Ten-Watt FM Broadcast Transmitter

Model FM10X

Technical Manual

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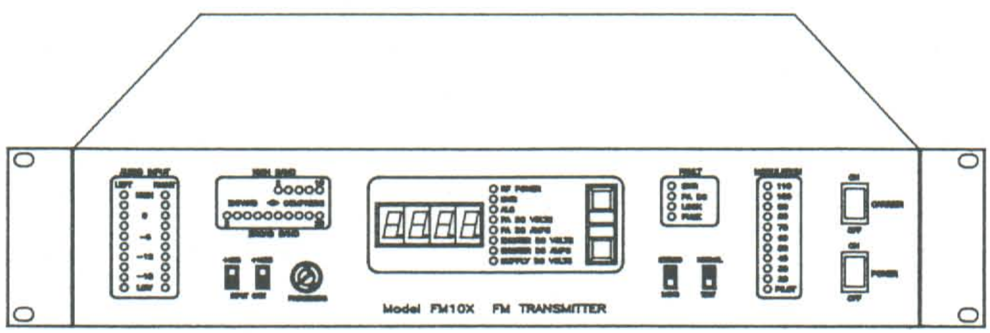

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1.0 - INTRODUCTION

The FM10X is a ten-watt FM stereo broadcast transmitter. Development of the FM10X grew out of a need to provide quality, easily transportable FM broadcast stations, that could be set up and operated anywhere in the world. The result is a unit that integrates audio processing, stereo generation, and RF generation into one compact, rugged, and inexpensive unit.

The following design criteria were employed:

- Integrate audio processing, stereo generation, and RF generation without compromising signal quality.
- Build in metering and diagnostic capabilities.
- Minimize internal adjustments. (Where trim pots are used, in most cases they provide only fine adjustment.)
- Insure long-term stability and reliability in harsh environments.
- Provide for selection of operating frequency on the field.
- Setup and verification of operating parameters with the minimum of test equipment.
- Provide technical standards commensurate with the state of the art and comply with government standards worldwide.

In the interest of providing long-term stability and reliability, the FM10X employs precision laser-trimmed analog multipliers, digitally-synthesized subcarriers, and crystal-controlled switched-capacitor filters.

An audio processing formula that integrates short-term expansion with the conventional short- and long-term gain reduction enhances program loudness without degrading quality.

A special test point facilitates the use of an inexpensive short-wave receiver to make precise measurements of deviation (using Bessel nulls) and operating frequency.

The FM10X is small enough to carry in a suitcase. With the addition of an audio source---mixer, tape deck, satellite receiver, etc.--- and an antenna, the FM10X is a complete ten-watt FM stereo broadcast station, capable of serving a town or village. Provision is made for the metering and control of an external RF amplifier for wider coverage.

2.0 - SPECIFICATIONS

FREQUENCY RANGE:	87 - 108 MHz
FREQUENCY STABILITY:	Better than 1000 Hz from 0 to 50 degrees C.
RF OUTPUT:	10 watts (VSWR 1.5:1 or better.)
RF SPURIOUS PRODUCTS:	Better than -65 dB.
AC POWER:	120 or 240 volts AC, 50-60 Hz
AUDIO RESPONSE:	Conforms to 75 uS pre-emphasis curve as follows:
With processor,	50Hz-10kHz, + 0.25, -1dB
	50Hz-15kHz +0.25, -3dB
Without processor,	50Hz - 15kHz , +/- 0.25dB.
HARMONIC DISTORTION:	50Hz - 15kHz, THD plus noise
With processor,	less than 0.5%
Without processor,	less than 0.2%.
STEREO SEPARATION:	Better than 40dB
FM & AM NOISE:	Down better than 62dB
AUDIO INPUT:	Nominal -10dbm to +10dbm into 50k balanced
SCA INPUT LEVEL:	60-100KHz, 1V RMS for 7.5 KHz deviation.
SIZE	3.5 in. high x 16.5 in. wide x 15 in. deep. (Exclusive of rack adapters)
WEIGHT	17 lb, 6 oz.

3.0 - DESCRIPTION

The FM10X is a complete 10-watt FM broadcast transmitter contained in a 3.5" x 16.5" x 15" package. The unit has built-in audio processing, stereo generation, RF frequency synthesizer, and digital multimeter.

Audio levels, processing, and other operating parameters are shown on front panel dot- and bar-graph displays, along with a four-digit numeric display.

3.1 FRONT PANEL

3.1.1 AUDIO INPUT display

10-segment graphic bar-dot display of relative left and right audio processor input level. (After the input gain-set attenuator.)

3.1.2 INPUT GAIN switches.

" + 6db" and " + 12db" slide switches set audio input sensitivity.

Switches		Nominal Input
+6 DB	+12DB	Sensitivity
DOWN	DOWN	+10 DBm
UP	DOWN	+4DBm
UP	UP	-2dbm
UP	UP	-8DBm

3.1.3 HIGH BAND and BROAD BAND display.

During audio processing, indicate amount of gain control for broadband and pre-emphasized audio, respectively.

3.1.4 PROCESSING control

Sets depth of audio processing. See 5.2.4

3.1.5 Four-digit multimeter

Pushbuttons select one of eight parameters to be displayed on the four-digit multimeter. Green LED indicates parameter selected.

3.1.6 FAULT indicators

RF drive and PA supply voltage are reduced when a fault condition exists. See 5.2.6 for a description of faults. [Note: Some units manufactured before May 1992 did not have PA supply voltage control.] See 6.10

3.1.7 STEREO-MONO switch

STEREO activates stereo generator. In MONO, only left channel audio is used to provide 100% modulation.

3.1.8 NORMAL-TEST switch

NORMAL, broadband level threshold 2db below high-band threshold.

TEST, used in proof-of-performance testing, sets the thresholds the same. (Operating in TEST mode will degrade the high frequency audio response of most program material.)

3.1.9 MODULATION display

Indicates modulation percentage. See 5.2.7.

3.1.10 CARRIER switch

Switches the 24-volt DC supply to the internal 10-watt RF amplifier and provides 24-volt control signal to 15-pin connector on the rear panel to control the power supply in an external RF power amplifier.

3.1.11 POWER switch

Main power switch for the unit.

3.2 REAR PANEL

3.2.1 AC Power receptacle module

Input for AC power. Module also has fuse and 120/240V switch. See 4.1.

3.2.2 EXTERNAL RF AMPLIFIER connector

Control and metering lines for external RF amplifier. See 4.2.

3.2.3 AF MONITOR jacks, RIGHT & LEFT

Processed, de-emphasized (75usec.) sample of stereo generator input signals. Suitable for feeding a studio monitor, and for doing audio testing.

3.2.4 SCA INPUT

An external SCA generator may be connected to the SCA IN connector on the rear panel. The input is intended for the 60- to 99-KHz range, but a lower frequency may be used if the FM10X is operated in the MONO mode. (The band of 23 to 53 KHz is used for stereo transmission.) The subcarrier input should be a nominal 1 volt RMS. The input sensitivity may be set using the SCA trim-pot on the STEREO GENERATOR circuit board. See 7.2.1.

3.2.5 Audio INPUT, RIGHT & LEFT

See 4.4

3.2.6 RF OUTPUT connector

Ten watts or less RF output. See 4.5.

4.0 - INSTALLATION

CAUTION - BEFORE OPERATING THE FM10X FOR THE FIRST TIME:

CHECK A.C. LINE VOLTAGE SETTING (see 4.1)

CHECK FREQUENCY SETTING (see 7.3.1)

4.1 AC LINE VOLTAGE SETTING

The FM10X may be set to operate from either a 120-volt or 240-volt AC power source. To set the input voltage, unplug the AC power cord from the rear of the unit. On the power receptacle is a plastic slide cover; slide to expose the cartridge fuse. A small printed-circuit board is plugged in just beneath the fuse. The orientation of this board determines the line voltage setting. A "120" or "240" will be visible under the fuse. If a change is called for, use a hook or long-nose pliers to pull out the card, turn so that the appropriate voltage is indicated, and reinsert card into the receptacle assembly.

4.2 FREQUENCY SETTING

4.2.1 RF Frequency Synthesizer

Thumbwheel switches for setting the operating frequency of the FM10X are accessible by removing the top cover of the unit. See 7.3.1 for details.

The MODULATION trim-pot, just to the left of the thumbwheel frequency-set switches, compensates for slight variations in deviation sensitivity with frequency for the individual RF exciter boards. The trim-pot dial should be set according to the Modulation Compensator chart. See 7.3.2.

4.2.2 Ten-watt RF amplifier

Tuning of the ten-watt RF amplifier stage is fairly broad. In many cases it will not require retuning after a frequency change. If, however, the power output has dropped off due to a frequency change, repeak the output with the two trimmer capacitors located on the 10-watt RF amplifier circuit board - accessible by removing the bottom cover. See 7.6.2 for more detail.

5.0 - OPERATION

CAUTION - BEFORE OPERATING THE FM10X FOR THE FIRST TIME:
CHECK A.C. LINE VOLTAGE SETTING (see 4.1)
CHECK FREQUENCY SETTING (see 7.3.1)

5.1 SETUP

1. CARRIER switch OFF.

2. POWER switch ON.

3. STEREO-MONO to desired mode.

Note: For MONO, feed audio only to the left channel. In MONO, audio is taken from the left channel, but right channel audio can affect the audio processing.

4. NORMAL-TEST switch to "NORMAL".

5. Apply program audio at a normal level.

6. Set PROCESSING control to "50."

7. Find experimentally, the combination of INPUT GAIN switch settings that will bring the BROAD BAND gain-reduction indicator to mid scale for "normal" level program. The audio processor will accommodate a fairly wide range of input levels with no degradation of audio quality. See 3.1.2.

5.2 NORMAL OPERATION

5.2.1 AUDIO INPUT indicators

Under normal operating conditions the left and right AUDIO INPUT indicators will both be active, indicating the relative audio input level. During pauses in program the red LOW LED will come on.

5.2.2 BROAD BAND indicator

The BROAD BAND indicator will show short-term "syllabic-rate" expansion and gain reduction around a long-term (several seconds) average gain set.

The magnitude of the short-term expansion and compression (the rapid left and right movement of the green light) is determined by the program material and the setting of the PROCESSING control.

5.2.3 HIGH BAND indicator

Activity of the HIGH BAND indicator is determined by the high-frequency content of the program. With 75usec. pre-emphasis, HIGH BAND processing will begin at about 2000 khz and increase as the audio frequency increases. Some programs, especially speech, will show no activity; for some music there will be lots.

5.2.4 PROCESSING control

The PROCESSING setting will be determined by a combination of program material and personal taste. In general, mid-range (40 to 70) should be satisfactory. For the classical music purist 10 to 40 might be a good range. The audio will be heavily processed at 70 to 100.

If the program source is already well processed, set the PROCESSING to "0" or "10".

5.2.5 Digital Multimeter

The digital multimeter is a four-digit numeric display in the center of the front panel. "Up" and "down" pushbuttons facilitate selection from a menu of eight parameters. A green LED indicates the one selected.

The parameters are:

RF POWER Actually reads RF voltage-squared, so the accuracy can be affected by VSWR (RF voltage-to-current ratio). See 7.4.1 and 7.4.2 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 and RF drive. [Note: Some units manufactured before May 1992 did not have PA supply voltage control.] With full output, ALC will read about 5.0 volts. When the RF output is being regulated by the RF power-control circuit this voltage will be reduced - typically reading 1 to 4 volts. It will be less than one volt during a LOCK fault. The ALC voltage will be reduced during PA DC overcurrent, SWR, or LOCK fault conditions. This is a useful parameter to monitor when making adjustments to the power output stage.

PA DC VOLTS Supply voltage of the external RF power amplifier. (Voltage at positive side of PA DC current shunt.)

PA DC AMPS Transistor drain (or collector) current for external RF power amplifier.

EXCITER DC VOLTS Supply DC voltage for internal 10-watt RF amplifier. (Nominally 18-24 volts.)

EXCITER DC AMPS Transistor drain current for 10-watt RF amplifier. (Typically 0.5 to 1.0 amps.)

SUPPLY DC VOLTS Internal 12-volt supply.

5.2.6 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. (For this to work properly, the POWER LIMIT control must be set at, or just above, the operating power level. See 7.4.1 - 7.4.3.)

PA DC: Power supply current for the external RF amplifier is at the preset limit. ALC voltage has been reduced to hold supply current to the preset limit. See 5.2.5.

LOCK: Frequency synthesizer phase-lock loop unlocked. Drive inhibited by reduced ALC voltage. (Under normal conditions it will take up to 20 seconds at power up to lock.)

FUSE: Not used.

5.2.7 STEREO-MONO switch.

Selects mode. See 5.1.

5.2.8 NORMAL-TEST switch.

Set to NORMAL during operation. See 3.1.8

5.2.9 MODULATION display.

Indicates modulation percentage. Peak-hold bar-graph display of modulation percentage. "100" coincides with 75 khz deviation. The display holds for about 0.1 seconds after the peak. Resolution is increased over a conventional 10-segment bar-graph display through the use of dither enhancement. (Dither modulates the brightness of the LED.) The "PILOT" indicator lights when the unit is in the stereo mode.

5.2.10 CARRIER switch.

Switches power to RF amplifiers. See 3.1.9

5.2.11 POWER switch.

Main power switch.

6.0 - CIRCUIT DESCRIPTION

6.1 AUDIO PROCESSOR

The audio processor is a 4.5 x 6-inch circuit board located in the upper compartment of the unit at left front. The board is accessible by removing the unit top cover. (One circuit of the processor - the 8th-order elliptical filter - is on the stereo generator board.) The processor provides the audio control functions of compressor, limiter, and expander. The pre-emphasis networks are on this board. Refer to 9.1. Reference numbers will be for the left channel. Where there is a right-channel counterpart, references will be in parenthesis.

Audio input from the XLR connector on the rear panel of the unit goes to differential-input amplifier U1A (U2A).

The gain of inverting amplifier U1B (U2B) is set by binary data on the " +6DB" and " +12DB" lines. One of four feedback points is selected by analog switch U3 in approximate 6DB steps.

The output of U1B (U2B) goes to an eighth-order elliptical switched-capacitor low-pass 15.2 kHz filter. The filter is located on the stereo generator board to take advantage of the ground-plane and proximity to the 1.52-MHz clock.

U4B (U4A), along with R22/C8 (R58/C20), form third-order low-pass filtering, attenuating audio products below 30 Hz.

The output level of analog multiplier U5 (U6) is the product of the audio signal at pin 13 and the DC voltage difference between pins 7 and 9. At full gain (no gain reduction) this difference will be 10 volts DC.

When either the positive or negative peaks of the output of U5 (U6) exceeds the gain-reduction threshold, DC bias is generated by U13A, producing broad-band gain reduction. Q5 is a precision-matched transistor pair. It, along with U13B, form a log converter, so that a given voltage change will produce a given number of DB of gain control of U5 (U6). The log conversion insures uniform level-processing characteristics over - and well beyond - the 20-DB control range. The log conversion has an additional benefit; it allows 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 gain reduction is controlled by R650, located on front-panel display board. See 5.2.4.

Pre-emphasis in microseconds is the product of the capacitance of C10 (C22), multiplied by the gain of U8 (U9), times the value of R31 (R67). For 75-microsecond pre-emphasis the gain of U8 (U9) will be about 1.11. The pre-emphasis curve - 75uS, 50uS, 25uS, or FLAT - is selected by jumpering the appropriate pins on header JP1. Fine adjustment of the pre-emphasis is made with trim pot R29 (R65). See 7.1.2.

For high-band processing the peak output of U10B is detected and gain-reduction bias is generated, as with the broadband processor. The high-band processing, however, modifies the pre-emphasis curve rather than overall gain.

Peak audio voltages are compared to a plus and minus 5.00-volt reference, U17 and U18. This same reference voltage is used by the stereo generator, metering, and display boards.

For explanation of on-board adjustments see 7.1.

6.2 STEREO GENERATOR

The stereo generator is the right-rear 4.5 x 4.5-inch board in the upper compartment of the unit, accessible by removing the top cover. The component-side of the board is mostly ground plane. The board has inputs for left- and right-channel audio from which it generates a composite stereo signal. (8th-order, 15.2-kHz elliptical low-pass filters (U201 and U202) are on this board, but belong to the audio processor.)

U207A, with Y201, is 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 at pin 6, used by filters U201 and U202. 3.6 MHz, 1.9 MHz and 304 kHz are also derived from dividers in U208.

Exclusive-OR gates U210A and B provide a stepped approximation of a 38 kHz sine wave - a scheme described in the CMOS Cookbook by Don Lancaster (Howard W. Sams &. Co., Inc., Indianapolis, IN - 1978). With the resistor ratios used, the synthesized sine-wave has very little harmonic energy below the 7th harmonic. U210C and D generate the 19-kHz pilot subcarrier. U211 is a dual switched-capacitor filter, configured as 2nd-order low-pass filters with Q,s 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 - THD of less than 0.05%.

U212 is a precision four-quadrant analog multiplier. The output of U212 is the product of 38 kHz applied to the "Y" input and the difference of left and right audio - the L-R signal - applied to the "X" input. The resulting output is a double sideband suppressed carrier - the L-R subcarrier.

SCA subcarrier, left, right, left-minus-right subcarrier, and 19-kHz pilot subcarrier are combined into the composite stereo signal by summing amplifier U206A.

Analog switch U205, at the input of U206A, provides switching of left and right audio for stereo and mono modes. In the mono mode the subcarriers are turned off, 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. R210 (R222) and C207 (C211) are a 75 usec de-emphasis network. Processed, de-emphasized (75usec.) samples of the stereo generator input signals are used for feeding a studio monitor and for doing audio testing.

VR201 and VR202 supply plus and minus 6 volts, respectively. Supply for the subcarrier generators is 5.00-volt reference from the audio processor board.

For explanation of on-board adjustments see 7.2.

6.3 FREQUENCY SYNTHESIZER

The frequency synthesizer is a 4.5" x 7.0" board located in the upper compartment of the unit. The entire component side of the board is ground plane. Thumb-wheel switches along the front edge of the board set the operating frequency. The VCO (voltage-controlled oscillator) circuitry is inside a cast aluminum shield cover. There is an input connection for modulation. About 35 mW. output is available into 50 ohms.

VCO, Q301 operates at the synthesizer output frequency of 87 MHz to 108 MHz. The frequency is controlled by voltage-variable capacitors D307 and D308. Q304 and Q305 form an active filter to supply clean DC to the drain of Q301. Q305 also serves as a common-base RF amplifier for Q301. U308 and U309 are hybrid RF amplifiers to provide buffering and gain. The output level of the synthesizer is controlled by Q302. With 5 volts DC at the ALC input, the sythesizer will produce full output; as the ALC is reduced, so is the RF output.

A sample of the RF from the VCO goes to the input of U302. U302 is a dual modulus 10/11 divider that has been connected to divide by 10. The output of U302 is 8.7 to 10.8 MHz. This signal, available at TP202, may be used with an HF receiver for deviation and frequency measurements. See 7.2.5.2 and 7.3.3.

U304 is a phase-locked-loop frequency synthesizer IC. The 10.24 MHz from the crystal oscillator is divided to 10KHz. Internal programmable dividers (along with dual modulus divider U1) divide the 8.7 to 10.8 MHz RF to 10kHz also. Differences between the two signals produce error signals at pins 7 and 8.

The U304 dividers are set with thumb-wheel switches. The binary output of the 0.1-MHz switch programs the "A" counter directly. BCD data from the 100's, tens, and units thumbwheels is converted to binary data by EPROM U310 to set the "N" counter. There is also provision on the circuit board for using either DIP switches or jumpers to set the frequency. See 7.3.1.

U305B 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 U305. U306A and B are a filter/integrator. It is configured to isolate the VCO from op-amp noise. Q303 and D302 are VCO input voltage clamps.

Lock and unlock status signals are available at the outputs of U303E and U303F, respectively. Modulation is introduced to the VCO through R351 and R326 to R329. About 4.1 millivolts across R329 produces 75 kHz deviation.

6.4 ALC - METERING

The ALC and metering circuitry is on a 4.0" x 4.5" circuit board in the upper compartment of the chassis. This board 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, and drive for the front-panel fault indicators.

The 10-watt RF output amplifier has a 0.1-ohm current metering shunt in the 24-volt transistor drain supply lead. The shunt resistor is located on the 10-watt circuit board. The two sides of that resistor come to the "IPA SHUNT+" and "IPA SHUNT-" inputs of the ALC-meter board. Op-amp U405 drives transistor Q404 to produce a voltage across emitter resistor R431 equal to the voltage across the meter shunt. Assuming a transistor alpha of better than .995, voltage drop across collector resistor R432 will very nearly equal that of R31, thus producing a ground-referenced voltage source for metering of 0.1 volts per amp.

A voltage divider from the "IPA SHUNT+" line feeds the line for DC voltage metering.

The metering circuits for the drain (or collector) current and voltage of an external RF amplifier are identical to that just described for the IPA. U403 and Q403 form the shunt-voltage level translator circuit. The PA shunt lines come from the 15-pin connector on the rear panel. It should be noted that, because of the voltage rating of the U403 op- amp, this metering may not be used with external amplifiers that have supplies greater than 24 volts.

U410A, U411A, and U411B - with their respective diodes - are diode linearity correction circuits. Their DC inputs come from diode detectors in the RF reflectometer (either the reflectometer on the 10-watt RF amplifier board, or an external reflectometer via the 15-pin connector on the rear panel).

U401A, U401B, Q401, and Q402 are components of a DC squaring circuit. Since the DC output voltage of U401B is proportional to RF voltage squared, it is also proportional to RF power.

U402A, U404A, and U404B are level sensors for RF power, reflected RF power and external PA current, respectively. When either of these parameters exceeds the limits, the output of U402B will be forced low, reducing the ALC (RF level control) voltage.

The DC voltage setpoint for U404A (reflected RF voltage) is one-fifth that of U402A (forward RF voltage). This ratio corresponds to an SWR of 1.5:1. SWR protection is available only if the POWER SET control has been set to either control the RF power, or just above the point at which it will control power - as may be the case when running an RF power amplifier at saturation.

The U406 invertors drive the front panel fault indicators.

To get a direct reading of SWR, the reference input of the digital panel meter is fed from a voltage proportional to the forward-minus-reflected RF voltage, while forward-plus-reflected is fed to the DPM input.

U408 and U409 are used as data selectors for the digital panel meter input and reference voltages. Binary select data for U408 and U409 comes from the display board.

6.5 POWER SUPPLY

The power supply for the FM10X occupies the right-hand side of the chassis. The power transformer and two bridge rectifiers are mounted on the chassis. Three 10,000 MFD filter capacitors are mounted on the underside of the chassis base plate. On the top of the chassis, opposite the capacitors, is a circuit board. The board has the capacitors and rectifier bridge for the negative supply and the three three-terminal regulators. The regulators are heat-sinked to the chassis inside partition. The power supply provides +24 volts at 1 amp., +12 volts at 1 amp., and -12 volts at .25 amp.

AC input for the power supply is through a receptacle/filter module on the rear panel. It receives the AC line cord, holds the line fuse, and has facility for switching between 120 and 240 VAC.See 4.1.

Each of the two 12VAC secondaries has a bridge rectifier. The DC outputs (about 17VDC) of the bridges are connected in series, so there is available a no-load voltage of about 17 and 34 volts DC.

The 34 volts goes to a 24-volt three-terminal regulator; the 17 volts to a 12-volt regulator.

AC from the lower secondary is AC-coupled to a bridge to provide the negative supply. The negative supply has a three-terminal -12V regulator.

6.6 DISPLAY

Front-panel indicator LEDs, numeric display, slide switches, and processing control are mounted on the 3.5" x 14.5" display circuit board. The component side of the board may be accessed by removing the front panel. (Remove 8 flat-head screws.) The board has the circuits for the digital panel meter, modulation peak detector, and LED display drivers, as well as indicators and switches mentioned above.

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 U601A and U601B 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; but rather a red LOW indicator lights when audio is below the level of the second step. Transistors Q601 and Q602 divert current from the LOW LEDs when any other LED is lit.

Resolution in the linear displays - HIGH BAND, BROAD BAND, and MODULATION - has been improved through utilization of 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. U606A, U606B, and associated components are the dither generator. Dither output is a triangular wave.

U604, U605, and U608 are linear drivers for the HIGH BAND, BROAD BAND, and MODULATION LED displays.

Composite stereo (or mono) is full-wave detected by diodes D605 and D606. U607, U613, Q603, and Q604 are components of a peak sample-and-hold circuit.

Oscillator U609F supplies a low frequency square wave to the FAULT indicators, causing the fault indications to flash on and off.

Digital multimeter inputs are selected with pushbuttons located to the right of the multimeter menu. Signals from the push buttons are conditioned by U609A and U609B. U610 is an up/down counter. Binary input to U611 from U610 selects a green menu indicator light, and lights the appropriate decimal point on the numeric read-out. The binary lines also go to analog data selectors on the ALC/metering board.

PROCESSING control R650 is part of the audio processor. See 6.1.

The DPM IN and DPM REF lines are analog and reference inputs to digital multimeter IC U612. They come from analog data selectors on the ALC/metering.

6.7 TWO-WATT RF AMPLIFIER

The two-watt RF amplifier uses a CA2832 hybrid high-gain wideband amplifier capable of 2 watts output at 100 MHz. The amplifier operates from the 24-volt supply, and is turned on with the CARRIER switch. It amplifies the signal from the RF frequency synthesizer, feeding the 10-watt amplifier.

A resistor pad reduces input level. The circuit board has components for input and output coupling, and for power supply filtering.

6.8 TEN-WATT RF AMPLIFIER

The ten-watt RF amplifier is located in the underside of the chassis on the left side. All circuits for the amplifier are on a 7.5" x 2.25" printed circuit board. The board includes the amplifier, a matching and filtering network, and a reflectometer. The amplifier is turned on with the CARRIER switch.

The amplifier device is a MRF136 MOSFET with 24 volts on the drain. Capacitors C806 and C808 facilitate optimization of load matching.

Forward and reflected power information (RF FWD and RF REFL) from the reflectometer goes to the DB15 connector on the rear panel of the unit. The reflectometer information will go to the metering board via the DB15 connector, only if the FM10X is being used as a transmitter. (If the FM10X is being used as an exciter, then a reflectometer at the output of the external amplifier should be connected to the appropriate DB15 pins.)

6.9 DB15 INPUT FILTER

If the FM10X is to be used as an exciter, control and metering of an external RF amplifier is made possible by a 15-pin DB15 connector on the rear panel. The connector is mounted on a 1.5" x 3.0" circuit board. Resistor, capacitors, and RF chokes provide RF filtering. If the unit is being used as a 10-watt transmitter, it is necessary to jumper pin 2 to 9, 3 to 10, and 4 to 11. This will connect the 10-watt RF reflectometer to the ALC-meter board.

See 9.9.1.

6.10 AUXILIARY ALC

[Note: Some units manufactured before May 1992 did not have this circuit.]

The auxiliary ALC control circuit, located just to the right of the power transformer, is a series linear regulator that controls the supply voltage to the RF power amplifier. With 5 volts of ALC, full (24 volts) voltage is applied to the RF PA. As ALC is decreased to about 2.5 volts, the supply voltage drops close to zero. Below about 2.5 volts ALC the RF drive is reduced, preventing RF feedthrough when the frequency synthesizer is out of lock.

7.0 - INTERNAL ADJUSTMENTS

7.1 AUDIO PROCESSOR

7.1.1 PRE-EMPHASIS SELECTION

The pre-emphasis curve - 75uS, 50uS, 25uS, or FLAT - is selected by jumpering the appropriate pins on header JP1.

Note: If other than 75uS pre-emphasis is used and the AF MONITOR outputs are used, the de-emphasis components on the stereo generator circuit board should be modified accordingly. See 6.2.

7.1.2 PRE-EMPHASIS ADJUST

Fine adjustment of the pre-emphasis is made with trim pot R29 and R65 for left and right channels, respectively. Pots are set to bring 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 signal levels be kept below the processor gain-control threshold.

Measurements may be made using either the de-emphasized output of an FM modulation monitor, or the AF MONITOR outputs on the rear panel of the FM10X.

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

7.2 STEREO GENERATOR

7.2.1 SCA LEVEL

Using an SCA modulation monitor, set for 7.5 kHz deviation.

(Approximate setting of the SCA level can be made by looking at TP301 on the RF synthesizer board with an oscilloscope. At 10% modulation, the subcarrier will be close to 340 millivolts peak-to-peak. This is best observed in the MONO mode.)

7.2.2 L-R LEVEL

Feed a 400 Hz sine wave into one channel. Observe the classic single-channel composite stereo waveform at TP301 on the RF synthesizer circuit board. Adjust the L-R LEVEL control for a straight center line.

Since proper adjustment of the control will coincide with best stereo separation, an FM monitor should be used to make or confirm the adjustment.

7.2.3 19-kHz LEVEL

Adjust the 19-kHz pilot for 9% modulation as indicated on an FM modulation monitor.

(The COMPOSITE LEVEL should be set first, since it follows the 19 kHz LEVEL control.)

7.2.4 19-kHz PHASE

Apply 400-Hz audio to the left channel.

Look at the composite stereo signal at TP301 on the synthesizer circuit board with an oscilloscope, expanding the display to view the 19-kHz component on the horizontal center line.

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.

Recheck separation and adjustment of L-R LEVEL per 7.2.2. above.

7.2.5 COMPOSITE LEVEL

7.2.5.1 Using modulation monitor.

1. Set STEREO-MONO switch to MONO.

2. Check that the setting of the MODULATION compensation control, R51 on the synthesizer circuit board, is according to the chart for the frequency of operation. See 7.3.2.

3. Feed a sine-wave signal source of about 2.5 kHz into the left channel at a level sufficient to put the BROADBAND 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%.

7.2.5.2 Using Bessel nulls.

If done properly, the Bessel Null method to be described will give better accuracy than a modulation monitor. The following procedure will set the gain-control threshold for 90 percent modulation.

1. Set STEREO-MONO switch to MONO.

2. Check that the setting of the MODULATION compensation control R351 on the synthesizer circuit board is according to the chart for the frequency of operation. See 7.3.2.

3. Feed a 2807 Hz sine-wave signal source into the left channel at a level sufficient to put the BROADBAND gain-reduction indicator somewhere in the middle of its range. The modulation setting will be only as precise as the frequency of the sine wave; a one-percent error in frequency will result in a one-percent error in deviation.

4. Couple a shortwave receiver tuned to one-tenth the operating frequency (8.70 MHz to 10.80 MHz) to TP302 on the frequency synthesizer circuit board. (In most cases there need not be a direct connection.)

The receiver must have either a narrow IF bandwidth setting or a BFO (beat frequency oscillator).

5. Adjust the COMPOSITE level control to null the carrier.

   a) If using a BFO: Set the BFO for a low frequency audio tone. Listen for this tone to disappear at the carrier null.

b) Without a BFO: Watch the signal-level indicator on the receiver or determine by ear the point at which the carrier nulls. (This only works if the bandwidth is narrow enough to discriminate against the 2.8 kHz sidebands.)

6. 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%.

7.3 FREQUENCY SYNTHESIZER

7.3.1 FREQUENCY (CHANNEL) selection.

Thumbwheel switches set the operating frequency of the FM10X. Any multiple of 0.1 MHz is available in the FM broadcast band from 87 to 108 MHz.
Examples of thumbwheel settings:

for 88.1 MHz:

0	8	8	1

for 107.9 MHz:

1	0	7	9

Provision is made on the synthesizer circuit board for using either DIP switches or jumpers in place of the EPROM and thumbwheel switches. If the thumbwheel switches are not used, the EPROM (U310) and resistors R345, R346, R347, and R348 must be removed. The operating frequency will be the sum of the switches on. For example, 64+16+8+0.1 for 88.1 MHz; or 64+32+8+2+1+0.8+0.1 for 107.9 MHz.

7.3.2 MODULATION compensator.

The MODULATION trim-pot, just to the left of the thumbwheel switches, compensates for slight variations in deviation sensitivity with frequency. Each mark (of ten) on the trim-pot represents about 1.8% modulation compensation. (For exact setting, see 7.2.5 for measuring deviation.)

Frequency MHz:	Compensator Setting:
88	70
90	65
92	60
94	55
96-108	50

The compensator settings shown are approximate.

7.3.3 MODULATION MEASUREMENT and adjustment.

Next to the 10.24 MHz crystal on the circuit board is a 5.5-18 PF ceramic trimmer capacitor (C307). Use C307 to set the frequency of the 10.24 MHz crystal while observing the output frequency of the synthesizer. Use one of three 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. Or connect a counter to TP302 and measure one-tenth operating frequency. (Do not connect to the 10.24-MHz clock circuit.)

3. Using a shortwave receiver and test point TP301 will, in most cases, give better accuracy than 1 or 2 above.

   a) Temporarily set the synthesizer to 100.0 MHz.

   b) Tune a shortwave receiver to a 10-MHz standard such as WWV or JJY. Loosely couple the receiver to TP302 so that the 10 MHz signal strength from TP302 is about equal to that being received from the standard station. Usually setting the receiver (if it's a portable, such as the Sony 2010) on top of the FM10X with the receiver antenna a few inches from the TP302 test point will be about right.

   c) Use the C7 trimmer capacitor to "zero beat" the two signals.

7.4 ALC - METERING

7.4.1 POWER CALIBRATE

When changing between the internal reflectometer in the 10-watt RF amplifier and an external reflectometer, the power metering will require recalibration.

While looking at RF POWER on the digital panel meter set the POWER CALIBRATE trimpot to agree with an external RF power meter.

7.4.2 POWER SET

Adjust for desired output power. (Operation of the POWER SET control is not affected by the POWER CALIBRATE.)

There may be circumstances where the RF output amplifier will be running at saturation (full output).

The POWER SET trim pot adjustment sets both the forward and reflected RF power thresholds (see 6.4). Therefore, if it is desired to run the power amplifier at saturation, the POWER SET control should be set to a point just above where it would provide power regulation. This will insure limiting of power in the event the SWR exceeds 1.5:1.

7.4.3 SWR CALIBRATE

Set the digital panel meter to read SWR.

With the FM10X operating at normal power output, ground pin 3 of U411 on the ALC/METER circuit board. This simulates zero reflected power - the condition that exists when the VSWR is 1:1.

With the pin grounded, adjust the SWR CAL trim pot for a reading of "1.01."

7.4.4 PA CURRENT LIMIT

Since it may not be practical to increase the PA current for purposes of setting the PA CURRENT LIMIT control, an indirect method will be suggested.

Looking at the DC voltage at pin 6 of U4 on the ALC/METER circuit board, adjust the PA CURRENT LIMIT control for a voltage equal to 0.1 x Current Threshold, in amps. If, for example, the limit is to be 15 amps., set the voltage to 1.5 volts.

7.5 DISPLAY- Modulation calibrate

CAUTION: Disconnect power before removing the front panel. The POWER switch connects to the AC power line, so use care when making the following adjustment.

The MODULATION CALIBRATE trim pot sets the sensitivity of the front panel MODULATION bar-graph display. The control is accessible with the front panel removed (8 flat-head screws).

This adjustment may be made only if the COMPOSITE LEVEL has been properly set. See 7.2.5.

1. Set STEREO-MONO switch to MONO.

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

4. Set the MODULATION CALIBRATE trim pot so that the "90" light on the front panel MODULATION display just starts to light.

7.6 TEN-WATT RF AMPLIFIER

Tuning of the RF output network of the FM10X is done with two ceramic trimmer capacitors located on the 10-watt RF amplifier printed circuit board. The board is accessed by removing the bottom cover of the FM10X.

7.6.1 BIAS SET

The BIAS SET pot is found only on early units. If present, it should be set full counter clockwise.

7.6.2 Output Network tuning

The RF output network for the ten-watt amplifier is set at the factory to provides 10 watts output into a 50-ohm resistive load over the frequency range of 88 to 108 MHz. This setting was achieved by tuning C806 and C808 for maximum RF output at 104.1 MHz. This is a compromise setting that, in most cases, will allow for changes in operating frequency without the necessity of retuning the output network.

In most cases, however, the efficiency of the RF amplifier can be improved--less heating of the RF output transistor--by retuning C806 and C808 to optimize the amplifier for a particular operating frequency or to accommodate an RF load mismatch. (Mismatches that show an SWR of 1.5:1 or more should be corrected by repairing or tuning the antenna.)

Retuning of the amplifier may also be called for when the RF power output is low or when the EXCITER DC AMPS reads more than 1.2 amps (for 10 watts).

1. Turn the POWER SET trimpot on the meter board full clockwise.

2. While observing the RF output power with an RF wattmeter or on the FM10X digital multimeter, alternately tune C806 and C808 until maximum RF output power is obtained.

3. Note the EXCITER DC AMPS reading.

4. Turn C806 by a small amount in the direction that causes a <u>decrease</u> in EXCITER DC AMPS. Turn far enough to cause a drop of a few percent in RF output power. (If turned in the wrong direction, the EXCITER DC AMPS will increase.)

5. Set the POWER SET control for 10 watts output.

   (Power output can be increased at 108 MHz, if necessary, by spreading the turns of L803.)

8.0 - PERFORMANCE VERIFICATION

8.0 PERFORMANCE VERIFICATION

Measurement of the following parameters will provide a comprehensive characterization of the performance of the FM10X:

1. Carrier frequency.
2. RF output power.
3. RF bandwidth and RF harmonics. See 8.3 below.
4. Pilot Frequency.
5. Audio frequency response.
6. Audio distortion.
7. Modulation percentage.
8. FM and AM noise.
9. Stereo separation between left and right.
10. Crosstalk between main channel and subcarrier.
11. 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 8.12.

8.0.1 Audio proof-of-performance measurements.

References to "100 percent" modulation assumes nine percent pilot and 91 percent for the rest of the composite stereo signal.

Because the audio processing threshold is at 90 percent modulation, it is not possible to make audio proof-of-performance measurements at 100 percent modulation through the audio processor. Instead, audio data for 100 percent modulation is taken from the input of the stereo generator, and then data including the audio processor is taken at a level below the audio processing threshold.

The 100-percent-modulation data for response, distortion, stereo separation, crosstalk, and noise is taken with left and right audio fed into the ten-pin connector that plugs into J2 on the audio processor circuit board.

A second set of data is taken at 80 percent modulation with the audio source feeding the normal left and right audio inputs of the FM10X.

8.0.2 De-emphasis input network.

A precision de-emphasis network connected between the oscillator and the audio input of the FM10X can be very helpful when making the audio measurements. Care must be taken that the network accuracy is not affected by the input impedance of the FM10X or by the source impedance of the test oscillator.

With the de-emphasis network, oscillator level adjustments need only accommodate gain errors, instead of the whole pre-emphasis curve.

8.1 CARRIER FREQUENCY

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

For adjusting frequency, see 7.3.3 (FCC tolerance +/- 2000 Hz. FCC Part 73.1540 and 73.1545.)

8.2 OUTPUT POWER

The RF power reading on the digital multimeter should be verified with a wattmeter in the RF output line. Output power should be in the range of 90% to 105% of rating.

See 7.4.1 and 7.4.2 for power setting.

8.3 RF BANDWIDTH and RF HARMONICS

RF bandwidth and spurious emissions are observed with an RF spectrum analyzer.

In the STEREO mode, feed 15.0 kHz audio into one channel to provide 85% modulation as indicated on a monitor. This will produce 38% main, 38% stereo subcarrier, and 9% pilot per FCC Part 2.989. An alternative is to use pink noise into one channel.

Using a spectrum analyzer, verify that all of the following are true: (FCC 73.317)

1. Emissions that are more than 600 kHz from the carrier are at least $43 + \log_{10}$ (power in watts) dB down. That would be 53 dB for 10 watts; 63 dB for 100 watts. The scan should include to the tenth harmonic.

2. Emissions that are between 240 kHz and 600 kHz from the carrier are down at least 35 dB.

3. Emissions that are between 120 kHz and 240 kHz from the carrier are down at least 25 dB.

8.4 PILOT FREQUENCY

The pilot frequency is to be within 2 Hz of 19,000 Hz. (FCC Part 73.322.) Using a frequency counter, measure 1.9 MHz at pin 1 of U209 on the 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, the value of C213 may be changed. (Changing C213 from 56PF to 68PF lowered the 1.9 MHz by about 35 Hz.)

8.5 AUDIO FREQUENCY RESPONSE

For the response tests, readings are taken from an FM modulation monitor.

Audio frequency response measurements for left and right channels are made at frequencies of 50, 100, 400, 1k, 5k, 10k, and 15k Hertz.

See 8.0.1 and 8.0.2.

8.6 AUDIO DISTORTION

Distortion measurements are made from the de-emphasized output of an FM modulation monitor.

Audio distortion measurements are made for left and right channels at frequencies of 50, 100, 400, 1k, 5k, 10k, and 15k Hertz.

See 8.0.1 and 8.0.2.

8.7 MODULATION PERCENTAGE

While feeding an audio signal into the left channel only, it should be confirmed that the total modulation percentage remains constant when switching between MONO and STEREO.

Modulation percentage is measured with an FM modulation monitor, or by using an HF receiver and Bessel nulls. See 7.2.5., 7.3.2., and 7.5.

19 kHz pilot modulation should be 9 percent.

8.8 FM and AM NOISE

Noise readings are taken from a de-emphasized output of a modulation monitor.

8.9 STEREO SEPARATION

Left-into-right and right-into-left stereo separation measurements are made with an FM modulation monitor for frequencies of 50, 100, 400, 1k, 5k, 10k, and 15k Hertz.

8.10 CROSS TALK

For the 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. The balance is made at 400 Hz.

8.10.1 MAIN-CHANNEL INTO SUB

Left and right channels are fed in phase with audio (L+R) at 50, 100, 400, 1k, 5k, 10k, and 15k Hertz at 100 percent modulation, while the stereo subcarrier (L-R) level is observed on an FM modulation monitor.

8.10.2 SUB-CHANNEL INTO MAIN

Audio is fed into the left and right channel as above, except the polarity of the audio of one channel must be reversed ("L-R" input). Using the frequencies of 8.10.1 above, observe the main channel (L+R) level with a modulation monitor.

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.

8.12 ADDITIONAL PERFORMANCE CHECKS

In addition to what has been covered, a complete check of the unit will include the following:

1. Perform physical inspection. Look for damage. Check that chassis hardware is secure. Check that circuit boards are secure.

2. Check functionality of switches and processing control.

3. Observe that all indicators function.

4. Check frequency synthesizer lock at 72 MHz and 110 MHz.

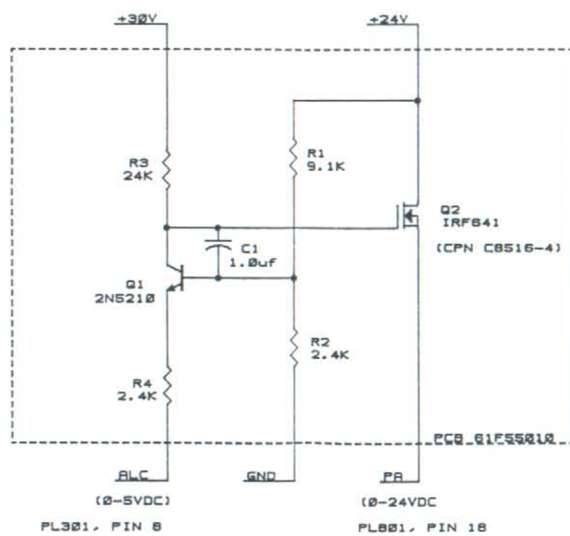
5. Measure AC line current with and without carrier on.

6. Perform functional test of SCA input, MONITOR outputs, and DB15 connector.

7. Check all metering functions.

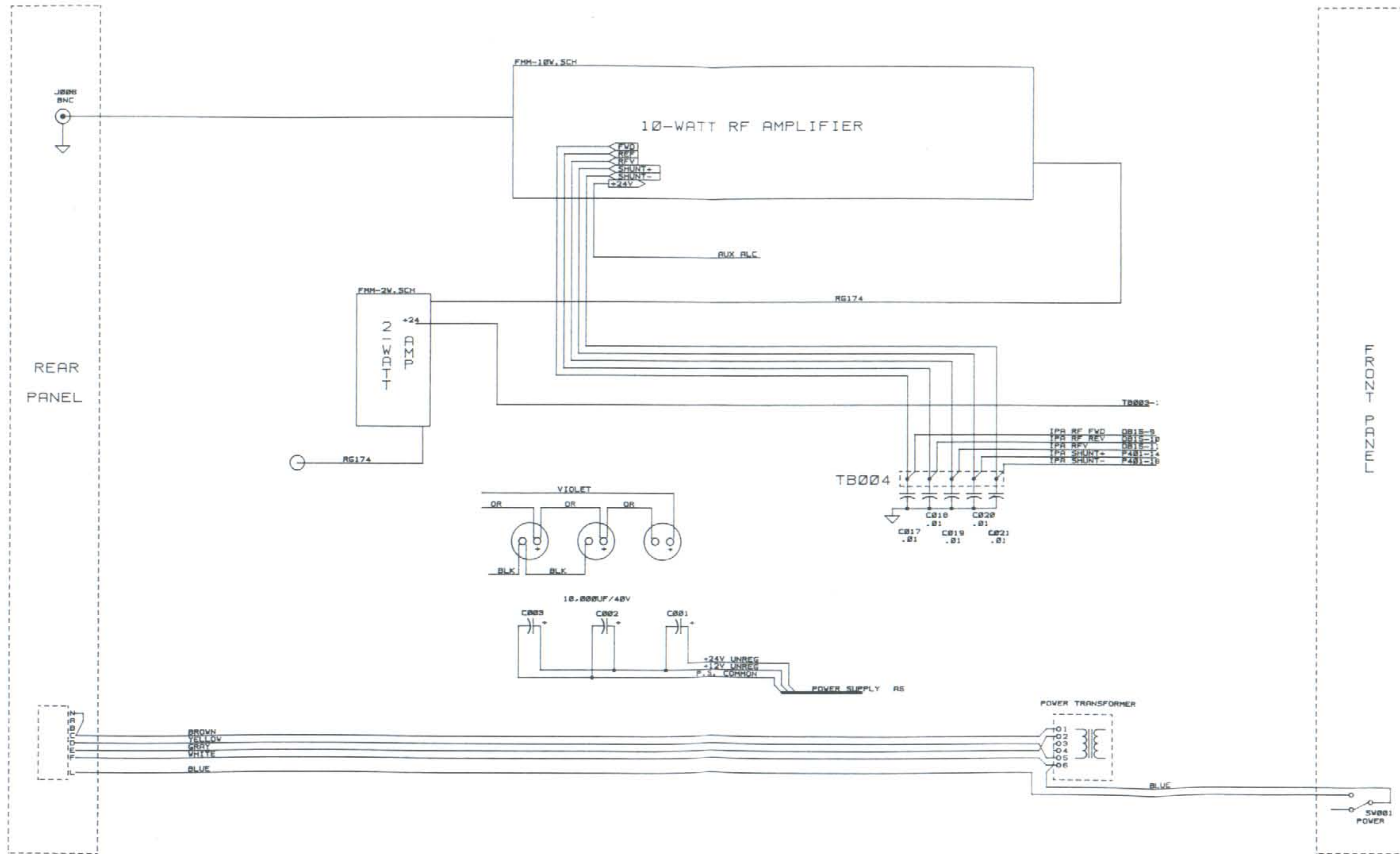
8. Test ALC action with PA current overload, SWR, and PLL lock.

(NOTE: The FCC type acceptance procedures call for testing of the carrier frequency over the temperature range of 0 degrees to 50 degrees centigrade, and at line voltages from 85% to 115%of rating. See FCC Part 2.995.)



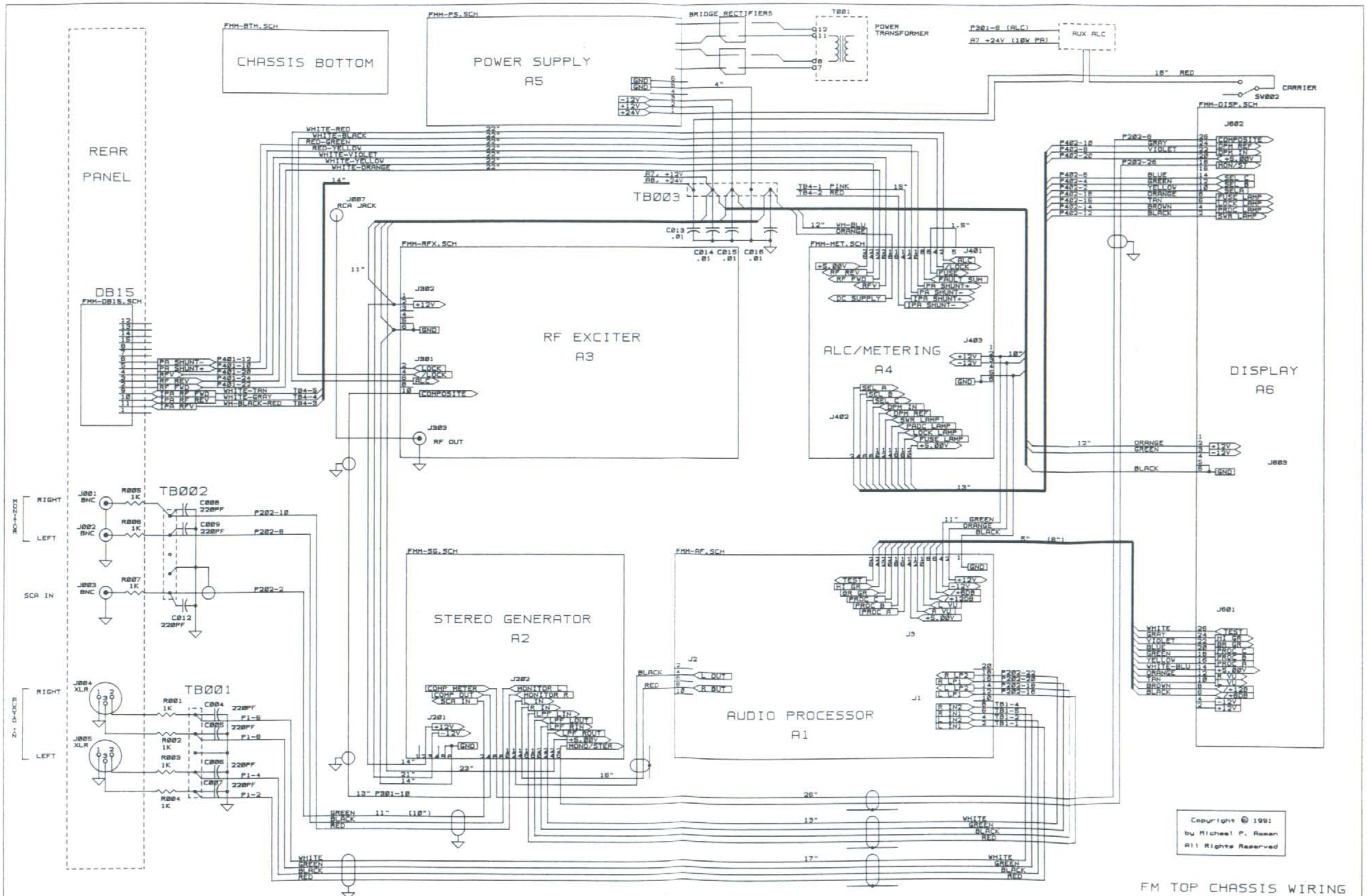
Auxillary ALC control board.

21 AUG 92



FM BOTTOM CHASSIS WIRING

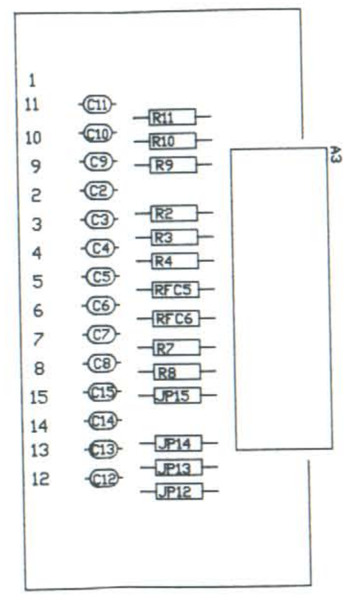
18 SEP 91



FM TOP CHASSIS WIRING

9.10

21 AUG 92



1
11
10
9
2
3
4
5
6
7
8
15
14
13
12
C11
C10
C9
C2
C3
C4
C5
C6
C7
C8
C15
C14
C13
C12
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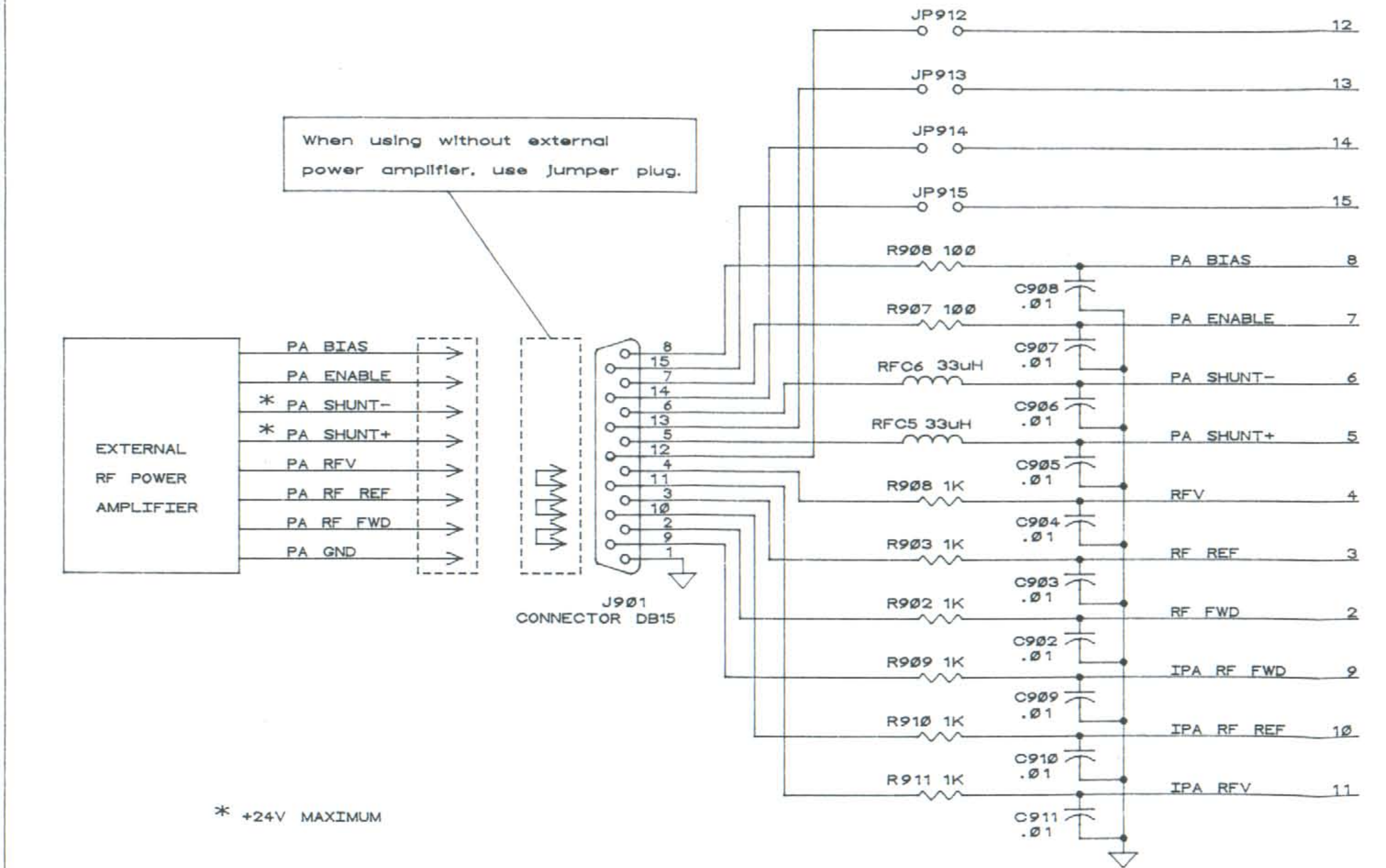
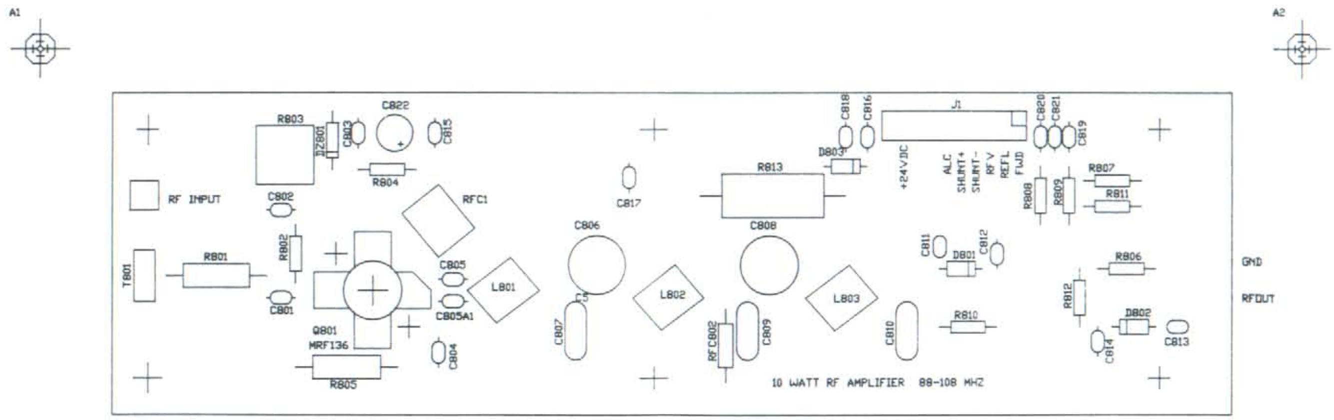
JP12
A3



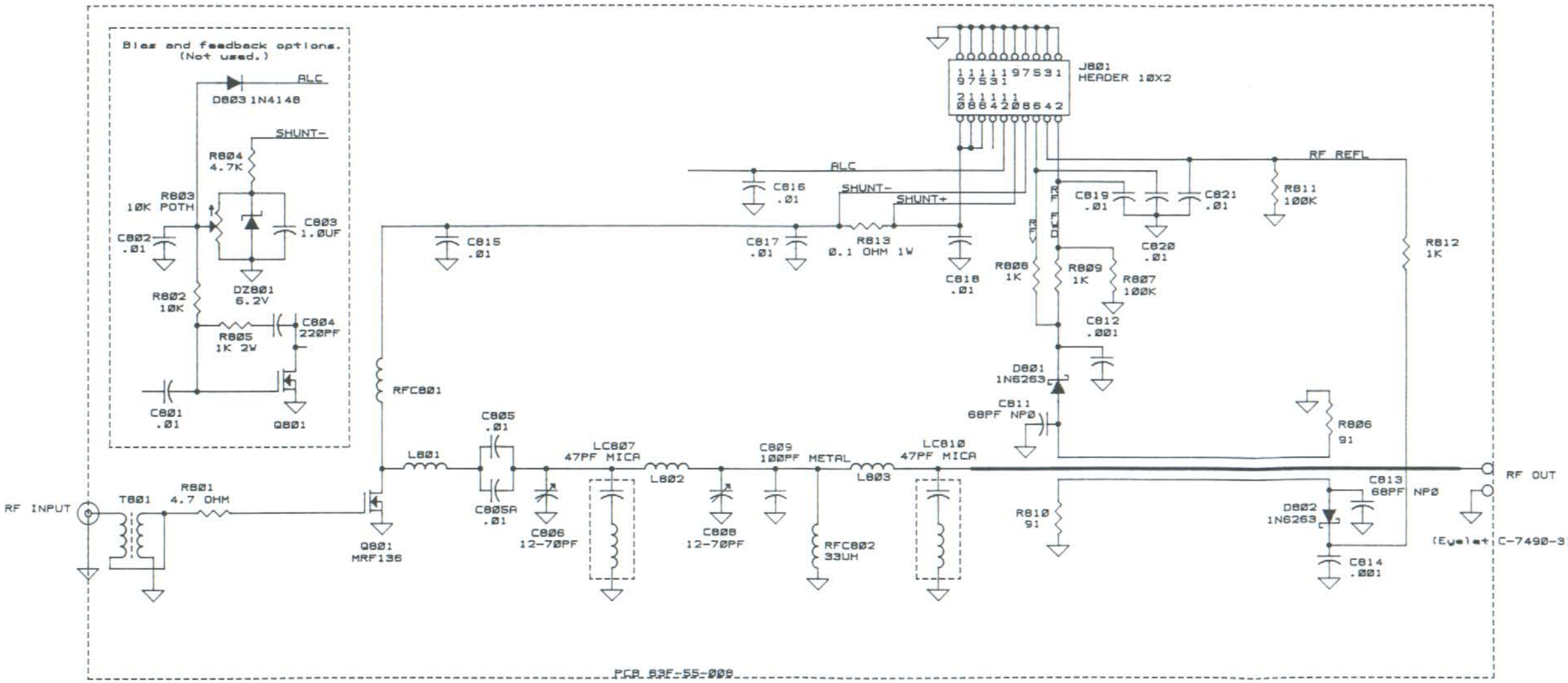
DB15 INPUT FILTER

16 SEP 91



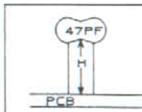
FM 10-WATT RF AMP.	CPN P10321-1
DEPT 270	DFOIL A 2800A8
PROJECT T111	CGROUNDPLANE A 2801A6
PLOT SCALE 2:1	COMPID
	CSLDRMASK
HCJB22-008	DSLDRMASK
MPA 3 JULY 91	BTMCOMPID

FM008X1 Top Overlay



T801: 1.5" Twisted-pair #24 wire wrap.
2 passes through Amidon T37-6 core.

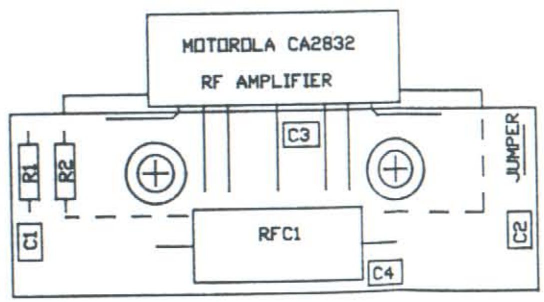
	RFC801	L801	L802	L803
Turns	5	5	4	5
Turns per inch	10	10	8	10
Wound on 3/16" Dia. with #16 Enameled wire.				



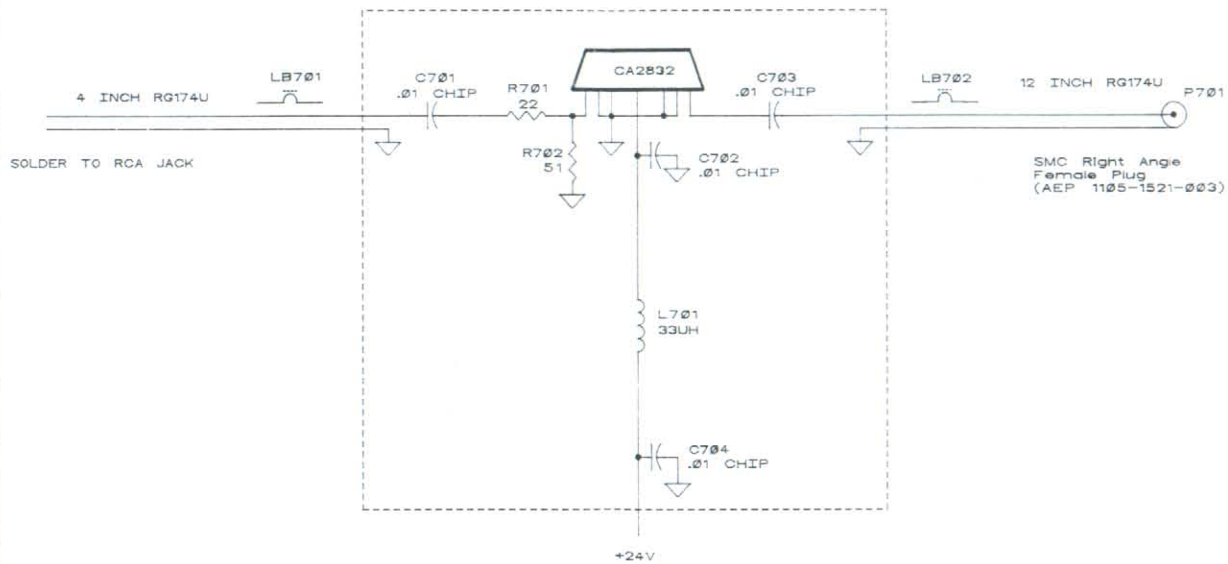
LC807, H = 0.3"
LC810, H = 0.4"

10-WATT RF AMPLIFIER

6 Feb 92

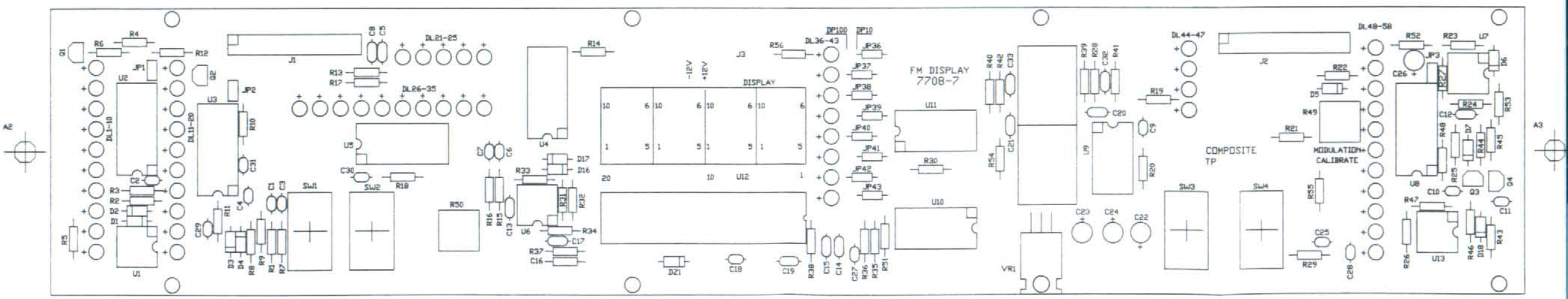


C1 - C4	.01 CHIP
R1	22 OHM .25W
R2	51 OHM .25 W
RFC1	33UH
U1	MOTOROLA CA2832

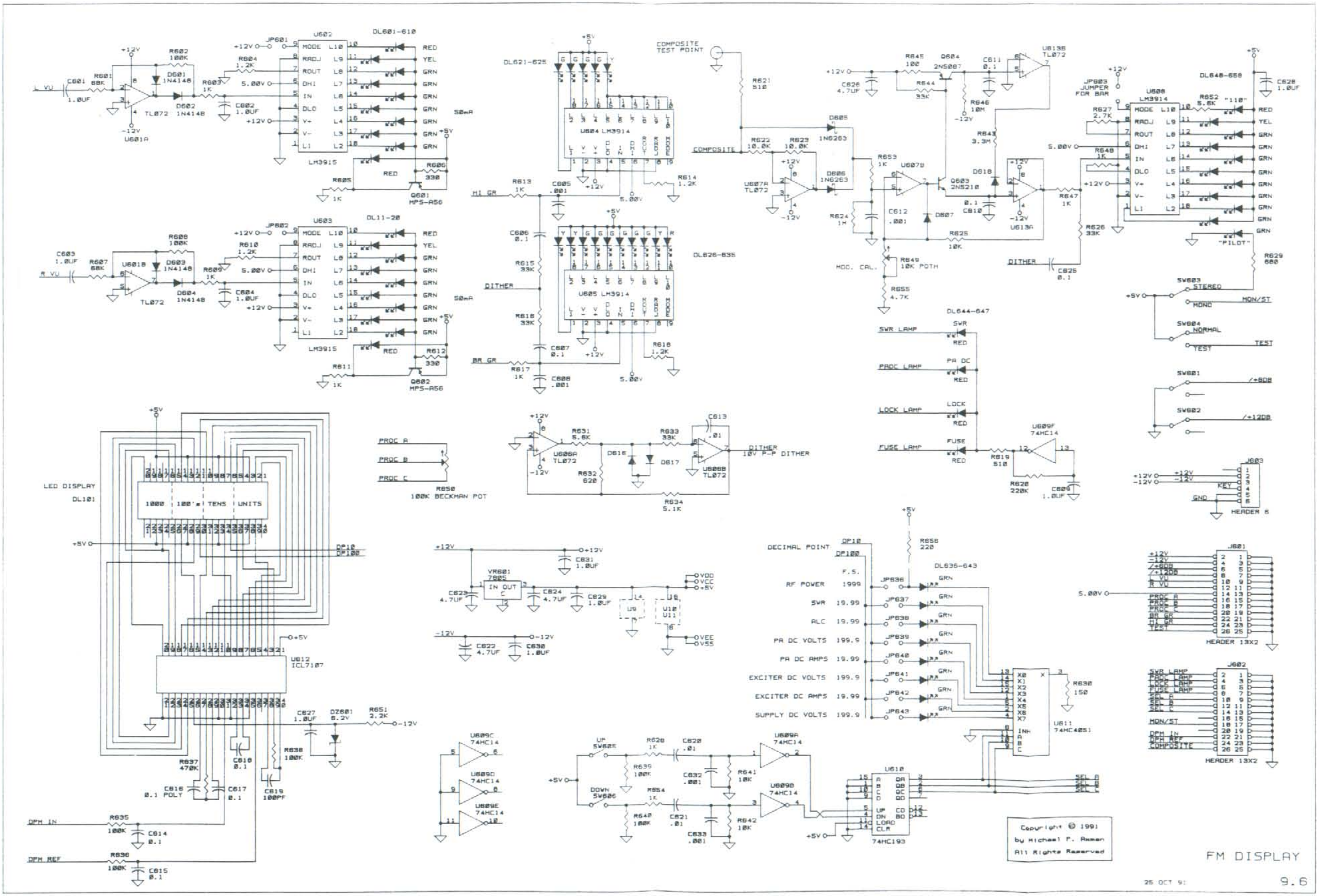


2-WATT RF AMPLIFIER

 16 SEP 91


FM DISPLAY
7708-7
COMPOSITE
TP
MODULATION
CALIBRATE
DISPLAY
-12V
+12V
A2
A3

A 2825-7



U602
LM3915
DL601-610
U603
DL11-20
U601A
U601B
TL072
1N4148
L VU
R VU
50mA
MPS-A56
DL621-625
U604 LM3914
DL626-635
U605 LM3914
HI GR
BR GR
DITHER
COMPOSITE TEST POINT
COMPOSITE
U607A
TL072
1N6263
2N5087
2N5210
U613B
TL072
U613A
MOD. CAL.
R649 10K POTH
JP603 JUMPER FOR BAR
U608
LM3914
DL648-658
"110"
"PILOT"
RED
YEL
GRN
STEREO
MONO
MON/ST
NORMAL
TEST
SW603
SW604
SW601
SW602
/+60B
/+120B
DL644-647
SWR LAMP
PROC LAMP
LOCK LAMP
FUSE LAMP
U609F
74HC14
J603
HEADER 6
KEY
GND
LED DISPLAY
DL101
1000
100's
TENS
UNITS
U612
ICL7107
DPM IN
DPM REF
PROC A
PROC B
PROC C
R650
100K BECKMAN POT
U606A
TL072
U606B
TL072
DITHER
10V P-P DITHER
VR601
7805
IN OUT
VDD
VCC
VEE
VSS
U609C
74HC14
U609D
74HC14
U609E
74HC14
UP
SW605
DOWN
SW606
U609A
74HC14
U609B
74HC14
U610
74HC193
SEL A
SEL B
SEL C
DECIMAL POINT
DP10
DP100
F.S.
RF POWER 1999
SWR 19.99
ALC 19.99
PA DC VOLTS 199.9
PA DC AMPS 19.99
EXCITER DC VOLTS 199.9
EXCITER DC AMPS 19.99
SUPPLY DC VOLTS 199.9
DL636-643
U611
74HC4051
J601
HEADER 13X2
J602
HEADER 13X2
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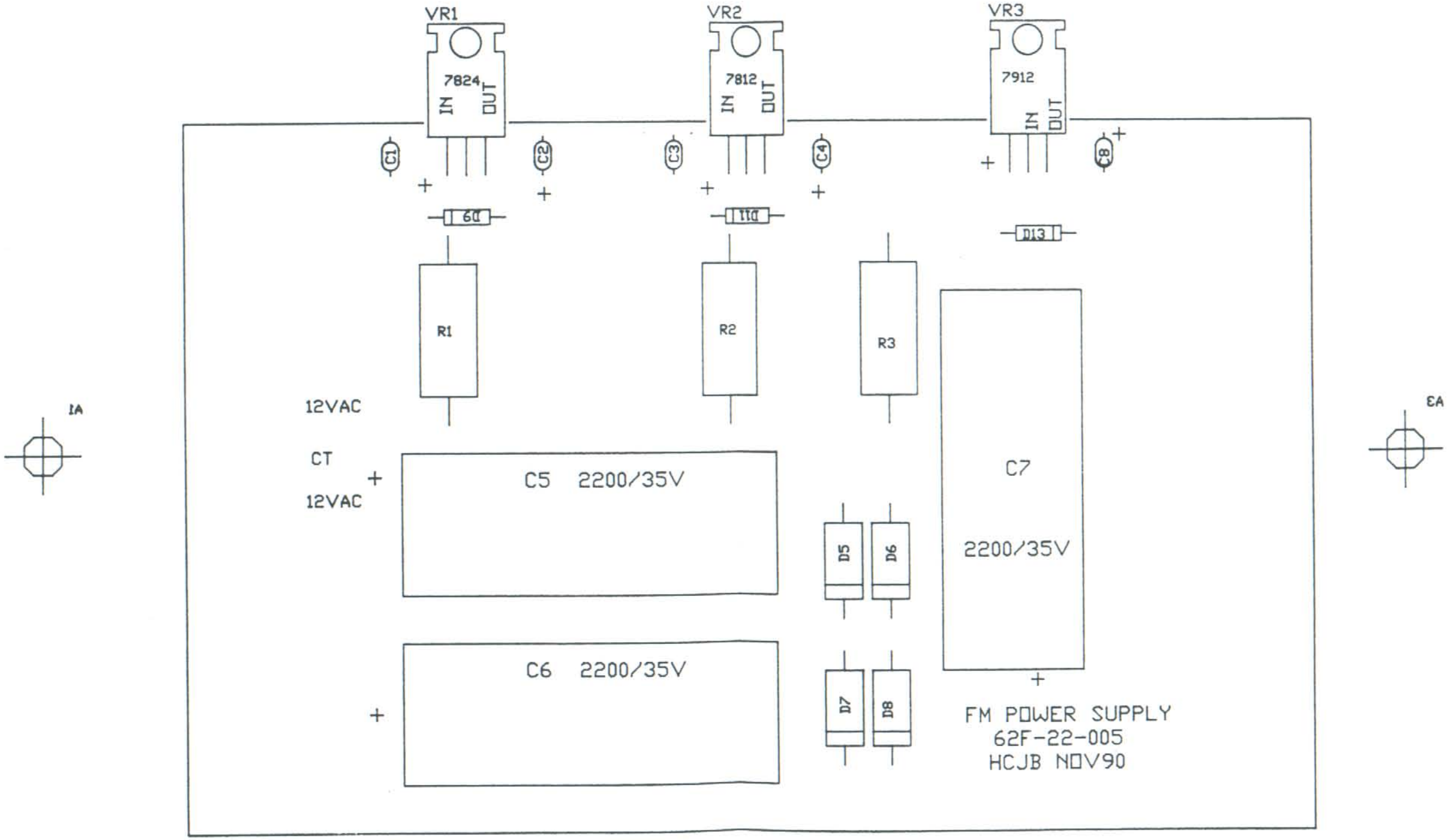
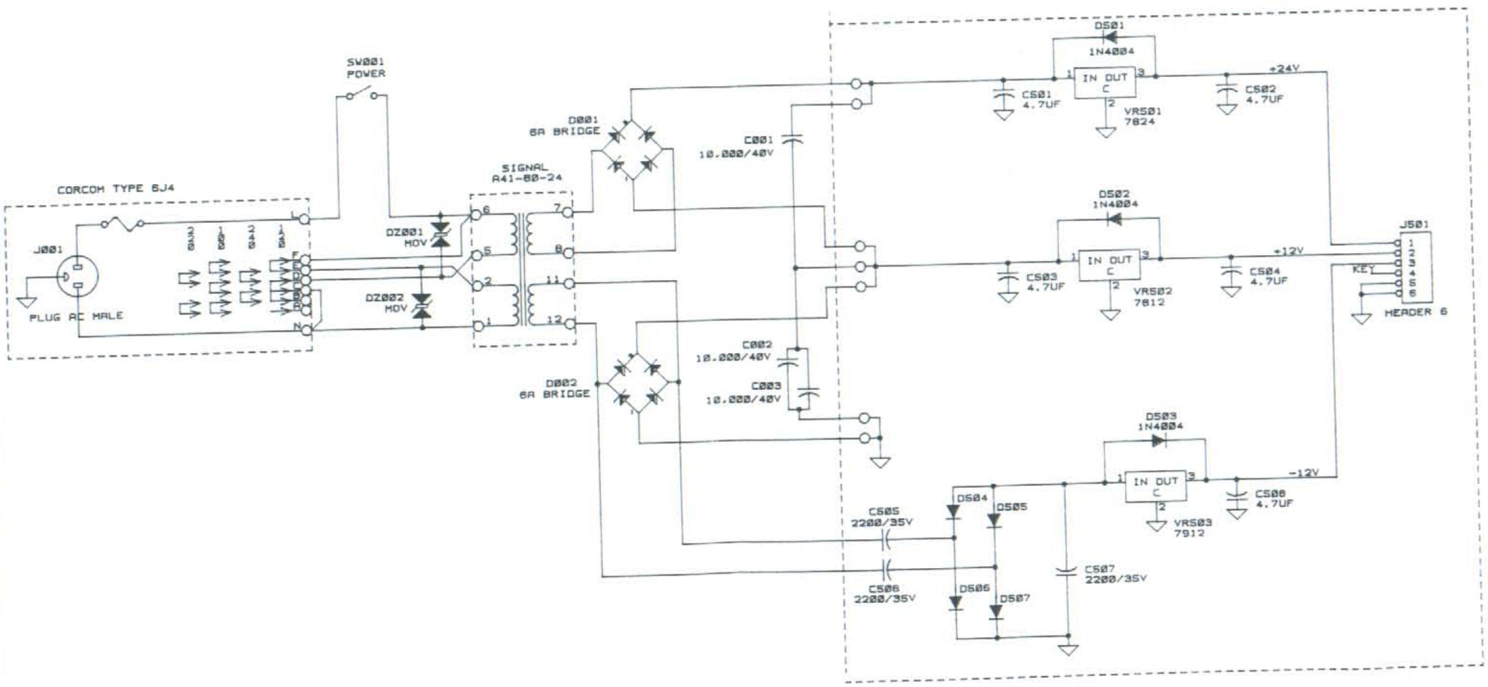
All Rights Reserved
FM DISPLAY
25 OCT 91
9.6

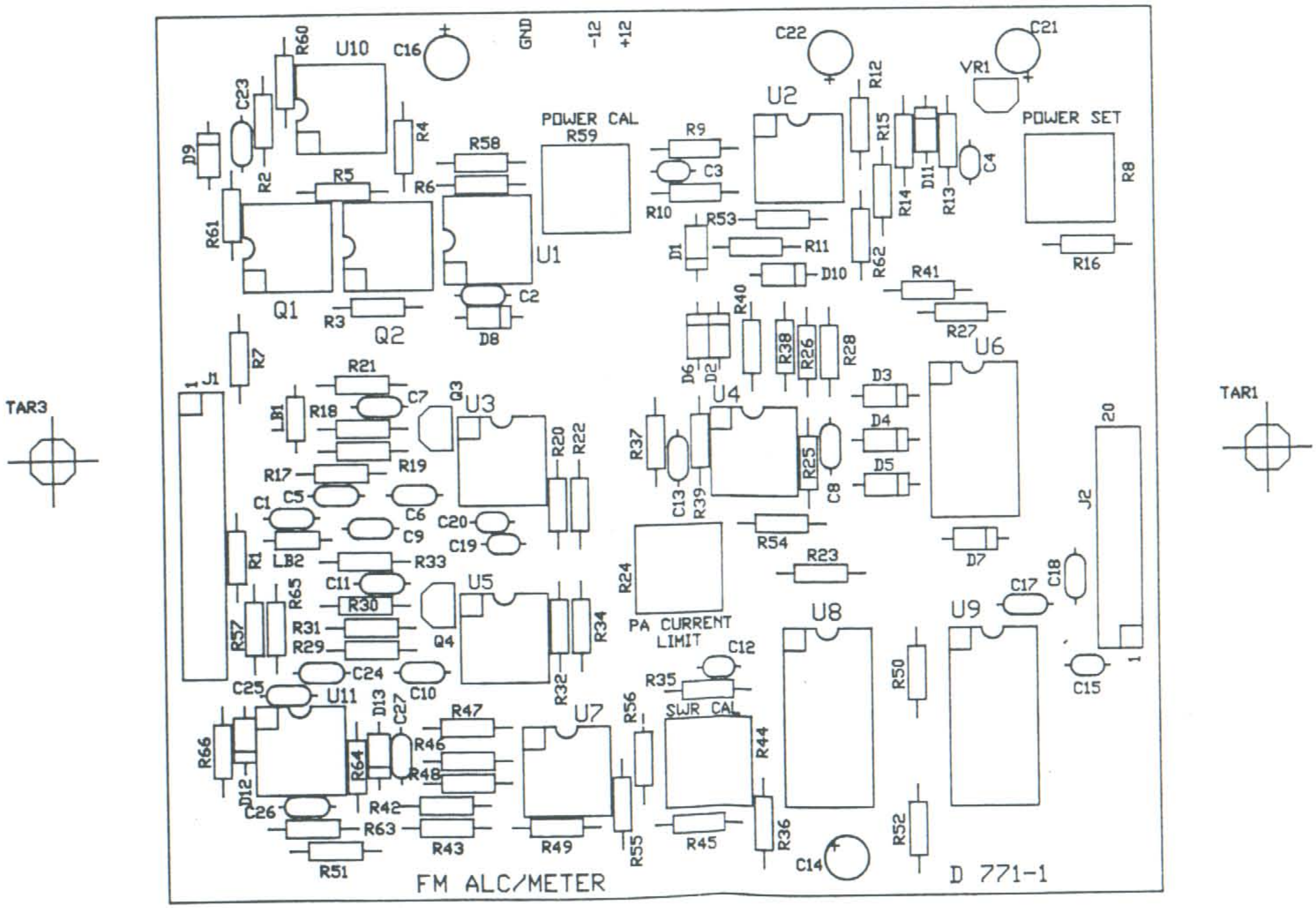

VR1
7824
IN
OUT
VR2
7812
IN
OUT
VR3
7912
IN
OUT
C1
C2
C3
C4
C8
D9
D11
D13
R1
R2
R3
12VAC
CT
12VAC
C5 2200/35V
C6 2200/35V
C7
2200/35V
D5
D6
D7
D8
FM POWER SUPPLY
62F-22-005
HCJB NOV90



FM POWER SUPPLY

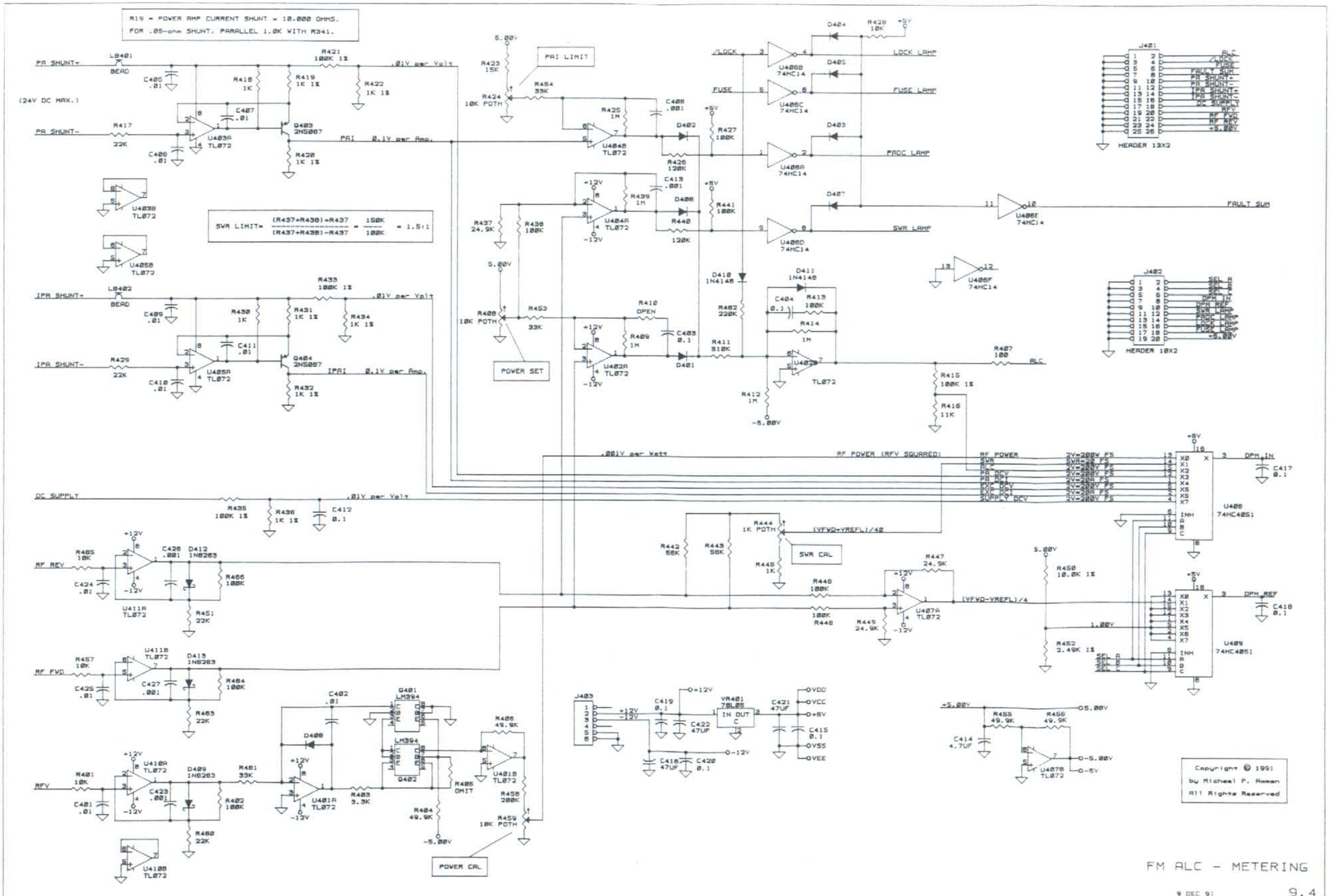
9.5

21 AUG 92



FM ALC/METER
D 771-1
POWER CAL
R59
POWER SET
PA CURRENT
LIMIT
SWR CAL
GND
-12
+12
TAR1
TAR3
U1
U2
U3
U4
U5
U6
U7
U8
U9
U10
U11
Q1
Q2
Q3
Q4
J1
J2
VR1

A 2811-7


R19 = POWER AMP CURRENT SHUNT = 10.000 OHMS.
FOR .05-ohm SHUNT, PARALLEL 1.0K WITH R341.
PA SHUNT+
PA SHUNT-
(24V DC MAX.)
PAI 0.1V per Amp.
.01V per Volt
IPA SHUNT+
IPA SHUNT-
IPAI 0.1V per Amp.
PAI LIMIT
POWER SET
SWR LIMIT= (R437+R438)+R437 / (R437+R438)-R437 = 150K / 100K = 1.5:1
/LOCK
FUSE
LOCK LAMP
FUSE LAMP
PADC LAMP
SWR LAMP
FAULT SUM
ALC
HEADER 13X2
HEADER 10X2
DC SUPPLY
.001V per Watt
RF POWER (RFV SQUARED)
RF REV
RF FWD
RFV
SWR CAL
(VFWD+VREFL)/40
(VFWD-VREFL)/4
DPM IN
DPM REF
POWER CAL
U408 74HC4051
U409 74HC4051
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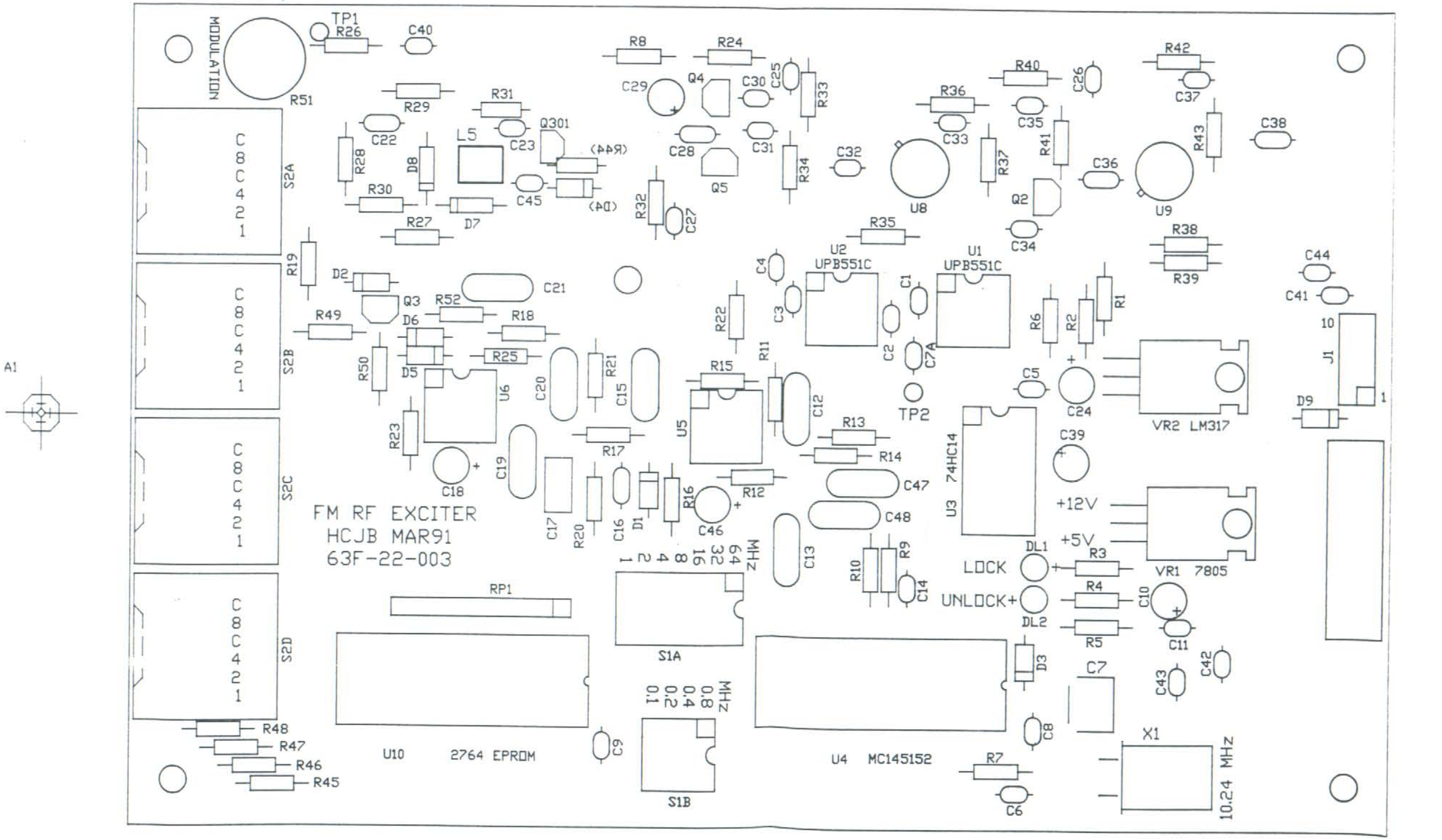
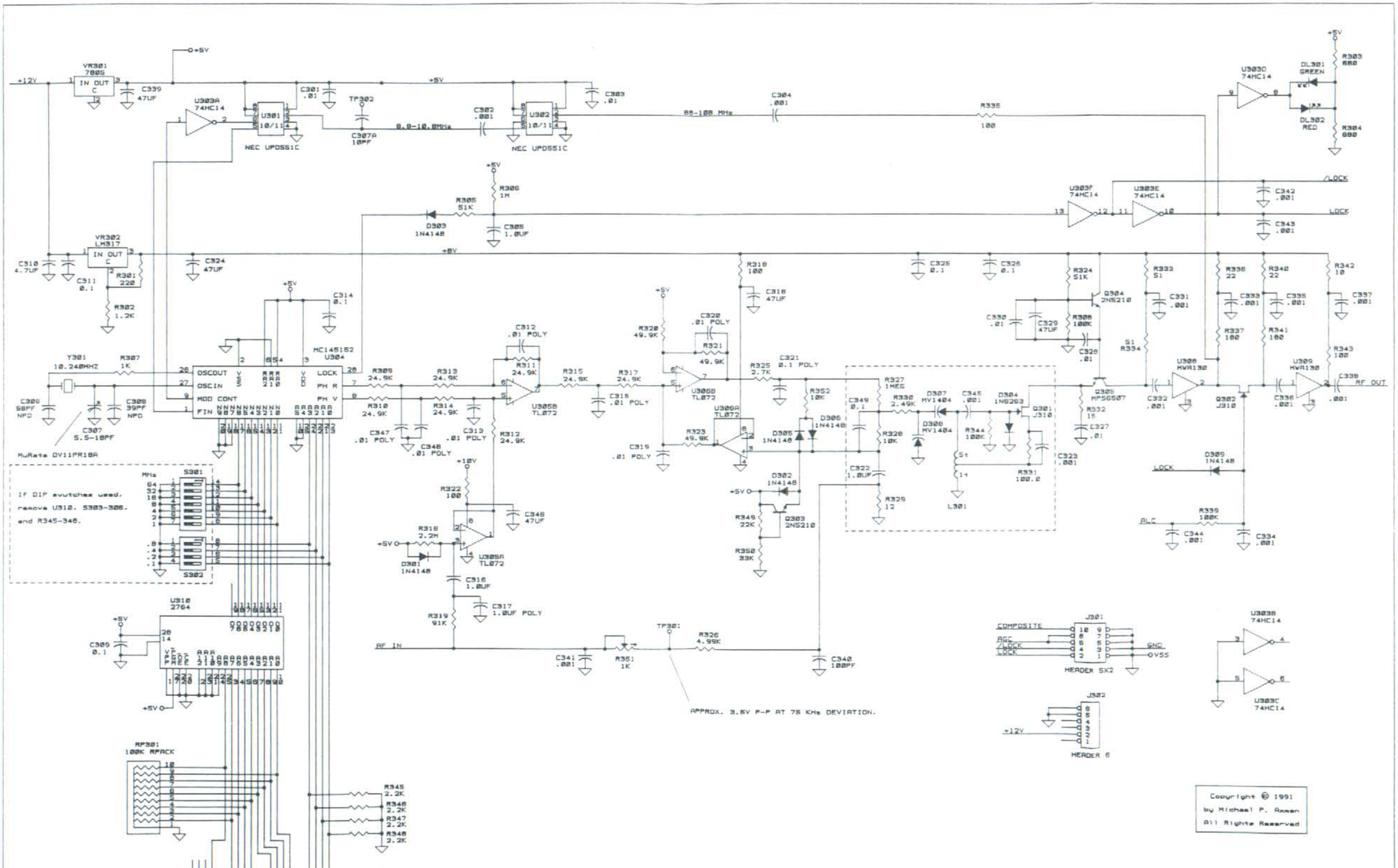
FM ALC - METERING
9 DEC 91
9.4

Modulation compensation.
See 7.3.2 for settings.



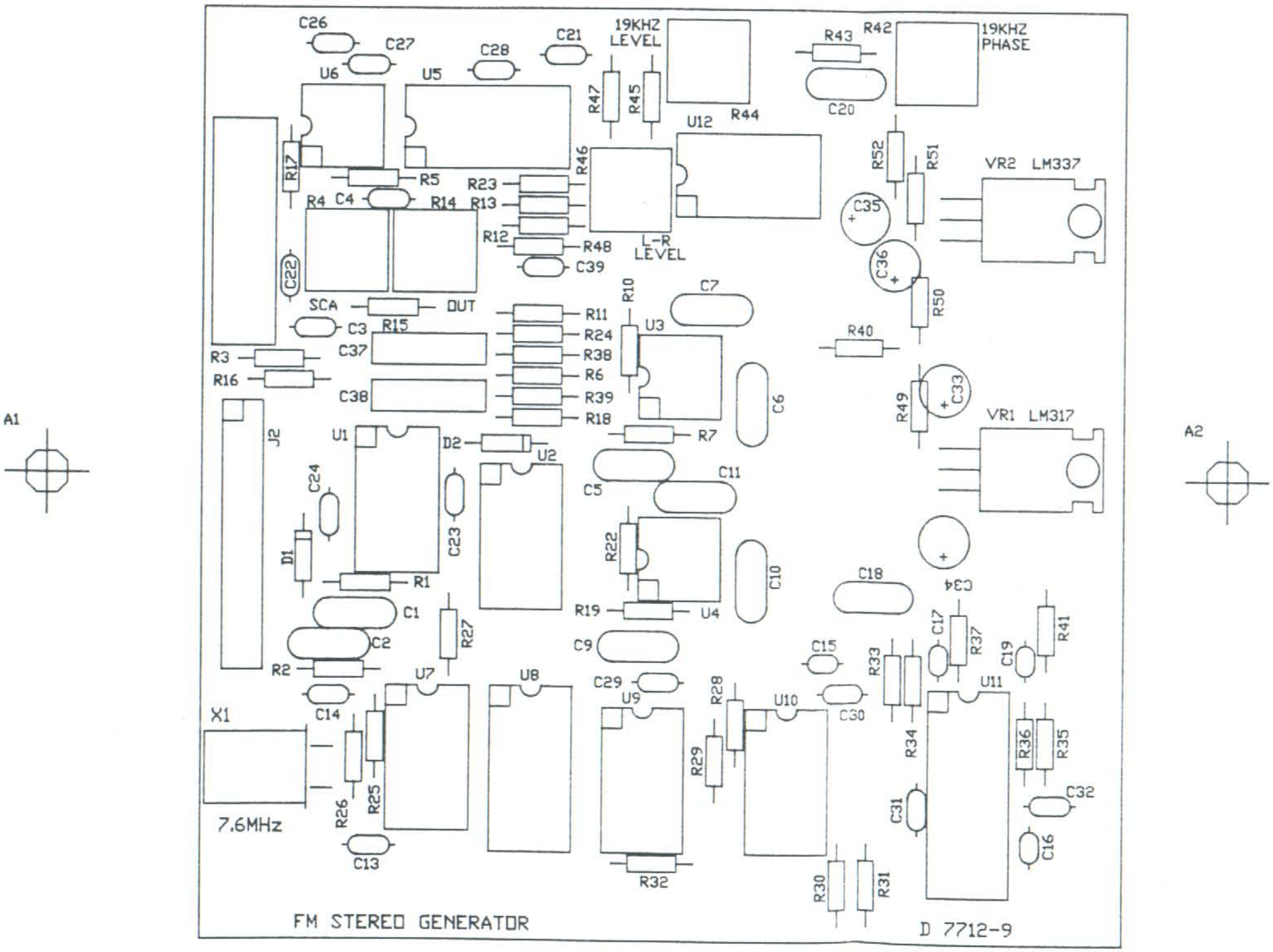


FM RF EXCITER

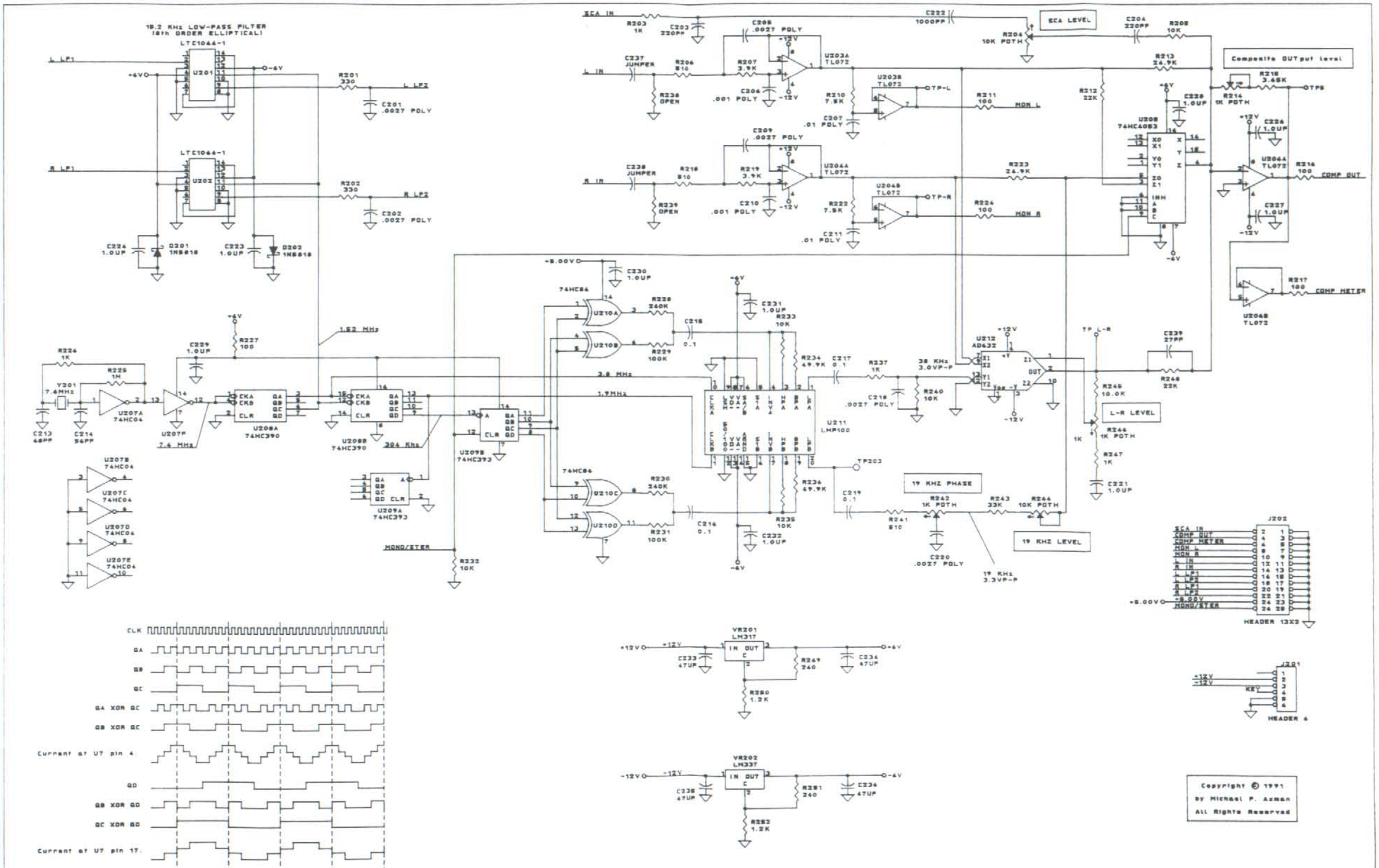
(FM FREQUENCY SYNTHESIZER)

9.3

21 AUG 92


19KHZ LEVEL
19KHZ PHASE
L-R LEVEL
VR2 LM337
VR1 LM317
SCA
OUT
X1
7.6MHz
A1
A2
FM STEREO GENERATOR
D 7712-9

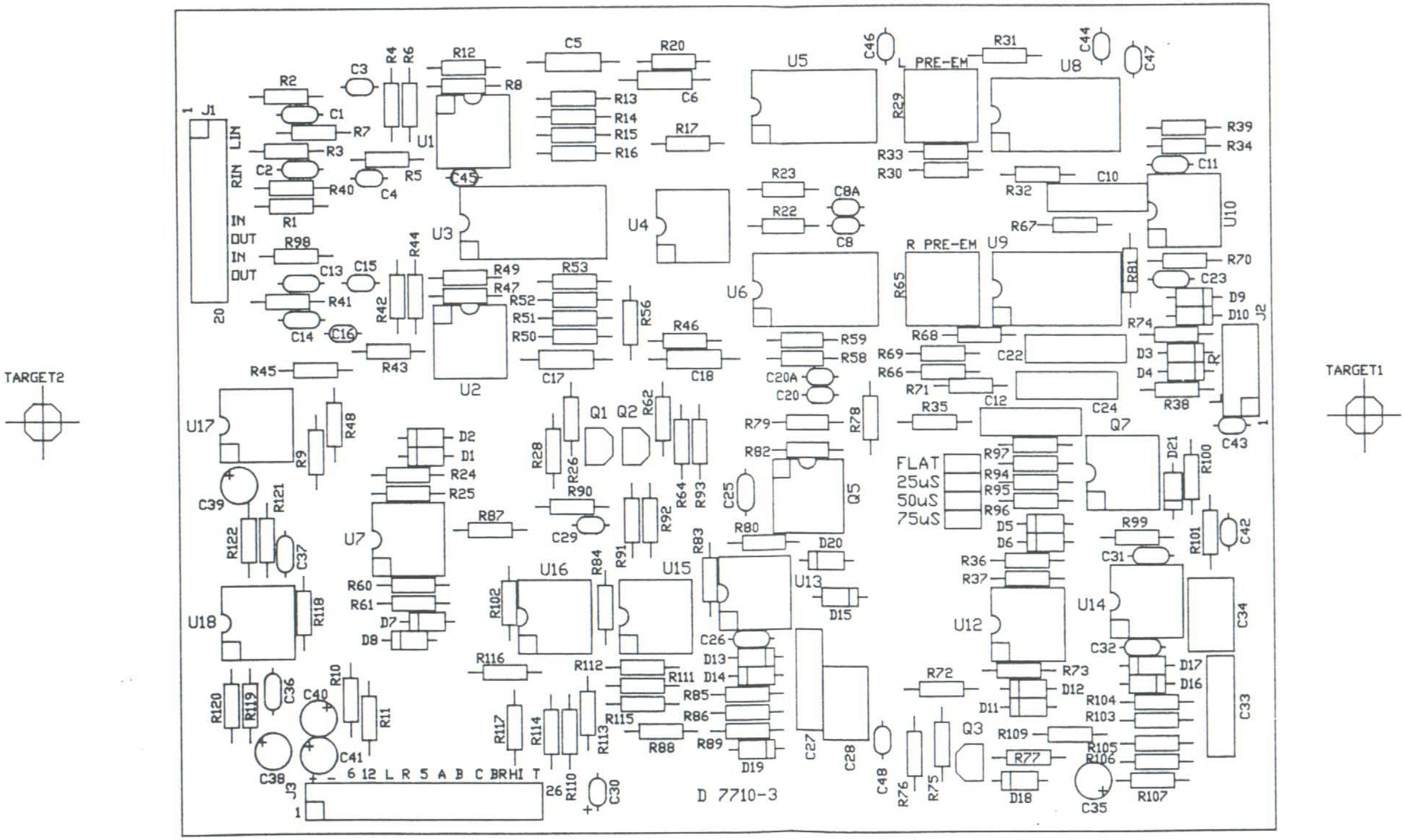
A 2806-7



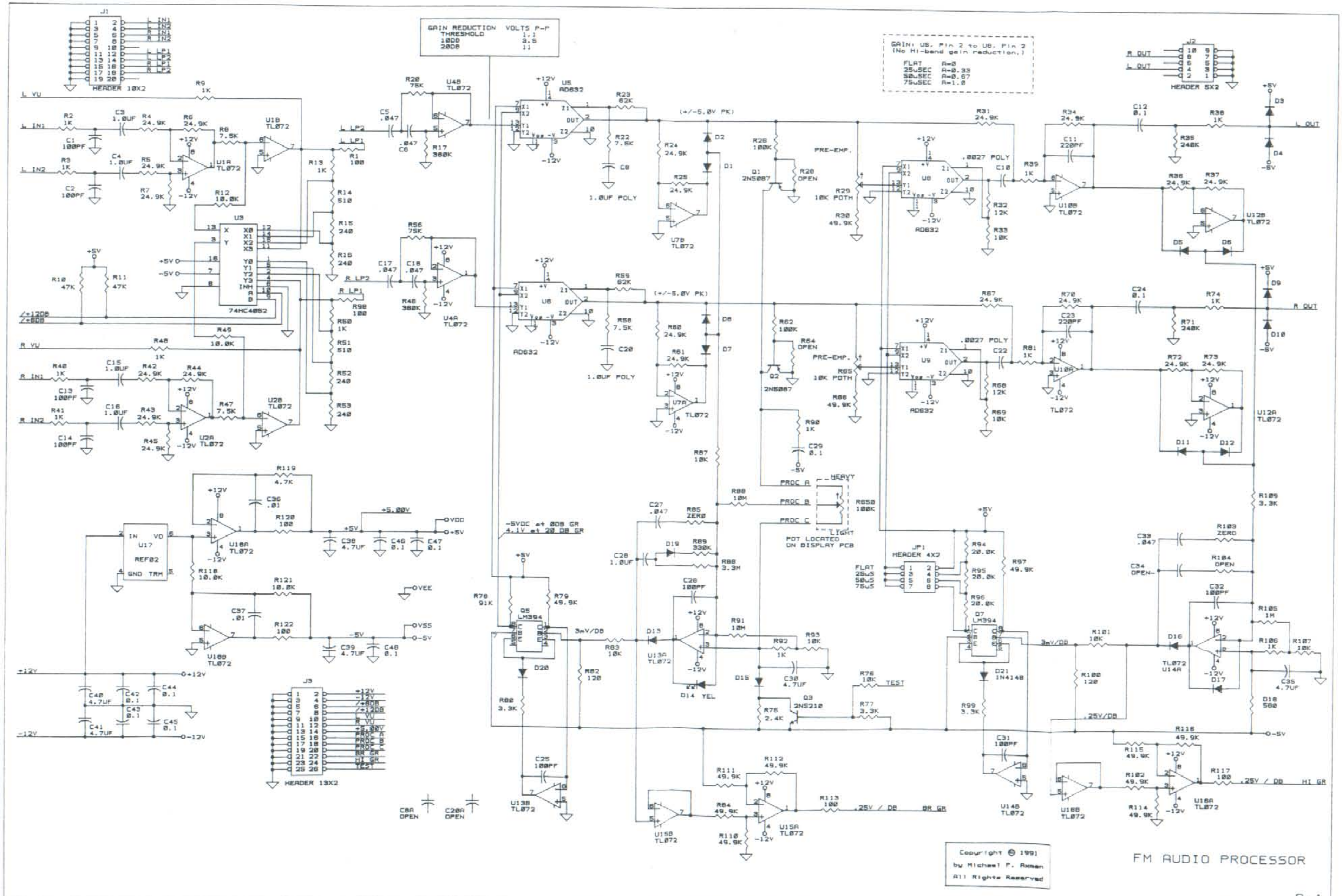
FM STEREO GENERATOR

21 NOV 91

9.2


TARGET2
TARGET1
J1
LIN
RIN
IN
OUT
IN
OUT
20
L PRE-EM
R PRE-EM
J2
FLAT
25uS
50uS
75uS
Q1
Q2
Q3
Q5
Q7
J3
+ - 6 12 L R 5 A B C BRHI T
26
D 7710-3

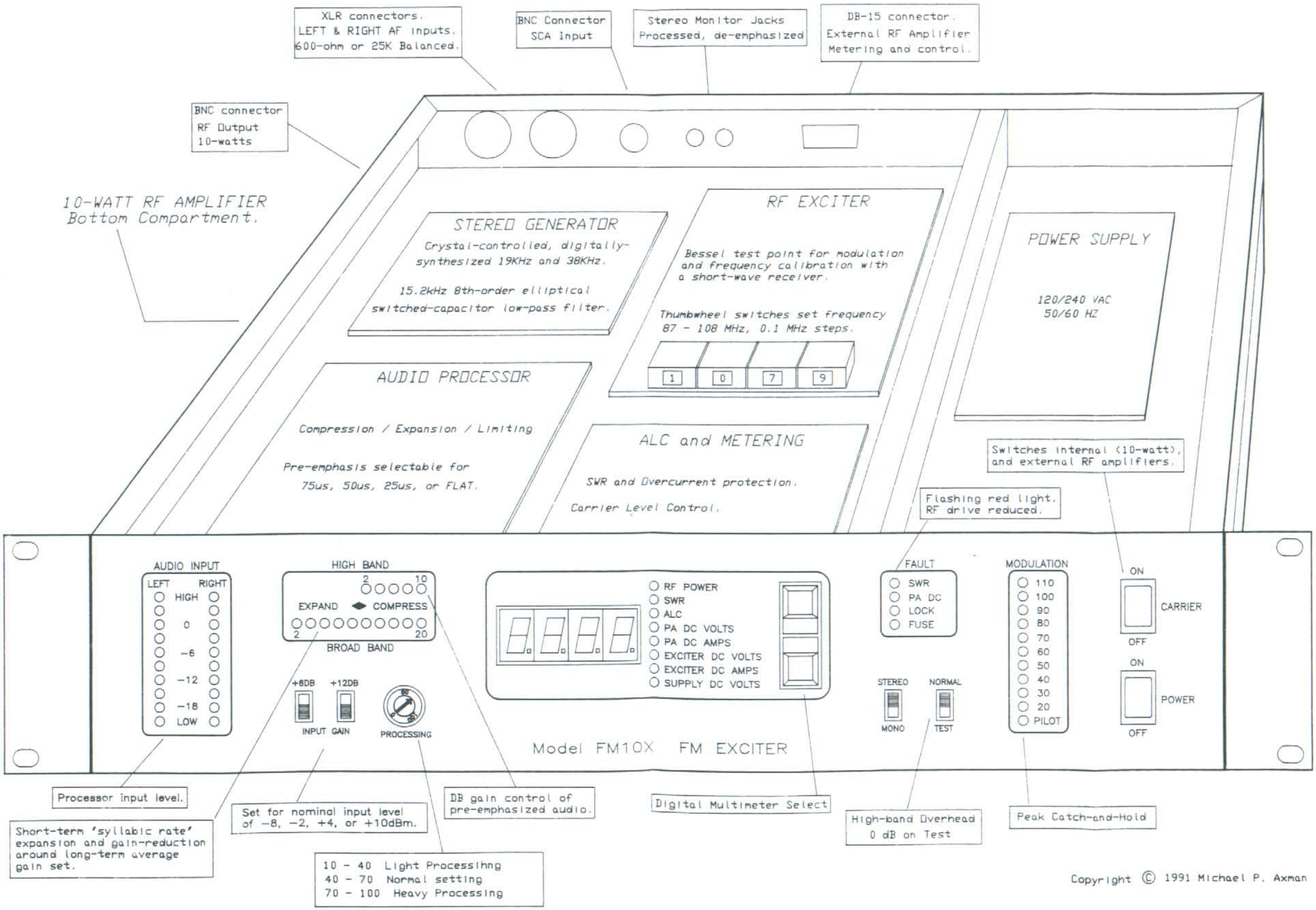
A 2816-6



GAIN REDUCTION VOLTS P-P
THRESHOLD 1.1
10DB 3.5
20DB 11
GAIN: U5, Pin 2 to U8, Pin 2
(No Hi-band gain reduction.)
FLAT A=0
25uSEC A=0.33
50uSEC A=0.67
75uSEC A=1.0
HEADER 10X2
HEADER 5X2
HEADER 13X2
HEADER 4X2
PRE-EMP.
POT LOCATED ON DISPLAY PCB
-5VDC at 0DB GR
4.1V at 20 DB GR
FM AUDIO PROCESSOR

21 AUG 92

9.1



XLR connectors.
LEFT & RIGHT AF inputs.
600-ohm or 25K Balanced.
BNC Connector
SCA Input
Stereo Monitor Jacks
Processed, de-emphasized
DB-15 connector.
External RF Amplifier
Metering and control.
BNC connector
RF Output
10-watts
10-WATT RF AMPLIFIER
Bottom Compartment.
STEREO GENERATOR
Crystal-controlled, digitally-synthesized 19KHz and 38KHz.
15.2kHz 8th-order elliptical switched-capacitor low-pass filter.
RF EXCITER
Bessel test point for modulation and frequency calibration with a short-wave receiver.
Thumbwheel switches set frequency 87 - 108 MHz, 0.1 MHz steps.
1 0 7 9
POWER SUPPLY
120/240 VAC
50/60 HZ
AUDIO PROCESSOR
Compression / Expansion / Limiting
Pre-emphasis selectable for 75us, 50us, 25us, or FLAT.
ALC and METERING
SWR and Overcurrent protection.
Carrier Level Control.
Switches internal (10-watt), and external RF amplifiers.
Flashing red light.
RF drive reduced.
AUDIO INPUT
LEFT RIGHT
HIGH 0 -6 -12 -18 LOW
HIGH BAND
2 10
EXPAND COMPRESS
2 20
BROAD BAND
+6DB +12DB
INPUT GAIN
PROCESSING
RF POWER
SWR
ALC
PA DC VOLTS
PA DC AMPS
EXCITER DC VOLTS
EXCITER DC AMPS
SUPPLY DC VOLTS
FAULT
SWR
PA DC
LOCK
FUSE
STEREO
MONO
NORMAL
TEST
MODULATION
110 100 90 80 70 60 50 40 30 20 PILOT
ON
CARRIER
OFF
ON
POWER
OFF
Model FM10X FM EXCITER
Processor input level.
Short-term 'syllabic rate' expansion and gain-reduction around long-term average gain set.
Set for nominal input level of -8, -2, +4, or +10dBm.
DB gain control of pre-emphasized audio.
10 - 40 Light Processihng
40 - 70 Normal setting
70 - 100 Heavy Processing
Digital Multimeter Select
High-band Overhead
0 dB on Test
Peak Catch-and-Hold