Model 680
FM Exciter

TECHNICAL MANUAL

SPARTA
Division of Cetec Corporation

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IN CASE OF TROUBLE

Before calling the factory for assistance, refer to the trouble shooting Section 5-3. Listed there are a few preliminary checks that should be made if you suspect a problem in the exciter. It is recommended that no tuning or power supply adjustments be made until these checks have been done.

TABLE of CONTENTS

TABLE OF CONTENTS (Continued)

LIST of TABLES

LIST of ILLUSTRATIONS

SECTION I
GENERAL INFORMATION

1-1. INTRODUCTION

This manual contains information required to install, operate and maintain the Sparta Model 680 FM Exciter. Section I describes the exciter and lists its specifications, Section II provides installation instructions, Section III contains operating procedures, and Section IV describes the principles of operation. Maintenance procedures and troubleshooting diagrams are contained in Section V and replaceable parts are identified and listed in Section VI.

1-2. GENERAL DESCRIPTION

The Model 680 FM Exciter (figure 1-1) is an all solid state unit that provides a monaural mode of operation in accordance with FCC and international standards. When used in conjunction with the Type 681 metering panel this exciter becomes a complete 10 watt FM transmitter. When used with the Sparta models 682 stereo generator and 683 SCA generator (or other approved units) the system provides complete stereo and SCA modes of operation.

The Model 680 FM exciter can be used to drive the input stages of any FM Broadcast Transmitter Type accepted by the Federal Communications Commission for use under Part 73 of the Rules.

No complicated adjustments or maintenance procedures are required for operation of this unit. There are no user adjustable controls except for the center - frequency control.

1-2.1 PHYSICAL DESCRIPTION

The Model 680 consists of a single unit of standard rack panel construction. Physical characteristics of the Model 680 are listed in table 1-1.

Table 1-1. Physical Characteristics

Dimensions:	3-1/2" high, 10" deep, 19" wide
Weight:	13 pounds
Construction Style:	1/8" alodined aluminum with painted front panel with mounting flanges notched to mate with standard 19" equipment rack.
Maximum Altitude:	12,500 feet
Maximum Humidity:	0-85% continuous 0-100% limited
Connectors:	RF Output BNC Type Wide band Input (2) All others: Standard barrier strip

1-2.2 FUNCTIONAL DESCRIPTION

The Model 680 FM Exciter provides ten (10) Watts output power into a matched 50 ohm load within the FM broadcast band. It has two wide band inputs and can accept the outputs of a stereo generator and SCA generator simultaneously or the composite output of a STL receiver.

Table 1-2. Electrical Characteristics

Power requirements:	95-135 VAC, 50 to 60 Hz, Single phase, 28 watts nominal
Frequency Range:	85-125 MHz
Power Output:	10 Watts
Output Impedance:	35.5 to 91 ohms resistance, 50 ohms nominal
Load VSWR:	0 to infinity at all phase angles
Modulation:	F3 and F9
Modulation Capability:	± 100 KHz
Harmonic Attenuation:	- 43 db below carrier
Frequency Stability:	± 1 KHz
Ambient Temperature Range:	0° C to + 45° C (+ 32° F to 113° F)
Altitude Range:	To 12,500'
Frequency Response	
Monaural:	+ 0.25 to -0.5 db from 75 US curve
Wide Band:	± 1.0 db 20 Hz to 250 KHz
Wide Band Phase Response:	± 0.25° from phase linearity
FM Noise:	70 db below 100% modulation at 400 Hz
AM Noise:	At least - 55 db below carrier level
Distortion:	0.5 or less all frequencies
Input Impedance	
Monaural Audio:	600 ohms (± 10%) balanced
Wide Band:	1 K unbalanced
Input Levels	
Monaural Audio:	Approx. 0 dbm at 400 Hz
Wide Band:	2 Volts peak to peak (Approx.)
Spurious Sidebands:	- 65 db below carrier to 2.5 MHz
RF Bandwidth:	2.5 MHz at -3 db power points

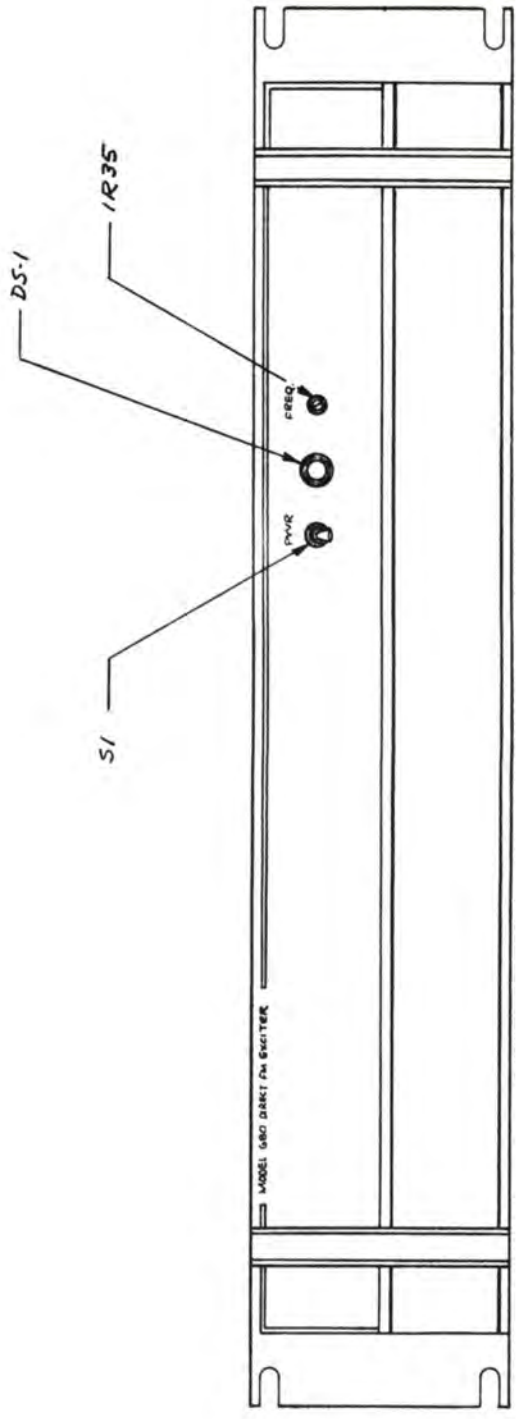


FIGURE 1-1
MODEL 680 DIRECT FM EXCITER
FRONT PANEL

SECTION II
INSTALLATION

2-1. INSTALLATION PLANNING

Dimensions essential to know for proper installation of the Model 680 FM Exciter are shown in figure 2-1.

Install the exciter in the transmitter or in an equipment rack so as to keep it as far as possible from

High Current Transformers

Filter Chokes

Fans, Blowers

High Current AC Power Cables

Hot Resistors

Vacuum Tubes

2-1.1 ENVIRONMENTAL REQUIREMENTS

Location of the Model 680 must be within the following environmental limitations:

a. Maximum altitude : 12,500 feet

b. Maximum temperature : + 45° C (113° F)

c. Minimum temperature : 0° C (32° F)

d. Maximum humidity : 85%

2-1.2 POWER REQUIREMENTS

95-135 VAC, 50 to 60 Hz, 1 Ø, 28 watts nominal

2-1.3 COOLING REQUIREMENTS

The Model 680 is convection cooled and considerations for panel mounting should include adequate space around the unit to permit free flow of air. Use as low a mounting position as possible. The Model 682 stereo generator and the Model 683 SCA generator, if used, should be mounted below the exciter.

2-2. INPUT AND OUTPUT CONNECTIONS

All input and output connections for the Model 680 are made at the rear of the unit. (See figure 1-1).

2-2.1 PRIMARY POWER CONNECTION

117 VAC should be wired to terminals 1 and 2 of TB-1. If only a 220 volt source is available a stepdown transformer is necessary. A recommended type is a Triad Type N-68X.

2-2.2 METER PANEL CONNECTIONS

When used as a 10 watt transmitter the Model 681 meter panel is required. Instructions for connecting this panel will be included with that unit.

2-2.3 CONTROL CONNECTIONS

The power amplifier should be connected so that it will come on whenever the filaments of the transmitter are energized. Terminals 5 and 6 of TB-1 can be used for this function. AC power to the balance of the exciter should remain on at all times.

2-2.4 INPUT SIGNAL CONNECTIONS

Refer to Figure 2-1 for the input signal connections. All audio inputs to the 680 are available for use at the same time therefore when a composite signal from the stereo generator (or STL receiver) is being fed into the wide band input the mono input terminals are still "live". For this reason no signal should be fed into the mono input when in the stereo mode. It is a good practice to bring these terminals out to a patch panel so that, should you ever experience trouble with the stereo equipment, a mono signal could be patched into the exciter. It is not necessary to terminate this input when not in use.

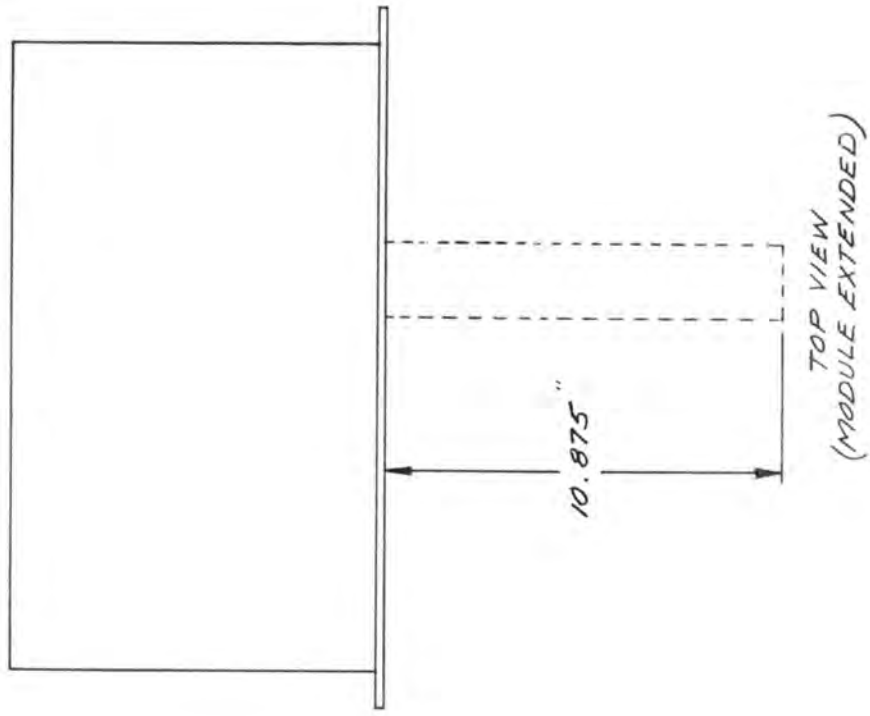
Both of the wide band inputs are identical. Either J1 or J2 can be connected to the composite signal source. The other input can be left open, shorted out or connected to a SCA generator. Since any signal fed into any of the inputs will modulate the transmitter care should be taken in lead connection since a long, unused cable connected to the system might pick up noise and degrade the performance of the system.

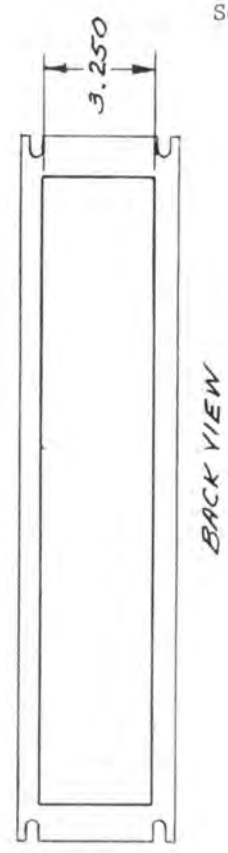
2-2.5 OUTPUT SIGNAL CONNECTION

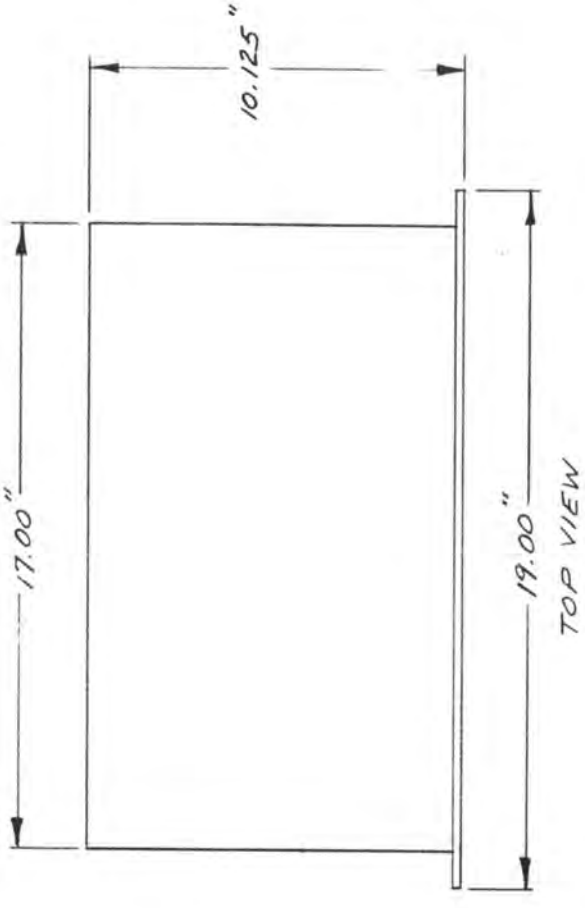
When used as a ten watt transmitter the output of the exciter will be connected to the Model 681 metering panel for power measuring purposes. A full description of this panel and its interconnection with the Model 680 exciter will be included as a part of the 681 hardware. When operating into the early stages of a higher power transmitter attempt should be made to provide a 50 ohm load for the exciter. The grid circuits of most vacuum tube stages can be adjusted to provide the proper load. This can be realized by tuning the input stages for maximum grid current or, for Class AB_2 circuits, for maximum power out of the stage. No attempt should be made to "tune" the exciter to the transmitter - rather, the transmitter should be tuned to the exciter. A bad match to the input grid could cause a lack of drive and this situation can often be improved by changing the length of cable feeding the transmitter.

2-3. TURN-ON PROCEDURE

Assuming that all of the proper connections have been made the 680 can be turned on. It will take approximately 30 seconds for the exciter to lock onto the assigned frequency. Once lock has been accomplished the frequency will be crystal controlled. The center frequency should be adjusted using the front panel control to within $\pm$ 100 Hz of the proper frequency. This is the only adjustment necessary. All other adjustments were factory set and re-adjustment is not necessary. The unit is now ready for operation.







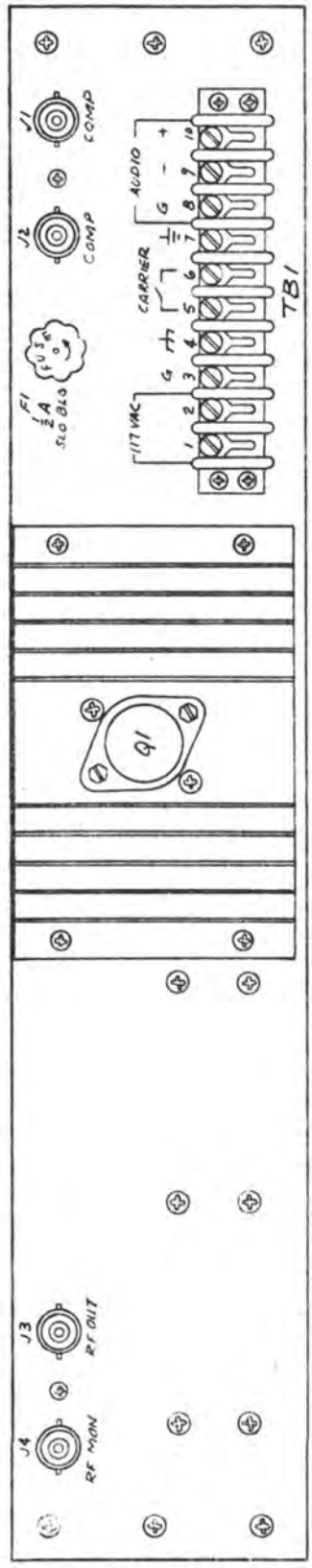


FIGURE 2-2

MODEL 680 DIRECT FM EXCITER -- REAR VIEW

SECTION III
OPERATION

3-1. OPERATING CONTROLS

The Model 680 has only one operating control - the center-frequency adjustment located on the front panel.

3-2. OPERATING PROCEDURE

When operating power is initially applied the exciter will start at 86 MHz and slowly sweep up the band until the digital discriminator locks it to a reference crystal oscillator. This process will take approximately 30 seconds for the top end of the FM band - less for the lower end of the band. Once locked, the exciter will remain crystal controlled.

3-2.1 CHANNELIZATION

The exciter is crystal controlled and completely adjusted for operation on a specific frequency at the factory. The crystal frequency for a specific allocation is computed as follows:

$$F_{xtal} = \frac{F \text{ carrier} + 200 \text{ KHz}}{2}$$

Table 3-1 contains a reference listing of FM broadcast frequency allocations and the required crystal frequency for each allocation.

Table 3-1 FM Frequency allocations/crystal Frequencies

CARRIER FREQUENCY (MHz)	CRYSTAL FREQUENCY (MHz)	CARRIER FREQUENCY (MHz)	CRYSTAL FREQUENCY (MHz)	CARRIER FREQUENCY (MHz)	CRYSTAL FREQUENCY (MHz)
88.1	44.15	94.9	47.55	101.5	50.85
88.3	44.25	95.1	47.65	101.7	50.95
88.5	44.35	95.3	47.75	101.9	51.05
88.7	44.45	95.5	47.85	102.1	51.15
88.9	44.55	95.7	47.95	102.3	51.25
89.1	44.65	95.9	48.05	102.5	51.35
89.3	44.75	96.1	48.15	102.7	51.45
89.5	44.85	96.3	48.25	102.9	51.55
89.7	44.95	96.5	48.35	103.1	51.65
89.9	45.05	96.7	48.45	103.3	51.75
90.1	45.15	96.9	48.55	103.5	51.85
90.3	45.25	97.1	48.65	103.7	51.95
90.5	45.35	97.3	48.75	103.9	52.05
90.7	45.45	97.5	48.85	104.1	52.15
90.9	45.55	97.7	48.95	104.3	52.25
91.1	45.65	97.9	49.05	104.5	52.35
91.3	45.75	98.1	49.15	104.7	52.45
91.5	45.85	98.3	49.25	104.9	52.55
91.7	45.95	98.5	49.35	105.1	52.65
91.9	46.05	98.7	49.45	105.3	52.75
92.1	46.15	98.9	49.55	105.5	52.85
92.3	46.25	99.1	49.65	105.7	52.95
92.5	46.35	99.3	49.75	105.9	53.05
92.7	46.45	99.5	49.85	106.1	53.15
92.9	46.55	99.7	49.95	106.3	53.25
93.1	46.65	99.9	50.05	106.5	53.35
93.3	46.75	100.1	50.15	106.7	53.45
93.5	46.85	100.3	50.25	106.9	53.55
93.7	46.95	100.5	50.35	107.1	53.65
93.9	47.05	100.7	50.45	107.3	53.75
94.1	47.15	100.9	50.55	107.5	53.85
94.3	47.25	101.1	50.65	107.7	53.95
94.5	47.35	101.3	50.75	107.9	54.05
94.7	47.45				

S/N 150 UP

SECTION IV
PRINCIPLES OF OPERATION

4-1. INTRODUCTION

This section describes the principles of operation of the Model 680 FM Exciter. Reference to Figure 5 will help in your understanding of the text.

4-2 POWER SUPPLIES

The 680 FM Exciter utilizes two independant regulated power supplies to provide the proper operating potentials for the various stages. The stages that require a high-current supply - The Radio-Frequency power amplifier on board No. 065-8040 - are supplied by the regulator consisting of active devices Q1, 2Q2, and 2IC2. The regulated voltage is set by potentiometer 2R12 to approximately 12 Volts. Since the operation of this high-current regulator is similar to the operation of the other one consisting of active devices 2Q1, and 2IC1, an explanation of the operation of one will suffice.

Approximately 17 volts RMS from transformer T2 is supplied to the bridge rectifer D1-4. Capacitors C1 and C2 charge to approximately the peak value of the AC input, about 24 volts. This voltage is supplied to the operational amplifier 2IC2, transistor 2Q2 and Q1.

A positive 7 volts is applied to the plus input of the operational amplifier and is kept constant by the action of zener diode 2Z2. Since little or no voltage is present at the minus input (pin 2) of the amplifier until there is voltage present at the output (emitter of Q1), the output terminal (pin 6) of the amplifier will go high (swing towards the supply voltage) and cause current to flow into 2Q2 via resistor 2R10. Transistor 2Q2 operates as an emitter follower and causes current to flow into the base of Q1. This causes the emitter of Q1 to swing towards the supply voltage. The voltage will climb until the voltage at the - input (pin 2) of the operational amplifier exceeds the 7 volts on the + input (pin 3). At this point the output voltage will stabilize. The actual output voltage necessary to cause the circuit to reach this stable state is adjusted by potentiometer 2R12. Because of the large amount of gain enclosed within this feedback loop, excellent stability is achieved and less than 1 mV ripple is present at the output.

The circuit is self-protecting from short circuits. The scheme will be refered to as a "brute force" method of protection. Rather than having extra circuits to fold-back the output if excessive current flows, the 680 simply uses large enough components to withstand short-circuit conditions until the primary fuse has a chance to blow.

4-3 PRE-EMPHASIS AMPLIFIER

Operational Amplifier 1IC1 and its peripheral components comprise a circuit for obtaining the 75 uS time-constant pre-emphasis characteristic required for operation under Part 73 of FCC Rules. Operation is quite simple. The circuit is adjusted to obtain unity voltage gain if 1C2 was removed from the circuit. With capacitor 1C2 re-connected it, and resistor 1R6, comprise an integrator with a time-constant of 75 uS (10K X 7,500 pF = 75 uS). Since the integrator is in the feedback loop the entire amplifier will function as a differentiator with a 75 uS time-constant. This is the required condition for pre-emphasis.

The audio-frequency signal is supplied via input terminals TB1-9 and TB1-10 to the balancing transformer, T1. The output from this transformer is applied to the input terminals of the pre-emphasis amplifier. After the pre-emphasis is accomplished, the signal is routed via resistor 1R11 to the FM Modulator.

An additional signal, without pre-emphasis, is applied to the modulator also. This signal is a wide-band input from J1 and J2. Resistors 1R8, 1R9, 1R12 and Capacitors 1C3, 1C4, and 1C7 comprise a compensated attenuator. This allows 1L1 to be bypassed for RF without destroying the phase-linearity of the modulator.

4-4 OSCILLATOR AND MODULATOR

Transistor 1Q1 and varicap diodes 1D1 and 1D2 comprise a low noise, low distortion, frequency-modulated oscillator. This oscillator operates at the intended carrier frequency between 85 and 125 MHz. The center frequency is maintained within the required tolerance by a digital discriminator and crystal-controlled reference oscillator. The oscillator is a modified Hartley with the feedback necessary to sustain oscillation from collector to base of 1Q1. To understand this circuit it is necessary to consider that capacitors 1C12, 1C16 and inductor 1L3 form a pi-network. Capacitor 1C11 modifies the inductive reactance of 1L3 to make it seem smaller than it is. The same for 1C10 and the vari-caps 1D1 and 1D2. This pi-network provides the necessary 180 degree phase shift necessary to sustain oscillation. The inductive reactance of 1L3 and the combined capacitive reactance of 1C12 and 1C16 equal each other at the frequency of oscillation.

The capacity of vari-cap diodes 1D1 and 1D2 is a function of the voltage across them. Since a change in capacity of the vari-cap diodes will alter the apparent reactance of 1L3 and hence the frequency of oscillation, and AC variation of the DC bias on the vari-caps will cause frequency-modulation of the oscillator. In the same way, changing the DC Bias on these vari-cap diodes will serve to alter the center frequency. This DC bias is continuously adjusted by the digital discriminator circuitry to maintain the oscillator on frequency.

4-5 RADIO FREQUENCY AMPLIFIER

The RF signal from the oscillator is supplied to the buffer amplifier 1Q2. This amplifier is conventional in design and serves to increase the power level to about 1 Watt. This stage feeds a coaxial cable supplying signal to the stripline RF Amplifier module using 3Q1 and 3Q2 as active devices. It is important that this cable be properly matched at all frequencies of interest so it is terminated resistively by 3R1 and 3R2. These resistors, inductor 3L1 and the input impedance of transistor 3Q1 provide a good match with a 1.05: 1 VSWR throughout the entire FM Band. This network attenuates the signal by about 10 db. Transistor 3Q1's sole purpose is to get back to a 1 Watt power level after the input network's power loss.

The input impedance of transistor 3Q2 is about 1/2 ohm and the reactance is about 4 ohms, inductive, in the FM band. Capacitors 3C6, 3C7 and inductor 3L4 comprise a pi-network to transform this hard-to-match impedance to about 5 ohms with little reactance. This new impedance is transformed up to about 25 ohms to match the collector of 3Q1, by capacitors 3C4 and 3C5 as seen from the collector of 3Q1. The operating "Q" of this circuit is about 4. Output transistor 3Q2 only requires about a watt of RF drive to produce over 10 Watts output. The problem is to get this power into the transistor at these very low impedance values. The above-mentioned circuit accomplishes this with a minimum of components and adjustments.

The output impedance of transistor 3Q2 is about 12 ohms. This is transformed up to 50 ohms by capacitors 3C10 and 3C11. As in the input circuitry, 3L7 cancels the reactance of these capacitors at the operating frequency. The other components on the stripline RF assembly serve to stabilize the circuit and feed power to the various stages.

The power output can be varied within narrow limits by using an external resistor between terminals TB1-6 and TB1-5. This is done if the unit is to be used as a complete FM Transmitter. As an exciter, these terminals are strapped together and the power-supply voltage is reduced until exactly 10 Watts is available at the output.

4-6 REFERENCE OSCILLATOR AND SYNC DETECTOR

Transistor 1Q3 and its associated components comprise an overtone crystal oscillator. The crystal operating frequency is selected to equal the operating frequency plus 200 KHz, divided by two. This means that for a carrier frequency of 100.1 MHz, the crystal frequency will be 50.15 MHz. The crystal is a special temperature-stable device, optimized for operation in this circuit. The output from this oscillator feeds a balancing transformer, 1T1. 1T1 supplies current to switch alternate pairs of diodes in the sync detector comprised of diodes 1D3-6. An additional input to the detector comes from the buffer amplifier via 1C23. This input is at the carrier frequency. The synchronous detector is used

essentially as a mixer. An important property of this type if mixer is that it doesn't allow any of the reference oscillator signal to get fed back into the buffer. This would produce a pair of spurious sidebands on the output signal that tend to degrade the operation of stereo demodulators in FM receivers. This makes your FM Station sound a lot worse than it should considering that the proof-of-performance measurements were quite acceptable. Without these spurious sidebands the signal will sound very clean on even the most inexpensive of receivers. Another property of this mixer is that it operates as though it doubled the frequency of the reference oscillator before mixing it with the incoming signal. The mathematics involved are a bit more sophisticated, but for all practical purposes, this is what is happening.

The output of the synchronous detector is a 200 KHz sine wave when the transmitter is on frequency. This sine wave contains both the frequency modulation and the frequency deviation components of the FM carrier. Should the FM carrier frequency change the 200 KHz signal frequency will change also. As the instantaneous frequency of the FM signal is varying with modulation so is the 200 KHz signal.

4-7 200 KHz DISCRIMINATOR

The low level 200 KHz signal from the detector is applied to the input of 1IC2, an operational amplifier connected as a clipper. The output of this stage is a symetrical square wave.

Capacitor 1C32 and resistor 1R31 differentiate the square wave into a sharply-peaked waveform with very steep risetimes. The negative-going edge of this waveform triggers a monostable multivibrator, 1IC3. This multivibrator provides an output pulse of uniform width regardless of the repetition rate of that pulse. Because of this, the duty-cycle of the output waveform is dependent upon frequency. Simple integration of this signal by 1R34 and 1C35 produces a DC potential with an amplitude that is a function of frequency. Circuit constants are chosen so that at 200 KHz the DC voltage is 2 Volts. Since the transfer function of this system is linear, the level will be 4 Volts at 400 KHz and 0 volts at 0 frequency.

1IC4 operates as a DC Amplifier and comparator. The voltage at the inverting input (pin 2) is set by potentiometer R35 and determines the "crossover point" of the discriminator and hence the center frequency of the exciter. The output of this amplifier is applied back to the vari-cap modulators via 1R42 to set their bias and maintain the center frequency of the FM Signal within limits.

The operating potentials for this circuit are very critical since if the power supply voltage were to drift only slightly the crossover point and hence the center frequency would drift considerably. For this reason a special temperature-compensated monolythic regulator (1IC5) has been used to keep all of the important parameters constant. The output of this regulator is 5 Volts. Its input comes from the +15 volt bus.

SECTION V
MAINTENANCE

5-1 PERIODIC MAINTENANCE

No special maintenance procedures are necessary. The Model 680 FM exciter is designed with components that should not exhibit problems throughout the life of the equipment. The devices that have known failure modes (such as aluminum electrolytic capacitors) are not mounted on printed circuit boards where they would be hard to replace. None of the active devices are operating with parameters known to cause time-dependent failure modes.

Once a month the center frequency should be adjusted to maintain it within 100 Hz of the proper frequency. Initially, the center frequency will drift about 250 Hz per month as the crystal ages. This is the normal ageing rate for overtone crystals.

Eventually, this drift will stabilize to about plus or minus 1 KHz per year. If the equipment is operated continuously the drift will be less.

The top and bottom covers should be removed and the dust blown out of the exciter using a soft blast device such as a vacuum cleaner rather than an air compressor. Remember to re-install the covers (both top and bottom) and all screws after cleaning.

5-2. ALIGNMENT AND ADJUSTMENT PROCEDURE

WARNING

Consult the warranty notice in the front of this manual before performing any service on this FM exciter. Should field adjustment or alignment become necessary it should be performed only by experienced personnel having an adequate understanding of digital and stripline techniques.

5-2.1 TEST EQUIPMENT

The following test equipment is required to adjust the Model 680 exciter.

Wideband high frequency oscilloscope	Tektronix 454 or equivalent
7.5 V DC bias supply	9V radio battery and 50K potentiometer
VTVM	Heath IM16 or equivalent
RF Dummy Load and Power Meter	Bird Model 612
Frequency Counter	Hewlett Packard 5300A or equivalent
FM Receiver	KLH Model 21 or equivalent

5-2.2 POWER SUPPLY ADJUSTMENT

(1) Remove jumper from TB1-6 and TB1-5.
(2) Connect 117VAC 50/60 Hz to TB1-1 and TB1-2, ground wire to TB1-3.
(3) Connect positive (+) lead of voltmeter to positive (+) terminal on board #065-8060 - connect common lead to chassis.
(4) Turn on S1, power switch, and adjust 2R6 for EXACTLY 15 volts indicated on the meter.
(5) Connect positive (+) lead of voltmeter to positive (+) terminal on board #065-8040.
(6) Adjust 2R12 to EXACTLY 12 volts.
(7) Remove test leads.

5-2.3 OSCILLATOR ADJUSTMENT

(1) Connect a 7.5 volt DC Bias supply across 1C8. The positive (+) terminal connects to the "hot" side and the negative (-) lead connects to chassis.
(2) Remove crystal 1Y1 from its socket.
(3) Tune a FM Receiver to the assigned frequency of the exciter.
(4) Carefully tune 1L3 with a GC 9302 alignment tool until the carrier is heard on the receiver.
(5) Remove the bias supply and short out capacitor 1C8.
(6) Insert crystal 1Y1 and adjust inductor 1L6 until the carrier is again heard on the FM Receiver.
(7) Turn off exciter.

5-2.4 BUFFER ALIGNMENT

(1) Connect Oscilloscope to either lead of 1C31. Set to maximum vertical sensitivity and a sweep speed of approximately 1mS/cm.
(2) Turn on exciter and remove the short across 1C8. Verify that the exciter locks by observing a stable 100 KHz waveform on the oscilloscope.
(3) Adjust Capacitor 1C22 for a maximum amplitude 100 KHz signal.

5-2.5 POWER AMPLIFIER ALIGNMENT

(1) Connect a dummy load wattmeter to the output terminal, J3, and connect a jumper between terminals TB1-6 and TB1-5.
(2) Adjust 3C10 and 3C11 for maximum power output.
(3) Adjust 3C4 and 3C5 for maximum power output.
(4) Readjust 3C10 and 3C11 for maximum power output
(5) Readjust 3C4 and 3C5 for maximum power output.
(6) Continue until there is no further increase in power output.
(7) Power output should be in excess of ten watts. Reduce power output by reducing regulator output voltage with 2R12.
(8) Measure the reduced voltage. It should be 11.5 volts or less. If not, the amplifier is improperly tuned. Go back over adjustments again.

5-2.6 FINAL EXCITER ADJUSTMENTS

(1) Connect a VTVM across 1C8 and very carefully adjust inductor 1L3 for exactly 7.5 volts.
(2) Connect oscilloscope to 1C31, adjust 1L6 one full turn clockwise from maximum level as indicated on the oscilloscope.
(3) Connect a frequency counter to the RF Monitor jack, J4, and adjust to final frequency using R35, frequency adjust control.
(4) Remove all test equipment leads and reassemble equipment.

5-3. TROUBLESHOOTING

The following information is provided to facilitate trouble shooting of the 680. Information contained in other sections of this manual should be used along with the following table to aid in locating a faulty circuit or component. An understanding of circuit operation is very helpful in locating troubles. See "Principles of Operation" section for complete information.

5-3. TROUBLESHOOTING (Continued)

Before calling the manufacturer for assistance, the following list of checks should be performed if you suspect trouble in the exciter. No tuning or power supply adjustments should be attempted until the checks have been made.

Check for Power Output: Power output from the exciter can be checked with an RF Wattmeter. If a Wattmeter is not available, remove the pilot lamp from its front panel socket and insert the pilot lamp pins between the center and outer conductors of the monitor output, J4. If there is RF the lamp will glow. No RF output may be caused by power supply or RF stage malfunction. Perform power supply checks first.

Check for Frequency: Connect a frequency counter to monitor output, J4, and see if the exciter is on frequency. If a counter is not available use a portable receiver and see if the carrier can be "heard" at the right spot on the dial. If there is RF out but on the wrong frequency (one to several mHz above or below carrier) the problem is most likely in the AFC circuitry. Proceed to AFC check.

Power Supply Checks: a VOM or VTVM is all that is required to check the power supplies. Note that there must be a jumper (or meter if exciter is supplied with a metering panel) across terminals 5 and 6 of TB-1 on rear of exciter. Remove top cover and connect RF output to proper load (50 dummy load or transmitter input). Turn the power on and measure the 15 Volt supply at the red "VCE" test point on the modulator board. Reading should be 15 Volts ± 0.25 Volt. Next, check the 5 Volt regulator at the blue "5"V test Point. The reading should be 5.0 ± 0.2 Volts. The high current supply for the RF amplifier can be checked on the RF amplifier PC board at the junction of 3L6 and 3C9. The reading there should be 10V ± 0.1 Volt. Refer to check-out sheet for factory setting. If the reading is not constant, that is, the voltage swings up and down, this is an indication that there may be no load on the supply. Without RF drive to the RF amplifier it will not draw power supply current. In other words 1Q1 or 1Q2 may be defective or have low gain.

AFC Voltage Check: The AFC circuit produces bias for the varicaps 1D1 and 1D2. When the exciter is operating normally the AFC voltage at the orange "AFC" test point will be 7.5 volts as shown on the check-out sheet. The voltage should change rapidly plus and minus when a hand is moved near the oscillator transistor 1Q1. If the AFC voltage is high (constant 12 to 15 Volts) or low (constant 1 to 3 Volts) the AFC is locked out. If this is the case, it can be reset by turning off the power for 30 seconds, then turn power back on while monitoring the AFC voltage. The voltage should go to + 12 or 13 Volts then swing downscale and eventually stabilize near 7.5 Volts. Refer to Troubleshooting Guide for possible cause of abnormal AFC voltages.

Table 5-1. Troubleshooting Guide

SYMPTOM	POSSIBLE CAUSE
Pilot Lamp won't light	No 117Vac input Defective F1 or T2 Defective Switch, S1 or DS1
No RF Power out	Power supply - refer to Power Supply Check Defective Transistor Jumper missing on TB1 - 5 and 6
Off Frequency AFC "Lock Out"	Excessive Modulation Input Defective 5 Volt Supply Regulator Defective XTAL 1Y1. Check to see if properly plugged into socket. Defective AFC Circuit Components Check for 200kHz IF
Abnormal Power Supply Voltages	Defective 2Q1, 2Q2, 2IC1, 2IC2 Defective 5 Volt Zener 2Z1 or 2Z2 Defective C1, C2
High Current Supply Voltage Not Constant	No RF Drive to 3Q1 or 3Q2
Low Power Output	Improper Load Defective C1 or C2 Low Power Supply Voltage
High FM Noise	Noise input to J1, J2, or TB-1-9 and TB1-10 Defective C1 or C2 Shorted 2Q1 Defective 1IC1 Noisy 2Z1 or 2Z2
High AM Noise (exciter only)	Defective C1 or C2 Shorted Q1 Shorted 2Q2 Defective 2Z1
High Distortion	Defective 1IC1 Shorted 2Q1

5-4 MAINTENANCE AND TROUBLESHOOTING DIAGRAMS

Figure 5-1 Schematic Diagram - Model 680

SECTION VI
REPLACEABLE PARTS

6-1 ORDERING INFORMATION

When ordering parts for the Model 680 FM Exciter, give the model number and the serial number of the equipment and the reference designation and Sparta part number. To order a part not listed in paragraph 6-3 of this section, give a complete description of the part including function and location.

All parts should be ordered from:

SPARTA ELECTRONIC CORPORATION
5851 Florin-Perkins Road
Sacramento, California 95828
Telephone: (916) 383-5353
Telex: 377-488
Cable Address: SPARTA

6-2 PARTS LOCATION

The location of parts listed in table 6-2 are shown in figures 6-1 through 6-3.

6-3 TABLES OF REPLACEMENT PARTS

A list of manufacturers of the component parts of the Model 680 is provided by table 6-1. Table 6-2 contains a listing of replaceable parts. The manufacturer of the particular part listed in table 6-2 is indicated by a code number, which is used to identify the manufacturer as listed in table 6-1.

Table 6-1 List of Manufacturers

Code No.	Manufacturer	Address
P. Smith	Paul Smith Co. Div. of Standard International	Cincinnati, Ohio
System	System Metals Inc.	Chatsworth, California
01295	Texas Instruments Inc.	Dallas, Texas
01766	International Crystal Mfg. Co.	Oklahoma City, Oklahoma
02114	Ferroxcube Corp. of America	Saugerties, New York
02660	Amphenol Corporation	Broadview, Illinois
02735	Radio Corporation of America	Somerville, New Jersey
04713	Motorola Semiconductor	Phoenix, Arizona
05397	Kemet-Lindy Division of Union Carbide	Cleveland, Ohio
07263	Fairchild Semiconductor	Mountain View, California
09353	C & K Components	Watertown, Massachusetts
11502	IRC	Boone, North Carolina
12040	National Semiconductor	Plattsburgh, New York
13664	Workman Electronic Products	Sarasota, Florida
15450	Erie Technological Products	Erie, Pennsylvania
19647	Caddock Electronics Inc.	Riverside, California
23265	Sparta, Division of Cetec Corporation	Sacramento, California
50155	Communications Transistor Corporation	San Carlos, California
56289	Sprague Electric Co.	North Adams, Massachusetts
71279	Cambridge Thermionic Corporation	Cambridge, Massachusetts
71400	Bussman, Division of McGraw-Edison	St. Louis, Missouri
71590	Globe Union - Centralab Division	Milwaukee, Wisconsin
71785	Howard B. Jones, Division of Cinch Manufacturing Company	Chicago, Illinois
72136	Elmenco	Bronx, New York
72765	Drake Manufacturing Co.	Harwood Heights, Illinois
73445	Amperex Electronic Corporation	Hicksville, New York
78488	Stackpole Carbon Co.	St. Marys, Pennsylvania
78971	Underwood Electric & Manufacturing Co.	Maywood, Illinois
80223	United Transformer Co.	New York, New York
80294	Bourns Inc.	Riverside, California
97965	Stancor, Division of Essex Wire Corporation	Chicago, Illinois
98978	International Electronic Research Corporation	Burbank, California

Table 6-2 Replaceable Parts List

Chassis Mounted Components					
Desig.	Description	Part No.	Mfr.	Mfr. Part No.	Total
	Chassis, front	022-4072	23265	P-224072	1
	Chassis, back	022-4071	23265	P-224071	1
	Chassis, left side	022-4074	23265	P-224074-01	1
	Chassis, center divider	022-4074-02	23265	P-224074-02	1
	Chassis, right side	022-4073	23265	P-224073	1
	Dress strip	022-4085	23265	P-224085	1
	Handle	022-4086	23265	P-224086	2
	T-1 mounting bracket	022-4077-03	23265	P-224077-03	1
	Power supply mounting bracket	022-4077-04	23265	P-24077-04	1
	Modulator mounting bracket	022-4076-02	23265	P-234076-02	2
	Modulator mounting plate	022-4076	23265	P-224076-01	1
	RFA mounting bracket Cover plate, bottom Cover plate	022-4075 022-4091 022-4083	23265	P-224075 P-224091 P-224083	1 1 1
	Wire harness	091-6800	23265	091-6800	1
A-1	Modulator	002-6800-11	23265	002-6800-11	1
A-2	RF amplifier	002-6800-10	23265	002-6800-10	1
A-3	Power supply	002-6800-12	23265	002-6800-12	1
C-1	Capacitor, electrolytic 1500 uF/50V	112-0010	56289	TVL-1341	2
C-2	Same as C-1				
C-3	Capacitor, 5 pf/500V	101-0144	72136	DM15050	1
C-4/13	Capacitor, .001MF/1kV	110-0013	71590	DD102	10
C-14/15	Capacitor, 47pF/500V	101-0163	72136	DM15-470	2
D-1	Bridge rectifier	161-0332	04713	MDA802	1
DS-1	Lamp, 28V	244-0014	72765	11604	1
F-1	Fuse, 1/2 A Slo-Blo	261-0007	71400	MDL 0.5	1

Table 6-2 Replaceable Parts List (Continued)

Desig.	Description	Part No.	Mfr.	Mfr. Part No.	Total
HS-1	Heat sink	022-4078	23265	P-224078	1
J-1	Connector, BNC	287-0034	02660	UG-1094A/U	4
J-2	Same as J-1				
J-3	Same as J-1				
J-4	Same as J-1				
Q-1	Transistor, NPN silicon	149-0026	18723	2N3055	1
R-35	Potentiometer, 5K, 1/2W WW	130-0400	80294	271-1-502	1
S-1	Switch, DPDT	299-0011	09353	7201	1
T-1	Transformer, audio	318-0116	80223	A-20	1
T-2	Transformer, power	326-0012	97965	RT-202	1
TB-1	Terminal board	477-0670	71785	10-140Y	1
XDS-1	Lampholder	244-0003	72765	4428-001	1
XF-1	Fuseholder	261-0012	71400	342004A	1

Table 6-2. Replaceable Parts List

A-1 - Modulator					
Desig	Description	Part No.	Mfr.	Mfr. Part No.	Total
1C-1	Not used				
1C-2	Capacitor, 7500 pf/100V	101-0052	72136	DM19-752	1
1C-3	Capacitor, 47 pf/500V	101-0163	72136	DM15-470	2
1C-4	Same as 1C-3				
1C-5	Capacitor, 910pf/100V	101-0050	72136	DM15-911	7
1C-6	Capacitor, 4.7uF/35V	104-0115	05397	CSR BF 475K	6
1C-7	Capacitor, 470pf/500V	101-0047	72136	DM15471	3
1C-8	Capacitor, 47MF/20V	104-0126	05397	M39003/01-2055	2
1C-9	Same as 1C-5				
1C-10	Determined in Final Test				
1C-11	Determined in Final Test				
1C-12	Capacitor, 27pf/500V	101-0157	72136	DM15-270	2
1C-13	Determined in Final Test				
1C-14	Capacitor, 150uF/15V	104-0131	05397	M39003/1-2037	2
1C-15	Same as 1C-5				
1C-16	Same as 1C-12				
1C-17	Capacitor, 75pf/500V	101-0169	72136	DM15-750	2
1C-18	Capacitor, 0.47uF/25V	110-0040	56289	5C023474X0250B3	3
1C-19	Same as 1C-18				
1C-20	Same as 1C-5				
1C-21	Capacitor, 100pf/500V	101-0172	72136	DM15-101	2
1C-22	Capacitor, Var., 9-35pf	114-0006	15450	538-011D9-35	1
1C-23	Capacitor, 2pf/500V	101-0142	72136	DM15-020	1
1C-24	Same as 1C-5				
1C-25	Same as 1C-18				
1C-26	Same as 1C-17				
1C-27	Not used				

Desig	Description	Part No.	Mfr.	Mfr. Part No.	Total
1C-28	Same as 1C-5				
1C-29	Capacitor, 68pf/500V	101-0168	72136	DM15-680	1
1C-30	Same as 1C-21				
1C-31	Same as 1C-6				
1C-32	Same as 1C-7				
1C-33	Same as 1C-6				
1C-34	Determined in Final Test				
1C-35	Same as 1C-8				
1C-36	Not used				
1C-37	Same as 1C-14				
1C-38/41	Same as 1C-6				
1D-1	Varicap diode	161-0501	04713	MV1650	2
1D-2	Same as 1D-1				
1D-3	Diode, silicon	161-0096	01295	1N914A	4
1D-4	Same as 1D-3				
1D-5	Same as 1D-3				
1D-6	Same as 1D-3				
1IC-1	Integrated Circuit	150-0005	12040	UA709C	1
1IC-2	Integrated Circuit	150-0025	02735	CA3012	1
1IC-3	Integrated circuit	150-0009	04713	MC9601	1
1IC-4	Integrated circuit	150-0003	12040	UA741C	1
1IC-5	Integrated circuit	150-0023	07263	LM309H	1
IL-1	Inductor, 3.9uH	186-0014	71279	9310-26	5
IL-2	Same as IL-1				
IL-3	Inductor, adj., 1.5-3.9uH	187-0002	P. Smith	092872-DJ-3	2
IL-4	Inductor, 10uH	186-0019	71279	550-3640-45	1
IL-5	Inductor, 4.7uH	186-0004	23265	9310-36	1
IL-6	Same as IL-3				

Desig	Description	Part No.	Mfr.	Mfr. Part No.	Total
IL-7	Same as IL-1				
IL-8	Same as IL-1				
IL-9	Same as IL-1				
PCB	Printed circuit board	065-8060C	23265	065-8060C	1
1Q-1	Transistor, NPN Silicon	149-0183	02735	2N4427	1
1Q-2	Transistor, NPN Silicon	149-0041	04713	2N5913	1
1Q-3	Transistor, NPN Silicon	149-0032	04713	2N4124	1
1R-1	Resistor, 620 ohms, 1/2W, 5%	136-0031	11502		11
1R-2	Same as 1R-1				
1R-3	Same as 1R-1				
1R-4	Same as 1R-1				
1R-5	Same as 1R-1				
1R-6	Resistor, 10K, 1/2W, 5%	136-0057	11502		3
1R-7	Same as 1R-1				
1R-8	Resistor, 1K, 1/2W, 5%	136-0034	11502		2
1R-9	Same as 1R-8				
1R-10	Same as 1R-1				
1R-11	Resistor, 4.7K, 1/2W, 5%	136-0047	11502		1
1R-12	Same as 1R-1				
1R-13	Resistor, 56 ohms, 1/2W, 5%	136-0013	11502		1
1R-14	Same as 1R-6				
1R-15	Resistor, 3.9K, 1/2W, 5%	136-0045	11502		5
1R-16	Resistor, 10 ohm, 1/2W, 5%	136-0005	11502		2
1R-17	Resistor, 47 ohms, 1/2W, 5%	136-0011	11502		1
1R-18	Resistor, 51 ohms, 1/2W, 5%	136-0012	11502		1
1R-19	Same as 1R-16				
1R-20	Resistor, 27 Ohms, 1/2W, 5%	136-0007	11502		3

Desig	Description	Part No.	Mfr.	Mfr. Part No.	Total
1R-21	Resistor, 62 ohms, 1/2W, 5%	136-0014	11502		1
1R-22	Same as 1R-6				
1R-23	Same as 1R-15				
1R-24	Same as 1R-15				
1R-25	Same as 1R-20				
1R-26	Same as 1R-20				
1R-27	Resistor, 100K, 1/2W, 5%	136-0085	11502		1
1R-28	Not used				
1R-29	Resistor 470 ohms, 1/2W, 5%	136-0028	11502		1
1R-30	Same as 1R-15				
1R-31	Same as 1R-15				
1R-32	Resistor, 18 ohms, 1/2W, 5%	136-0005-03	11502		1
1R-33	Resistor, 4.7K, 1/4W, 1%	134-0020	19647	MM177	2
1R-34	Same as 1R-33				
1R-35	Chassis mounted component				
1R-36	Same as 1R-1		19647		
1R-37	Not used				
1R-38	Not used				
1R-39/40	Same as 1R-1				
1R-41	Resistor, 120K, 1/2W, 5%	136-0087	11502		2
1R-42	Same as 1R-41				2
1R-43	Resistor, 2.2K, 1/2 W, 5%	136-0038			1
1R-44	Thermistor, 160 ohm	145-0001	13664	FS-926	1
1T-1	Transformer, wide band	022-4067	23265	P-224067	1
1Y-1	Crystal	165-0003	01766	845088	1

Table 6-2. Replaceable Parts List

A-2 - RF Amplifier					
Desig	Description	Part No.	Mfr.	Mfr. Part No.	Total
3C-1*	Capacitor, 4.7uF/35V	104-0115	05397	CSR BF 475K	2
3C-2	Capacitor, 200pf/350V	101-0004	78971	J101	5
3C-3	Not used				
3C-4	Capacitor, Var., 9-35pf	114-0008	15450	538-000D 9-35	4
3C-5	Same as 3C-4				
3C-6A	Capacitor, 150pf/350V	101-0002	78971	J101	2
3C-6B	Same as 3C-6A				
3C-7A	Same as 3C-2				
3C-7B	Same as 3C-2				
3C-8	Same as 3C-1				
3C-9A/B	Same as 3C-2				
3C-10/11	Same as 3C-4				
3L-1	Inductor, 10uH	186-0019	71279	9310-36	1
3L-2	Inductor, 3.9uH	186-0014	71279	9310-26	1
3L-3	Inductor, 3.99uH	022-4080	23265	022-4080	2
3L-4	Inductor, 0.95uH	022-4079	23265	022-4079	1
3L-5	Inductor, 5uH	022-4081	23265	022-4081	1
3L-6	Inductor, 95nH	022-4082	23265	022-4082	1
3L-7	Same as 3L-3				
PCB	Printed circuit board	065-8040	23265	065-8040	1
3Q-1	Transistor, NPN Silicon	149-0040	50155	2212	1
3Q-2	Transistor, NPN Silicon	149-0039	01281	PT 8837	1
3R-1	Resistor, 39 ohm, 1/2W, 5%	136-0009	11502		1
3R-2	Resistor, Ferrite	599-0113	02114	56-590-65/4B	1
3R-3	Resistor, 10 ohm, 1/2W, 5%	136-0005	11502		1
3R-4	Resistor, 47 ohm, 1/2W, 5%	136-0011	11502		1
3R-5	Resistor - ferrite	599-0115	02114	VK211-17/4B	1

Table 6-2. Replaceable Parts List

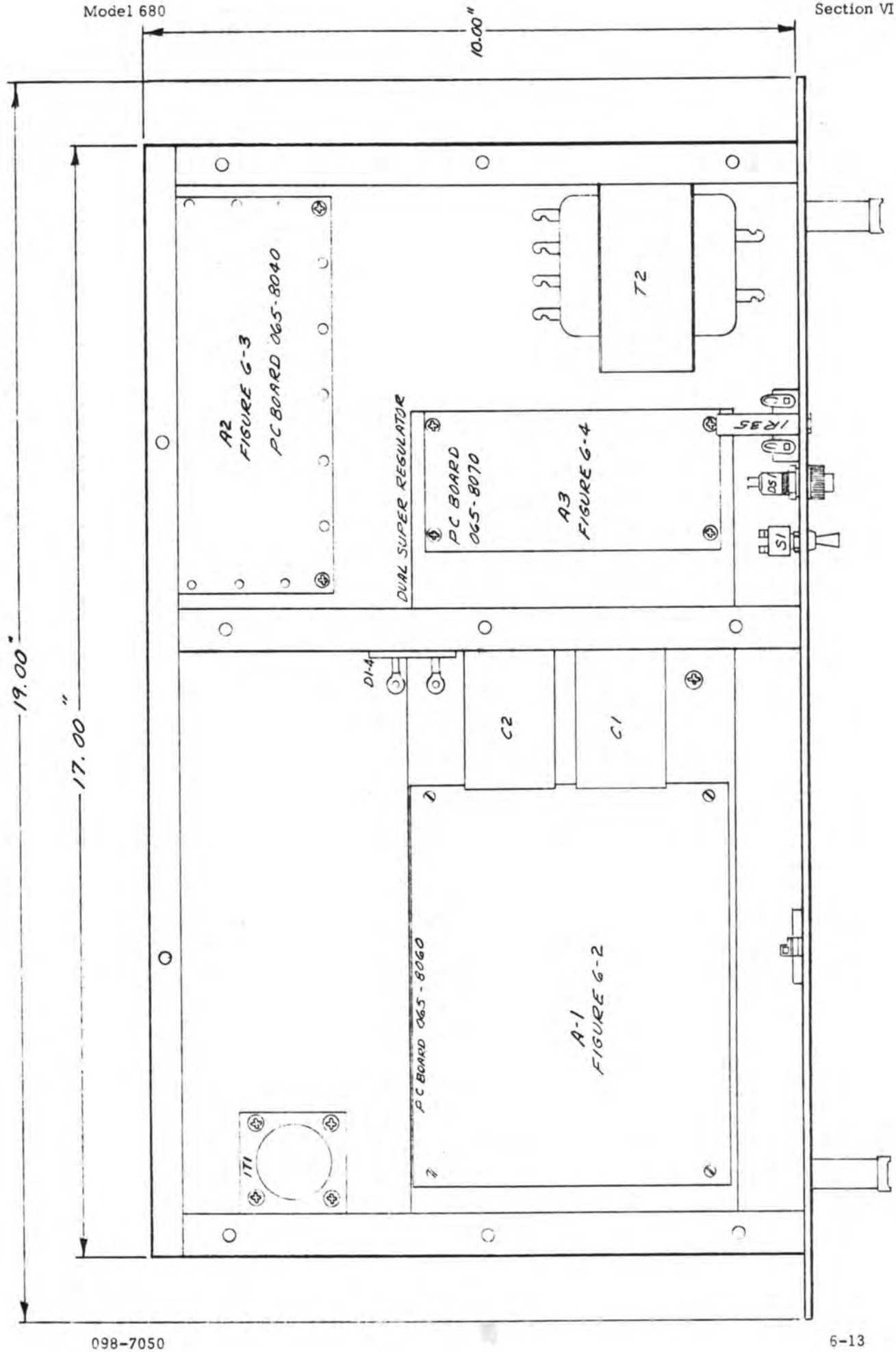
A-3 - Power Supply					
Desig	Description	Part No.	Mfr.	Mfr. Part No.	Total
2C-1	Capacitor, 750pf/500V	101-0048	72136	DM15-751	2
2C-2	Capacitor, 1000uF/16V	112-0008	73445	C437AR/E1000	2
2C-3	Same as 2C-1				
2C-4	Same as 2C-2				
2C-5/6	Capacitor, 0.47uF/25V	110-0040	56289	5CO23474X0250B3	2
HSK-1	Heat sink	614-0001	IERC	LB66B1B	2
HSK-2	Same as HSK-1				
2IC-1	Integrated circuit	150-0003	12040	UA74IC	2
2IC-2	Same as 2IC-1				
PCB	Printed circuit board	065-8070	23265	065-8070	1
2Q-1	Transistor, NPN Silicon	149-0023	02735	2N5493	2
2Q-2	Same as 2Q-1				
2R-1	Resistor, 270 ohm, 1/2W, 5%	136-0023	11502		5
2R-2	Same as 2R-1				
2R-3	Resistor, 620 ohm, 1/2W, 5%	136-0031	11502		2
2R-4	Same as 2R-1				
2R-5	Resistor, 4.7K, 1/2W, 5%	136-0047	11502		2
2R-6	Potentiometer, 10K	130-0016	78488	PT15YB	2
2R-7	Same as 2R-1				
2R-8	Same as 2R-1				
2R-9	Same as 2R-3				
2R-10	Resistor, 18Ohm, 1/2W,5%	136-0005-03	11502		1
2R-11	Same as 2R-5				
2R-12	Same as 2R-6				
2Z-1	Zener diode	161-0022	04713	1N4733	2
2Z-2	Same as 2Z-1				

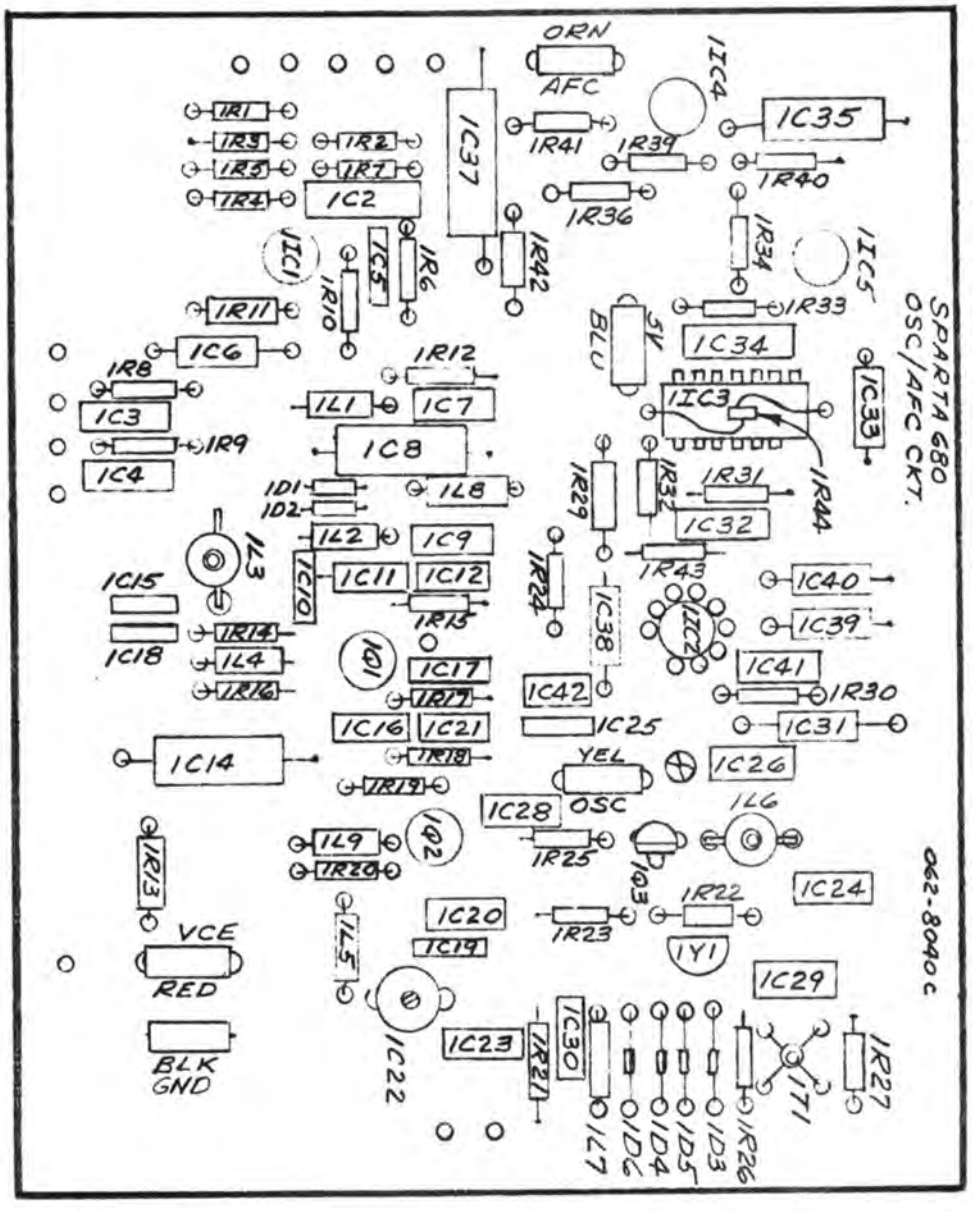
Table 6-2 Replaceable Parts List

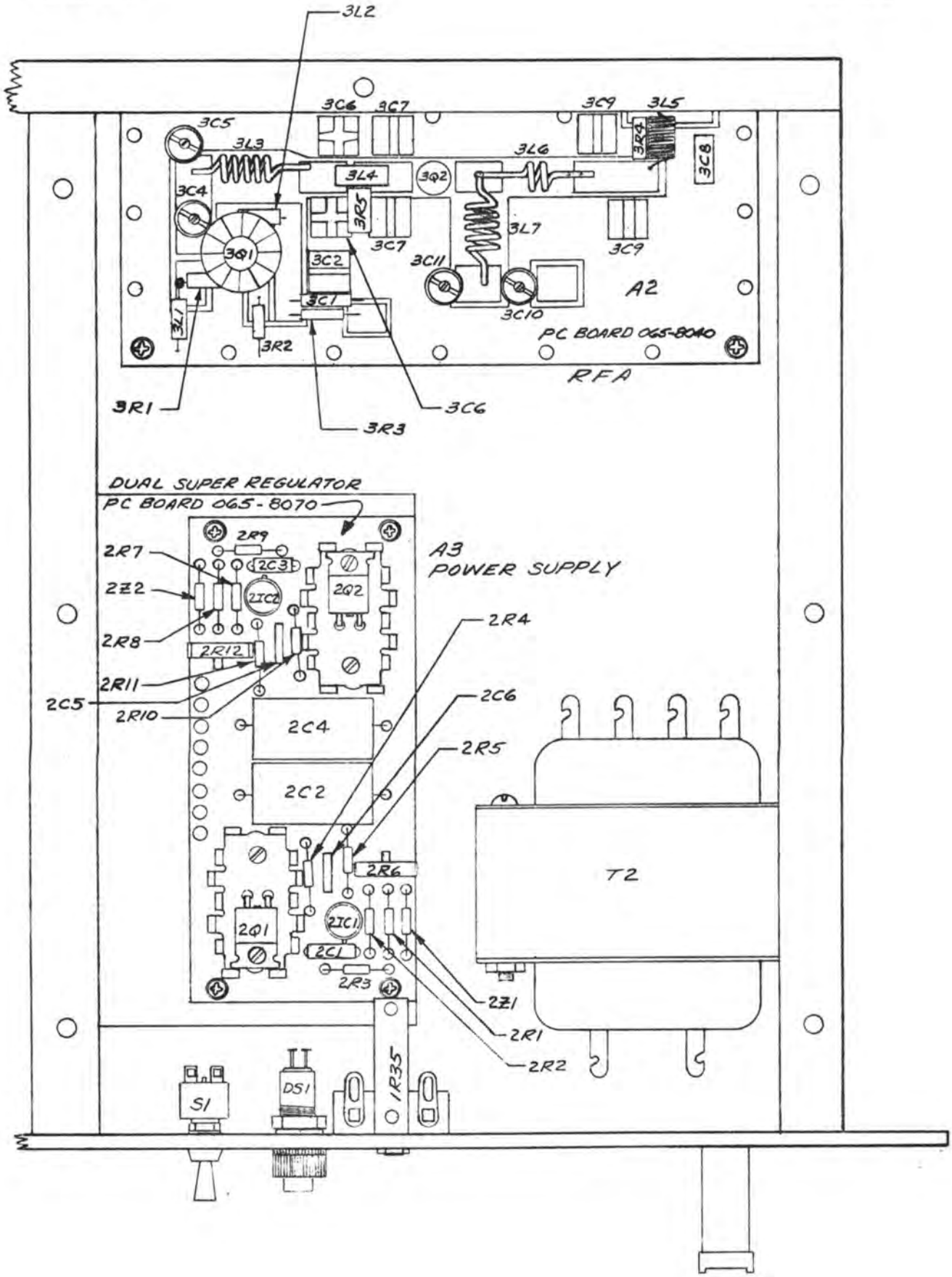
Metering Panel (Optional)					
Desig	Description	Part No.	Mfr.	Mfr. Part No.	Total
C-1	Capacitor, .01 MFD/1KV	110-0230	71590	DD1032	3
C-2	Same as C1				
C-3	Same as C1				
D-1	Diode, Silicon	161-0096	01295	IN914A	1
DC-1	Directional Coupler	015-6801	23265	015-6801	1
M-1	Meter, 0-15V	368-0019	32171	2S-DVV-015	1
M-2	Meter, 0-2A	368-0018	32171	2S-DAA-002	1
M-3	Meter, 0-1 MADC w/o - 125% scale	368-9156	32171	820-702	1
PCB	PC Board	065-7030	23265	065-7030	1
R-1	Not Used				
R-2	Resistor, 10K, 1/2W	136-0057	11502		1
R-3	Potentiometer, 10K	130-0039	80294	3339P-103	1
	Meter Bezel	368-0007-04	32171		3
	Meter Panel	022-4162	23265	022-4162	1
	Dress Plate	022-4163	23265	022-4163	1

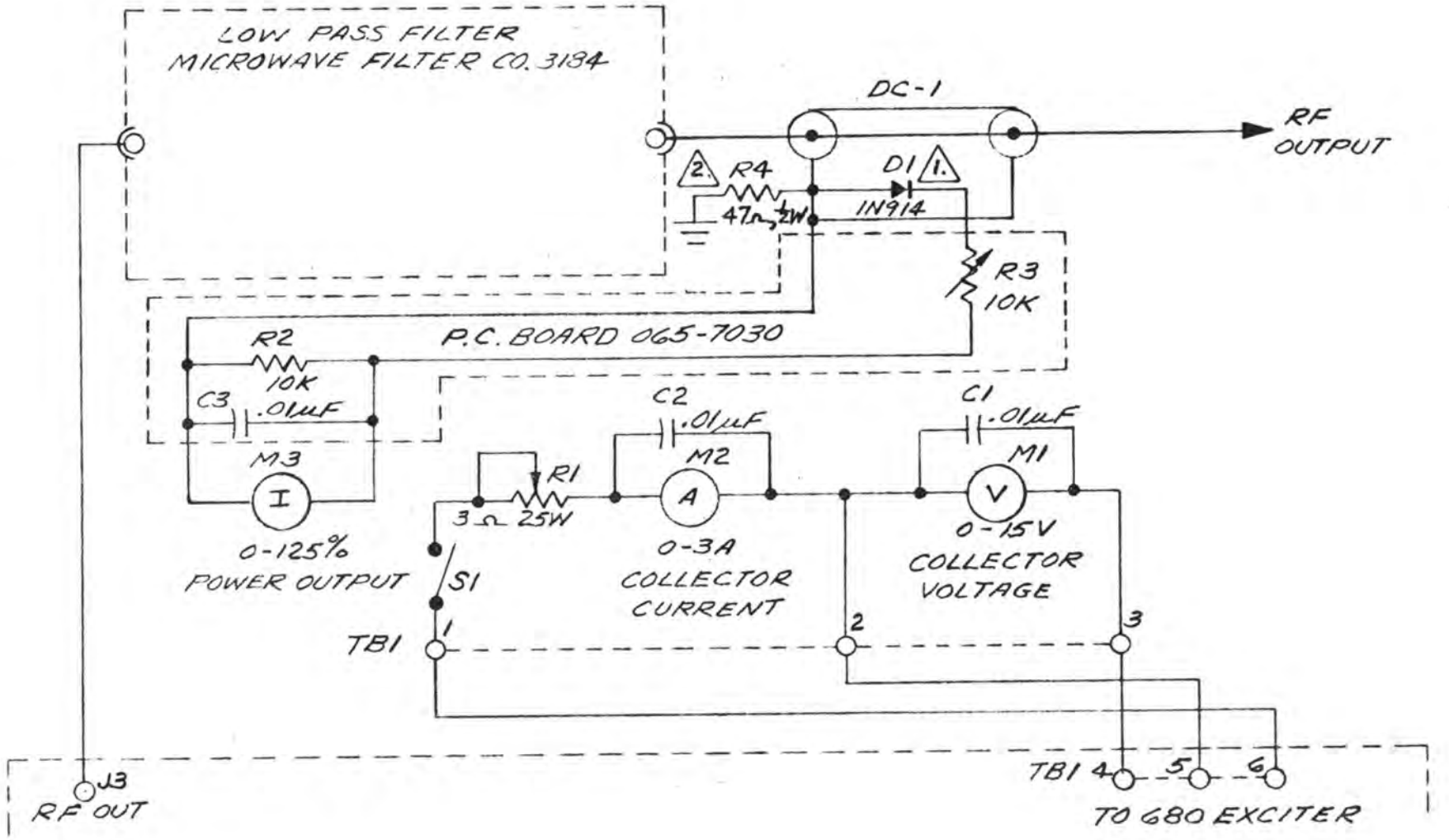
Table 6-2 Replaceable Parts List

Model 680/1 - 10 Watt Transmitter					
Desig	Description	Part No.	Mfr.	Mfr. Part No.	Total
C-1	Capacitor, .01 MFD/1KV	110-0230	71590	DD1032	3
C-2	Same as C1				
C-3	Same as C1				
D-1	Diode, Silicon	161-0096	01295	IN914A	1
DC-1	Directional Coupler	015-6801	23265	015-6801	1
M-1	Meter, 0-15V	368-0019	32171	25-DVV-015	1
M-2	Meter, 0-2A	368-0018	32171	25-DAA-002	1
M-3	Meter, 0-1 MADC w/o - 125% scale	368-9156	32171	820-702	1
LPF	Low Pass Filter	433-0532	27834	3184	1
PCB	PC Board	065-7030	23265	065-7030	1
R-1	Resistor, 3 ohm/25W	137-0252-07	44655	0142	1
R-2	Resistor, 10K, 1/2W	136-0057	11502		1
R-3	Potentiometer, 10K	130-0039	80294	3339P-103	1
S-1	Switch, DPST	299-0011	09353	7201D	1
	Meter Bezel	368-0007-04	32171	2BA3	3
	Meter Panel	022-4162	23265	022-4162	1
	Dress Plate	022-4163	23265	022-4163	1
	Meter Panel	001-6801	23265	001-6801	1
	Cabinet	100-7050	System	SM14S	1









SPARTA ELECTRONIC CORPORATION, SACRAMENTO, CALIFORNIA 95828				TITLE: SCHEMATIC DIAG. MODEL 680/1 METERING PANEL
DWN R.A.G.	DATE 10-2-73	SCALE NONE	SHT 1 OF 1	DWG NO. S 208A
APVD	DATE 11-8-74			

2. MOUNTED INSIDE DC-1 COUPLER HOUSING.

NOTES: 1. MOUNTED INSIDE BNC CONNECTOR.