INSTRUCTION MANUAL

675 FM EXCITER

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SECTION 1

GENERAL INFORMATION

1-1 DESCRIPTION

The QEI Type 675 FM exciter is an all solid state, on carrier direct FM, phase locked, frequency synthesized exciter designed to meet or exceed the FCC requirements for use in the standard FM broadcast band (88-108 MHz). The Exciter may be programmed to operate on any 100 kHz increment in the FM band using the same high stability 8 MHz crystal as a reference.

The Exciter is manufactured in a standard 3 1/2" X 19" rack mount. All operator controls, adjustments and indicators are located on the front panel. Signal input and output connections, fuse, AC power and the MONO-COMP switch are located on the rear panel.

The Exciter is all solid state, employing silicon transistors, diodes and integrated circuits. The Exciter features phase locked stability and on carrier direct FM for full multiplex operation with freedom from spurious responses. The Power Amplifier is capable of withstanding any magnitude or phase of VSWR and the power output is adjustable from less than 5 to greater than 20 watts.

1-2 ELECTRICAL SPECIFICATIONS

Primary Power	105-125/210-250 Vac 50/60 Hz.
Power Consumption	Approximately 50 watts max.
Power Output	Adjustable from less than 5 to greater than 20 watts
Frequency Range	88 MHz to 108 MHz (Programmable)
Type of Emission	180F3 or 300F9
Modulation Capability (less than 1% THD)	150 KHz peak
Frequency Stability	$\pm$ 500 Hz (-10 C to +55 C)
Output Impedance	50 ohms
VSWR Protection	Any magnitude or phase
Harmonic and Spurious Suppression	Better than 80 dB

Mono Input	
a. Impedance	600 ohms (balanced)
b. Level	+10 dBm for 75 KHz dev. @ 400 Hz
c. Pre-emphasis	75 usec + 1 dB (50 usec optional)
Stereo Input	
a. Impedance	10K
b. Level	3.5Vpp for 75 KHz deviation
SCA Inputs (2)	
a. Impedance	10K
b. Level	1Vpp for 10% injection
Distortion	0.2% max. THD @ 75 KHz dev.
FM Noise (below 75 kHz dev. with 75 usec de-emp.)	Better than -70dB
AM Noise	Better than -55dB
Stereo Separation	Better than 40dB from 30 Hz to 15kHz with QEI Model 772 Stereo Generator
Crosstalk (Main to SCA)	-55dB
Crosstalk (SCA to Main)	-65dB
Environmental	0° C to +55° C operating. (-15° C to +55° C with 30 minute warm up)

1-3 MECHANICAL SPECIFICATIONS

Dimensions	3 1/2"H. X 19"W. X 14"D.
Net Weight	13 pounds
Shipping Weight	17 pounds
Maximum Operating Temp.	131° F (55° C) Ambient

1-4 INSTRUMENT IDENTIFICATION

This unit is identified by a Model Number and a serial number located on the rear panel. All correspondence to your sales representative or the factory in regard to this unit should reference the complete Model and Serial Numbers.

1-5 ACCESSORIES

The Exciter may be used as a 10 Watt Transmitter with the accessory Meter Panel. This Panel contains Final Amplifier Metering, Incident and Reflected Power Metering, directional coupler, and signal sampler.

SECTION 2

INSTALLATION

2-1 INITIAL INSPECTION

Check the shipping carton for external damage. If the carton exhibits evidence of abuse in handling (holes, broken corners, etc.) ask the carrier agent to be present when the unit is unpacked. Carefully unpack the unit and inspect all equipment for physical damage. Immediately after unpacking, any bent or broken parts or scratches should be noted. Keep all packing material for proof of damage claim or for possible future use.

2-2 PREPARATION FOR USE

The unit is designed to be mounted in a standard 19" rack. Air space should be provided above and below the unit so that heat generated by the circuitry may be dissipated. Additional cooling may be required if the unit is placed above high heat generating equipment in order to keep the ambient temperature below the maximum specified.

Mount the unit to the rack using (4) #10 countersunk screws and finishing washers.

The unit requires a 105-125V single phase, 50 or 60 Hz power source or a 210-250V single phase, 50 or 60 Hz power source. The Serial Tag on the back panel shows for which power source the unit is wired. See Section 5-5 for information on changing taps.

Connect a suitable 50 ohm RF load to RF OUT jack J1 using a type N connector and RG-8/U or equivalent cable. Connect Mono audio line to TB1 and/or Stereo Generator to COMP jack J2. Connect SCA Generator to either SCA jack J3 or J4. Connect AC power plug to appropriate power source.

C A U T I O N

When connecting the Exciter to the Transmitter, tuning of the transmitter input circuitry will be facilitated by the use of a 3dB 30 watt pad and a thru-line wattmeter between the Exciter and the Transmitter. If these devices are not available reduce the output power of the exciter and tune the input of the transmitter until a somewhat reasonable match is obtained. If the transmitter is already tuned to exciter frequency a "touch up" adjustment should be all that is necessary. If the IPA of the transmitter can be mistuned to the point of oscillation be sure to use the 3dB pad. It is possible to drive large amounts of power back into the Exciter from an oscillating IPA thereby destroying the output transistor.

In some transmitters it is possible to overdrive the IPA of the transmitter causing it to break up. Therefore, you should keep the PWR ADJ control of the exciter at minimum, then slowly increase it until the IPA of the transmitter indicates the same amount of grid current as with your previous exciter. The final stage of the transmitter can be tuned for full output at this time.

2-3 REPACKING FOR SHIPMENT

NOTE: BEFORE RETURNING A UNIT FOR REPAIR OR CALIBRATION, CONTACT THE FACTORY FOR A RETURN AUTHORIZATION.

Attach a tag showing owner's name and address. A description of the service required should also be included. Unit must be shipped prepaid and insured for full value. Use the original shipping carton and packing material for re-shipment. If they are not available, proceed as follows:

A. Use a carton with minimum test strength of 250 lbs.

B. Use heavy paper or sheets of cardboard to protect all surfaces.

C. Use at least four inches of tightly packed shock absorbing material such as extra firm polyurethane foam or rubberized hair. NEWSPAPER IS NOT SUFFICIENT CUSHIONING MATERIAL.

D. Use heavy reinforced shipping tape to secure the outside of the carton.

E. Use large FRAGILE labels on each surface.

SECTION 3

OPERATION

3-1 OPERATOR CONTROL AND INDICATORS (FRONT PANEL)

1. POWER Switch S1 and POWER Indicator CR2

   This switch controls primary power to the unit. The LED (CR2) will light indicating power on. If the LED flashes, it indicates a power supply overload or an extreme RF load mismatch.

2. MULTIMETER Switch S2 and MULTIMETER M1.

   This switch controls the function monitored by the meter. A list of multimeter readings is supplied by the factory with each unit. Since these readings are only a relative indication, it is recommended that they be checked and logged periodically so that any excessive deviation from normal will be recognized.

3. PWR ADJ Control R1

   This screwdriver adjustment can be used to vary the RF output from less than 5 watts to over 20 watts. If the Exciter is to be used below approximately 12 watts output, it is recommended that the tap on the power transformer secondary be moved to the 75% point. This will limit the maximum output power to less than 12 watts but will cut down on the primary power consumed and lower heat dissipation within the unit. See Section 5-6.

4. FREQ ADJ Control R2

   This screwdriver adjustment can be used to fine tune the Exciter over a range of approximately $\pm$500 Hz.

5. AFC LOCKED Lamp DS1 and Socket XDS1

   This lamp indicates when the FMO is locked to the reference crystal oscillator. If the FMO is not locked to the reference, sensing circuitry will extinguish lamp DS1 and shut down the RF output of the Exciter. It is normal for this lamp to light and RF power to appear within a few seconds after the Exciter is energized.

3-2 CONTROLS AND CONNECTIONS (REAR PANEL)

1. MONO/COMP Switch S3

   This switch selects either the mono or stereo input signals. In the mono position, the input signal is automatically pre-emphasized in accordance with the 75 usec curve.

2. RF OUT Jack J1.

3. COMP Jack J2.

   Approximately 3.5 Vpp across 10K is required for 75 kHz deviation.

4. SCA Jacks J3 and J4.

   Approximately 1Vpp across 10K is required for 7.5 kHz deviation.

5. METER Jack J5.

   This jack provides access to the PA voltage and current information required by the optional meter panel. This panel is used when the Exciter is used as a low power transmitter.

6. TB1.

   This is a 600 ohm balanced audio input. +10 dBm ±1 dB is required for 75 kHz deviation at 400 Hz. This input is always pre-emphasized. The center terminal of TB1 is connected to chassis ground.

7. FUSE F1 and XF1.

   This is the primary power fuse for the unit. It is the only fuse necessary since all power supplies are short circuit protected. It should be replaced only with a fuse of the same type and rating as the original (3AG 1A).

3-3 INITIAL OPERATION

1. Operate POWER switch and verify that LED CR2 is lit.

2. Verify that AFC LOCKED lamp lights and RF output appears within a few seconds.

3. Check MULTIMETER readings against factory supplied information. Readings should agree within ±10%.

   NOTE: The RF reading will vary somewhat depending on the RF load connected to the Exciter.

3-4 NORMAL OPERATION

For normal operation, use PWR ADJ Control R1 to set power output to level required. Check MULTIMETER readings periodically to verify that no drastic changes have taken place.

Use FREQ ADJ control R2 to fine tune Exciter to exact frequency. Remember that a phase locked Exciter does not exhibit the drift of a frequency locked exciter. Be sure that any frequency error is in the Exciter and not in the measuring instrument before you attempt to tune the Exciter.

Use signal levels in Section 3-2 to get approximate 100% levels and use as FCC Type Approved modulation monitor QEI Model 691 or equivalent for exact determination of modulation.

SECTION 4

THEORY OF OPERATION

4-1 GENERAL

Refer to block diagram of the Exciter. The Exciter circuitry is on three circuit boards: A2-FMO and Phase Lock Assembly; A3-IPA and PA Assembly; and A4-Power Supply Regulator Assembly.

1. A2 FMO and Phase Lock Assembly

   A packaged on carrier direct FM oscillator sub-assembly produces the basic signal. This signal is amplified by the FMO buffer and control amplifier to a level of approximately 100 mw. A sample if this signal is fed to a high speed divider which reduces the frequency to nominally 5 MHz (fc/20). This 5 MHz signal is then processed by the programmable divider whose output is 5 kHz regardless of the assigned frequency. The output of an 8 MHz crystal controlled oscillator is digitally divided to 5 kHz. This signal is phase compared with the output of the programmable divider and the resulting signal is filtered and used to control the FM oscillator sub-assembly. Thus, the programmable divider allows the use of the same high stability 8 MHz reference crystal regardless of channel assignment.

It should be noted that a phase locked loop requires a phase error <u>not</u> a <u>frequency</u> error to generate its correction signal. Because of this, the output of a phase locked exciter exhibits long term phase coherence with the reference oscillator without the frequency drift associated with frequency locked loop exciters.

Circuitry is included that senses lock and provides a signal that cuts off the control amplifier thereby shutting off the RF output until lock is established.

2. A3-IPA and PA Assembly.

   This board contains a two stage amplifier which raises the 100 mw output of the A2 assembly to a level of 20 watts. The transistors are of the emitter ballasted type and this in conjunction with the circuit and power supply design allow operation into any magnitude or phase of VSWR without damage. However, good operating practice dictates that this VSWR protection not be abused. Do not knowingly operate the Exciter without a proper RF load.

3. A4-Power Supply Regulator Assembly.

This board contains three power supplies. The IPA-PA power supply regulator, the +15V FMO regulator and the 5V FMO logic regulator. All of these supplies are short circuit protected. the IPA-PA supply can be varied from approximately 14V to 24V using the PWR ADJ control for the purpose of controlling the output power of the Exciter.

4-2 DETAIL CIRCUIT DESCRIPTION

1. A2 FMO and Phase Lock Assembly.

The output of the FMO sub-assembly is fed to the base of Q1, the FMO buffer. This stage drives Q3, the control amplifier and U1, a high speed emitter coupled logic (ECL) flip-flop. Q3 raises the power level to approximately 100 mw, a level sufficient to drive the IPA. If an unlocked condition is sensed, a signal is developed which causes Q2 to conduct thereby shorting the base of Q3 to ground and shutting off the RF output.

Q4 provides level matching between the output of U1 (fc ÷ 2) and the input of U2. U2 is a high speed divide by 10 circuit. The output of U2 is therefore fc ÷ 20. U3, U4, U5, and U6 make up the programmable divider. By grounding the appropriate points (as shown in Table 5-1), this circuit can be made to divide by any whole number from 2 to 2000. For operation in the FM band, the circuit is made to divide by a number between 881 and 1079. When this is done, the output frequency of the programmable divider is 5 kHz when the FMO is operating on the assigned channel.

Q14, Y1 and associated circuitry form a stable 8 MHz crystal oscillator which provides the reference frequency for the system. C27 is the coarse tune capacitor and Q8 (a transistor used as a varicap) provides the voltage controlled fine tuning. Q8 is controlled by the FREQ ADJ pot on the front panel. Q9 buffers the output of the reference oscillator and provides level matching to drive U7. U7, U8, and U9 are TTL integrated circuits. The output of U9 is 8 MHz ÷ 1600 or 5 kHz. This 5 kHz square wave is differentiated and applied to Q7. When Q7 conducts, it discharges C21. C21 is charged through constant current source Q6, R46, and R47. The result of this action is to convert the 5 kHz square wave to a linear 5 kHz sawtooth. R47 is an amplitude and linearity adjustment.

The 5 kHz output of the programmable divider drives pulse amplifier Q5. The output of Q5 and the sawtooth converter are coupled to U12. This IC and associated circuitry form a "sample hold" phase detector. U12 is a gated Operation Transconductance Amplifier. This device has a high impedance (constant current) output. R39 and C20 form a storage circuit. U12 charges this storage circuit to the point on the input sawtooth which is coincident with the pulse from Q5.

Therefore, as the phase angle between the reference derived and the FMO derived 5 kHz signals changes, the voltage on C20 rides up or down. However, since the voltage can change only when the pulse from Q5 is present, the filter required to eliminate the reference frequency is greatly reduced. U11 is a high input inpedance voltage follower which eliminates any loading of the storage circuit. The low impedance output of U11 is filtered and applied to the AFC control port of the FMO sub-assembly thereby closing the control loop.

Q10 buffers the output of U9 (reference 5 kHz) and drives the REF position on the MULTIMETER.

U10, Q11, and Q12 form the circuit that senses lock. A 5 kHz square wave from U9 and a 5 kHz pulse from the programmable divider are fed to U10. If the two inputs are not locked, a square wave will appear at pin 6 of U10. This signal is converted to a DC level by Q11 and this level is applied to Q12 which drives the other half of U10. The output of U10 is then fed to Q2 where it shuts down the RF output and to Q13 which turns off the AFC LOCKED lamp.

2. A3 IPA and PA Assembly

The output of the A2 Assembly (approximately 100 mw) is applied to T1. T1 and T2 provide impedance matching to the base of Q1, the IPA. C2 stabilizes the amplifier throughout the power adjust range. C7, C8, and L2 provide impedance matching between the collector of Q1 and the base of Q2, the PA. L5, C14, and C15 provide impedance matching between the collector of Q2 and the load. CR1 and associated circuitry drives the RF position on the MULTIMETER. Parallel bypass capacitors are used on both stages to insure that the power supply is bypassed for all frequencies. This precaution is necessary due to the extremely high low frequency gain of RF power transistors. If adequate bypassing is not used, low frequency oscillations of a sufficient magnitude to destroy the transistor can occur. Do not operate the Exciter with any of these bypass capacitors disconnected. Although the PA can withstand VSWR without damage, good operating practice dictates that the Exciter should not knowingly be operated without a proper load.

3. A4 Power Supply Regulator Assembly.

   a. IPA-PA Regulator

      A 12 volt zener diode, CR4, is the reference for this supply. The PWR ADJ control R1 (front panel control) supplies all or part of the 12 volts across CR4 to the base of Q2. Q2 and Q3 form a DC amplifier with a gain of approximately 2. This raises the voltage supplied to the base of pass transistor A1Q1 (mtd. on heat sink on rear of unit) to approximately 24.7 volts max.

The emitter of the pass transistor supplies the load through R12. If the current drawn through R12 is excessive, the voltage drop across R12 will exceed the forward voltage necessary to cause Q4 to conduct. When Q4 conducts, it fires SCR CR3 which shorts out the reference thereby causing the supply to shut down. When this occurs, C1 starts to charge through R11. When the voltage at the junction of R11 and C1 becomes more negative than the gate voltage of SCR CR1, CR1 fires discharging C1. The resulting pulse causes Q1 to momentarily interrupt the holding current through CR3 thereby cutting off CR3. This action resets the supply automatically.

b. 15 Volt Regulator

Zener diode CR6 is the reference for this regulator. Q5 and Q7 amplify the voltage across this diode to approximately 15 volts. Q6 acts similar to Q4 if the current drawn from the supply exceeds approximately 100 ma.

c. 5 Volt Regulator

A 6.3 volt zener diode CR5 is the reference for this regulator. Q8 buffers the voltage across this diode and drives the chassis mounted pass transistor A1Q2. Q9 and R25 provide the current limit function for this supply. The limit point is approximately 500 ma.

SECTION 5

ALIGNMENT AND TROUBLE SHOOTING

5-1 EQUIPMENT REQUIRED BUT NOT SUPPLIED

1. RF load (50 ohms - 20 watts min.)
2. RF Wattmeter (Bird 43 or equivalent)
3. FM Modulation Monitor (QEI 691 or equivalent)
4. Audio Generator (less than .1% distortion)
5. Distortion Analyzer (Hewlett Packard 331 or Equivalent)
6. Dual Trace 10 MHz Oscilloscope (Telequipment D54 or equivalent)
7. 110 MHz Counter (Stability better than 1 part in 10)
8. Signal Sampler (-20 to -30 dB output)
9. Spectrum Analyzer

NOTE: DO NOT ATTEMPT TROUBLESHOOTING OR ALIGNMENT OF THIS UNIT WITHOUT ADEQUATE TOOLS AND TEST EQUIPMENT.

Before starting alignment of this unit, verify that three supply voltages are present and correct. Connect the Exciter to a suitable (50 ohm - 20 watt) RF load through the signal sampler.

5-2 FMO AND PHASE LOCK ASSEMBLY ALIGNMENT

1. AFC Adjustment

   a. Connect a scope to test point "L". Adjust A2R47 for the greatest amplitude linear 5 kHz sawtooth obtainable.

   b. Connect a scope to pin 6 of A2U11. Adjust trimmer accessible through hole in FMO can until pin 6 shows a DC level. Either side of lock will give a sawtooth signal whose frequency becomes lower as lock is approached.

2. Modulation Level Adjustment

   a. Connect an FM Modulation Monitor to the low level output of the signal sampler.

   b. Connect a 400 Hz +10 dBm signal to TB1. Place S3 in MONO position. Adjust A2R31 until monitor reads 100%.

   c. Connect a 400 Hz 3.5 Vpp (1.25 Vrms) signal to COMP jack J2. Place S3 in COMP position. Adjust A2R65 until monitor reads 100%.

3. Coarse Frequency Adjustment

   a. Connect a counter to the low level output of the signal sampler.

NOTE: BE SURE OF THE ACCURACY AND STABILITY OF THE COUNTER

b. Remove all modulation from the Exciter. If any modulation is present, it is necessary for the counter to have a gate time of at least four seconds in order to obtain a correct reading.

c. Set FREQ ADJ pot R2 to the center of its range.

d. Adjust A2C27 until Exciter is on frequency.

e. Vary FREQ ADJ pot R2 from end to end. Frequency should vary approximately ±500 Hz. Reset Exciter on frequency.

5-3 POWER AMPLIFIER ALIGNMENT

1. Coarse Alignment

a. Connect a power meter capable of displaying 25W to the RF OUT jack J1 located on the rear panel of the unit. Connect a signal sampling probe to the output of the power meter. Connect a spectrum analyzer to the probe. Connect a 50 ohm dummy load to the output of the signal sampling probe. Be sure that the power meter and dummy load are designed to use at FM broadcast frequencies.

b. Apply power to the unit and observe pilot lamp CR2 and AFC LOCKED lamp DS1. If lamp does not illuminate, refer to FMO alignment procedure.

c. Set PWR ADJ control R1 full clockwise. Set the MULTIMETER switch S2 to the IPA position. Set A3C2 to mid-range.

d. Observe an indication of IPA collector current on the multimeter. Maximize this indication by adjusting A2C6 and A2C7 of the A2 board.

e. Set the multimeter switch to the PA position. Adjust A3C7 and A3C8 for a maximum reading in this position.

f. Set the multimeter switch to the RF position. Adjust A3C14 and A3C15 for a maximum reading in this position. The coarse alignment is now complete.

2. Final Alignment

a. Set MULTIMETER switch S2 to the RF position. Adjust A3C14 and A3C15 for maximum reading on the multimeter. If the Power Amplifier draws excessive current and trips the power supply overload circuitry, adjust A3C15 clockwise until this condition is corrected. When this condition appears, the output power is in excess of 20 watts. Adjust A3C15 clockwise to reduce the output power to 20 watts. Readjust A3C14 for a maximum reading on the multimeter.

b. Adjust A3C7 and A3C8 for a maximum reading on the MULTIMETER.

c. Adjust A3C2 for stability as observed on the spectrum analyzer as follows:

Turn the PWR ADJ control R1 to the max, CCW position. Adjust A3C2 for stability as observed on the spectrum analyzer. Turn the PWR ADJ control to the max. CW position. Adjust A3C2 if necessary to stabilize the unit.

5-4 EXCITER-TRANSMITTER INTERFACE

When connecting the Exciter to the Transmitter, tuning of the transmitter input circuitry will be facilitated by the use of a 3dB 20 watt pad and a thru-line wattmeter between the Exciter and the Transmitter. If these devices are not available, reduce the output power of the exciter and tune the input of the transmitter until a somewhat reasonable match is obtained. If the Transmitter is already tuned to exciter frequency, a "touch up" adjustment should be all that is necessary. If the IPA of the transmitter can be mistuned to the point of oscillation, be sure to use the 3dB pad. It is possible to drive large amounts of power back into the Exciter from an oscillating IPA thereby destroying the output transistor.

5-5 TROUBLESHOOTING

Refer to schematics for waveform and voltage information. Using these, the theory of operation in Section 4 and the test equipment listed should allow a competent engineer to diagnose most problems. If factory help is required, it is as close as your telephone.

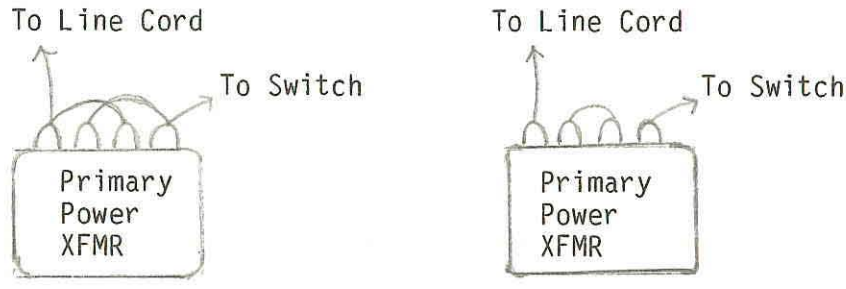
In addition, do not attempt replacement of components on printed circuit boards unless you are familiar with this work. All PC boards can be severely damaged by using the wrong tools or methods. Do not use a soldering iron over 25 watts or anything other than 60/40 ROSIN core solder. Use a "solder sucker" or "solder wick" wire to remove a component.

Because the Power Supplies are overload protected, it is possible for a defect on the A2 or A3 boards to cause a voltage to be either missing or less than nominal. If a voltage is low or missing, remove the load and see if th voltage returns.

5-6 POWER TRANSFORMER WIRING

1. Input Voltage Change

a. Change jumpers as shown on next page.



105-125V Connection

210-250V Connection

NOTE: Refer to Chassis Schematic for further details.

b. Mark rear of chassis to show supply for which unit is wired.

2. Tap Change

a. If Exciter is to be used below 12 watts, connect Red/Yellow lead to CR1 instead of Yellow lead. This change will limit output power to approximately 12 watts, but will reduce heat dissipation within the unit.

b. Change A4R10 from 820 ohm to 1.5K. This insures that the IPA-PA supply stays in regulation with the reduced input voltage.

c. Change A4R19 from 120 ohm 2 watt to 68 ohm 2 watt. This insures that the +15 volt supply stays in regulation.

TABLE 5-1

PROGRAM KEY

X---TIE TO GROUND O---OPEN *--- SHORT

FREQ. MHz	X1-X2	A1	B1	C1	D1	A2	B2	C2	D2	A3	B3	C3	D3
88.1	0		X	X					X	X	X	X	
88.3	0		X	X	X	X	X	X		X	X	X	
88.5	0			X	X	X	X	X		X	X	X	
88.7	0		X		X	X	X	X		X	X	X	
88.9	0				X	X	X	X		X	X	X	
89.1	0		X	X		X	X	X		X	X	X	
89.3	0		X	X	X		X	X		X	X	X	
89.5	0			X	X		X	X		X	X	X	
89.7	0		X		X		X	X		X	X	X	
89.9	0				X		X	X		X	X	X	
90.1	0		X	X			X	X		X	X	X	
90.3	0		X	X	X	X	X	X	X		X	X	
90.5	0			X	X	X	X	X	X		X	X	
90.7	0		X		X	X	X	X	X		X	X	
90.9	0				X	X	X	X	X		X	X	
91.1	0		X	X		X	X	X	X		X	X	
91.3	0		X	X	X		X	X	X		X	X	
91.5	0			X	X		X	X	X		X	X	
91.7	0		X		X		X	X	X		X	X	
91.9	0				X		X	X	X		X	X	
92.1	0		X	X			X	X	X		X	X	
92.3	0		X	X	X	X		X	X		X	X	
92.5	0			X	X	X		X	X		X	X	
92.7	0		X		X	X		X	X		X	X	
92.9	0				X	X		X	X		X	X	
93.1	0		X	X		X		X	X		X	X	
93.3	0		X	X	X			X	X		X	X	
93.5	0			X	X			X	X		X	X	
93.7	0		X		X			X	X		X	X	
93.9	0				X			X	X		X	X	
94.1	0		X	X				X	X		X	X	
94.3	0		X	X	X	X	X		X		X	X	
94.5	0			X	X	X	X		X		X	X	
94.7	0		X		X	X	X		X		X	X	
94.9	0				X	X	X		X		X	X	

FREQ. MHZ	X1-X2	A1	B1	C1	D1	A2	B2	C2	D2	A3	B3	C3	D3
95.1	0		X	X		X	X		X		X	X	
95.3	0		X	X	X		X		X		X	X	
95.5	0			X	X		X		X		X	X	
95.7	0		X		X		X		X		X	X	
95.9	0				X		X		X		X	X	
96.1	0		X	X			X		X		X	X	
96.3	0		X	X	X	X			X		X	X	
96.5	0			X	X	X			X		X	X	
96.7	0		X		X	X			X		X	X	
96.9	0				X	X			X		X	X	
97.1	0		X	X		X			X		X	X	
97.3	0		X	X	X				X		X	X	
97.5	0			X	X				X		X	X	
97.7	0		X		X				X		X	X	
97.9	0				X				X		X	X	
98.1	0		X	X					X		X	X	
98.3	0		X	X	X	X	X	X			X	X	
98.5	0			X	X	X	X	X			X	X	
98.7	0		X		X	X	X	X			X	X	
98.9	0				X	X	X	X			X	X	
99.1	0		X	X		X	X	X			X	X	
99.3	0		X	X	X		X	X			X	X	
99.5	0			X	X		X	X			X	X	
99.7	0		X		X		X	X			X	X	
99.9	0				X		X	X			X	X	
100.1	*	X	X	X	X	X	X	X	X	X	X	X	X
100.3	*	X		X	X	X	X	X	X	X	X	X	X
100.5	*	X	X		X	X	X	X	X	X	X	X	X
100.7	*	X			X	X	X	X	X	X	X	X	X
100.9	*	X	X	X		X	X	X	X	X	X	X	X
101.1	*	X	X	X	X		X	X	X	X	X	X	X
101.3	*	X		X	X		X	X	X	X	X	X	X
101.5	*	X	X		X		X	X	X	X	X	X	X
101.7	*	X			X		X	X	X	X	X	X	X
101.9	*	X	X	X			X	X	X	X	X	X	X
102.1	*	X	X	X	X	X		X	X	X	X	X	X
102.3	*	X		X	X	X		X	X	X	X	X	X
102.5	*	X	X		X	X		X	X	X	X	X	X
102.7	*	X			X	X		X	X	X	X	X	X
102.9	*	X	X	X		X		X	X	X	X	X	X

FREQ. MHz	X1-X2	A1	B1	C1	D1	A2	B2	C2	D2	A3	B3	C3	D3
103.1	*	X	X	X	X			X	X	X	X	X	X
103.3	*	X		X	X			X	X	X	X	X	X
103.5	*	X	X		X			X	X	X	X	X	X
103.7	*	X			X			X	X	X	X	X	X
103.9	*	X	X	X				X	X	X	X	X	X
104.1	*	X	X	X	X	X	X		X	X	X	X	X
104.3	*	X		X	X	X	X		X	X	X	X	X
104.5	*	X	X		X	X	X		X	X	X	X	X
104.7	*	X			X	X	X		X	X	X	X	X
104.9	*	X	X	X		X	X		X	X	X	X	X
105.1	*	X	X	X	X		X		X	X	X	X	X
105.3	*	X		X	X		X		X	X	X	X	X
105.5	*	X	X		X		X		X	X	X	X	X
105.7	*	X			X		X		X	X	X	X	X
105.9	*	X	X	X			X		X	X	X	X	X
106.1	*	X	X	X	X	X			X	X	X	X	X
106.3	*	X		X	X	X			X	X	X	X	X
106.5	*	X	X		X	X			X	X	X	X	X
106.7	*	X			X	X			X	X	X	X	X
106.9	*	X	X	X		X			X	X	X	X	X
107.1	*	X	X	X	X				X	X	X	X	X
107.3	*	X		X	X				X	X	X	X	X
107.5	*	X	X		X				X	X	X	X	X
107.7	*	X			X				X	X	X	X	X
107.9	*	X	X	X					X	X	X	X	X

SECTION 6

PARTS LIST (CHASSIS)

REF. DES.	DESCRIPTION	QEI PART NO.
A1A2	Assembly, FMO & Phase Lock	100-6753001
A1A3	Assembly, IPA-PA	100-6753003
A1A4	Assembly, Power Supply Reg.	100-6753004
A1C1	Capacitor, Cer., .01uf, 1KV	110-0103-K
A1C2	Capacitor, Cer., .01uf, 1KV	110-0103-K
A1C3	Capacitor, Elect. 4900uf, 50V	110-3508-25
A1C4	Capacitor, Elect., 5000uf, 15V	110-3308
A1C5	Capacitor, Feed thru, 1000pf	110-7102
A1C6	Capacitor, Feed thru, 1000pf	110-7102
A1C7	Capacitor, Feed thru, 1000pf	110-7102
A1C8	Capacitor, Feed thru, 1000pf	110-7102
A1C9	Capacitor, Feed thru, 1000pf	110-7102
A1C10	Capacitor, Feed thru, 1000pf	110-7102
A1C11	Capacitor, Feed thru, 1000pf	110-7102
A1C12	Capacitor, Feed thru, 1000pf	110-7102
A1C13	Capacitor, Feed thru, 1000pf	110-7102
A1C14	Capacitor, Feed thru, 1000pf	110-7102
A1C15	Capacitor, Feed thru, 1000pf	110-7102
A1C16	Capacitor, Elect., 500uf, 25V	110-3507
A1C17	Capacitor, Cer., .05uf	110-0503
A1C18	Capacitor, Cer., .05uf	110-0503
A1C19	Capacitor, Cer., .01uf, 100V	110-0103
A1CR1	Rectifier, Bridge	113-1960-1
A1CR2	Diode, LED	113-3000
A1DS1	Lamp, Incandescent 28V (327)	117-0327
A1F1	Fuse, AGC 1	120-0002
A1J1	Jack, RF UG-58	130-0004
A1J2	Jack, Coax UG-625	130-0001
A1J3	Jack, Coax UG-625	130-0001
A1J4	Jack, Coax UG-625	130-0001
A1J5	Jack, 3 Ckt.	130-2000
A1J6	Jack, Phono	130-0010
A1M1	Meter, 0-1 ma	145-0004
A1P1	Plug, Power/w line cord	130-5004
A1Q1	Transistor, NPN, 2N3055	160-03055
A1Q2	Transistor, NPN, 2N5294	160-05294
A1R1	Resistor, Var., 5K	RV4LAYSA502A
A1R2	Resistor, Var., 5K	RV4LAYSA502A
A1R3	Resistor, Carb., 5.6K, 1/2W,5%	RC20GF562J
A1R4	Resistor, Carb., 220 ohm, 1/2W,5%	RC20GF221J
A1S1	Switch, SPDT	175-0006
A1S2	Switch, Rotary	175-0005
A1S3	Switch, SPDT	175-0006

REF. DES.	DESCRIPTION	QEI PART NO.
A1T1	Transformer	180-3140
A1TB1	Terminal Board	181-0003
A1XDS1	Socket, Lamp	192-0001
A1XF1	Holder, Fuse	193-0001

A2 FMO AND PHASE LOCK ASSEMBLY

REF. DES.	DESCRIPTION	QEI PART NO.
A2	Assembly, P.C.	100-6753001
A2A1	Sub-Assembly, FMP	6752001
A2C1	Capacitor, Mica, 470pf, DM15	110-1471
A2C2	Capacitor, Feed-thru, 1000pf	110-7102
A2C3	Capacitor, Feed-thru, 1000pf	110-7102
A2C4	Capacitor, Cer., .001uf	110-0102
A2C5	Capacitor, Cer., .001uf	110-0102
A2C6	Capacitor, Var., 5-65pf	110-6565
A2C7	Capacitor, Var., 5-65pf	110-6565
A2C8	Capacitor, Mica, 51pf, DM15	110-1510
A2C9	Capacitor, Mica, 10pf DM15	110-1100
A2C10	Capacitor, Cer., .001uf	110-0102
A2C11	Capacitor, Cer., .1uf	110-0104
A2C12	Capacitor, Tant., 1.0uf	110-3105T
A2C13	Capacitor, Mica, 470pf	110-1471
A2C14	Capacitor, Cer., .001uf	110-0102
A2C15	Capacitor, Cer., .01uf	110-0103
A2C16	Capacitor, Cer., .01uf	110-0103
A2C17	Capacitor, Poly., .01uf, 5%	110-4103
A2C18	Capacitor, Mica, DM15	SELECTED
A2C19	Capacitor, Mica, 24pf, DM15	110-1240
A2C20	Capacitor, Mica, 120pf, DM15	110-1121
A2C21	Capacitor, Cer., .01uf	110-0103
A2C22	Capacitor, Cer., .001uf	110-0102
A2C23	Capacitor, Elect., 5.0uf	110-3505
A2C24	Capacitor, Mica, 470pf, DM15	110-1471
A2C25	Capacitor, Mica, 470pf, DM15	110-1471
A2C26	Capacitor, Mica, 22pf, DM15	110-1220
A2C27	Capacitor, Var., 1-10pf	110-6110
A2C28	Capacitor, Mica, 10pf, DM15	110-1100
A2C29	Capacitor, Cer., .1uf	110-0104
A2C30	Capacitor, Tant., 1.0uf	110-3105T
A2C31	Capacitor, Cer., .001uf	110-0102
A2C32	Capacitor, Elect., 100uf, 25V	110-3107
A2C33	Capacitor, Tant., 1.0uf	110-3105T
A2C34	Capacitor, Cer., .1uf	110-0104
A2C35	Capacitor, Tant., 1.0uf	110-3105T
A2C36	Capacitor, Elect., 5uf, 25V	110-3505
A2C37	Capacitor, Cer., .001uf	110-0102

REF. DES.	DESCRIPTION	QEI PART NO.
A2C38	Capacitor, Cer., .05uf	110-0503
A2C39	Capacitor, Mica, 1000pf	110-1102
A2C40	Capacitor, Elect., 15uf	110-3156
A2C41	Capacitor, Cer., .1uf	110-0104
A2C42	Capacitor, Elect., 100uf	110-3107
A2CR1	Diode	113-04446
A2CR2	Diode	113-04446
A2CR3	Diode	113-04446
A2CR4	Diode	113-04446
A2CR5	Diode	113-04446
A2CR6	Diode	113-04446
A2CR7	Diode	113-04001
A2CR8 - CR11	Diode Assembly	113-04446-4
A2L1	Inductor, RFC	140-2016
A2L2	Inductor, RF, 4 turn	
A2P1	Plug, Coax	130-0011
A2Q1	Transistor, NPN, 2N3866	160-03866
A2Q2	Transistor, NPN, 2N4401	160-04401
A2Q3	Transistor, NPN, 2N3866	160-03866
A2Q4	Transistor, NPN, 2N5179	160-05179
A2Q5	Transistor, PNP, 2N4403	160-04403
A2Q6	Transistor, FET, 2N3819	160-13819
A2Q7	Transistor, NPN, 2N4401	160-04401
A2Q8	Transistor, PNP, 2N4403	160-04403
A2Q9	Transistor, NPN, 2N4401	160-04401
A2Q10	Transistor, NPN, 2N4401	160-04401
A2Q11	Transistor, NPN, 2N4401	160-04401
A2Q12	Transistor, NPN, 2N4401	160-04401
A2Q13	Transistor, NPN, 2N4401	160-04401
A2Q14	Transistor, NPN, 2N4401	160-04401
A2R1	Resistor, Carb., 2.2K,1/2W,5%	RC20GF222J
A2R2	Resistor, Carb., 560 ohm,1/2W,5%	RC20GF561J
A2R3	Resistor, Carb., 51 ohm,1/2W,5%	RC20GF510J
A2R4	Resistor, Carb., 270 ohm,1/2W,5%	RC20GF271J
A2R5	Resistor, Carb., 2.2K,1/2W,5%	RC20GF222J
A2R6	Resistor, Carb., 220 ohm,1/2W,5%	RC20GF221J
A2R7	Resistor, Carb., 4.7K,1/2W,5%	RC20GF472J
A2R8	Resistor, Carb., 2.2K,1/2W,5%	RC20GF222J
A2R9	Resistor, Carb., 2.2K,1/2W,5%	RC20GF222J
A2R10	Resistor, Carb., 51 ohm,1/2W,5%	RC20GF510J
A2R11	Resistor, Carb., 3.3K,1/2W,5%	RC20GF332J
A2R12 - A2R24	Resistor, Carb., 4.7K,1/4W,5%	RC07GF472J
A2R25	Resistor, Carb., 330 ohm,1/2W,5%	RC20GF331J
A2R26	Resistor, Carb., 3.3K,1/2W,5%	RC20GF332J
A2R27	Resistor, Carb., 620 ohm,1/2W,5%	RC20GF621J
A2R28	Resistor, Carb., 220 ohm,1/2W,5%	RC20GF221J
A2R29	Resistor, Carb., 560 ohm,1/2W,5%	RC20GF561J
A2R30	Resistor, Carb., 1.5K,1/2W,5%	RC20GF152J
A2R31	Resistor, Var., 1K	167-3102

REF. DES.	DESCRIPTION	QEI PART NO.
A2R32	Resistor, Film, 7.87K,1/4W,1%	165-7871
A2R33	Resistor, Film, 499 ohm,1/4W,1%	165-4990
A2R34	Resistor, Carb., 1K, 1/2W,5%	RC20GF102J
A2R35	Resistor, Carb., 1K, 1/2W,5%	RC20GF102J
A2R36	Resistor, Carb., 33K, 1/2W,5%	RC20GF333J
A2R37	Resistor, Carb., 33K, 1/2W,5%	RC20GF333J
A2R38	Resistor, Carb., 4.7K, 1/4W,5%	RC07GF472J
A2R39	Resistor, Carb., 270 ohm, 1/2W,5%	RC20GF271J
A2R40	Resistor, Carb., 3.3K, 1/2W,5%	RC20GF332J
A2R41	Resistor, Carb., 3.3K, 1/2W,5%	RC20GF332J
A2R42	Resistor, Carb., 27K, 1/2W,5%	RC20GF273J
A2R43	Resistor, Carb., 1.5K, 1/2W,5%	RC20GF152J
A2R44	Resistor, Carb., 4.7K, 1/4W,5%	RC07GF472J
A2R45	Resistor, Carb., 8.2K, 1/2W,5%	RC20GF822J
A2R46	Resistor, Carb., 1K, 1/2W,5%	RC20GF102J
A2R47	Resistor, Var., 10K	167-3103
A2R48	Resistor, Carb., 4.7K, 1/4W,5%	RC07GF472J
A2R49	Resistor, Carb., 330 ohm, 1/2W,5%	RC20GF331J
A2R50	Resistor, Carb., 10K, 1/2W,5%	RC20GF103J
A2R51	Resistor, Carb., 10K, 1/2W,5%	RC20GF103J
A2R52	Resistor, Carb., 270 ohm,1/2W,5%	RC20GF271J
A2R53	Resistor, Carb., 2.2K,1/2W/5%	RC20GF222J
A2R54	Resistor, Carb., 100K,1/2W,5%	RC20GF104J
A2R55	Resistor, Carb., 2.7K,1/2W,5%	RC20GF272J
A2R56	Resistor, Carb., 1.5K,1/2W,5%	RC20GF152J
A2R57	Resistor, Carb., 470 ohm,1/2W,5%	RC20GF471J
A2R58	Resistor, Carb., 2.2K,1/2W,5%	RC20GF222J
A2R59	Resistor, Carb., 1.5K,1/2W,5%	RC20GF152J
A2R60	Resistor, Carb., 820 ohm,1/2W,5%	RC20GF821J
A2R61	Resistor, Carb., 820 ohm,1/2W,5%	RC20GF821J
A2R62	Resistor, Carb., 1.5K,1/2W,5%	RC20GF152J
A2R63	Resistor, Carb., 10K,1/2W,5%	RC20GF103J
A2R64	Resistor, Carb., 10K,1/2W,5%	RC20GF103J
A2R65	Resistor, Var., 10K	167-3103
A2R66	Resistor, Carb., 10K,1/2W,5%	RC20GF103J
A2R67	Resistor, Carb., 470K,1/2W,5%	RC20GF474J
A2R68	Resistor, Carb., 10K,1/2W,5%	RC20GF103J
A2R69	Resistor, Carb., 270 ohm,1/2W,5%	RC20GF271J
A2R70	Resistor, Carb., 270 ohm,1/2W,5%	RC20GF271J
A2R71	Resistor, Carb., 1K,1/2W,5%	RC20GF102J
A2T1	Trans., RF	140-2006
A2T2	Trans., Audio	180-2001
A2U1	IC, ECL, 10131	182-10231
A2U2	IC, TTL, 74S196	182-8290
A2U3	IC, TTL, 74192	182-4192
A2U4	IC, TTL, 74192	182-4192
A2U5	IC, TTL, 74192	182-4192

REF. DES.	DESCRIPTION	QEI PART NO.
A2U6	IC, TTL, 7474	182-7474
A2U7	IC, TTL, 7493	182-7493
A2U8	IC, TTL, 7490	182-7490
A2U9	IC, TTL, 7490	182-7490
A2U10	IC, TTL, 7474	182-7474
A2U11	IC, Op Amp, 741	182-1741
A2U12	IC, OTA, CA3080	182-3080
A2Y1	Crystal, 2.5 PPM, 8 MHz	198-0800

A3 IPA-PA ASSEMBLY

REF. DES.	DESCRIPTION	QEI PART NO.
A3	Assembly, Printed Circuit	100-6753003
A3C1	Capacitor, Mica, 39pf, DM15	110-1390
A3C2	Capacitor, Var., 5-65pf	110-6565
A3C3	Capacitor, Cer., .01uf @ 100V	110-0103
A3C4	Capacitor, Elect., 5uf @ 35V	110-3503
A3C5	Capacitor, Cer., Feed-thru, 1000pf	110-7102
A3C6	Capacitor, Mica, 10pf, DM15	110-1100
A3C7	Capacitor, Var., 16-150pf	110-6615
A3C8	Capacitor, Var., 16-100pf	110-6610
A3C9	Capacitor, Cer., .01uf @ 100V	110-0103
A3C10	Capacitor, Cer., .01uf @ 100V	110-0103
A3C11	Capacitor, Cer., .01uf @ 100V	110-0103
A3C12	Capacitor, Elect., 5uf @ 35V	110-3505
A3C13	Capacitor, Cer., Feed-thru, 1000pf	110-7102
A3C14	Capacitor, Var., 4-40pf	110-6440
A3C15	Capacitor, Var., 4-40pf	110-6440
A3C16	Capacitor, Cer., 0.5pf	110-00R5
A3C17	Capacitor, Cer., Feed-thru, 1000pf	110-7102
A3C18	Capacitor, Var., 16-150pf	110-6615
A3C19	Capacitor, Var., 16-100pf	110-6610
A3CR1	Diode, Silicon	113-04446
A3L1	Inductor RF	
A3L2	Inductor RF	
A3L3	Inductor, Wideband Choke	140-2016
A3L4	Inductor RF	
A3L5	Inductor RF	
A3L6	Inductor, Wideband Choke	140-2016
A3L7	Inductor RF	
A3L8	Inductor, Wideband Choke	140-2008
A3Q1	Transistor, NPN, 2N5641	160-05641
A3Q2	Transistor, NPN, 2N5643	160-05643
A3R1	Resistor, Carb., 18K,1/2W,5%	RC20GF183J
A3R2	Resistor, W.W., 34 ohm, 5W	166-0340
A3R3	Resistor, Carb., 2.2K,1/2W,5%	RC20GF222J
A3R4	Resistor, W.W., 27 Ohm, 3W	166-0027
A3R5	Resistor, Carb., 820 Ohm,1/2W,5%	RC20GF821J
A3R6	Resistor, Carb., 2.2K,1/2W,5%	RC20GF222J
A3R7	Resistor, Carb., 1.0K,1/2W,5%	RC20GF102J
A3R8	Resistor, Carb., 10K,1/2W,5%	RC20GF103J
A3R9	Resistor, Carb., 15K,1/2W,5%	RC20GF153J
A3R10	Resistor, Carb., 100 Ohm,1/2W,5%	RC20GF101J
A3R11	Resistor, Carb., 100 Ohm,1/2W,5%	RC20GF101J
A3T1	Trans., Bifilar Wound	140-2266
A3T2	Trans., Bifilar Wound	140-2213

A4 POWER SUPPLY ASSEMBLY

REF. DES.	DESCRIPTION	QEI PART NO.
A4	Assembly, Printed Circuit	100-6753004
A4C1	Capacitor, Tant., 1uf, 35V	110-3105T
A4C2	Capacitor, Cer., .05uf, 16V	110-0503
A4C3	Capacitor, Elect., 100uf, 25V	110-3107
A4C4	Capacitor, Elect., 100uf, 25V	110-3107
A4CR1	Diode, SCR, 2N5061	113-45061
A4CR2	Diode, Silicon, 1N4446	113-04446
A4CR3	Diode, SCR, 2N5061	113-45061
A4CR4	Diode, Zener, 12V, 1N5242	113-25242
A4CR5	Diode, Zener, 5.6V, 1N5232	113-25232
A4CR6	Diode, Zener, 6.3V, 1N5234	113-25234
A4CR7	Diode, Silicon, 1N4001	113-04001
A4CR8	Diode, Silicon, 1N4001	113-04001
A4CR9	Diode, Silicon, 1N4001	113-04001
A4CR10	Diode, Silicon, 1N4001	113-04001
A4Q1	Transistor, NPN, 2N4401	160-04401
A4Q2	Transistor, NPN, 2N4401	160-04401
A4Q3	Transistor, PNP, 2N40410	160-040410
A4Q4	Transistor, PNP, 2N4403	160-04403
A4Q5	Transistor, NPN, 2N40409	160-040409
A4Q6	Transistor, PNP, 2N4403	160-04403
A4Q7	Transistor, NPN, 2N4401	160-04401
A4Q8	Transistor, NPN, 2N3053	160-03053
A4Q9	Transistor, NPN, 2N4401	160-04401
A4R1	Resistor, Carb., 22K,1/2W,5%	RC20GF223J
A4R2	Resistor, Carb., 620 Ohm,1/2W,5%	RC20GF621J
A4R3	Resistor, Carb., 10K,1/2W,5%	RC20GF103J
A4R4	Resistor, Carb., 1.5K,1/2W,5%	RC20GF152J
A4R5	Resistor, Carb., 2.7K,1/2W,5%	RC20GF272J
A4R6	Resistor, Carb., 2.7K,1/2W,5%	RC20GF272J
A4R7	Resistor, Carb., 470 Ohm,1/2W,5%	RC20GF471J
A4R8	Resistor, Carb., 1.2K,1/2W,5%	RC20GF122J
A4R9	Resistor, Carb., 1.2K,1/2W,5%	RC20GF122J
A4R10	Resistor, Carb., 820 Ohm,1/2W,5%	RC20GF821J
A4R11	Resistor, Carb., 330K,1/2W,5%	RC20GF334J
A4R12	Resistor, W.W., .15 Ohm, 3W,10%	166-0015
A4R13	Resistor, Carb., 47K,1/2W,5%	RC20GF473J
A4R14	Resistor, Carb., 2.2K,1/2W,5%	RC20GF222J
A4R15	Resistor, Carb., 2.2K,1/2W,5%	RC20GF222J
A4R16	Resistor, Carb., 3.3K,1/2W,5%	RC20GF332J
A4R17	Resistor, Carb., 820 Ohm,1/2W,5%	RC20GF821J
A4R18	Resistor, Carb., 4.7 Ohm,1/2W,5%	RC20GF4R7J

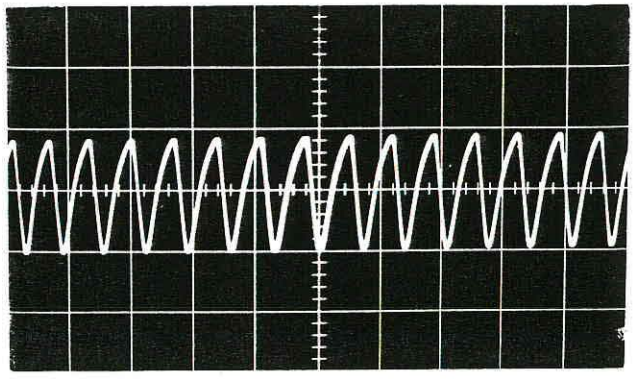
REF. DES.	DESCRIPTION	QEI PART NO.
A4R19	Resistor, Carb., 120 Ohm, 2W,10%	RC42GF121J
A4R20	Resistor, Carb., 27K,1/2W,5%	RC20GF273J
A4R21	Resistor, Carb., 820 Ohm,1/2W,5%	RC20GF821J
A4R22	Resistor, Carb., 180 Ohm,1/2W,5%	RC20GF181J
A4R23	Resistor, Carb., 180 Ohm,1/2W,5%	RC20GF181J
A4R24	Resistor, Carb., 6.8K,1/2W,5%	RC20GF682J
A4R25	Resistor, W.W., .56 Ohm,3W,10%	166-0056
A4R26	Resistor, Carb., 10K,1/2W,5%	RC20GF103J
A4R27	Resistor, Carb., 180 Ohm,1/2W,5%	RC20GF181J
A4R28	Resistor, Carb., 3.3K,1/2W,5%	RC20GF332J

SECTION 7

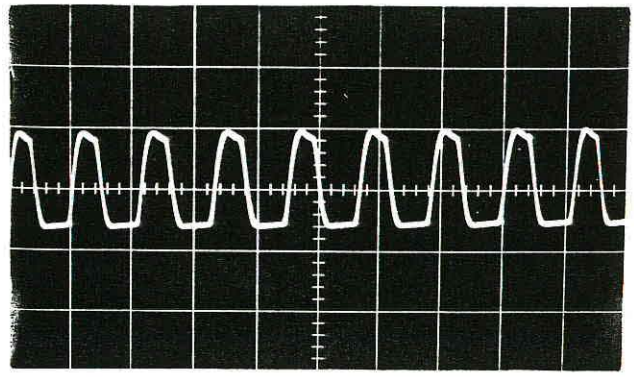
SCHEMATICS, LAYOUTS, WAVEFORMS

WAVEFORMS

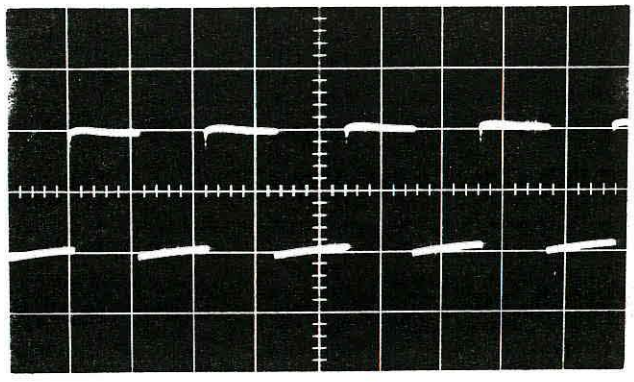
The following waveforms were measured on a 15MHz bandwidth oscilloscope using a 10X low capacity probe. The number below each waveform corresponds to the point at which the measurement was made.



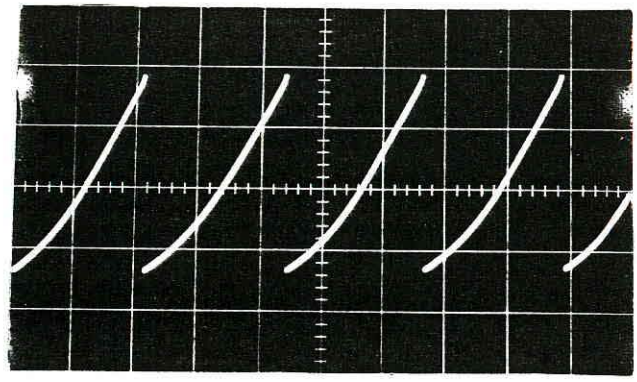
(1) .2usec/cm
.2V/cm



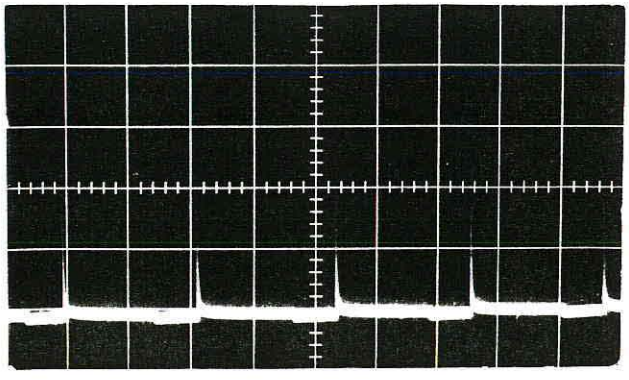
(2) .2usec/cm
.2V/cm



(3) .1msec/cm
.2V/cm



(4) .1msec/cm
.2V/cm



(5) .1msec/cm
.1V/cm