OPERATING MANUAL

EMTRON DX-3SP

HF LINEAR AMPLIFIER

February 2009

Emtron

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INITIAL SETTINGS FOR PLATE AND LOAD CAPACITORS

TEST FREQUENCY	BAND	FACTORY SETTINGS 50 OHM LOAD		USER SETTINGS ANTENNA	
		PLATE	LOAD	PLATE	LOAD
28.600 MHz	10m				
24.900 MHz	12m				
21.200 MHz	15m				
18.100 MHz	17m				
14.200 MHz	20m				
10.125 MHz	30m				
7.070 MHz	40m				
3.600 MHz	80m				
1.800 MHz	160m				
1.850 MHz	160m				
1.900 MHz	160m				

TABLE 1

(Also found in Chapter 10)

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DX-3SP LINEAR AMPLIFIER

Serial No . . . . . .

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CAUTION

The DX-3SP has been designed for 100% safe operation and long life. Interlocking sensing circuitry constantly monitors conditions inside the amplifier. It must be noted however, that the high voltages present inside the DX-3SP are EXTREMELY DANGEROUS. Do not remove the top cover under any circumstances if any leads are still plugged into the rear of the amplifier - especially if the AC lead is plugged in the power outlet. Before any component inside the high voltage, power supply or output section is touched, unplug all rear panel leads and allow at least 5 minutes of 'off time'. After that, you should further check this by momentarily shorting the tube anode to the chassis with a suitable insulated lead.

1 GENERAL DESCRIPTION

The Emtron DX-3SP Linear Amplifier is a 4000 watt average output power, for the 160m through 10m amateur bands (9 bands), housed in a desk-top cabinet with self-contained power supply and cooling system.

It utilises a two high performance tetrodes, type FU-728F, a ceramic metal tube with a plate dissipation of 1500W. The tubes are air cooled by a commercial grade forced air turbine blower system and two extra suction fans above the tube.

Tetrodes offer exceptionally stable operation and levels of quality performance far exceeding that which can be expected from triodes. The harmonic output and intermodulation distortion achieved with this tube are exceptionally low. This is especially important when dealing with a high output power.

The Emtron DX-3SP is supplied as standard with a host of features including solid state metering and comprehensive protection systems.

In addition, a unique Emtron QSK module is available as standard. With this installed, extremely rapid switching times between transmit and receive are possible, with consequent advantages when using CW or the digital modes.

Operation of the DX-3SP is greatly simplified by the absence of meter switching and of front panel level setting controls. The front panel moving LED display systems indicate simultaneously: the output forward and reverse power, screen grid current (positive and negative), the plate voltage and the plate current, while 5 single LED’s indicate: Ready, Overdrive warning, High SWR cut-off indication, On Air and Fault.

The Emtron Electronic Bias Switch (EBS) automatically switches the standing current (typically 0.5 A) off when there is no modulation. This reduces the average tube dissipation.

On initial switch on, the unique Emtron "soft start" circuitry ensures that no damaging AC surge currents are generated.

Professional, fine output tuning adjustment is possible, due to the 6: 1 reduction mechanism fitted.

1.1 DX-3SP – Internal View

The main components of a DX-3SP amplifier are shown in the picture below.

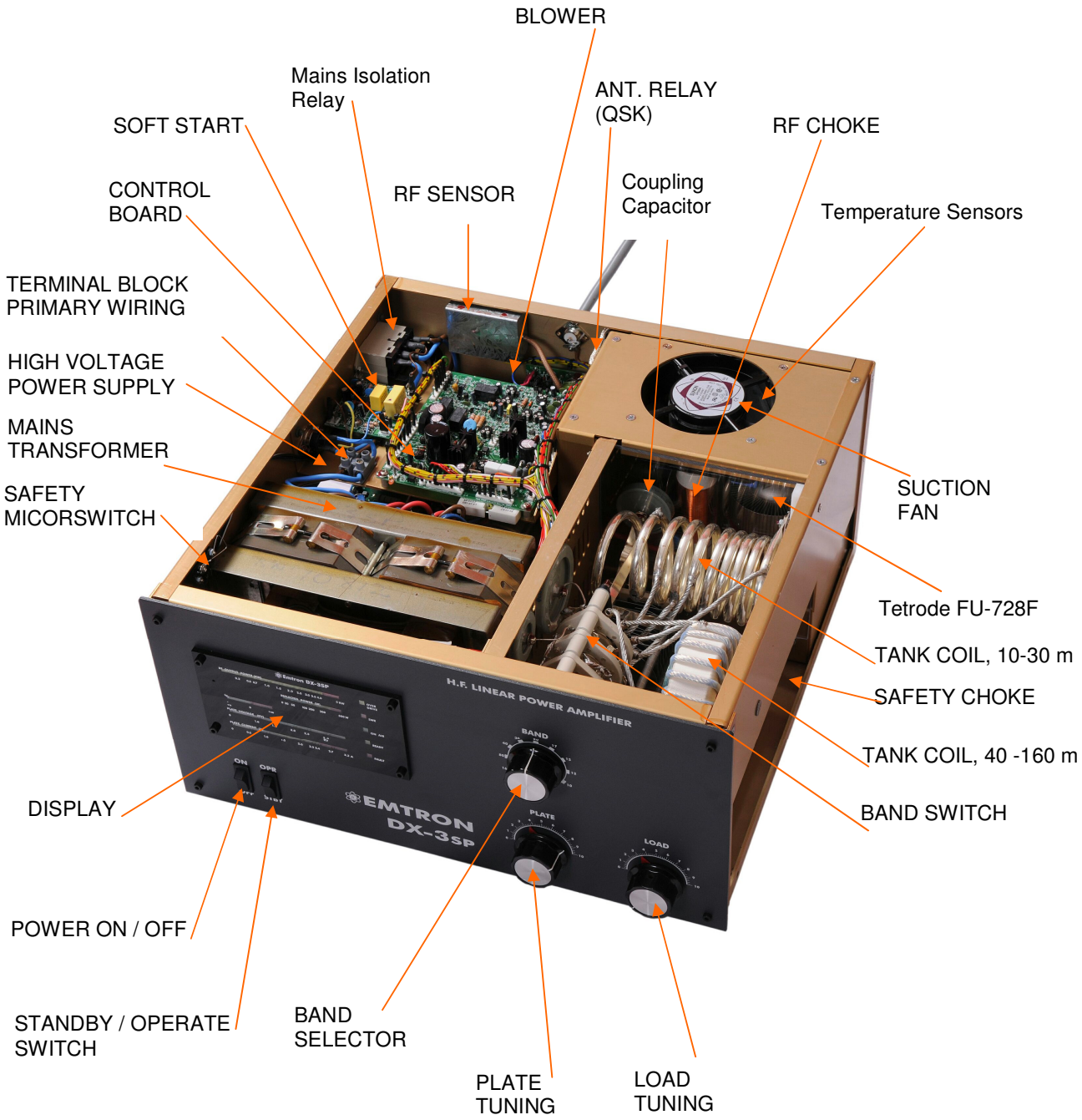


Figure 1

2 TECHNICAL SPECIFICATIONS

FREQUENCY COVERAGE: Complete (manually tuned) coverage of the nine HF amateur bands:

1.800 – 2.000 MHz
3.500 – 4.000 MHz
7.000 – 7.500 MHz
10.000 – 10.300 MHz
14.000 – 14.350 MHz
18.000 – 18.500 MHz
21.000 – 21.500 MHz
24.000 – 24.500 MHz
28.500 – 29.990 MHz

TRANSMITTING MODES: The DX-3SP supports SSB, CW, AM, FM, RTTY and SSTV.

OUTPUT POWER: Typical 4000 watts carrier or up to 5000 W PEP

DUTY CYCLE: Suitable for SSB operation.

CW: 4 minutes transmit, 1 minute receive.

AM: 3 minutes transmit, 1 minute receive.

DRIVE POWER: Nominal 60-90 watts for full rated output.

INPUT IMPEDANCE: Nominal 50 ohm passive impedance, unbalanced. VSWR 1.4:1 or less.

OUTPUT IMPEDANCE: Nominal 50 ohm passive impedance, unbalanced. VSWR 2.6:1 or less.

DISTORTION: Third order intermodulation products are more than 35 dB below rated output.

HARMONICS: Harmonic output is better than 50dB below the rated output.

FAULT PROTECTION: The comprehensive fault protection system includes circuitry to monitor:

- *plate current:* should the plate current exceed a safe value, the amplifier goes to standby for 2 minutes. The nominal trip plate current is 2.5 A
- *screen grid over-current:* Absolute tube protection is offered with visual warning and a reduced power level being enabled if the screen current exceeds a pre-set limit.

  The screen current is limited to about 50 – 60 mA total, for the 2 tubes.
- *temperature:* Should the tube's temperature exceed a specific level, amplifier operation is suspended until the temperature drops to a safe level.

  The cut-off temperature sensor has a nominal value of 110° (230F).

  The fan speed control temperature sensor has a nominal value of 80° (176F).

OPERATIONAL PROTECTION

- *Overdrive protection:* Should the DX-3SP be overdriven, a LED warning indicator will light up when the linearity limit is reached. If the drive is increased further, a 2 second cut off (by-pass) will follow.

- *SWR protection:* Should the DX-3SP sense an SWR exceeding 2.6:1, a LED warning indicator will light up, simultaneously with a 3 second cut off.

METERING: The front panel moving LED display systems indicate:

"Moving light" LED indicators:

- output power
- reflected power
- screen grid current (positive / negative)
- plate voltage
- plate current

Five single LED's:

- on air
- ready
- fault
- overdrive warning
- SWR cut-off indicator

EBS: Electronic Bias Switch - automatically switches the standing current (about 0.5 A) to a lower ("pre-bias") value - when there is no input drive.

PRE-BIAS: A small current will flow in the tube when the amplifier is keyed on, but there is no modulation. This will prevent a harsh sound at the beginning of each word, when the EBS is activated and the tube goes through a non-linear zone, before reaching the correct initial bias.

The nominal Pre-Bias current is 40 mA (30 to 60 mA, not critical).

QSK: makes possible the antenna switching at very fast rate - typically 3ms switching time in each direction.

SOFT START: when switched on, the mains power is gradually applied to the transformer, over a period of about 5 seconds, to avoid the high in-rush current typical for such high loads.

Typical voltage drop on the triac: 1 V when not transmitting, <2 V at full power.

PTT Switching: Open circuit voltage +6 VDC. Ground to key (6 mA to ground).

COOLING: Two speed forced air cooling.

OPERATING TEMPERATURE: 0 to 40° Celsius

FUSING: Two 40 A normal acting fuses in each mains line on the rear panel.

OPERATING MAINS VOLTAGE: 200 to 240 V, Single Phase (Transformer taps: 200, 220, 230, 240 V).

Optional 400V, power between 2 mains phases.

CURRENT CONSUMPTION: about 35 A_{RMS} when transmitting full power at 240 V mains.

DIMENSIONS: 470 mm wide, 250 mm high, 470 mm deep (18.5" x 10" x 18.5")

WEIGHT: 55 kg (120 lb) unpacked (with the transformer installed)

TRANSFORMER: shipped separately in a wooden box approx. 310 x 250 x 260 mm (12" x 10" x 10.25"), 30 kg (66 lb).

3 UNPACKING

The DX-3SP is packed in a heavy duty package easily sufficient to protect the amplifier during transportation, even in case of fairly rough handling. The weight of the mains transformer does mean, however, that dropping the amplifier would without doubt result in some damage when the transformer is installed inside.

3.1 Opening the carton

When opening the packing, do not cut the carton. Save the packing material for possible further re-use. Shipment of your DX-3SP in other than factory packing may result in non-warranty damage.

3.2 Opening the DX-3SP cover

Remove the 4 screws on each side and remove the cover. An inspection of the interior of the amplifier should reveal no damage or adversely affected components. Should there be any form of problem, notify your supplier immediately.

3.3 Installing the transformer

Make sure the transformer is wired for the nominal mains voltage in your area. See 7.4.

Two people are needed to install the transformer. The best is to put the DX-3SP on a flat, smooth surface such as a bench or a table-top, covered by a small carpet of a folded blanket, so that it can be moved by sliding it on the table. Locate the cover micro-switch and temporarily tape the micro-switch down to avoid damage to the sense wire during transformer installation.

Lift the transformer and lower it into the chassis, positioned with the 12-pin connector towards the front of the amplifier. Put the transformer in at a slight sidewise angle, while taking care that it does not touch the sections of the wire loom between the control board and the front panel display. Mind also the micro-switch, the front panel switches and the control board at the back. *See pictures below.*

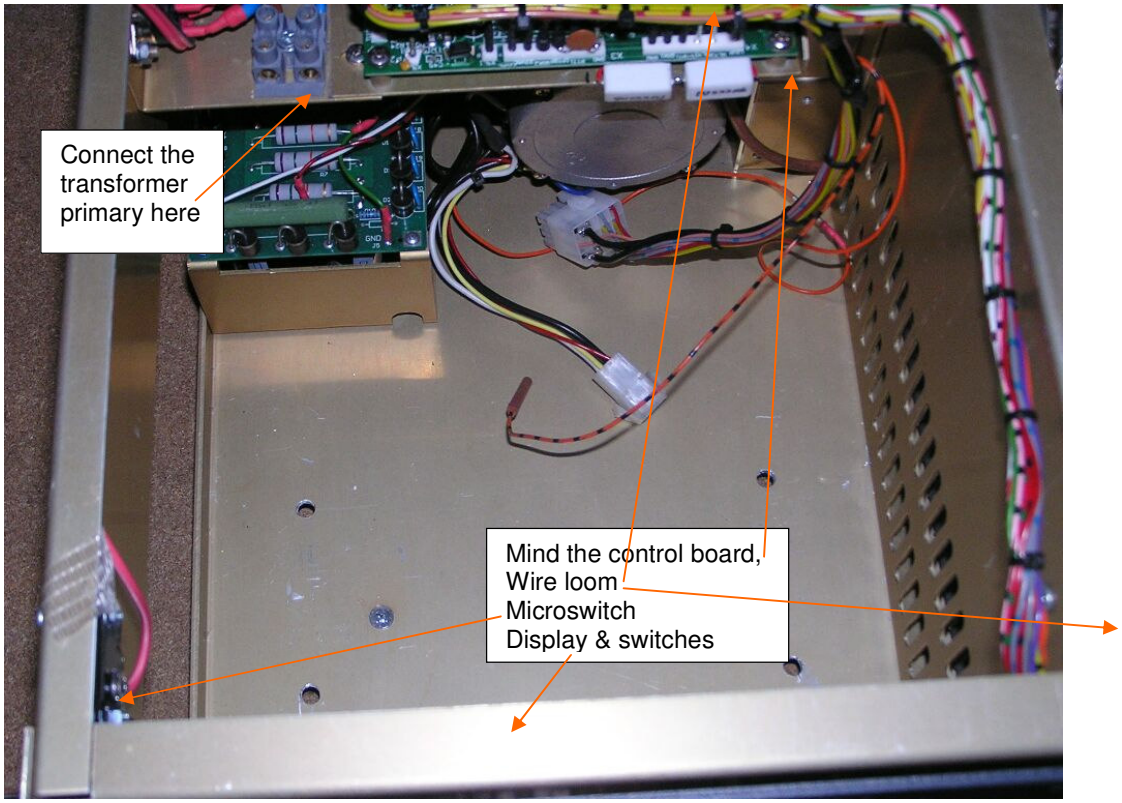


Figure 2

Move the transformer close to the front panel (do not slide it – lift it and move). This will create more space at the back, so that the high voltage wires can be connected. Plug the two wires from the high voltage power supply into the 2 pins at the lower part of the transformer. Connect also the 4-way connector and the orange / black wire. The mating single wire comes from the blower mounted relay and it is orange / black. It is the only single wire that will mate with the connector. *See Fig. 3 below*.

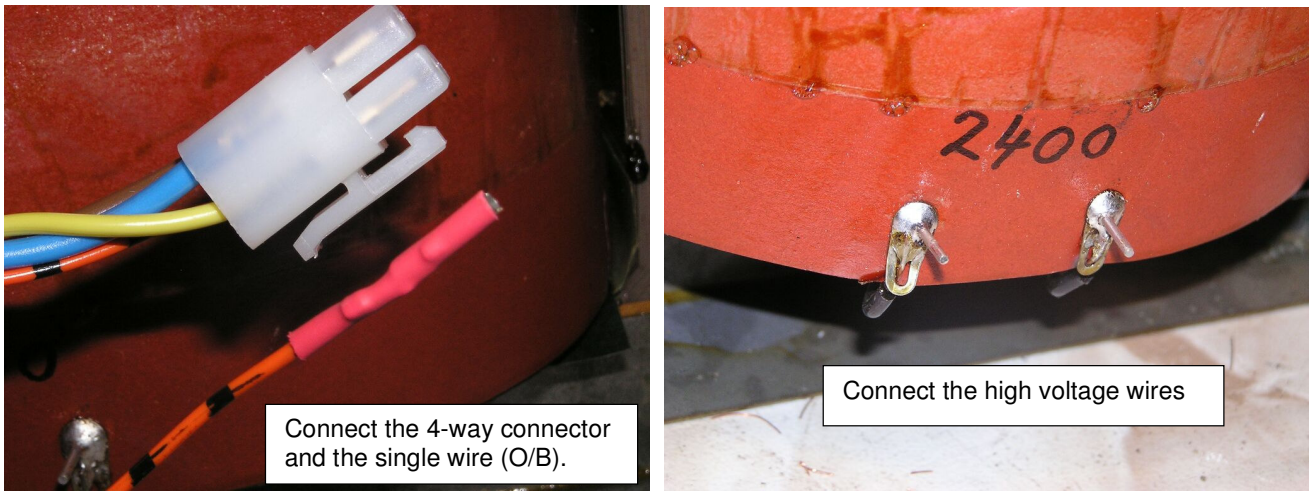


Figure 3

Move the transformer to the middle position, trying to line up the holes in the transformer with the holes in the chassis. When the holes line up, pull the amplifier so that it overhangs, about 1/3 on the desk and 2/3 out. Make sure somebody is helping during this operation. The back of a chair of suitable height can be used to help support the amplifier, but make sure someone else is holding it firmly in position. Insert the screws and washers from underneath. When all 4 screws are in, tighten them firmly using a large size Philips screwdriver.

Plug in the 12-way connector.

Connect the 2 mains wires to the terminal block of the soft start module. *See pictures, Fig.1, Fig.2.*
Remove the tape securing the cover interlock switch down before installing cover. Put the cover back and the installation is complete.

4 INSTALLATION ENVIRONMENT

4.1 Required environment

The DX-3SP amplifier can be operated at an ambient temperature between 0 and 40° Celsius. It should be installed in a place with good ventilation and protected from the direct sunlight. At least 5 cm (2"of free space must be left at the left and right of the amplifier for ventilation. Do not place any object on top of the amplifier, especially above the ventilation opening.

An environment free of dust, smoke and high humidity is required, as for any high powered RF amplifier. Dust or particles resulting from burning fire wood or coal could be responsible for sparks or electrical discharges between the capacitor plates, or in other parts of the RF section.

4.2 Power requirements

Single phase, 200, 220, 230 or 240 Vac nominal or 400 Vac (special order)

When operating at full power, up to 37A from the 200 VAC mains is required (even more if tuning is not correct). Ensure that the AC supply you intend to use is fully rated and properly fused. The Emtron "soft start" circuitry ensures that there are no momentary surges of current at power-up; therefore the fuse does not need to be over-rated. However, the wiring of the mains supply for the amplifier should be able to handle the power at full load with minimal drop in the voltage, to insure the performance of your DX-3SP does not suffer.

5 FRONT PANEL

The following controls and indicators are present on the front panel:

5.1 Controls

BAND SWITCH

A nine position switch selects the desired frequency range. The operating bands are indicated in metres.

PLATE TUNE

Tunes the amplifier operating frequency. A chart of approximate starting settings is given in Table-1

LOAD TUNE

Tunes the amplifier output loading. A chart of approximate starting settings is given in Table-1

ON/OFF

Switches the AC power on and off. On initial switch on, the standby mode is enabled. Note also the appropriate switch down sequence, given in Section 11.

OPR/STBY

Enables the amplifier once it has warmed up. In STANDBY mode, the screen voltage is removed and any RF power applied to the input is bypassed to the output. If this switch is changed to OPERATE before the READY light comes on, the FAULT light will turn on. This is not a fault, but it is better to leave the switch in STBY position until the amplifier is ready to operate.

5.2 Displays

All the DX-3SP indicators are concentrated in a single, "moving light" display (*See Fig. 4*). The following values are displayed (top to bottom):

Output Power - Scale up to 5 kW, non linear.

Reflected Power - Scale up to 500W, non linear.

Plate Voltage - Scale up to 3.5 kV

Ig2 - Zero-centered display. Green: full scale 80 mA reverse screen current. Red: full scale 50 mA of positive screen current. Above this value, the red LEDs will flash, warning to increase the loading, or reduce the drive.

Plate Current - Scale up to 3.2 A.

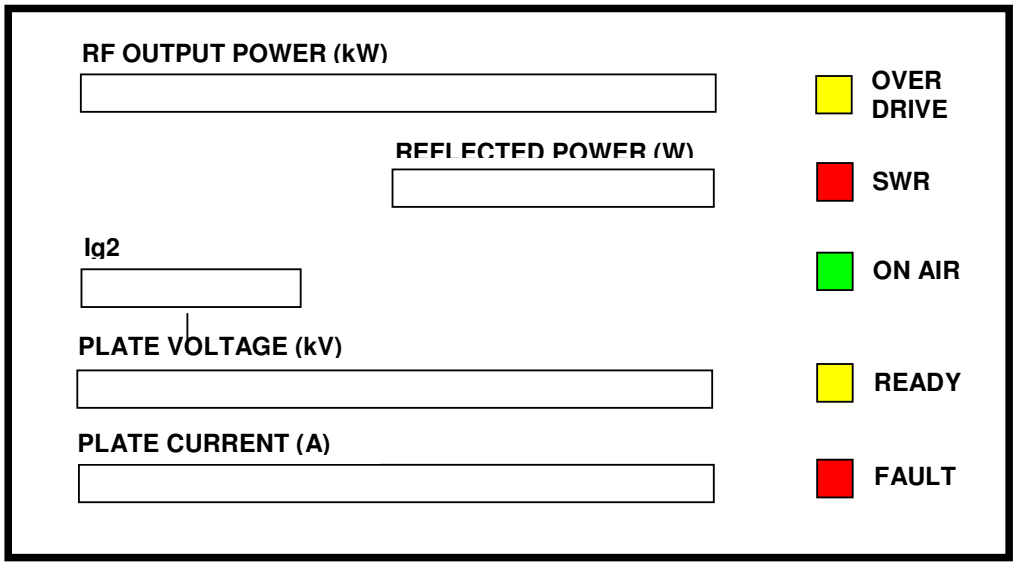


Figure 4 Front Panel Display

ON Air - single LED, green. When pressing PTT, this LED turns on (while in OPERATE and READY).

READY - single LED, yellow. Turns on at the end of warm-up period, when the mains power to DX-3SP is switched on. It turns off for about 2 minutes if the plate current protection is triggered. In this case, the FAULT light also turns on. It turns OFF while in an SWR Fault condition or over-temperature Fault.

FAULT - single LED, red. Turns on in 3 situations:

- when the over-temperature protection is triggered, the FAULT turns on until the tube cools to a safe level. During this time, the operation of the amplifier is disabled, the screen voltage is off and any RF power applied to the input is bypassed directly to the output. The READY light is also off.
- when the over-current protection is triggered, FAULT turns on for 2 minutes, while READY turns off.
- at DX-3SP power up, if the OPR/STBY switch on the front panel is left in OPR position. The FAULT light will go off when the DX-3SP is ready for operation, after warm-up.

SWR - single LED, red. A three second cut-off will happen if your antenna has a SWR worse than 2.6:1 at the operating frequency. During the cut-off, the RF from the input is directly by-passed to the output.

OVER-DRIVE - single LED, yellow. Flashes when the input drive is exceeding the linear operation level. If even more drive is applied, the overdrive protection will cut off the operation for about 2 seconds.

NOTE: the input drive for the indicator to turn on depends on a certain extent on the tuning of the amplifier.

6 REAR PANEL

The following connectors and controls are present on the rear panel

6.1 Power / Earth connections

A wing-nut Earth connection is provided at the rear of DX-3SP. A good Earth link must be provided here. Connect this first, before making any other connection to the amplifier. Two fuse holders are fitted along with 40A, normal acting fuses.

6.2 RF connections

RF INPUT

The RF input is an SO-239 female connector. A 50 ohm coaxial cable line of good quality terminated with a PL-259 coaxial connector is required to connect the transceiver or exciter output to the input connector of your DX-3SP amplifier.

RF OUTPUT

The RF output is also a female SO-239 connector. The use of a high quality RG-8A/U, RG-213 or similar 50 ohm coaxial cable line terminated with a 'VHF' type PL-259 connector is essential. Similarly, a VSWR of 2.6: 1 or better is mandatory. Remember too, that the EMTRON DX-3SP amplifier can deliver 4000 W continuously and up to 5000 W PEP in the SSB mode. Not all antennas can handle such power.

6.3 Transceiver control

PTT

The PTT input is a female RCA connector. This line controls the transmit / receive switching system. This jack must be connected to transceiver or exciter relay contacts which are open on RECEIVE and closed on TRANSMIT.

The PTT input presents an open circuit voltage of + 6V with respect to the chassis. A current of 6 mA must be switched by the transceiver or exciter.

7 ELECTRICAL CONNECTIONS

7.1 Connections to Transceiver / Exciter

Signal connections

Before making any connections, ensure that DX-3SP is not connected to AC power, and the transceiver is not transmitting. Connect the antenna first to the DX-3SP output. Then connect the transceiver output to the DX-3SP RF input. Plug the PTT lead into the RCA socket marked PTT on the rear panel.

The most appropriate interconnection layout is shown in Figure 5 below. In this set-up, the transmit/receive relays in the DX-3SP are controlled directly by the transceiver or exciter.

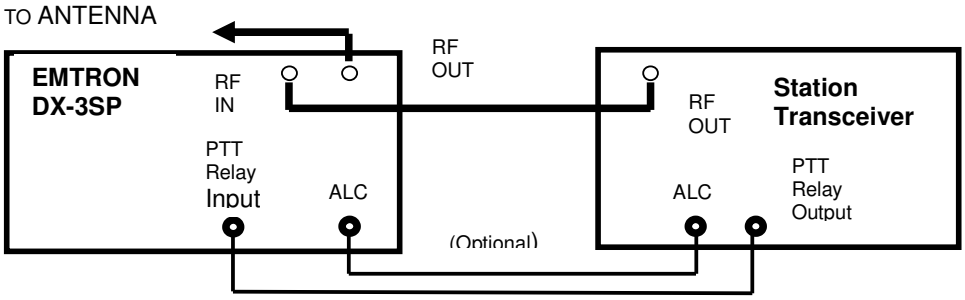


Figure 5 Connections between DX-3SP and Station Transceiver

7.2 Earth and mains connections

Power connections

Before connecting any power to the amplifier, make a good Earth connection to the screw with wing nut at the rear of DX-3SP. Terminate the power cable if necessary (export versions). Check that the transformer tap corresponds to the nominal local mains voltage. Make sure the POWER switch on the front panel is in the OFF position. Then plug the power cable into the power outlet.

7.3 Terminating the power cable (export version)

As different countries have different standards for their power connections, the DX-3SP amplifiers exported from Australia are supplied with an un-terminated power cable. The **green / yellow wire** is connected to the amplifier chassis and MUST be connected to the **safety ground** of the AC mains supply. It must NEVER be connected to one of the AC "hot" wires or to the Neutral wire.

IN THE U.S.: The Brown and Blue wires connect to the mains transformer inputs. Brown wire is to be connected to AC line 1 and Blue wire to AC line 2. Both lines are fused.

IN OTHER COUNTRIES: The brown wire is to be connected to the LIVE or ACTIVE line. The blue wire is to be connected to NEUTRAL.

7.4 Operation at 240V, 230V, 220V, 200V (export version)

The Emtron DX-3SP will normally arrive pre-set for the power source of the country the amplifier has been sold to. However if operation to another mains voltage is required, the appropriate connection changes will be needed.

Figure 7 shows the transformer connections for 200V, 220V, 230V and 240V operation. If a change is required, this should be done only by a qualified technician, after taking all the necessary safety precautions. *See CAUTION on page 5.*

To change the transformer tap, a single brown wire has to be unsoldered and moved to the new tap. *See below*

PLEASE NOTE: **The DX-3SP should not be connected to a mains supply of less than 200VAC!**

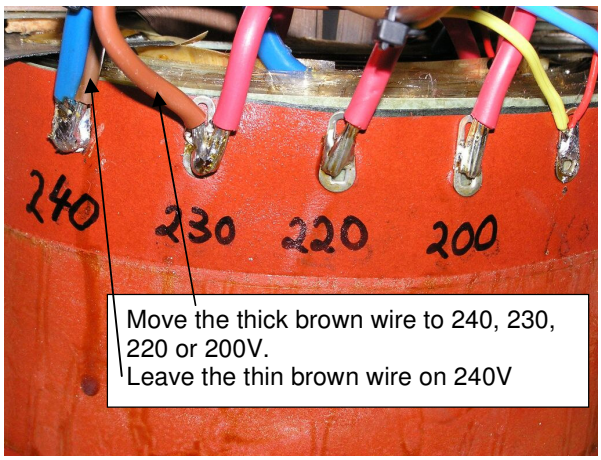


Figure 6 Wiring for 230V shown as example

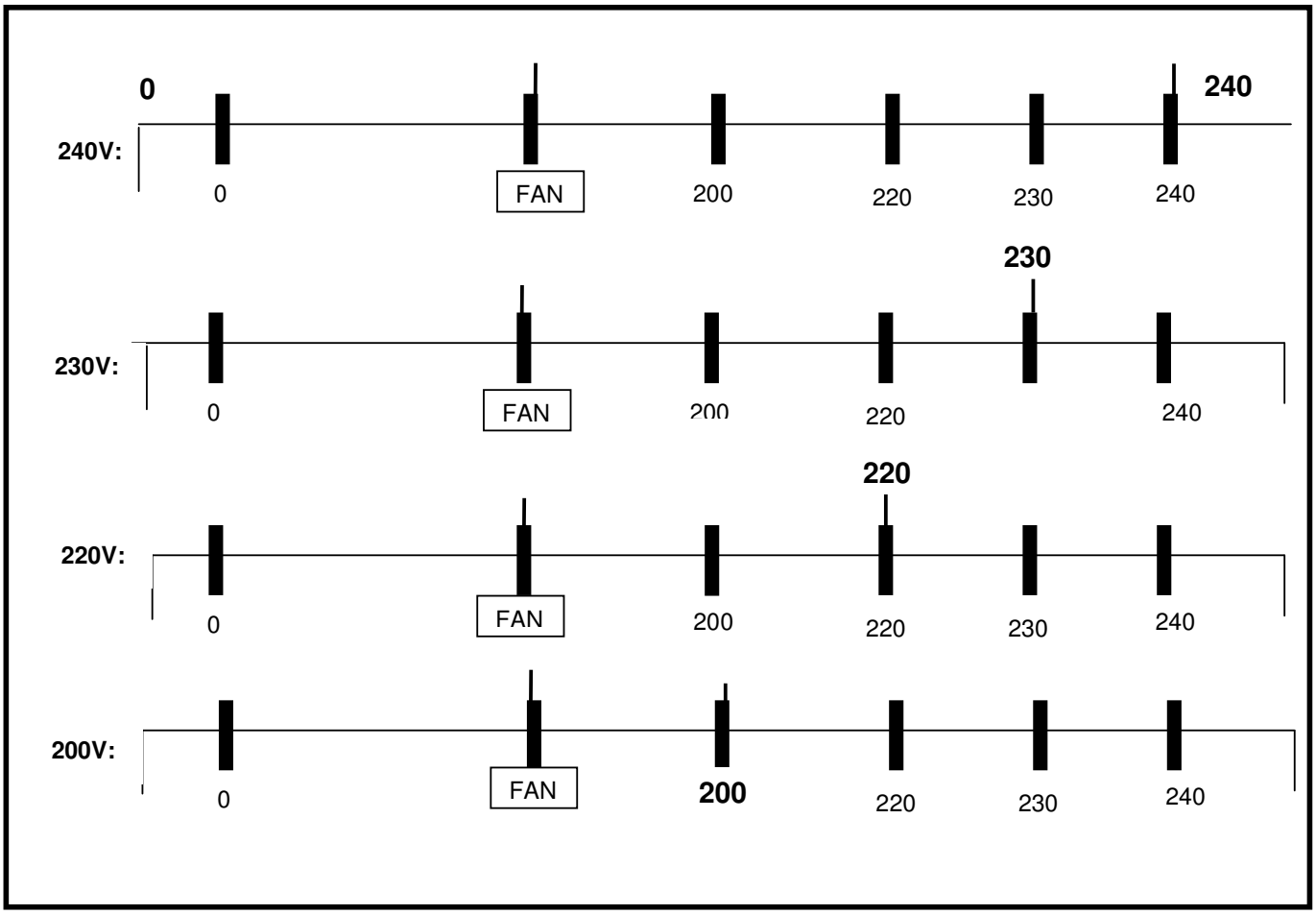


Figure 7 TRANSFORMER AC INPUT CONNECTIONS

8 DX-3SP DESCRIPTION

8.1 RF Section

The RF section occupies the right hand side of the DX-3SP (looking from the top - front). See picture in 1.1.

RF Switch and tuned circuits

At the front of the amplifier are two variable capacitors, for plate and load tuning. A 9-position ceramic switch is employed for the 9 operating bands. Next to the switch is the 40 to 160 metre tank coil (torroid). The silver plated, large diameter copper tube is the 10 to 30 metre tank coil.

RF Sub-chassis

The FU-728F tubes are positioned on a separate RF sub-chassis. All the connections to the tubes, except for the plate, are under this sub-chassis. A 9-way heavy duty connector is used for the outside connections. The fan blows air into this sub-chassis, which is forced out through the ventilation fins of the tubes. The air temperature is sensed by sensors placed above the tubes. The sensors must stay in a position close to horizontal. Make sure they are not pushed down, too close to the tube, as high voltage exists between them. The plates are connected to the RF network and to the choke supplying the 3400VDC voltage to the plate of the FU-728F tubes. Above the tubes there is one fans sucking air and reducing the back pressure to the blower.

8.2 Mains transformer

The transformer is the heart of the amplifier, a high performance type, designed to reduce the size and weight. It is built with a generous reserve of power, handling easily the DX-3SP requirements in heavy duty operation. The primary can be wired for 200VAC, 220VAC, 230VAC or 240VAC operation. *See Figure* 7.

There are several secondary windings, as follows:

- Filament supply (9 Vac)
- Low voltage supply to the controller board (10 Vac)
- QSK module supply (27 Vac)
- Bias supply (110 Vac)
- Screen grid supply (295 Vac)
- High voltage supply (2400 Vac)

8.3 H. V. Power Supply

A full wave bridge rectifier and filter converts the high voltage AC into high voltage DC with a huge reserve capacity of 58 microfarads.

8.4 Soft start module

At power up, the mains power is gradually applied to the transformer by the soft start module. The power is gradually applied over a time of about 5 seconds, avoiding the high inrush current typical for such big loads.

8.5 Sensor module

A small metal box positioned at the output of the DX-3SP. It detects the forward and reverse power, for measurement and display.

8.6 Antenna relay / QSK module

The QSK module acts as an antenna relay controlled by the transceiver, via the control board. It switches the antenna between the transceiver, during reception, and amplifier, during transmission. It is also used to bypass the RF from the transceiver, directly into the antenna, when the amplifier is in standby mode, or during special conditions like overdrive, bad SWR or other error conditions.

The QSK is a module with two very fast, high power vacuum relays, and the control circuitry. The purpose of QSK is to allow very fast switching between transmit and receive, during digital communications. See Appendix 2 showing oscilloscope displays of fast switching times and contact bounce-free operation of the QSK module.

8.7 Display board

This board has a number of inputs where various voltages are connected. The board converts these voltages into a "moving LED" type of display. Two of these displays have flashing light indication (Ig2+ and plate current).

8.8 Control board

The brain of the amplifier is the Control Board. The following circuitry is part of this board:

- Bias voltage regulator, also incorporating a sensitive grid current detector for overdrive detection. Adjustable pre-bias, removes the distortion at the beginning of the word, when EBS is activated.
- Screen voltage regulator, with adjustable voltage and adjustable current limiting, for tube protection.
- Overdrive protection and timer - based on detecting grid current, it initially gives visual warning and, at higher level of overdrive, it cuts off the amplifier for 2 seconds. It ensures a clean signal, making it virtually impossible to overdrive the DX-3SP.
- SWR detector and timer - switches the amplifier to bypass mode for about 3 seconds when high SWR is detected. Adjustable SWR level. Factory adjusted to about 2.6 : 1
- EBS - the Electronic Bias Switch - senses the presence of RF input power and turns on the bias to start transmission. Factory adjusted for about 0.5W. When the input power exceeds this limit, the plate current starts flowing. When there is no speech, even for a very short time, the tube dissipation is cut to a low value, as set by the pre-bias adjustment.
- Interlocking, timer for filament warm-up
- Relay control: ready relay, SWR relay, over-drive relay, antenna relay
- QSK switching control
- Display control: Ig2 measurement and display, SWR cut-off display, overdrive warning display, READY display, FAULT display
- Logic circuitry, two low voltage supplies to the various electronic circuits

9 POWERING UP

Before switching the power on, check all the necessary connections: Earth, Antenna, Transceiver, PTT. Make sure the 2 switches on the front panel are in the positions: OFF, STBY.

Switch now the mains power ON (The power switch to ON position). The "soft start" system will take about 5 seconds to fully turn the power on. SWR light will turn on briefly, then off. Wait for the DX-3SP to warm up, until the READY light turns on.

This takes about 2 - 3 minutes.

WARNING !

WHEN YOU SWITCH THE POWER ON, YOU MUST HEAR AIR FLOW NOISE.

IF THERE IS NO AIR FLOW NOISE, SWITCH THE POWER OFF IMMEDIATELY AND CONTACT YOUR SUPPLIER.

10 OPERATION

10.1 TUNING PROCEDURE

INITIAL SETTINGS FOR PLATE AND LOAD CAPACITORS

TEST FREQUENCY	BAND	FACTORY SETTINGS 50 OHM LOAD		USER SETTINGS ANTENNA	
		PLATE	LOAD	PLATE	LOAD
28.600 MHz	10m				
24.900 MHz	12m				
21.200 MHz	15m				
18.100 MHz	17m				
14.200 MHz	20m				
10.125 MHz	30m				
7.070 MHz	40m				
3.600 MHz	80m				
1.800 MHz	160m				
1.850 MHz	160m				
1.900 MHz	160m				

TABLE 1

For convenience TABLE 1 has been also reproduced on the front inner cover

10.1.1 General

For each band and operating frequency, the transceiver settings must match the position of the BAND switch on the front panel of the DX-3SP, while the PLATE and LOAD knobs must be adjusted for optimum operation which gives – in conjunction with the input drive level, the maximum output power that can be obtained for that input power.

When the tuning is correct, this will also result in a minimum plate current, minimum plate dissipation and good linearity.

10.1.2 Preliminary tuning

- Turn the BAND switch to the same band setting as the transceiver.
- Put LOAD and PLATE knobs in the initial positions given in Table 1.
- DX-3SP must be powered ON and "Ready", with the OPR/STBY switch in OPR position.
- Start with the transmitter at minimum power, in a "carrier" mode e.g. RTTY or CW - key down.
- Key the transceiver ON and gradually apply power to the DX-3SP. When 0.5 to l W of drive is reached, the EBS is activated and the plate current jumps from zero to about 0.5 A.
- Increase the drive until there is some output power indicated. If the current plate Ip reaches about 1 A and there is still no output indication, turn PTT off and check the connections, the band and the initial settings.
- As soon as there is any power indication, tune PLATE for maximum output (and minimum plate current).
- Apply more drive and adjust PLATE again for maximum output. Keep PTT ON for short time only (about 10 seconds). Go gradually, in several steps. When about 1000W output is reached, adjust LOAD for maximum output. At low and medium power Ig2 indication will be green (the screen current is reverse, or negative). While tuning try to minimise this green indication.
- At high power the Ig2 indication is red (normal, or positive screen current). If there is no red Ig2 indication, it is likely that LOAD needs to be turned clockwise, towards higher numbers on the dial. While tuning, try to maximise the red Ig2 indication.
- Apply more drive and adjust both knobs again. When screen current is too high (flashing red Ig2 indication), increase loading by turning anti-clockwise the loading knob. (LOAD towards lower numbers on dial) until Ig2 drops almost to zero. Then adjust PLATE for maximum output power and maximum Ig2. **At this point, Ig2+ is the most sensitive indicator of resonance on the working frequency**. If Ig2 goes too high (e.g. starts blinking), increase the loading again, then tune PLATE.
- Repeat the above steps, while gradually increasing the input drive power, until the overdrive indicator just starts turning on. Now the DX-3SP is tuned for operation at full power on that particular operating frequency.

NOTES:

1. The maximum power is obtained from a DX-3SP when:
   - onset of the overdrive indication
   - PLATE is tuned for maximum output power, maximum screen current Ig2 and minimum plate current, Ip
   - Ig2 indicator shows 2 to 4 red LEDs (depending on frequency and load, sometimes Ig2 is very low, 1 LED or no indication at all).
2. The above conditions will also give the best linearity.

3. During the preliminary tuning, switch PTT on and off several times, to allow time for tube cooling. The tube dissipation (at a given drive level) is minimum when tuning is optimum. In short, be brief, with tuning "bursts".

4. Preliminary tuning, as described above, is only necessary when operating for the first time in a certain band. When the final settings for PLATE and LOAD have been found for the particular working conditions - especially the antenna used, note your settings on Table 1. The new settings will normally differ to some extent from the ones indicated, depending on the “resistance and reactance" of your antenna load.

5. If less than maximum power is run, it is possible that the Ig2 indication remains green and never goes into red.

10.1.3 Final tuning

Once the preliminary tuning has been done for each band / antenna combination, the values found for PLATE and LOAD can be used for final tuning, with no need to repeat the preliminary tuning every time.

Tuning for full power

- Start with low drive level and the PLATE and LOAD knobs in the known initial positions.
- Put PTT ON and increase the power (fairly quickly), to the onset of the overdrive indication. If the screen current (red Ig2) goes too high, adjust LOAD, by turning the knob to the left – towards lower numbers on the dial (increasing the load).
- Adjust the drive level and LOAD until the overdrive indicator is just about to turn ON, and at the same time Ig2 shows two or three red LED's ON.
- Fine tune PLATE for maximum output and maximum Ig2. Repeat the step above if required.
- When the desired tuning level is achieved on a band, record the plate and load numbers in the ‘Users Settings’ of Table 1.

***NOTE**: A flashing red Ig2 indicator, even for a long time, is not harmful to the tube, since Ig2 is limited to a safe value.*

Tuning for less than full power

NOTE: Low output power could create more tube plate dissipation then the normal / full output.

- Start at low power, with the initial values for PLATE and LOAD
- Put PTT ON and apply drive until the output is about 1/2 of the desired power.
- Adjust LOAD for maximum output. Most likely, the knob will have to be rotated clockwise, towards higher numbers on the dial.
- Adjust PLATE for maximum output
- Apply more power
- Repeat the 3 steps above until the required power is achieved. If screen current is indicated by Ig2, it should display two to four red LED's. Maximise this Ig2 indication (and the output power at the same time), by tuning PLATE

  Please note that the tuning at lower power is different from the setting at full power (especially LOAD).
- If the output goes higher then desired, reduce the drive *and re-tune*. **Never reduce the output by de-tuning the amplifier**!

NOTE: If the output is low (say, less than about 2000W), Ig2+ will never show any screen current at all. Ig2 might even indicate a negative current, in green - this is normal and is no cause for concern.

If there is green Ig2- indication, for a given input drive, try to minimise it and even to obtain red indication. For this, it is likely that LOAD needs to be moved clockwise, followed by PLATE retuning. If red indication is achieved, try to maximise it by tuning.

With low drive / low output it is likely the Ig2 indication to be green, increase as more drive is applied, then decrease and become red at higher output.

10.1.4 Potential problems during tuning

The tuning operation should be completed fairly quickly. If the tuning process takes a longer time, it should be done by switching the transmission on and off several times, to allow the tube time to cool.

- If the FAULT light comes on, it is possible that the plate current has reached too high values due to incorrect plate tuning. In this case, reduce the excitation power, wait for the FAULT light to turn off (about 2 minutes) and resume tuning.
- If the overdrive protection is activated, by cutting off the amplifier for 2 seconds. It is likely in this case that you are applying too much power at the input. Reduce the power and watch the "overdrive" LED. Increase the power only until this light starts flashing.
- If the overdrive protection is activated at low power – this could be due to incorrect loading. Turn the LOAD control clockwise and tune PLATE. Increase the drive and repeat in small steps.
- If the SWR protection cuts in – it is likely to be a problem with either the feedline, antenna or associated antenna switching components. In principle, the SWR protection level in DX-3SP is adjustable, but it is far preferable for you to fix your antenna system.

10.2 USING YOUR DX-3SP

While tuning and adjusting the amplifier, a CW mode is normally used. When these operations are finished, you can change to the operating mode you wish to use and start operating.

10.2.1 CW / RTTY and all digital modes

In CW, the setting up of the amplifier is similar to that of the tuning mode. After adjusting the input power level to the amplifier, according to the desired output level, and tuning the plate and load capacitors, you can simply start operating by applying the same carrier level as during tuning. If the amplifier is set to deliver full output power, or close to, then screen current will be present (red Ig2). As in the case of tuning, the best operation is achieved when there is a certain amount of screen current flowing, corresponding to two to four red LED's turning on in the Ig2 display.

10.2.2 Voice modes (SSB)

When a voice modulation is applied to the amplifier, the drive level is not precisely defined, as in the case of tuning with continuous carrier. If there is screen current flowing, or an input overdrive, they will be indicated only at peak of modulation, by the respective indicators flashing. The Ig2 indicator is likely to flash both green and red. You will have to adjust the microphone gain, or the RF drive, or both, in an attempt to achieve peak input driving conditions similar to those you have used while tuning. Occasional flashing of the overdrive indicator is acceptable. If the over-driving is severe, a momentary cut-off will occur.

10.2.3 Hints on good linearity and efficiency

Operating with good efficiency: If you are watching the plate current indicator, you must be aware that the total power the amplifier is drawing from the mains is proportional to the plate current. Power that is not sent to antenna is dissipated by the tube. As explained in the Tuning section, the best tuning achieves a maximum power output at the same time with a minimum plate current, drastically minimizing the tube dissipation. Be aware that at a low power level, slightly different tuning is required than is for full power.

Achieving the best linearity: The amplifier must be tuned and operated all the time in the linear mode. This is important because a non-linear operation will generate harmonics which will disturb RF communications in other bands and frequencies.

We must distinguish two situations:

Less than full power.

With less then full power (say 3000W or less), correct tuning and no input overdrive indication, you will *always have your DX-3SP operating with a good linearity and clean signal.*

Full power operation.

At full power, there are two things that must be watched to see when you reach the limit of linear operation: the screen current, Ig2, and the grid current, indicated by the "Over-drive" LED.

In this case a good linearity is maintained up to the moment when the screen current is approaching the full scale value of the Ig2 indicator and it starts flashing, or when the overdrive indicator fully turns on.

A high screen current, indicated by 4 LED's on in the Ig2 display, will create a moderate level of distortion.

Even a small amount of grid current will cause severe distortion. When the "Over-drive" indicator just begins to turn on, there is a very small amount of distortion, created by a grid current of about 150 microamperes.

With this indicator flashing, you are at the limit of the RF carrier clipping. This is probably more acceptable in a voice mode of operation. In CW or digital modes, the best is to slightly reduce the drive, just below this level. A severe level of over-driving is not possible anyway, due to the cut-off protection. The cut-off will happen at about 200 microamperes of grid current. See *Appendix 2: Waveforms* - and *Section 12: Troubleshooting* for oscilloscope displays showing examples of a two tone generator driving the DX-3SP in linear mode.

The Ig2 indicator should have three to four LED's flashing ON at peak of modulation. This (combined with a correct plate tuning), indicates an optimum loading, good efficiency and good linearity. A lower screen current, due to excessive loading, will reduce the output power, with an equal amount of extra power dissipated by the tube. A higher screen current, making all four LED's in the Ig2 flashing, will increase the distortion.

11 SWITCHING THE POWER OFF

When you have finished using the amplifier and you want to switch it off, the following procedure is recommended: Stop transmitting. Put the switch on STBY. Leave the DX-3SP running idle for a few minutes, to cool the tubes, and then switch the power off.

12 TROUBLESHOOTING - If something goes wrong

12.1 No power

When you switch on a DX-3SP, it takes about 3 - 5 seconds for the lights on the front panel display to come on. This is due to the "soft start" circuit. If nothing happens after turning the power on, switch off at the front panel, then check the following:

- make sure the power point has power
- make sure the power plug is fully pushed in into the power outlet

If it is still not working, unplug the power cord from the mains, then remove the fuses from the fuse holders on the rear panel of DX-3SP and check them with an ohmmeter. If a fuse is blown, replace it with a fuse of the same type and try again. If the fuse blows again, or if the fuses were not blown in the first place, contact your supplier.

12.2 Fan not working

As soon as you switch the power on, you should notice two things about your DX-3SP: the display should indicate about 3000V of plate voltage and you should be able to hear the fan running. The amplifier is not supposed to be powered without the fan, even in idling mode. If the fan does not operate when you power up, or if it stops while using the amplifier, switch the mains power off immediately and contact your supplier.

12.3 If the FAULT light turns on

The FAULT (red) light turns on in two situations:

- Over-current in the plate circuit

This could happen due to a flash-over in the tube, or as a result of a momentary high plate current during tuning. This completely disables the amplifier for about 2 minutes. The same timer is activated as when the amplifier is switched on, causing the READY light to turn off. If the OPR/STBY switch on the front panel is put on STBY, the FAULT will turn off, but the READY will be also off. When the READY comes on again, the FAULT will disappear (if the amplifier was left in OPR), and the DX-3SP is ready to operate again.

- Over-temperature cut-off. *See below.*

12.4 Over-temperature cut-off

The operation of the amplifier is disabled, but the timer is not activated. The READY light turns off, and the FAULT light turns on. When the tube cools down, the FAULT turns off and the operation can resume. This type of fault should never happen. DX-3SP has a very efficient air cooling system. When the ventilation is not restricted, in normal ambient conditions, when properly tuned, a DX-3SP can operate at full power for extended periods of time, with the fan not even going to high speed. The temperature cut-off happens when the tube reaches 150º Celsius, with ample safety margin to the specified limit of 200º for the FU-728F tubes.

12.5 Over-current cut-off

If the plate current exceeds even for a brief time a pre-set safe limit, an over-current detector will activate the power up timer, disabling the amplifier for about 2 minutes. During this time the READY light is off, and the FAULT light is on, if the amplifier is left in OPR mode, as explained under 12.3, "If the FAULT light turns on".

12.6 Ig2 blinks fast - No plate voltage

If the high voltage is lost due to a fault in the amplifier, the screen current tends to reach very high values. This is an unlikely situation, but if did happen, this would normally guarantee a tube failure in unprotected amplifiers that do not have a current limiting circuit. The screen current limiting in DX-3SP is so efficient, that the tube is fully protected even in such a situation and test bench DX-3SP's have been extensively run with no plate voltage and maximum screen voltage, with no effect on the tube. If this loss of high voltage should happen to your DX-3SP, the Ig2 display will have the red LEDs flashing, due to the screen current exceeding the pre-set limit, with no input power applied to the amplifier, while switched to OPR.

In such a case, it is possible that the high voltage is still shown on the meter, but it does not reach the tube. In any case, this is a major fault. Put the amplifier on STBY and the flashing will stop. Then switch the power off and contact your supplier.

12.7 Sparks / Discharges in RF area

Very high RF voltages are present in the amplifier during the operation at high power. Incursion of dust or even suicidal insects can cause such temporary problems.

12.8 SWR cut-off

The factory adjustment for SWR protection is about 2.6: 1. This adjustment can be changed, but the best is to operate with a properly matched antenna. Should your DX-3SP 'see' bad SWR, it will shut down for 3 seconds (in bypass mode).

12.9 Frequent over-drive protection cut-off

As previously described in the tuning and operation sections, there is a protection system acting on DX-3SP input overdrive. When the drive reaches the limit where signal distortion begins to occur, the overdrive indicator on the front panel will warn you to reduce the drive. If you increase the drive even further, a cut-off protection is activated.

After about 2 seconds of amplifier bypass, the operation is resumed, but if you have not reduced the drive, the protection will be activated again. To stop it, you must reduce the input power drive. This protection is not adjustable - you must not exceed the limit.

12.10 Tube replacement

It is very unlikely that you will ever need to replace an FU-728F. If there is a need for that, the tube is easy to replace. However, contact your supplier, because a bias adjustment is required for the new tube. *See also Appendix 3.*

13 WARRANTY / SERVICE

The full FOUR YEARS warranty for DX-3SP amplifiers covers all parts and labour, except for the tubes. The tubes are under a limited warranty for one year only.

14 GLOSSARY

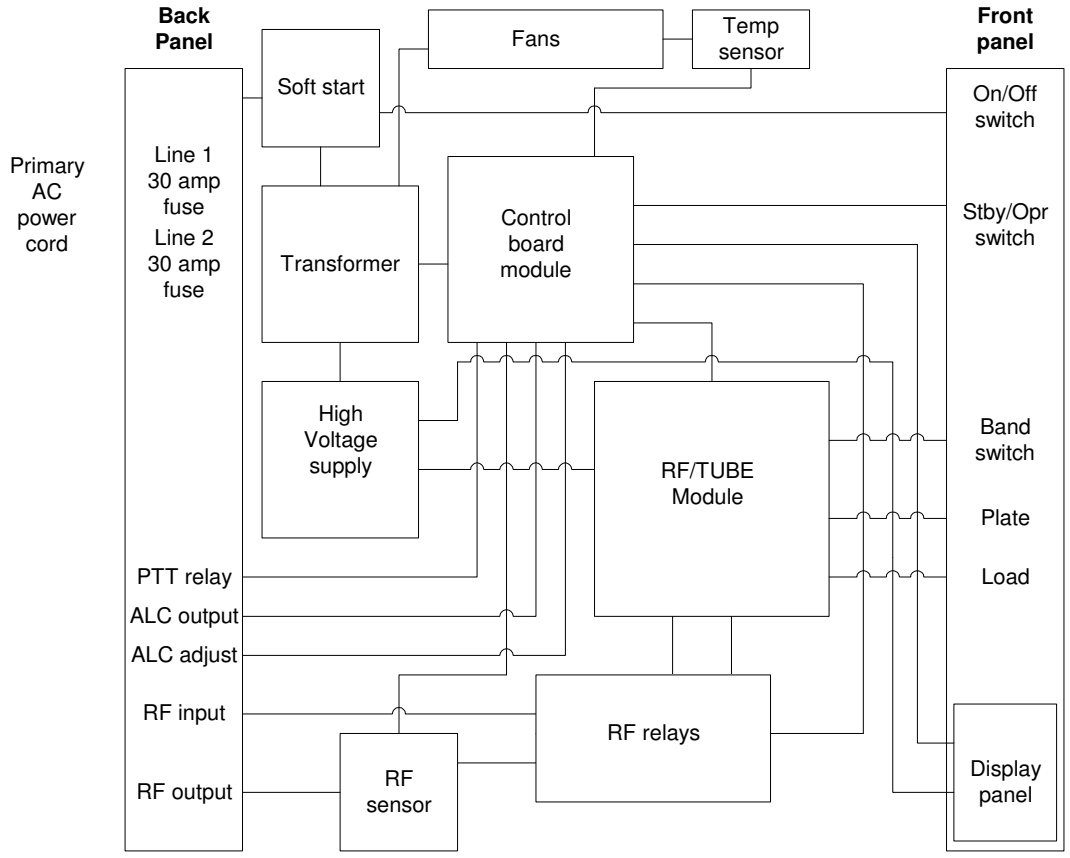
AC	Alternating Current
ALC	Automatic Level Control
AM	Amplitude Modulation
BALUN	Balanced / Unbalanced Transformer
BNC	Bayonet Neil-Concelman Connector
CW	Continuous Wave
dB	decibel
DC	Direct Current
EBS	Electronic Bias Switch
FM	Frequency Modulation
HF	High Frequency
HV	High Voltage
IEC	International Electro-technical Commission
IMD	Inter-Modulation Distortion
LED	Light Emitting Diode
PEP	Peak Envelope Power
RF	Radio Frequency
RTTY	Radio Tele Type
SSB	Single Side Band
SSTV	Slow Scan Tele Vision
SWR	Standing Wave Ratio
VAC	Volts, Alternating Current
VDC	Volts, Direct Current
WARC	World Administrative Radio-communications Conference
VSWR	Voltage Standing Wave Ratio

15 APPENDIX 1: SCHEMATIC DIAGRAMS

15.1 Block Diagrams

15.1.1 DX-3SP Block Diagram

DX-2sp Block Diagram



Block Diagram 3/15/06
by: M. Farrer

15.1.2 AC INPUT AND WIRING DIAGRAM

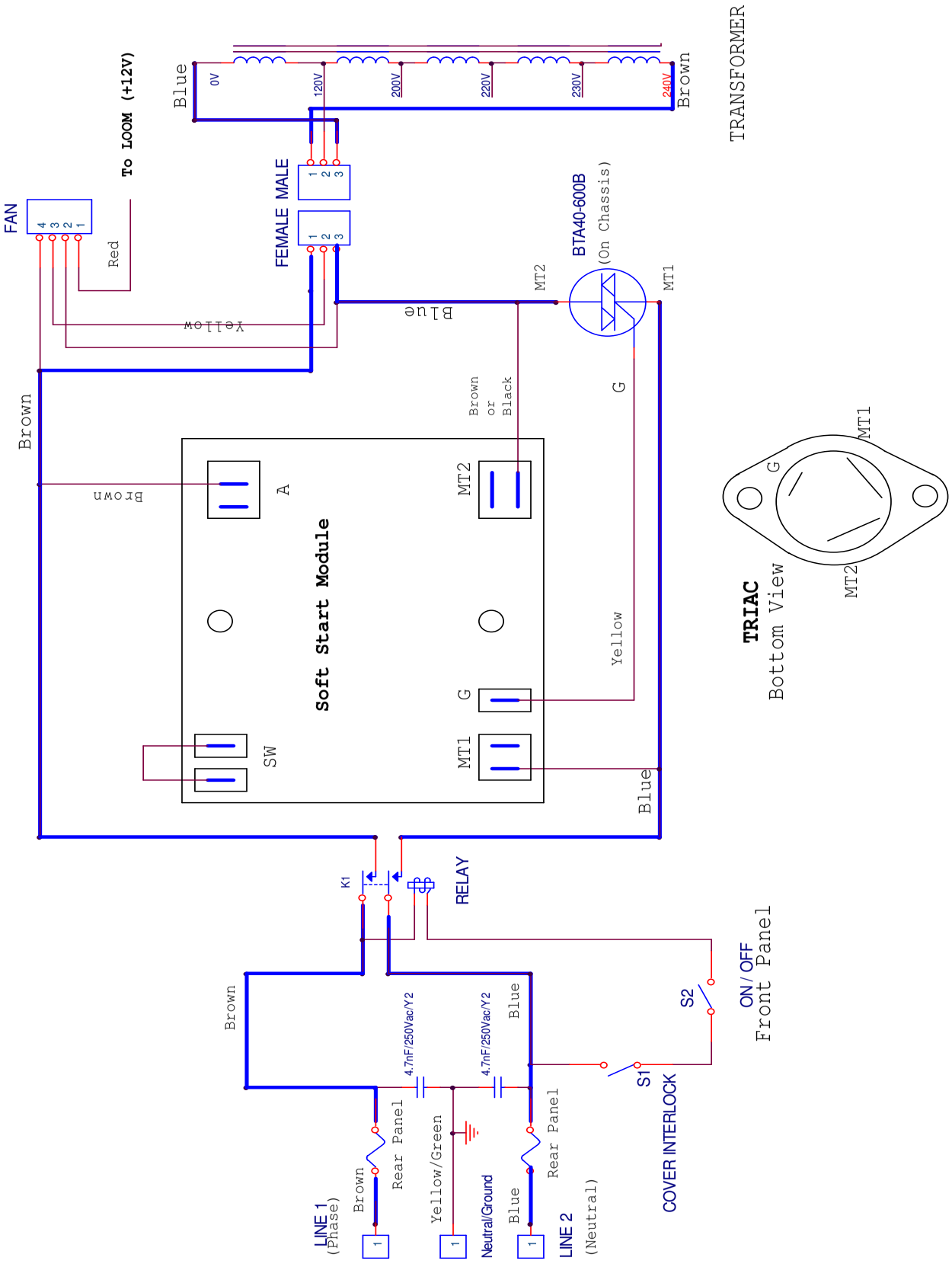


Figure 8 Note: The 2 Y2 capacitors (4.7nF) are now on the PCB

15.2 Circuit Diagrams

15.2.1 SOFT START Single Phase – Circuit Diagram

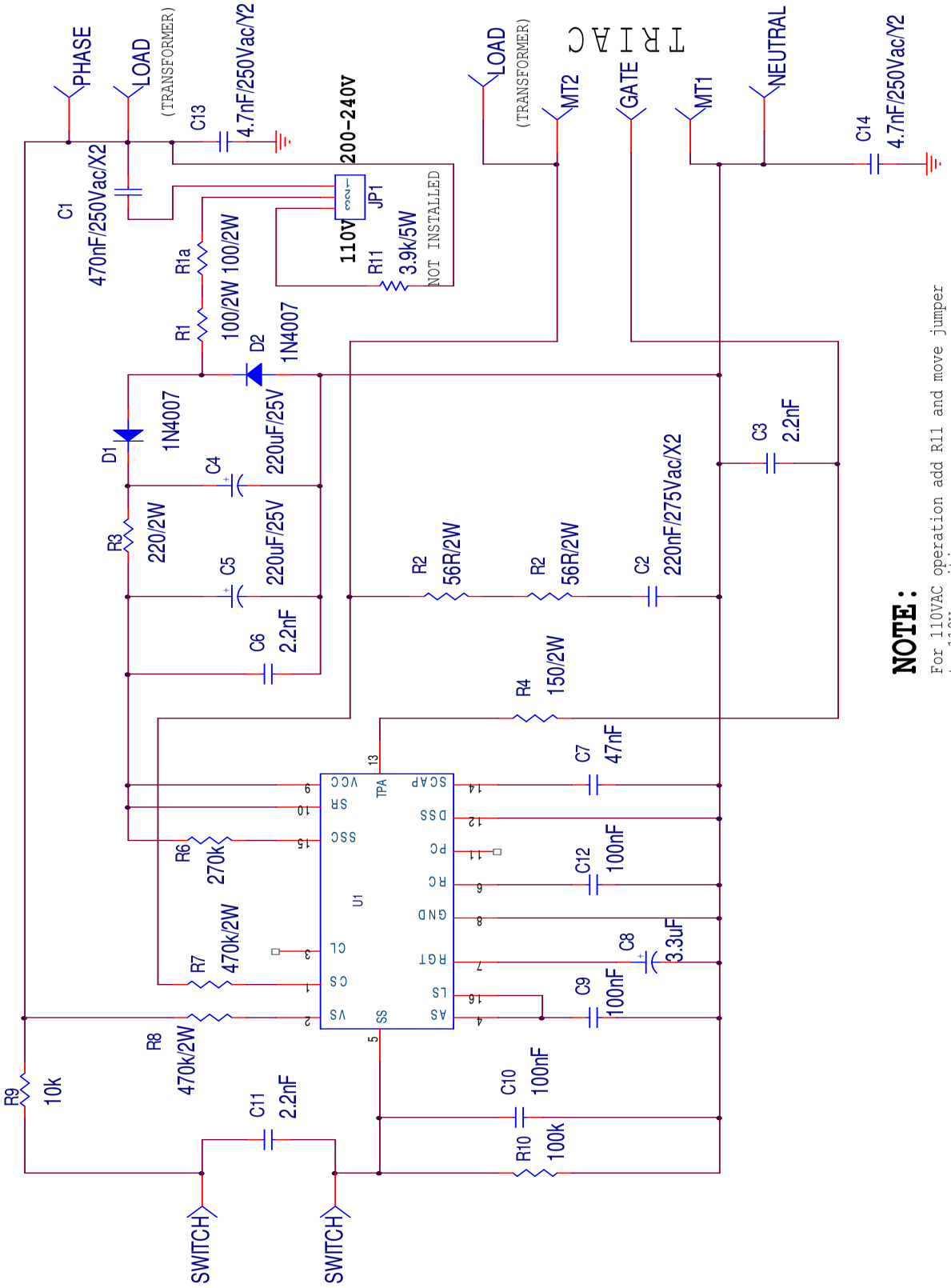


Figure 9

15.2.2HIGH VOLTAGE POWER SUPPLY – Circuit Diagram

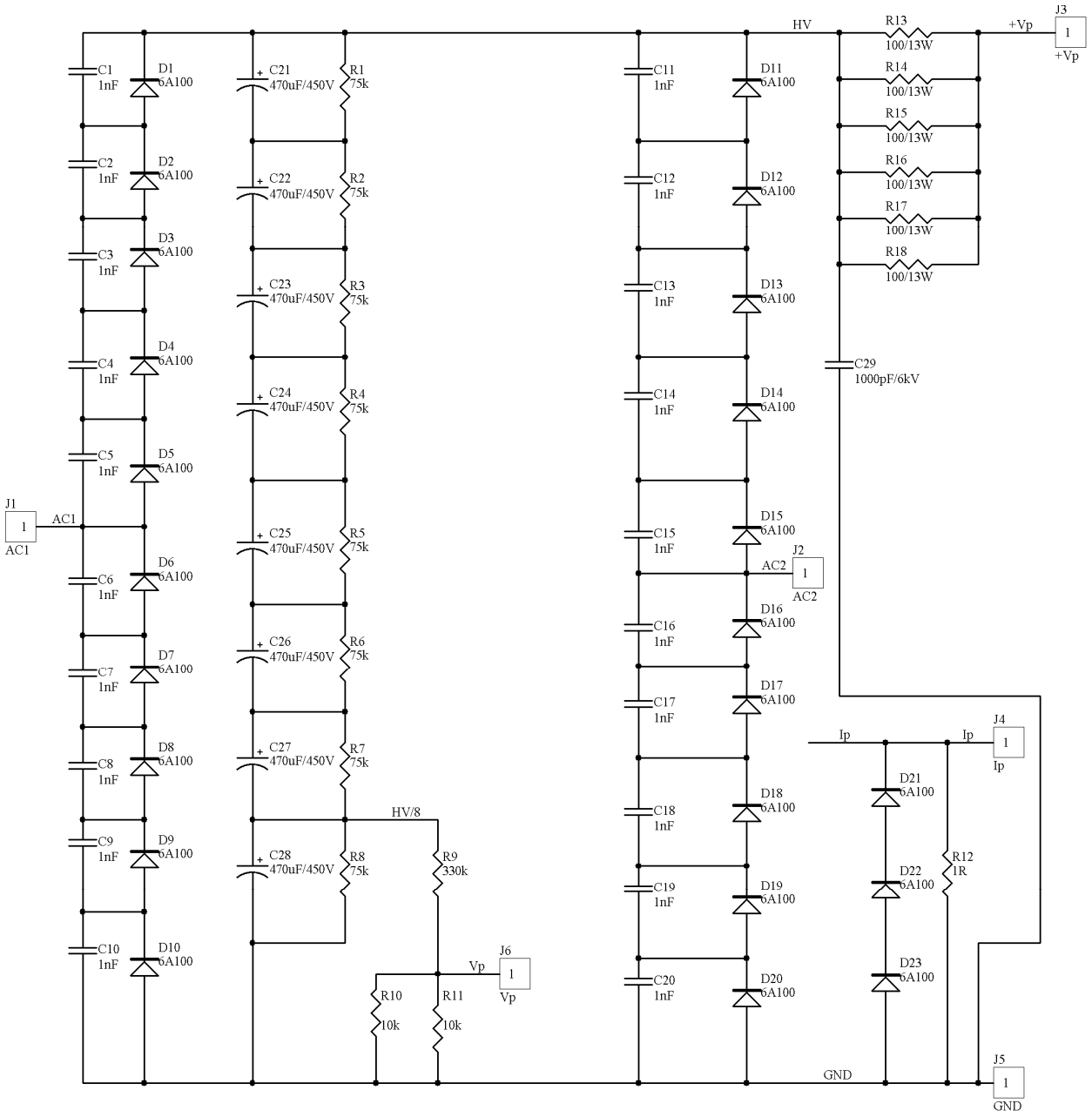


Figure 10

15.2.3 RF Module Simplified

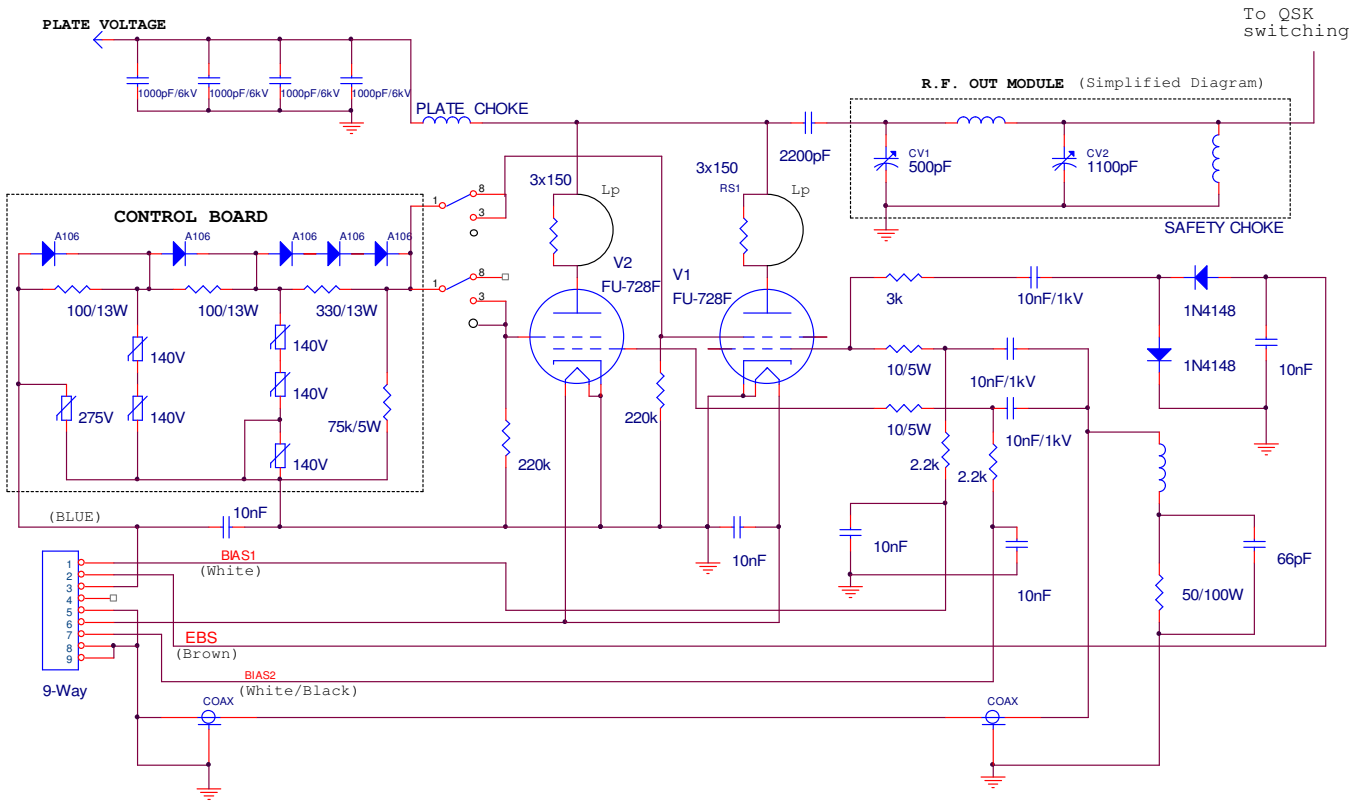


Figure 11

15.2.4 RF output circuit

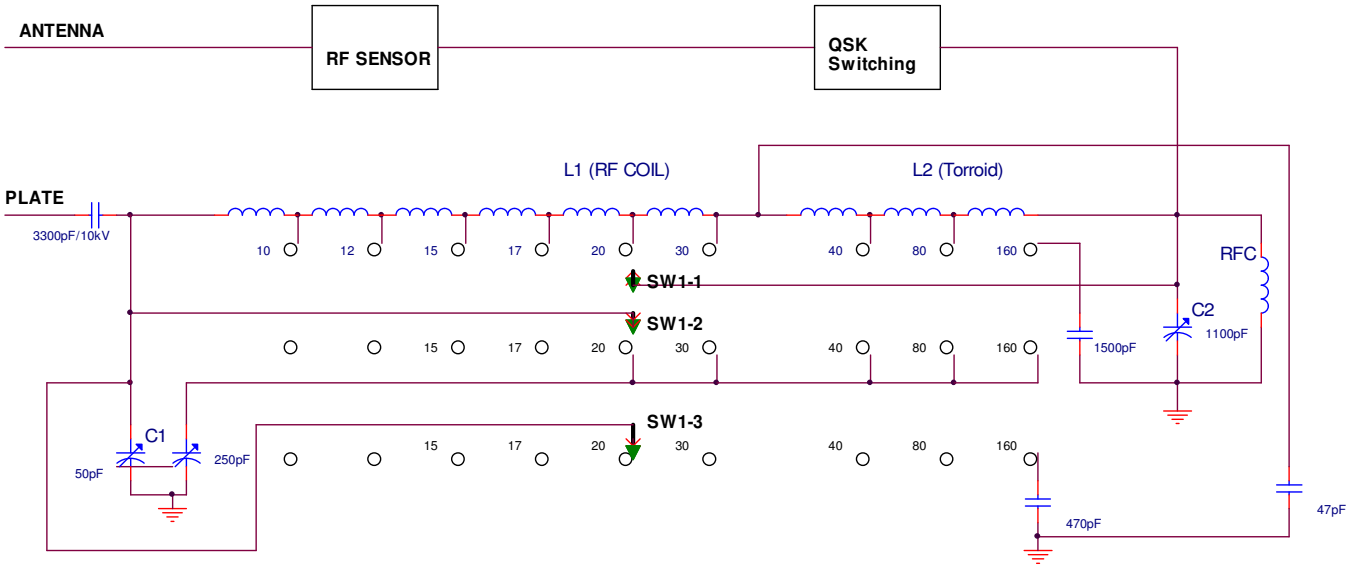


Figure 12

15.2.5 QSK – Circuit Diagram

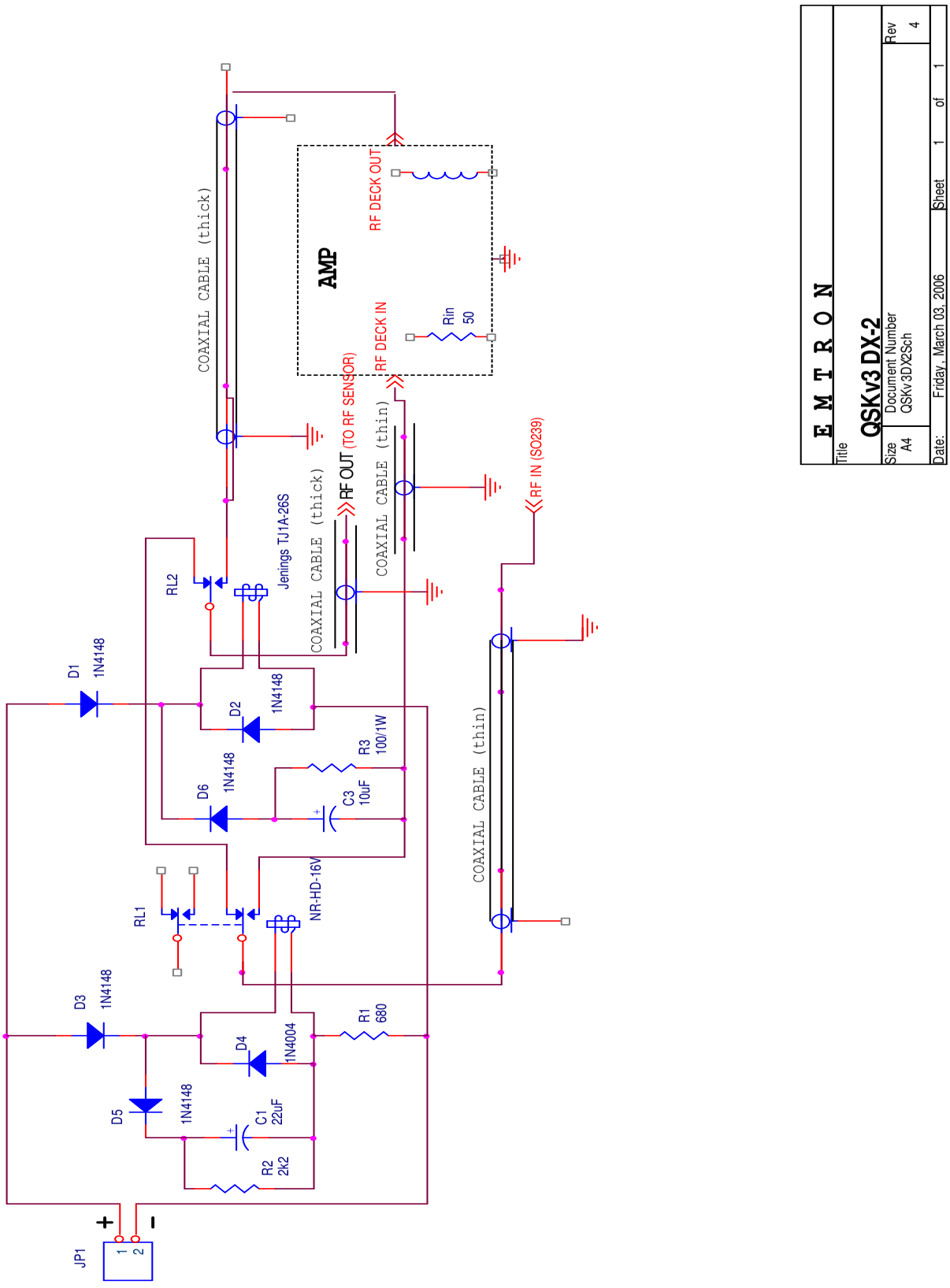


Figure 13

15.2.6 RF Sensor

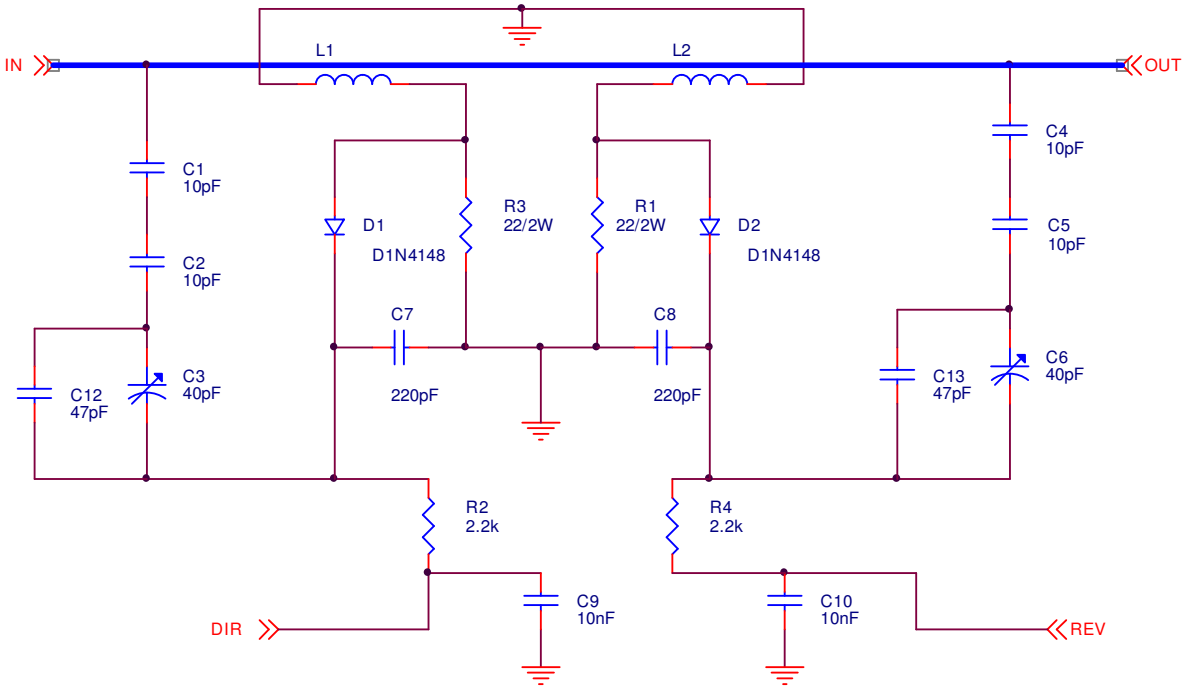


Figure 14

15.2.7 DISPLAY BOARD – Circuit Diagram

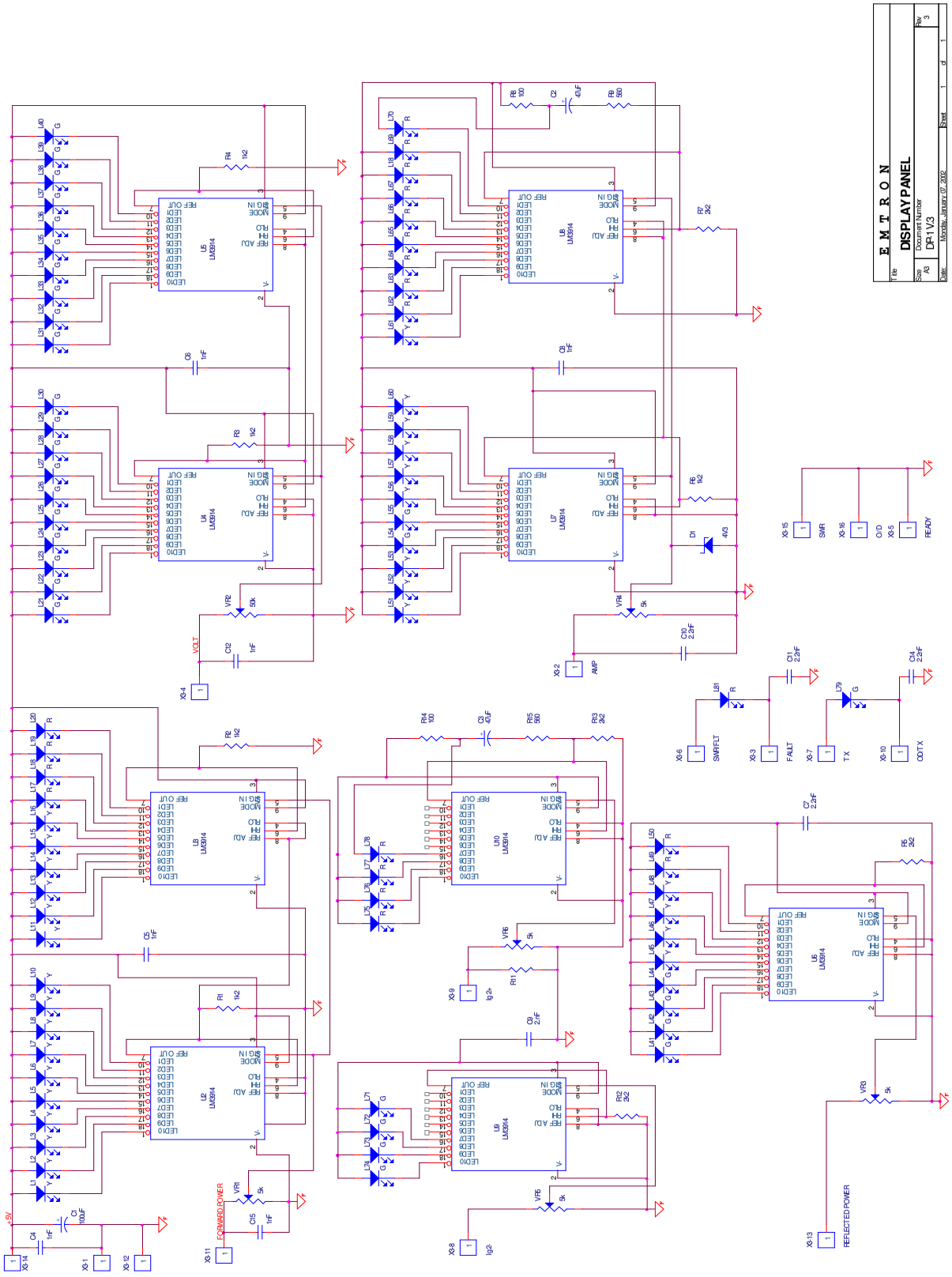


Figure 15

15.2.8 CONTROL BOARD – Circuit Diagram

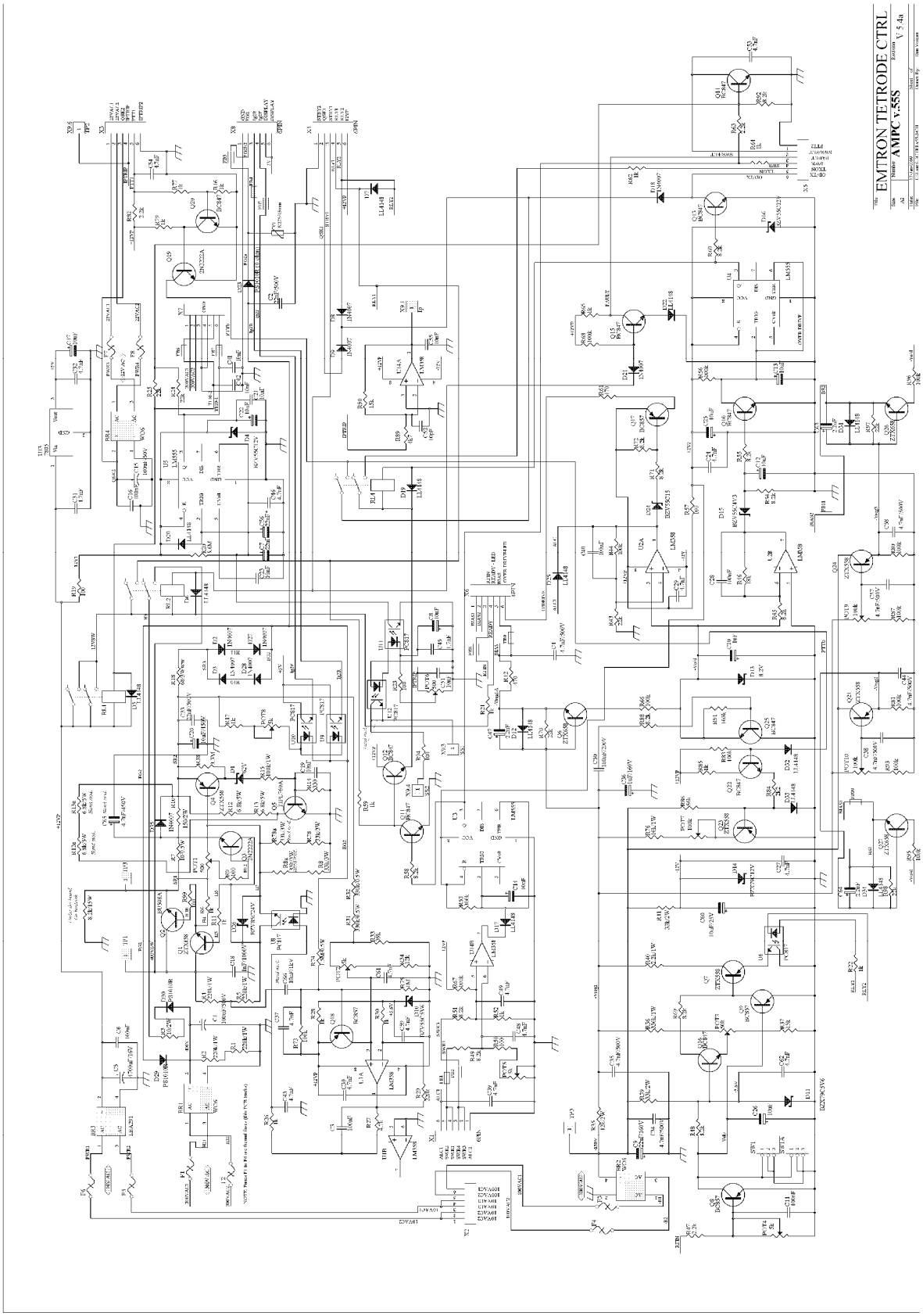
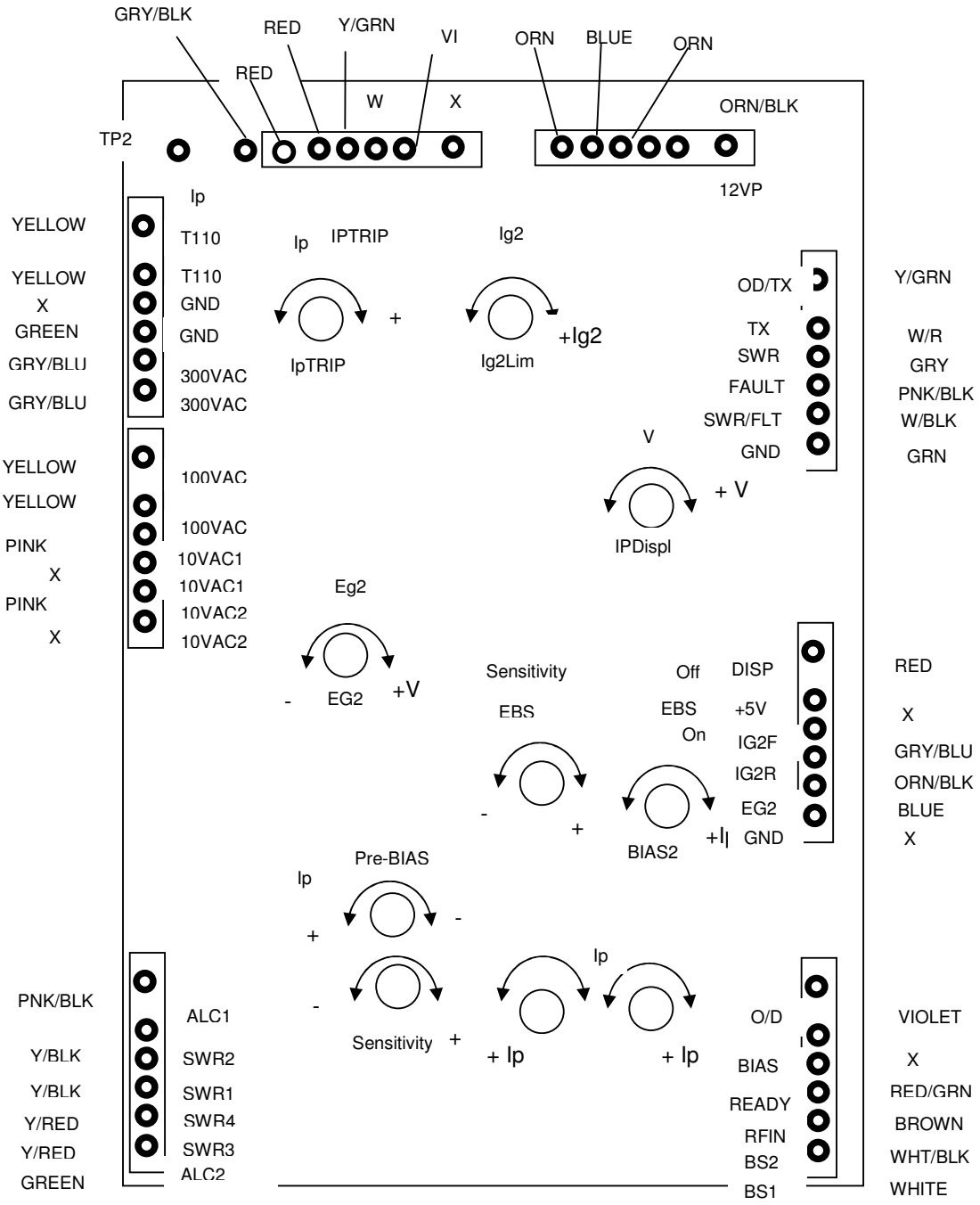


Figure 16

15.3 Control Board and Adjustment Points

The drawing below shows all the connections to the control board and the adjustment points.

Unless you know very well what you are doing and you have a reason to do it, **do not modify any adjustment!**



LEGEND:

GRY – grey GRN – green W – white V – violet Y – yellow PNK - pink

BLU – blue R – red BLK – black ORN - orange

Figure 17

15.3.1 Control Board Component Layout

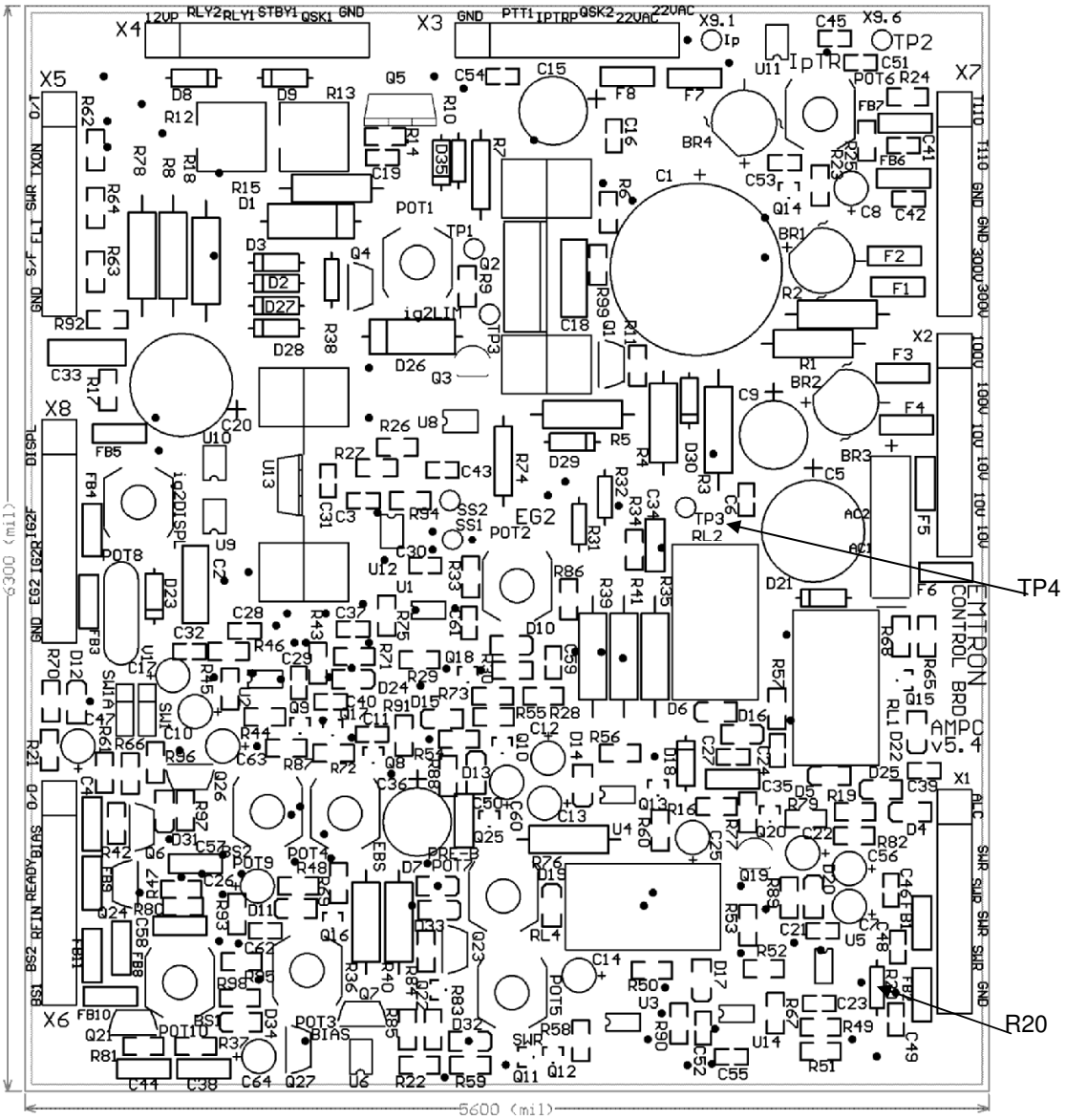


Figure 18

15.3.2 Control Board – Solder Side Track work

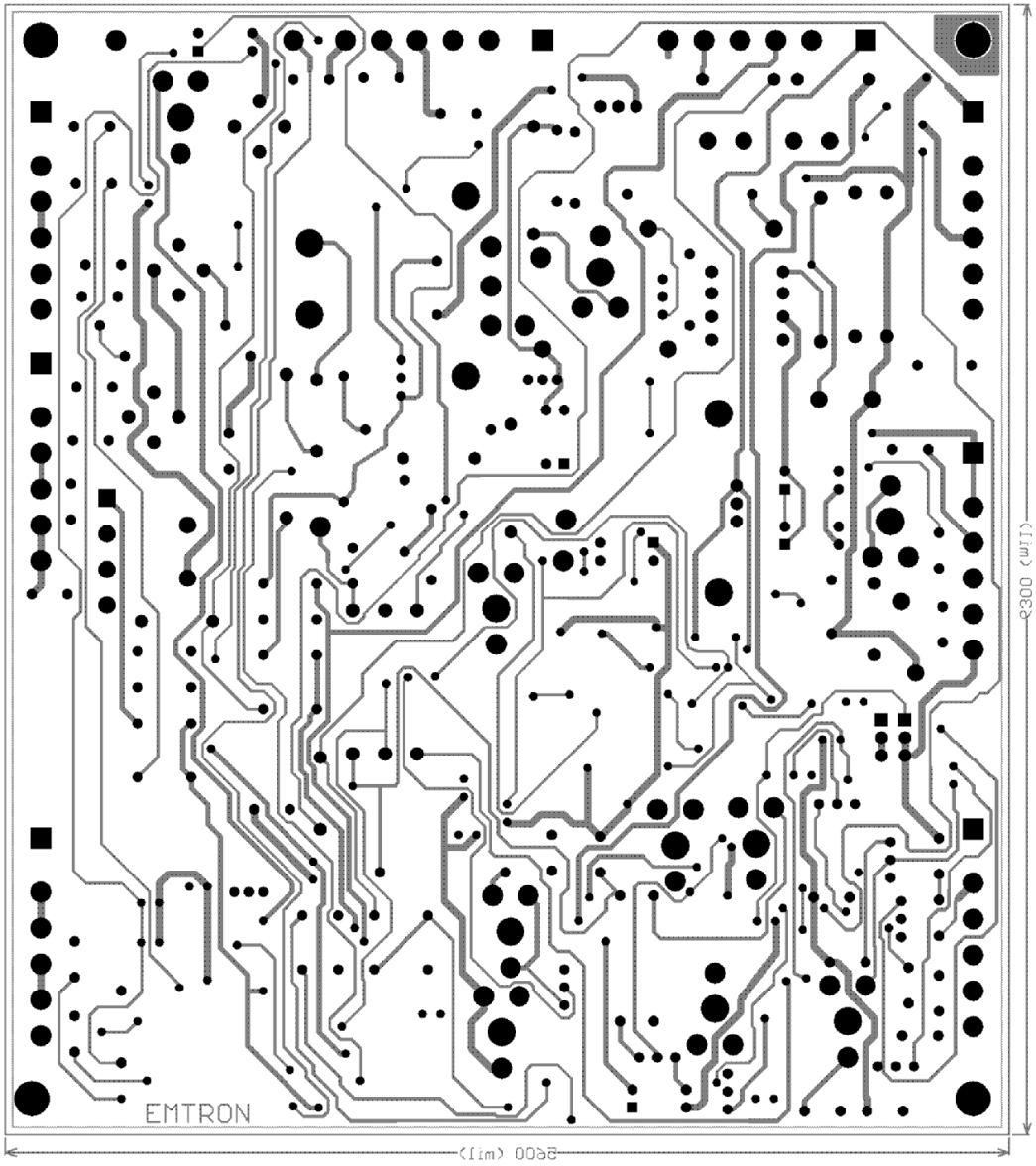


Figure 19

16 APPENDIX 2: WAVEFORMS

16.1 QSK Switching

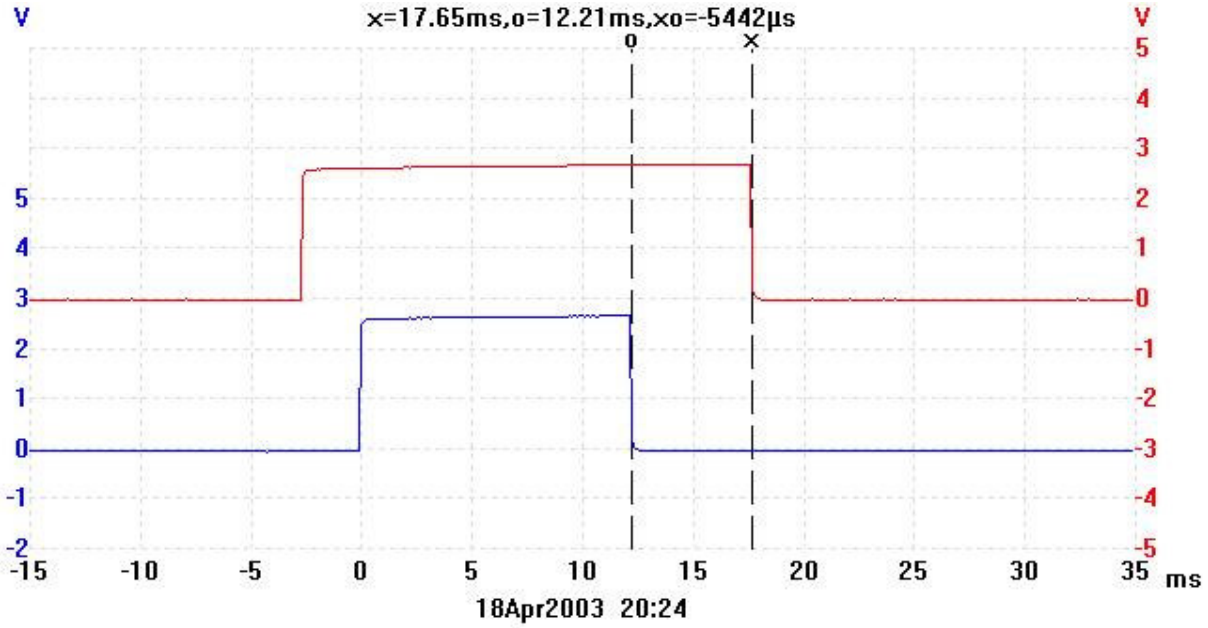
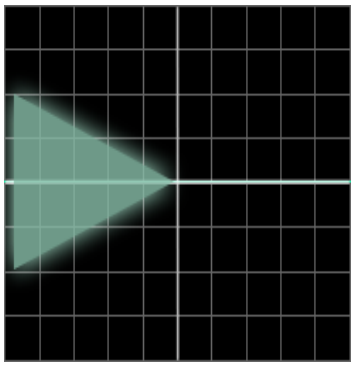


Figure 20 No “Hot switching”: The output relay (Top trace) switches first, and then the RF drive is applied (Bottom trace)

16.2 Linearity



Linear Trapezoid Modulation Pattern

Figure 21 Sample of linearity curve obtained by using a two-tone generator and a PC oscilloscope in XY mode.

17 APPENDIX 3: ADJUSTMENTS

ADJUSTMENTS TO EMTRON DX-3SP AMPLIFIERS

CAUTION

Most of the following adjustments require the amplifier to be open and powered up. This also implies defeating the mains interlock safety switch, which is extremely dangerous since high voltage / high power DC and AC and RF voltages are exposed. **We do not recommend anyone to do this**, since extreme precaution and safety measures are required.
If however, this is attempted, it should be only by technical people qualified and experienced in working with high voltage and high power circuits, including RF.

17.1 Control Board

This procedure refers to adjustments made to the board already installed in the amplifier.
This would be required, for example, after replacing the tube or after certain repairs.
After a tube replacement only one or two adjustments are required: BIAS and (if EBS used): PRE-BIAS

17.1.1 PRE-BIAS ADJUSTMENT

Adjustment: POT7, marked PRE-BIAS

The pre-bias is required when the Electronic Bias Switching (EBS) is used. If the EBS link is kept in OFF position, the pre-bias does not need to be adjusted. PRE-BIAS must be adjusted before BIAS.
When EBS is activated (the default situation), keying the amplifier causes the plate current to stay cut off (as if the PTT was off), until a small amount of drive is applied. The “Pre-bias” establishes a small plate current as soon as PTT is on. The transition to full ON is then less abrupt, while the tube dissipation is still reduced by using EBS.

PTT Off: **Ip = 0**
PTT On (no drive) and EBS on: **Ip = Ipb (pre-bias current)**
PTT On (no drive) and EBS off: **Ip = Ip0 (standing current)**

PROCEDURE:
Remove the cover and connect a voltmeter between the test point TP2 (top corner) and the chassis.
Make sure EBS is ON. (The EBS jumper is in the position towards the rear of amplifier).
See also Pictures in Fig. 18 and 19.
With the amplifier running, wait the warm-up time.
When READY, put OPR switch on and key the amplifier with NO INPUT DRIVE.
Read the voltage at TP2. **NOTE**: the voltage at TP2 is NEGATIVE with respect to ground.
Adjust POT7 (PRE-BIAS) to obtain the desired pre-bias current.

The recommended pre-bias current is 30 to 60 mA, or a reading of -30 to -60 mV on the voltmeter at TP2.

NOTE: the pre-bias current is not critical.

17.1.2 BIAS ADJUSTMENT

Adjustment: POT3, marked BIAS

Adjust Pre-Bias before adjusting Bias.
This adjusts the plate standing current, with the EBS Off and the amplifier keyed with NO INPUT DRIVE.

PROCEDURE:
There is a switch on the sub-chassis which allows switching off the screen voltage at any of the 2 tubes. When turned to the left, the left hand side tube is operational and the other tube is disabled. In the middle position, both tubes are operational. When turned to the right, the right hand side tube is operational and the left tube is disabled.

There are 3 bias adjustment potentiometers: POT3 (BIAS), affecting both tubes and POT10 (BS1) and POT9 (BS2) only adjusting the bias to the tube connected to the pins BS1 and BS2 respectively.

Adjust initially POT10 and POT9 fully clockwise, then rotate back about 20 degrees (they are likely to be already in the required position).
Turn the screen switch (on the sub-chassis) say – to the left. Key the amplifier with NO RF DRIVE and adjust POT3 for ½ of the total standing current, or about 0.25 A.

Key off and switch to the other (right) tube.
Key ON again and adjust POT9 (BS2) for the same current. (This is correct if the white bias wire is connected to the BS1 pin and white/black to the BS2 pin).
Key off and put the switch in the middle position.

Key ON and adjust POT3 for the total standing current desired (0.47 A).

Then the operations above can be repeated to ensure the 2 tubes have approximately the same standing current.
Switch again to the left tube only, then right tube only and check the current.
If there are differences more than about 5 mA, adjust only POT9 or POT10 to make them equal. Once the 2 tubes are balanced, POT3 can be adjusted again to fine tune the final value.

The recommended bias currents is 470 mA (460 to 480), or -470 mV nominal on the voltmeter at TP2.

NOTE: it is important to have POT9 and POT10 close to the clockwise end and use them only for small adjustments to balance the tubes, while the main adjustment is done for both tubes simultaneously, using POT3.

CAUTION: With a new tube, start at a low plate current. Rotate POT3 (BIAS) for minimum current (counter-clockwise) before keying the amplifier.
With the adjustment in the wrong position, the plate current could reach very high values.
During this adjustment there is no output power. All the power taken from the high voltage supply is dissipated by the tube.
Be brief and quick. Put PTT on for a few seconds, then off. Repeat several times until the desired standing current is achieved.

NOTE: After adjustment, move the EBS link back in the ON position (default) if EBS is desired.

The above 2 adjustments are required when changing a tube or when changing the control board.

*The remaining following adjustments are pre-adjusted with a new control board and normally there is no need to change them. A possible exception could be the **SWR** protection which might require some fine tuning after changing the control board or the RF sensor module, but usually the factory pre-adjustment is close enough. Also **EBS** might need adjustment depending on the personal preference of the operator (See 17.1.4)*

17.1.3 SWR PROTECTION ADJUSTMENT

Adjustment: POT5, marked SWR.

This adjustment requires a special jig with a load made of 2 non-inductive, high power resistors (at least 300W).
They can be switched between 130 ohm and 140 ohm. With a 50 ohm output these 2 loads give an SWR of 2.6:1 and 2.8:1 respectively. The adjustment is nominally for a ratio of 2.7:1 to trigger the protection in the form of antenna by-pass.

Usually this adjustment is performed on 20m (14.200 MHz) at full power.
With a 50 ohm dummy load, transmit and adjust for full power (or close to full power).
Stop transmitting and replace the 50 ohm dummy load with the special dummy load described above.
Switch the dummy load to 140 ohm and key the amplifier for just one second.
If the protection wasn't activated immediately, increase the sensitivity (rotate anticlockwise).
Repeat applying power for a short time only, until the protection is triggered.

Switch the special dummy load to 130 ohm and repeat. This time the protection should not trigger. If it triggers, reduce the sensitivity. Try several times using 130 and 140 ohm load. The protection threshold should be between these 2 values (135 ohm, corresponding to 2.7:1 SWR).

17.1.4 EBS ADJUSTMENT

Adjustment: POT4, marked EBS

Usually this adjustment is performed on 20m (14.200 MHz), but it can be done on any band.

Transmit into a dummy load or antenna.
Apply very low input drive.
With the EBS activated (with the EBS jumper in the forward position, or ON):

Checking the existing adjustment: increase slowly the input drive, starting from zero, until the EBS system activates the amplifier. This can be checked by watching the plate current or the RF output power or the current or power taken from the AC mains. Any one of these can be monitored and a jump in reading happens when EBS switches.
Check that this happens for an input drive between 0.5 – 1 Watt.

Adjusting EBS: if the adjustment is not correct or you prefer a lower or higher setting, apply the desired amount of power and then adjust POT6 until you find the limit where the EBS activates.

NOTE 1: a higher threshold is likely to give reports of the beginning of the words being cut off. If this is the case, a lower threshold (higher sensitivity) can be used.
A low threshold can make the EBS activate erratically, for example due to the ambient noise in the room, or even due to the noise generated by the fan. This is not a problem in itself, except that the tube will dissipate extra power during the times when you hold the key down but do not speak (eg between the words, while speaking). However, these moments are usually brief and it won't make much difference.

NOTE 2: for factory adjustment, a negative voltage with the value of 1.6 V is applied to the RFIN pin (X6.4) on the control board when this board is checked, then when the amplifier is tested the adjustment is only checked with RF, but not changed. The actual EBS threshold could be slightly different between bands.

17.1.5 SCREEN VOLTAGE ADJUSTMENT

Adjustment: POT2, marked SCREEN

The screen voltage can be measured on the pin marked EG2 on the control board (close to the jumper EBS, this pin has a blue wire connected to it). Since the pin is isolated, a more easily accessible point can be used: FB3 (top of the ferrite bead) or V1 (the MOV pin) or either end of the zero-ohm resistor marked D23.

The amplifier must be READY and on OPR for the screen voltage to be present.
The nominal adjustment is 356V unloaded.

NOTE: the screen voltage does not need adjustment unless the value was altered by somebody.

17.1.6 SCREEN CURRENT LIMIT ADJUSTMENT

Adjustment: POT1, IG2LIMIT

Do not adjust this potentiometer, it has been factory adjusted and there is no need to change.

With the amplifier switched off or on STANDBY, remove the blue wire on pin EG2.
Connect an analogue mA-meter with a 100 mA full scale range (+ to the control board) and then (-) to an adjustable resistive load with a range from 3 kohm to about 20 kohm (this jig is also required for the display board adjustment, it is convenient to adjust the ig2 indicator at the same time). The other end of the resistor goes to the chassis.
The power rating must be 20 – 25 W (short time loading only).

Connect also a voltmeter to measure the screen voltage.

Put the front panel switch on OPR.
Start with a higher value (20 kohm) of the resistor and reduce the resistance gradually. At 7 kohm the reading will be about 50 mA and the voltage starts dropping. The reading should be 345 – 350 V.
Continue reducing the resistance until the current reaches about 70 mA. The screen voltage must drop to about 300 V or less under this load.
If not, adjust POT1.

NOTE 1: While adjusting ig2 limit, the ig2+ indicator on the display board can also be checked / adjusted at the same time.
NOTE 2: IG2 LIMIT can be checked / adjusted also by simply putting a mA-meter in series with the blue wire connected to

the EG2 pin on the control board. While operating the amplifier at full power, by rotating the LOAD knob, IG2 can be varied and the screen voltage can be measured. This way the current limit of the screen regulator and the ig2 indicator on the front panel can be checked quickly, without the need for a special load.
However, the amplifier has to be opened and wires used to extend the screen voltage connection to an external current meter and volt meter.

17.1.7 IPTRIP ADJUSTMENT

Adjustment: POT6, marking: IP TRIP
This is the sensitivity of the high plate current protection (cut-off).

When the plate current exceeds the adjusted limit, even for a very short time, the start-up timer is reset. The screen voltage is cut off and the FAULT light turns on. To make the FAULT light go off, the amplifier must be put on STANDBY. If left on OPR, the operation will resume automatically at the end of the (about) 2 minutes warm-up time. During this time, any RF power applied to the input is bypassed into antenna.

Connect a DC supply to pin TP2 on the control board (in the top corner). Negative to TP2, positive to the chassis.
With the amplifier powered and the READY light on, put the front panel switch on OPR.
Apply a current gradually increasing from zero and check that the protection is triggered at about 2.5 A of current. When this happens, the FAULT light will turn on.
If the current value found is much different from 2.5 A, adjust POT6.

To repeat the adjustment or checking, a waiting time of about 2 minutes is needed every time for the READY light to turn on again.
To speed up, the resistor R20 (5.6 Mohm) can be paralleled briefly with a lower value resistor (1k – 100k). Touch R20 with, say 10 kohm in parallel and the Ready light will turn on immediately.
See picture below (Fig. 23) for the position of R20.

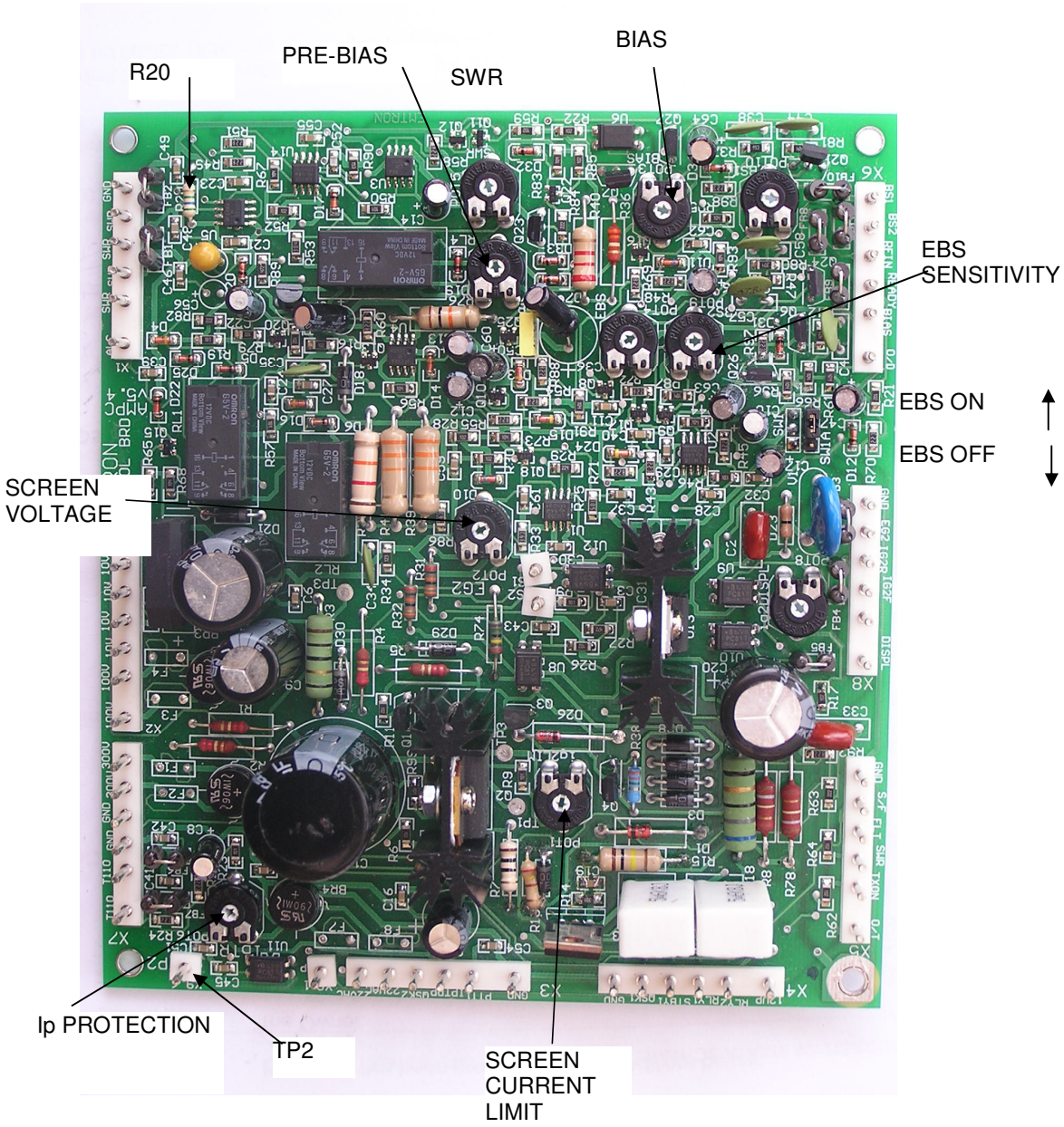


Figure 22 Control Board – Component side view

17.2 Display Board Adjustments

The display board is pre-adjusted during testing. However, when a new display board is installed in the amplifier, most adjustments need to be fine-tuned. Remove the front panel glass to gain access to adjustments. The ig2+ adjustment is recommended also when the control board is replaced.

17.2.1 PLATE CURRENT

Adjustment: VR4, Marked: AMP

Connect a power supply to pin TP2 on the control board: negative to TP2, positive to the chassis.
Apply a current with a value of 1 A.

Adjust potentiometer AMP for correct indication.

17.2.2 PLATE VOLTAGE

Adjustment: VR2, marked: VOLT

Using a voltmeter with a high voltage probe, measure the plate voltage.
Adjust potentiometer VOLT for correct indication on the display.

17.2.3 REFLECTED POWER

Adjustment: VR3, marked: RF R

Make sure the amplifier is in STANDBY.
Reverse the input and output RF connections.
- connect the transceiver or exciter to the amplifier output
- connect the dummy load to the input of the amplifier

Apply 100W drive and adjust “RF R” for 100W indication
Reverse again the RF cable - connect them the right way.

17.2.4 FORWARD POWER

Adjustment: VR1, marked: RF F

On 20m, operate the amplifier at the full nominal power CW (4000 W), as indicated by an external power meter:
Adjust potentiometer “RF F” for correct display indication

17.2.5 SCREEN CURRENT

Adjustment: VR6, marked IG2+, VR5, marked IG2-

ig2+: connect a mA meter in series with the screen supply, between the control board pin EG2 and the blue screen wire. (See also the control board adjustment for IG2 LIMIT).
Generate a current in the mA meter, either by connecting a load, or by operating the amplifier close to full power.
Adjust VR6 for 4 LED's on, at the limit of starting to flash, for a current ig2+ of about 50 mA.
ig2-: put VR5 in the middle position (6 o’clock) for an approximate adjustment.
The factory adjustment is done while testing the amplifier. Ig2 is negative (reverse) at mid-range output power. By changing the tuning the negative ig2 can be adjusted to read -80mA on the external mA-meter. Then VR5 is adjusted for full scale indication of the green light (4 green LED’s ON).

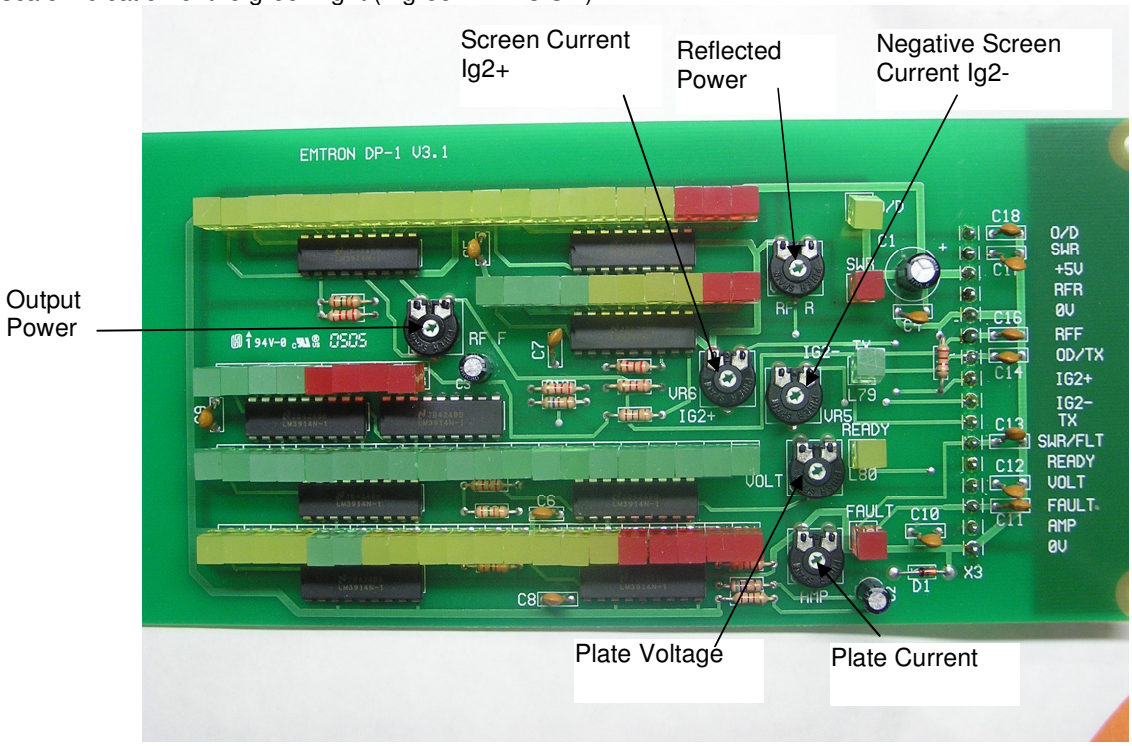


Figure 23 Display Board

17.3 RF Sensor (Bridge) Adjustment

The amplifier is switched off for this adjustment.

Check if adjustment is required as per following procedure, before opening the sensor.

Unsolder and remove the metal cover.

Connect a transceiver to the input and a dummy load to the output of the amplifier.
Connect a voltmeter (+) to pin SW1 or SW2 on the control board (with yellow/black wires).
Apply 30-50W RF on 20m (14.2MHz) and read the voltage.
Move the voltmeter to pin SW3 or SW4 (red/black wires) and read the voltage.
Typical readings:

- Yellow / black wires: 1.5 – 2.2 V
- Yellow / red wires: 100mV or less (preferably <40 mV).

Adjust the trimmer on the output side (left hand side) in the RF sensor for minimum reading on the yellow / red wires. (Use an RF screwdriver).

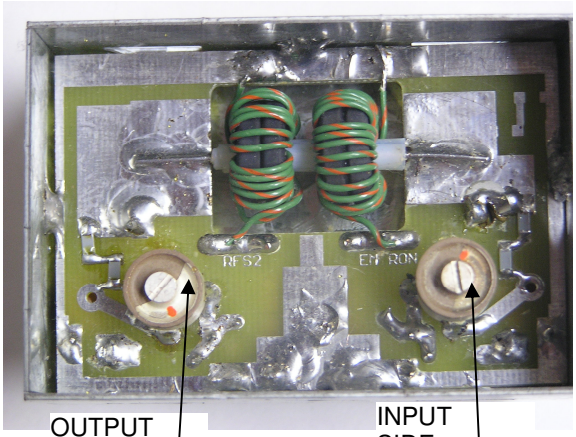
Reverse the 2 RF cables: apply power to the output of the amplifier and put the dummy load on the input.
Apply power again.
The typical readings are the same, but reversed:

- Yellow / black wires: 100mV or less (preferably <40 mV).
- Yellow / red wires: 1.5 – 2.2 V

Adjust the trimmer on the input side (right hand side) in the RF sensor for minimum reading on the yellow / black wires.

Re-position the RF sensor cover and solder.

NOTE: the above voltages can be measured as explained above and if the readings are correct, no adjustment is necessary (the sensors are pre-adjusted before being installed).
The adjustment is very stable and normally no readjustment is necessary. Some models of RF bridge don't even have trimmers, fixed capacitors have been used instead.



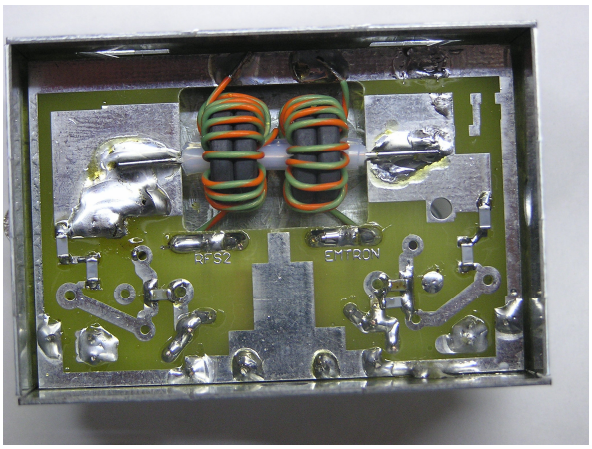


Figure 24 RF Bridge

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