OPERATION AND MAINTENANCE MANUAL

SCR1000
VHF FM REPEATER

'Advanced Communications Electronics'

SPECTRUM COMMUNICATIONS

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SECTION 1 INTRODUCTION

We would like to take this opportunity to thank you for becoming one of the discerning individuals or organizations to see the Spectrum Communications' SCR1000 VHF FM Repeater. This instrument represents a state of the art achievement, and embodies thousands of hours of engineering time. Our company is dedicated to the development of very high quality products, manufactured in limited quantities, and we anticipate that they will always be in short supply. Only the finest quality components and workmanship are used throughout the SCR-1000. The components are carefully selected and derated for many years of trouble-free operation. The unit is 100% solid-state see in designed for continuous duty, unattended service. The control, timer, and ID boards all use CMOS logic IC's for long reliable life. (No relays are used in the system.) Many front panel and "on board" controls, status indicators, and two panel meters are provided for operator convenience to facilitate initial set-up and long-term maintenance. Two jacks are mounted on the back panel and include provisions for remote control, Autopatch. DC outputs, AF Inputs and outputs, etc. Two binding posts are also provided for automatic emergency DC battery power in the event of an AC power failure. An AC power supply and digital CW are built in.

SECTION 2 UNPACKING

Carefully unpack the repeater and save the packing material. Locate the local mic and two connectors supplied.

In case of damage - be sure to notify the delivering carrier at once. All shipments are insured for full value, and damages are the responsibility of the freight common carrier. Our equipment is carefully packed and shipped in perfect condition, and our responsibility for damage ends when the carton is delivered to the carrier.

SECTION 3 OPERATING CONTROLS & INSTRUCTIONS

3.1 GENERAL

Always have a 50 ohm load connected to the transmitter output before turning on the AC power as the transmitter will come up in the transmit mode for a time duration set by the "HANG TIME" control. Connect the local mic (supplied) to the front panel connector. Connect the receiver input. (Normally from a duplexer.) Plug the line cord into a source of 115-120V, 50-60Hz power. (Or 220V 50-60Hz if unit is so wired.)

After AC power is energized, all of the meter readings. except the Receiver functions. should be logged for future reference. The readings can be extremely helpful in the future for maintenance or troubleshooting tests.

3.2 FRONT PANEL CONTROLS

3.2.1 AC POWER – activates or deactivates AC line power. (light indicates power on.

3.2.2 AC LINE – 3A AC line fuse

3.2.3 INCOMING SIGNAL – Indicates the presence of incoming signal to the COR circuitry.

3.2.4 TRANSMIT LIGHT – Indicates that the transmitter is activated and "On the Air". (Actually triggered from the Exciter B+ line)

3.2.5 COR DISABLE – When this button is pushed, (and the lamp is illuminated), the COR circuitry is disabled. An incoming signal may be monitored on the local speaker and signal level meter, but it will not trigger the repeater transmitter. Note that when the COR is disabled, the ID'er and local mic can still bring-up the repeater transmitter. Also, in this position, the unit may be operated as a full duplex Base Station.

3.2.6 COR SIMULATE – This pushbutton will trigger the COR circuitry, and simulate an incoming signal to the switching circuits. This is very useful for repeater testing purposes, as it brings-up the transmitter and permits the other front-panel controls to be tested. A push-on, push-off switch is used, and will remain activated until the button is pushed a second time and the light goes off. While activated, the Time-Out timer may be set, and the INHIBIT-RESET and COR DISABLE functions checked. When released, the HANG TIME may be set. Also, while activated, the Exciter and Final Am currents and relative outputs may be checked on the meters. The machine is "Timed-Out when the INCOMING SIGNAL lamp is lit, but the TRNASMITTER light is out – (assuming the repeater is not in INHIBIT mode.)

3.2.7 INHIBIT-RESET – This pushbutton/indicator performs a double function.

Positive local control of the repeater transmitter. When pushed, (and illuminated), the transmitter is shut-down and cannot be brought up by any means, (except the local mic PTT button.)

If the transmitter has been remotely inhibited, this lamp will be illuminated to display this condition of the internal logic circuits. The inhibit mode, (either remote or locally initiated), may be Reset by pushing this button. (light goes out.)

3.2.8 MANUAL ID – When pushed, this button instantly brings up the CW ID without waiting for the normal time interval. The light indicates that the ID is on, (whether manually or automatically activated). This control is very useful for setting the various ID board controls. If the button is held in, the unit will ID continuously until the button is released. (Pushing this button will not upset the normal ID timing interval set by the timer pot on the ID board).

3.2.9 MONITOR VOLUME – Adjusts the receiver audio level to the front panel monitor speaker. (Has no effect on repeated audio.) Note that the CW ID is not audible on the local monitor speaker. This control should be set to minimum when the repeater is left unattended.

3.2.10 SQUELCH – Simultaneously sets both the receiver squelch threshold and the COR Trigger point. As the control is advanced clockwise, a stronger signal will be required to trigger the repeater. Since the Squelch/COR circuit is very sensitive, it is not necessary to set this control on the very edge of threshold. Normally it should be set at least ⅛ to ¼ turn beyond threshold. This will still be very sensitive, but will prevent "nuisance triggering" of the machine by extremely weak signals, noise, or other extraneous signals which may be present at the repeater site.

Note that with this "hysteresis" squelch circuit, there is a very beneficial effect with weak, fluttery incoming signals, especially at lower settings of the squelch control. If a signal fades below the level necessary to initially "break" the squelch, it would normally "chop-out" of the squelch with most standard receiver designs. However with this circuit, the signal can fade a few dB below the opening point before the squelch closes. This has the effect of greatly reducing chopping on weak, fading signals – which can be quite annoying. The hysteresis squelch circuit makes operation of the repeater with weak incoming signals much smoother and much more of a pleasure to operate. Note that the amount of hysteresis (i.e., the difference between the squelch opening and closing levels at a given setting) decreases as the squelch control is advanced.

3.2.11 REPEAT AUDIO – Sets the level of audio from the receiver (only) into the transmitter. This control should be set such that a received signal with 4KHz deviation is repeated with exactly 4Khz deviation also. (The proper setting for 1:1 input-output deviation is with the knob straight up at the 12 o'clock position. Increasing this control beyond this setting will result in signals being re-transmitted with greater output deviation than input deviation, and consequently, an increase in background noise, hum and distortion. Also, this will drive the repeater audio stages into clipping, (at about 5KHz of output deviation). Remember – all FM signals are clipped and filtered at the transceiver. Any further clipping at the repeater transmitter only adds needless distortion and loss of audio quality! (Note that the repeater transmitter's audio processing stages prevent over deviation of the repeater transmitter. Max deviation is normally internally set at 5KHz – e.g. if an incoming signal has 6-7 KHz deviation, it will be retransmitted at 5KHz deviation.

3.2.12 HANG TIME – Sets the repeater transmitter's "carrier hang time" (the amount of time the repeater transmitter stays on the air after the received signal drops). Typically set for 4 to 5 sec.

3.2.13 TIME-OUT – Sets the transmitter "time-out time". When the repeater is "timed-out", the transmitter is shut down after a certain time duration. The Time-out may be either on the input (receiver), or output (transmitter) of the repeater per a jumper wire on the COR/TIMER/CONTROL Board. When the T.O. is on the input, the timer circuit times the duration of the incoming signal and shuts-down the transmitter after the pre-determined time interval has elapsed. The timer resets instantly when the incoming signal drops and is reapplied (in this case, the Hang Time is usually several seconds, and there is no need to let the repeater carrier drop to reset the timer. Repeater users may reset the timer by merely letting up on their mic button for a fraction of a second). When T.O. is on the output, the timer resets when the repeater transmitter carrier drops. In this case, users must let the repeater carrier drop for reset, and hang time is usually fairly short. We recommend T.O. on the input with about 4 sec. hang time. The repeater will be factory set up for T.O. on the input unless otherwise specified.

3.2.14 RF/SIGNAL METER/SWITCH – These readings should also be logged for future reference. The 5V and 13.8V readings should be within ½ V. If a sizable variation is noted in the future, a problem is indicated with that stage.

For the 30W 136-174 MHz Repeater: The normal range of Exciter Current is 1.1 to 1.4A on the 1.5A scale. The normal range of Final Amp Current is about 2.7 to 3.5A on the 7.5A scale.

For the 30W 220-240 MHz Repeater: The Exciter Current is read as 2X the 1.5A scale; (i.e. 3A Full Scale). Normal current is 1.7 to 2.2A.

For the 75W 136-174 MHz Repeater: Both Exciter and Final Current are read as 2X the normal 1.5 and 7.5A scales; (i.e. 3A and 15A Full Scale). Normal Exciter Current is 2.0 – 2.5A. Normal Final Current is 7.5-8.5A, and should not exceed 9A.

For the 75W 163-174 MHz Repeaters: See Section 6.4.1 for detailed information on the 75W unit.

3.3 REAR PANEL JACKS

3.3.1 EXTERNAL DC INPUT – EMERGENCY POWER (Red & Black Binding Posts)

This DC input is provided so that the repeater can be operated on an external source of DC power, such as a car or truck battery, should there be a failure in AC line power. Assuming a 12V battery is connected to the terminals, when the built-in AC power supply's output voltage drops below 11V, the battery current conducts through the power diode to power the repeater until AC current is restored. The switching action is instantaneous, reliable, and 100% solid state – no manual switches or relays are required.

When the repeater is operating normally on its built-in AC power supply, about 100mA of current is delivered to the battery as a trickle charge. Note: This is not enough to charge a discharged battery – only enough to "float" a fully charged battery and prevent self-discharge. When the battery is discharged, it must be charged.

The Red terminal is the +12V input. Black is the ground or – terminal. The input is fused with an 8A fuse. If the 12V leads are reversed, the reverse voltage protection diode will conduct very heavily and blow the fuse – thus protecting the repeater from damage. When operating on battery power, the repeater will draw about 5 amps of current while transmitting. At least a

70 Amp-Hour battery is recommended. Keep the battery leads as short as possible (6 - 8 feet maximum) and use at least #12 wire (#8 or #10 preferred).

In normal operation, the battery voltage must not exceed 13.0V or there could be damage to the repeater. If it is desired to run the repeater strictly on external DC Power Supply, disconnect the AC line cord, and in this case only, the external DC voltage may be as high as 14.6V.

3.3.2 ACCESSORY JACKS J602 & J603

These jacks are provided for convenience in interfacing the repeater to other auxiliary equipment and for test purposes. See Table 2 for the pin configurations.

J603 includes pins for +5 and +13.8VDC output to power auxiliary equipment (½A max each – continuous). There are also two pins for remote repeater transmitter control. With this feature, the repeater transmitter may be Inhibited (shutdown) or Reset (to normal operation) remotely – a very useful feature. When inhibited, the transmitter cannot be brought up by any means (except the local microphone). Note that the front panel Inhibit-Reset lighted push-button switch performs this same control function locally (the indicator lamp is illuminated when the repeater is in Inhibit mode).

A positive-going standard 4-5V logic level trigger pulse is required to trigger the Inhibit-Reset circuitry. (the circuit triggers on the leading edge of a fast rise time pulse.) This trigger pulse may be the output TTL level pulse of a Touch Tone decoder (such as the Spectrum TTC100), other digital circuitry, a simple transistor switch, or even relay contacts connected between the Reset and Inhibit pins and the +5V supply. A single pulse into the Inhibit pin will instantly shut down the transmitter. The transmitter will remain in Inhibit mode until a trigger pulse is applied to the Reset pin which will instantly reset the control circuits to normal operation.

J602 includes pins for Audio Inputs and Outputs, transmitter keying (PTT) and COR switching. These connections are very useful for interfacing equipment such as an Autopatch, TT Decoder, or external source of audio input to the repeater transmitter.

Pins 1, 2, and 3 bring Repeat Audio out of, and back into the repeater. (Repeat Audio is the audio out of the receiver which modulates the transmitter.) Pins 1 and 2 are normally jumped together, but this connection may be opened for Autopatch or other use. Also, with proper external circuitry (Such as a DIP relay or transmission gate), repeat audio could be muted for the duration of a touch-tone Autopatch turn-on sequence so that these tones are not repeated. Shielded wire must be used for these connections, and pin 3 used for the shield ground connections. (Pin 3 is not directly grounded at the jack in order to eliminate hum-producing “ground loops”. It is connected to chassis ground at the far end of the internal shielded wires.) In order to keep hum to a minimum, only low-level audio signal grounds should be connected to Pin 3 (i.e. not DC ground, etc.).

Pin 4 – Ground this pin to trigger the transmitter remotely (may be grounded through the collector of a NPN switching transistor such as a 2N2222A or through relay contacts, etc.). Triggering the transmitter for any length of time via Pin 4 will not cause the transmitter to "time out".

Pin 5 – This is an open collector transistor switch which is triggered by the COR – (switches ON – or "low" – when there is an incoming signal to the receiver). Useful for Autopatch and many other applications.

Pin 6 – Auxiliary Audio Input to the transmitter. (Level Adjust pot is on the ID & Audio Mixer Board). Maximum input sensitivity is 100mV p-p (36V rms) for ± 5 KHz transmitter deviation with a 1 KHz tone. Use shielded wire on pin 6 and use pin 3 for ground. Useful for Autopatch or any other application which requires voice or tone audio to modulate the repeater's transmitter.

Pin 7 – Receiver Audio Output (High Impedance line), after squelch gate. Maximum output level: 0.6V p-p (0.22V rms) w/1 KHz tone @ 5 KHz deviation. Do not load down this terminal with low impedance loads. Use at least a 10K Ohm load impedance or greater. (10K ohm pot, etc.) Shielded wire is required for connection to this point. Use Pin 8 for ground.

Pin 8 – Chassis Ground

SECTION 4 REPEATER INSTALLATION & OPERATION

4.1 DUPLEXERS, WHITE NOISE, DE-SENSE, ETC

We recommend a good quality duplexer with approximately 90 dB isolation and silver-plated cavity center conductors. Duplexers with a bandpass/band-reject response are highly recommended. Each repeater transmitter is carefully checked on a spectrum analyzer before it is shipped, and white noise is a least 90 dB down @ .6 MHz. Spurious outputs are at least 70 dB down. Note that transmitter white noise is low-level wideband noise that is generated in all types of oscillator, multiplier, and amplifier stages. This noise will be found to varying degrees in all transmitters. If not properly filtered out by the duplexer, this noise can mask weak received signals.

System performance may be computed as follows:

30W Output (Note: 0dBm = 1mW)	+ 45dBm
White Noise is 90dB below carrier	– 90dBm
Absolute Level of Noise	– 45dBm
Duplexer isolation to receiver port	– 90dBm
Level of white noise at receiver port	–135dBm

This is below minimum detectable signal level of the receiver.

Transmitter white noise is best checked with a steady, weak signal into the repeater system (20 to 30dB of quieting) with duplexer and antenna connected. Listen on the local monitor speaker, and alternately push the COR Disable switch on and off, while listening for an increase in noise which may mask the weak signal. (Reduce Hang Time to zero.) If an increase in noise is heard when the transmitter is activated, it is most likely not de-sense as is commonly believed, but transmitter white noise getting back into the receiver due to insufficient isolation in the duplexer. The extremely wide dynamic range of the Spec Comm receiver precludes true desensitization of the receiver due to overload by the transmit carrier unless the duplexer is greatly out of tune, or, where two antennas are used and there is insufficient separation. (80dB minimum – 100ft vertical separation minimum recommended.)

4.1.1 DUPLEXER TUNING

If the transmitter white noise is a problem, the duplexer may have to be tuned slightly into your system since different cable lengths and antenna VSWR can affect cavity tuning. (Antenna VSWR must be under 1.4:1 for a duplexer to operate properly.) If cavity tuning is required, carefully tune the Transmitter cavities for minimum noise on the weak signal, consistent with maximum power out to the antenna. (Note: Only double shielded coax cable should be used in the system such as RG-214/U. Do not use the commonly available loose braid types such as RG-8. Keep cables at least one foot apart. It is recommended that the cavity tuning rods be measured and marked so that you can return to the original settings if required.

4.2 TRANSMITTER TUNING FOR MINIMUM WHITE NOISE

If the duplexer has been tuned and some white noise remains, it may be necessary to tune the repeater transmitter for minimum noise. Again, this should be done with a weak, steady received signal which is monitored on the local speaker while the COR Disable button is pushed on and off. The coils and the various trimmer caps should be carefully tuned for minimum white noise consistent with maximum output power (preferably with a Bird wattmeter, or equivalent, at the output of the duplexer). The coils should be tuned 1 turn, or 2 turns, and the effect noted. If there is no effect, return to the original setting. If necessary, the ceramic trimmer caps may be adjusted a fraction of a turn only. Driver and final amp trimmers are adjusted for maximum output consistent with minimum white noise and minimum current.

If all else fails, any remaining white noise can normally be eliminated by the addition of one or more cavities (notch type) to the transmit side of the duplexer. This will pass the transmit carrier, but notch-out white noise on the receive frequency.

4.3 HIGH POWER AMPLIFIERS

If it is desired to add an amplifier to the repeater transmitter's output, with 70-150 Watts output, one additional cavity (notch type) may be required in the Transmit side of the duplexer. It is a little recognized fact that transmitting amplifiers (like receiving pre-amps) have gain and a noise figure, which typically about 30 dB for solid-state amps! In other words, while the amplifier will provide 5 to 8 dB of gain, it will also increase white noise by about 30 dB. If this is a problem, the only solution is an additional transmitter notch cavity, which will supply about 30 dB of increased filtering of white noise between transmitter and receiver.

4.4 INCREASING RECEIVER REJECTION OF OUT-OF-BAND SIGNALS

The Spec Comm Receiver incorporates one of the sharpest and widest dynamic range front-end designs on the market, but even so, if the repeater antenna is located at a site with many nearby VHF transmitters, additional front-end filtering may be required to prevent spurious mixing products (a filter should be planned into the system in advance in this case). Transmitters within 20 MHz will usually be the biggest problem. Remember – most duplexers have little or no out of band rejection – only a notch on the transmit frequency, so do no rely on the duplexer for out of band filtering; with the exception of the bandpass/band-reject type which is supplied by Spectrum Communications Corporation.

If spurious received signals or de-sense/front-end overload is a problem due to nearby VHF transmitters, (sometimes producing extreme levels of several hundred-thousand microvolts), the only solution is a good quality cavity filter in the receiver input line. In general, a bandpass filter is recommended, as this will greatly attenuate everything beyond about 5 MHz. For closer-in interference, or where there is only 1 interfering signal, a Notch Type Filter is usually preferable. Contact Spectrum Communications for further details. Out FL-6 Filter/Preamp is highly recommended to filter out strong signals more than 4 MHz away.

4.5 TOWER & GUY WIRE NOISE

In some single-site repeater installations, there may be a problem with intermittent crackling noises on the repeater signal, (particularly on weak received signals), especially when there are high winds. This noise has been traced to poor and intermittent metal-to-metal connections on the antenna tower or nearby metal objects – such as guy wire connection points, tower let joints, supporting mast intermittently touching the tower-s top collar, rusty joints, etc. These metal objects pick up RF from the repeater's transmitted signal, and when moved slightly, will arc microscopically to any other metal object touching it. The arc, (which is a very low level effect), produces a wideband RF noise which is radiated, picked up by the repeater's antenna, and heard in the receiver – which is, of course, then re-transmitted.

One stubborn case was traced to a point where a rusty steel supporting mast passed through the collar at the top of the tower, only a few feet below the repeater antenna. The cure to the intermittent connection, which produced a heavy static on windy days, was rather unique. The tower collar as packed with automotive lithium chassis lubricant. This grease is very 'lossy' at VHF, and effectively shorted-out the poor connection, and eliminated the noise from that source.

The solution to these intermittent joints is to either bond or insulate the poor connections. Bonding involves either clamping, soldering, or welding the connections together. Wire braid, copper strap, heavy wire, etc., may be used. Any materials, which can rust, must not be used since rusty joints are the worst offenders. Once bonded, the connections should be waterproofed with a material such as the commonly available Silicon Rubber. As an alternative, the connections may be insulated. Guy wires should be insulated with ceramic compression insulators only about 1 inch from each tower leg. Any wire or metal objects within about 50 feet of the antenna should not touch each other! Also, beware of noise on the repeater's output do to intermittent cable or antenna connections! Some fiberglass encased 6dB gain base station antennas are known to become internally intermittent after as little as 2-years service – thus producing a terrific noise on the transmitted signal! (Check for intermittent VSWR).

SECTION 5 SPECIFICATIONS

5.1 RECEIVER

Front End	Extremely wide dynamic range/low noise figure front end. Built-in Preamp plus RF Stage and 8-Poles of Preselection filtering. With Exclusive Double Balance Mixer which greatly reduces intermod, de-sense, and overload.	
Sensitivity	0.3µV typical for 12dB SINAD	
Squelch/COR/Threshold	0.1 – 0.2µV typical, 0.25µV maximum (Noise operated squelch; fast attack.) Schmidt Trigger/Hysteresis design.	
Selectivity	Standard Filter 8-Pole Crystal Filter, plus 4-Pole Ceramic Filter -6dB @ 6.5 KHz; -70dB typical @ 15KH; > -125dB typical @ 25 KHz. (20dB quieting Method) (-85dB nominal EIA) (Optional Sharp Filter, -6dB @ 5.5 KHz; -104dB typical @ 15 KHz)	
De-Sense – Overload	With a 1µV desired signal, de-sense begins at approximately 50,000µV @ 600 KHz and 100,000µV @ 3 MHz.	
Modulation Acceptance	7 KHz nominal	
Image and Spurious Response	-90dB typical image -70dB minimum spurious	
Intermodulation	-75dB nominal, EIA	
IF	21.4 MHz & 455 KHz, double conversion	
Crystal Information (40-50 MHz Range)	136-151.000 MHz	Xtal Freq = (Recv Freq + 21.4 MHz) / 4
	151.001-174 MHz	Xtal Freq = (Recv Freq – 21.4 MHz) / 4
	216-250 MHz	Xtal Freq = (Recv Freq + 21.4 MHz) / 6
	3rd Overtone, Parallel Resonant, w/30pF load cap., R_S 30 ohms. HC-25/U case. Calibration Tolerance: 0.001% @ 23°C. Temperature tolerance: 0.0005% from -20 to +60°C	
AF De-emphasis	-6dB/octave per EIA Specifications	
Local Monitor	High quality speaker with oversize magnet for excellent voice fidelity.	

5.2 TRANSMITTER

<table>
<tr><td>RF Output</td><td colspan="2">30W typical @ 13.8VDC, 25W minimum.</td></tr>
<tr><td>Final Stage</td><td colspan="2">Efficiency: 70% typical. Emitter ballasted transistor withstands infinite VSWR for up to 1 minute without damage. High efficiency heat sink.</td></tr>
<tr><td>Modulation</td><td colspan="2">True FM for optimum audio quality. Instantaneous deviation limiting. Up to ±7 KHz maximum. Each unit is factory calibrated for 1:1 input-output deviation. (e.g. 5 KHz input deviation = 5 KHz output deviation) Front panel adjustable. Hum & Noise on the carrier is negligible. Overall system audio fidelity & quality is excellent – so much so that it's very difficult to tell the difference between "Direct" and "Repeat" copy!</td></tr>
<tr><td>Pre-emphasis</td><td colspan="2">6dB per octave; per EIA Specification</td></tr>
<tr><td>Spurious</td><td colspan="2">-75dB typical. -70dB minimum.</td></tr>
<tr><td>Harmonics</td><td colspan="2">-65dB minimum. Triple section low-pass filter built in.</td></tr>
<tr><td rowspan="4">Transmit Crystals</td><td colspan="2">Fundamental mode, parallel resonant, w/32pF load capacity; R_S less than 25 Ohms, HC-25/U case.
Calibration Tolerance: 0.001% @ 23°C.
Temperature Tolerance: 0.0005% from -20 to +60°C</td></tr>
<tr><td>136-174 MHz</td><td>Crystal Frequency = Xmit Freq / 8</td></tr>
<tr><td>216-250 MHz</td><td>Crystal Frequency = Xmit Freq / 12</td></tr>
<tr><td colspan="2">For Optional OS-12 Crystal Oscillator Oven:
Calibration Tolerance: 0.001% @ 80°C.
Temperature Tolerance: 0.0005% from +40 to +90°C</td></tr>
</table>

5.3 GENERAL

Frequency Range	136-174 MHz or 216 -250 MHz
Frequency Stability (TX)	0.00020% maximum, -30 to +60°C with OS-18 Crystal Oscillator Oven
Rx & Tx w/o OS-18	0.001% nominal, -20 to +60°C with 0.0005% precision grade crystals supplied throughout.
Remote Control	Inhibits or Resets transmitter remotely with a 5V trigger pulse or level shift.
Timers (all adjustable)	Time Out: 0.5 to 4 minute typical Carrier Hang Time: 0.1 to 6 seconds typical ID Time: 0.5 to 10 minutes typical (can be modified to 30 minutes maximum).
Control Logic & Timers	Fully Solid State CMOS logic, (TTL compatible. No Relays. "time-Out" may be triggered on repeater input, (received signal): or repeater output (Xmtr. Carrier drop) – simple jumper wire change. CMOS circuitry assures extremely good long-term reliability – and, its super-low current consumption is very beneficial when operating on battery power.
CMOS CW ID'er	Factory Programmed Memory is contained in a PROM IC chip. Adjustable code speed, tone pitch, timing cycle, and AF output level. Very pleasing (sinusoidal) tone quality. 250 bit memory-sufficient for any call sign. 1 channel std. (4 channel ID max).

Local Mic	Supplied with high quality ceramic or dynamic mic w/neoprene coiled cord & 4 pin plug. Adjustable Mic gain.
AC Power Supply	110-125V (or 220-240V) @ 50/60Hz. Extremely heavy-duty power transformer. Massive heat sink on regulator transistor. Although normal DC current consumption is about 5A, the transformer & regulator pass transistor are rated for 12 & 30A, and the bridge rectifier 35A for extremely high reliability. AC Line Input is protected from transients, spikes, and surges by a heavy duty MOV (Metal Oxide Varistor) transient suppressor.
Emergency Battery Power	Provision for automatic instantaneous (solid state) switchover to 12VDC Emergency Battery Power if normal AC power fails. No manual switching of relays required. (Reset is also instantaneous & automatic.) DC Input is fused and reverse polarity protected. Trickle charge to battery is provided.
Accessory Jacks (2)	For CTCSS Community Tone Panel, Autopatch, Transmitter Remote Control, DC out to auxiliary equipment, etc. Includes: +5 and +13.8VDC @ 500mA each; Receiver AF out, (High Impedance – use 10K minimum load impedance); Aux. Transmitter AF input, (1 K-Ohm) – adjustable level. Aux. PTT – (Ground To Xmit); "inhibit" & Reset, (trigger w/positive going 5V (TTL) logic pulse or other switched 5V level); and Ground. 2 spare pins are also provided. (When SCAP Autopatch is used, these 2 pins are used for Phone Line Input.)
DC Current Draw (@ 13.8VDC) (@12VDC, subtract approx. 20%)	Standby – Squelched – all panel lights off – 320mA nom. Un-squelched, ½ Local Volume, 2 panel lamps on, "Inhibited" – 550 mA nom. Transmit – 5.5A nominal
RF Connectors	Type N Standard. Note: My unit has SO-239 connectors
Panel Size	7"H x 19"W Chassis Depth: 13" plus 2 5/8" for heat sink.

5.4 FRONT PANEL METERING & STATUS INDICATORS

Meter 1	Exciter Relative Output Final Relative Output Receiver Signal Strength
Meter 2	+5 Supply Voltage +13.8 Supply Voltage Exciter Current 0-1.5A Final Current 0-7.5A.
Indicator Lights	AC Power; Incoming Signal (COR); Transmit

5.5 FRONT PANEL TEST & CONTROL FUNCTIONS

Lighted Pushbuttons	COR Disable, COR Simulate – manually activates COR & Timer circuits, etc. Manual
Panel Controls	Local Monitor Volume Squelch/COR Threshold Adjust Repeat AF Level Carrier Hang Time Time-Out Time

SECTION 6 CIRCUIT DESCRIPTION

6.1 RECEIVER CIRCUIT DESCRIPTION

6.1.1 The receiver front end consists of an RF Preamplifier stage followed by a second RF Amplifier stage. The transistors used for this application are new, state of the art types which are designed to provide an extremely low noise figure while simultaneously giving high gain, and an extremely wide dynamic range. Eight “HI Q” resonators are intermixed before, between, and after the two RF transistors. These tuned circuits provide extremely good rejection of strong out of band signals which could otherwise overload the front end. Shield partitions are used between each tuned circuit in order to obtain optimum skirt selectivity characteristics. The output of the RF amp stages if fed to a true Double Balance Mixer which converts the VHF signal down to the 21.4 MHz IF frequency. This type of mixer is used due to its extremely wide dynamic range characteristics and its extreme simplicity of operation. Note that they are widely used in microwave receiver applications due to their superior performance capabilities. Double Balanced Mixers are well known for their excellent strong signal handling capabilities – which lead to very low spurious responses, de-sense and overload.

6.1.2 The Local Oscillator (LO) chain consists of a third overtone crystal oscillator stage (Q104) which operates in the 40-50 MHz range. Q104’s collector output is filtered by the L110/C128 tank circuit, and its output is fed to the base of the Q105 multiplier circuit. Its output if filtered by a “double tuned” filter network which consists of L111 and C131 plus L112 and C135. This signal is fed to the base of “Q106, a second multiplier or amp stage whose output is similarly filtered by another double tuned filter consisting of L113 and C137 plus L114 and C141. For 136-151 MHz receivers, Q105 and Q106 are doubler stages. For 151.001-174 Mhz receivers, Q105 is a tripler stage and Q106 is an amplifier stage. For 216-250 Mhz receivers, Q105 is a tripler, and Q106 is doubler stage. The multiplier chain’s RF output is filtered by a double tuned filter in order to reduce spurious outputs which would lead to spurious responses in the receiver. The final L.O. output is at a level of approximately 5-15mW, (the relatively high level required by the mixer). The L.O. output frequency is always exactly 21.400 MHz above the desired receive frequency for 136-151.000 MHz (& 220 MHz) receivers and 21.400 Mhz below the desired receive frequency for 151.001-174 Mhz receivers. This is done to minimize problems with the image response. A LO output test point is provided at TP1, and a frequency counter or spectrum analyzer may be connected to this terminal.

6.1.3 The first mixer (M101) is immediately followed by a 4 pole first IF crystal filter (FL101 and FL102) which begins to filter out off channel signals before they reach the IF amp stages. This filter network is followed by 0103, the first IF amplifier stage, which provides about 3DdB of gain. Q103's output is tuned by the L120 and C153 tank circuit, and fed to a second 4 Pole crystal filter (FL103 and FL104) which adds further adjacent channel selectivity. A 21.4 MHz IF frequency is used in this design since it places the image 42.8 MHz away from the desired receive frequency. This image is extremely well attenuated by the very sharp filters in the receiver front and stages. This high frequency IF is far superior in this respect to the commonly used 10.7 MHz IF stages.

6.1.4 The 21.4 MHz first IF signal is fed to U101 which is a multi-purpose second IF IC. This IC performs the functions of second L0 and mixer (down to the 455 KHz second IF frequency). This mixer is also double-balanced to reduce spurious responses. The second L0 operates at a frequency of 21.855 MHz. U101 also includes 455 KHz second IF Amplifier and Limiter stages as well as the FM Quadrature Detector, and high frequency (35 KHz) squelch Noise Amp. The second mixer‘s output at U101 pin 3 is filtered by a 4 Pole ceramic filter which provides additional skirt selectivity for excellent adjacent channel rejection. Its output is fed to pin 5, which is the Limiter Amplifier input. The amplifier's output is at pin 7 and feeds the FM Detector‘s input at pin 8. The resonant circuit composed of L122 and C162 form the tuned circuit required for the Quadrature Detector. The detected FM output is internally amplified and appears at U101 pin 9. The audio output is coupled to the 35 KHz high frequency noise amp and active bandpass filter, the input to which is U101, pin 10. Pin 11 is the Noise Amp output. The amplified noise is fed to a detector circuit composed of C175, R150, diode CR108, and bias resistor R151. This circuit rectifies the high frequency noise and converts it to a negative DC voltage which is proportional to signal quieting in the FM receiver; and this negative voltage drives the bias voltage across C175 down as the noise increases (weaker or no signal).

6.1.5 Front panel squelch pot R604 sets the squelch threshold point by setting the voltage at which diode CR108 begins to conduct, thereby setting the maximum voltage across C175. The voltage across C175 directly triggers the squelch gate built into U101. Pin 12 is the squelch trigger terminal, and pin 14 is the gating V terminal which shorts the audio output to ground at the junction of R149 and C179 in order to perform the gating function. There is 100µV of hysteresis at pin 12, and this circuit allows the squelch to close at a weaker incoming signal level than the level required to open the squelch initially. This feature allows the squelch to remain open even though the signal may fade a few dB into the noise, and reduces squelch-chopping effects on weak, fluttery mobile signals.

6.1.6 The audio output from the FM detector at pin 9 U101 is de-emphasized by the R145/C178 network at 6dB per octave roll off per EIA specifications, and connected to the AF Preamp input at pin 3 of U102A. A CTCSS tone output point is provided at terminal E109. Op Amp stage U102A is an audio amplifier with a gain of about four times, and the audio output is taken from Pin 4. (Gain measured from Junction R145/C178 to terminal E110.) The AF Preamp's audio output is connected to the front panel Rpt. Audio and Monitor Volume pots. Audio from the monitor volume pot is fed to pin 1 of U104, the audio power amplifier IC. U104 drives the front panel monitor speaker so that incoming signals may be monitored.

6.1.7 U103 is used as the 455 KHz 5 Meter Amplifier. This amplifier increases the level of the 455 KHz IF signal to a point sufficient to be detected by diodes CR106 and CR107. This detected IF voltage drives Q109 an emitter follower buffer stage. Q109's emitter is connected to E105. the S Meter output, through current limiting resistor R141. (R141 sets full scale on the S Meter and may be adjusted if the S Meter reads too high or low on an extremely strong signal – greater than 100µv.) Q111 is used as a voltage regulator stage and supplies regulated 9 VDC to all of the appropriate points on the board. Zener diode CR114 sets the 10V reference voltage on the base of Q111. Q112 is a switching transistor which gates U104 on or off for squelch action. (This eliminates idling "hiss" in U104.)

NOTE — Part/Terminal Numbering System

- Receiver - 100 Series
- Transmitter - 200 Series
- COR/Timer/Control - 300 Series
- Power Supply/Reg./Mtr. - 400 Series
- ID & Audio Mixer - 500 Series
- Main Chassis - 600 Series

6.2 TRANSMITTER

6.2.1 Initial FM signal generation is accomplished at Q202 and its supporting circuitry. This stage is a modified Clapp oscillator with the 18 MHz crystal operating on the inductive slope of its parallel resonance curve. The collector circuit of Q202 is resonated at the second harmonic of the crystal frequency, (third harmonic on 220 MHz versions), by a double-tuned filter, and is applied to the base of Q203, a frequency doubler. FM modulation is affected by modulating the crystal load capacitance with varactor diode CR203. A steady-state DC bias for CR203 is provided by R127, and the modulating audio signal is superimposed on this voltage through C209.

6.2.2 Modulating audio for CR203 is pre-emphasized by R203, C201 and C259, and is applied to IC201A where it is amplified by a factor of 68. The output of IC201A is applied to back-to-back diodes CR201 and CR202 which cause the audio signal to be limited to a maximum value of about 1.4Vp-p. The limited audio signal is next applied to a 3-secion RC low-pass filter which removes most of the high order harmonic distortion produced by the limiting process. The output of the low-pass filter is fed to IC201B for further amplification, and is finally connected to the varactor modulator through Deviation Pot R212.

6.2.3 The RF drive to Q203, not at 36 MHz (55 MHz in 220 MHz versions), is doubled in frequency and is filtered by another double tuned circuit before bing applied to the base of Q204. Q204 is another frequency doubler, and the 72 MHz drive at its base (110 MHz in 220 MHz versions), is multiplied in the collector circuit to 144 MHz (220 MHz), the final output frequency. The signal is again filtered in a double –tuned circuit, and is fed to the base of pre-driver Q205. The signal is further amplified by Q206, and is applied as drive to the Class C amplifier chain consisting of Q207 and Q208. (In SCR1000 2M repeater applications, the output Q206 is applied directly Q208, and Q207 is eliminated). Power output from Q208 (about 10-12 Watts in 220 MHz versions) is finally applied to a 2-section harmonic filter, and is routed to the RF output of the board. A sample of the RF output from Q208 is picked off before the harmonic filter, and is rectified by CR205 and CR206 to drive a Relative Output meter.

6.2.4 For high stability applications, (FCC Type Accepted units, etc.), the OS-18 Crystal Oscillator/Oven is used. Q211 is the oscillator transistor which is operated in the Clapp configuration in the 17-22 MHz range. IC202 is the precision Temperature Controller IC which maintains the oven temperature at +80 2°C. Q210 is the power transistor employed as an effective heating element for the oven. The Temperature Controller is a proportional type which smoothly controls the temperature of the crystal and all of the oscillator components. This results in extremely good frequency stability, even over very wide temperature excursions, far superior to that of typical TCXOs! The oscillator's output drives the <hold>[1] of multiplier transistor Q202. See schematic diagram – Figure 6.

6.2.5 The 13.8 VDC input is applied directly to Class C stages Q207 and Q208, and also to audio stage IC201. Oscillator stage Q202 is run continuously from a 9 volt Zener diode regulator for maximum stability. Grounding the PTT input to Q201 causes Q201 to turn on, applying +13.5V to both frequency doubler stages and both pre-driver stages.

6.2.6 The RF output of exciter board is next applied to the final amplifier board. The final amplifier is Q209 (or Q210), and emitter ballasted RF power transistor. The power amplifier is designed with sufficient heat-sinking to provide a nominal output of 30 Watts in continuous service when operate into a proper 50 ohm load. The power transistor is capable of withstanding open and shorted load conditions for short periods of time, but this should be avoided, since certain VSWR conditions can cause excessive heat build-up in the amplifier and possibly damage the device.

6.2.7 The output of the amplifier is passed through a 3-section (2-section on 220 MHz) low-pass filter which greatly attenuates all harmonics. A diode rectifier provides a relative indication of peak output voltage which is sampled just ahead of the low-pass filter. R247 is set for a relative final output reading of 6-8 on the meter for approximately 30-Watts out to a 50-Ohm load.

6.3 CONTROL/TIMER/COR BOARD (CTC100A)

6.3.1 Referring to the schematic, the COR trigger output from the receiver is connected to terminal E323 on the COR board. This trigger voltage is in a high state with no received signal (squelch closed); and it switches low with a received signal (squelch open). The voltage is dropped to a lower level by resistive voltage divider R13 and R14, and then applied to one input (Pin-6) of NOR gate U2D. The remaining input of U2D is driven from the output of U3A, a flip-flop which is toggled by output of U2D, then, is a logic high in the presence of either a simulated or an actual signal acquisition, and is used to drive Q3, the INCOMING SIGNAL indicator lamp driver. This logic level is switched by the front panel COR DISABLE switch and is used to trigger the HANG timer which consists of Q1, and NOR gates U1A and U1B.

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6.3.2 The HANG timer works in the following manner: A COR activation causes Pin-9 of U1B to go high which in turn causes the U1A/U1B flip-flop to be set. Simultaneously, transistor Q1 is turned on, causing the 20µF capacitor to rapidly discharge. At this point, pins 3 and 10 of U1 are at logic levels "one" and "zero" respectively, and remain in this state as long as the COR is activated. Upon deactivation of the COR, pin 9 of U1B goes "low", and transistor Q1 turns off, allowing the 20µF capacitor to charge through R9, the front panel HANG TIME pot. When the 20µF capacitor has charged to the threshold point of U1A, the U1A-U1B flip-flop is reset and returns to the standby mode.

6.3.3 The TIME-OUT timer operates in the following manner: Upon activation of the COR, and for the duration of COR activation, pin 3 of U1 will be high, and pin 10 of U1, as well as pin 11 of U1, will be low. The low condition of pins 10 and 11 of U1 will cause transistor Q4 to be in the off state, and the high condition on pin 3 will cause the 330µF capacitor to charge through the front panel TIME-OUT pot. When the voltage on the 330µF capacitor reaches the threshold of &2A, pin 1 of U2B will go low, triggering the U2B-U2C flip-flop. At this point the timer is in the "timed-out" state with pins 3 and 10 of U2 at logic "one" and "zero" respectively. The timer remains in this state until a negative transition appears at board terminal #5, at which time the U2B-U2C flip-flop will be reset. Depending on which jumper wire configuration is selected (terminal #5 and #4, or terminal #5 and #7) time-out reset will occur either upon COR deactivation (removal of RCVR signal) or upon "HANG" timer reset (transmitter drop).

6.3.4 The normally low output from the time-out timer and the active low output from the hang timer are summed in NOR gate U2D, which turns on the transmitter PTT driver, Q8. Also summed into U1D is the output of the reset-inhibit flip-flip, U3B. Momentary activation of the inhibit lamp driver, Q9. A pair of inputs is provided for remote inhibit and reset through terminals 20 and 19 respectively.

6.3.5 A positive going pulse of V_{CC} amplitude on pin 20 will inhibit the transmitter, while a similar pulse on pin 19 will reset the unit to normal operation.

Note: In the above description, add 300 to all COR Board part and terminal numbers.

6.4 ID25 ID/AUDIO AMPLIFIER & MIXER BOARD

6.4.1 Note: Add 500 to all ID250 Part and Terminal numbers below.

6.4.2 Note: Unless otherwise noted, in the following discussion any reference to a "high" logic state shall be defined as a voltage of at least 70% of the positive power supply voltage (3.5 Volts in the case of a 5 Volt supply), and a "low" logic state shall be a voltage of no more than 20% of the positive supply (1 Volt in the case of a 5 Volt supply). These levels will typically be full positive supply and zero volts respectively.

6.4.3 Referring to the schematic diagram, notice that two trigger inputs are provided at E12 and E13, either one of which can be used, depending on the sense of the input source. Assuming that neither trigger input has been activated for some time, pin 10 of U4 will remain low, and transistor Q3 will be held in the off state, allowing C11 to charge through R29. If the trigger inputs remain inactive long enough (approximately 1.5 minutes), C11 will charge up to the threshold point of the U8 flip-flop, causing pin 4 of U8 to go high and pin 3 of U8 to go low. The high state on pin 4 causes the I.D. timer clock to stop via clock counter, U9, to its zero state. The unit is no in the standby condition, and will be activated immediately upon the next trigger input.

6.4.4 When a trigger signal arrives, it will cause pin 10 of U4 to go high, which in turn, causes the U8 flip-flop to be set, and also causes Q3 to keep C11 discharged as long as there is input activity at intervals of less than 1.5 minutes. As soon as the U8 flip-flop is set, the high level on pin 3 is converted by C2 and R13 into a short positive going spike which passes through D11 and sets the trigger flip-flop, U5, causing an I.D. to be generated immediately. (Details of the I.D. generation sequence will follow later). As long as the activity timer detects input activity, pin 4 of U8 will remain low and the U8 I.D. clock will be allowed to run, producing positive pulses at its 27 Hz (nominal) rate. These pulses trigger U9, a binary divider which divides the 27 Hz clock by 8192. Thus, as long as the I.D. clock is running, the output of U9 (pin 3) will go high every 303 seconds (approximately 5 minutes), and will trigger the U5 flip-flop, causing an I.D. sequence to be generated. Note that the output pulse on pin 3 of U9 is also routed, via diode D13, back to the U9 reset input, resetting the divider to its zero state, and allowing another timing cycle to start.

6.4.5 Triggering of the I.D. sequence generator can come from one of three sources, any of which will set the trigger flip-flop, U5. These sources are:

1. an initial triggering input after inactivity through D11
2. a regularly scheduled I.D. during activity through D12
3. a manual I.D. at any time through E1.

When the U5 flip-flop has been set, pin 3 will go high and pin 4 will go low. The high on pin 3 causes Q1 to turn on (assuming that E<hold>[2] and E3 are jumped), clamping the transmitter hold output <hold> to ground for the duration of the I.D. cycle.

6.4.6 The low on pin 4 of U5 causes binary counter, U1, to be released from its reset state (a high on the reset input keeps the counter from toggling). When pin 4 of U5 is low, pin 3 will be high, turning on Q4 & Q5, and enabling the 5VDC supply to PROM U2. Output pulses from the code speed oscillator, U6, cause U1 to count up in a binary sequence, and the binary outputs are applied to the address inputs of U2, a PROM organized in a 256 bit long by 4 bit wide configuration. Each of the 256 possible binary outputs from U1 corresponds to a unique 4-bit word which appears at pins 9, 10, 11, & 12 of U2. The contents of each word have been programmed at Spec Comm so that, looking at any single bit of the 4-bit output, the sequence

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of 1's and 0's represents the Morse code message. (A dot is a "1" in 1-bit location, while a dash consists of a "1" in three consecutive bit locations.) The particular 1-bit data channel desired is selected by U3, a quad analog switch. A high on anyone of the four message select inputs (E18, E30, E31, E32) will cause one of the four outputs of U2 to control the U5 tone oscillator.

6.4.7 As long as code pulses appear at the output of U3, transistor Q6 will keep discharging C15 at regular intervals. If code output from U3 ceases long enough for C15 to charge up to the threshold level of U7 (a quad NAND gate with Schmitt trigger outputs), pin 3 of U7 will go low, and pin 4 of U7 will snap high. This positive going pulse is differentiated by C13 and R36, and is applied as a reset pulse to pin 1 of the U5 flip-flop. When U5 is reset, pin 4 will go high, resetting U1 to zero and preventing any further counting. Pin 3 of U5 will go low, turning Q4 and Q5 off, thus removing the 5VDC supply to PROM U2. (Removing the 5 VDC supply for U2 during standby saves about 80mA of current consumption, and results in a standby current draw of about 5mA.

6.4.8 If E33 is grounded, pin 11 of U7 will go high, triggering the U5 tone oscillator through U6 for as long as E33 is grounded. If E34 is raised to a high level, pin 10 of U7 will oscillate at an approximate 20Hz rate keying the tone oscillator on and off at the same rate. This sound is intended to approximate a telephone ring signal, and is intended for applications where a distinctive signaling sound is needed. (Autopatch, etc.)

6.4.9 The output of the tone oscillator, a harmonic rich square wave, is filtered by the L1/C6-8 tank circuit, and is finally buffered by emitter follower stage Q2. A four input dual Op Amp audio preamplifier/mixer is incorporated onto the ID250 board. The local microphone input (E19 & E20) to this stage is amplified by U1A. The three other inputs (RPT AF, I.D., AUX AF) are resistively summed with the U1A output, and the mixed A.F. output appears at E21 as composite repeater audio. The IC1 stage was designed to operate with a medium impedance ceramic microphone (such as the Spec Comm M-10), and the AUXILIARY A.F. INPUT has been provided with a level adjusting potentiometer. In normal use, the audio output from E9 of the ID'er is connected to E25 of the mixer.

6.4.10 I.D. MEMORY: If it is desired to change the ID (call letters) in the memory, contact Spectrum Communications. The factory can normally program and ship a new PROM memory chip within a few days. Note that it takes special factory equipment to program the PROM IC – it is NOT field programmable. (Simply take the PROM out of its socket, and plug in the new PROM).

6.5 75-WATT SCR100 AMPLIFIER UNIT (BA-75RPT)

6.5.1 INTRODUCTION

The 75-Watt SCR1000 is a special version of the SCR1000 repeater. It includes a higher power transmitter exciter board, a final amplifier board and uses 2 RF output transistors; increased power supply current capability with a larger power transformer and electrolytic filter capacitor, and two "super rugged" 200W/30A pass transistors in parallel. Massive heat sinks are provided for pass transistors and the final amplifier transistors.

6.5.2 OPERATION

In normal operation, the 75-Watt amplifier id driven with approximately 10 Watts of power from the exciter board. Normal exciter current is about 2.0-2.5A. Normal final current is 7.5-8.5A. Do not let the final current exceed 9A, (for best long-term reliability). Final Amplifier current can be adjusted by turning the Output Tuning capacitor C283A, on the final board closest to the RF output connector. Always tune for best efficiency, i.e., minimum current consistent with good power output. (Typically achieved when increasing the capacity of the output tuning capacitor –CW- towards max capacity.)

The amplifier is designed to withstand VSWR up to 3:1 for as much as 5 minutes. Although the amp uses the most rugged "emitter ballasted" transistors available, it was not designed to withstand open or shorted load conditions, (although it may do so for very short periods). A good 50-Ohm load must always be connected to the output before transmitting.

The unit was tuned at the factory with a Bird Model 43 Wattmeter into a 50-Ohm load. If you do not read at least 70W output into your system a slight adjustment of the above-mentioned output tuning capacitor, C183A, may be required.

6.5.3 COOLING – **IMPORTANT**

This amplifier was designed for use with an external (optional) "muffin" fan which blows cooling air over the rear heat sinks and transformer. (120 cfm minimum fan rating must be used). The fan should be mounted on the back door of the rack or cabinet used, or on metal brackets, etc. The air should be carefully directed so the two heat sinks and the transformer are all in the air stream.

Although it is not recommended, the unit may be used without a fan for short duty cycle operation (i.e. up to 15 minutes maximum transmit time, with at least a 30 minute cooling down period.) With the optional fan, maximum transmit time is unlimited, (100% continuous duty).

6.5.4 METERING, ETC

Note that for the 75-Watt transmitter, both front panel current meters read 2-times normal indication; i.e. the exciter current is 3.0A full scale, (2x the 1.5A scale, and the final current is read on the 15A scale).

Normal B+ to the final, as measured at the feed-through cap on the transmitter housing is 13.0 to 13.8VDC maximum while transmitting.

6.5.5 LOAD VSWR

Important: For maximum operating life and best reliability, be sure that the load VSWR does not exceed 1.5:1. (When a duplexer is used, this is the VSWR looking into the duplexer's TX input.) Also, do not tune the duplexer while transmitting at the 75W level since extremely high VSWR loads can be presented to the amplifier when the duplexer is de-tuned. A high VSWR load could possibly cause damage to the output circuitry if the transmitter is keyed for a prolonged period of time.

6.5.6 AC POWER TRANSFORMER

The transformer in the SCR1000 is normally wired with the primary tap at the 115VAC point. This tap is the optimum point for operation over an AC line voltage range of about 113-120VAC. If the actual line voltage (while transmitting) is above or below these limits, the primary tap wire should be changed accordingly. For example, if the line voltage is in the area of 110VAC, change the tap fro the 115 to the 105VAC tap. Likewise, if the line voltage is greater than 120VAC, change the tap to the 125VAC lug.

6.6 POWER SUPPLY

6.6.1 The standard power supply consists of a heavy-duty 12A power transformer, 35A bridge rectifier, 30A/200W pass transistor(s) mounted on a massive heat sink, and an IC voltage regulator/metering board. The AC line input is fused, and protected from line spikes and transients by a high capacity MOV transient suppressor. The supply is very conservatively designed – normal current draw is only 5.5A (10.5A for the 75W unit). C603 is used to filter the rectified AC. IC401 is a feedback voltage regulator which drives the Darlington pass transistor configuration made up of Q601 and Q602. These 2 power transistors provide a very high overall current gain of over 1000. The regulator also includes a "fold-back current limiting" feature which automatically and instantly "folds-back" the supply's output to a very low voltage and current if the output is shorted – their by protecting the supply. This circuit provides excellent regulation and filtering – ripple is less than 10mVp-p at an 8A load.

6.6.2 An overvoltage "crowbar" shutdown circuit is used to shutdown the power supply in the unlikely event that the pass transistor should short out. If Q601 does short, Zener diode CR402 will conduct, thereby turning on SCR CR401. When CR401 conducts, it will draw a very large current though R401 for a few hundred milliseconds, thereby quickly blowing front panel AC line fuse F601 and shutting down the repeater before any damage is done. If this should happen, F601 and Q601 must be replaced, but Q601 (and Q602 for the 75-Watt repeater) should first be checked with an ohmmeter for shorts.

6.6.3 Also included on this board are various meter shunts, (wire wound resistors), and calibration pots for the volt and current meter functions. A separate fixed 5V regulator is provided to supply this voltage to the logic circuitry. It is rated 1.3A and ahs built-in current limiting/short-circuit protection.

6.6.4 CHANGING POWER TRANSFORMER TAPS

The AC Power transformer is normally wired for 115V, 50-60Hz input, but the primary taps may be easily rewired for higher or lower AC line voltage input. For Example: if you AC line voltage is low (say 104-110V), then move the wires on the T601 primary from the 115V lugs to the 105V lugs. Likewise, the primary can be wired for 220V input. See the schematic diagram on the power supply.

SECTION 7 ALIGNMENT

7.1 RECEIVER ALIGNMENT

Receiver alignment should not be require unless an RF transistor, IF IC101, or the receive frequency is changed. Even in this case, only a slight touch-up should be required.

7.1.1 FRONT-END ALIGNMENT

Connect a good quality FM signal generator to the receiver antenna jack and an AC voltmeter (or “Sinnader” Meter) from the hot speaker lead to chassis ground. With the signal generator set for minimum (0) output, note the average AC voltmeter reading. (Squelch full CCW). Increase the generator’s output level and tune it for best receiver quieting, (or best SINAD with 5 KHz deviation). Alternately tune the eight RF Amp trimmer caps (C103, 4, 9, 10, 12, 16, 17, 19) for best quieting (or SINAD), keeping the generator set for about 10dB of quieting (or 10-12dB SINAD). With the generator tuned for the best quieting point in the receiver pass-band, it should be possible to achieve 0.4µV or less for 20dB of quieting, (1/10 the original noise reading). Typical 12dB SINAD point is 0.3µV.

7.1.2 OSCILLATOR/MULTIPLIER ALIGHMENT

Apply a modulated test signal to the antenna jack (about 10µV). Using a standard hex alignment tool, tune the L110 oscillator slug in (CW) until the oscillator stops oscillating. (Received signal disappears) Slowly turn the slug out (CCW) until the oscillator just starts, then turn the slug out 1.5 turns past this point. If the oscillator does not stop, tune the coil for max L.O. output, or best SINAD as mentioned below. The multiplier coils L111 though L114 may be roughly tuned for best reception of an extremely weak signal; but for optimum alignment, a sensitive RF detector (RF voltmeter, Spectrum Analyzer, -10dBm power meter, etc.) should be connected to the L.O. output TP1 shown in Figure 6. The above coils should then be peaked for maximum output.

7.1.3 21.4 MHz IF ADJUSTMENT

Set the RF panel meter switch to the “RX signal” function. Apply an unmodulated signal to the receiver RF input at the proper frequency and increase the signal level until the front panel meter reads approximately 1/3 scale. Adjust L120 for maximum meter reading. Alternately, L120 may be adjusted for best SINAD on a weak signal, (approximately 0.25µV).

7.1.4 QUADATURE COIL ADJUSTMENT

Use the same setup as in 7.1.1. above, except inject a strong signal (approximately 100µV) into the receiver. Be sure the signal is on frequency and has 4-5 KHz deviation. Tune the Quad Coil L122 for maximum AF output voltage as read by the AC voltmeter. Then apply a small drop of cement to the coil slug.

7.1.5 SIGNAL STRENGTH (S-METER) ADJUSTMENT

Set the meter switch to the "RX Signal" function. With no input signal, adjust R137 for a 'zero' meter reading. (For a somewhat more "sensitive S-Meter, set R137 for a no signal reading of 0.5 on the scale.

7.1.6 CRYSTAL FREQUENCY ADJUSTMENT

Connect an accurate and sensitive frequency counter to TP1, and adjust the crystal trimmer cap (C122) for the correct frequency. The LO output frequency will be 21.400 MHz above the desired receive frequency for 136 to 151.00 MHz (& 220 MHz) receive frequencies; and 21.400 MHz below the desired receive frequency for 151.001 to 174 MHz receive frequencies.

7.2 TRANSMITTER ALIGNMENT

As noted with the receiver, the transmitter should not require alignment unless a RF transistor or IC is changed. Factory tune-up of these circuits is done with elaborate equipment including a spectrum analyzer. Subsequent adjustment should not be performed unless absolutely necessary, as improper alignment could result in undesirable spurious emissions. If alignment is necessary, perform only the applicable steps below.

7.2.1 Observe the Exciter Current Meter, with no crystal installed, the unit should draw 125-200mA in the transmit mode.

Check operation of the audio processing stages by connecting an oscilloscope probe to the wiper of the deviation control. With an input at E201 from an external audio generator, the waveform should be a clean sine-wave, turning into a square wave as the input audio level is increased. Adjustment of the deviation control should produce up to or 8 Volts of peak to peak audio at this point. When proper operation of these stages has been confirmed, set the deviation control at its mid-point and check for the modulated signal on a nearby receiver or deviation meter.

Install the crystal in its socket and key the transmitter. The indicated exciter current consumption should be noticeably higher (about 1.4 Amp @ 8W out, and about 1.8-2.2 Amp @ 10W out for the 220 MHz board.) A VHF RF power meter connected to the antenna connector should no indicate some RF output. Tune all trimmer capacitors for maximum RF output. C277 and C278 in the input circuit of the 30W power amplifier stage are adjusted for maximum drive to the device (indicated by final collector current), while C282 is adjusted for maximum power output consistent with good efficiency, (minimum collector current. Normally, CW adjustment). When tuning this stage, observe that tuning the output trimmers in one direction, (normally CCW), will cause a sharp rise in collector current with only a small change in output power. This indicates a decline in stage efficiency and should be avoided. When operating properly, the stage should draw 2.7 to 3.5 amps (at 13.8V) for 30W output, and, in no case, should the stage collector current be allowed to exceed 3.5 amps. Always tune the amplifier for maximum output efficiency and minimum white noise. Don't hesitate to loose a Watt or two of output if a large current savings or white noise reduction can be obtained. The reduced current will result in increased long-term reliability.

Tuning the system duplexer while the repeater transmitter is activated can cause very high VSWR conditions to be presented to the final amplifier stage. Always observe final collector current (on the front panel meter) when tuning the duplexer, and keep transmissions short when VSWR conditions are high.

REPLACING TRANSMIT CRYSTAL: If the crystal is replaced and it cannot be zeroed on frequency, change the value of C269 on the terminals near the crystal. If the TX frequency is too high, increase the value of C269. If it is too low, decrease the value of C269. (Typical range: 30 to 200pF).

7.2.2 SETTING TRANSMITTER DEVIATION

Set front pane RPT AUDIO pot at full CW. Apply a strong signal to the receiver input (100µV min) modulated with +/-5 KHz with a 1 KHz tone. Set the DEVIATION adjust pot (R212) for the desired maximum deviation. Typically 5 (commercial or 6 KHz (amateur) maximum. Then set the REPEAT AUDIO pot at the 12 o'clock position. Set the generator deviation for <hold>[3] deviation. Repeat these adjustments twice.

7.3 ID/AF MIXER BOARD ASJUSTMENTS

See Chassis Layout (Figure 5), and ID/AF Mixer Board Layout Drawings and schematic. As shown of the drawings, trim-pots are provided to adjust ID Code Speed, CW Tone, ID Timing Interval, ID Audio Output level, Local Mic Gain and AUX AF Input Level. The "Mic Gain" is normally set to max. "AUS Level" sets the deviation level of the AUX AF Input at jack J602-6.

"Code Speed" and "ID Time" may be set as desired. Note: Front Panel "Manual ID" button has no effect whatsoever on the ID timing interval. ID level is normally set for about 2 KHz deviation max. The "CS Tone" pot is adjusted for a pleasing tone pitch. If it is desired to change the "sound" or character of the CW note, the value of C6-8 may be changed on the board (see dwg. No. 3200114 and the schematic). For lower pitch notes add an additional 0.1µF cap; and for higher pitch tones, remove a 0.11µF cap.

7.4 POWER SUPPLY, REGULATOR & METERING BOARD ADJUSTMENTS

<u>R410 – 13.8V SUPPLY ADJUST:</u> Adjust for 13.8 volts at E1204 on the transmitter housing with a known accurate DC voltmeter or DVM. This adjustment should be made with the transmitter activated. After this, and each of the following adjustments, turn the meter knob back and forth one position several times to be sure the meter stabilizes on the correct reading each time. Some resistance in pointer movement is normal.

[3] Unable to read the scanned document clearly

R404 – VOLT METER CAL: After the power supply has been adjusted to 13.8 volts under load, put meter switch S606 in the 13.8V position and adjust R404 for an indication of 13.8V on the front panel meter.

R417 – EXCITER I METER CAL: Unsolder the wire connected to E1205 on the transmitter housing, and connect an accurate DC ammeter in the line. Activate the repeater transmitter and measure the current draw. With switch S606 in the "I EXC" position, adjust R417 so that the front panel meter reads the same current measured above.

R418 – FINAL I METER CAL: Unsolder the wire connected to E1204 on the transmitter housing and connect an accurate DC ammeter in the line. Activate the repeater transmitter and measure the current draw. With switch S606 in the "I FINAL" position, adjust R418 so that the front panel meter reads the same current measure above.

SECTION 8 TROUBLESHOOTING

8.1 RECEIVER TROUBLESHOOTING CHART

<table>
<tr><th>SYMPTOM</th><th>CHECK</th><th>REMEDY</th></tr>
<tr><td>No audio output</td><td>U104 Pin 4 (LM383) DC Voltage, with squelch open</td><td>Replace if less than 4V.</td></tr>
<tr><td>Receiver completely dead</td><td>9V Test Point, E114, (See Figure 6). 13.5V TP, E104.</td><td>If 13.5V is OK, but 9V is 0, replace Q111. (B+ line was shorted.</td></tr>
<tr><td>Squelch must be advanced somewhat in very hot or cold ambient day</td><td></td><td>Normal in extreme temperature conditions</td></tr>
<tr><td>Audio Output low and/or distorted; poor squelch performance.</td><td>Tuning of L122</td><td>Peak for max AF output on strong tone modulated signal.</td></tr>
<tr><td>Low Sensitivity, or no copy at all.</td><td>Q101, Q102, Q103, Q104, Q105, Q106.
Tuning of front-end trim caps
L.O. Tuning: L110, L111, L112, L113, L114</td><td>Replace if doubtful. (If Q101 is damaged, most likely it was due to high transmitter power entering receiver antenna jack, nearby lightening, etc. Check duplexer, cables, antenna, etch for intermittents.</td></tr>
<tr><td colspan="3">Note: The boards are designed to fold out for service. Be sure power is disconnected from the unit when a board is being moved. Also, be sure that no short circuits occur during servicing, as certain semiconductors could be instantly damaged.</td></tr>
<tr><td colspan="3">Note: Tubular Cap Color Code (Receiver and Transmitter Boards.
1) First two color bands are the same as standard resistor color code.
2) Third band – White = X0.1 and Gray = X.01
3) Fourth band – Gold = 5% tolerance
4) Example: Blue-Gray-White-Gold = 6.8pF, 5%</td></tr>
</table>

8.2 TRANSMITTER TROUBLESHOOTING CHART

SYMPTOM	CHECK	REMEDY
No power output (low final current)	1) Power supply voltage 2) Q308 on CTC100A Board; also Q201 3) Damaged final transistor 4) Power output of the exciter	1) Replace bad part 2) Ditto 3) Ditto 4) Retune Exciter or replace bad part
Low power output (high final current)	1) Detuned final 2) High VSWR 3) Shorted or open component in P.A. output circuit (check caps) 4) Damaged final transistor	1) Retune 2) Tune or replace antenna 3) Replace damaged part 4) Replace damaged part
Distorted Modulation	1) Excessive audio drive 2) Off frequency 3) IC201 with scope for distortion	1) Adjust R218 2) Adjust Xtal Trim cap C217 Replace defective parts
No Modulation	IC201 (Pins 12 & 10) with scope for distortion. (Inject 1KHz tone into E201).	Replace defective component(s)
Crystal can not be set to proper frequency	1) Off frequency crystal 2) Incorrect value of C269	1) Replace 2) Change C269 (30-200pF)
Excessive white noise or spurious	Exciter and/or final amp tuning – (trim caps). (Use of spectrum analyzer is highly recommended)	Tune for minimum noise or spurious consistent with maximum power out.

8.3 POWER SUPPLY TROUBLESHOOTING

Turn off the unit immediately after observing any power supply problem.

<table>
<tr><th>SYMPTOM</th><th>CHECK</th><th>REMEDY</th></tr>
<tr><td>13.8V Supply dead. Panel meter 0; or, very high (meter pegged. AC hum on transmitter signal</td><td>Q601, Q602</td><td>Replace if shorted or open.</td></tr>
<tr><td colspan="3">Normal DC Voltage readings on Q601 are:
• Collector to Ground: 22-25V
• Base to Ground: 16V
• Emitter to Ground: 15V
If replacing Q601 and Q602 does not work, replace IC401, but this normally is not required.</td></tr>
</table>

APPENDIX

FIGURE 1: FRONT VIEW OF THE SCR1000 (image not available)
FIGURE 2: REAR VIEW OF THE SCR1000 (image not available)
FIGURE 3: UNDER CHASSIS VIEW (image not available)

FIGURE 4: CHASSIS LAYOUT (1)

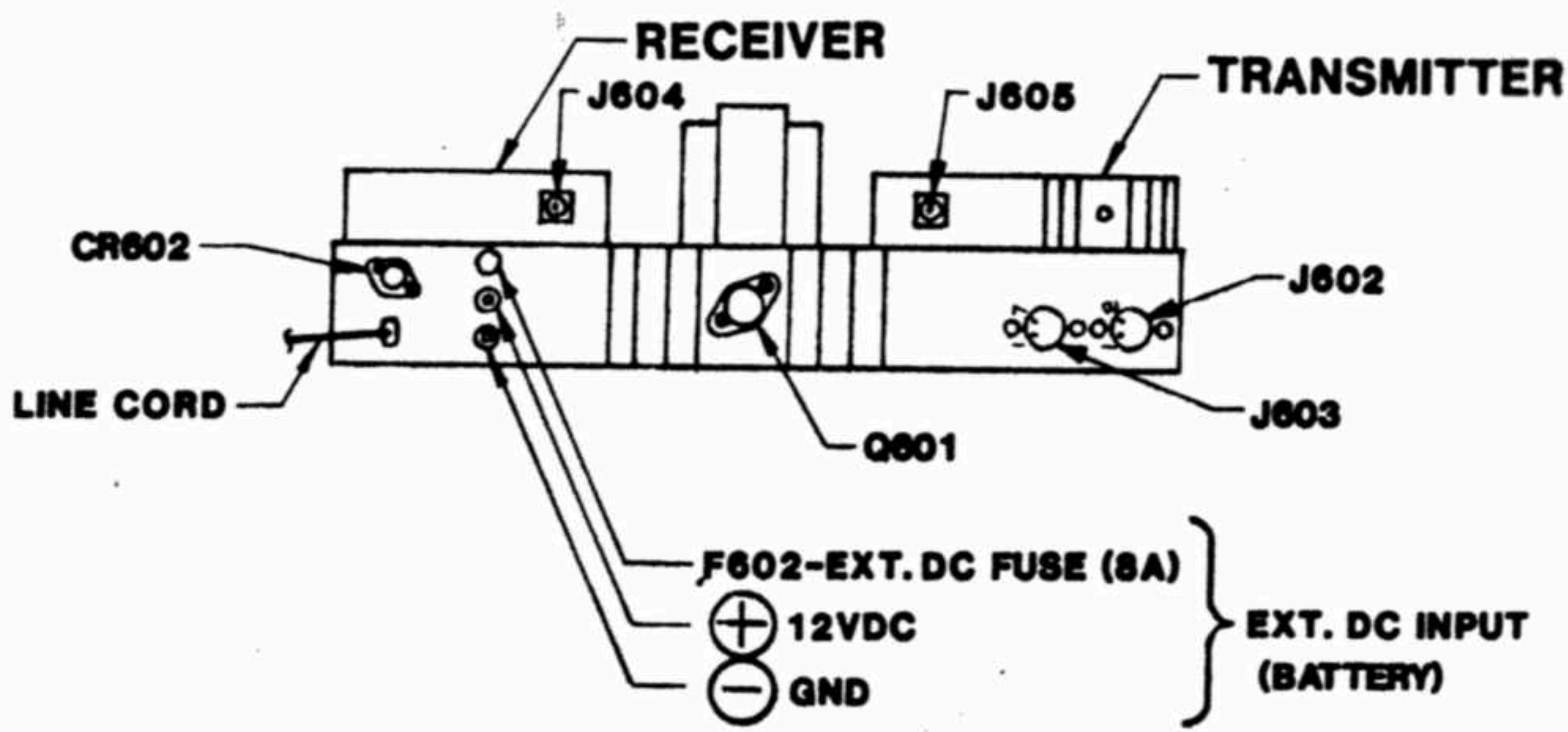


FIGURE 4

FIGURE 5: CHASSIS LAYOUT (2)

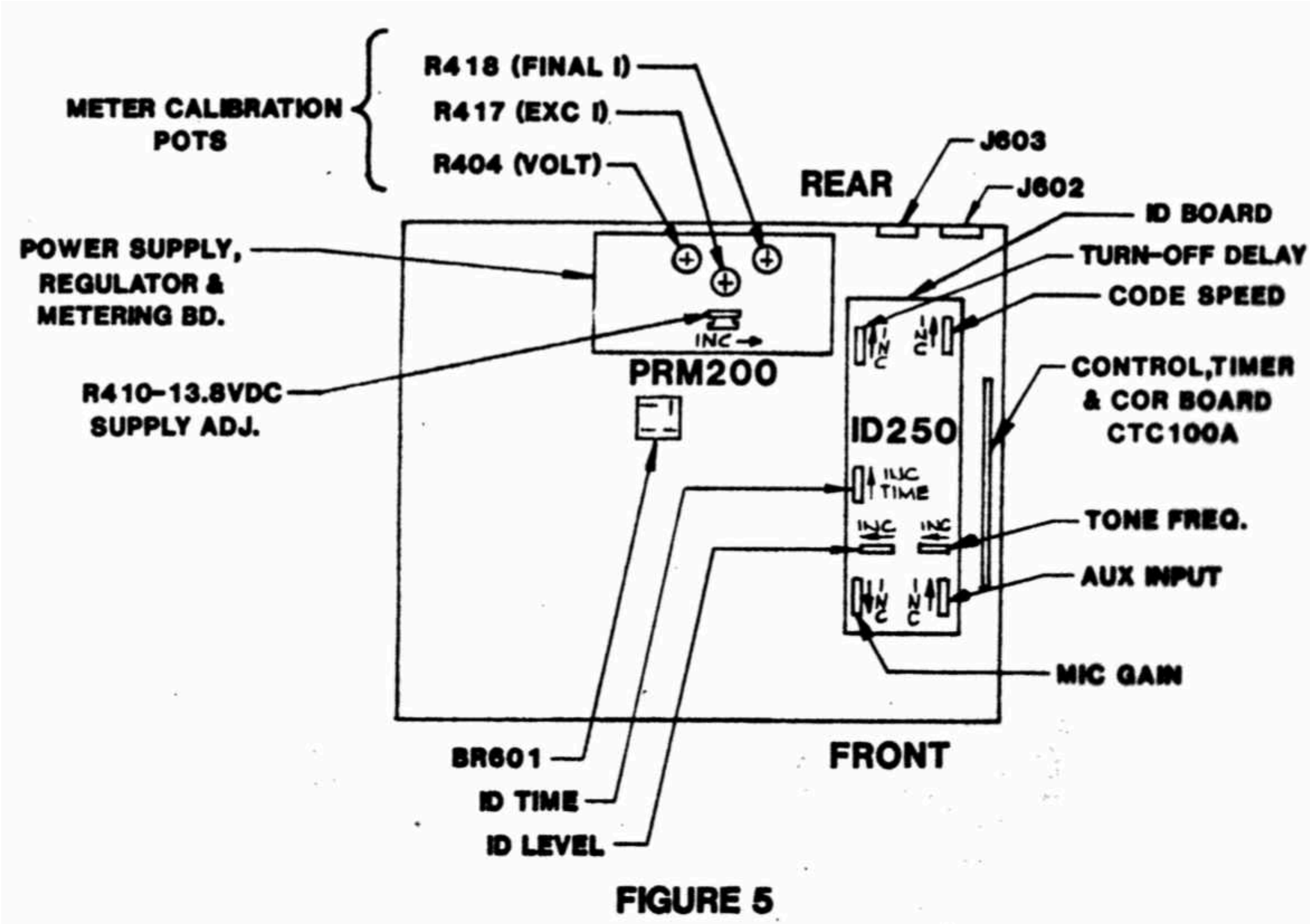
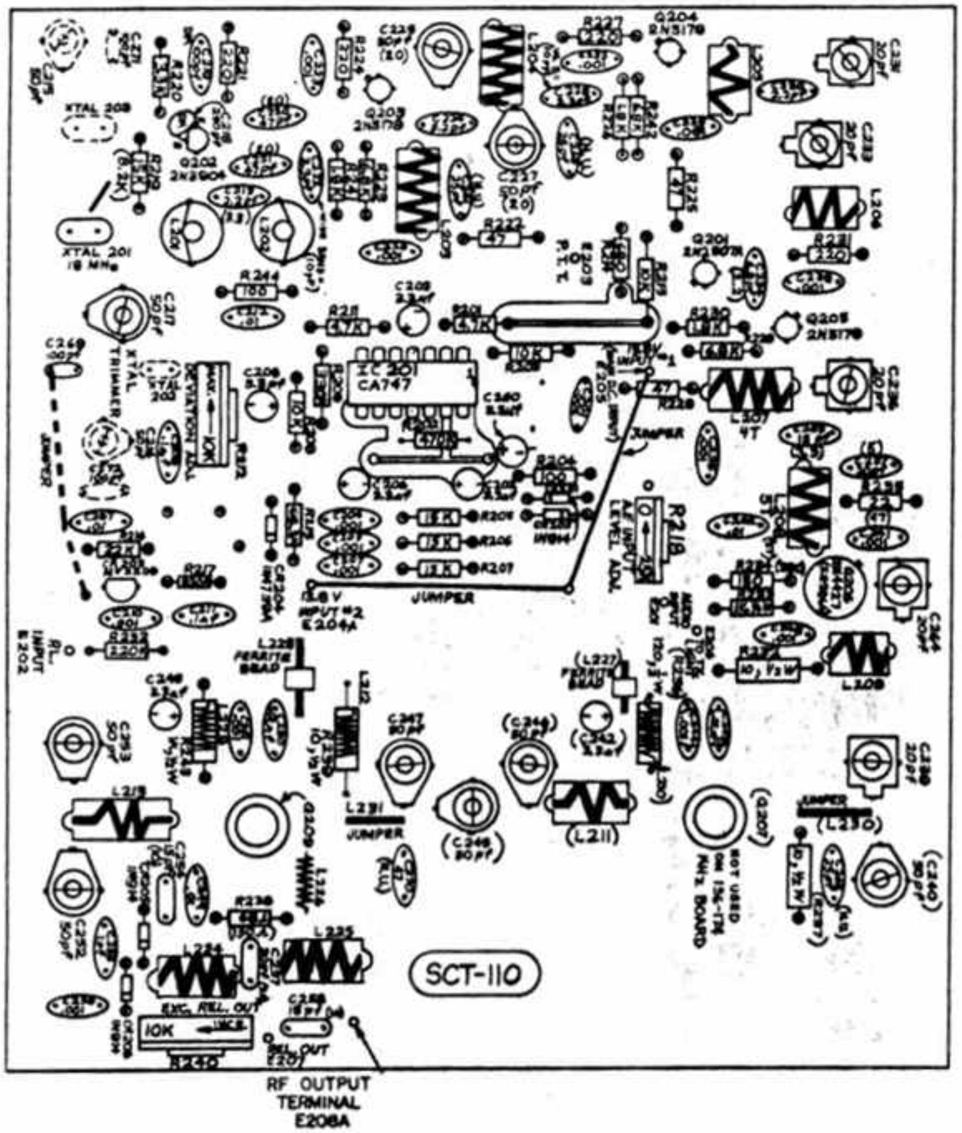


FIGURE 6: RECEIVER BOARD COMPONENT LAYOUT (image not available)

FIGURE 7a: TRANSMITTER BOARD LAYOUT



NOTES:
1) VALUES IN ( ) ARE FOR 220 MHz UNIT.
(N.U.) = NOT USED ON 220 MHz UNIT.
2) NOT ALL PARTS SHOWN ARE USED ON ALL VERSIONS OF THE SCT-110.

FIGURE 7b: CRYSTAL OSCILLATOR OVEN MODULE LAYOUT

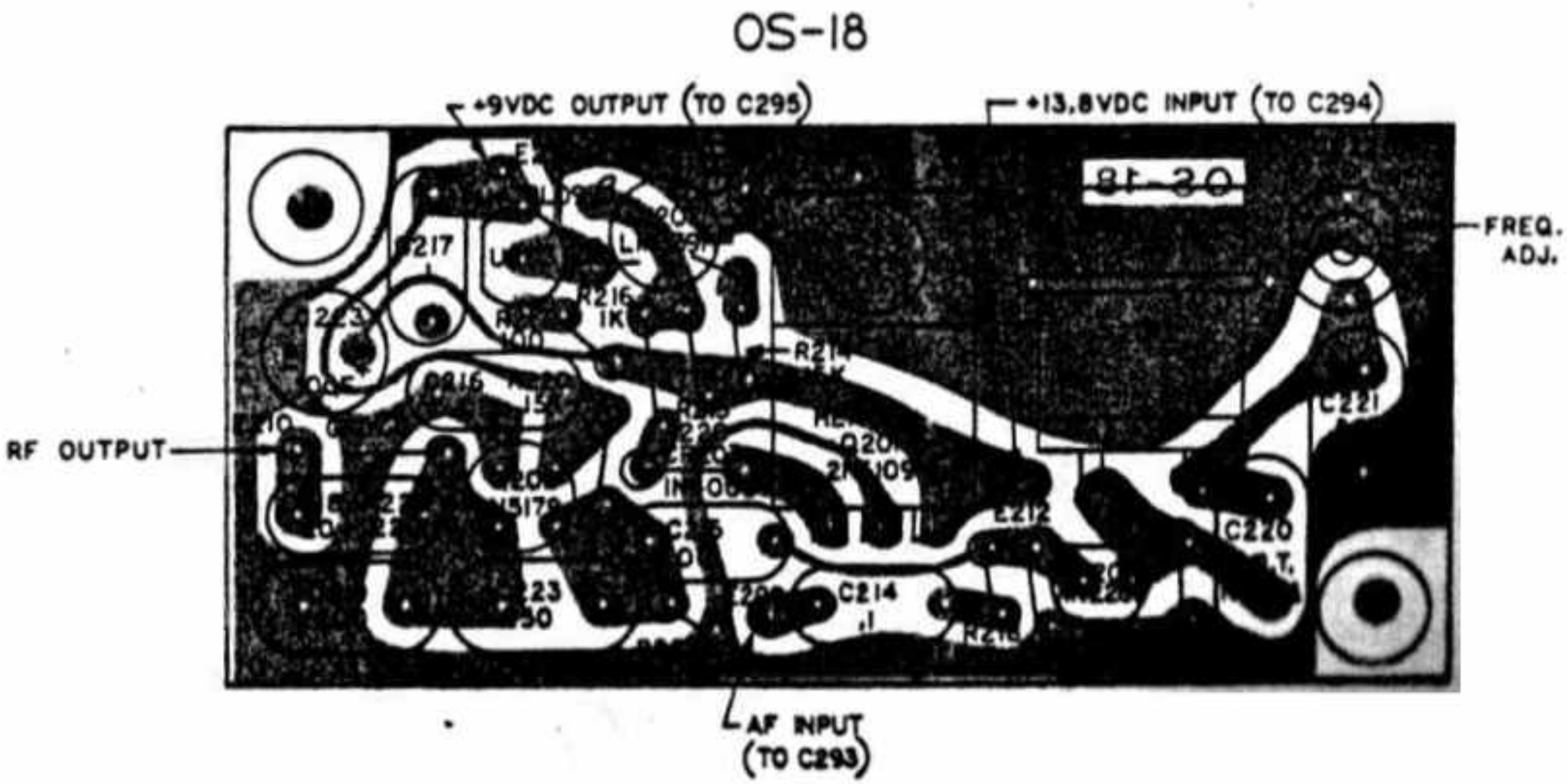


FIGURE 8: CRYSTAL OSCILLATOR/OVEN MODUEL SCHEMATIC

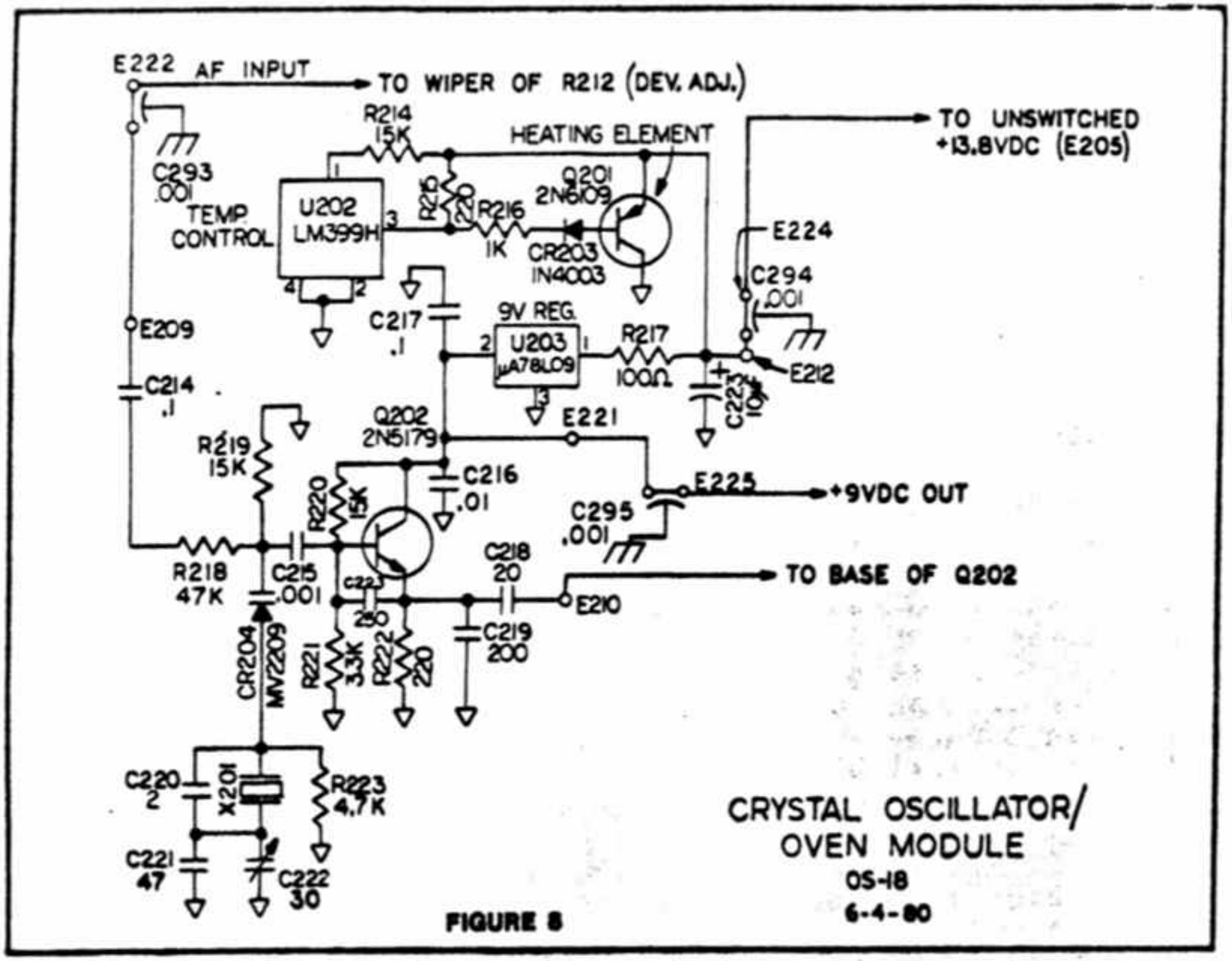


FIGURE 8

FIGURE 9: AMPLIFIER BOARD

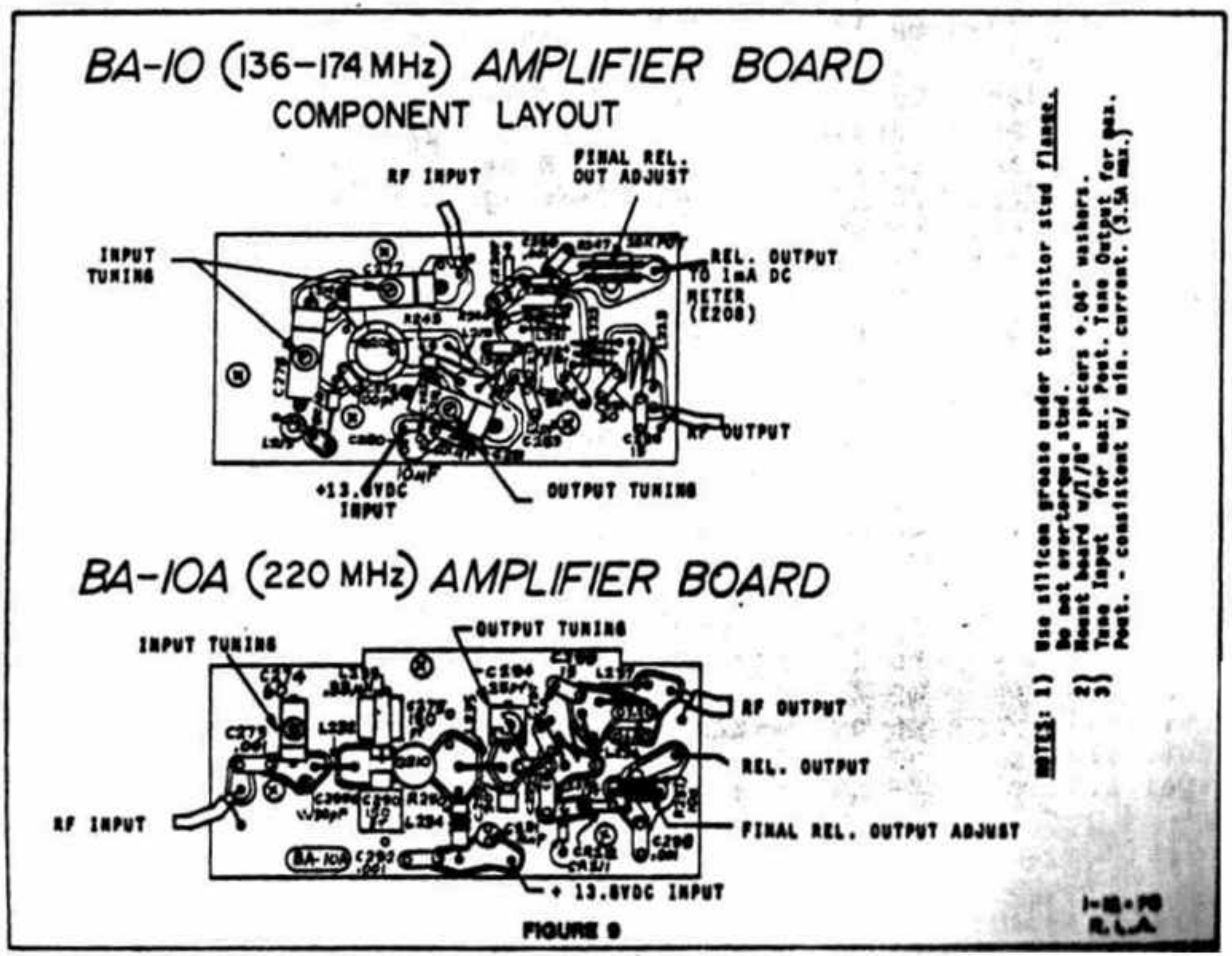


FIGURE 10: COR/TIMER/CONTROL BOARD CTC100A LAYOUT

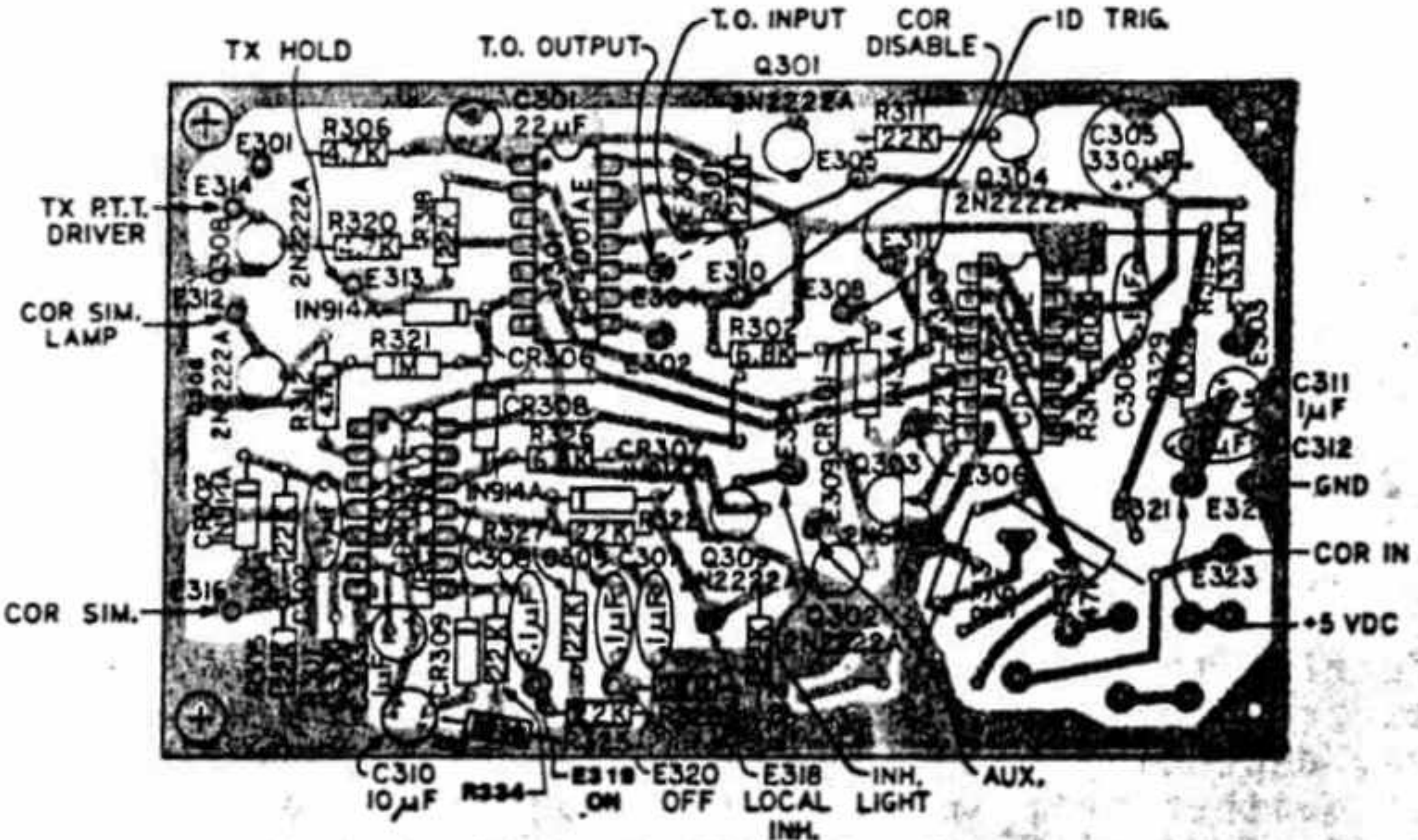


FIGURE 11: POWER SUPPLY BOARD LAYOUT

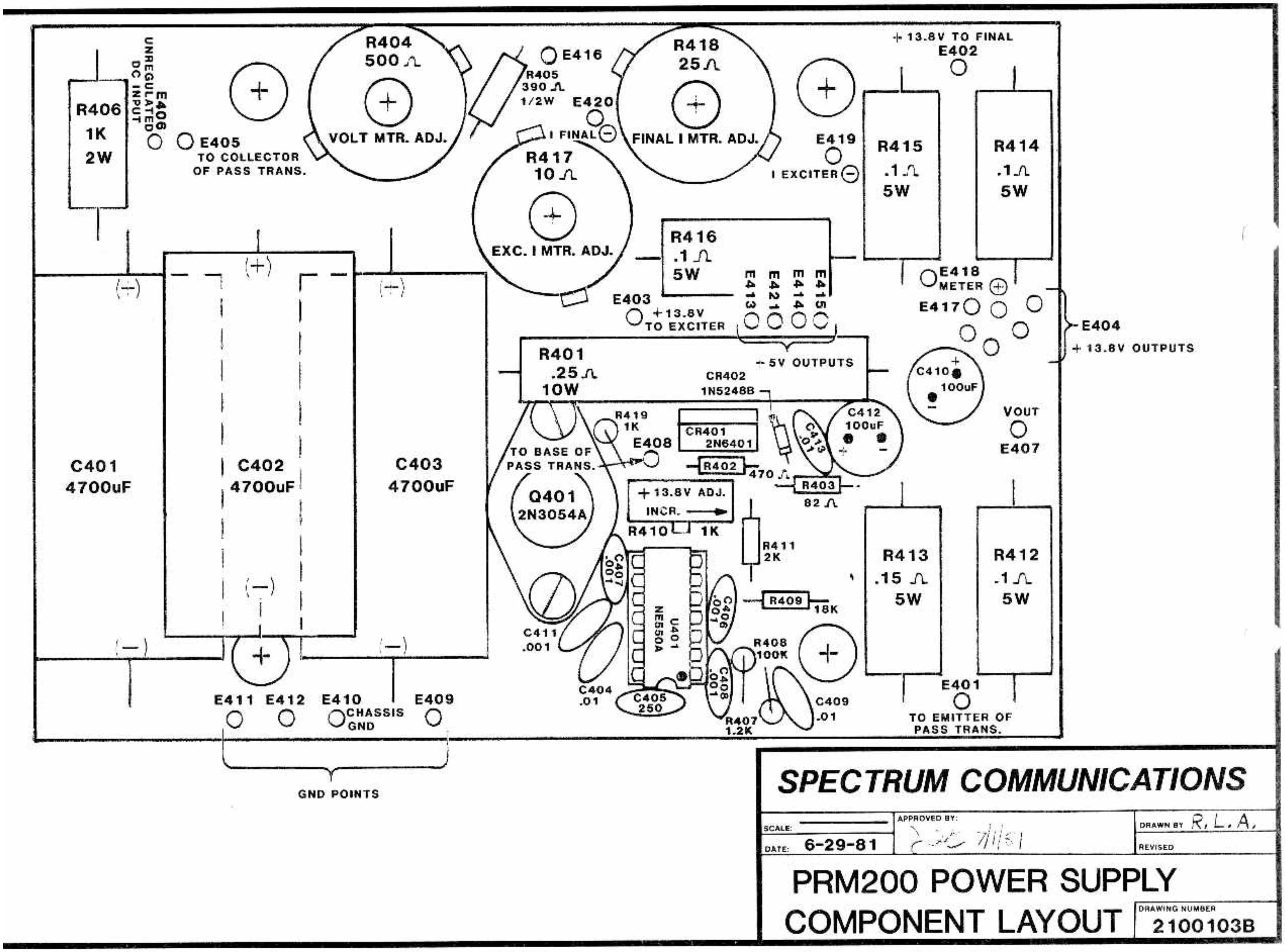
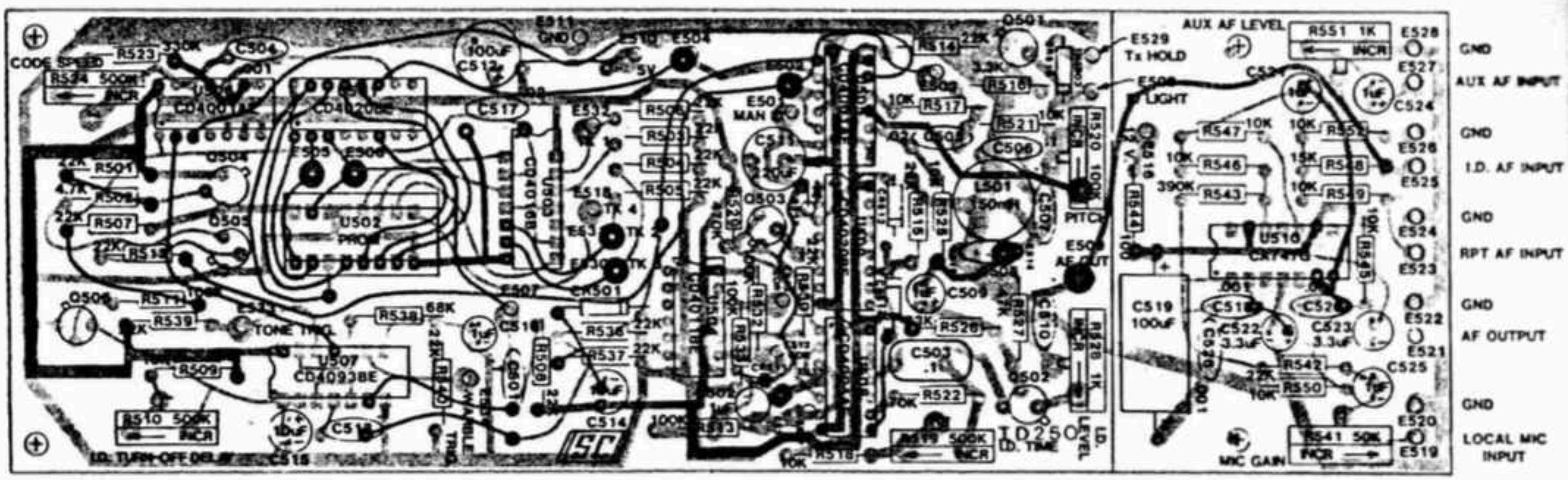


FIGURE 12: I.D. BOARD COMPONENT LAYOUT



NOTES:

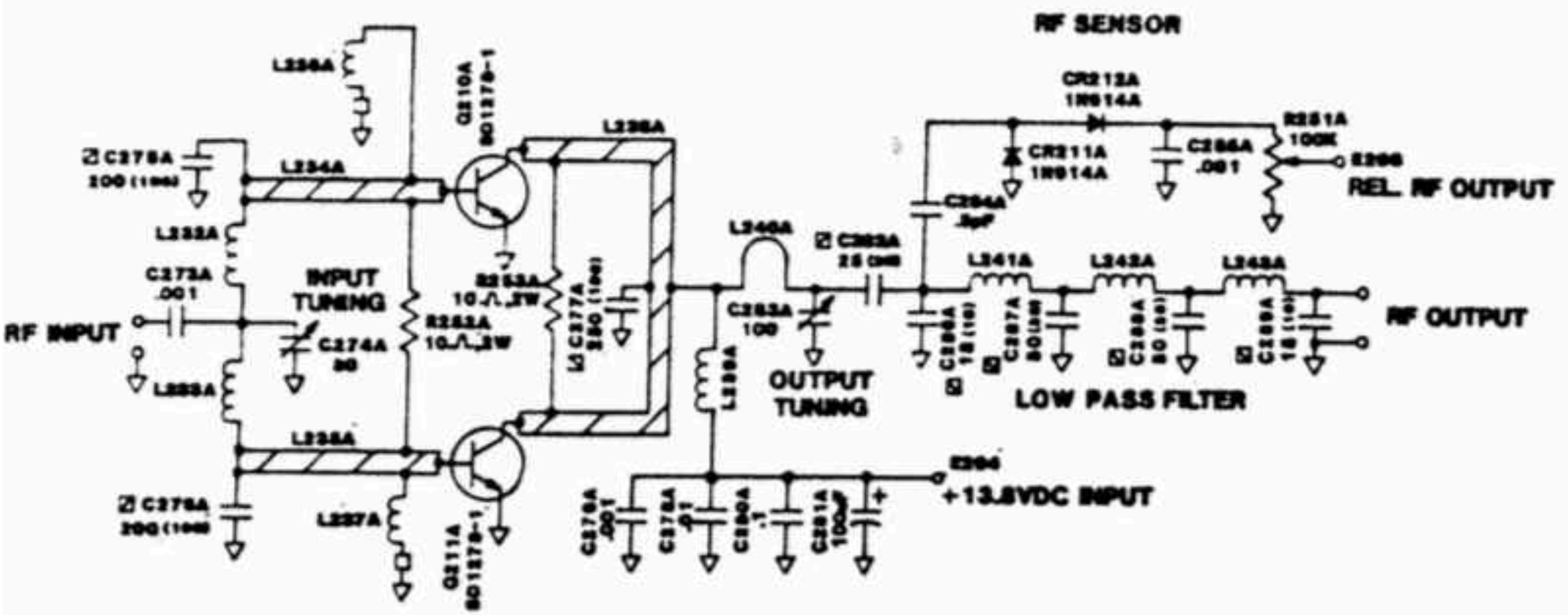
1) ALL TRANSISTORS ARE 2N2222A'S EXCEPT Q504 WHICH IS A 2N2907A.
2) U502-DM74S287N, DM74S387N/N82S129N.
3) E505 WILL TURN-OFF PROM AFTER 128 BITS WHEN CONNECTED TO E507.
4) E506 WILL TURN-OFF PROM AFTER 256 BITS WHEN CONNECTED TO E507.
5) ALL DIODES ARE 1N914A'S UNLESS OTHERWISE SPECIFIED.

SPECTRUM COMMUNICATIONS

ID250 COMPONENT LAYOUT

10-24-80

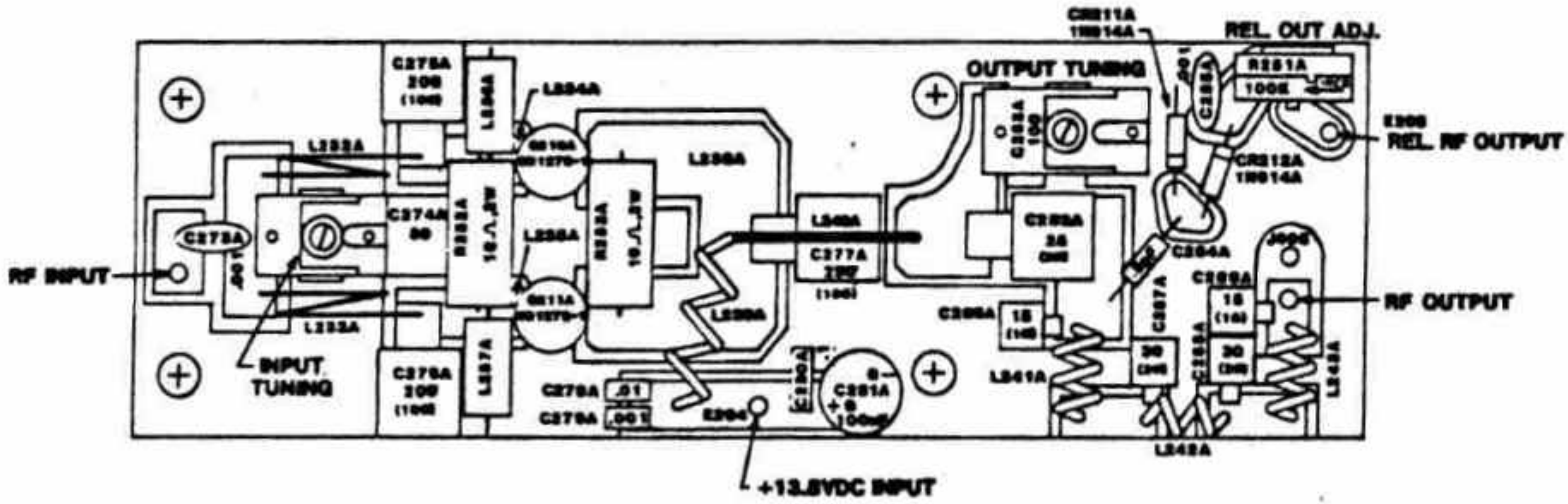
FIGURE 13: BA75 HIGH POWER P.A. OPTION SCHEMATIC



NOTES:

1) ☒ INDICATES STANDEX CHIP CAPS.
2) ( )DENOTES VALUE CHANGES FOR 216-230MHz.
3)POWER OUTPUT IS 60W MIN. FOR 216-230MHz.

FIGURE 14: BA-75RPT AMP LAYOUT



NOTES:

1) ( )DENOTES VALUE CHANGES FOR 216-230MHz.
2)POWER OUTPUT IS 60W MIN. FOR 216-230MHz.

FIGURE 15: (image not available)

FIGURE 16: COR/TIMER/CONTROL BOARD SCHEMATIC

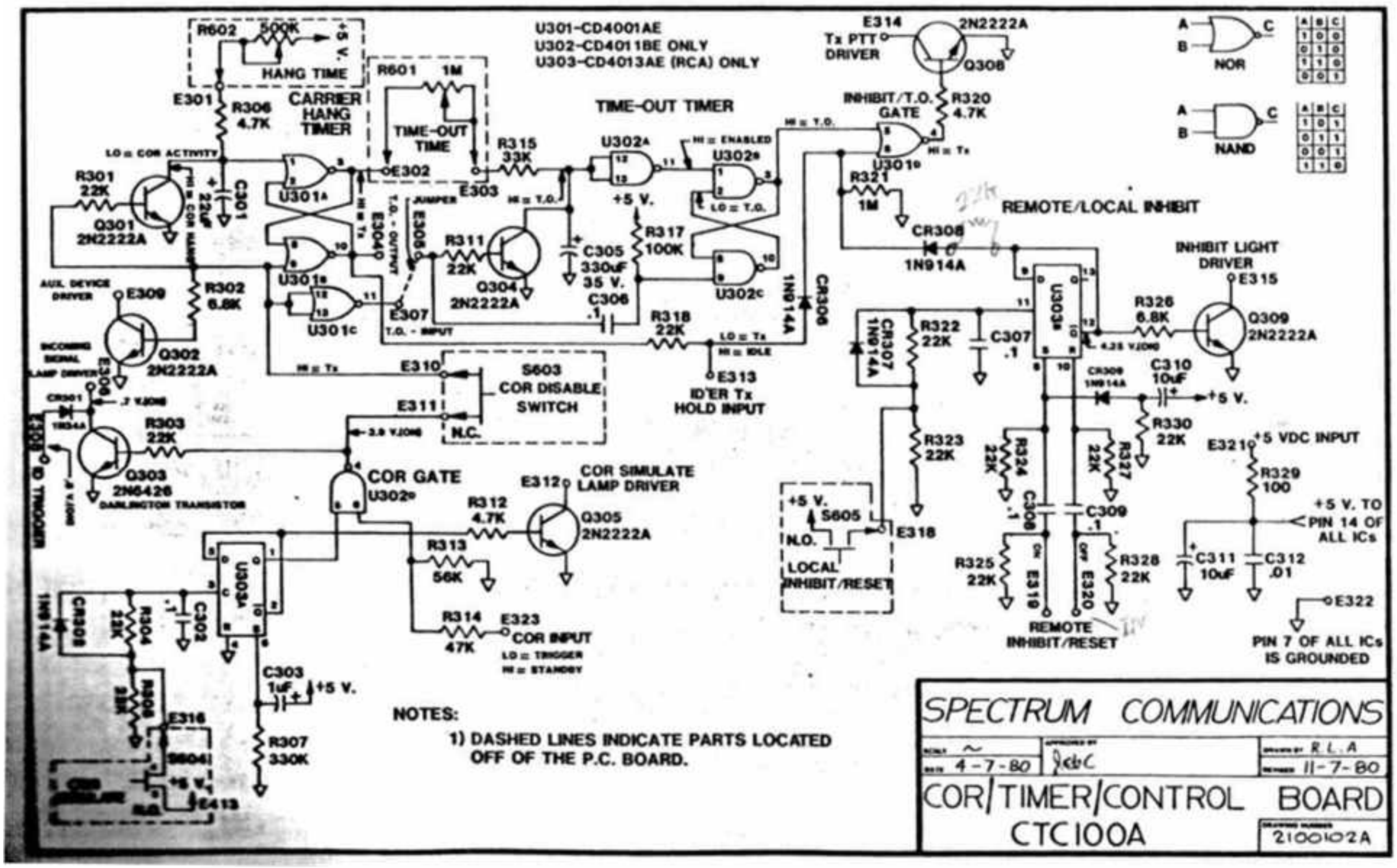


FIGURE 17: ID & AUDIO MIXER BOARD SCHEMATIC

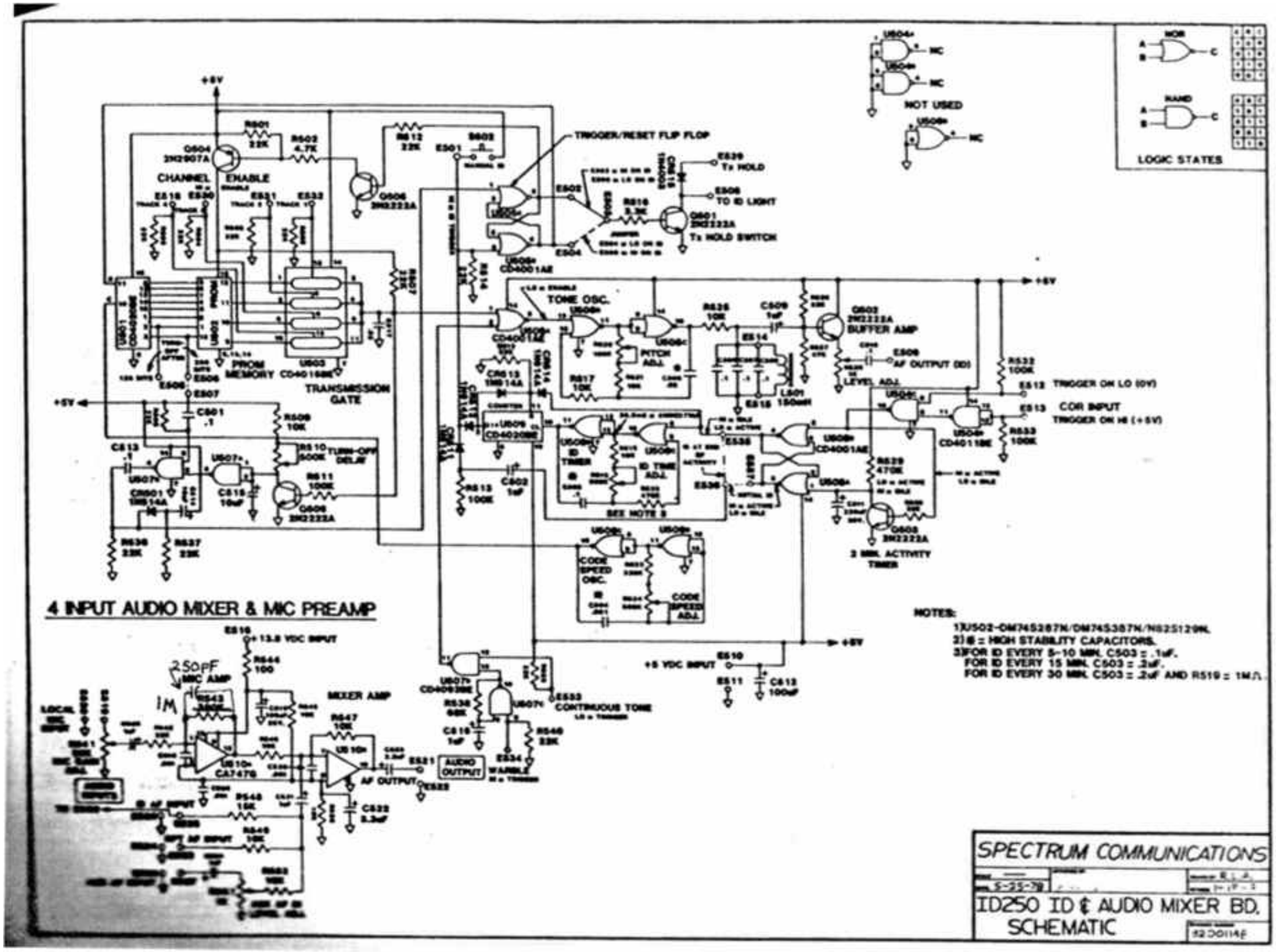


FIGURE 18: POWER SUPPLY AND METERING SCHEMATIC