



FM600 Broadcast Transmitter

# User's Manual

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## Important Notices

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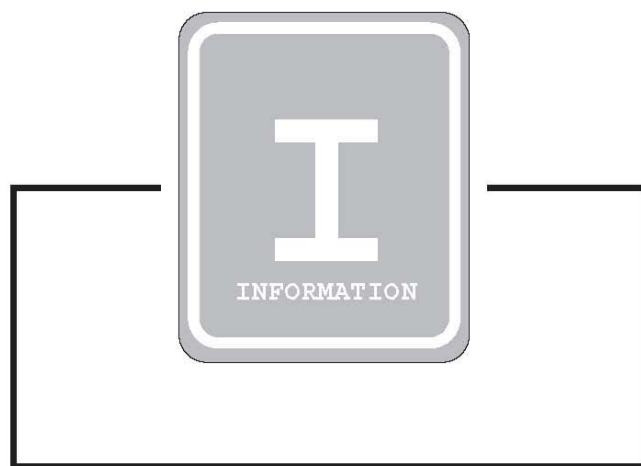
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## *Section 1—Getting Acquainted*

This section provides a general description of the FM600 transmitter and introduces you to safety conventions used within this document. *Review this material before installing or operating the transmitter.*

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## 1.1 Your Transmitter

The FM600 is a member of a family of FM stereo broadcast transmitters. Crown transmitters are known for their integration, ease-of-use, and reliability.

The integration is most apparent in the standard transmitter configuration which incorporates audio processing, stereo generation, and RF amplification without compromised signal quality. A single Crown transmitter can replace several pieces of equipment in a traditional system.

Ease-of-use is apparent in the user-friendly front panel interface and in the installation procedure. Simply select your operating frequency (using 5 external switches), add an audio source, attach an antenna, and connect AC power and you're ready to broadcast. Of course, the FM series of transmitters also feature more sophisticated inputs and monitoring connections if needed.

Reliability is a Crown tradition. The first Crown transmitters were designed for rigors of worldwide and potentially portable use. The modular design, quality components, engineering approach, and high production standards ensure stable performance.

Remote control and metering of the transmitter are made possible through a built-in I/O connector. For more direct monitoring, the front panel includes a digital multimeter display and status indicators. Automatic control circuitry provides protection for high VSWR as well as high current, voltage, and temperature conditions.



**Illustration 1-1 FM600 Stereo Broadcast Transmitter**



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## 1.2 Applications and Options

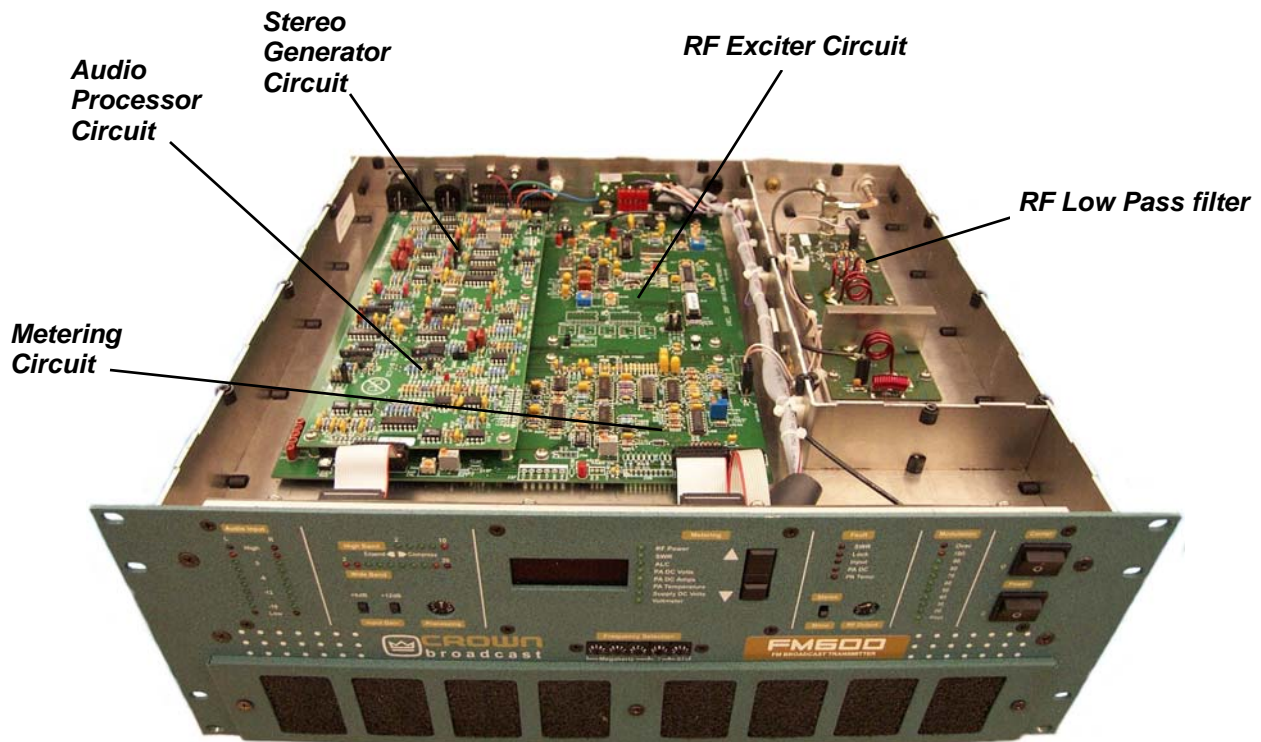
Crown transmitters are designed for versatility in applications. They have been used as stand-alone and backup transmitters and in booster, translator, satellator, and nearcast applications. The following discussion describes these applications further.

Model numbers describe the configuration of the product (which has to do with its intended purpose) and the RF output power which you can expect.

The number portion of each name represents the maximum RF output power. The FM600, for example, can generate up to 600 watts of RF output power.

Suffix letters describe the configuration. The FM600T, for example, is the standard or transmitter configuration. Except where specified, this document describes the transmitter configuration. In this configuration, the product includes the following components (functions):

- Audio Processor/Stereo Generator
- RF Exciter
- Metering
- Low-Pass filter



**Illustration 1–2 Standard (Transmitter) Configuration**

---

### *1.2.1 Stand-Alone*

In the standard configuration, the FM600 is an ideal stand-alone transmitter. When you add an audio source (monaural, L/R stereo, or composite signal), an antenna, and AC power, the transmitter becomes a complete FM stereo broadcast station, capable of serving a community.

As stand-alone transmitters, Crown units often replace multiple pieces of equipment in a traditional setup (exciter, audio processor, RF amplifier).

### *1.2.2 Backup*

In the standard configuration, Crown transmitters are also used in backup applications. Should your primary transmitter become disabled, you can continue to broadcast while repairs take place. In addition, the FM transmitters can replace disabled portions of your existing system including the exciter, audio processor, or amplifier. Transfer switches on each side of the existing and backup transmitters make the change-over possible with minimal downtime.

### *1.2.3 Exciter*

In addition to the standard configuration, the FM600 is available in optional configurations to meet a variety of needs.

An "E" suffix, as in the FM600E, for example, represents an exciter-only configuration. In this configuration, the audio processor and stereo generator boards are replaced with circuitry to bypass their function. The exciter configurations are the least expensive way to get Crown quality components into your transmission system.

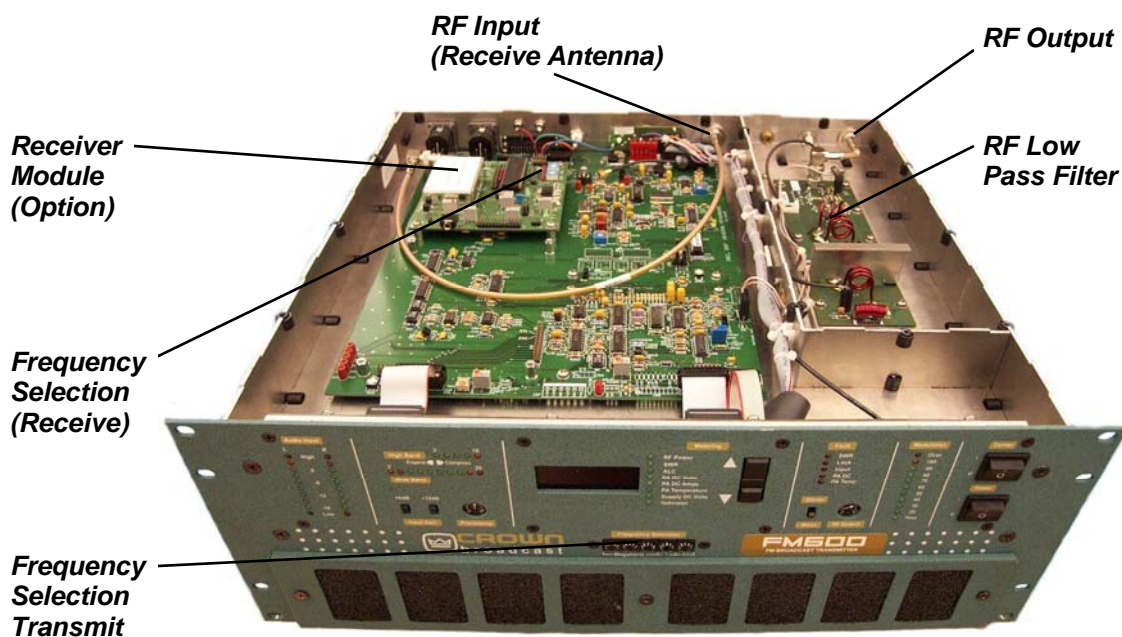
You might consider the Crown exciter when other portions of your system are performing satisfactorily and you want to maximize your investment in present equipment.

---

### 1.2.4 Translator

A receiver configuration (FM600R, for example) replaces the audio processor/stereo generator board with a receiver module. This added feature makes the FM600 ideal for translator service in terrestrial-fed networks. These networks represent a popular and effective way to increase your broadcasting coverage. Translators, acting as repeater emitters, are necessary links in this chain of events.

Traditionally, network engineers have relied on multiple steps and multiple pieces of equipment to accomplish the task. Others have integrated the translator function (receiver and exciter) to feed an amplifier. Crown, on the other hand, starts with an integrated transmitter and adds a solid-state Receiver Module to form the ideal translator.



**Illustration 1–3 Crown's Integrated Translator**

This option enables RF input and RF output on any of Crown's FM series of transmitters. In addition, the module supplies a composite output to the RF exciter portion of the transmitter. From here, the signal is brought to full power by the built-in power amplifier for retransmission. The Receiver Module has been specifically designed to handle SCA channel output up to 100 kHz for audio and high-speed data.

FSK ID programming is built-in to ensure compliance with FCC regulations regarding the on-air identification of translators. Simply specify the call sign of the repeater station when ordering. Should you need to change the location of the translator, replacement FSK chips are available. The Receiver Module option should be ordered at the time of initial transmitter purchase. However, an option kit is available for field converting existing Crown units.

In the translator configuration there are differences in the function of the front panel. See Section 3 for a description.

---

### 1.2.5 Satellator

One additional option is available for all configurations—an FSK Identifier (FSK IDer). This added feature enables the FM600 to transmit its call sign or operating frequency in a Morse code style. This option is intended for use in satellite-fed networks. Transmitters equipped in this fashion are often known as "satellators."

Connect the transmitter to your satellite receiver and the pre-programmed FSK IDer does the rest—shifting the frequency to comply with FCC requirements and in a manner that is unnoticeable to the listener. The FSK IDer module should be ordered at the time you order your transmitter, but is available separately (factory programmed for your installation).

**FSK IDer**



**Illustration 1–4 Transmitter with FSK IDer Option**

Add the FSK IDer option to the exciter configuration for the most economical satellator. (A composite input signal is required.)

---

### *1.3 Transmitter/Exciter Specifications*

|                                 |  |
|---------------------------------|--|
| <b>Frequency Range</b>          | 87.9 MHz–107.9 MHz (76 MHz–90 MHz optionally available)              |
| <b>RF Power Output</b>          | (VSWR 1.7:1 or better)   |
| FM600                           | Up to 660 watts output   |
| <b>RF Output Impedance</b>      | 50 Ohms  |
| <b>Frequency Stability</b>      | Meets FCC specifications from 0-50 degrees C                         |
| <b>Audio Input Impedance</b>    | 50k $\Omega$ bridging, balanced, or 600 $\Omega$                     |
| <b>Audio Input Level</b>        | Selectable for –10 dBm to +10 dBm for 75 kHz deviation at 400 Hz     |
| <b>Pre-emphasis</b>             | Selectable for 25, 50, or 75 $\mu$ sec; or flat                      |
| <b>Audio Response</b>           | Conforms to 75 $\mu$ sec pre-emphasis curve as follows:              |
| Complete Transmitter            | $\pm 0.30$ dB (50 Hz–10 kHz)<br>$\pm 1.0$ dB (10 kHz–15 kHz)         |
| Exciter only                    | $\pm 0.25$ dB (50 Hz–15 kHz)   |
| <b>Distortion (THD + Noise)</b> |  |
| Complete Transmitter            | Less than 0.7% (at 15kHz)  |
| Exciter only                    | Less than 0.3% (50Hz-15kHz)  |
| <b>Stereo Separation</b>        |  |
| Complete Transmitter            | Better than –40dB (50Hz-15kHz)                                       |
| Exciter only                    | Better than –40dB (50Hz-15kHz)                                       |
| <b>Crosstalk</b>                | Main into Sub, better than –40dB<br>Sub into Main, better than –40dB |
| <b>Stereo Pilot</b>             | 19 kHz $\pm 2$ Hz, 9% modulation                                     |

---

|                                |   |
|--------------------------------|---|
| <b>Subcarrier Suppression</b>  | 50dB below $\pm 75$ kHz deviation                               |
| <b>FM S/N Ratio</b> (FM noise) |   |
| Complete Transmitter           | Better than $-60$ dB  |
| Exciter only                   | Better than $-70$ dB  |
| <b>AM S/N Ratio</b>            | Asynchronous and synchronous noise better than FCC requirements |
| <b>RF Bandwidth</b>            | $\pm 120$ kHz, better than $-35$ dB                             |
|                                | $\pm 240$ kHz, better than $-45$ dB                             |
| <b>RF Spurious Products</b>    | Better than $-71$ dB  |
| <b>Operating Environment</b>   | Temperature ( $0^{\circ}\text{C}$ to $50^{\circ}\text{C}$ )     |
|                                | Humidity (0 to 80% at $20^{\circ}\text{C}$ )                    |
|                                | Maximum Altitude (3,000 Meters; 9834 Feet)                      |
| <b>AC Power</b>                | 120-240 volts* $\pm 10\%$ 50/60Hz                               |

*Note: We set voltage and ampere requirements to assist you in designing your system. Depending on your operating frequency, actual requirements for maximum voltage and current readings are 10–15% lower than stated.*

|                   |   |
|-------------------|---|
| <b>Regulatory</b> | Type notified FCC parts 73 and 74<br>Meets FCC, DOC             |
| <b>Dimensions</b> | 32.38 x 59.69 x 62.23 centimeters<br>12.75 x 23.5 x 24.5 Inches |
| <b>Weight</b>     | 38 lbs<br>17.237 Kg   |

\*200 volts AC input or greater, recommended for RF power output of 575W or greater. Voltage measured at the AC power input connector to transmitter.

---

## 1.4 Receiver Specifications

### **Monaural Sensitivity** (demodulated, de-emphasized)

3.5  $\mu$  V for signal-to-noise > 50 dB

### **Stereo Sensitivity** (19-kHz pilot frequency added)

31  $\mu$  V for signal-to-noise > 50 dB

### **Connector**

Standard type N-Female, 50  $\Omega$

### **Shipping Weight**

1 lb

## 1.5 Safety Considerations

Crown Broadcast assumes the responsibility for providing you with a safe product and safety guidelines during its use. “Safety” means protection to all individuals who install, operate, and service the transmitter as well as protection of the transmitter itself. To promote safety, we use standard hazard alert labeling on the product and in this manual. Follow the associated guidelines to avoid potential hazard.

### 1.5.1 Dangers

DANGER represents the most severe hazard alert. Extreme bodily harm or death will occur if DANGER guidelines are not followed.

### 1.5.2 Warnings

WARNING represents hazards which could result in severe injury or death.

### 1.5.3 Cautions

CAUTION indicates potential personal injury, or equipment or property damage if the associated guidelines are not followed. Particular cautions in this text also indicate unauthorized radio-frequency operation.

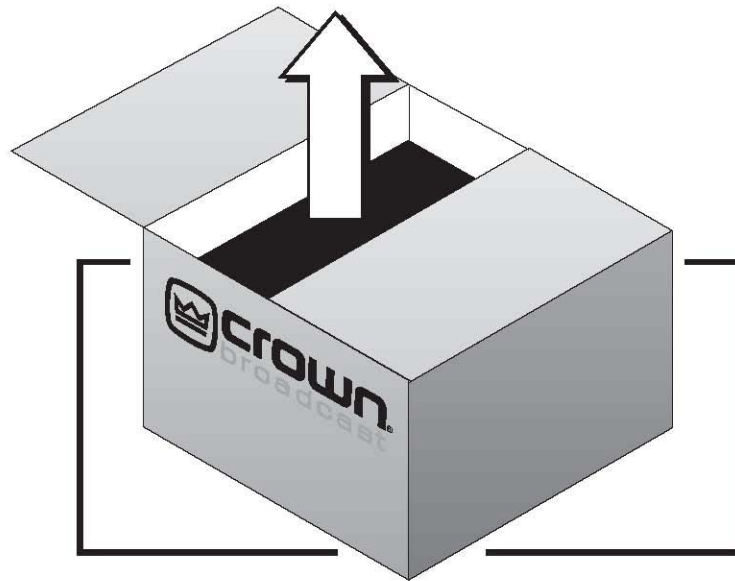


Illustration 1–5 Sample Hazard Alert

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## ***Notes***





## *Section 2—Installation*

This section provides important guidelines for installing your transmitter.  
Review this information carefully for proper installation.

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## 2.1 Operating Environment

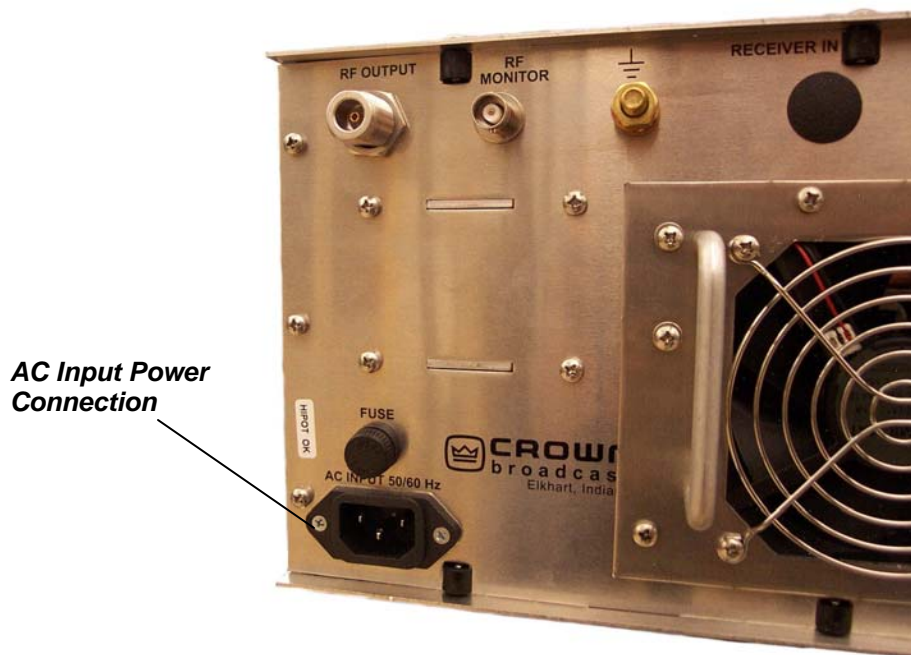
You can install the FM transmitter in a standard component rack or on a suitable surface such as a bench or desk. In any case, the area should be as clean and well ventilated as possible. Always allow for at least 2 cm of clearance under the unit for ventilation. If you set the transmitter on a flat surface, install spacers on the bottom cover plate. If you install the transmitter in a rack, provide adequate clearance above and below. Do not locate the transmitter directly above a hot piece of equipment.

## 2.2 Power Connections

The FM600 can operate on any voltage between 120 and 240 volts AC (50 or 60 Hz; single phase).

### 2.2.1 AC Line Voltage Setting

Voltage selection is automatic; configuration is not necessary.

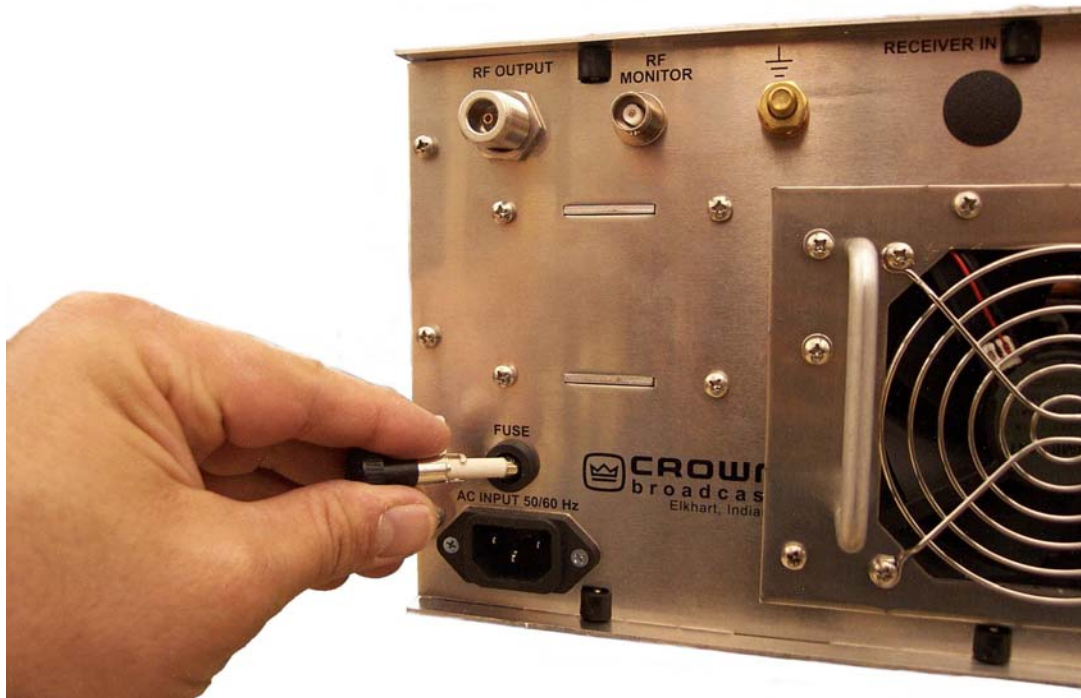


**Illustration 2–2 AC Input Power Connection**

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### 2.2.2 Fuses

The fuse holder is located on the back panel just above the power connection.



**Illustration 2–3 Fuse Holder**

For 120 to 200 VAC operation, use the fuse installed at the factory. For 200 to 240 VAC operation, use the slow-blow fuse located in a hardware kit within the transmitter packaging. Consult the following table:

| AC Input Voltage | Fuse Rating |
|------------------|-------------|
| 120-200 VAC      | 12 Ampere   |
| 200-240 VAC      | 6 Ampere    |

**Illustration 2–4 Fuse Reference Table**

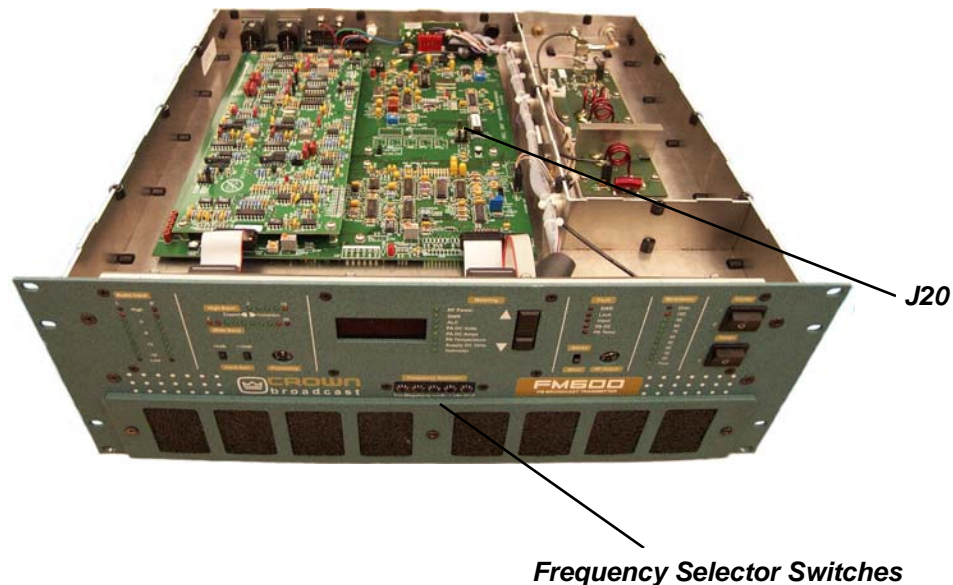
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## 2.3 Frequency (Channel) Selection

Your transmitter is capable of operating between 87.9 and 107.9 MHz in the FM band. The transmitter can also operate between 76 and 90 MHz by shorting pins 9 and 10 of J20 on the motherboard. See Illustration 2-6.

To adjust the operating frequency, follow these steps:

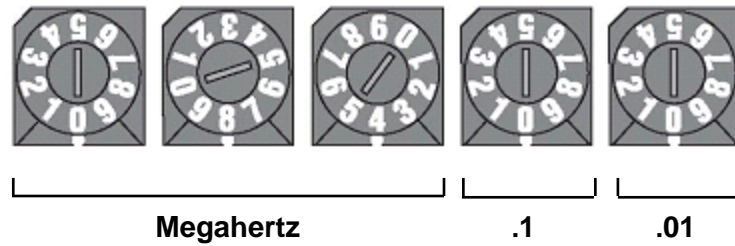
1. Locate the frequency selector switches on the front panel which will be used to change the setting. See Illustrations 2-6 and 2-7.
2. Use small flat blade screwdriver or another suitable device to rotate the switches to the desired setting. (The selected number will appear directly above the white indicator dot on each switch.) See examples of selected frequencies in the illustration below.
3. To change the operating band from 87.9-107.9MHz to 76-90MHz or vice versa, or to adjust the modulation compensation pot, remove the top cover to gain access to these features. See Illustrations 2-6 and 2-10.



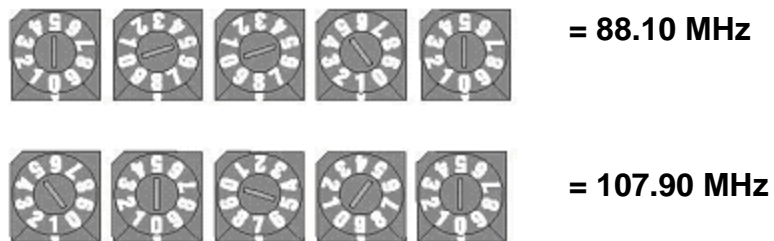
**Illustration 2-6 Top Cover Removed**

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## 2.3 Frequency (Channel) Selection, continued



**Illustration 2–7 Transmitter Front Panel (Frequency Selector Switches)**



**Illustration 2–8 Two Sample Frequency Selections**

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### 2.3.1 Modulation Compensator

The Modulation trim-potentiometer (see Illustration 2–10) compensates for slight variations in deviation sensitivity with frequency. Set the trim-pot dial according to the following graph:

| Frequency of Operation (MHz) | Modulation Compensation Pot Setting |
|------------------------------|-------------------------------------|
| 108                          | 0                                   |
| 106                          | 10                                  |
| 104                          | 15                                  |
| 102                          | 25                                  |
| 100                          | 35                                  |
| 98                           | 40                                  |
| 97.1                         | 45                                  |
| 96                           | 55                                  |
| 94                           | 60                                  |
| 92                           | 70                                  |
| 90                           | 75                                  |
| 88                           | 80                                  |
| 86                           | 80                                  |
| 84                           | 80                                  |
| 82.4                         | 70                                  |
| 82                           | 65                                  |
| 80                           | 55                                  |
| 78                           | 30                                  |
| 76                           | 0                                   |

**Illustration 2–9 Modulation Compensator Settings**

These compensator settings are approximate. Each mark on the potentiometer represents about 1.8% modulation compensation.

**Modulation  
Compensator  
Pot**



**Illustration 2–10 Modulation Compensator Pot**

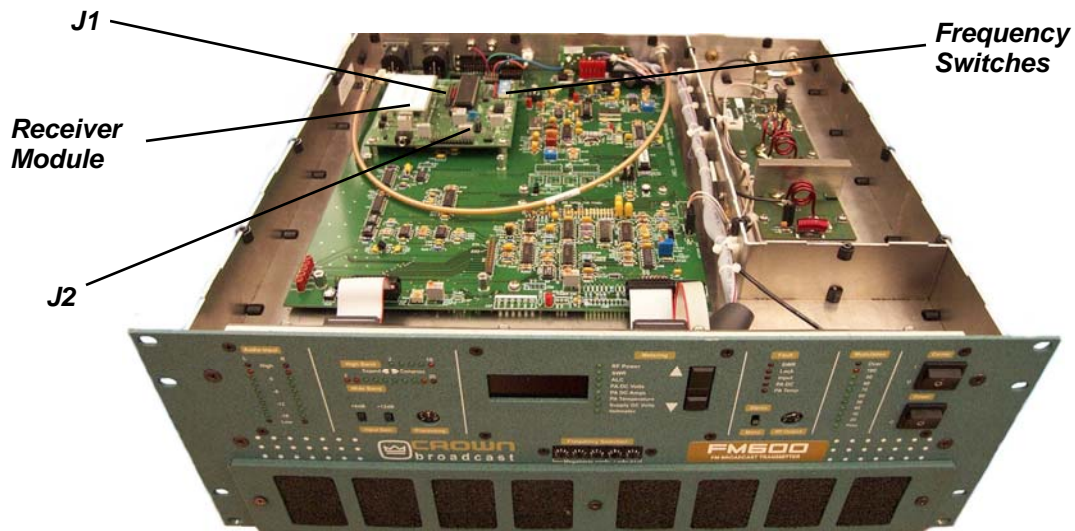


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## 2.4 Receiver Frequency Selection

If you have a transmitter equipped with the receiver option, you will need to set the receiving or incoming frequency.

1. With the top cover removed, locate the receiver module and the two switches (labeled SW1 and SW2).



**Illustration 2-11 Receiver Module Switches**

2. Use the adjacent chart to set the switches for the desired incoming frequency.
3. For frequencies in the Japan FM band, short pins 7&8 on J1 on the receiver card.
4. For 75us pre-emphasis short pins 3&4 and 5&6 on J2 of the Receiver card.
5. For 50us pre-emphasis short pins 1&2 and 7&8 on J2 of the Receiver card.
6. After setting the frequency, replace the top cover and screws.

| Freq. 74-90<br>MHz | Freq. 88-108<br>MHz | SW1 | SW2 | Freq. 74-90<br>MHz | Freq. 88-108<br>MHz | SW1 | SW2 |
|--------------------|---------------------|-----|-----|--------------------|---------------------|-----|-----|
| 74.9               | 87.9                | 0   | 0   | 78.9               | 91.9                | 1   | 4   |
| 75.0               | 88.0                | 8   | 0   | 79.0               | 92.0                | 9   | 4   |
| 75.1               | 88.1                | 0   | 1   | 79.1               | 92.1                | 1   | 5   |
| 75.2               | 88.2                | 8   | 1   | 79.2               | 92.2                | 9   | 5   |
| 75.3               | 88.3                | 0   | 2   | 79.3               | 92.3                | 1   | 6   |
| 75.4               | 88.4                | 8   | 2   | 79.4               | 92.4                | 9   | 6   |
| 75.5               | 88.5                | 0   | 3   | 79.5               | 92.5                | 1   | 7   |
| 75.6               | 88.6                | 8   | 3   | 79.6               | 92.6                | 9   | 7   |
| 75.7               | 88.7                | 0   | 4   | 79.7               | 92.7                | 1   | 8   |
| 75.8               | 88.8                | 8   | 4   | 79.8               | 92.8                | 9   | 8   |
| 75.9               | 88.9                | 0   | 5   | 79.9               | 92.9                | 1   | 9   |
| 76.0               | 89.0                | 8   | 5   | 80.0               | 93.0                | 9   | 9   |
| 76.1               | 89.1                | 0   | 6   | 80.1               | 93.1                | 1   | A   |
| 76.2               | 89.2                | 8   | 6   | 80.2               | 93.2                | 9   | A   |
| 76.3               | 89.3                | 0   | 7   | 80.3               | 93.3                | 1   | B   |
| 76.4               | 89.4                | 8   | 7   | 80.4               | 93.4                | 9   | B   |
| 76.5               | 89.5                | 0   | 8   | 80.5               | 93.5                | 1   | C   |
| 76.6               | 89.6                | 8   | 8   | 80.6               | 93.6                | 9   | C   |
| 76.7               | 89.7                | 0   | 9   | 80.7               | 93.7                | 1   | D   |
| 76.8               | 89.8                | 8   | 9   | 80.8               | 93.8                | 9   | D   |
| 76.9               | 89.9                | 0   | A   | 80.9               | 93.9                | 1   | E   |
| 77.0               | 90.0                | 8   | A   | 81.0               | 94.0                | 9   | E   |
| 77.1               | 90.1                | 0   | B   | 81.1               | 94.1                | 1   | F   |
| 77.2               | 90.2                | 8   | B   | 81.2               | 94.2                | 9   | F   |
| 77.3               | 90.3                | 0   | C   | 81.3               | 94.3                | 2   | 0   |
| 77.4               | 90.4                | 8   | C   | 81.4               | 94.4                | A   | 0   |
| 77.5               | 90.5                | 0   | D   | 81.5               | 94.5                | 2   | 1   |
| 77.6               | 90.6                | 8   | D   | 81.6               | 94.6                | A   | 1   |
| 77.7               | 90.7                | 0   | E   | 81.7               | 94.7                | 2   | 2   |
| 77.8               | 90.8                | 8   | E   | 81.8               | 94.8                | A   | 2   |
| 77.9               | 90.9                | 0   | F   | 81.9               | 94.9                | 2   | 3   |
| 78.0               | 91.0                | 8   | F   | 82.0               | 95.0                | A   | 3   |
| 78.1               | 91.1                | 1   | 0   | 82.1               | 95.1                | 2   | 4   |
| 78.2               | 91.2                | 9   | 0   | 82.2               | 95.2                | A   | 4   |
| 78.3               | 91.3                | 1   | 1   | 82.3               | 95.3                | 2   | 5   |
| 78.4               | 91.4                | 9   | 1   | 82.4               | 95.4                | A   | 5   |
| 78.5               | 91.5                | 1   | 2   | 82.5               | 95.5                | 2   | 6   |
| 78.6               | 91.6                | 9   | 2   | 82.6               | 95.6                | A   | 6   |
| 78.7               | 91.7                | 1   | 3   | 82.7               | 95.7                | 2   | 7   |
| 78.8               | 91.8                | 9   | 3   | 82.8               | 95.8                | A   | 7   |

Illustration 2–12-1 Receiver Frequency Selection  
(Continued on next page)



| Freq. 74-90<br>MHz | Freq. 88-108<br>MHz | SW1 | SW2 | Freq. 74-90<br>MHz | Freq. 88-108<br>MHz | SW1 | SW2 |
|--------------------|---------------------|-----|-----|--------------------|---------------------|-----|-----|
| 82.9               | 95.9                | 2   | 8   | 86.6               | 99.6                | B   | A   |
| 83.0               | 96.0                | A   | 8   | 86.7               | 99.7                | 3   | B   |
| 83.1               | 96.1                | 2   | 9   | 86.8               | 99.8                | B   | B   |
| 83.2               | 96.2                | A   | 9   | 86.9               | 99.9                | 3   | C   |
| 83.3               | 96.3                | 2   | A   | 87.0               | 100.0               | B   | C   |
| 83.4               | 96.4                | A   | A   | 87.1               | 100.1               | 3   | D   |
| 83.5               | 96.5                | 2   | B   | 87.2               | 100.2               | B   | D   |
| 83.6               | 96.6                | A   | B   | 87.3               | 100.3               | 3   | E   |
| 83.7               | 96.7                | 2   | C   | 87.4               | 100.4               | B   | E   |
| 83.8               | 96.8                | A   | C   | 87.5               | 100.5               | 3   | F   |
| 83.9               | 96.9                | 2   | D   | 87.6               | 100.6               | B   | F   |
| 84.0               | 97.0                | A   | D   | 87.7               | 100.7               | 4   | 0   |
| 84.1               | 97.1                | 2   | E   | 87.8               | 100.8               | C   | 0   |
| 84.2               | 97.2                | A   | E   | 87.9               | 100.9               | 4   | 1   |
| 84.3               | 97.3                | 2   | F   | 88.0               | 101.0               | C   | 1   |
| 84.4               | 97.4                | A   | F   | 88.1               | 101.1               | 4   | 2   |
| 84.5               | 97.5                | 3   | 0   | 88.2               | 101.2               | C   | 2   |
| 84.6               | 97.6                | B   | 0   | 88.3               | 101.3               | 4   | 3   |
| 84.7               | 97.7                | 3   | 1   | 88.4               | 101.4               | C   | 3   |
| 84.8               | 97.8                | B   | 1   | 88.5               | 101.5               | 4   | 4   |
| 84.9               | 97.9                | 3   | 2   | 88.6               | 101.6               | C   | 4   |
| 85.0               | 98.0                | B   | 2   | 88.7               | 101.7               | 4   | 5   |
| 85.1               | 98.1                | 3   | 3   | 88.8               | 101.8               | C   | 5   |
| 85.2               | 98.2                | B   | 3   | 88.9               | 101.9               | 4   | 6   |
| 85.3               | 98.3                | 3   | 4   | 89.0               | 102.0               | C   | 6   |
| 85.4               | 98.4                | B   | 4   | 89.1               | 102.1               | 4   | 7   |
| 85.5               | 98.5                | 3   | 5   | 89.2               | 102.2               | C   | 7   |
| 85.6               | 98.6                | B   | 5   | 89.3               | 102.3               | 4   | 8   |
| 85.7               | 98.7                | 3   | 6   | 89.4               | 102.4               | C   | 8   |
| 85.8               | 98.8                | B   | 6   | 89.5               | 102.5               | 4   | 9   |
| 85.9               | 98.9                | 3   | 7   | 89.6               | 102.6               | C   | 9   |
| 86.0               | 99.0                | B   | 7   | 89.7               | 102.7               | 4   | A   |
| 86.1               | 99.1                | 3   | 8   | 89.8               | 102.8               | C   | A   |
| 86.2               | 99.2                | B   | 8   | 89.9               | 102.9               | 4   | B   |
| 86.3               | 99.3                | 3   | 9   | 90.0               | 103.0               | C   | B   |
| 86.4               | 99.4                | B   | 9   | X                  | 103.1               | 4   | C   |
| 86.5               | 99.5                | 3   | A   | X                  | 103.2               | C   | C   |

Illustration 2-12-2 Receiver Frequency Selection  
(Continued on next page)

| Freq. 74-90<br>MHz | Freq. 88-108<br>MHz | SW1 | SW2 | Freq. 74-90<br>MHz | Freq. 88-108<br>MHz | SW1 | SW2 |
|--------------------|---------------------|-----|-----|--------------------|---------------------|-----|-----|
| X                  | 103.3               | 4   | D   | X                  | 107.0               | D   | F   |
| X                  | 103.4               | C   | D   | X                  | 107.1               | 6   | 0   |
| X                  | 103.5               | 4   | E   | X                  | 107.2               | E   | 0   |
| X                  | 103.6               | C   | E   | X                  | 107.3               | 6   | 1   |
| X                  | 103.7               | 4   | F   | X                  | 107.4               | E   | 1   |
| X                  | 103.8               | C   | F   | X                  | 107.5               | 6   | 2   |
| X                  | 103.9               | 5   | 0   | X                  | 107.6               | E   | 2   |
| X                  | 104.0               | D   | 0   | X                  | 107.7               | 6   | 3   |
| X                  | 104.1               | 5   | 1   | X                  | 107.8               | E   | 3   |
| X                  | 104.2               | D   | 1   | X                  | 107.9               | 6   | 4   |
| X                  | 104.3               | 5   | 2   | X                  | 108.0               | E   | 4   |
| X                  | 104.4               | D   | 2   |                    |                     |     |     |
| X                  | 104.5               | 5   | 3   |                    |                     |     |     |
| X                  | 104.6               | D   | 3   |                    |                     |     |     |
| X                  | 104.7               | 5   | 4   |                    |                     |     |     |
| X                  | 104.8               | D   | 4   |                    |                     |     |     |
| X                  | 104.9               | 5   | 5   |                    |                     |     |     |
| X                  | 105.0               | D   | 5   |                    |                     |     |     |
| X                  | 105.1               | 5   | 6   |                    |                     |     |     |
| X                  | 105.2               | D   | 6   |                    |                     |     |     |
| X                  | 105.3               | 5   | 7   |                    |                     |     |     |
| X                  | 105.4               | D   | 7   |                    |                     |     |     |
| X                  | 105.5               | 5   | 8   |                    |                     |     |     |
| X                  | 105.6               | D   | 8   |                    |                     |     |     |
| X                  | 105.7               | 5   | 9   |                    |                     |     |     |
| X                  | 105.8               | D   | 9   |                    |                     |     |     |
| X                  | 105.9               | 5   | A   |                    |                     |     |     |
| X                  | 106.0               | D   | A   |                    |                     |     |     |
| X                  | 106.1               | 5   | B   |                    |                     |     |     |
| X                  | 106.2               | D   | B   |                    |                     |     |     |
| X                  | 106.3               | 5   | C   |                    |                     |     |     |
| X                  | 106.4               | D   | C   |                    |                     |     |     |
| X                  | 106.5               | 5   | D   |                    |                     |     |     |
| X                  | 106.6               | D   | D   |                    |                     |     |     |
| X                  | 106.7               | 5   | E   |                    |                     |     |     |
| X                  | 106.8               | D   | E   |                    |                     |     |     |
| X                  | 106.9               | 5   | F   |                    |                     |     |     |

Illustration 2–12-3 Receiver Frequency Selection

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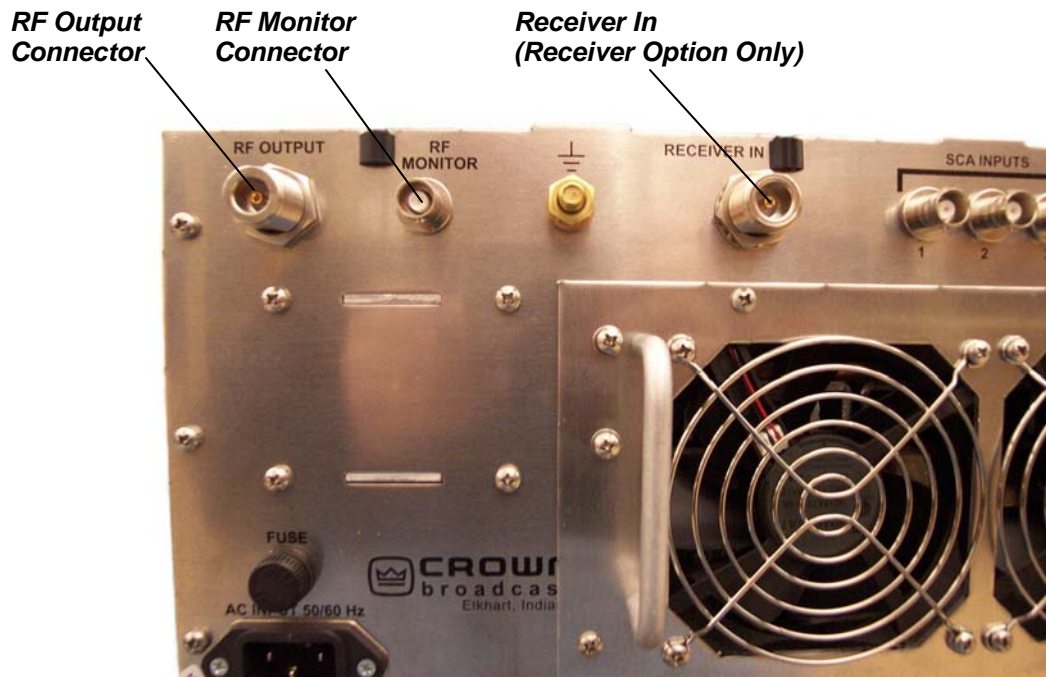
## 2.5 RF Connections

Connect the RF load, an antenna or the input of an external power amplifier, to the type-N, RF output connector on the rear panel. VSWR should be 1.5:1 or better.



The RF monitor is intended primarily for a modulation monitor connection. Information gained through this connection can supplement that which is available on the transmitter front panel displays.

If your transmitter is equipped with the receiver option, connect the incoming RF to the Receiver IN connector.



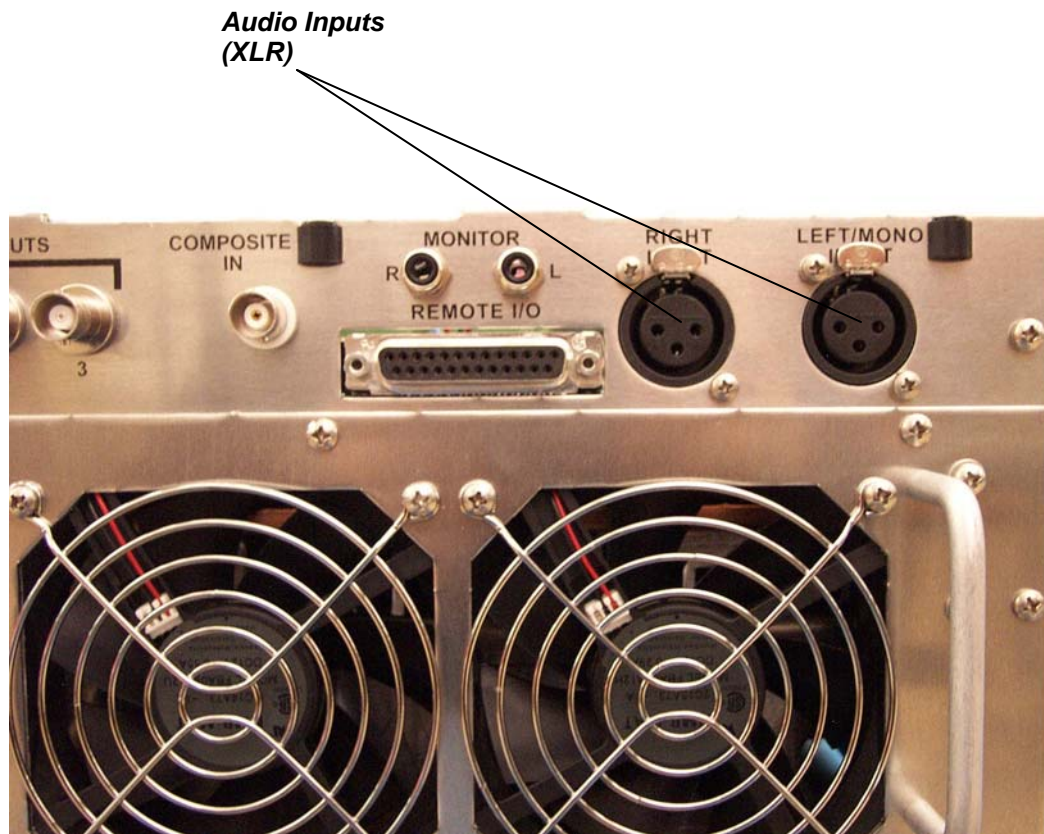
**Illustration 2-13 RF Connections**

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## 2.6 Audio Input Connections

Attach audio inputs to the Left and Right XLR connectors on the rear panel. (The Left channel audio is used on Mono.) Pin 1 of the XLR connector goes to chassis ground. Pins 2 and 3 represent a balanced differential input with an impedance of about 50 k $\Omega$ . They may be connected to balanced or unbalanced left and right program sources.

The audio input cables should be shielded pairs, whether the source is balanced or unbalanced. For an unbalanced program source, one line (preferably the one connecting to pin 3) should be grounded to the shield at the source. Audio will then connect to the line going to pin 2.



**Illustration 2-14 XLR Audio Input Connectors**

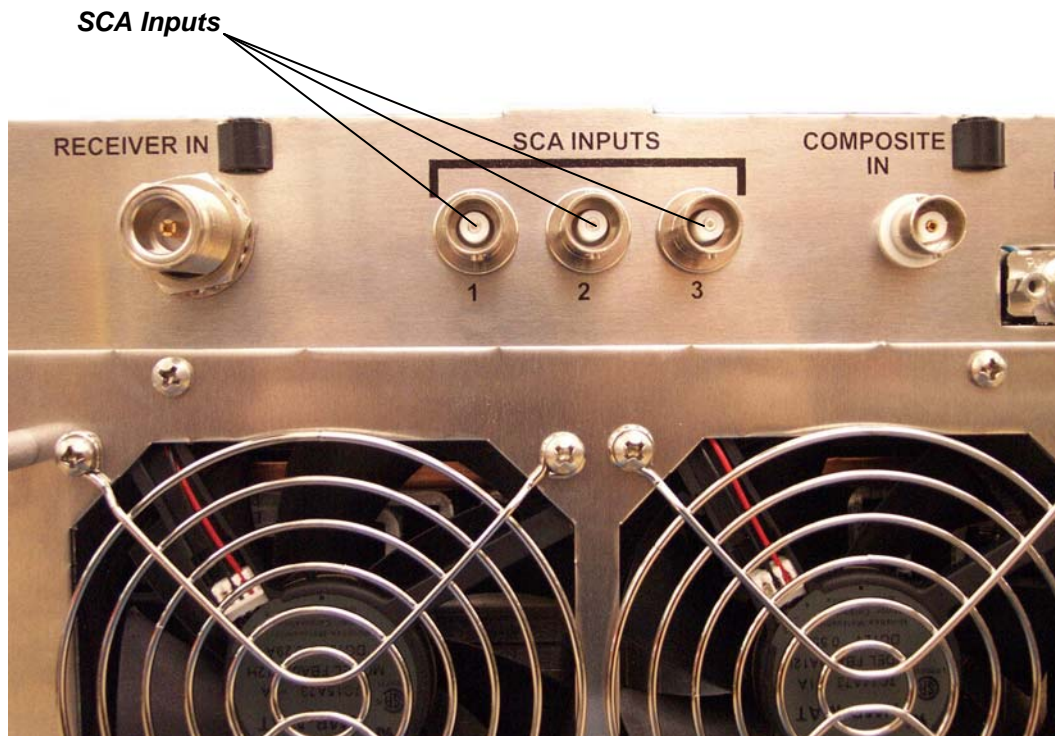
By bringing the audio return line back to the program source, the balanced differential input of the transmitter is used to best advantage to minimize noise. This practice is especially helpful if the program lines are fairly long, but is a good practice for any distance.

If the program source requires a 600  $\Omega$  termination, see the motherboard configuration chart on page 4-9 for the proper configuration of the jumpers.

---

## 2.7 SCA Input Connections

You can connect external SCA generators to the SCA In connectors (BNC-type) on the rear panel. The inputs are intended for the 60 kHz to 99 kHz range, but a lower frequency may be used if the transmitter is operated in Mono mode. (The 23 to 53 kHz band is used for stereo transmission.) For 7.5 kHz deviation (10% modulation), input of approximately 3.5–volts (peak-to-peak) is required.



**Illustration 2–15 SCA Input Connectors**

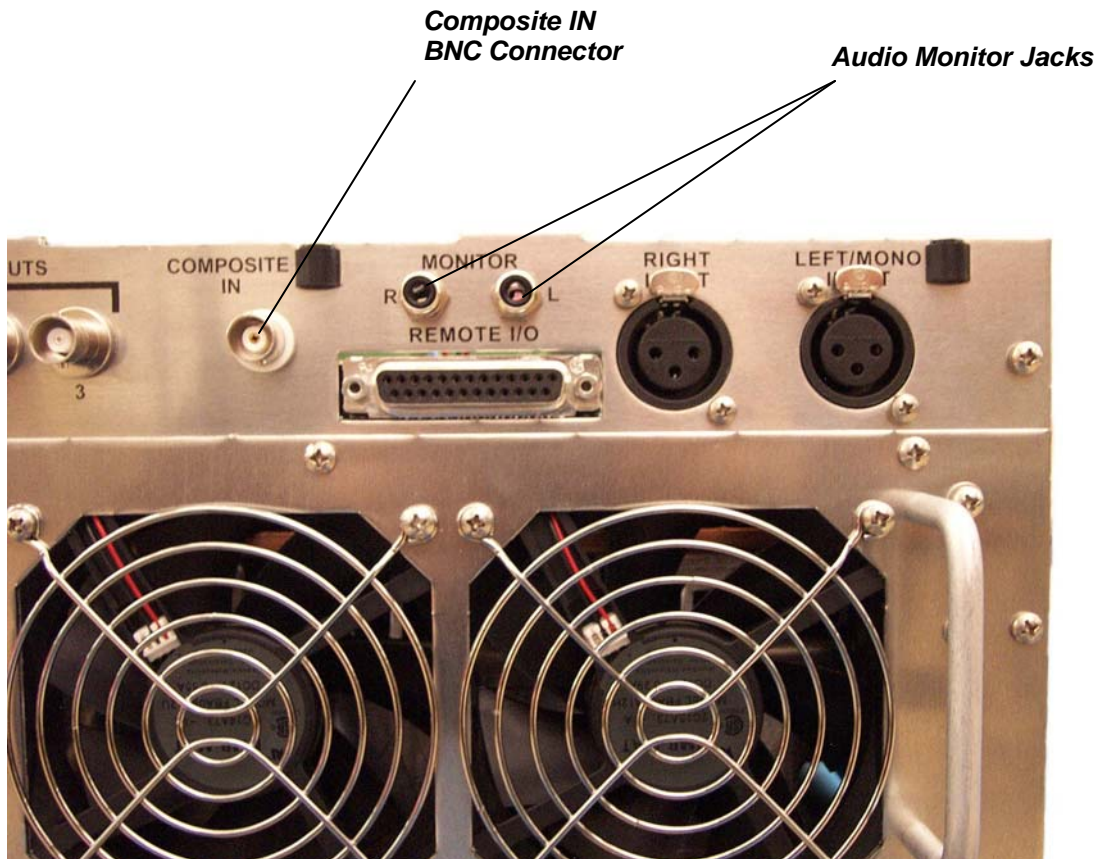
## 2.8 Composite Input Connection

You may feed composite stereo (or mono audio) directly to the RF exciter bypassing the internal audio processor and stereo generator. To use the Crown transmitter as an RF Exciter only ("E" version or when using the "T" version with composite input), it is necessary to use the Composite Input section of the transmitter. This will feed composite stereo (or mono audio) directly to the RF exciter. In the "T" version, this will bypass the internal audio processor and stereo generator.

Input sensitivity is approximately 3.5–volt P-P for 75 kHz deviation.

1. Enable the Composite Input by grounding pin 14 of the Remote I/O connector (see Illustration 2–18).
2. Connect the composite signal using the Composite In BNC connector.





**Illustration 2–16 Composite In and Audio Monitor Connections**

## *2.9 Audio Monitor Connections*

Processed, de-emphasized samples of the left and right audio inputs to the stereo generator are available at the Monitor jacks on the rear panel. The signals are suitable for feeding a studio monitor and for doing audio testing. De-emphasis is normally set for 75  $\mu$ sec; set to 50  $\mu$ sec by moving jumpers, HD201 and HD202, on the Audio Processor/Stereo Generator board.

## *2.10 Pre-emphasis Selection*

Select the pre-emphasis curve (75  $\mu$ sec, 50  $\mu$ sec, 25  $\mu$ sec, or Flat) by jumpering the appropriate pins of header HD1 on the Audio Processor/Stereo Generator board. If you change the pre-emphasis, change the de-emphasis jumpers HD201 and HD202 on the Audio Processor/Stereo Generator board to match.

---

## 2.11 Program Input Fault Time-out

You can enable an automatic turn-off of the carrier in the event of program failure. To enable this option, see remote I/O connector pin out chart on page 2-16. The time between program failure and carrier turn-off is set by a jumper (JP1) on the Driver Switch Logic board. (See page 6-3 for board location.) Jumper pins 1 and 2 (the two pins closest to the edge of the board) for a delay of approximately 30 seconds; pins 3 and 4 for a 2 minute delay; pins 5 and 6 for a 4 minute delay, and pins 7 and 8 for an 8 minute delay. Placing a jumper on pins 9 and 10 will disable the time-out timer.

## 2.12 Remote I/O Connector

Remote control and remote metering of the transmitter is made possible through a 25 pin, D-sub connector on the rear panel. (No connections are required for normal operation.)

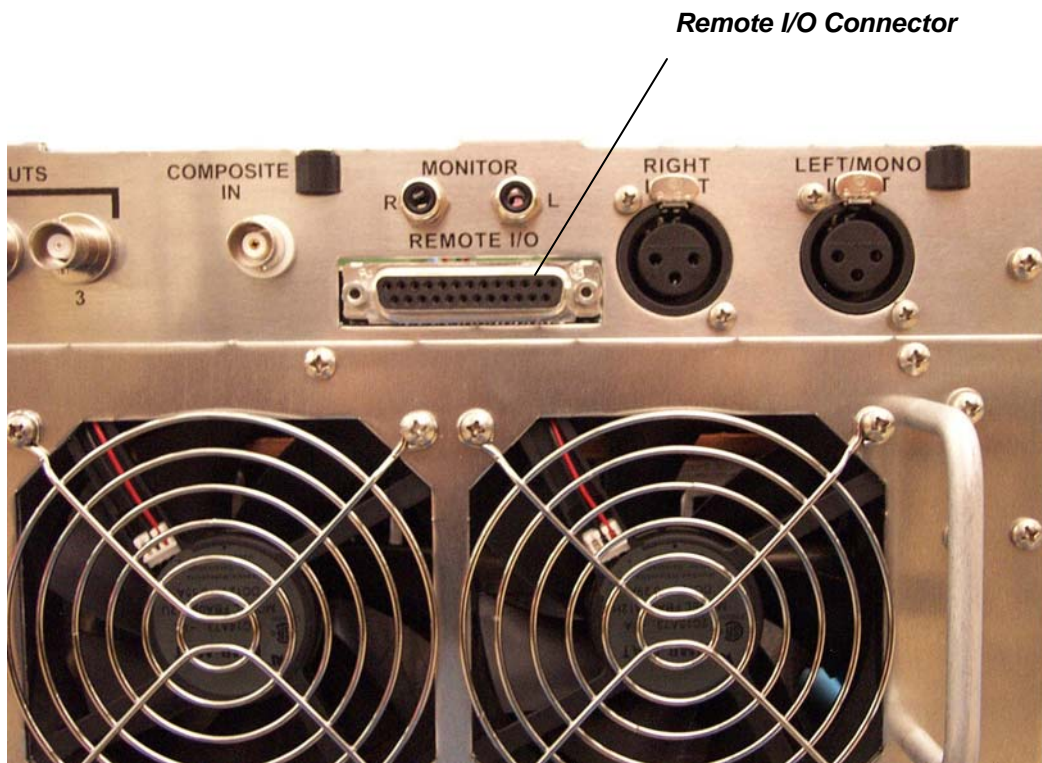


Illustration 2-17 Remote I/O Connector

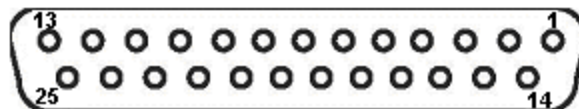


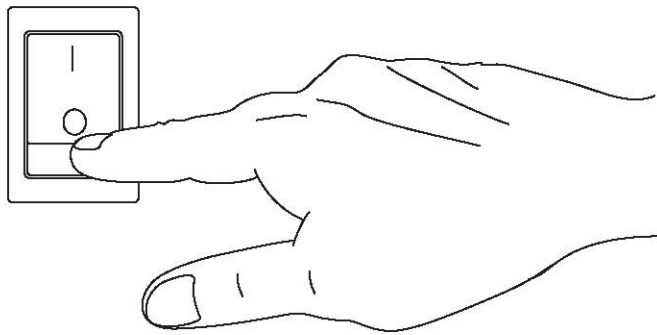
Illustration 2-18 Remote I/O Connector (DB-25 Female)

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| Pin Number | Function   |
|------------|--|
| 1.         | <b>Ground</b>  |
| 2.         | <b>FMV Control</b>   |
| 3.         | <b>Composite Out</b> (sample of stereo generator output)   |
| 4.         | <b>FSK In</b> (Normally high; pull low to shift carrier frequency approximately 7.5 KHz. Connect to open collector or relay contacts of user-supplied FSK keyer.)  |
| 5.         | <b>/Auto Carrier Off</b> (Pull low to enable automatic turnoff of carrier with program failure.)   |
| 6.         | <b>Meter Battery</b> (Unregulated DC voltage; 5 VDC=50 VDC)  |
| 7.         | <b>Meter RF Watts</b> (1 VDC = 100 Watts)  |
| 8.         | <b>Meter PA Volts</b> (5 VDC = 50VDC)  |
| 9.         | <b>Remote Raise</b> (A momentary switch, holding this pin low will slowly raise the RF output)   |
| 10.        | <b>Remote Lower</b> (A momentary switch, holding this pin low will slowly lower the RF output)   |
| 11.        | <b>Remote SWR</b> (A buffered metering output with a calculated reading of standing wave ratio in VDC.)  |
| 12.        | <b>External ALC Control</b>  |
| 13.        | <b>No Connection</b>   |
| 14.        | <b>/Ext. Enable</b> (Pull low to disable the internal stereo generator and enable External Composite Input.)   |
| 15.        | <b>38 KHz Out</b> (From stereo generator for power supply synchronization. For transmitter equipped with receiver option, this pin becomes the right audio output for an 8-ohm monitor speaker. 38 KHz is disabled.) |
| 16.        | <b>ALC</b>   |
| 17.        | <b>/Carrier Off</b> ( Pull low to turn carrier off)  |
| 18.        | <b>Fault Summary</b> ( line goes high if any fault light is activated.)  |
| 19.        | <b>Meter PA Temperature</b> (5 VDC=100 degrees C.)   |
| 20.        | <b>Meter PA Current</b> (1VDC=10 DC Amperes.)  |
| 21.        | <b>Front Panel Voltmeter Input.</b>  |
| 22.        | <b>No Connection.</b>  |
| 23.        | <b>RDS RX</b>  |
| 24.        | <b>RDS TX</b>  |
| 25.        | <b>Ground</b>  |

---





### *Section 3—Operation*

This section provides general operating parameters of your transmitter and a detailed description of its front panel display.

---

### 3.1 Initial Power-up Procedures

These steps summarize the operating procedures you should use for the initial operation of the transmitter. More detailed information follows.



1. Turn on the main power switch.

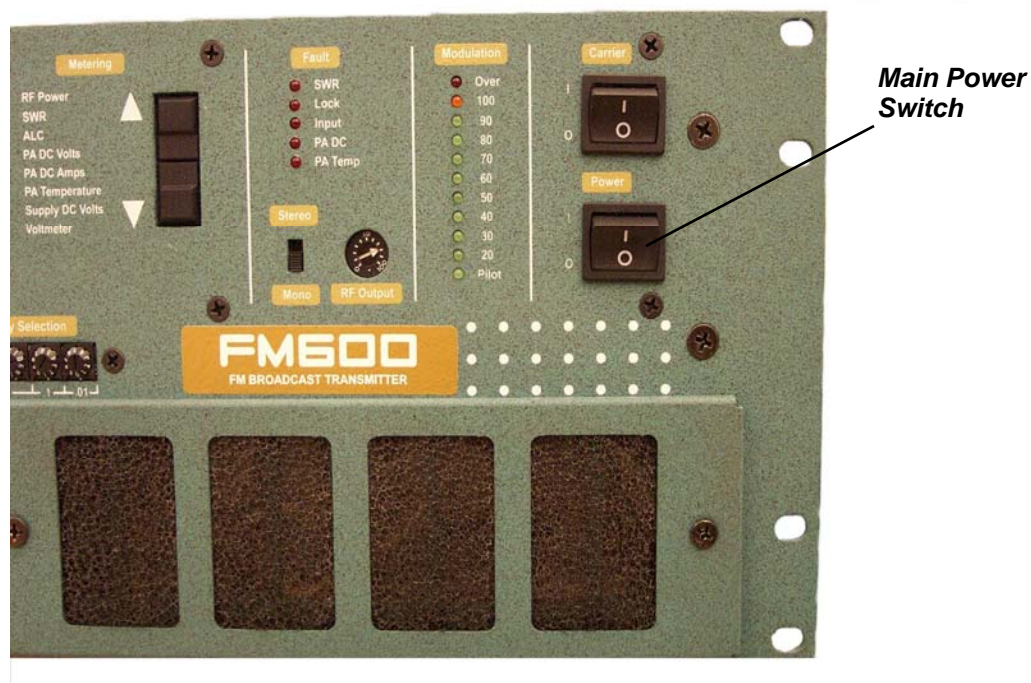


Illustration 3-2 Front Panel Power Switch

- 
2. Verify the following:
    - A. All three power amplifier cooling fans run continuously.
    - B. The Lock Fault indicator flashes for approximately 5 seconds, then goes off.
  3. Set the Input Gain switches for mid-scale wideband gain reduction on an average program level (see section 3.4).
  4. Set the Processing control (see section 3.5; normal setting is "50").
  5. Set the Stereo-Mono switch to Stereo (see section 3.6).
  6. Turn on the Carrier switch.
  7. Check the following parameters on the front panel multimeter:
    - A. RF Output power should be set for 600 watts
    - B. SWR should be less than 1.1. (A reading greater than 1.25 indicates an antenna mis match.
    - C. ALC should be between 4.00 and 6.00 volts.
    - D. PA DC volts should be 46 to 56 volts. (Varies with antenna match, power and frequency.)
    - E. PA DC Amperes should be 12-16 amps. (Varies with antenna match, power, and frequency.)
    - F. PA Temperature should initially read 20–35 degrees C (room temperature). After one hour the reading should be 40–60 degrees C.
    - G. Driver Supply voltage should be about 24 volts.
    - H. Voltmeter should be reading 0.0.

The remainder of this section describes the functions of the front panel indicators and switches.

---

## 3.2 Power Switches

### 3.2.1 Power Switch

The main on/off power switch controls both the high voltage and low voltage internal power supplies.

### 3.2.2 Carrier Switch

This switch controls power to the RF amplifiers and supplies a logic high to the Driver Switch Logic board, which enables the power supply for the RF driver.

A "Lock Fault" or a low pin 17 (/Carrier Off) on the Remote I/O connector will hold the carrier off. (See section 2.12.)

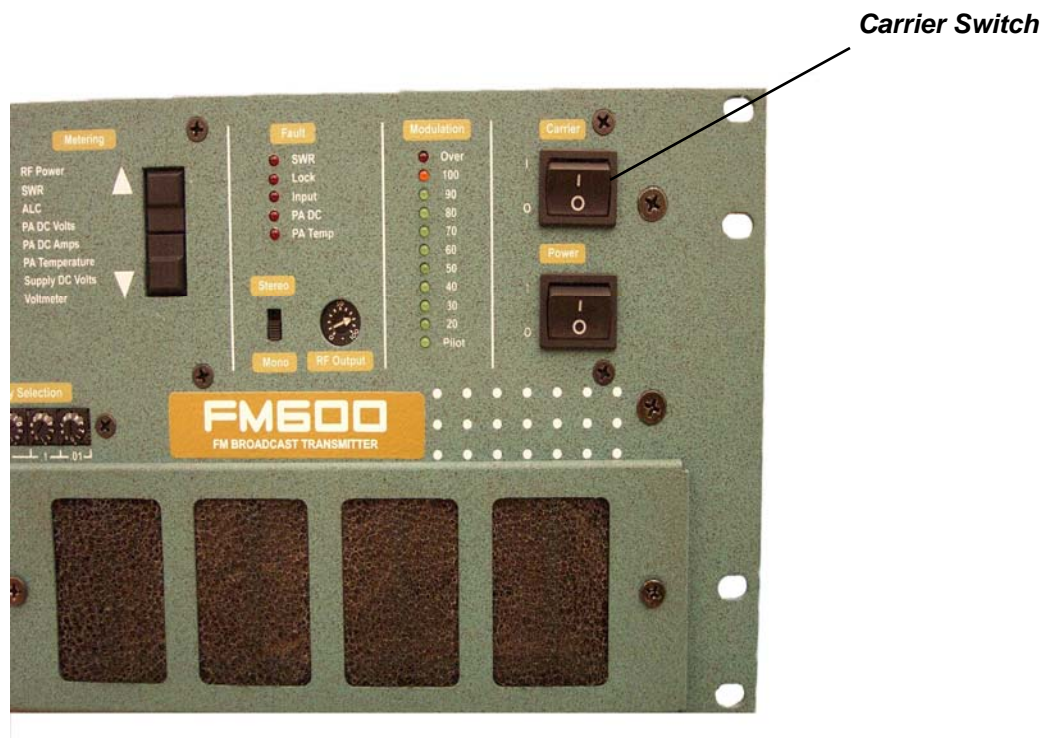


Illustration 3–3 Front Panel Carrier Switch

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## 3.3 Front Panel Bar-Dot Displays

Bar-dot LEDs show audio input levels, wideband and highband audio gain control, and modulation percentage. Resolution for the gain control and modulation displays is increased over a conventional bar-graph display using dither enhancement which modulates the brightness of the LED to give the effect of a fade from dot to dot. (See section 4.7.)

### 3.3.1 Audio Processor Input

Two vertical, moving-dot displays for the left and right channels indicate the relative audio levels, in 3 dB steps, at the input of the audio processor. Under normal operating conditions, the left and right Audio Processor indicators will be active, indicating the relative audio input level after the Input Gain switches. During program pauses, the red Low LED will light.

The translator configuration shows relative audio levels from the included receiver.

### 3.3.2 Highband and Wideband Display

During audio processing, the moving-dot displays indicate the amount of gain control for broadband (Wide) and pre-emphasized (High) audio.

As long as program material causes activity of the Wideband green indicators, determined by the program source level and Input Gain switches, the transmitter will be fully modulated. (See section 3.4.)

The Wideband indicator shows short-term “syllabic-rate” expansion and gain reduction around a long-term (several seconds) average gain set. In the translator configuration, the Wideband indicator also shows relative RF signal strength.

Program material and the setting of the Processing control determine the magnitude of the short-term expansion and compression (the rapid left and right movement of the green light).

High-frequency program content affects the activity of the Highband indicator. With 75- $\mu$ sec pre-emphasis, Highband processing begins at about 2 kHz and increases as the audio frequency increases. Some programs, especially speech, may show no activity while some music programs may show a great deal of activity.

### 3.3.3 Modulation Display

A 10-segment, vertical peak-and-hold, bar graph displays the peak modulation percentage. A reading of “100” coincides with 75 kHz deviation. The display holds briefly (about 0.1 seconds) after the peak. The “Pilot” indicator illuminates when the transmitter is in the stereo mode.

To verify the actual (or more precise) modulation percentage, connect a certified modulation monitor to the RF monitor jack on the rear panel.

---

### 3.4 Input Gain Switches

The “+6 dB” and “+12 dB” slide switches set audio input sensitivity according to the following table.

| Normal Input Sensitivity | Switches |       |
|--------------------------|----------|-------|
|                          | +6dB     | +12dB |
| +10dBm                   | Down     | Down  |
| +4dBm                    | Up       | Down  |
| -2dBm                    | Down     | Up    |
| -8dBm                    | Up       | Up    |

**Illustration 3–4 Input Gain Switches**

Find, experimentally, the combination of Input Gain switch settings that will bring the Wideband gain-reduction indicator to mid scale for “normal” level program material. The audio processor will accommodate a fairly wide range of input levels with no degradation of audio quality.

### 3.5 Processing Control

Two factors contribute to the setting of the Processing control: program material and personal taste. For most program material, a setting in the range of 40 to 70 provides good program density. For the classical music purist, who might prefer preservation of music dynamics over density, 10 to 40 is a good range. The audio will be heavily processed in the 70 to 100 range.

If the program source is already well processed, as might be the case with a satellite feed, set the Processing to “0” or “10”.

### 3.6 Stereo-Mono Switch

The Stereo-Mono slide switch selects the transmission mode. In Mono, feed audio *only to the left channel*. Although right-channel audio will not be heard as audio modulation, it will affect the audio processing.

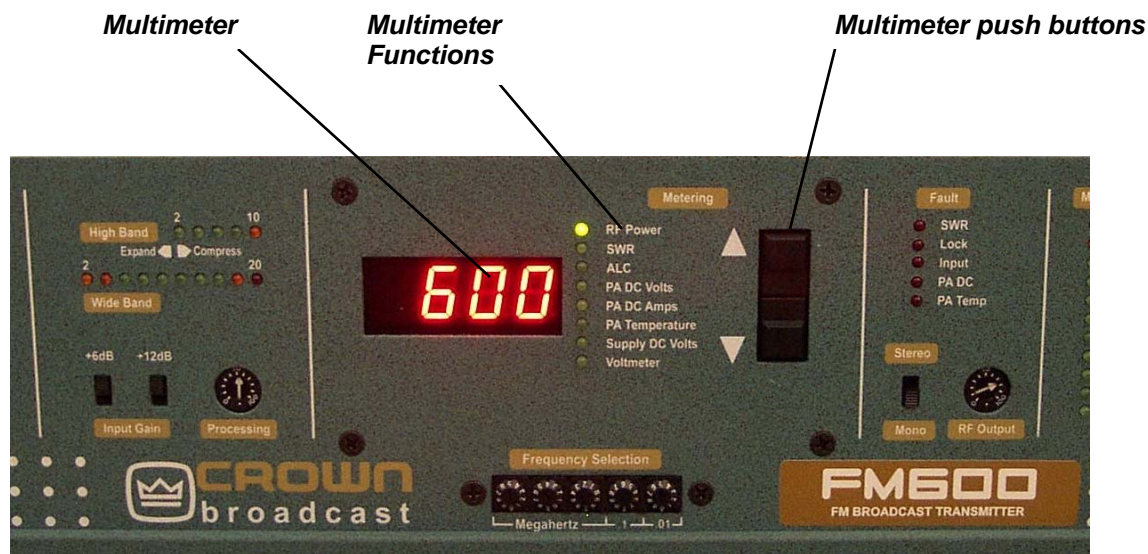
### 3.7 RF Output Control

Set this control for the desired output power level. Preferably, set the power with an external RF wattmeter connected in the coaxial line to the antenna. You may also use the RF power reading on the digital multimeter.

The control sets the RF output voltage. Actual RF output power varies as the approximate square of the relative setting of the control. For example, a setting of “50” is approximately 1/4 full power.

### 3.8 Digital Multimeter

The four-digit numeric display in the center of the front panel provides information on transmitter operation. Use the “Up” and “down” push-buttons to select one of the following parameters. A green LED indicates the one selected.



**Illustration 3–5 Digital Multimeter**

**RF Power**—Actually reads RF voltage squared, so the accuracy can be affected by VSWR (RF voltage-to-current ratio). See section 5.4 for calibration. Requires calibration with the RF reflectometer being used.

**SWR**—Direct reading of the antenna standing-wave ratio (the ratio of the desired load impedance, 50 ohms, to actual load).

**ALC**—DC gain control bias used to regulate PA supply voltage. With the PA power supply at full output voltage, ALC will read about 6.0 volts. When the RF output is being regulated by the RF power control circuit, this voltage will be reduced, typically reading 4 to 5.5 volts. The ALC voltage will be reduced during PA DC overcurrent, SWR, or LOCK fault conditions.

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PA DC Volts—Supply voltage of the RF power amplifier.

PA DC Amps—Transistor drain current for the RF power amplifier.

PA Temperature—Temperature of the RF power amplifier heatsink in degrees C.

Driver Supply Volts—Regulated 24 volt DC supply for the RF driver amplifier.

Voltmeter—Reads the voltage at a test point located on the front edge of the motherboard. A test lead connected to this point can be used for making voltage measurements in the transmitter. The test point is intended as a servicing aid; an alternative to an external test meter. Remember that the accuracy is only as good as the reference voltage used by the metering circuit. Servicing a fault affected by the reference affects the Voltmeter reading. The metering scale is 0 to 199.9 volts.

In the translator configuration, you can read a relative indication of RF signal strength numerically in the Voltmeter setting.

### *3.9 Fault Indicators*

Faults are indicated by a blinking red light as follows:

SWR—Load VSWR exceeds 1.5:1. ALC voltage is reduced to limit the reflected RF power.

Lock—Frequency synthesizer phase-lock loop is unlocked. This indicator normally blinks for about five seconds at power turn-on. Whenever this light is blinking, supply voltages will be inhibited for the RF driver stage as well as for the RF power amplifier.

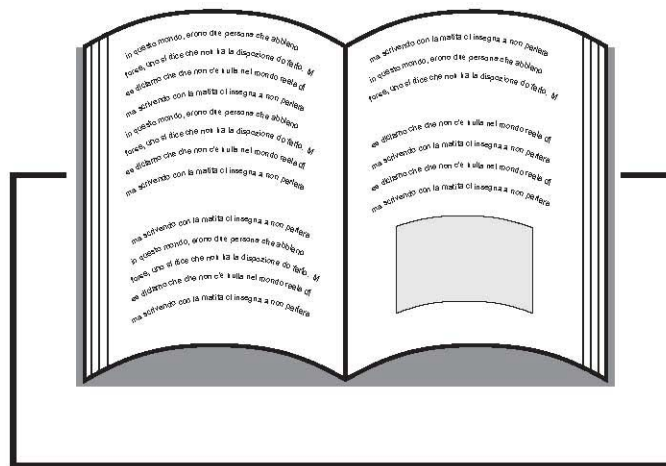
Input—The automatic carrier-off circuit is enabled (see sections 2.11 and 2.12) and the absence of a program input signal has exceeded the preset time. (The circuit treats white or pink noise as an absence of a program.)

PA DC—Power supply current for the RF power output amplifier is at the preset limit. ALC voltage has been reduced, reducing the PA supply voltage to hold supply current to the preset limit.

PA Temp—PA heatsink temperature has reached 93° C (199° F).

At about 97°C (207° F), ALC voltage begins to decrease, reducing the PA supply voltage to prevent a further increase in temperature. By 105° C (221° F) the PA will be at the minimum output level, of approximately 190 Watts.





## *Section 4—Principles of Operation*

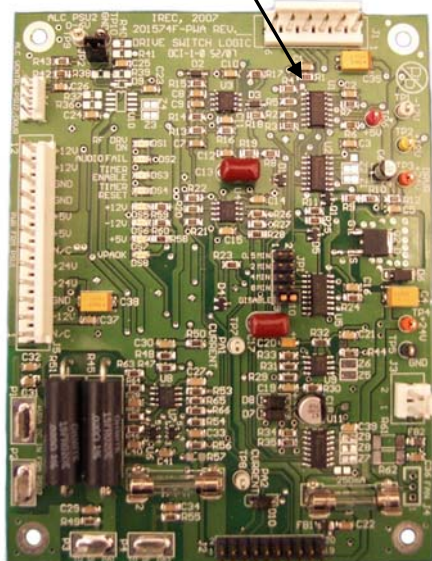
This section discusses the circuit principles upon which the transmitter functions. This information is not needed for day-to-day operation of the transmitter but may be useful for advanced users and service personnel.

## 4.1 Part Numbering

As this section refers to individual components, you should be familiar with the part numbering scheme used.

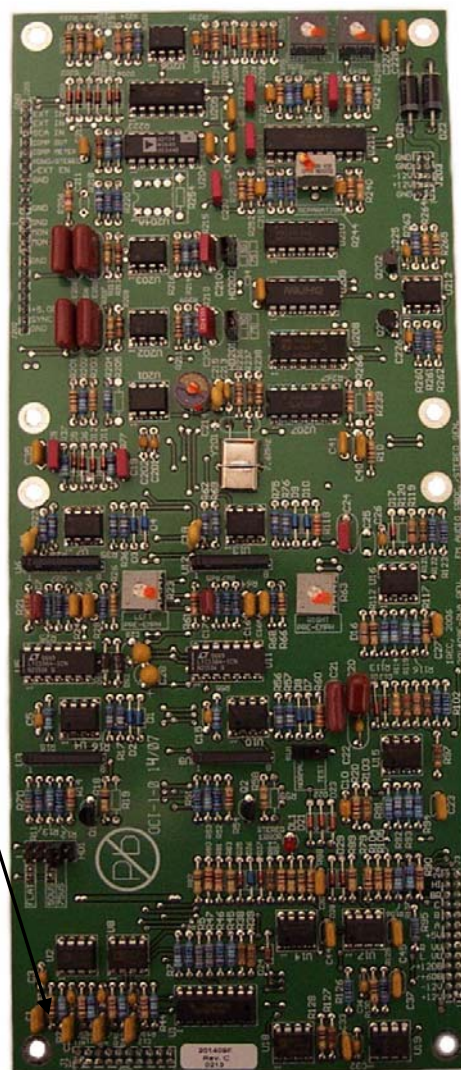
The circuit boards and component placement drawings use designators such as “R1”, “R2”, and “C1.” These same designators are used throughout the transmitter on several different circuit boards and component placement drawings. When referencing a particular component it is necessary to also reference the circuit board that it is associated with.

**Resistor R1**



**Driver Switch Logic Board**

**Resistor R1**



**Audio Processor/Stereo Generator Board**

**Illustration 4–1 Resistor R1 On Different Circuit Boards**

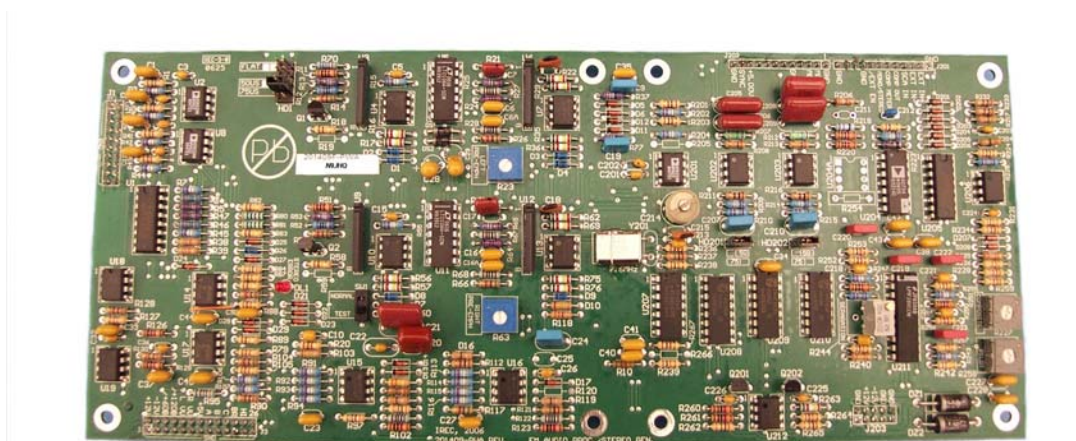
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## 4.2 Audio Processor/Stereo Generator Circuit Board

The audio board provides the control functions of audio processing-compression, limiting, and expansion, as well as stereo phase-error detection, pre-emphasis and generation of the composite stereo signal.

Illustration 6-4 and accompanying schematic may be useful to you during this discussion. The overall schematic for the audio board is divided into two sheets; one each for the processor and stereo generator sections of the board.

Reference numbers are for the left channel. Where there is a right-channel counterpart, reference number are in parenthesis.



**Illustration 4–2 Audio Processor/Stereo Generator Board**

### 4.2.1 Audio Processor Section

Audio input from the XLR connector on the rear panel of the transmitter goes to instrument amplifier, U2 (U8). Two-bit binary data on the +6 dB and +12 dB control lines sets the gain of U2 (U8) to one of four levels in 6-dB steps. Gain of U2 is determined by R5, R6, or R7 (R45, R46, or R47) as selected by analog switch U1.

U3 (U9) is a THAT2180 voltage-controlled amplifier with a control-voltage-to-gain constant of 6.1 mV/dB. The 2180 is a current-in/current-out device, so signal *voltages* at the input and output will be zero. R11 converts the audio voltage at the output of U2 (U8) to current at the input of U3 (U9). U3 (U9) output current is converted to audio voltage by U4A (U10A).

U4B (U10B) is a unity-gain inverter. When the positive peaks at the output of U4A (U10A) or U4B (U10B) exceeds the gain-reduction threshold, U15 generates a 0.25 Volts-per-dB DC control bias, producing wide-band gain reduction for U3 (U9). The dB-linear allows a front-panel display of gain control on a linear scale with even distribution of dB.

---

Q1 (Q2) is a recover/expansion gate with a threshold about 18 dB below the normal program level. The amount of short-term expansion and time for gain recovery is controlled by the PROCESSING control, located on the front panel display board. (See section 3.5.)

Audio components above 15,200 Hz are greatly attenuated by eighth-order switched-capacitor elliptical filter, U5 (U11). The filter cut-off frequency is determined by a 1.52-MHz clock (100 x 15,200 Hz) signal from the stereo generator section of the board. The broadband signal level at the output of U5 (U11) is about 5 dB below that required for full modulation. (With normal program material, the 5 dB of headroom will be filled with pre-emphasized audio.)

Pre-emphasis in microseconds is the product of the capacitance of C7 (C17), multiplied by the current-gain of U6 (U12), times the value of R22 (R62). (For description of the device used for U6 (12), see explanation for U3 (U9) above.) For a 75 micro-seconds pre-emphasis, the gain of U6 (U12) will be about 1.11.

Selection of the pre-emphasis curve (75  $\mu$ S, 50  $\mu$ S, or Flat) is made by moving the jumper on HD1 to the pins designated on the board. Fine adjustment of the pre-emphasis is made with R23 (R63). (See section 5.1.)

For high-band processing, the peak output of U7A (U13A) and U7B (U13B) is detected and gain-reduction bias is generated, as with the broadband processor. The high-band processing, however, shifts the pre-emphasis curve rather than affecting overall gain. Peak audio voltages are compared to plus and minus 5-volt reference voltages at the outputs of U19A and U19B. This same reference voltage is used in the stereo generator section.

A stereo phasing error occurs when left and right inputs are of equal amplitude but opposite polarity. The most common cause is incorrect wiring of a left or right balanced audio line somewhere in the program chain-sometimes at the source of a recording. When this happens, all the audio is in the left-minus-right stereo subcarrier-none in the left-plus-right baseband. The error can go unnoticed by one listening on a stereo receiver, but the audio may disappear on a mono receiver. In normal programming there may be short-term polarity reversals of left versus right, either incidental or-for effect-intentional. A phase error of several seconds duration is processed by U14A and U14B and interpreted as a real error. During a phasing error the right-channel level is gradually reduced by 6 dB. For a listener to a stereo radio, the right-channel volume will be lower, while on a mono receiver there will be a reduction of volume.

NORMAL/TEST switch. In the TEST position, the stage gains are set to a fixed level. See section 6.2

#### **4.2.2 Stereo Generator Section**

Composite stereo signal is generated from left and right-channel audio inputs. This section also has the amplifier (U201) for an optional external composite input and provision for insertion of SCA signal(s).

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Processed, pre-emphasized left and right audio is passed through third-order lowpass filters comprised of U202A (203A) and associated circuitry. The filters decrease the level of audio products below 30 Hz. This low-frequency roll off is necessary to prevent disturbance to the phase-lock loop in the RF frequency synthesizer by extremely low-frequency audio components. (See caution at section 2.8.)

U204 is a precision, four-quadrant, analog multiplier. The output of U204 is the product of 38 kHz applied to the Y input and the difference of left and right audio (L-R signal) applied to the X input. The resulting output is a double sideband, suppressed carrier/the L-R subcarrier.

Spectral purity of the stereo subcarrier is dependant on a pure 38-kHz sine wave at the multiplier input.

U207A and Y201 comprise a 7.6-MHz crystal oscillator from which the 19 and 38-kHz subcarriers are digitally synthesized. U207F is a buffer. The 7.6 MHz is divided by 5 in U208A to provide 1.52 Mhz, used by switched-capacitor filters U5 and U11 in the audio section. 3.8 MHz, 1.9 MHz, and 304 kHz are also derived from dividers in U208. Exclusive-OR gates, U210C and U210D, provide a stepped approximation of a 38-kHz sine wave. With the resistor ratios used, the synthesized sine wave has very little harmonic energy below the 7th harmonic. U210A and B generate the 19-kHz pilot subcarrier. U211 is a dual switched-capacitor filter, configured as second-order, low-pass filters, each one with a Q of 5. The 38 and 19-kHz outputs of pins 1 and 20, respectively, are fairly pure sine waves. Harmonic distortion products are better than 66 dB down-with a THD of less than 0.05%. SEPARATION control R244 sets the 38-kHz level at the Y input of U204.

Resistor matrix R219, R220, R221, and R223 sum the L+R audio with the L-R subcarrier to produce a current at the junction of R221 and R223 that will be converted to composite stereo (less pilot) at the output of summing amplifier U206A. SCA signal is also injected at the input of U206A. 19-kHz pilot is combined with composite stereo in summing amplifier U206B.

Analog switch U205, at the input of U206A, provides switching of left and right audio for stereo and mono modes. In the mono mode, right channel audio is disabled, and the left channel audio is increased from 45% modulation to 100%.

MON L and MON R outputs go to the AF Monitor jacks on the rear panel. R209+R210 (R214+R215) and C207 (C210) is a de-emphasis network. Processed, de-emphasized samples of the left and right audio are used for a studio monitor and for audio testing. Jumpers at HD201 (HD202) allow selection of 50- $\mu$ sec or 75- $\mu$ sec de-emphasis.

VR212A and B supply +7 volts and -7 volts, respectively. A 5-volt reference from the audio processor section supplies the subcarrier generators.

For an explanation of on-board adjustments see section 5.2.



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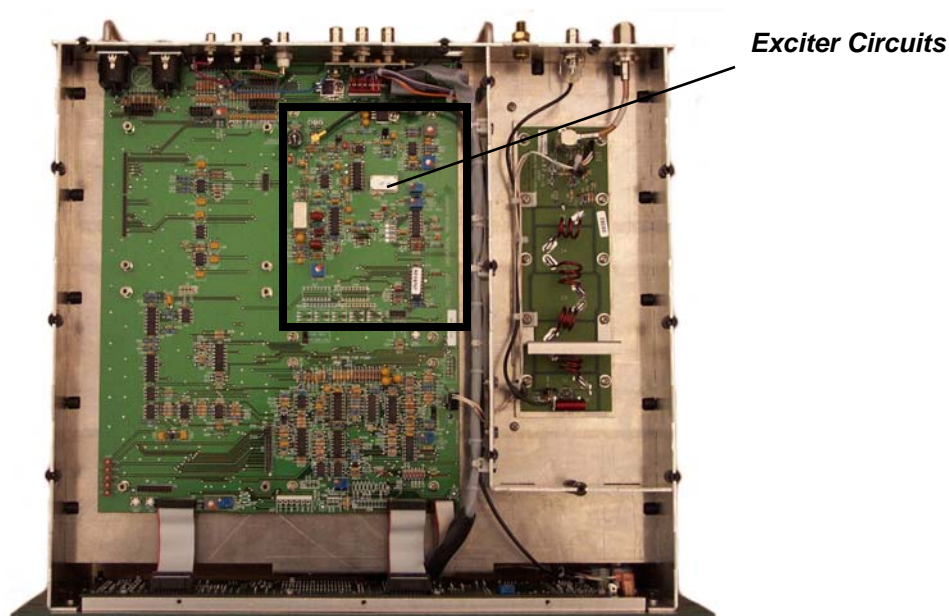
### 4.3 RF Exciter Circuit

This circuit is also known as the Frequency Synthesizer. The Frequency Synthesizer part of the motherboard is no longer a separate module as was the case on older transmitters. The entire component side of the motherboard is a ground plane. Frequency selector switches located on the front panel of the transmitter establish the operating frequency. The VCO (voltage-controlled oscillator) circuitry is inside an aluminum case.

Illustration 6-6 and accompanying schematics can be used as reference in this discussion.

VCO1 operates at the synthesizer output frequency of 87 MHz to 108 MHz.

The frequency is controlled by a voltage applied to pin 8 of the VCO. A sample of the RF comes from A2 and is fed to the PLL chip U13. U13 is a phase-locked-loop frequency synthesizer IC. The 10.24 MHz from the crystal oscillator is divided to 10 kHz. Internal programmable dividers divide the 87 - 108 MHz RF to 10 kHz. Differences between the two signals produce error signals at pins 7 and 8 of U14.



**Illustration 4–3 Motherboard (Exciter Circuits)**

Frequency selector switches are read by shift registers U17 and U18. Data from the shift registers is read by U16 which then programs the PLL (Phase Lock Loop) IC U13.

U14B is a differential amplifier and filter for the error signal. Audio that is out of phase with that appearing on the error voltage is introduced by U14A, allowing for greater loop bandwidth with less degradation of the low frequency audio response.

Lock and unlock status signals are available at the outputs of U15E and U15F respectively.

Modulation is introduced to the VCO through R72 and R122.

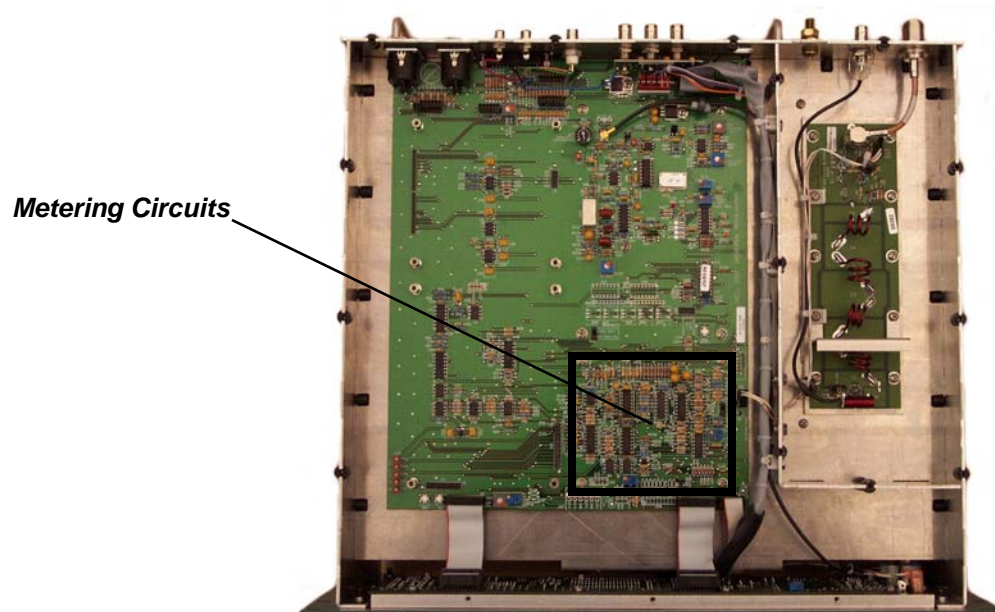
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## 4.4 Metering Circuit

The ALC and metering circuitry is on the motherboard (see Illustration 6–6). This circuit processes information for the RF and DC metering, and produces ALC (RF level-control) bias. It also provides reference and input voltages for the digital panel meter, voltages for remote metering, and drive for the front-panel fault indicators.

Illustration 6–6 and accompanying schematics complement this discussion.

PA voltage and current come from a metering shunt on the Driver Switch Logic board. The PAI input is a current proportional to PA current; R153 converts the current to voltage used for metering and control. A voltage divider from the PAV line is used for DC voltage metering.



**Illustration 4–4 Motherboard (Metering Circuits)**

U23A, U23B, and U24A, with their respective diodes, are diode linearity correction circuits. Their DC inputs come from diode detectors in the RF reflectometer in the RF low-pass filter compartment.

U24B, U24C, are components of a DC squaring circuit. Since the DC output voltage of U24C is proportional to RF voltage squared, it is also proportional to RF power.

U22C, U22A, U20A, and U22D are level sensors for RF power, reflected RF power, PA temperature, and external PA current, respectively. When either of these parameters exceeds the limits, the output of U22B will be forced low, reducing the ALC (RF level control) voltage, which, in turn, reduces the PA supply voltage.

The DC voltage set point for U22A (reflected RF voltage) is one-fifth that of U22C (forward RF voltage). This ratio corresponds to an SWR of 1.5:1  $[(1+.2)/(1-.2)=1.5]$ . The U25 inverters drive the front panel fault indicators.

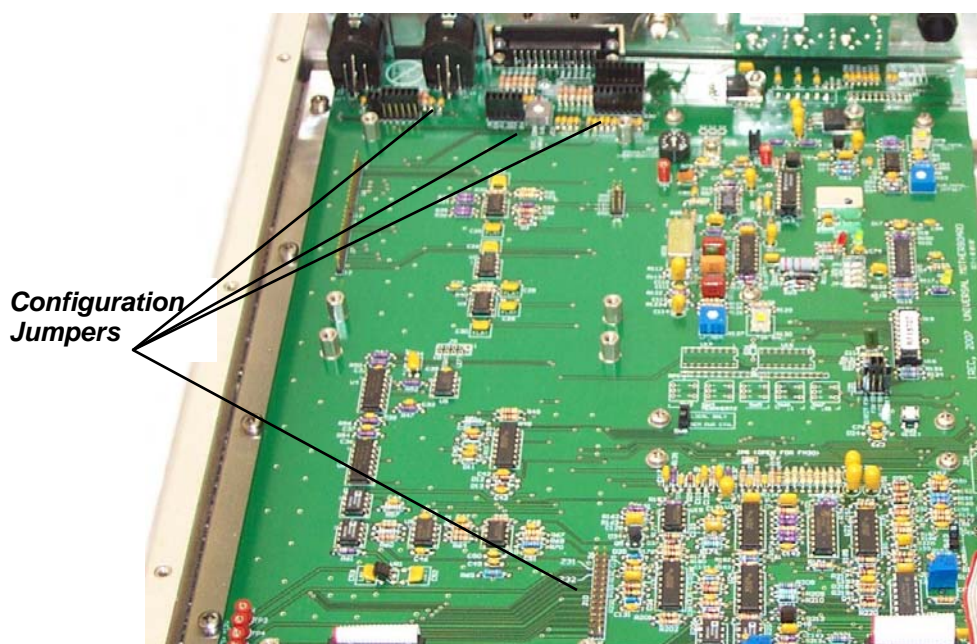
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## 4.5 Motherboard

The motherboard is the large board in the upper chassis interconnecting the audio processor/ stereo generator board or the optional receiver module to the RF exciter and metering circuits. The motherboard provides the interconnections for these boards, eliminating the need for a wiring harness, and provides input/output filtering. The RF exciter and Metering circuits are an integral part of the motherboard and are no longer separate boards as in past transmitter designs.

Also contained on the motherboard is the +5.00 volt reference and the composite drive Op amp and its associated circuitry.

The motherboard has configuration jumpers associated with different options that can be added at the time of order or at a later time as an upgrade. The motherboard configuration chart for these jumpers can be found on the following page.



**Illustration 4-5 Motherboard Configuration Jumpers**



| Jumper | FMA “E” | FMA “T”<br>50k-Ohm Input | FMA “T”<br>600-Ohm Input | FMA “R” |
|--------|---------|--------------------------|--------------------------|---------|
| Z1     | Short   | Short                    | Short                    | Short   |
| Z2     | Short   | Short                    | Short                    | Short   |
| Z3     | Open    | Open                     | Short                    | Open    |
| Z4     | Open    | Open                     | Open                     | Open    |
| Z5     | Open    | Open                     | Short                    | Open    |
| Z6     | Open    | Open                     | Open                     | Open    |
| Z7     | Open    | Open                     | Short                    | Open    |
| Z8     | Open    | Open                     | Short                    | Open    |
| Z9     | Short   | Open                     | Open                     | Open    |
| Z10    | Short   | Open                     | Open                     | Open    |
| Z11    | Short   | Open                     | Open                     | Open    |
| Z12    | Short   | Open                     | Open                     | Open    |
| Z13    | Short   | Open                     | Open                     | Open    |
| Z14    | Short   | Open                     | Open                     | Open    |
| Z15    | Open    | Open                     | Open                     | Open    |
| Z16    | Open    | Open                     | Open                     | Open    |
| Z17    | Open    | Open                     | Open                     | Open    |
| Z18    | Open    | Open                     | Open                     | Open    |
| Z19    | Open    | Open                     | Open                     | Open    |
| Z20    | Open    | Open                     | Open                     | Open    |
| Z21    | Open    | Open                     | Open                     | Open    |
| Z22    | Open    | Open                     | Open                     | Open    |
| Z23    | Short   | Short                    | Short                    | Short   |
| Z24    | Short   | Short                    | Short                    | Short   |
| Z25    | Short   | Short                    | Short                    | Short   |
| Z26    | Short   | Short                    | Short                    | Short   |
| Z27    | Short   | Short                    | Short                    | Short   |
| Z28    | Short   | Short                    | Short                    | Short   |
| Z29    | Short   | Short                    | Short                    | Short   |
| Z30    | Short   | Short                    | Short                    | Short   |
| Z31    | Open    | Open                     | Open                     | Open    |
| Z32    | Short   | Open                     | Open                     | Open    |
| Z33    | Short   | Open                     | Short                    | Open    |
| JMP1   | Open    | Open                     | Open                     | Open    |
| JMP2   | Open    | Open                     | Open                     | Open    |

**Motherboard Jumper Configuration Chart 4.6.1**

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## 4.6 Display Circuit Board

The front-panel LEDs, the numeric display, the slide switches, and the processing and RF level controls are mounted on the display circuit board. To access the component side of the board, remove the front panel by removing 12 screws. The board contains circuits for the digital panel meter, modulation peak detector, and LED display drivers, as well as indicators and switches mentioned above.

Illustration 6–9 and accompanying schematic complement this discussion.

Left and right audio from input stages of the audio processor board (just after the Input Gain attenuator) go to the L VU and R VU input on the display board. Peak rectifiers U1A and U1B drive the left and right Audio Input displays. The LED driver gives a 3–dB per step display. The lowest step of the display driver is not used; rather a red LOW indicator lights when audio is below the level of the second step. Transistors Q1 and Q2 divert current from the LOW LEDs when any other LED of the display is lit.

Resolution of the linear displays, High Band, Wide Band, and Modulation, has been improved using dither enhancement. With dither, the brightness of the LED is controlled by proximity of the input voltage relative to its voltage threshold. The effect is a smooth transition from step to step as input voltage is changed. U6A, U6B, and associated components comprise the dither generator. Dither output is a triangular wave.

Composite stereo (or mono) is full-wave detected by diodes D5 and D6, U7, U13, Q3, and Q4 are components of a peak sample-and-hold circuit.

Oscillator, U9F, supplies a low-frequency square wave to the Fault indicators, causing them to flash on and off.

Digital multimeter inputs are selected with push buttons located to the right of the multimeter menu. Signals from the push buttons are conditioned by U9A and U9B. U10 is an up/down counter. Binary input to U11 from U10 selects a green menu indicator light, and lights the appropriate decimal point on the numeric readout. The binary lines also go to analog data selectors on the ALC/ metering board.

Processing control, R50, is part of the audio processor. (See section 4.2.)

The DPM IN and DPM REF lines are analog and reference voltage inputs to digital multimeter IC U12. They originate from analog data selectors on the ALC/ metering board.

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## 4.7 Driver Switch Logic Circuit Board

The Driver Switch Logic board is mounted on the bottom side of the transmitter chassis with the two power supplies. The Driver Switch Logic board performs the following five different functions, program audio detection, audio fail timer, PA current monitor, PSU2 voltage monitor, and driver switch.

The program audio detection circuit and the audio fail timer is made up of U3,U4, and U5. U3A and U3B and associated circuitry discriminate between normal program material and white noise ( such as might be present from a studio transmitter link during program failure) or silence. U3A and surrounding components form a band-pass filter with a Q of 3 tuned to about 5kHz. U3B is a first-order low pass filter. Red (DS3) and green (DS4) LEDs on the board indicate the presence or absence of program determined by the balance of the detected signals from the two filters. U5 and U4B form a count-down timer. The time between a program fault and shutdown is selected by jumpering pins on header JP1. For times, see section 5.7. The times are proportional to the value of R28 ( that is, times can be doubled by doubling the value of R28). When the timer circuit times out, a red LED (DS2) will illuminate giving a visual indication of the audio fail timers status.

The PA current monitor circuit consists of R45(R51) U6(U7), U8 and associated circuitry. Note that components listed in parentheses ( ) are used in the PA current monitor for PA2. Current passing through R45(R51) creates a voltage drop that is measured by the current monitor U6(U7). U6(U7) has a gain of 5. The output voltage from U6(U7) is delivered to op-amp U8A (U8B) which has a gain of 4. The outputs of U8A and U8B are summed together through R47 and R53. The summed output equals the total currents drawn by both RF power amplifiers PA1 and PA2. This total current draw is displayed on the front panel as PA DC Amps.

The PSU2 voltage monitor is used to monitor the status of the high voltage power supply and determines if it is stable and operational. The PSU2 voltage monitor circuit is made up of R29, R30, U9A ,U11 and associated circuitry. R29 and R30 create a voltage divider circuit that scales down the voltage from the high voltage power supply. The scaled down power supply voltage is fed to comparator U9A. When the high voltage power supply has an output voltage above 21 volts, the output of comparator U9A goes high. The output of U9A is fed to inverter U11B which inverts the signal creating a logic low output. This output is fed to NOR gate U2C in the driver switch circuit. The logic high signal from U9A is also fed to U11A which enables the green LED (DS8) indicating that the voltage from the high voltage power supply is OK.

The driver switch circuit is the last circuit on the driver switch logic board that determines if the driver amplifier should be enabled based on the status of the above mentioned circuits. The driver switch circuit consists of U2C, Q1, Q2 and associated circuitry. Logic gate U2C is a NOR gate. The inputs to U2C are the outputs of the PSU2 voltage monitor and the audio fail timer circuits. If the outputs from the PSU2 voltage monitor circuit and the audio fail timer circuit are at a logic low, the resulting output of U2C will be a logic high, enabling transistor Q1 and turning on green LED (DS1) indicating that the driver amplifier should be enabled. When Q1 is turned on, this will place about  $-8.8$  volts (w/respect to the source of Q2) on the gate of the P-channel MOSFET Q2. This will cause MOSFET Q2 to conduct, delivering +24 volts to the driver amplifier, thus enabling the RF output.

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## 4.7 Driver Switch Logic Circuit Board, continued

Also present on the Driver Switch Logic board are power supply diagnostic LEDs and various circuit test points.

Several green LEDs give a visual indication that the power supplies are functioning. The LEDs do not indicate that the voltage is correct for its given power supply, they are just merely an indication that voltage is present. LED DS7 is the indicator for the +5 volt power supply, DS5 is the indicator for the +12 volt power supply and DS6 is for the -12 volt power supply.

Test points that are present on the board can be used to measure various power supply and circuit voltages. See illustration 4-6 for test point descriptions and typical voltages.

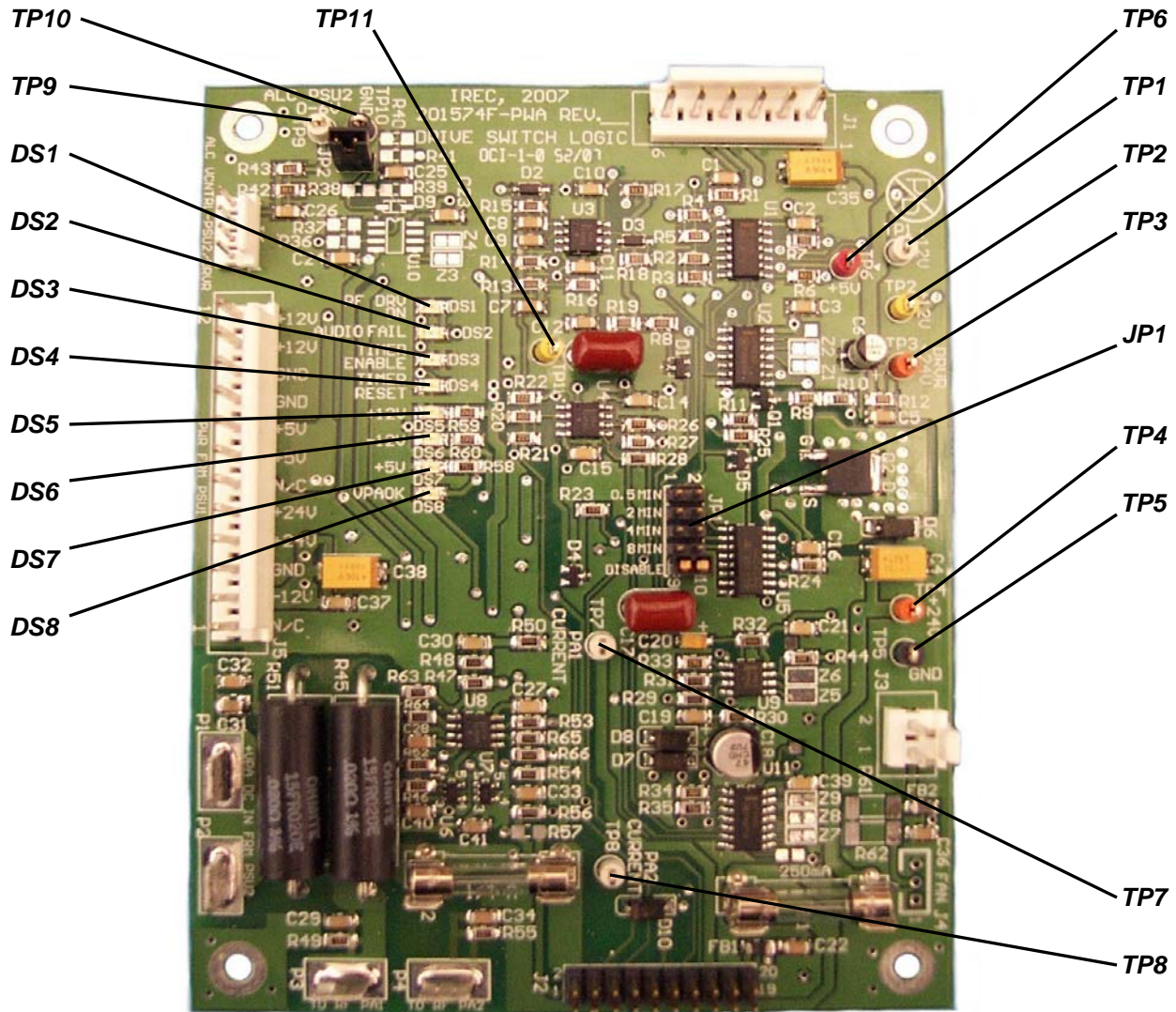
| Test Point | Description                   | Voltage            |
|------------|-------------------------------|--------------------|
| TP1        | -12V DC supply                | -11.76v to -12.24v |
| TP2        | +12V DC supply                | 11.76v to 12.24v   |
| TP3        | +24V Driver supply (switched) | 23.52v to 24.48v   |
| TP4        | +24V DC supply                | 23.52v to 24.48v   |
| TP5        | Ground                        | 0v                 |
| TP6        | +5V DC supply                 | 4.9v to 5.1v       |
| TP7        | PA1 Drain current/10          | .100v = 10 amps    |
| TP8        | PA2 Drain current/10          | .100v = 10 amps    |
| TP9        | ALC Control voltage           | 0v to 6v           |
| TP10       | Ground                        | 0v                 |
| TP11       | Audio filter output           | **See text below   |

**Illustration 4-6 Driver Switch Logic Board Test Points**

The voltages listed in the chart are approximate values. The colors in the left hand column indicate the color of the test point on the circuit board.

The audio filter output test point voltage should be 0 volts during an audio fault such as during silence or a loss of program audio. This voltage will be constantly changing while program audio is present. This circuit is only active if the /Auto Carrier line has been pulled low by grounding pin 5 on the Remote I/O connector on the back of the transmitter.

See illustration 4-7 for diagnostic LED and test point positions on the Driver Switch Logic board.



**Illustration 4-7 Driver Switch Logic Board**

### *4.8 RF Driver*

The RF Driver module is mounted next to the heat sinks on the bottom of the RF Amplifier/Combiner sub chassis. The driver amplifies the approximate 20 milliwatts from the frequency synthesizer to about 20 watts to drive the RF power amplifiers. A CA2832 hybrid, high-gain, wideband amplifier, operating at about 20 volts, provides about one watt of drive to a single BLF245 MOSFET amplifier. The BLF245 stage operates from a supply voltage of approximately 24 volts.

The circuit board provides for input/output coupling and for power supply filtering.

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## 4.9 RF Amplifier

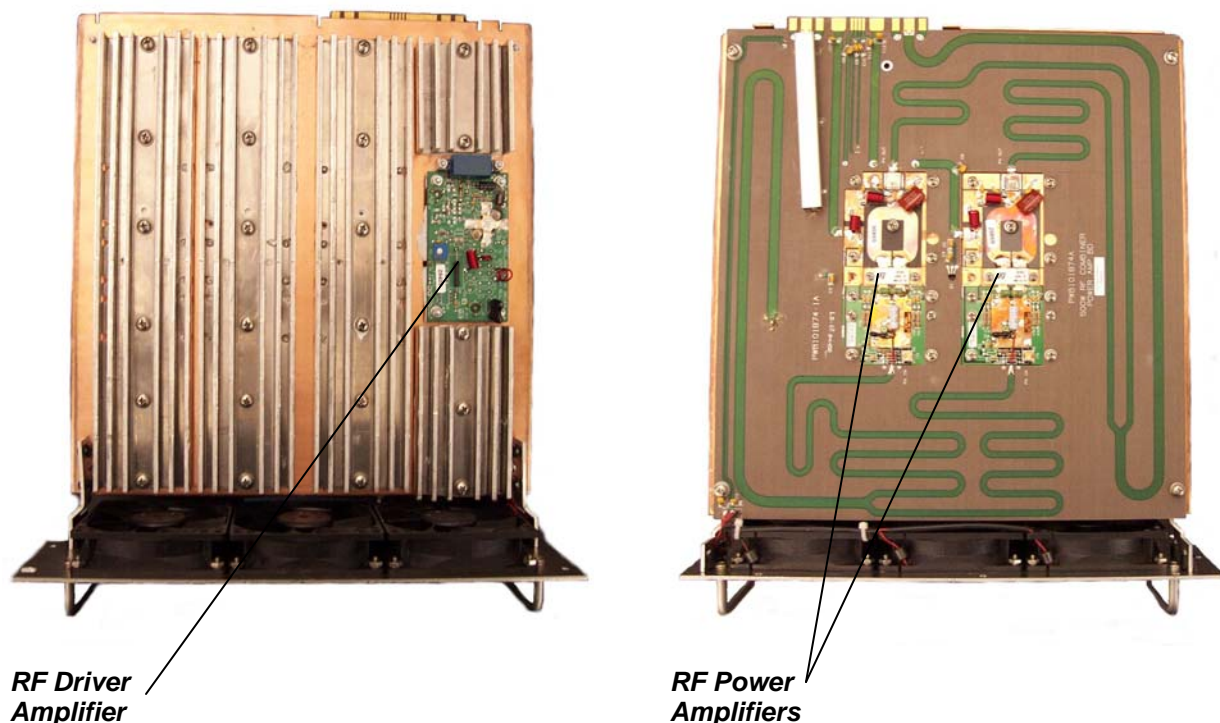
The RF power amplifier modules are mounted on a combiner board, heat sink, slide rail assembly which slides into the main chassis at the rear, and is fastened to the back panel with six screws. RF power, DC power, and control voltages enter the PA assembly through a 72-pin edge connector that slides into at the front of the chassis.

The amplifier is built around two SD2942, dual power MOSFET's rated for 50 volts DC and a maximum power of about 350 watts. When biased for class B, the transistor has a power gain of 20dB. The RF power amplifier is biased below class B in the transmitter.

Input transformer, T1111, is made up of two printed circuit boards. The four-turn primary board is separated from the one-turn secondary by a thin dielectric film. R1112-R1117 are for damping. Trim pot R1111 sets the bias.

Output transformer, T1121, has a one-turn primary on top of the circuit board and a two-turn secondary underneath. Inductors L1121 and L1122 provide power line filtering.

The amplifiers are surrounded by a 50 Ohm impedance, input/output combiner board which takes 15 watts input and divides it equally to each power amp. Then the output from each amplifier is combined to for a single output.



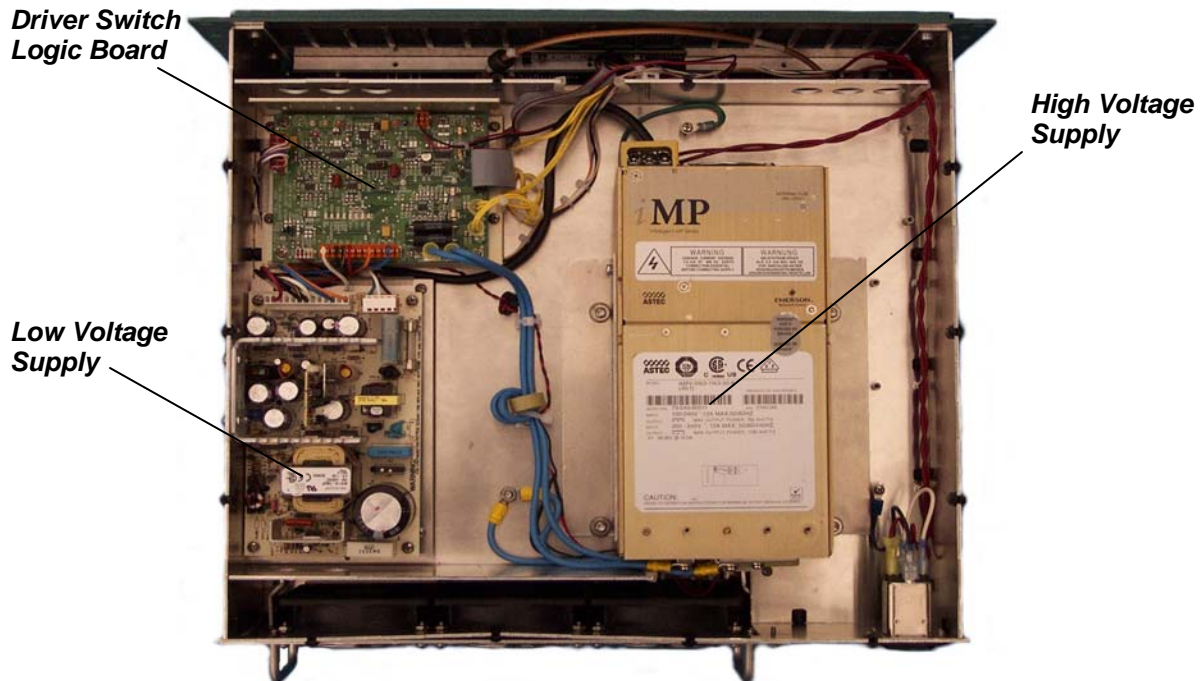
**Illustration 4-7 RF Power Amplifier Module**



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## 4.10 Chassis

The high voltage and low voltage power supplies, as well as the driver switch logic board are mounted on the bottom side of the chassis.



**Illustration 4-8 Chassis Bottom View**

## 4.11 RF Output Filter & Reflectometer

The RF low-pass filter/reflectometer is located in the right-hand compartment on the top of the chassis. See Illustration 6-13 and accompanying schematic for more information.

A ninth-order, elliptic, low-pass filter attenuates harmonics generated in the power amplifier. The capacitors for the filter are circuit board pads.

The reflectometer uses printed circuit board traces for micro-strip transmission lines. Transmission line segments (with an impedance of about 82 ohms) on either side of a 50-ohm conductor provide sample voltages representative of the square root of forward and reverse power.

DC voltages, representative of forward and reflected power, go through a bulkhead filter board to the motherboard, then to the metering board, where they are processed for power control and metering and for SWR metering and protection.



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## 4.12 Receiver Circuit Board Option

This option allows the transmitter to be used as a translator. The receiver board receives terrestrially fed RF signal and converts it to composite audio which is then fed into the exciter board. Microprocessor controlled phase lock loop technology ensures the received frequency will not drift, and multiple IF stages ensure high adjacent channel rejection. Refer to Illustrations 4–6, 6–16 and its schematic for the following discussion.

The square shaped metal can located on the left side of the receiver board is the tuner module. The incoming RF signal enters through the BNC connector (top left corner) and is tuned through the tuner module. Input attenuation is possible with the jumper labeled “LO” “DX”, on the top left corner of the receiver board. Very strong signals can be attenuated 20 dB automatically by placing the jumper on the left two pins (“LO” position). An additional 20 dB attenuation is also available with the jumpers in the top left corner of the board. The frequencies are tuned by setting switches SW1 and SW2 (upper right corner). These two switches are read upon power up (or by momentarily shorting J7) by the microprocessor (U4). The microprocessor then tunes the tuner module to the selected frequency. The frequency range is 87.9 Mhz at setting “00” to 107.9 Mhz at setting “64”. Other custom ranges are available.

Located in the lower left-hand corner of the Receiver Module is a 3.5mm headphone jack. Demodulated Left and Right audio is present at this jack. A regular pair of 32 ohm stereo headphones, such as the types used with portable audio devices, can be used to monitor the audio on the receiver module.

**Receiver  
Module**

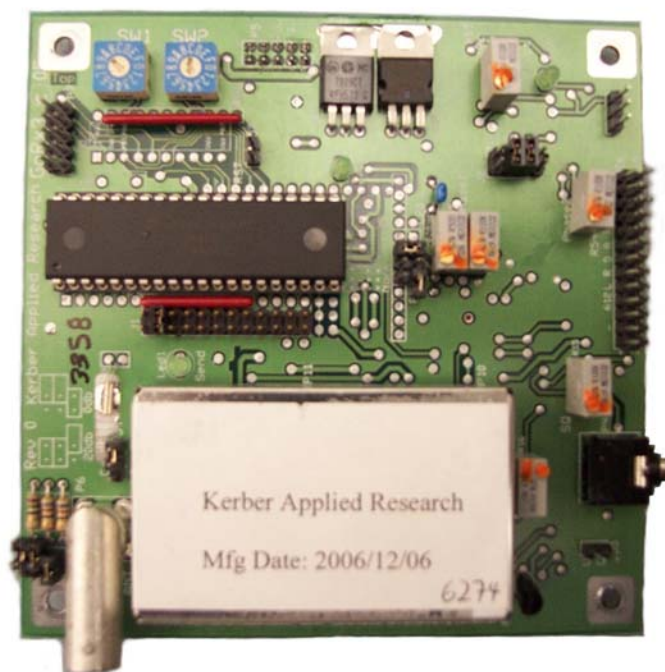


**Illustration 4–9 Receiver Module**

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## 4.12 Receiver Circuit Board Option (Continued)

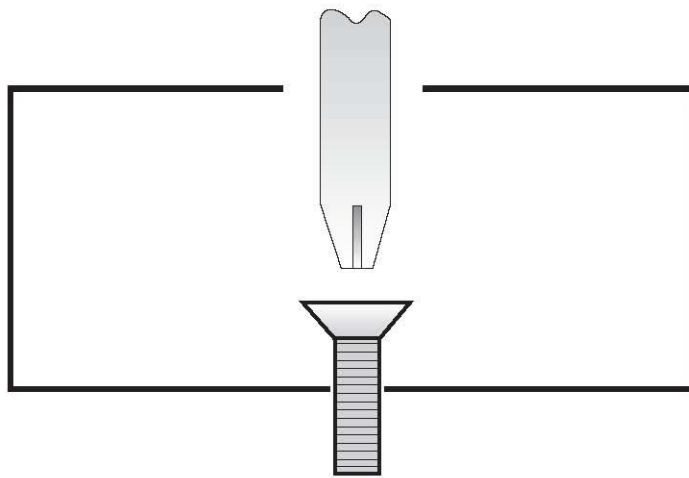
When a stereo signal is present, LED 3 illuminates which indicates that left and right audio is available. Then the stereo signals go to gain stages and out to the RCA jacks on the back of the cabinet. These can be used for off-air monitoring of the audio signal. Incoming frequency can be monitored from the frequency monitor BNC jack on the back. The stereo buffer, stereo decoder, and gain stages have no effect on the signal that goes through the transmitter. The power supply is fairly straight forward. The incoming 12 volt supply goes to a 7809, 9 volt regulator (VR1) which supplies all 9-volt needs on the board. The 9 volts also supplies a 7805, 5 volt regulator (VR2) which supplies all 5-volt needs on the board. Plus and minus 12 volts from the motherboard is filtered and supplies various needs on the board. Finally there is a precision reference voltage. Two 2.5 volt reference shunts act very much like a very accurate zener diode to provide a precision 5 volt supply to the metering board.



**Illustration 4–10 Receiver Module**

---

## ***Notes***



## *Section 5—Adjustments and Tests*

This section describes procedures for (1) advanced users who may be interested in customizing or optimizing the performance of the transmitter and (2) service personnel who want to return the transmitter to operational status following a maintenance procedure.

---

## *5.1 Audio Processor Adjustments*

### **5.1.1 Pre-Emphasis Selection**

Select the pre-emphasis curve (75  $\mu$ sec, 50  $\mu$ sec, 25  $\mu$ sec, or Flat) by jumpering the appropriate pins of header HD1 on the audio processor/stereo generator board. (See section 2.10.) If you change the pre-emphasis, change the de-emphasis jumpers, HD201 and HD202 on the audio processor/stereo generator board, to match. (See section 2.10.)

### **5.1.2 Pre-Emphasis Fine Adjustment**

Trim potentiometers, R23 and R63, (for left and right channels, respectively) provide for fine adjustment of the pre-emphasis. Set the potentiometers to bring the de-emphasized gain at 10 kHz equal to that of 400 Hz. (At the proper setting, 15.0 kHz will be down about 0.7 dB.)

When making these adjustments, it is important that you keep signal levels below the processor gain-control threshold.

A preferred method is to use a precision de-emphasis network in front of the audio input. Then, use the non-de-emphasized (flat) output from the FM modulation monitor for measurements.

## *5.2 Stereo Generator Adjustments*

### **5.2.1 Separation**

Feed a 400-Hz sine wave into one channel for at least 70% modulation. Observe the classic single-channel composite stereo waveform at TP1 in the RF Exciter circuit of the Motherboard. Adjust the Separation control R244 for a straight centerline.

Since proper adjustment of this control coincides with best stereo separation, use an FM monitor to make or confirm the adjustment.

---

## 5.2.2 Composite Output

You can make adjustments to the composite output in the following manner:

Using a Modulation Monitor

1. Set the Stereo-Mono switch to Mono.
2. Check that the setting of the Modulation compensation control (see Illustration 2–9) on the RF Exciter circuit, falls within the range specified for the frequency of operation. (See section 2.3.1.)
3. Feed a sine wave signal of about 2.5 kHz into the left channel at a level sufficient to put the wideband gain-reduction indicator somewhere in the middle of its range.
4. Set the Composite level control to produce 90% modulation as indicated on an FM monitor.
5. Apply pink noise or program material to the audio inputs and confirm, on both Mono and Stereo, that modulation peaks are between 95% and 100%.

### 5.2.3 19–kHz Level

Adjust the 19–kHz pilot for 9% modulation as indicated on an FM modulation monitor. (The composite output should be set first, since it follows the 19–kHz Level control.)

### 5.2.4 19–kHz Phase

1. Apply a 400–Hz audio signal to the left channel for at least 70% modulation.
2. Look at the composite stereo signal at TP301 on the RF Exciter circuit board with an oscilloscope, expanding the display to view the 19–kHz component on the horizontal centerline.
3. Switch the audio to the right-channel input. When the 19–kHz Phase is properly adjusted, the amplitude of the 19–kHz will remain constant when switching between left and right.
4. Recheck the separation adjustment as described in section 5.2.1.

## *5.3 Frequency Synthesizer Adjustments*

### 5.3.1 Frequency (Channel) Selection

Refer to section 2.3.

---

### 5.3.2 Modulation Compensator

Refer to section 2.3.1

### 5.3.3 Frequency Measurement and Adjustment

Next to the 10.24-MHz VCXO in the RF Exciter circuit on the motherboard is a 50K potentiometer (R101). Use R101 to set the frequency of the 10.24-MHz VCXO while observing the output frequency of the synthesizer.

Use one of two methods for checking frequency:

1. Use an FM frequency monitor.
2. Couple a frequency counter of known accuracy to the output of the synthesizer and observe the operating frequency.

### 5.3.4 FSK Frequency Offset Control

An FSK signal (used for automatic identification of FM repeaters) shifts the frequencies of the 10.24-MHz VCXO reference oscillator and the VCO.

Ground pin 4 on the DB25 connector located on the back panel of the transmitter. This will shift the operating frequency. Adjust R224 for an offset of the operating frequency of about 6 kHz. Un-grounding pin 4 will cause the operating frequency to return to normal.

Use one of two methods for checking frequency:

1. Use an FM frequency monitor.
2. Couple a frequency counter of known accuracy to the output of the synthesizer and observe the operating frequency.

## 5.4 Metering Adjustments

### 5.4.1 Power Calibrate

While looking at RF Power on the digital panel meter, set the Power Calibrate trim potentiometer (R215) to agree with an external RF power meter.

### 5.4.2 Power Set

With the front panel RF Output control fully clockwise, adjust the Power Set trim pot to 10% more than the rated power (660 watt for FM600) as indicated on an accurate external watt meter. If the authorized power is less than the maximum watts, you may use the power set to limit the range of RF output control. Operation below 200 watts is not possible due to the switching power supply not being able to reach zero volts.



---

### 5.4.3 SWR Calibrate

When the Carrier switch is off, or the RF power is less than about 5 watts, the SWR circuit automatically switches to a calibrate-check mode. (See section 4.5 for more information.) Set the digital panel meter to read SWR. With the Carrier switch off, set the SWR CAL trim pot (R66) to read 1.03.

### 5.4.4 PA Current Limit

Since it may not be practical to increase the PA current to set the PA Current Limit control, you may use this indirect method.

With the carrier turned off, look at the DC voltage at the right end of R413 in the Metering circuit on the motherboard. The current limit, in amperes, will be 0.35 amps higher than ten times this voltage. Set the current limit for 17.55 amps or 1.72 volts at R413.

## *5.5 Motherboard Configuration*

See section 4.6.1 for motherboard jumper configuration.

## *5.6 Display Modulation Calibration*

The Modulation Calibrate trim pot sets the sensitivity of the front panel Modulation bar graph display.

This adjustment may be made only after the Output trim pot on the Audio Processor/Stereo Generator board has been set. (See section 5.2.2.)

Set the Stereo-Mono switch to Mono.

Feed a sine wave source of about 2.5 kHz into the left channel at a level sufficient to put the wideband gain-reduction indicator somewhere in the middle of its range.

Set the Modulation Calibrate trim pot so that the "90" light on the front panel Modulation display just begins to light.

---

## *5.7 Driver Switch Logic Board Adjustments*

JP1, a 10-pin header on the Driver Switch Logic board, sets the time between program failure and carrier disable (automatic turnoff). The times are approximate. Sections 2.11, 2.12, and 4.7 contain further information.

1. Short pins 1 and 2 for a 30 second delay.
2. Short pins 3 and 4 for a 2 minute delay.
3. Short pins 5 and 6 for a 4 minute delay.
4. Short pins 7 and 8 for an 8 minute delay.
5. Short pins 9 and 10 to disable the circuit.

You may select other times by changing the value of R28. The time is proportional to the resistance.

## *5.8 Bias Set (RF Power Amplifier)*

The Bias Set trim pot is located inside the PA module on the input circuit board. Set the trim pot to its full clock-wise position for near-optimum bias.

---

## 5.9 Performance Verification

Measure the following parameters to receive a comprehensive characterization of transmitter performance:

- Carrier frequency
- RF output power
- RF bandwidth and RF harmonics (see section 5.12)
- Pilot frequency, phase, and modulation percentage
- Audio frequency response
- Audio distortion
- Modulation percentage
- FM and AM noise
- Stereo separation between left and right
- Crosstalk between main channel and subcarrier
- 38-kHz subcarrier suppression
- In addition to the above tests, which pertain to signal quality, a complete check of the unit will include items listed in section 5.21.

### 5.9.1 Audio Proof-of-Performance Measurements

References to “100%” modulation assume 9% pilot and 91% for the remainder of the composite stereo signal.

Because the audio processing threshold is at 90% modulation, it is not possible to make audio proof-of-performance measurements at 100% modulation through the audio processor. Instead, data is taken at a level below the audio processing threshold at 80% modulation.

### 5.9.2 De-emphasis Input Network

A precision de-emphasis network, connected between the test oscillator and the audio input of the transmitter, can be very helpful when making the audio measurements. Note that the input impedance of the transmitter or the source impedance of the test oscillator can affect network accuracy. With the de-emphasis network, oscillator level adjustments need only accommodate gain errors, instead of the whole pre-emphasis curve.

---

## *5.10 Carrier Frequency*

Carrier frequency is measured at the output frequency with a frequency monitor or suitable frequency counter.

To adjust frequency, see section 5.3.3. (FCC tolerance  $\pm 2000$  Hz per FCC Part 73.1540 and 73.1545.)

## *5.11 Output Power*

The output power reading on the front panel display should be 90–105% of the actual value. For a more precise measurement, use a watt meter in the RF output line. See sections 5.4.1 and 5.4.2 for setting power.

## *5.12 RF Bandwidth and RF Harmonics*

You can observe RF bandwidth and spurious emissions with an RF spectrum analyzer.

In the Stereo mode, feed a 15.0-kHz audio signal into one channel to provide 85% modulation as indicated on a monitor. Doing so produces 38% main, 38% stereo subcarrier, and 9% pilot per FCC Part 2.1049. As an alternative, use pink noise into one channel.

Using a spectrum analyzer, verify the following (per FCC 73.317):

1. Emissions more than 600 kHz from the carrier are at least  $43 + 10\log$  (power, in watts) dB down (71 dB for 600 watts). The scan should include the tenth harmonic.
2. Emissions between 240 kHz and 600 kHz from the carrier are down at least 35 dB.
3. Emissions between 120 kHz and 240 kHz from the carrier are down at least 25 dB.

## *5.13 Pilot Frequency*

The pilot frequency should be within 2 Hz of 19 kHz. (FCC Part 73.322.) Using a frequency counter, measure 1.9 MHz at pin 13 of U208 on the Audio Processor/Stereo Generator board. A 200-Hz error here corresponds to a 2-Hz error at 19 kHz. If the frequency is off by more than 50 Hz, you may change the value of C213. (Changing C213 from 56 pF to 68 pF lowers the 1.9 MHz by about 35 Hz.)

## *5.14 Audio Frequency Response*

For the response tests, take the readings from an FM modulation monitor. Make audio frequency response measurements for left and right channels at frequencies of 50 Hz, 100 Hz, 400 Hz, 1 kHz, 5 kHz, 10 kHz, and 15 kHz. See sections 5.9.1 and 5.9.2.

---

### *5.15 Audio Distortion*

Make distortion measurements from the de-emphasized output of an FM modulation monitor.

Make audio distortion measurements for left and right channels at frequencies of 50 Hz, 100 Hz, 400 Hz, 1 kHz, 5 kHz, 10 kHz, and 15 kHz. See sections 5.9.1 and 5.9.2.

### *5.16 Modulation Percentage*

While feeding an audio signal into the left channel only, confirm that the total modulation percentage remains constant when switching between Mono and Stereo.

Measure modulation percentage with an FM modulation monitor. See section 5.2.2.

19-kHz pilot modulation should be 9%.

### *5.17 FM and AM Noise*

Take noise readings from a de-emphasized output of a modulation monitor.

### *5.18 Stereo Separation*

Make left-into-right and right-into-left stereo separation measurements with an FM modulation monitor for frequencies of 50 Hz, 100 Hz, 400 Hz, 1 kHz, 5 kHz, 10 kHz, and 15 kHz.

### *5.19 Crosstalk*

For stereo crosstalk measurements, both left and right channels are fed at the same time. For best results, there needs to be a means of correcting small imbalances in levels and phase. The balance is made at 400 Hz.

#### **5.19.1 Main Channel Into Sub**

Feed the left and right channels in phase with audio (L+R) at 50 Hz, 100 Hz, 400 Hz, 1 kHz, 5 kHz, 10 kHz, and 15 kHz at 100% modulation, while observing the stereo subcarrier (L-R) level on an FM modulation monitor.

#### **5.19.2 Sub Channel Into Main**

Feed the audio into the left and right channel as above, with the exception of reversing the polarity of the audio of one channel (L-R input). Using the frequencies of 5.19.1 above, observe the main channel (L+R) level with a modulation monitor.

---

## 5.20 38-kHz Subcarrier Suppression

With no modulation, but in the Stereo mode, the 38-kHz subcarrier, as indicated on an FM modulation monitor, should be down at least 40 dB.

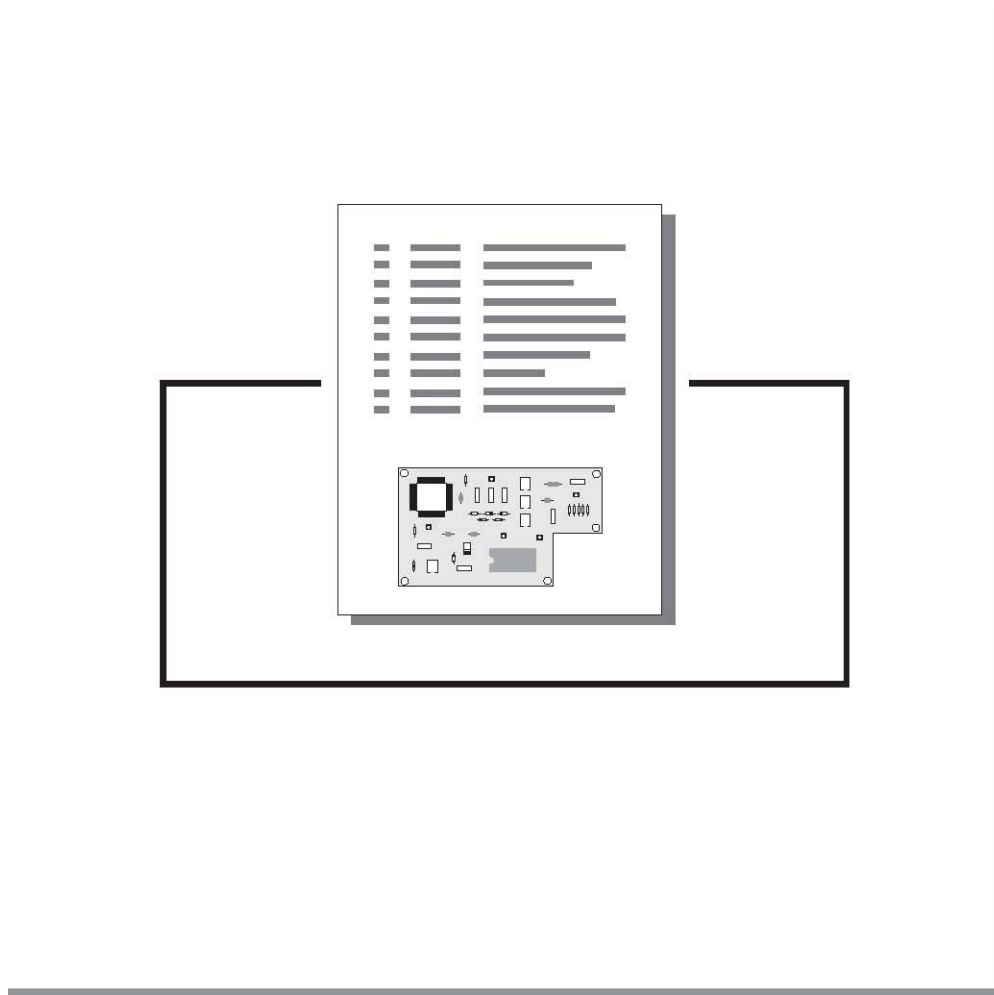
## 5.21 Additional Checks

In addition to the tests and adjustments mentioned in this section, the following checks ensure a complete performance appraisal of the transmitter:

1. Perform a physical inspection, looking for visible damage and checking that the chassis hardware and circuit boards are secure.
2. Check the functionality of switches and processing control.
3. Verify that all indicators function.
4. Check the frequency synthesizer lock at 80 MHz and 110 MHz.
5. Measure the AC line current with and without the carrier on.
6. Perform a functional test of the SCA input, Monitor outputs, and the monitor and control function at the 15-pin, D-sub connector.
7. Test the functionality of the FSK circuit.
8. Check the operation and timing of the automatic carrier-off circuitry associated with program failure.
9. Check all metering functions.
10. Test ALC action with PA current overload, SWR, and PLL lock.

### **NOTE:**

*FCC type acceptance procedures call for testing the carrier frequency over the temperature range of 0–50 degrees centigrade, and at line voltages from 85% to 115% of rating. (See FCC Part 2.1055.)*



## *Section 6—Reference Drawings*

The illustrations in this section may be useful for making adjustments, taking measurements, troubleshooting, or understanding the circuitry of your transmitter.



## 6.1 Views

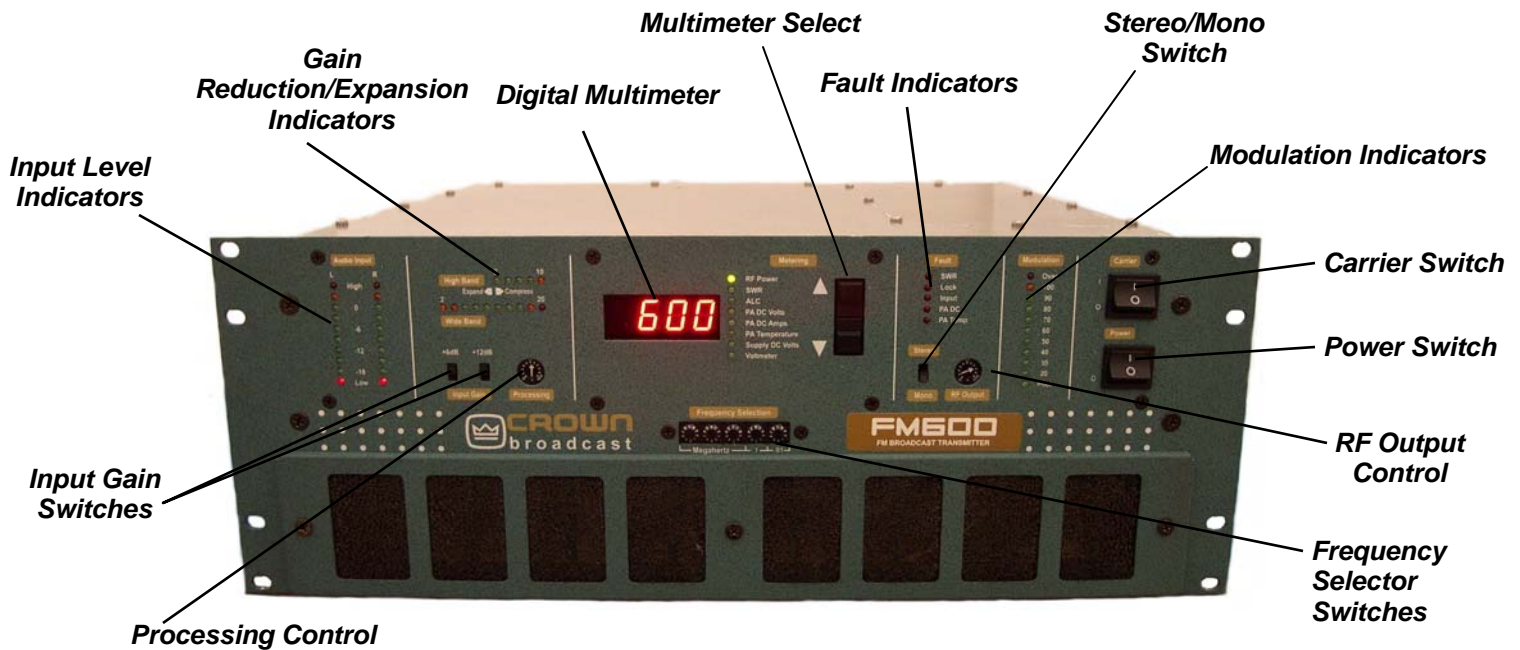


Illustration 6-1 Front View

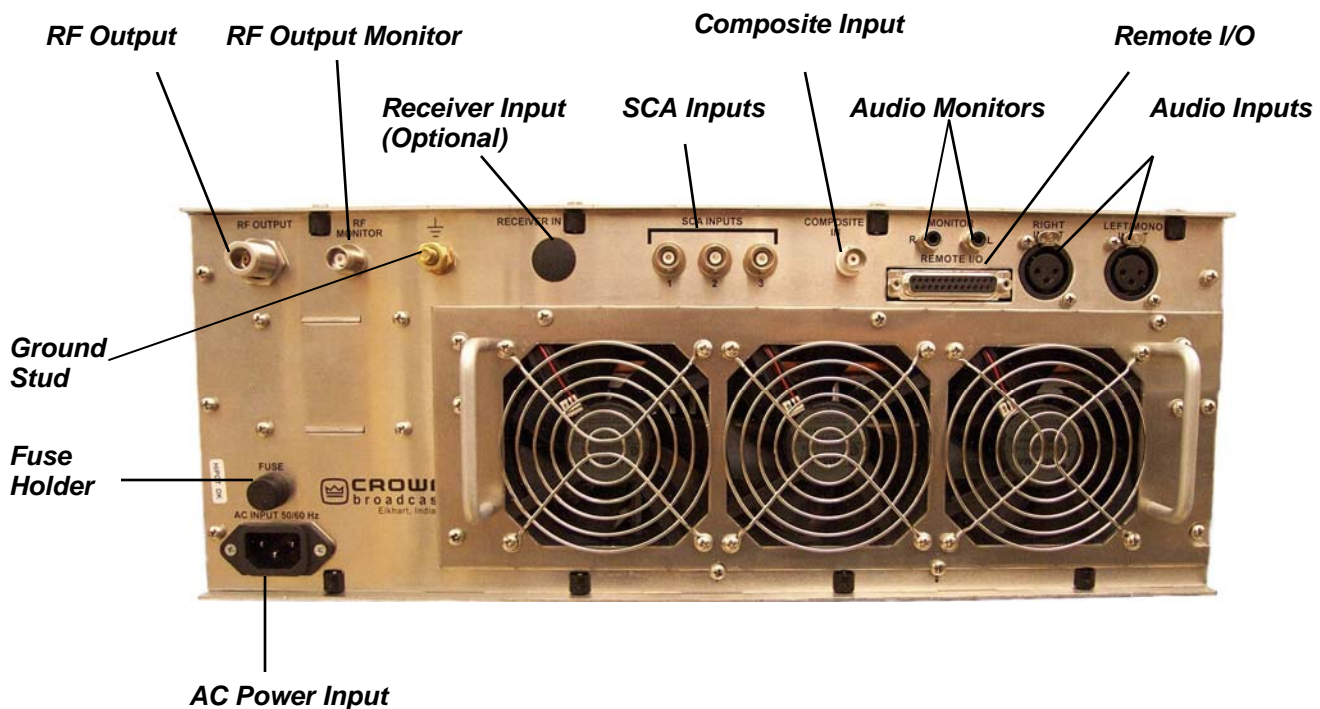
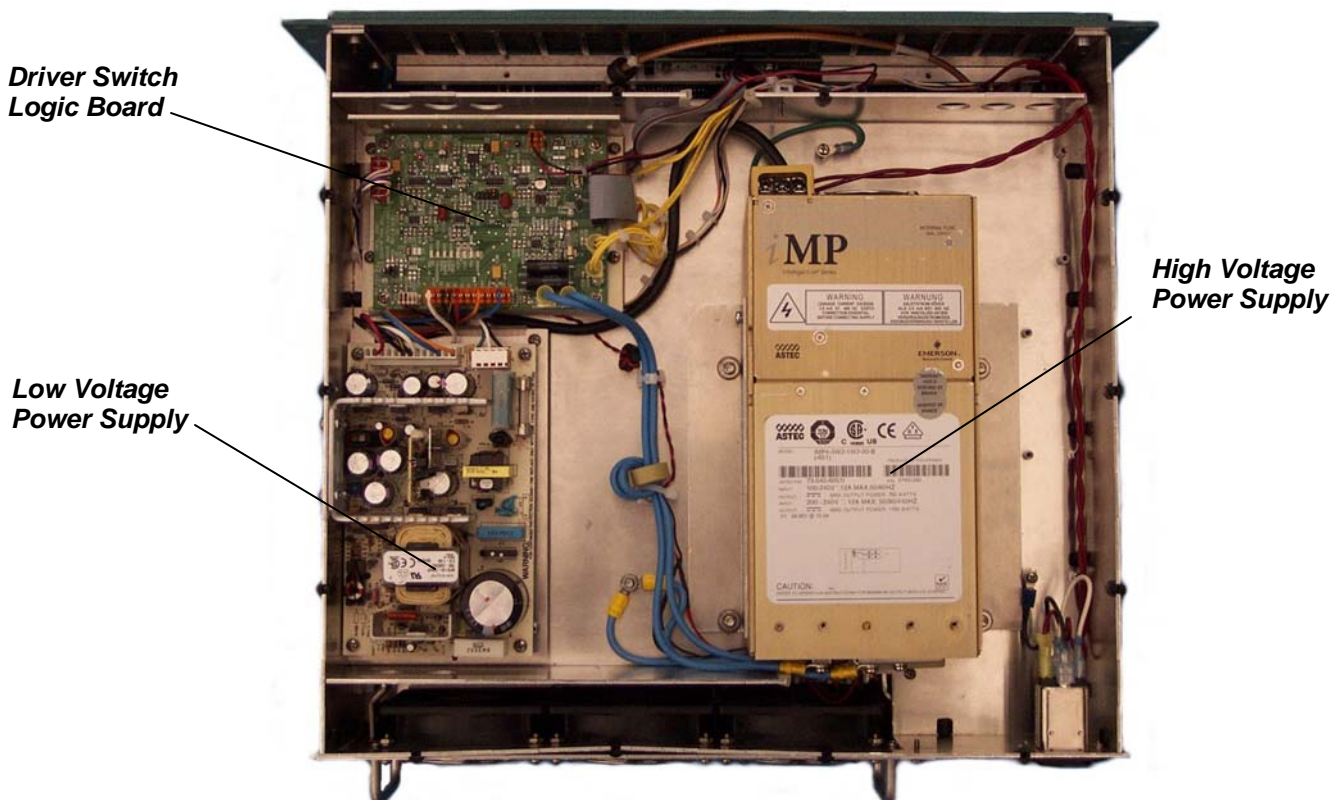


Illustration 6-2 Rear View



**Illustration 6-3 Chassis Top View**

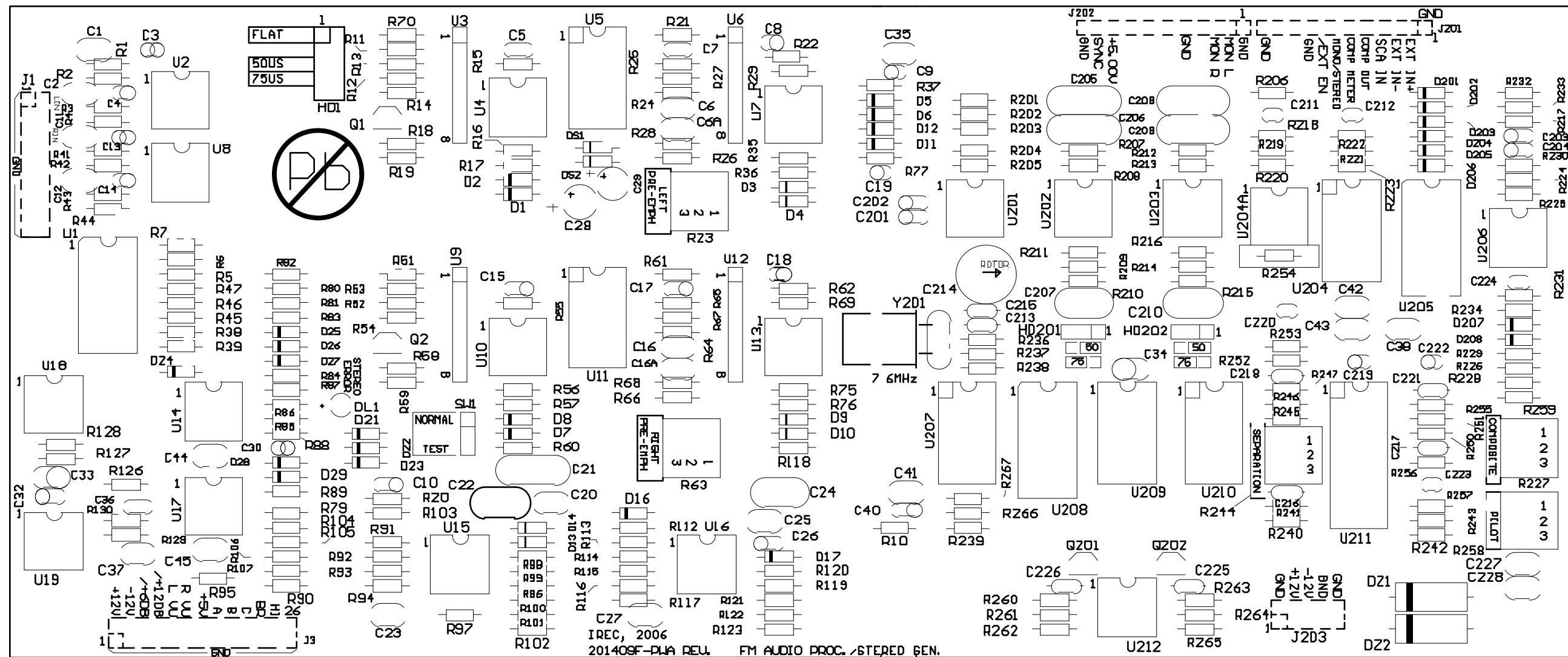


**Illustration 6-4 Chassis Bottom View**

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*Notes:*

## 6.2 Board Layout and Schematics



### Illustration 6-5 Audio Processor/Stereo Generator Board

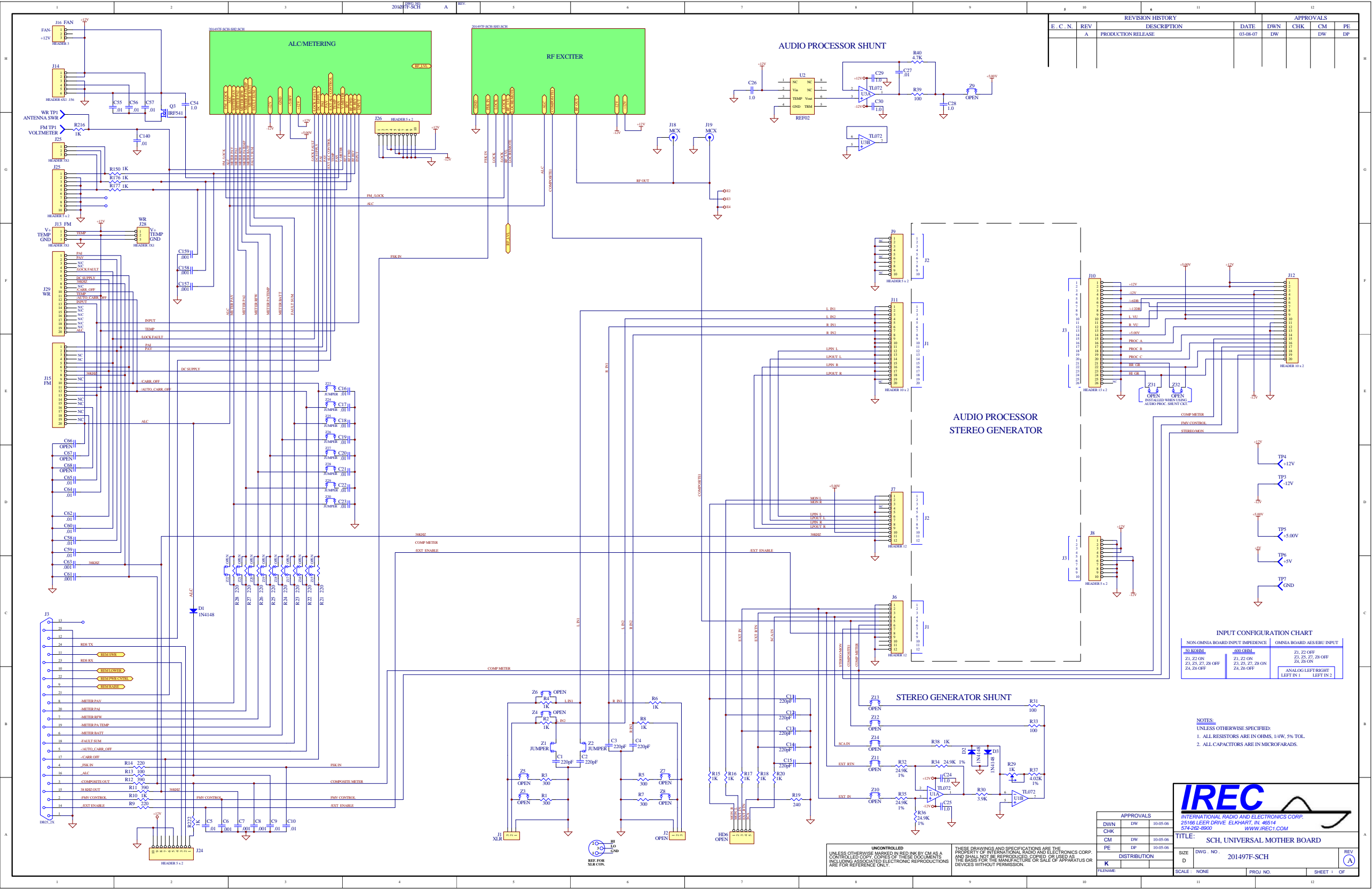








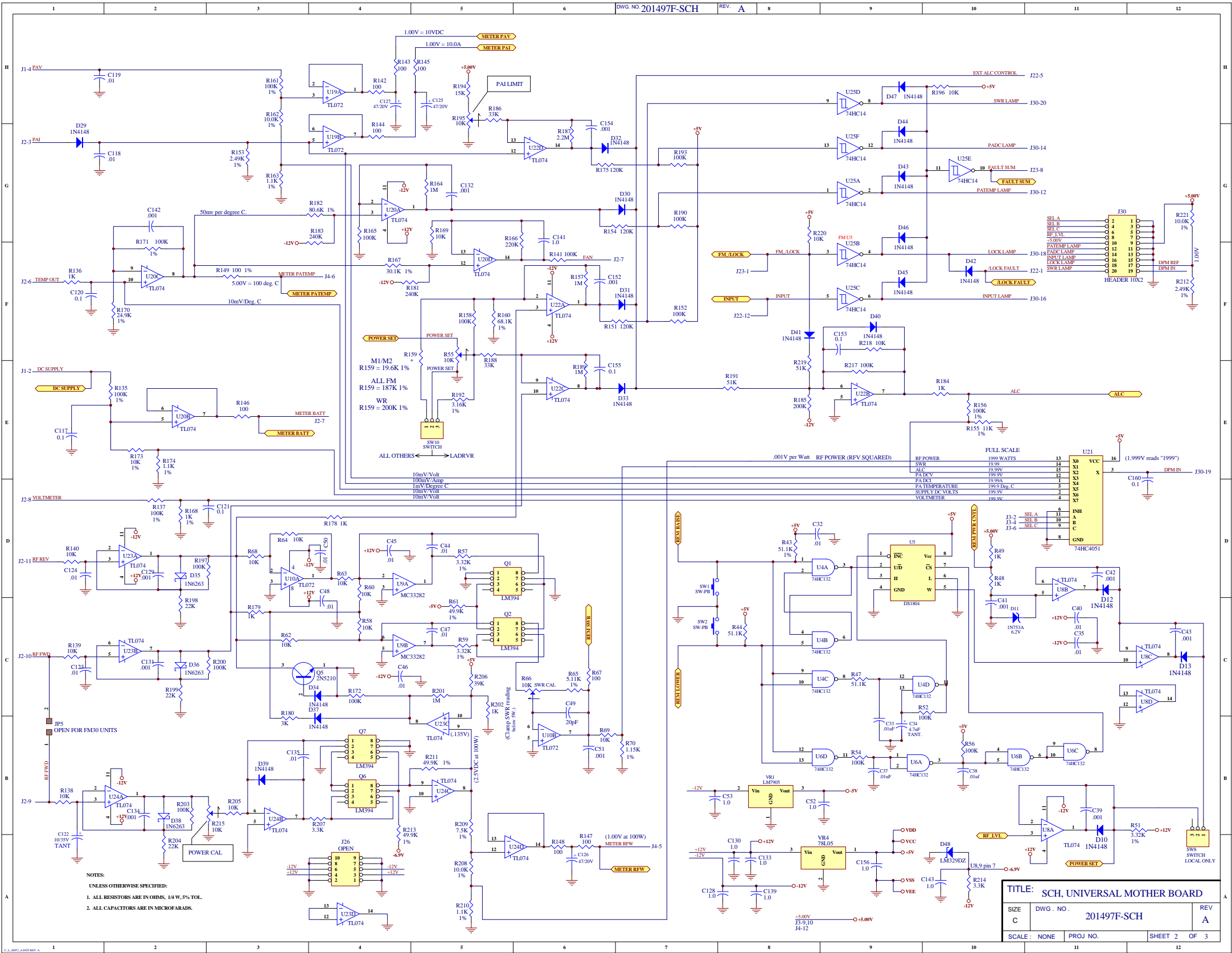
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Schematic Diagram: Motherboard (Sheet 1 of 3)



Board Layouts and Schematics



Schematic Diagram: Motherboard (Sheet 2 of 3)



Illustration 6-7 FM Frequency Selection Board (Top-Side)

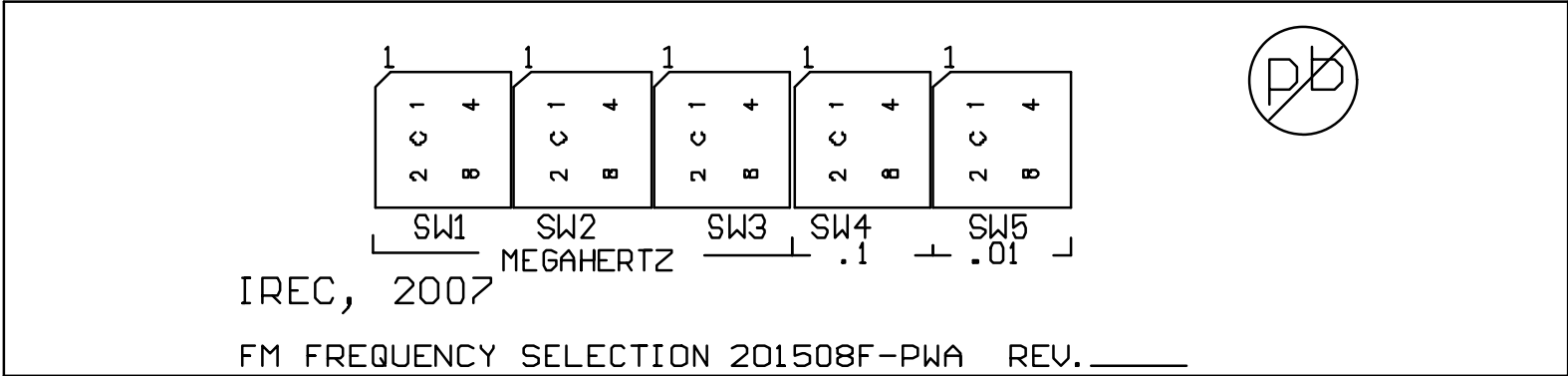
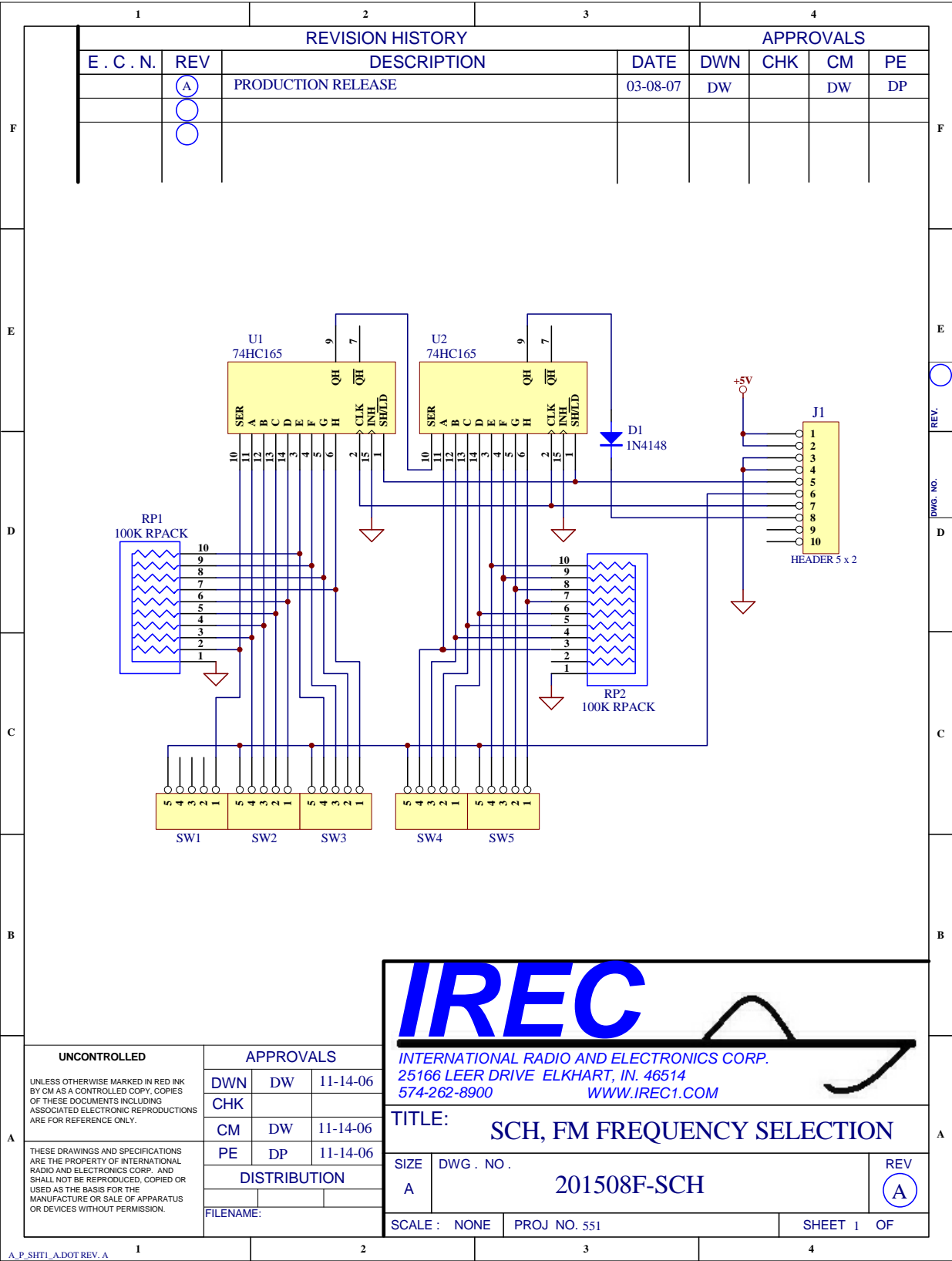
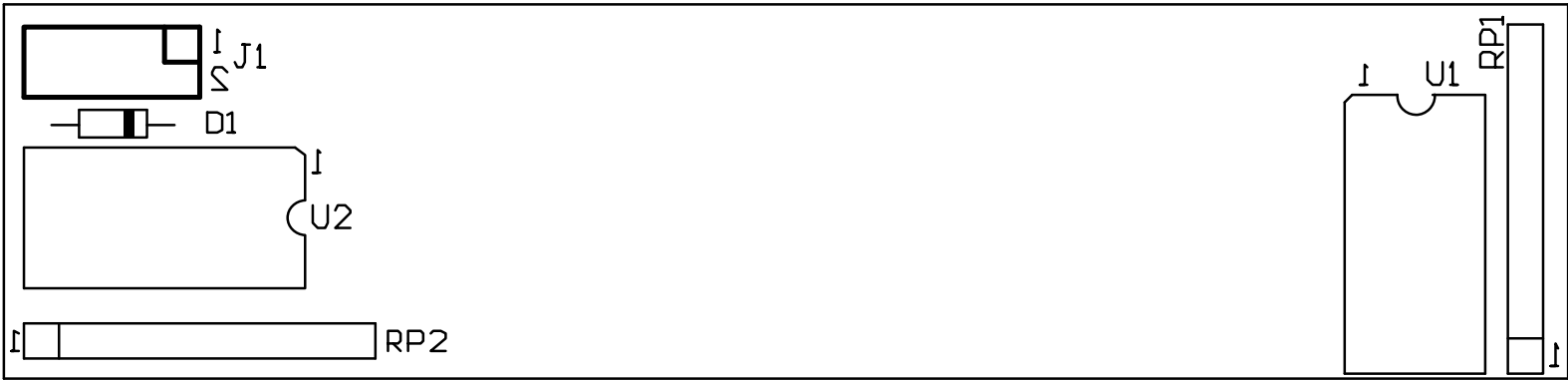


Illustration 6-8 FM Frequency Selection Board (Bottom-Side)



Schematic Diagram: FM Frequency Selection

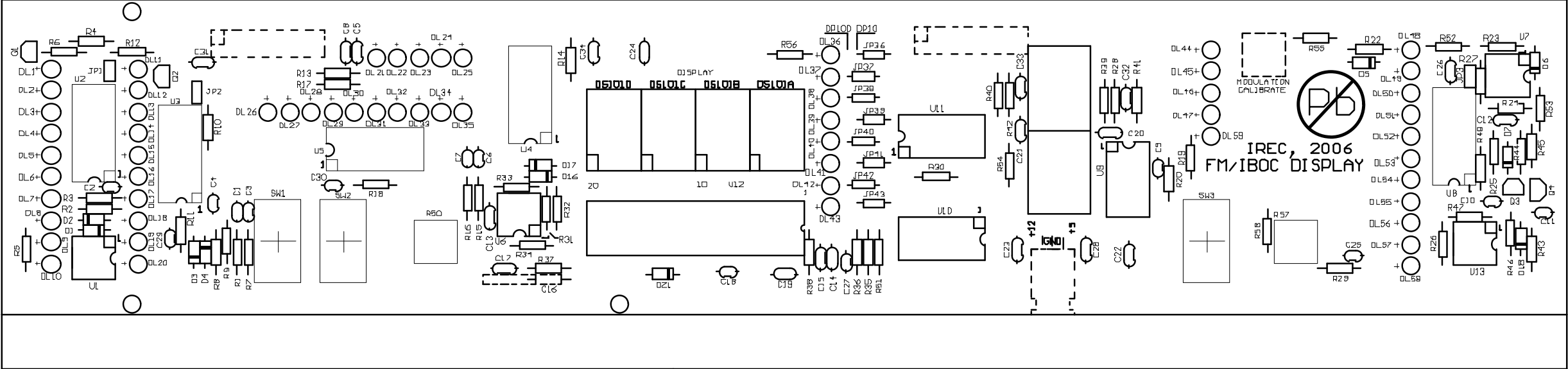
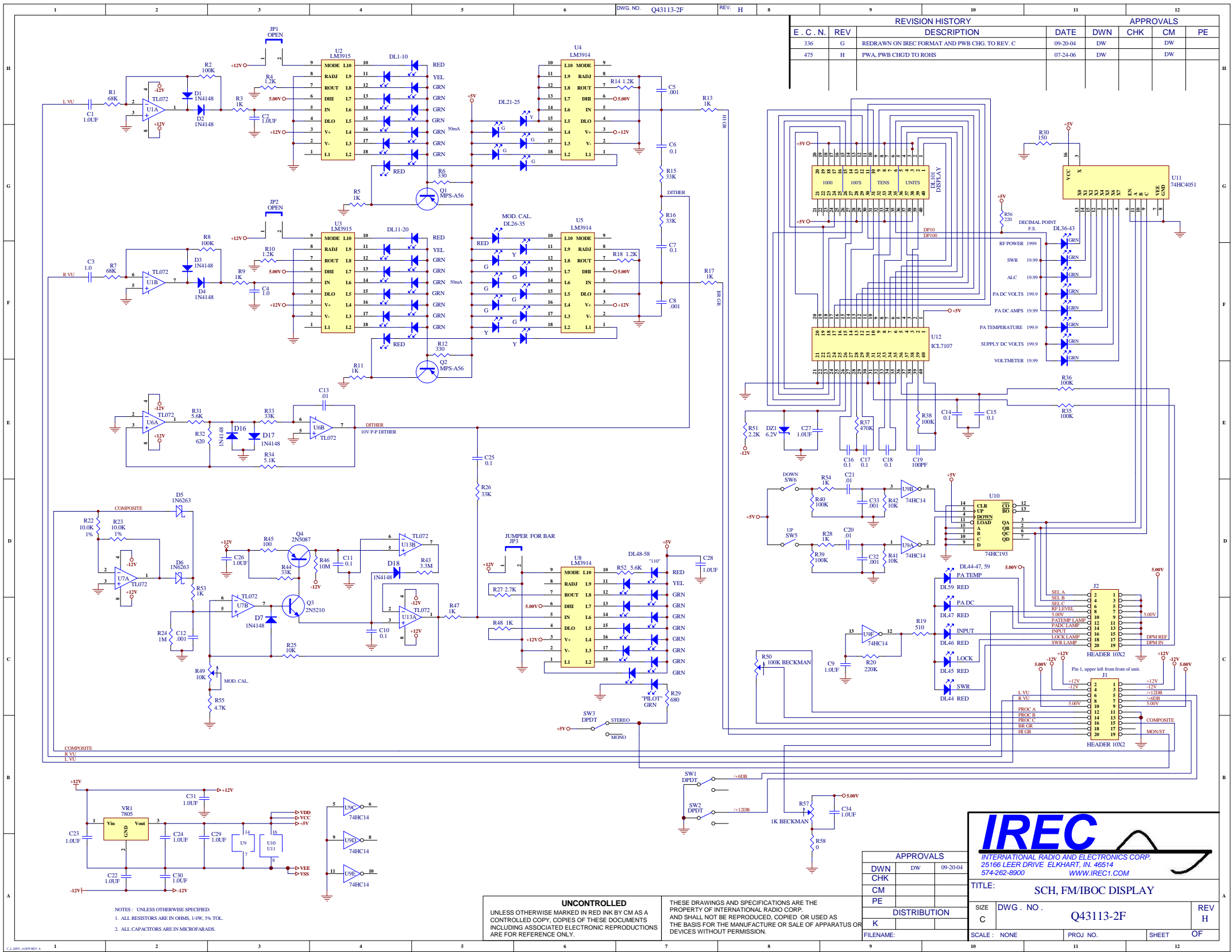


Illustration 6-9 FM Display Board

Board Layouts and Schematics



Schematic Diagram: FM Display

Top Overlay

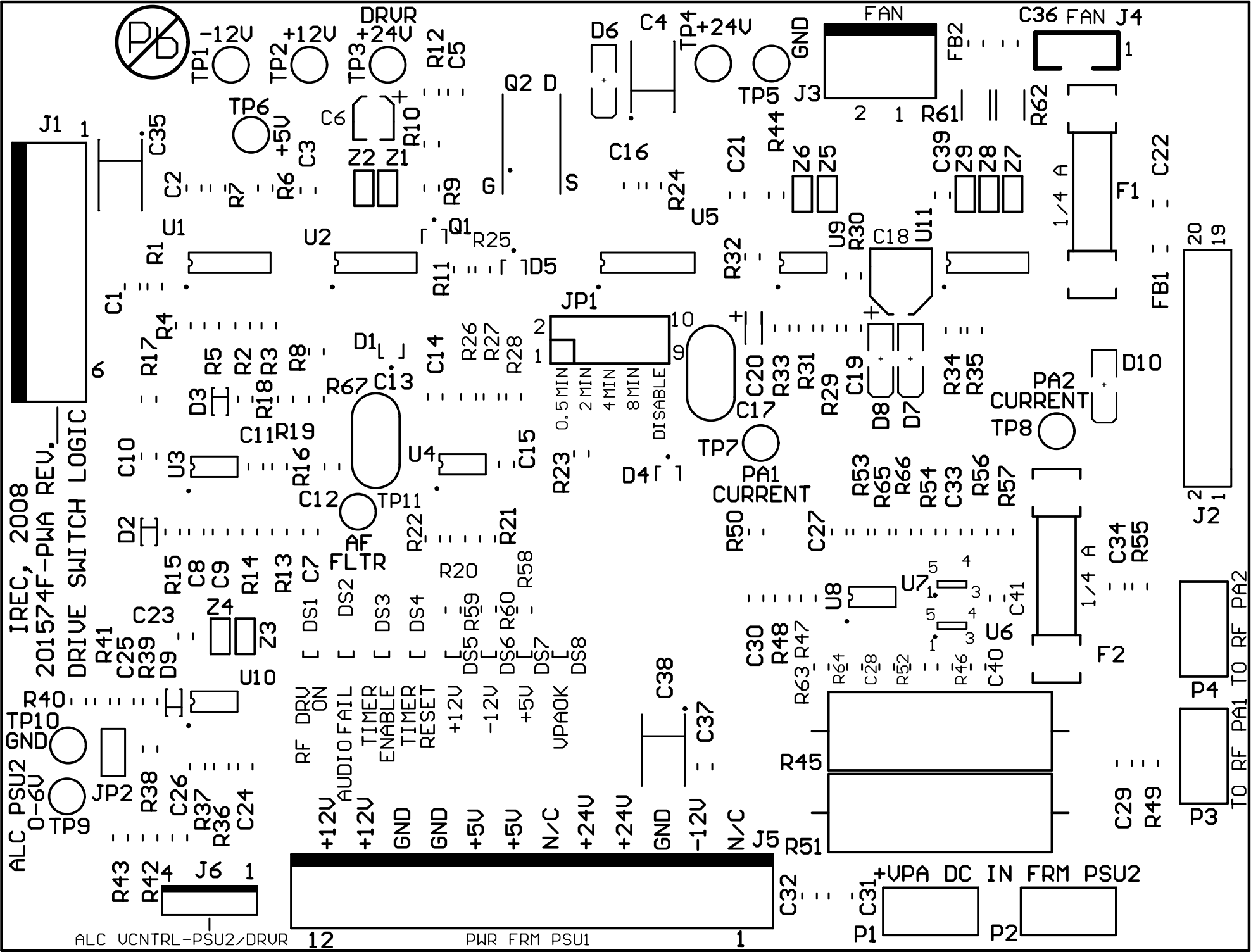
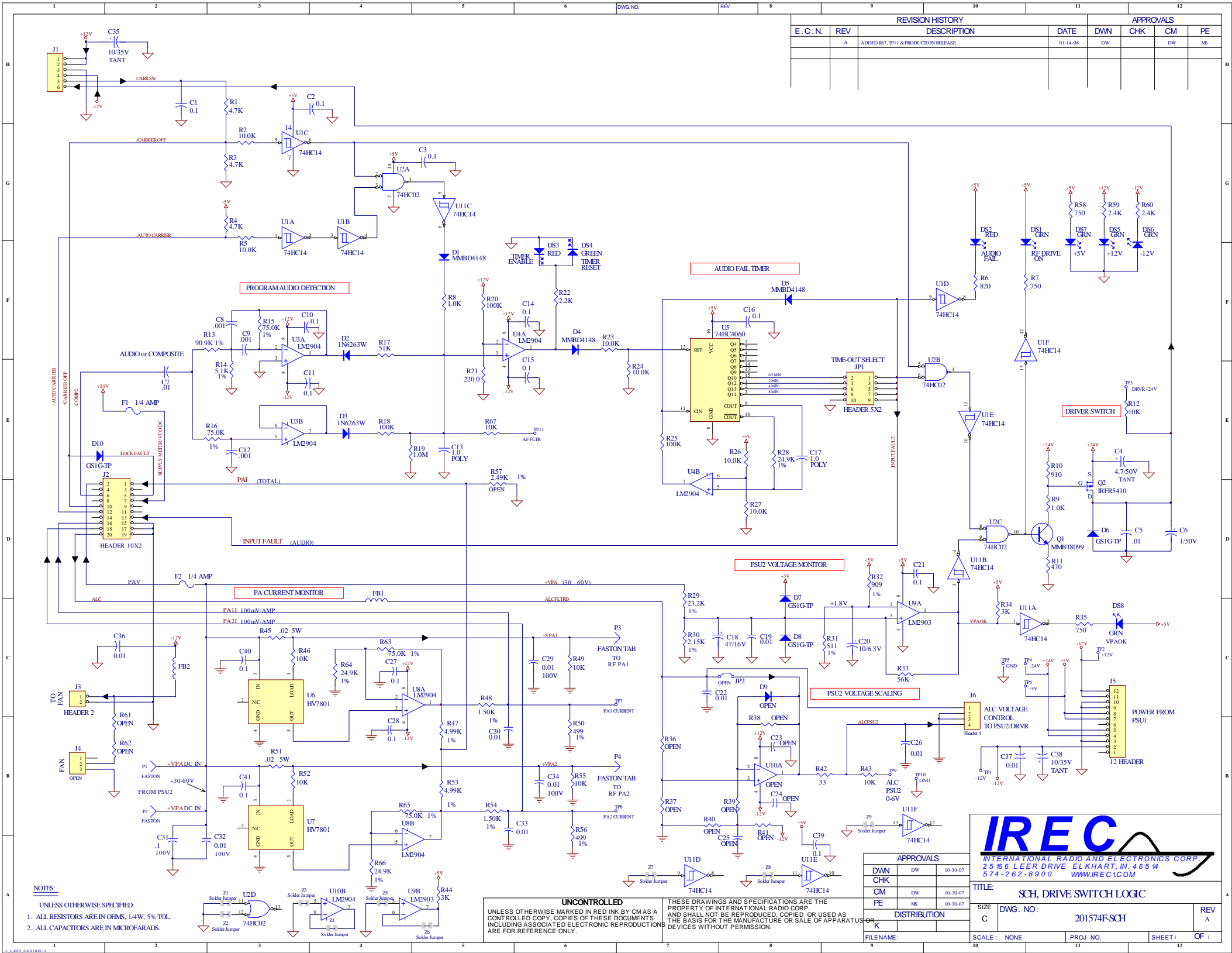


Illustration 6-10 Driver Switch Logic Board

Board Layouts and Schematics



Schematic Diagram: Driver Switch Logic Board

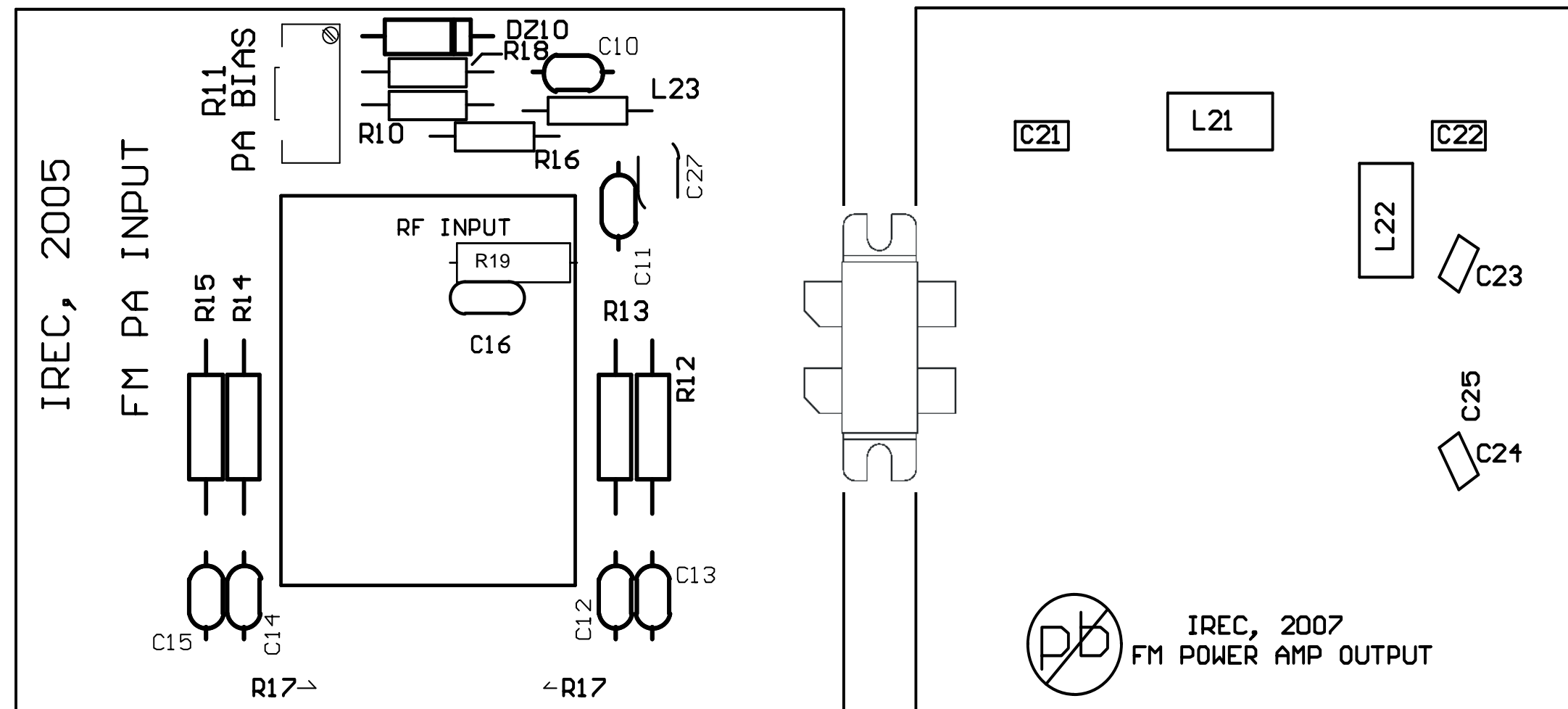


Illustration 6-12 FM600 Power Amplifier Module





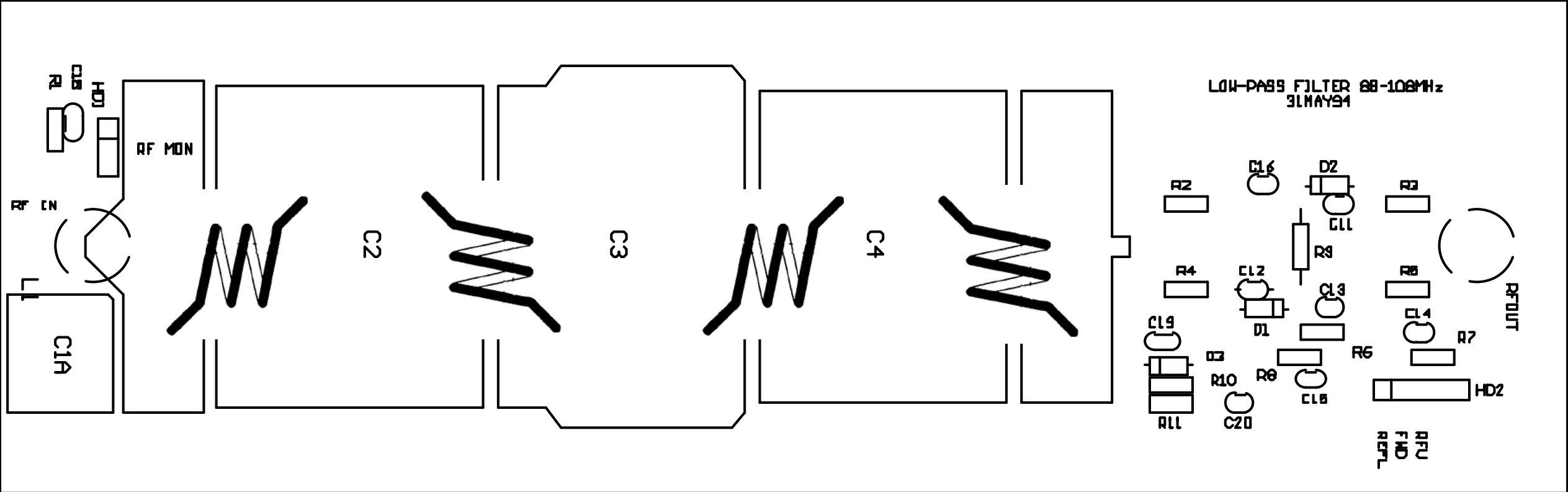


Illustration 6-13 FM Low Pass Filter #2

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1 2 3 4 5 6 7 8

| REVISION HISTORY |     |             |          | APPROVALS |     |    |    |
|------------------|-----|-------------|----------|-----------|-----|----|----|
| E . C . N.       | REV | DESCRIPTION | DATE     | DWN       | CHK | CM | PE |
|                  | J   | REDRAWN     | 12-05-03 | DW        |     |    | DP |
|                  |     |             |          |           |     |    |    |
|                  |     |             |          |           |     |    |    |

F

E

D

C

B

A

SHIELD

J1 RF IN

L1 OPEN

C1A 10pF

C17 3.5pF

C1 15.4pF

L2 90.5nH

C2 1.35pF

L3 94.1nH

C4 7.1pF

L4 87.5nH

C6 9.3pF

L5 77.9nH

C8 5.13pF

C10 2pF

C19 47pF

C18 47pF

R1 100

HD1 RF MONITOR

Aprox. 7V RMS with 200w RF in

R2 73.2

C11 47pF NPO

R3 10

R4 10

D1 1N6263

C12 47pF NPO

R6 1K

R7 20K

C13 0.001uF

C14 0.01uF

FWD

R8 20K

R9 1K

D2 1N6263

C15 .01

C16 0.001uF

REFL

RFV

HD2 1X5

J2 BNC RF OUT

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| DWN       | DW | 03-14-02 |
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TITLE: FM LOW PASS FILTER #2

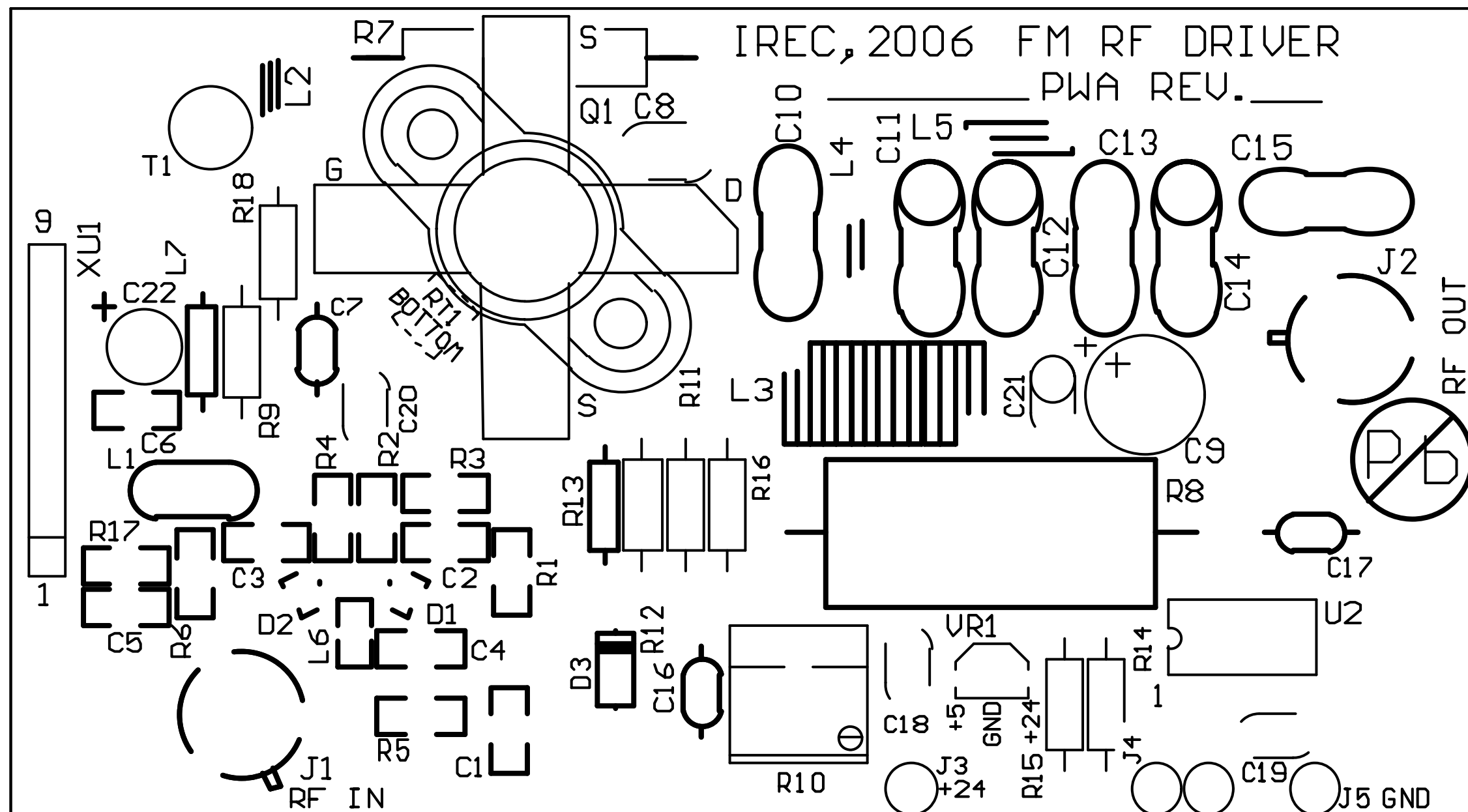
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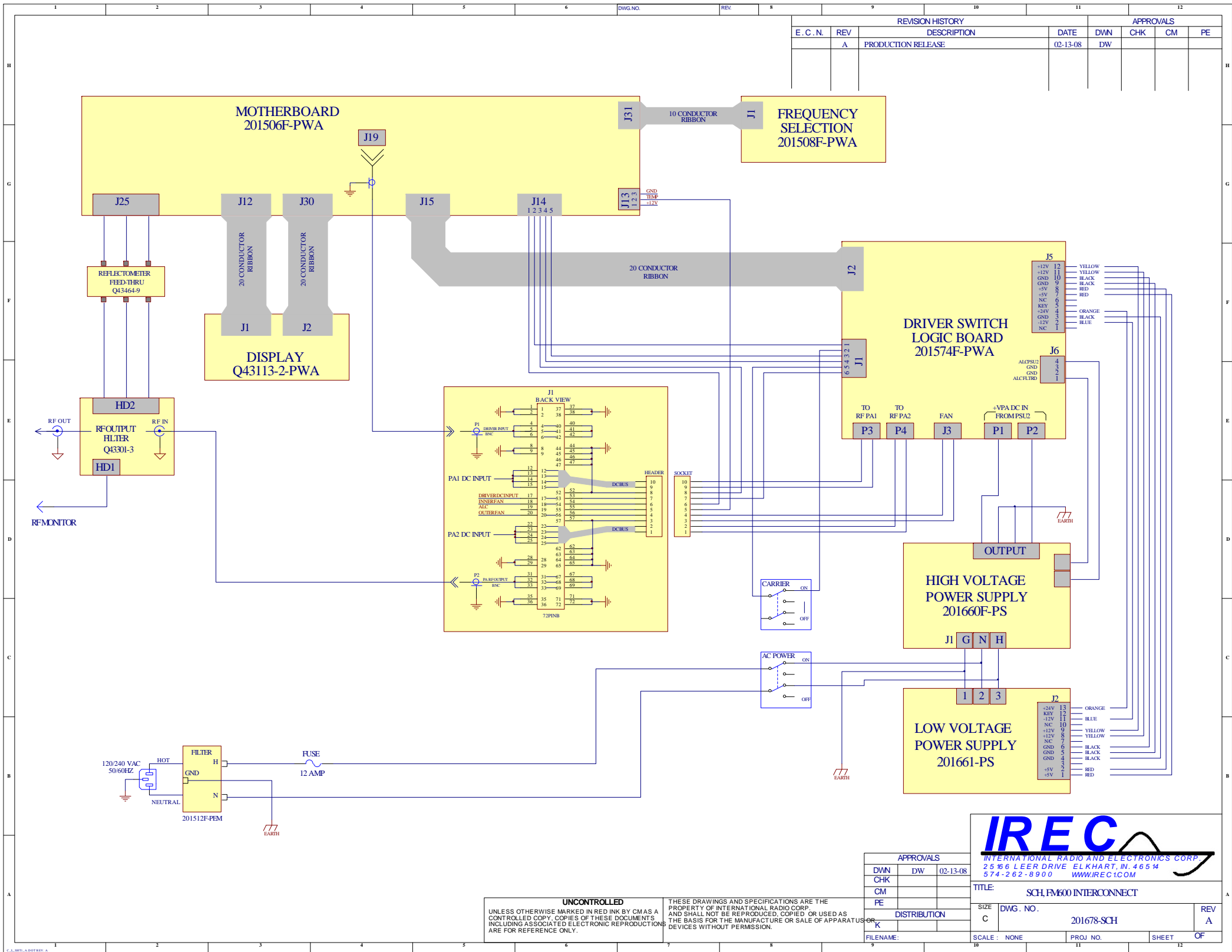
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B\_L\_SHT1\_A.DOT REV. A

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Schematic Diagram: FM600 Chassis Interconnect



## ***Section 7—Service and Support***

We understand that you may need various levels of support or that the product could require servicing at some point in time. This section provides information for both of these scenarios.

---

## *7.1 Service*

The product warranty (see opposite page) outlines our responsibility for defective products. Before returning a product for repair or replacement (our choice), call our Customer Service department using the following telephone number:

**(866) 262-8917**

Our Customer Service Representative will give you further instructions regarding the return of your product. Use the original shipping carton or a new one obtained from Crown. Place shipping spacers between the slide-out power amplifier assembly and the back panel. Please fill out the Factory Service Instructions sheet (page 7–5) and include it with your returned product.

## *7.2 24-Hour Support*

In most instances, what you need to know about your product can be found in this manual. There are times when you may need more in-depth information or even emergency-type information. We provide 24-hour technical assistance on your product via a toll telephone call. For **emergency help** or **detailed technical assistance**, call

**(866) 262-8917**

You may be required to leave a message at this number but your call will be returned promptly from our on-call technician.

## *7.3 Spare Parts*

To obtain spare parts, call **Crown Broadcast Sales** at the following number.

**(866) 262-8972**

You may also write to the following address:

**International Radio and Electronics Corporation**

**P.O. Box 2000**

**Elkhart, Indiana, U.S.A. 46515-2000**



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## **Crown Broadcast Three Year Limited Product Warranty**

### **Summary Of Warranty**

Crown Broadcast IREC warrants its broadcast products to the ORIGINAL PURCHASER of a NEW Crown Broadcast product, for a period of three (3) years after shipment from Crown Broadcast. All products are warranted to be free of defects in materials and workmanship and meet or exceed all specifications published by Crown Broadcast. Product nameplate with serial number must be intact and not altered in any way. This warranty is non-transferable. This warranty in its entirety is the only warranty offered by Crown Broadcast. No other warranties, expressed or implied, will be enforceable.

### **Exclusions**

Crown Broadcast will not warranty the product due to misuse, accident, neglect and improper installation or operation. Proper installation included A/C line surge suppression, lightning protection and proper grounding of the entire transmitter, and any other recommendations designated in the Instruction manual. This warranty does not extend to any other products other than those designed and manufactured by Crown Broadcast. This warranty does not cover any damage to any accessory such as loads, transmission line or antennas resulting from the use or failure of a Crown Broadcast transmitter. Warranty does not cover any loss of revenue resulting from any failure of a Crown Broadcast product, act of God, or natural disaster.

### **Procedure for Obtaining Warranty Service**

Crown Broadcast will repair or service, at our discretion, any product failure as a result of normal intended use. Warranty repair can only be performed at our plant facility in Elkhart, Indiana USA or at a factory authorized service depot. Expenses in remedying the defect will be borne by Crown Broadcast, including two-way ground transportation cost within the continental United States. Prior to returning any product or component to Crown Broadcast for warranty work or repair, a Return Authorization (RA) number must be obtained from the Crown Broadcast Customer Service Department. Product must be returned in the original factory pack or equivalent. Original factory pack materials may be obtained at a nominal charge by contacting Crown Broadcast Customer Service. Resolution of the defective product will be made within a reasonable time from the date of receipt of the defective product.

### **Warranty Alterations**

No person has the authority to enlarge, amend, or modify this warranty, in whole or in part. This warranty is not extended by the length of time for which the owner was deprived the use of the product. Repairs and replacement parts that are provided under the terms of this warranty shall carry only the unexpired portion of the warranty.

### **Product Design Changes**

Crown Broadcast reserves the right to change the design and manufacture of any product at any time without notice and without obligation to make corresponding changes in products previously manufactured.

### **Legal Remedies of Purchaser**

This written warranty is given in lieu of any oral or implied warranties not covered herein. Crown Broadcast disclaims all implied warranties including any warranties of merchantability or fitness for a particular purpose.

### **Crown Broadcast**

25166 Leer Drive Elkhart, Indiana 46514-5425, Phone: (574) 262-8900, Fax: (574) 262-5399  
[www.crownbroadcast.com](http://www.crownbroadcast.com)

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## ***Factory Service Instructions***

To obtain factory service, complete the bottom half of this page, include it with the unit, and ship to:

**International Radio and Electronics Corporation  
25166 Leer Drive  
Elkhart, Indiana, U.S.A. 46514-5425**

For units in warranty (within 3 years of purchase from any authorized Crown Dealer): We pay for ground UPS shipments from anywhere in the continental U.S. and Federal Express Second Day service from Hawaii and Alaska to the factory and back to you. Expedited service/shipment is available for an additional charge. You may forward your receipt for shipping charges which we will reimburse. We do not cover any charges for shipping outside the U.S. or any of the expenses involved in clearing customs.

If you have any questions about your Crown Broadcast product, please contact Crown Broadcast Customer Service at:

Telephone: (866) 262-8917 or (866) 262-8972  
Fax: (574) 262-5399

Name:

Company:

Shipping Address:

Phone Number: Fax:

Model:

Serial Number:

Purchase Date:

### **Nature of the Problem**

(Describe the conditions that existed when the problem occurred and what attempts were made to correct it.)

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Other equipment in your system: \_\_\_\_\_

If warranty has expired, payment will be: ☐ Cash/Check ☐ VISA ☐ Mastercard  
☐ Please Quote before servicing

Card Number: \_\_\_\_\_ Exp. Date: \_\_\_\_\_ Signature: \_\_\_\_\_

Return Shipment Preference if other than UPS Ground: ☐ Expedite Shipment ☐ Other \_\_\_\_\_

**ENCLOSE WITH UNIT—DO NOT MAIL SEPARATELY**

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## ***Appendix***

### ***Transmitter Output Efficiency***

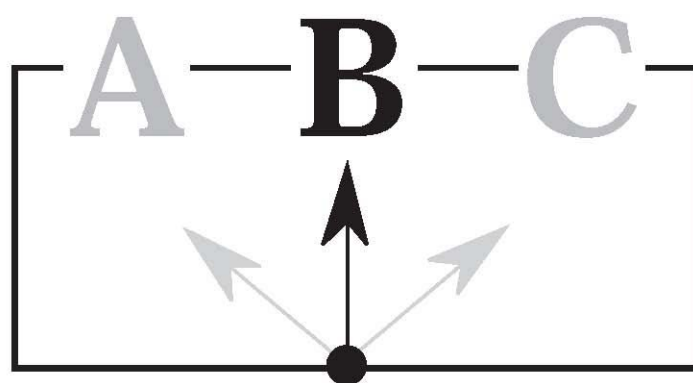
| <b>Frequency</b> | <b>RF Power</b> | <b>PA DC Volts</b> | <b>PA DC Current</b> | <b>Power Input</b> | <b>Efficiency</b> |
|------------------|-----------------|--------------------|----------------------|--------------------|-------------------|
| 89.7             | 660             | 47.3               | 17.2                 | 813.6              | 81.1              |
|                  | 600             | 45.1               | 15.9                 | 717.1              | 83.7              |
|                  | 450             | 39.4               | 13.68                | 539                | 83.5              |
|                  | 300             | 32.2               | 11.42                | 367.7              | 81.6              |
|                  | 150             | 22.9               | 8.87                 | 203.1              | 73.8              |
|                  | 60              | 14.5               | 6.95                 | 100.8              | 59.5              |
| 97.9             | 660             | 49.7               | 14.86                | 738.5              | 89.4              |
|                  | 600             | 47.1               | 14.12                | 665.1              | 90.2              |
|                  | 450             | 40.3               | 12.55                | 505.8              | 89                |
|                  | 300             | 32.4               | 11.11                | 360                | 83.3              |
|                  | 150             | 23                 | 9.22                 | 212.1              | 70.7              |
|                  | 60              | 14.8               | 8.26                 | 22.2               | 49.1              |
| 107.9            | 660             | 51.1               | 16.24                | 829.9              | 79.5              |
|                  | 600             | 48.8               | 15.8                 | 771                | 77.8              |
|                  | 450             | 42                 | 14.56                | 611.5              | 73.6              |
|                  | 300             | 34.6               | 12.83                | 443.9              | 67.6              |
|                  | 150             | 26.4               | 10.91                | 288                | 52.1              |
|                  | 60              | 16.2               | 7.09                 | 129.4              | 46.4              |

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*Notes:*



## *Glossary*

The following pages define terms and abbreviations used throughout this manual.

---

|                          |  |
|--------------------------|--|
| <b>AF</b>                | Audio Frequency; the frequencies between 20 Hz and 20 kHz in the electromagnetic spectrum  |
| <b>ALC</b>               | Automatic Level Control  |
| <b>AM</b>                | Amplitude Modulation; the process of impressing information on a radio-frequency signal by varying its amplitude.  |
| <b>Bandwidth</b>         | The range of frequencies available for signaling.  |
| <b>BCD</b>               | Binary-Coded Decimal; a digital system that uses binary codes to represent decimal digits.   |
| <b>BFO</b>               | Beat Frequency Oscillator  |
| <b>BNC</b>               | A bayonet locking connector for miniature coax; said to be short for Bayonet-Neill-Concelman.  |
| <b>Broadband</b>         | As used in the FM transmitter; refers to the entire audio spectrum as opposed to the spectrum influenced by the pre-emphasis; also called "Wideband".  |
| <b>Carrier</b>           | A continuous signal which is modulated with a second; information– carrying signal.  |
| <b>Crosstalk</b>         | In FM broadcasting, the term generally refers to the interaction between the main (L+R) and the subcarrier (L_R) signals as opposed to "separation" which generally refers to leakage between left (L) and right (R) channels. |
| <b>Density (program)</b> | A high average of modulation over time.  |
| <b>Deviation</b>         | The amount by which the carrier frequency changes either side of the center frequency.   |
| <b>DIP</b>               | Dual In-line Pins; term used to describe a pin arrangement.  |
| <b>Distortion</b>        | The unwanted changes in signal wave shape that occur during transmission between two points.   |
| <b>DPM</b>               | Digital Panel Meter  |
| <b>EPROM</b>             | Erasable Programmable Read Only Memory   |
| <b>Exciter</b>           | (1) A circuit that supplies the initial oscillator used in the driver stage.<br>(2) A transmitter configuration which excludes stereo generation and audio processing.   |



---

|                              |   |
|------------------------------|---|
| <b>FET</b>                   | Field-Effect Transistor   |
| <b>Frequency Synthesizer</b> | A circuit that generates precise frequency signals by means of a single crystal oscillator in conjunction with frequency dividers and multipliers.            |
| <b>FM</b>                    | Frequency Modulation; the process of impressing a radio signal by varying its frequency.  |
| <b>FSK</b>                   | Frequency Shift Keying; an F technique for shifting the frequency of the main carrier at a Morse code rate. Used in the on-air identification of frequencies. |
| <b>Gain Reduction</b>        | The process of reducing the gain of a given amplifier.  |
| <b>Harmonics</b>             | Undesirable energy at integral multiples of a desired, fundamental frequency.   |
| <b>High Frequency</b>        | Frequencies in the 3.0 to 30.0 MHz range.   |
| <b>Highband</b>              | Frequencies affected by the pre-emphasis.   |
| <b>I/O</b>                   | Input/Output  |
| <b>LED</b>                   | Light Emitting Diode  |
| <b>Modulation</b>            | The process by which a carrier is varied to represent an information-carrying signal.   |
| <b>MOSFET</b>                | Metal Oxide Semiconductor Field Effect Transistor; A voltage-controlled device with high input impedance due to its electrically isolated gate.               |
| <b>Nearcast</b>              | A transmission within a localized geographic area (ranging from a single room to several kilometers)  |
| <b>PA</b>                    | Power Amplifier   |
| <b>PAI</b>                   | Power Amplifier Current   |
| <b>PAV</b>                   | Power Amplifier Voltage   |
| <b>Pilot</b>                 | A 19-kHz signal used for stereo transmissions.  |
| <b>Pre-emphasis</b>          | The deliberate accentuation of the higher audio frequencies; made possible by a high-pass filter.   |
| <b>Processing</b>            | The procedure and or circuits used to modify incoming audio to make it suitable for transmission.   |
| <b>Receiver</b>              | An option which adds incoming RF capability to an existing transmitter. See also "Translator."  |

---

|                          |  |
|--------------------------|--|
| <b>RF</b>                | Radio Frequency;<br>(1) A specific portion of the electromagnetic spectrum between audio-frequency and the infrared portion.<br>(2) A frequency useful for radio transmission (roughly 10 kHz and 100,000 MHz).        |
| <b>SCA</b>               | Subsidiary Communications Authorization; see "subcarrier."   |
| <b>S/N</b>               | Signal to Noise  |
| <b>Spurious products</b> | Unintended signals present on the transmission output terminal.  |
| <b>Stability</b>         | A tolerance or measure of how well a component, circuit, or system maintains constant operating conditions over a period of time.  |
| <b>Stereo Pilot</b>      | See "Pilot."   |
| <b>Stereo separation</b> | The amount of left channel information that bleeds into the right channel (or vice versa).   |
| <b>Subcarrier</b>        | A carrier signal which operates at a lower frequency than the main carrier frequency and which modulates the main carrier.   |
| <b>Suppression</b>       | The process used to hold back or stop certain frequencies.   |
| <b>SWR</b>               | Standing Wave Ratio; on a transmission line, the ratio of the maximum voltage to the minimum voltage or maximum current to the minimum current; also the ratio of load impedance to intended (50 ohms) load impedance. |
| <b>THD</b>               | Total Harmonic Distortion  |
| <b>Translator</b>        | A transmitter designed to internally change an FM signal from one frequency to another for retransmission. Used in conjunction with terrestrial networks.  |
| <b>Satellator</b>        | A transmitter equipped with an FSK ID option for re-broadcasting a satellite fed signal.   |
| <b>VSWR</b>              | Voltage Standing Wave Ratio; see "SWR."  |
| <b>Wideband</b>          | See "Broadband."   |
| <b>VCO</b>               | Voltage Controlled Oscillator  |

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