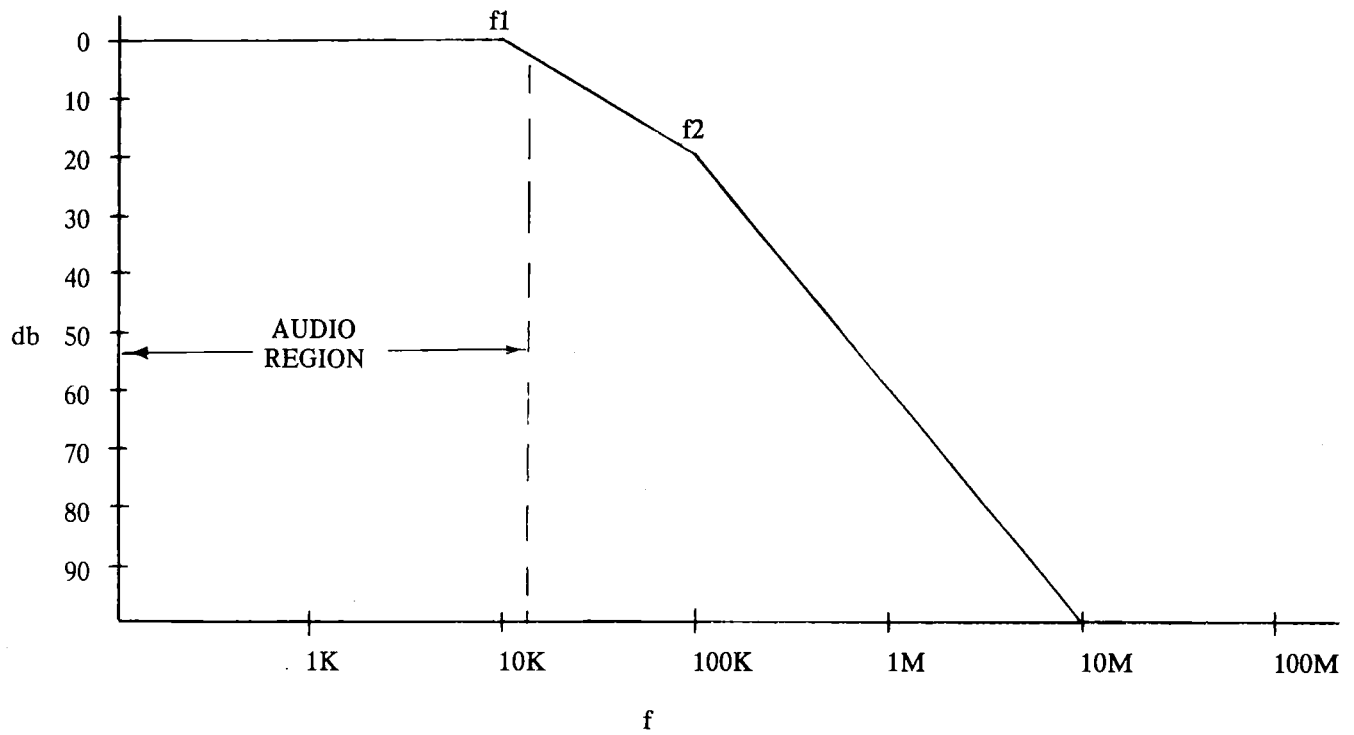


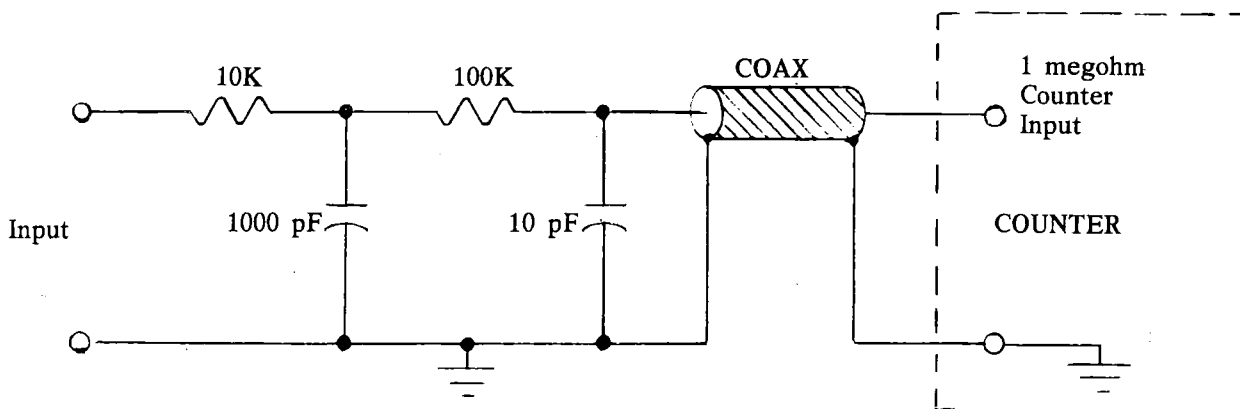
FIG. K

SPIKES ATTENUATED BY LOW PASS FILTER, ALLOWING CORRECT TRIGGERING.

LOW PASS FILTER FREQUENCY RESPONSE



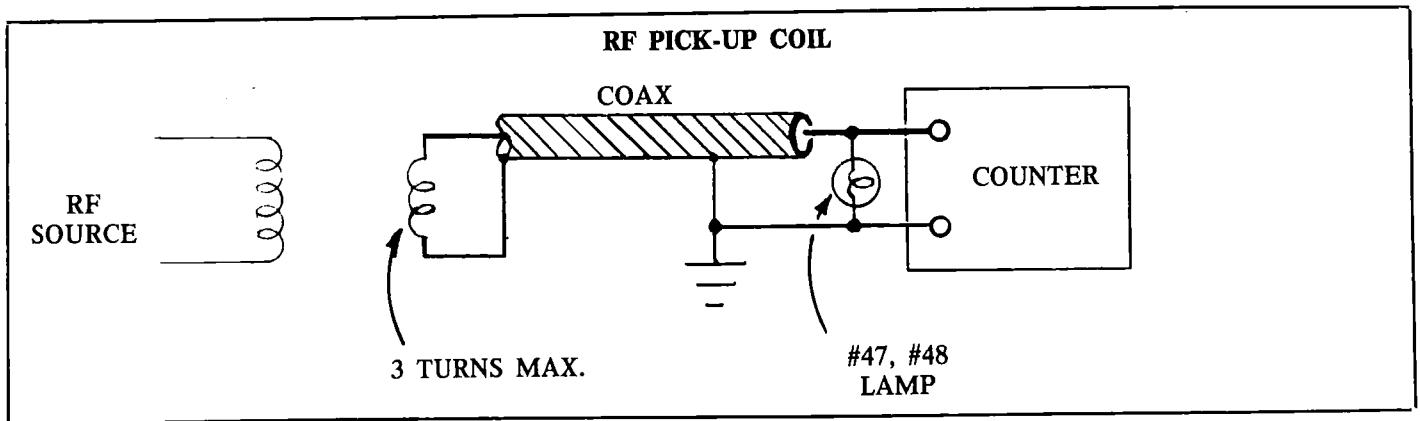
LOW PASS PROBE SCHEMATIC



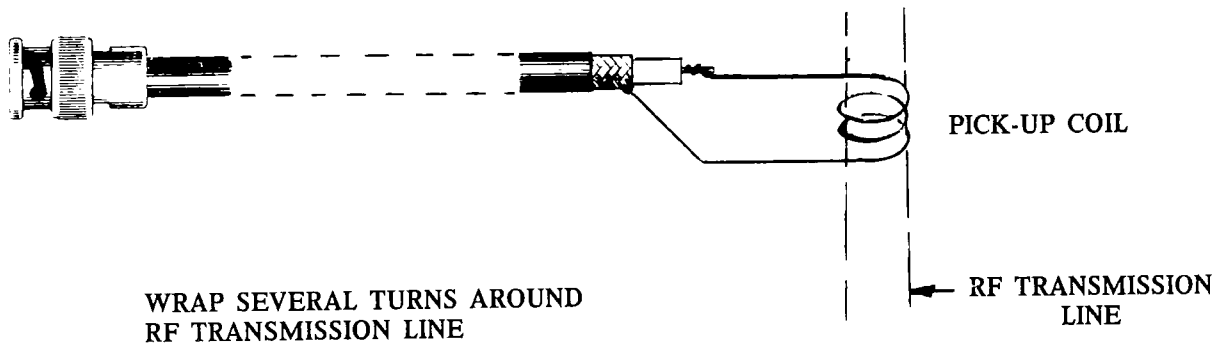
The frequency counter's input should be terminated with the characteristic impedance of the signal source when a cable is used to direct couple to the source. 50 ohms is a common value in RF work and RG58U coax can be used to direct couple the counter's input to a 50 ohm signal source. The counter's 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 mismatch.

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 counter's 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.

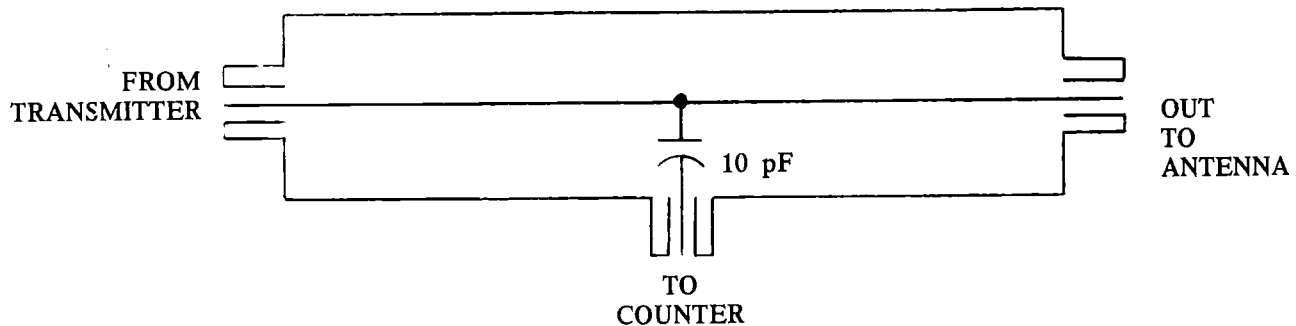
FIG. L



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 avoided when making frequency measurements.



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1501 Page Mill Road, Palo Alto, California 94304

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"Straight Talk on Frequency Counters in Communications Applications"

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

"ICM 7207 Complementary MOS Oscillator Controller, September 1975"

"Applications Bulletin A015 - Design for a Battery Operated Frequency Counter, December 1976."

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PP. 3-39, 3-40, MC10116 Triple Line Receiver.

Texas Instruments Incorporated, **The TTL Data Book for Design Engineers, First Edition**, 1973, PP. 451-455,
"SN74196 50/30-MHz Presettable Decade or Binary Counter/Latches".

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



OPTO-7000 FREQUENCY COUNTER KIT ASSEMBLY INSTRUCTIONS

Before beginning assembly examine all parts supplied and identify them using the parts list. Each part that is installed on the PC boards is given a reference designation that is screen printed near the PC board mounting location. All display PC board (OPTO-7000D) components will mount on the screen printed side and all solder connections will be made on the foil side. Components will be installed on both sides of the main PC board as indicated by the screen printing. Main PC board component leads will be soldered to the top and/or bottom sides of the PC board whenever possible (when the metal foil comes up to the component lead hole).

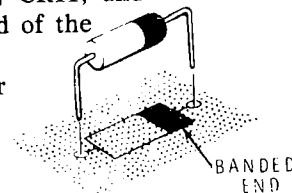
Satisfactory assembly requires the use of a 15 to 25W fine tip soldering iron or ideally a "soldering station" and small diameter resin core electrical solder. After soldering a component in place clip excess component lead and inspect the connection and make sure that the component lead has been soldered on both sides where possible. Check all work to avoid difficulty and insure correct operation.

Save excess component leads for use in later steps.

Steps with (*) are to be omitted if the optional "TCXO-70" precision time base is to be installed. See TCXO installation instructions.

PRINTED CIRCUIT BOARD ASSEMBLY

- () 1. Place and solder (10) ten small signal diodes (1N914 type) at main PC board locations CR5, CR6, CR7, CR8, CR13, CR14 and at display PC board locations CR9, CR10, CR11, and CR12. The banded end of the diode (cathode) must be aligned with the heavy banded end of the screen printed diode outline on the PC board. Solder the diode leads wherever a foil pad is supplied. (See composite PC board drawing for component side solder connections required).



- () 2. Examine the top side or switch side of the main counter PC board (the switch side has fewer screen printed component outlines). Locate the four feed-through locations marked with a square (□). At these four locations a piece of excess diode lead should be inserted through the hole and soldered on both sides of the PC board. Clip excess lead length after soldering.
- () 3. Examine the switch side of the main PC board. Place and solder the 39 uF bullet tantalum capacitor at C11. The rounded end of the cap must be oriented with the "+" indicated on the PC board. Solder the negative lead on the other side of the PC board between R8 and CR8.
- () 4. The following table lists the order in which the resistors will be installed. Place and solder the following resistors making sure the leads are soldered to the top and bottom of the PC board where possible.

	VALUE	MARKING	LOCATIONS
() 4.1	10 ohm	brn-blk-blk	R27, 28, 29, 30, 31, 32, 33, 34, 35, 36 (Display Board)
() 4.2	15 ohm	brn-grn-blk	R6
() 4.3	47 ohm	yel-vio-blk	R1, R20
() 4.4	100 ohm	brn-blk-brn	R2
() 4.5	150 ohm	brn-grn-brn	R5, R11, R19
() 4.6	270 ohm	red-vio-brn	R10
() 4.7	330 ohm	orn-orn-brn	R24
() 4.8	470 ohm	yel-vio-brn	R3
() 4.9	510 ohm	grn-brn-brn	R12, R14, R15, R16, R17, R25



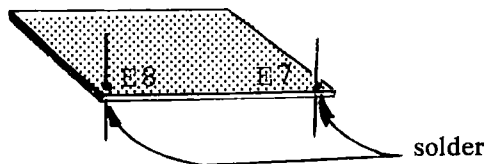
() 4.10	680 ohm	blu-gry-brn	R4
() 4.11	1K ohm	brn-blk-red	R13, R18, R23, R26
() 4.12	2.2K ohm	red-red-red	R22
() 4.13	100K ohm	brn-blk-yel	R7
() 4.14	1M ohm	brn-blk-grn	R8
* () 4.15	10 or 11M ohm	brn-blk-blu or brn-brn-blu	R21

Recheck all resistor leads to see that they have been soldered both top and bottom wherever the PC foil permits.

- () 5. Place and solder the 3.9 uHy choke (has visible copper winding) at location L1 and the 82 uHy choke (red insulation) at location L2. L2 requires top soldering of one lead.
- () 6. Place and solder the MC10116P integrated circuit at location U2. The notched end of the IC must be over the half circle screen printed on the IC outline on the PC board. Solder pin 9 of the IC (adjacent to R12) to the component side of the PC Board. (This is the only DIP IC not used with a socket.)
- () 7. Place and solder the following IC sockets.
 16 pin at U1
 14 pin at U3 and U4
 28 pin at U5
- () 8. Place and solder (3) three 47 uF axial electrolytic capacitors at locations C9, C16, and C17. The capacitor's negative lead is indicated with arrows on the body and the positive lead location is indicated on the PC board with a "+", make sure the arrow on the cap points away from the "+" on the PC board. Solder capacitor leads on both sides of the PC board where possible.
- () 9. Place and solder (4) four 1N4002 (or equivalent) rectifier diodes at PC board locations CR1, CR2, CR3, and CR4. The banded end of the rectifier must be aligned with the banded end of the screen printed diode outline on the PC board.
- * () 10. Place and solder the trimmer capacitor at location C14. Note that two of the trimmer leads are soldered on both sides of the PC board. Excessive heat will damage the trimmer! Do not allow soldering iron tip to touch trimmer body.
- () 11. Place and solder six (6) .001 uF disc capacitors at locations C3, C4, C7, C15, C18, and C10. Note that C15 and C3 each have one lead soldered on both sides of the PC board. To make a top solder connection, chip away ceramic insulation from capacitor lead to be soldered.
- () 12. Place one end of a .001 uF disc capacitor into PC board at location C2 leaving the remaining lead free to make connection to the input connector in a later step. The body of C2 should be as close to the PC board as possible. (Solder on component side)
- () 13. Place and solder the 470 pF disc capacitor at location C6. Chip away excess insulation from lead adjacent to Q1 location and solder.
- () 14. C5 is selected for low self inductance and its actual capacitance may be any value between 47 pF and 220 pf. (there are no other disc capacitors in this range used in this kit). Locate the capacitor and place and solder at PC board location C5.
- () 15. Place and solder the 100 pF silver mica capacitor (may be labeled 101J03) at location C8. Spread leads to accommodate hole spacing and solder on component side of the PC Board.



- * () 16. Place and solder the 22pF (20pF may be supplied) Disc cap at C13. Place and solder the 33 pF disc cap at C12. These capacitors will have either a neutral temperature coefficient (labeled NPO) or a negative temperature coefficient (such as N150, N750, etc.) depending upon the test characteristics of the particular crystal supplied.
- () 17. Open the package containing the E304 FET, MPS6516 transistor and resistor. Place and solder the FET at Q2, the transistor at Q3 and the resistor at Rx. For proper pin orientation of the FET, consult the diagram in the parts list and align the leads with the "D", "G", and "S" locations on the PC Board. The flat side of transistor Q3 must align with the outline on the PC Board. Top solder the FET and transistor leads where the PC foil permits.
- () 18. Place and solder the MPS6516 transistor at Q4. The transistor's flat side must be aligned with the PC board outline at Q4.
- () 19. Place and solder the 2N2369 transistor at Q5. The tab on the transistor case must be aligned with the PC board outline at Q5.
- () 20. Place and solder RF amplifier transistor (2N2857 or 2N5179 equivalent can be identified with four leads) at location Q1. This transistor should be installed about 1/4" off the PC Board. Top solder the two transistor leads that contact the PC foil.
- * () 21. Examine the details on the parts explosion pictorial showing the crystal installation. Place and solder the 5.24288 MHz crystal at location Y1 on the switch side of the PC board. Place the double stick foam tape between the crystal and PC board as shown.
- () 22. Remove the mica insulator from its package and wipe away any excess heat sink compound. Place the insulator over the U6 mounting location. Place the 7805 voltage regulator at PC board location U6. Bolt the regulator to the board using the 6-32 machine screw and hex nut shown in the parts explosion pictorial. Solder the regulator leads to the PC board. Note that regulator lead #3 must be soldered to both sides of the PC board.
- () 23. Place and solder the 2200 uF electrolytic capacitor at PC board location C1. Be sure to align the negative stripe on the capacitor body with the "-" sign on the PC board. The capacitor must be mounted all the way down on the PC Board.
- () 24. Place and solder an excess component lead at PC board location E2. Allow at least 3/4" of lead above the board for connection to the BNC input connector in a later step.
- () 25. Center a long piece of component lead lengthwise in PC board locations E7 and E8. Solder each piece to the PC board when centered.



LED DIGIT INSTALLATION

- () 26 Three of the seven FND 357/359 LED digits may be individually packaged indicating that they have tested decimal points. Place these three LED digits in locations D6, D5, and D4. Place the remaining digits in locations D7, D3, D2, and D1. Note that grooves mark the top of the LED digits and must be aligned with the PC board outline.
If all of the LED digits are packaged together then they all have tested decimal points and may be used at any location.
After inserting the LED digits in the display PC board turn the assembly over so that the digits rest against a flat surface. Push against the back of the display board to firmly seat the LED digits. Solder the digits to the display board. Inspect all solder connections for cold joints and solder bridges. (assembly tip: solder one pin on each display then recheck alignment before soldering remaining pins)



MAIN COUNTER BOARD/DISPLAY BOARD INTERFACING

- (X) 27. The component lead wires previously installed in main PC board locations E7 and E8 (Step #25) should be angled forward and placed in hole locations E11, E12 and E9, E10 respectively on the display PC board. Adjust the PC boards so that the 18 mating pairs of foil fingers line up and the boards are at right angles. The display board mounting pictorial shows how the triangle mark indicators should appear when the boards are perfectly aligned. Solder the wires to the display board at locations, E9, E10, E11 and E12. Clip excess wire length. If the boards are perfectly aligned then solder the 18 mating pairs of foil fingers together.

REAR PANEL ASSEMBLY

(See detail in Parts explosion pictorial)

The side of the rear panel with countersunk mounting holes must face the outside.

- (X) 28. Locate the two 3/8" solder lugs and solder a 1/2" length of component lead into the small hole in each lug.
- (X) 29. Examine the rear panel detail and install the two BNC input connectors and the power input jack. The bracket on the power input jack must not make electrical contact with the rear panel. Check for continuity (use an ohmmeter or continuity checker) between the power input jack bracket and one of the BNC input connectors ground lugs. If continuity is observed, adjust the position of the power input jack.
- (X) 30. Remove the protective paper backing and install the red display window in the cabinet bottom using two 4-40 x 1/4" black anodized flat head machine screws. Note that the front of the cabinet bottom has two 6-32 press nuts in the side for the installation of the "Tilt-up Bail/Handle".
- (X) 31. Install the rear panel assembly in the cabinet bottom using two 4-40 x 1/8" (1/4" may be supplied) Flat head, black anodized machine screws.
- (X) 32. Place the OPTO-7000 PC board assembly into the cabinet bottom as shown in the parts explosion pictorial. Check to see that the LED digits rest flush against the inside of the display window. The wires, installed previously on the 3/8" solder lugs should be bent at right angles and soldered to the ground plane (Switch Side) of the main counter PC Board.
- (X) 33. Remove the two screws that secure the rear panel and carefully lift the counter assembly out of the cabinet bottom. The rear panel must not be allowed to move with respect to the main PC board during the next step. Solder the wire from E2 to the center of the BNC connector nearby on the rear panel. Solder the free end of capacitor C2 to the center conductor of the nearby BNC connector on the rear panel.
- (X) 34. Prepare two 1 1/2" pieces of hook-up wire by stripping 1/4" of insulation from each end. Solder these two wires to the power input connector and to PC board locations E17 and E18 as indicated in the parts explosion pictorial.

CASE ASSEMBLY

- (X) 35. Use 6, 4-40 x 1/8" (1/4" may be supplied) black anodized, flat head machine screws to install three DPDT slide switches in the top cover. Check operation of the switches and adjust if necessary.
- (X) 36. Place the OPTO-7000 assembly into the top cover so that the slide switch solder lugs protrude through their respective hole locations in the main counter PC board. Before soldering the switch lugs check the counter assembly with top and bottom covers in position. Remove bottom cover and solder the 18 switch lugs to the PC board with the counter assembly in place.



FINAL ASSEMBLY AND CHECKOUT

If difficulty is encountered with any step check Troubleshooting Section.

37. With the power switch in the OFF position apply power (7.5 to 15 volts AC or DC) to the power input connector. Check for 5 to 5.3 volts on lead #2 of the voltage regulator U6 (lead 2 is adjacent to C17). Turn the power switch to ON and check for 5 to 5.3 volts at point E13. Switch power off and remove input power plug.
38. Install the following IC's in their sockets. The notch or half round indentation on the IC body must be placed over the half round mark on the PC board outline.

IC	LOCATION
7208	U5
7207A	U4
74196	U3
11C90	U1

Check every pin of each IC to make sure it is inserted into the socket and not folded under the IC body.

- () 39. Insert the power plug into the power jack, switch power on and observe the LED digits. There should be a display of all zeros and the decimal point should move whenever the gate or range switch position is changed.
- () 40. The counter can now be checked using a signal source such as a signal generator and then calibrated as per the calibration instructions. After calibration the bottom cover can be installed using hardware provided. For the details of the final cabinet assembly examine the Parts Explosion Pictorial drawing.



TROUBLE SHOOTING

It is the responsibility of the Kit builder to perform the following checks prior to obtaining factory assistance or repair service.

With Power Removed

- GM () 1. Check for proper polarity of all diodes, capacitors and transistors. Check to see that all IC's are installed correctly and are not reversed in their sockets.
- bu () 2. Check all IC's to see that there are no pins bent under the body of the clip. It may be necessary to remove the IC from its socket in order to perform this step.
- () 3. Start at one corner of the PC board and examine every solder connection one at a time and reheat any suspect cold solder connections. Remove any solder bridges or shorts. Use the main PC board component side soldering diagram to check all top solder connections.
- () 4. Use a voltmeter with negative test lead grounded to the ground plane to check all +5 volt connections. Use the schematic to determine which circuit points are connected to +5 volts. Note that the range switch "S2" switches power from the 60 MHz amplifier to the 600 MHz amplifier and prescaler chip and to check for +5V in these areas the range switch must be in the correct position. Pin 9 of U2 must measure between 2.2 and 2.7 volts DC when the range switch is on the 60 MHz position. Resistor Rx is factory selected to obtain this voltage range.
- () 5. Use a voltmeter with the positive test lead connected to +5 volts (Pin 2 of the 7805 regulator, U6) to check all ground connections. Use the schematic to determine which circuit points are grounded.

LED Display Problems

- () 6. The display PC Board interface connections, and the areas below U5 and U4 must be thoroughly checked for poor solder connections and solder shorts. Problems that appear in all seven digits such as segments missing or extra segments lit are usually found to be caused by solder shorts or cold solder connections. For missing segments use a jumper from the segment drive pin of U5 indicated in the schematic to the indicated segment pin on one of the digits. When an extra segment is lit, remove power and pull U5 from its socket. Reinstall U5 with the indicated segment drive pin pulled up. If the segment is still lit then the problem is not related to U5. When a single digit only will light at one time then the Xtal oscillator is not functioning. Check the Xtal, its oscillator components and U4.

Troubleshooting the Counting Circuit

- () 7. The logic circuits and amplifiers can not be tested by measuring DC Voltages. If an oscilloscope is not available and all of the checks mentioned above have been made then parts substitution can be tried. See the warranty information for policy on returning parts for replacement. Factory troubleshooting assistance is also available by phone or by mail.
- () 8. An oscilloscope can be used to trace a signal through the counter. A signal source of 5 MHz is available from the counter's oscillator and can be coupled to the 60 MHz input using a 100 pF, or smaller, capacitor in series. Use the scope to follow the signal through the input amplifier, through to pin 12 of U5. Note that the range switch must be in the 60 MHz position. The 600 MHz input should be connected to a 10 MHz signal with 50 ohm source impedance. An RF signal generator is ideal for this purpose. If Q1 is suspected, it can be removed from the PC board and replaced with a wire soldered from the emitter to collector lead locations. U1 will normally run warm to the touch when the range switch is in the 600 MHz position.

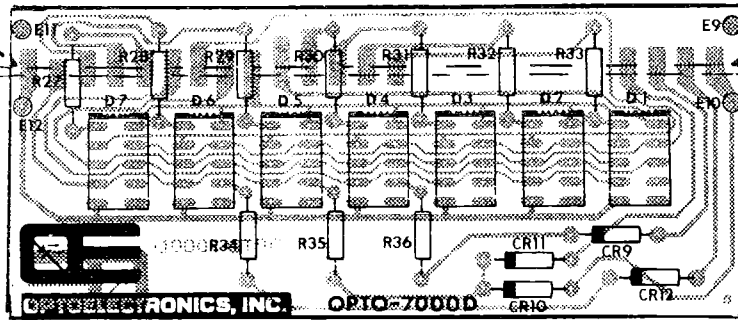


PC BOARD COMPOSITE DRAWINGS

(TRIANGLE)

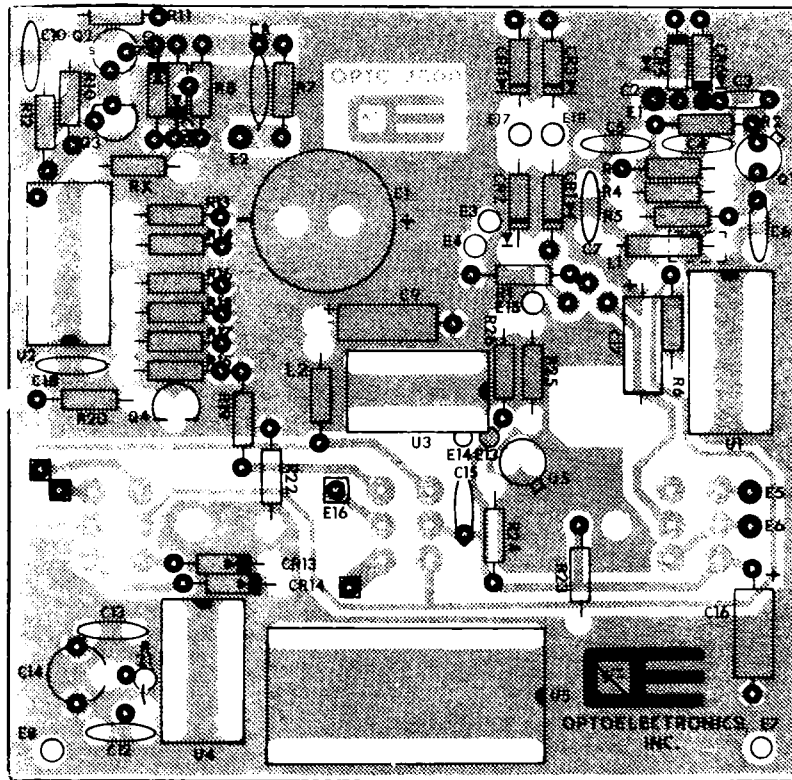
(TRIANGLE)

MAIN BOARD-
TO-DISPLAY
BOARD MATING
LOCATION



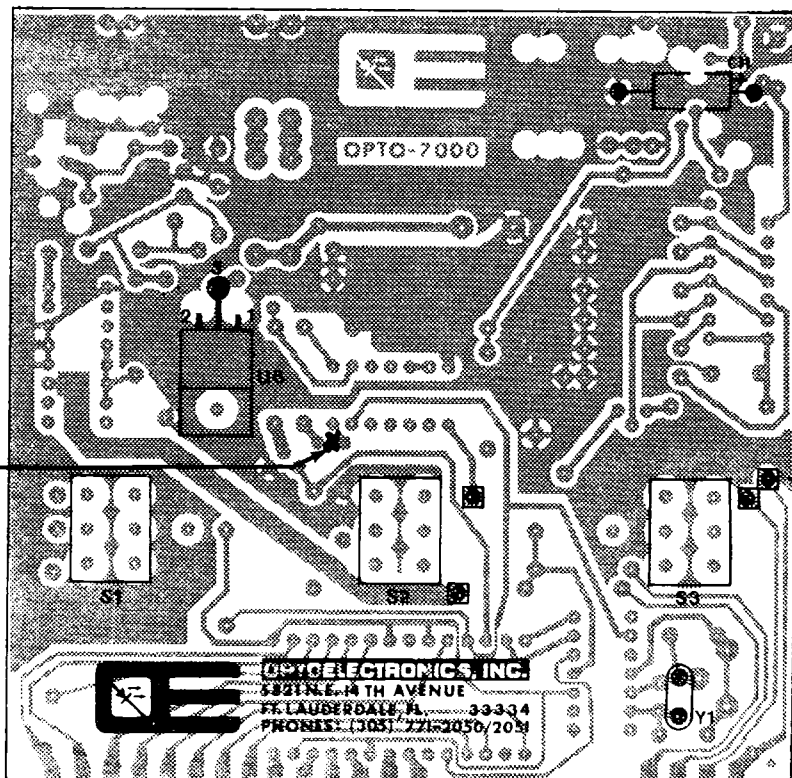
DISPLAY BOARD
(FOIL PATTERN
VIEWED THRU
PC BOARD TO
SHOW MAIN
BOARD MATING
MARKS)

72 CONNECTIONS
SOLDERED ON
COMPONENT
SIDE PLUS 18
MORE FOR
SWITCHES



MAIN BOARD
(DARK PADS
MARK ALL
POINTS TO BE
SOLDERED ON
THIS SIDE.
SWITCH LEGS
TO BE SOLD-
ERED THIS
SIDE LATER)

CUT FOIL
WHEN INSTAL-
LATING S-4
OPTION



MAIN BOARD
C11, U6, S1,2,3,
AND Y1 TO BE
MOUNTED THIS
SIDE.

SOLDER WHERE
INDICATED BY
DARK PADS.

OPTOELECTRONICS, INC.
1821 N.E. 14 TH AVENUE
FT. LAUDERDALE, FL 33304
PHONES: (305) 771-2050/2051

OPTO-7000 PARTS LIST

CAPS

- C1 - 2200 mF/16V
- C2 - .001 mF
- C3 - .001 mF
- C4 - .001 mF
- C5 - 47 to 150 pF
- C6 - 470 pF
- C7 - .001 mF
- C8 - 100 pF, silver mica
- C9 - 47 mF/10V
- C10 - .001 mF disc
- C11 - 39 mF/10V Tantalum
- C12 - 33 pF
- C13 - 20 or 22 pF
- C14 - Trimmer 2-30 pF
- C15 - .001 mF disc
- C16 - 47 mF/10V
- C17 - 47 mF/10V
- C18 - .001 mF disc

RESISTORS

- R1 - 47 ohm
- R2 - 100 ohm
- R3 - 470 ohm
- R4 - 680 ohm
- R5 - 150 ohm
- R6 - 15 ohm
- R7 - 100K
- R8 - 1M
- RX - Specially Selected (See Text)
will be between 100 & 500 ohms
- R10 - 270 ohm
- R11 - 150 ohm
- R12 - 510 ohm
- R13 - 1K
- R14 - 510 ohm
- R15 - 510 ohm
- R16 - 510 ohm
- R17 - 510 ohm
- R18 - 1K
- R19 - 150 ohm
- R20 - 47 ohm
- R21 - 10M, 1/2W/10 to 11 MEG
- R22 - 2.2K
- R23 - 1K
- R24 - 330 ohm
- R25 - 510 ohm
- R26 - 1K
- R27 - 10 ohm
- R28 - 10 ohm
- R29 - 10 ohm
- R30 - 10 ohm
- R31 - 10 ohm
- R32 - 10 ohm
- R33 - 10 ohm
- R34 - 10 ohm
- R35 - 10 ohm
- R36 - 10 ohm

DIODES

- CR1 - 4 1N4002 Type
- CR5 - 14 1N914 Type

CHOKES

- L1 - 3.9 uHy
- L2 - 82 uHy

IC's

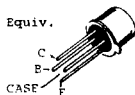
- U1 - 11C90 UHF Prescaler,
Fairchild
- U2 - MC10116P ECL Triple Line
Receiver, Motorola
- U3 - 74196 Decade Counter,
Texas Instruments
- U4 - 7207A Intersil
- U5 - 7208 Intersil
- U6 - 7805 Regulator

CRYSTAL

- Y1 - 5.24288 MHz Xtal

TRANSISTORS

- Q1 - 2N2857 or Equiv.



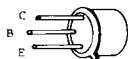
- Q2 - E304 N Channel FET



- Q3 - MPS6516 Low Noise PNP
- Q4 - MPS6516



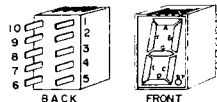
- Q5 - 2N2369 NPN High Speed Switch



MISC.

- 1 - OPTO-7000, Logic PC Board
- 1 - OPTO-7000D, Display PC Board
- 1 - Mica Insulator with Heat Sink Compound
- 7 - FND 357/359 LED Digits

FND 357/359 LED DIGIT

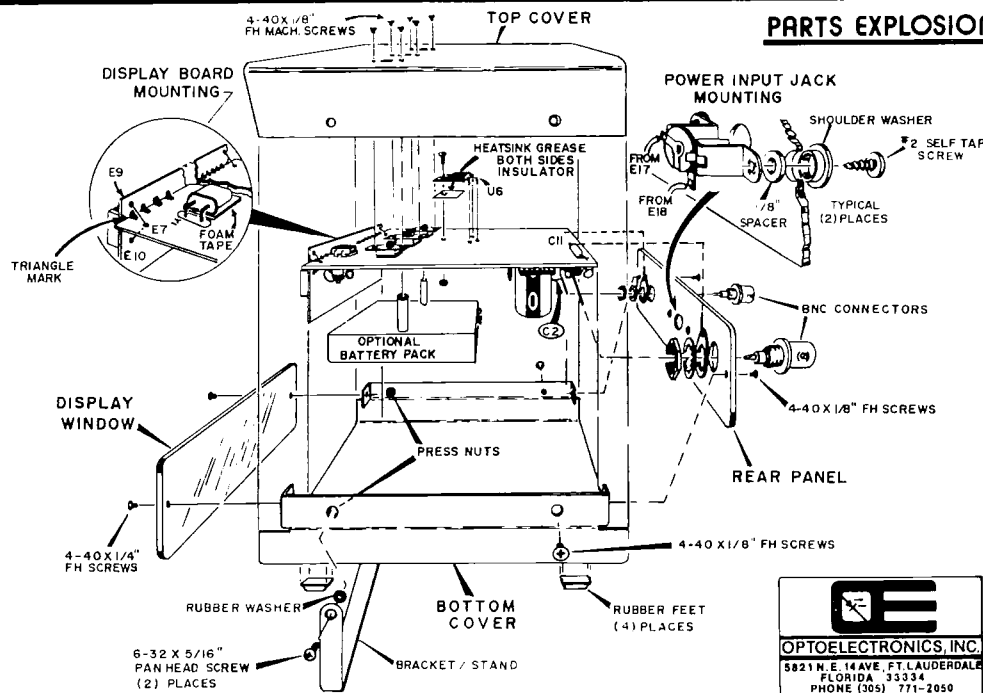


PIN NO.	CONNECTIONS
1	COM CATHODE
2	SEG F ANODE
3	SEG G ANODE
4	SEG E ANODE
5	SEG D ANODE
6	COM CATHODE
7	DEC PT
8	SEG C ANODE
9	SEG B ANODE
10	SEG A ANODE

- 1 - 28 pin IC Socket
- 1 - 16 pin IC Socket
- 2 - 14 pin IC Sockets
- 1 - Pin Type Power Recepticle
- 1 - Pin Type Plug
- 3' - Two Conductor Zip Cord
- 1 - 6/32 Hex Nut
- 1 - 6/32 x 1/2" Machine Screw
- 10 - 4/40 x 1/8" Black FH Machine Screws
- 2 - 4/40 x 1/4" Black FH Machine Screws
- 2 - 6/32 x 5/16 Black Anodized Machine Screws
- 2 - #2 x 3/8" Self Tap Screws
- 2 - #2 Shoulder Washers
- 2 - 1/8" Spacers
- 1 - Cabinet Top
- 1 - Cabinet Bottom
- 1 - Rear Panel
- 1 - Plexiglas Window
- 1 - Bracket/Stand
- 1 - Double Stick Foam Mounting Pad
- 4 - Self Stick Rubber Feet
- 2 - BNC Connectors with 2 #1497 Solder Lugs
- 3 - DPDT Mini Slide Switches
- 4" - Stranded Hook-up Wire
- 2 - #6 Washers, Neoprene

BATTERY PACK

- 1 - 50 mA Constant Current Charger Assembly
- 1 - Quad Battery Holder
- 1 - Battery Snap
- 2 - 2-56 x 3/4" Machine Screws & Hex Nuts
- 2 - 1/2" Spacers
- 4 - AA NICAD Batteries



OPTO-7000 FREQUENCY COUNTER

CALIBRATION INSTRUCTIONS

Before calibration, check the regulated supply voltage at pin 2 of the voltage regulator U6. The voltage should be between 5.1 and 5.35V referenced to ground. Resistor R1 can be replaced with a higher value to increase or a lower value to decrease the regulator's output voltage. The OPTO-7000 Counter should be allowed to warm up for 30 minutes before calibration.

Calibration is performed by allowing the OPTO-7000 to count an accurately known and stable signal (preferable between 3 MHz and 50MHz) and adjusting trimmer C14 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 nonmetallic screwdriver or TV alignment tool should be used when adjusting C14.

If an accurately calibrated frequency counter is available then allow it and the OPTO-7000 to measure a stable oscillator or signal generator output. Adjust the OPTO-7000 until identical readings are obtained. The reference frequency counter should have at least the same number of digits of resolution as the OPTO-7000.

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-7000 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 additional reference concerning the use of the color TV frequency standard is listed in the bibliography.

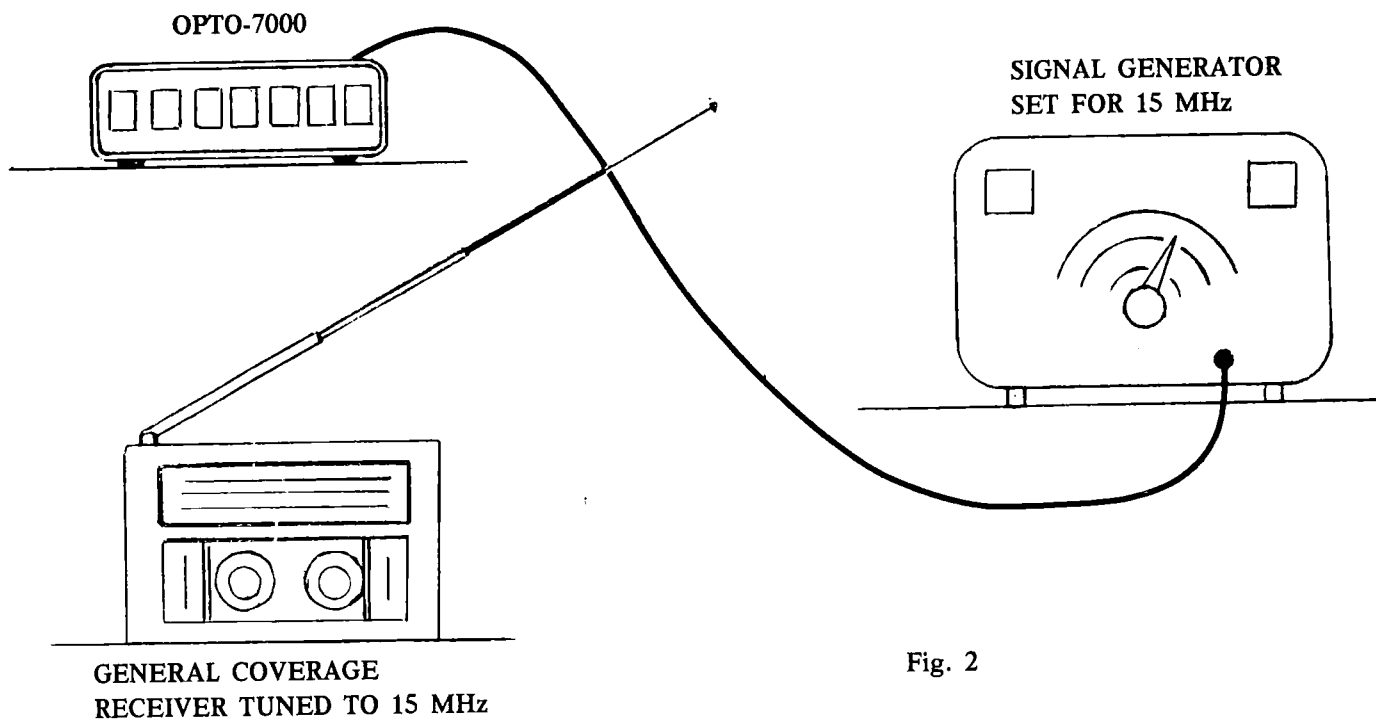


Fig. 2

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 Optoelectronics #TCXO-70 can be used as a precision .1 ppm time base for the OPTO-7000 Frequency Counter and comes from the factory precalibrated.



TCXO-70 INSTALLATION INSTRUCTIONS

The model TCXO-70 (Temperature Compensated Crystal Oscillator) is a precision frequency standard that has been factory calibrated to 5.242880 MHz. Specially designed temperature compensation circuitry keeps the output frequency within .1PPM over a 17° to 40°C temperature range. Deviation of less than 1.0PPM (.0001%) occurs outside this range between 0°C and 60°C. The TCXO has been pre-aged to reduce long term drift to less than 1 PPM per year. (± 1 PPM/3 years aging typical).

The TCXO power requirements are 20 mA at 5 volts DC. The output is a TTL compatible sine wave. An external trim adjustment is provided but should not be changed unless a precision frequency standard is available.

TCXO-70 PARTS LIST

1 — 5.242880 MHz TCXO

6" Stranded hook—up wire

1 Double stick foam mounting pad

- () 1. If the TCXO is being installed in a kit then proceed with the kit assembly sequence disregarding steps 4,15,10,16, and 21, which have been marked with an "*".

If the TCXO is to be installed in an already assembled OPTO—7000 Frequency Counter then remove the following components:

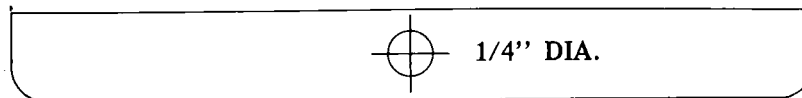
Y1 Crystal
C12 Disc Capacitor
C13 Disc Capacitor
C14 Trimmer Capacitor
R21 Resistor

- () 2. Place an excess component lead in the C14 mounting hole that is close to C12 and solder to both sides of the PC board. Clip excess lead length.

This feed through wire connects pin 4 of U4 to the ground plane.

- () 3. Cut the S3 switch lugs as close to the PC board as possible. Some solder removal may be necessary to allow the TCXO body to rest sufficiently close to the PC board when installed.
- () 4. Cut a piece of stranded hook—up wire 1—1/8" long and strip 1/8" of insulation from each end. Place one end of the wire in the C12 mounting hole adjacent to U4 and solder.
- () 5. Mount the TCXO on a piece of self stick foam pad close to U4 as shown in the illustration.
- () 6. Cut the "RF", "+", and "-" TCXO wires back to 1/4 in length. Solder the 1—1/8" wire previously installed at C12 to the RF location on the TCXO. Solder a 3" wire from the center terminal of switch S2, adjacent to C14 to the "+" connection of the TCXO. Solder a 1—1/2 wire from the ground plane near U4 to the "-" connection on the TCXO.

#S-4 SWITCH OPTION SWITCH DRILLING TEMPLATE

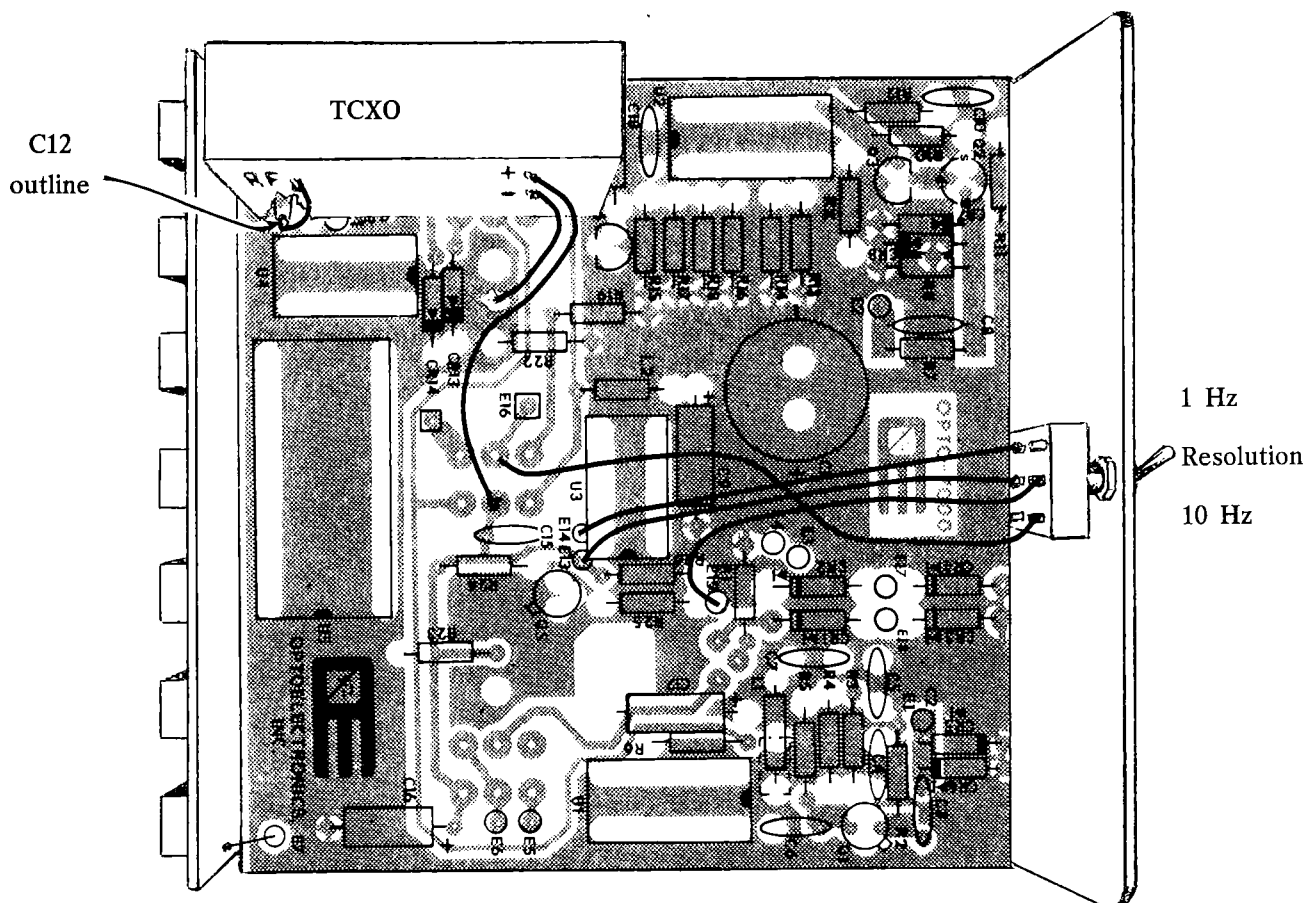


CUT TEMPLATE OUT AND ALIGN WITH
EDGE OF REAR PANEL, TAPE IN PLACE
AND DRILL HOLE CAREFULLY.

NOTE: SOME UNITS WILL HAVE A 1/8" PILOT HOLE
PREPUNCHED IN REAR PANEL. USE PILOT HOLE
INSTEAD OF TEMPLATE WHEN PROVIDED.



TCXO AND 1HZ SWITCH INSTALLATION



#S-4 Optional 1Hz Switch Installation Instructions

The #S-4 switch option allows frequencies from 10Hz to 6 MHz to be counted with 1Hz resolution. The switch is to be installed on the OPTO-7000 rear panel and wired as shown in the pictorial drawing. As shown in the schematic the switch increases resolution by removing power from the 74196 ÷10 scaler and directly coupling the output from the 60 MHz amplifier to the 7208 counter chip.

PARTS LIST

- 1 DPDT Mini Toggle switch
- 1 Toggle switch hex nut
- 1 Dress nut
- 1' Stranded hook-up wire

INSTALLATION NOTES

- () 1. If switch option #S-4 is being installed in a kit, then drill rear panel prior to assembly. Use template provided to determine drilling location. Drill a 1/8" pilot hole first and then a 1/4" hole for switch mounting. Install switch during rear panel assembly sequence. If switch option #S-4 is being installed in an already assembled OPTO-7000 counter then be sure to provide support for the rear panel to prevent damage to the PC board connections when drilling.
- () 2. Thread the hex nut on the switch shaft and place the switch in the hole previously drilled. The dress nut should be threaded on finger tight and the hex nut tightened from the rear of the panel.
- () 3. Use a razor knife to cut PC foil run between points E13 and E14 on the switch side of the main counter PC board. See note on PC Board Composite Drawing.



NICAD-70 BATTERY PACK INSTALLATION INSTRUCTIONS

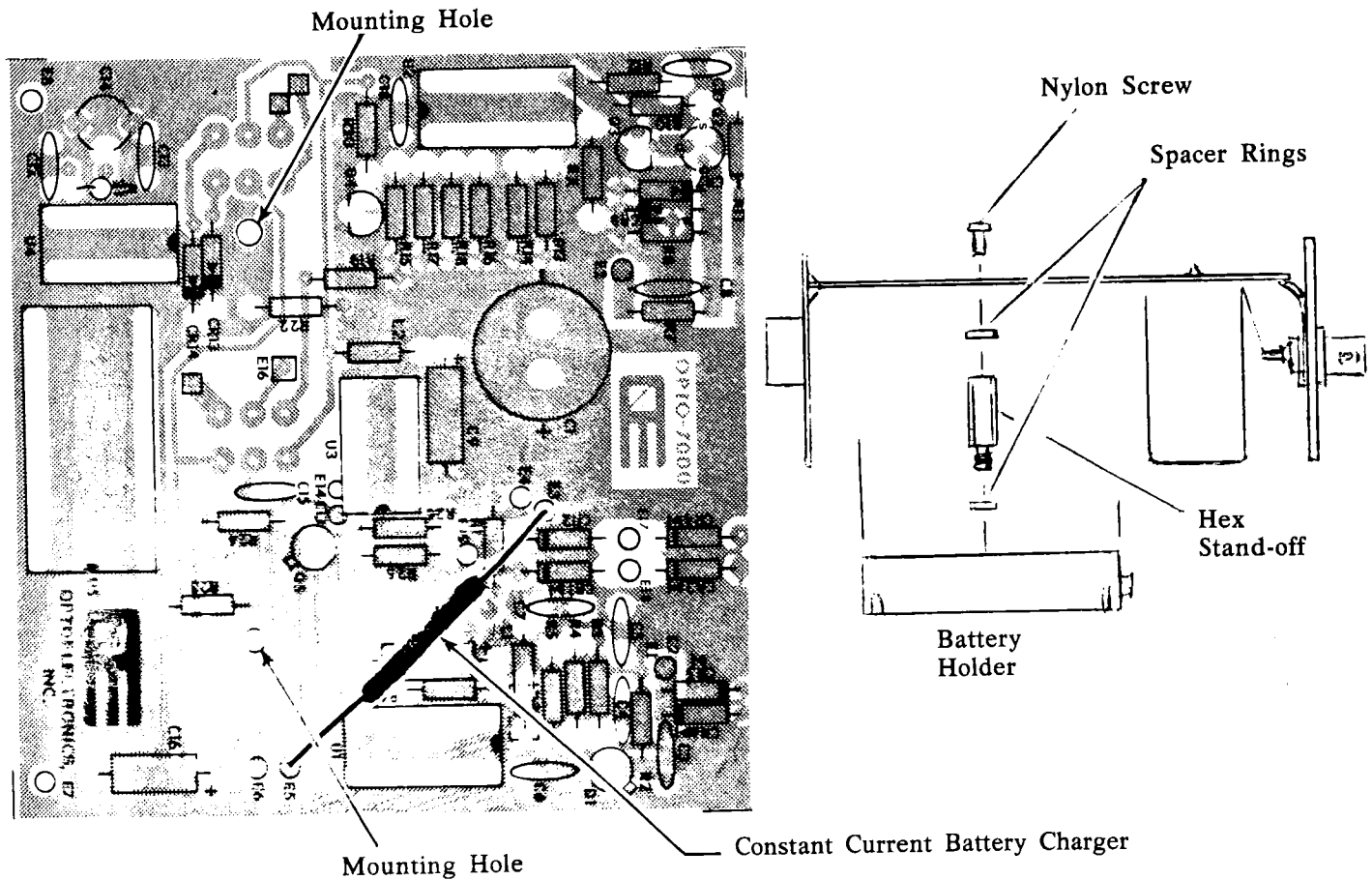
The NICAD-70 Battery Pack is designed to be installed inside the OPTO-7000 Frequency Counter and provide up to 3 hours of continuous portable operation.

Charging of the batteries occurs when an AC supply of at least 10 Volts (such as the model AC-70 plug transformer) or a DC supply of at least 10V, is connected to the OPTO-7000 counter and the power switch is left in the "OFF" position for a period of 8 to 10 hours. The batteries will also partially recharge when the power switch is in the "ON" position and the counter is operating from an external AC or DC supply.

A constant current charge regulator is provided with the Ni-Cad-70 Battery Pack to protect the batteries while maintaining a high charging rate.

PART LIST

- (1) Battery Holder
- (4) Fast Charge Rate AA Ni-Cad Batteries
- (1) Pre-Assembled Constant Current Charge regulator
- (1) Set of Mounting Hardware
- (1) Battery Snap



1. Solder yellow wire of battery charger in "E3" and the black wire in "E5".
2. Solder the red wire of the battery snap in "E6" and the black wire in "E4".
3. Place spacer ring over threaded end of hex stand-off, then thread stand-off into battery holder. Do this with both stand-offs.
4. Mount battery holder to main PC board, using another spacer ring and nylon screw (as shown) on each hex stand-off.

NOTE: Tape batteries in holder.
(If battery holder is equipped with wire leads, there will not be a battery snap).



OPTO-7000 FREQUENCY COUNTERS, ACCESSORIES AND OPTIONS

#OPTO—7000	Factory Assembled Counter	\$139.95
#OPTO—7000K	Counter Kit	99.95
OPTIONS		
#AC—70	115VAC Power Pack	4.95
#Ni-Cad-70	Rechargeable Battery Pack (With Charge Circuitry)	19.95
#S—4	Rear Panel Switch Installed 1HZ Resolution to 6 MHz	4.95
#S—4K	Same as Above in Kit Form	2.95
#TCXO—70	0.1 PPM TCXO, 17-40°C (Same Price With Kit or Factory Wired)	79.95
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
#AP—8015	10—600 MHz Preamp 15-50db Gain	49.95
#AP—8015K	Same as Above in Kit Form	39.95

All items available factory direct, delivery from stock. Prices listed and product availability 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.**



MODEL OPTO-7000

FREQUENCY COUNTER SERVICE & WARRANTY INFORMATION

FACTORY WIRED UNITS

Optoelectronics, inc. Model OPTO—7000 Factory Wired Frequency Counters are warranted to the original purchaser for one year from date of purchase against defects in workmanship or failure of circuitry, provided no unauthorized repairs or modifications have been attempted or performed and unit has not been subjected to misuse or abuse.

Defective units covered by the above warranty must be returned to factory, with transportation charges prepaid and a \$5.00 remittance for return shipping, handling and insurance.

Defective units eligible for warranty service will be promptly repaired or replaced at manufactures option.

KITS

Kit builders experiencing difficulty obtaining proper operation from their unit may receive trouble shooting assistance by phone or letter. (If writing please give complete details.)

All parts in the OPTO—7000 kit are guaranteed for one year. If suspected defective, return parts (not entire unit) for replacement parts at no charge. Package properly to insure safe arrival. (See "All Warranty Returns" information below.)

FACTORY SERVICE

Factory assembled units out of warranty or completed kits may be returned for repair provided: 1. Unit is completely assembled, 2. Kit has not been assembled with acid core solder and 3. Sender understands that repair work is charged for at \$15.00 per hour (maximum labor charge for OPTO—7000 is three hours, minimum charge is one hour) plus \$5.00 for return shipping, handling and insurance. No charge is made for electronic parts required. Repaired units receive 90 day warranty from date of return and will meet same specs as factory assembled units.

For factory repair service, return unit with check, cash or money order for \$50.00 (any unused amount will be refunded with repaired unit) or Master Charge or Visa charge card numbers. No C.O.D. returns. **Charge card authorization or prepayment will be required before any work is done.**

Our service department will provide a rapid repair turn—around, most repairs are completed same day received. Do not cause delays — enclose proper information and remittance.

ALL WARRANTY RETURNS—parts, kits or factory wired units must include:

- (1) Copy of sales receipt (readable)
- (2) Detailed description of problem/s.
- (3) Complete return address and phone number (U.P.S. street address for U.S.A.)
- (4) Proper packaging (insurance recommended) Note: Carriers will not pay for damage if items are not properly packaged. Return via United Parcel Service if possible.

Address all items to: OPTOELECTRONIC, INC.
Service Department
5821 N.E. 14th Avenue
Ft. Lauderdale, Florida 33334

The above warranty policies are the sole guarantees provided and are in lieu of any other expressed or implied obligation on the part of OPTOELECTRONICS, INC.

PLEASE NOTE: Factory service rates and service policies quoted herein are effective through 1978 but may subsequently be changed without notice. If in question, call or write for current service charges before returning a product for repair.

