

CHAPTER 1

MODEL 238C INSTALLATION

Model 238C is a high power antenna tuner that uses an adjustable reactive network for matching the unbalanced 50 ohm output impedance of transmitters and transceivers to a variety of balanced and unbalanced loads. It is usable over a frequency range of 1.8 to 30 MHz. Provision is made for selecting one of four antennas or for bypassing the matching network. A cross-needle SWR and wattmeter with switchable 200 and 2000 watt scales and selectable peak and average power output reading is included.

UNPACKING YOUR NEW TUNER

Examine your model 238C for signs of shipping damage. Should any damage be apparent, notify the delivering carrier immediately, stating the full extent of the damage.

Retain all damaged cartons if damage is apparent. Liability for shipping damage rests with the carrier. We also recommend that you keep the carton and packing fillers in the event that storage, moving, or shipment becomes necessary.

The following hardware and accessories are packed with your 238C. Make sure that you have not overlooked anything.

- (1) #23160 Capacitor, 1000 pF, 1 kV
- (1) #38088 .062" hex Allen wrench
- (1) #74020 Warranty card
- (1) #74428 238C Operator's Manual

TRANSMITTER CONNECTION

The model 238C is designed for connection to transmitters having a 50 ohm nominal output impedance. Connect the coaxial output of your transmitter to the SO-239 type INPUT connector on the rear panel of the tuner with a 50 ohm coaxial cable.

GROUND CONNECTION

Connect your station ground system to the GND wing nut terminal on the rear panel of the tuner with heavy braid or wire. The

ground connection should go directly to the earth ground system using as short a lead as possible.

ANTENNA CONNECTIONS

Connect antenna transmission line(s) to the appropriate terminal(s) on the tuner as follows.

For 50 ohm coax-fed antennas (unbalanced transmission lines) use ANT 1, ANT 2, ANT 3 or ANT 4.

For a single wire antenna connect to SINGLE WIRE terminal. The SINGLE WIRE terminal uses the ANT 4 antenna connection.

For balanced feedline systems, adding a jumper from SINGLE WIRE to one of the BALANCED LINE terminals as shown on the rear panel is required. A tin-plated steel jumper for this purpose has been provided. It is attached to one wing nut connector on the back; if balanced line will be used, attach the other side of the jumper to the other wing nut. Then connect the feedline to the two BALANCED LINE terminals.

ANT position 4 can be coax, single wire, or balanced line. ANT 1, ANT 2, ANT 3 must be coax only.

In both single wire and balanced line systems, take special care to route the transmission line as far away from the station equipment as possible. Never drape lines over the transmitter. These lines have high voltage points inside the shack which can produce strong RF fields.

Please note that 238C does NOT allow for the connection of either coax-fed and balanced line or single wire antennas to the ANT 4 connection at the same time. There is no switchable configuration for ANT 4 – any antennas connected to these jacks will be in use. If you have a coax fed antenna and a balanced line or single wire antenna connected to ANT 4 at the same time, both of these antennas will be in use when ANT 4 is selected from the front panel.

DC POWER CONNECTION

The 238C dual cross-needle wattmeter requires 12-15 VDC (13.5 VDC nominal) for meter lamp illumination and to power the peak-reading power output circuitry. Connect a cable from your 12-15 VDC power source to the rear panel 13.5 VDC jack. Center tip is positive, shell/case is negative. It is only necessary to connect DC power to operate the peak-reading wattmeter function and to illuminate the meter lamp. SWR metering and the average reading power output metering are usable even with no DC power connected.

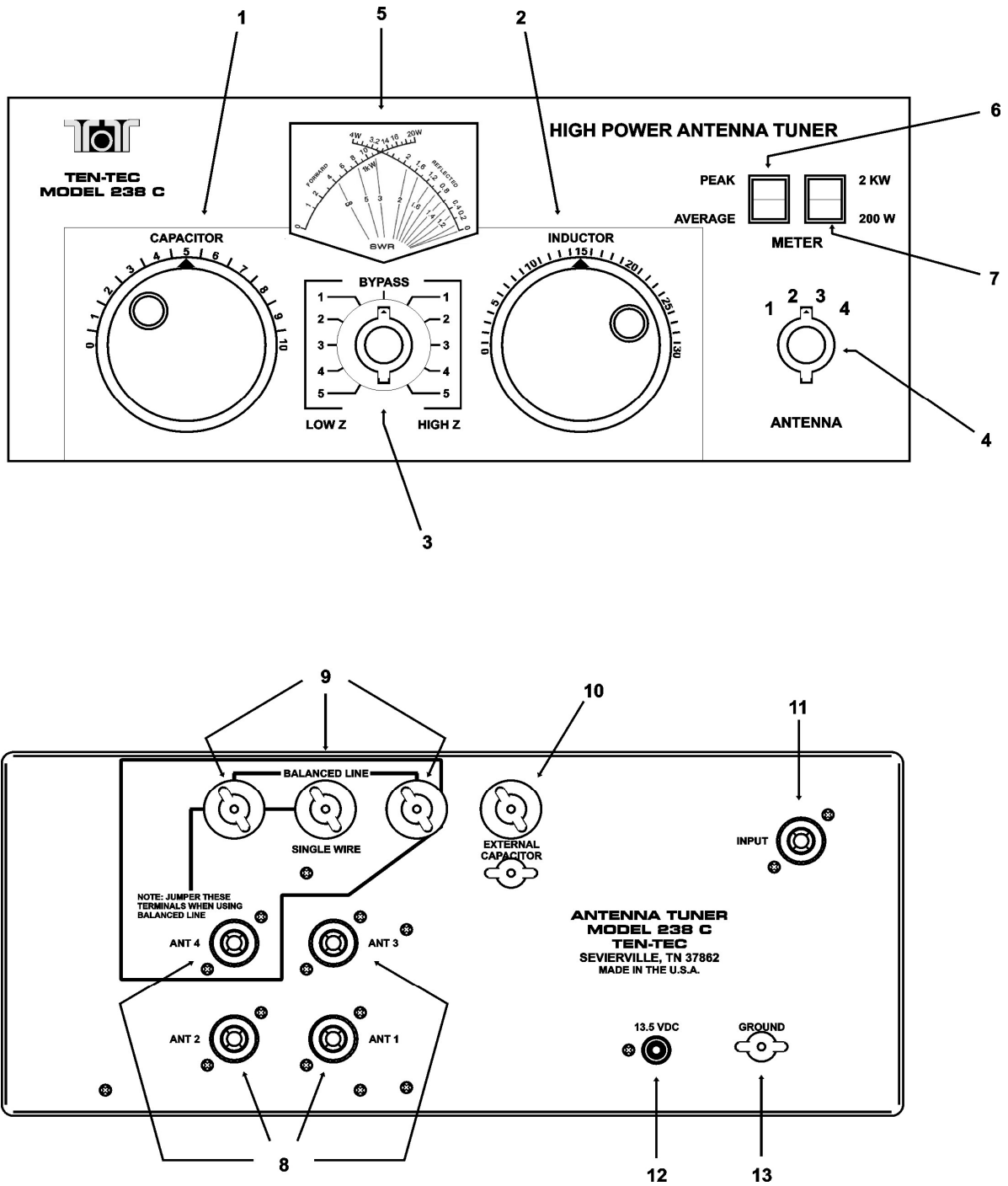


Figure 1-1 238C Front and Rear Panel

CHAPTER 2

OPERATING INSTRUCTIONS

The following set of instructions will allow the operator to quickly place the 238C into operation. Included are descriptions of the front panel controls and their functions. This is followed by instructions for antenna matching and selection, and a brief discourse on antenna systems matching theory. Figure 1-1 on the previous page shows a visual representation of each item on model 238C and its function or use.

FRONT PANEL CONTROLS

(1) CAPACITOR

This control connects to the variable tuning capacitor used as one of the elements in the "L" type matching network. This capacitor has a tuning range of 40-500 pF and is continuous tuning with no stops. A marker system of digits from 0-10 is silk screened in a 180 degree arc around the top of this control to make returning to earlier settings easier and quicker.

(2) INDUCTOR

This control is connected to the roller inductor, another element in the "L" type matching network. This inductor has a tuning range of 0.2-18 uH which is covered in approximately 30 revolutions of the control knob. A gear reduction system behind the front panel of the 238C is connected to a concentric skirt turns counter numbered 0-30 in a 180 degree arc over the top of this control, to make returning to earlier settings easier and quicker.

(3) IMPEDANCE SWITCH

This 11 position rotary switch is used to change the configuration of tuning network for matching either high or low impedance antenna systems. This switch also selects additional capacitors as needed for matching at lower frequencies. When placed in the 12 o'clock position, the tuner is connected to the BYPASS configuration and the network has no effect on the transmission line systems (antennas are fed through directly from the transmitter to the

antenna without use of the tuner). The SWR and power metering remains usable even when this switch is set to BYPASS.

The purpose of this switch is to set the capacitor either across the input or across the antenna, depending on whether a load of above or below 50 ohms is trying to be matched (reverses the "L" network).

(4) ANTENNA SELECT KNOB

This 4 position switch is used to select one of up to four antennas connected to the rear panel of the 238C and correspond to the ANT 1, ANT 2, ANT 3, and ANT 4 connectors.

(5) METER

The meter on model 238C is a dual cross-needle SWR and average or peak-reading wattmeter. Forward power output is measured on the right-hand needle, left-hand scale. Reflected power is read on the left-hand needle, right-hand scale. SWR is read by reading the point at which the two needles cross, on the red scale lines on the face of the meter. Power output is read in switchable scales of 200 or 2000 watts. Peak-reading wattmeter function requires that 12-15 VDC be connected to the 13.5 VDC rear panel jack. Average power and SWR can be read even without DC power connected.

(6) PEAK/AVERAGE SWITCH

This switch is used to select either average or peak power output reading power on the 238C meter. DC power must be connected to the rear of the tuner to enable the peak reading function. Average power can be read with or without DC power connected.

(7) POWER SCALE SWITCH

The power scale switch is used to set the power output metering to scales of either 200 or 2000 watts.

REAR PANEL CONTROLS

(8) MAIN ANTENNA CONNECTORS

Four SO-239 type connectors labeled ANT 1, ANT 2, ANT 3, and ANT 4 are provided for the connection of 50 ohm coaxial antennas.

(9) WING NUT ANTENNA CONNECTORS

Wing nut antenna connectors are provided on the ANT 4 connection for connection of either a single wire or balanced line-fed antenna. Please note a jumper must be installed between the SINGLE WIRE terminal and one of the BALANCED LINE terminals before balanced line is used.

A tin-plated steel jumper for this purpose has been provided. It is attached to one wing nut connector on the back; if balanced line will be used, attach the other side of the jumper to the other wing nut. Then connect the feedline to the two BALANCED LINE terminals.

Please note that 238C does NOT allow for the connection of either coax-fed and balanced line or single wire antennas to the ANT 4 connection at the same time. There is no switchable configuration for ANT 4 – any antennas connected to these jacks will be in use. If you have a coax fed antenna and a balanced line or single wire antenna connected to ANT 4 at the same time, both of these antennas will be in use when ANT 4 is selected from the front panel.

(10) EXTERNAL CAPACITOR

Some low impedances on 160 meters may require more capacitance than the 2400 pF available with the variable tuning capacitor. Extra capacitance can be added if needed. See the instruction titled **160 METER OPERATION NOTE** elsewhere in this chapter.

(11) INPUT

A 50 ohm coaxial cable is to be connected from the output of your transceiver or linear amplifier to this jack.

(12) 13.5 VDC

The 238C dual cross-needle wattmeter requires 12-15 VDC (13.5 VDC nominal) for meter lamp illumination and to power the peak-reading power output circuitry. Connect a cable from your 12-15 VDC power source to the rear panel 13.5 VDC jack. Center tip is positive, shell/case is negative. It is only necessary to connect DC power to operate the peak-reading wattmeter function and to illuminate the meter lamp. SWR metering and the average reading power output metering are usable even with no DC power connected.

(13) GROUND

Connect your station ground system to the GND wing nut terminal on the rear panel of the tuner with heavy braid or wire. The ground connection should go directly to the earth ground system using as short a lead as possible.

ANTENNA MATCHING

The procedure shown below will enable you to match almost any antenna system. Please note that this does not mean 238C will match any antenna system you may employ on any given HF frequency. The 238C's matching range is at least 10:1 SWR at full rated power output of up to 2000 watts. Some odd length center-fed wire antennas can easily have a transmission line impedance in the thousands of ohms; these antennas cannot be matched by the 238C or any other antenna tuner.

EASY START GUIDE

Read all the information in the manual leading up to this point, then use the below instructions to start using your tuner.

Set CAPACITOR to "2" and INDUCTOR to fully counter-clockwise ("0") and the center switch to BYPASS.

Turn the center switch to the LOW Z 1 position (immediately to the left of BYPASS). Apply 30 to 50 watts of transmitter power and note SWR shown on the meter. Unkey the transmitter, and then move the switch to the HIGH Z 1 position. Apply 30 to 50 watts

or less of transmitter power and note SWR shown on the meter. Depending on which of the HIGH Z 1 or LOW Z 1 settings showed a lower SWR, try more positions on the same side to see if the SWR is lower. Choose the position among all switch positions that shows lowest SWR.

Adjust the capacitor for lowest SWR. Then turn the roller inductor clockwise to a higher setting and note if SWR changes. If SWR drops, adjust the capacitor for a lower SWR value. Go back and forth between these two controls, adjusting them for best match and the lowest available SWR.

If the capacitor shows best meter null (lowest SWR) at a setting of '0', turn the center switch to the other side of BYPASS. If the best meter null (lowest SWR) is with the capacitor at '10', turn the center switch to the next higher position.

It is possible depending on your antenna and the frequency in use that a good 'starting' match may not be readily apparent (i.e. all starting positions on the center switch show a somewhat high SWR). Try adjusting the roller inductor and/or capacitor to a higher initial setting and repeat the same instructions if this is the case.

WARNING: While all the components of the 238C are rated to easily handle continuous duty operation at full rated power, do NOT adjust the antenna tuner when running high output power. Adjust the tuner for lowest SWR at less than 50 watts, and then enable your linear amplifier. High circulating currents are present when high power is applied to the tuner; adjusting the tuner controls for lower SWR while running high power through the tuner can damage the unit.

WARNING: In normal operation, the 238C produces very high RF voltages and currents. We do not recommend operation of this tuner without the top cover securely installed due to the danger of contact with high voltage.

WARNING: Always be sure that a dummy load or antenna is properly connected when power is applied. Voltages in excess of ratings can occur if no load is connected.

BALANCED LINE OPERATION NOTE

When using balanced line, if the SWR rises during a long transmission it is an indication that a significant portion of the transmitter power is being lost in the balun. This will be the case when the antenna impedance is greater than 500 ohms. Changing the length of the antenna and/or feedline will usually cure this problem. Also be aware (as noted elsewhere in this manual and on the rear panel of the 238C) that a jumper must be connected between one of the balanced line terminals and the SINGLE WIRE terminal on the rear of the 238C before balanced line is used. A jumper attached to one wing nut connector on the rear panel has been provided for this application.

160 METER OPERATION NOTE

Some low impedance antenna loads on 160 meters may require more capacitance than the 2400 pF available with the variable tuning capacitor at full mesh and the center switch at position 5 on the LOW Z side (example: tuning a shortened whip antenna on 160). If such a condition exists, adding additional capacitance across the variable capacitor will usually produce a better match. A low loss ceramic or mica transmitting capacitor should be used. A ceramic capacitor, Ten-Tec part #23160, 1000 pF, 1 kV, is included in the model 238C packing kit for your use. If needed, install the capacitor by connecting it between the two EXTERNAL CAPACITOR wing nuts located vertically on the rear panel. Most antenna installations will have no need to install this capacitor.

ANTENNA SYSTEMS MATCHING THEORY

Most transmitters are designed to work into a 50 ohm resistive load, and they are not able to effectively supply RF power to loads that depart far from this value. However, many antenna systems, which include the antenna and the transmission line have complex impedances that make it difficult, if not impossible, to load the transmitter properly. These impedances are a function of the operating frequency, type of antenna,

type and length of transmission line, height of antenna and its proximity to other objects.

The model 238C provides a coupling method to convert the resistive/reactive load to a pure resistance of 50 ohms that will accept maximum power from the transmitter. This is not to say that any and all antennas, when converted to a 50 ohm resistive impedance by means of a tuner will give identical performance. To best understand the tuner adjustments required, it is necessary to have a fundamental knowledge of how antenna systems function. It is recommended that additional reading on the subject be done by those interested in obtaining maximum performance from their antenna systems. The ARRL Antenna Handbook, ARRL Radio Amateur's Handbook (antenna and transmission line sections), Low Band DXing by John Devoldere, ON4UN and other antenna books published by the publishers of amateur radio magazines are excellent sources for information.

CHAPTER 3

SPECIFICATIONS

Circuit Type: L network

RF Power Rating: 2000 watts

Frequency Range: 1.8-30 MHz continuous

Input Impedance: 50 ohms nominal

Output Matching Range: At least 10:1 SWR, any phase angle.

Input/Output Connectors: Input and four antenna coax connectors are SO-239, UHF type. Studs with wing nuts for single wire and balanced feeders.

Capacitor Voltage Rating: 3500 volts

Inductor: 0.2-18 uH silver-plated roller inductor.

Size: 5" H x 12.125" W x 13.5" D (12.7 x 30.8 x 34.3 cm). Depth measurement cabinet only, does not account for knobs or connectors.

Weight: 12 lbs (5.45 kg).

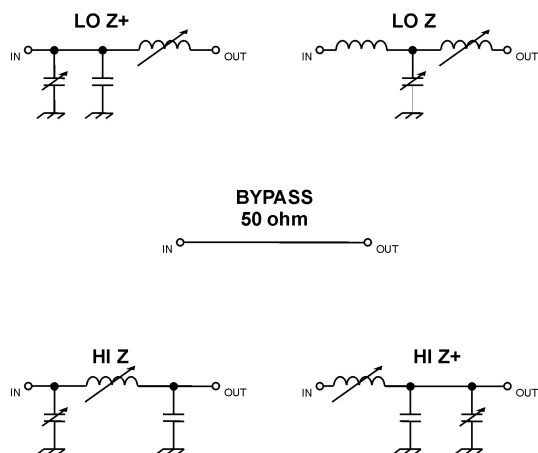
TECHNICAL INFORMATION

The matching circuit used in the model 238C is basically an "L" network. The "L" network has several advantages over other circuit configurations. It has only two adjustable parts; one inductor and one capacitor; most other networks use three. Because there are no internal nodes in the network, the maximum circuit voltages and currents which occur are never more than those present at the input or output terminals. Because there are only two variable components, there is only one setting of each which will provide a perfect match to a given load impedance, and this unique setting automatically provides the lowest network Q possible. Low Q means low circulating currents, hence low loss, and it also provides the widest frequency bandwidth of operation before retuning is necessary. Finally, since the inductor is always series, the network always provides

a two-pole low pass response to provide harmonic rejection.

There are, however, some disadvantages which have prevented wider use of the "L" network in the past. First, to match all possible antenna loads, two configurations are required. One, for impedances greater than 50 ohms (i.e. the antenna has a fairly low SWR already) the values of L and C in the network required for a perfect match become very small, smaller than the stray or minimum values of the components used. To circumvent this problem, a small fixed compensating capacitor or inductor is placed into the circuit depending upon whether the network is configured for low or high impedance respectively (HI Z or LO Z on the center tuner switch). At low frequencies, the value of network capacity needed to match some loads is quite large, requiring a large and expensive capacitor. To provide for this, fixed capacitors are placed in parallel with the variable capacitor to obtain the value needed. This function is performed by the center switch; further rotation from the center position increases the value of capacitance in the circuit.

There are 5 tuner configurations that are possible depending on the position of the center switch.

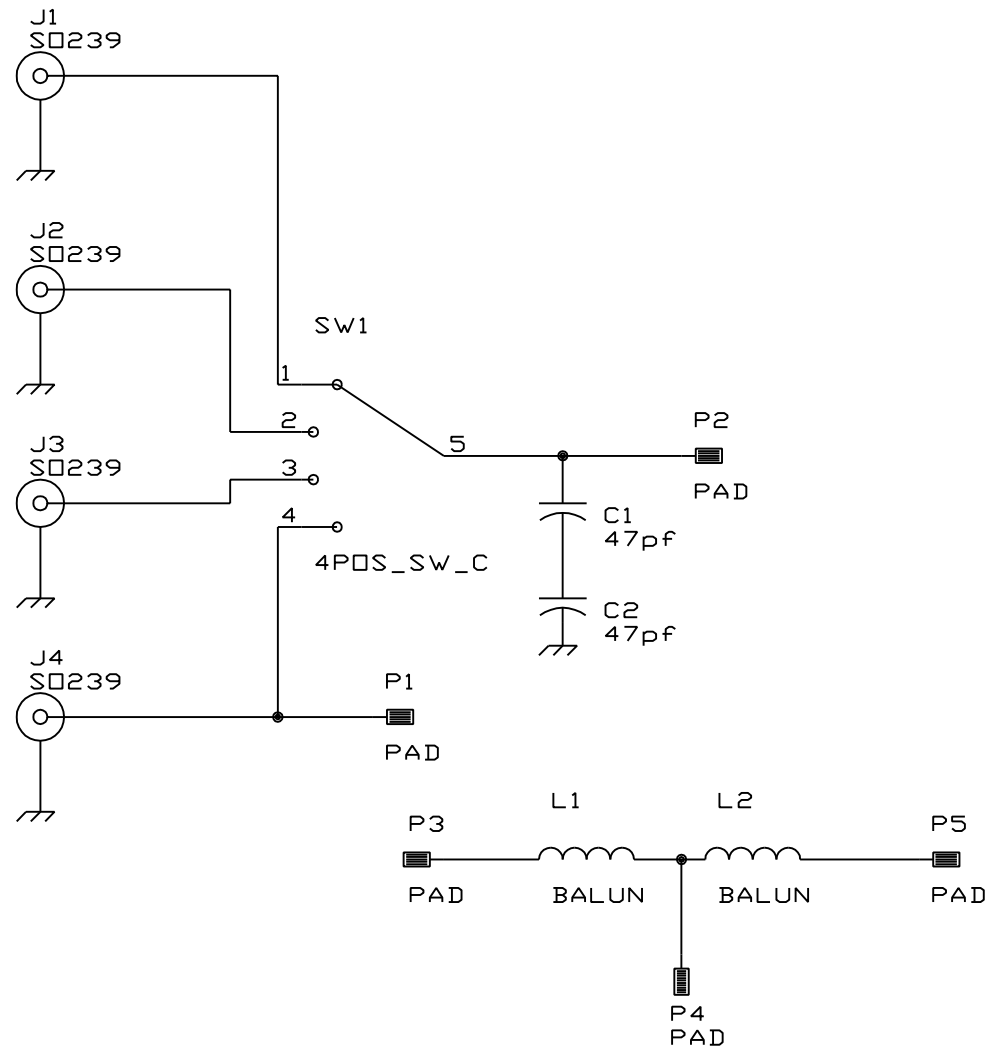


METER CALIBRATION

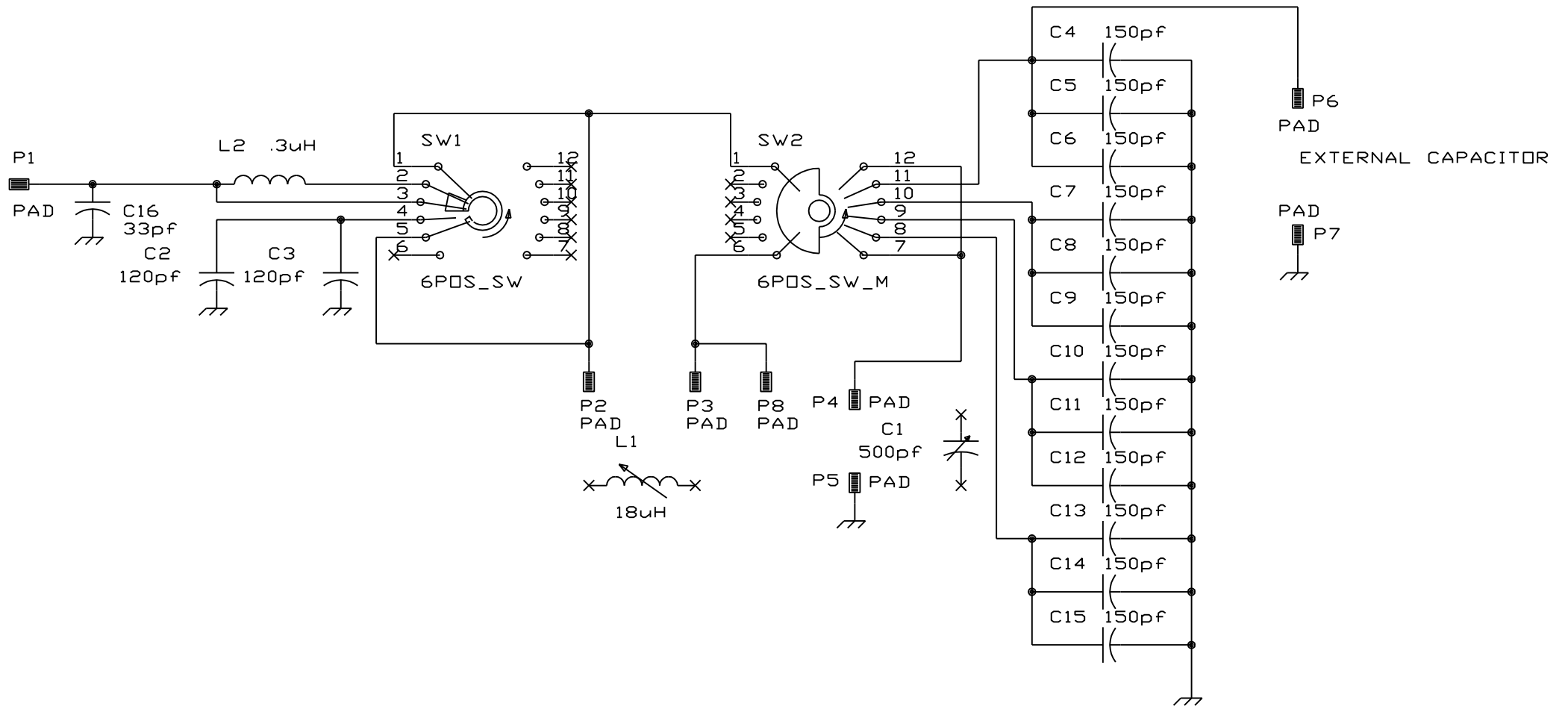
A metal plate is installed on the front of the 238C with 4 Philips screws. This plate has the markings for the capacitor, inductor and center impedance switch. It can be removed without taking off either of the two main knobs or the center switch knob.

Disconnect the tuner from DC power connected to the rear panel 13.5 VDC jack.

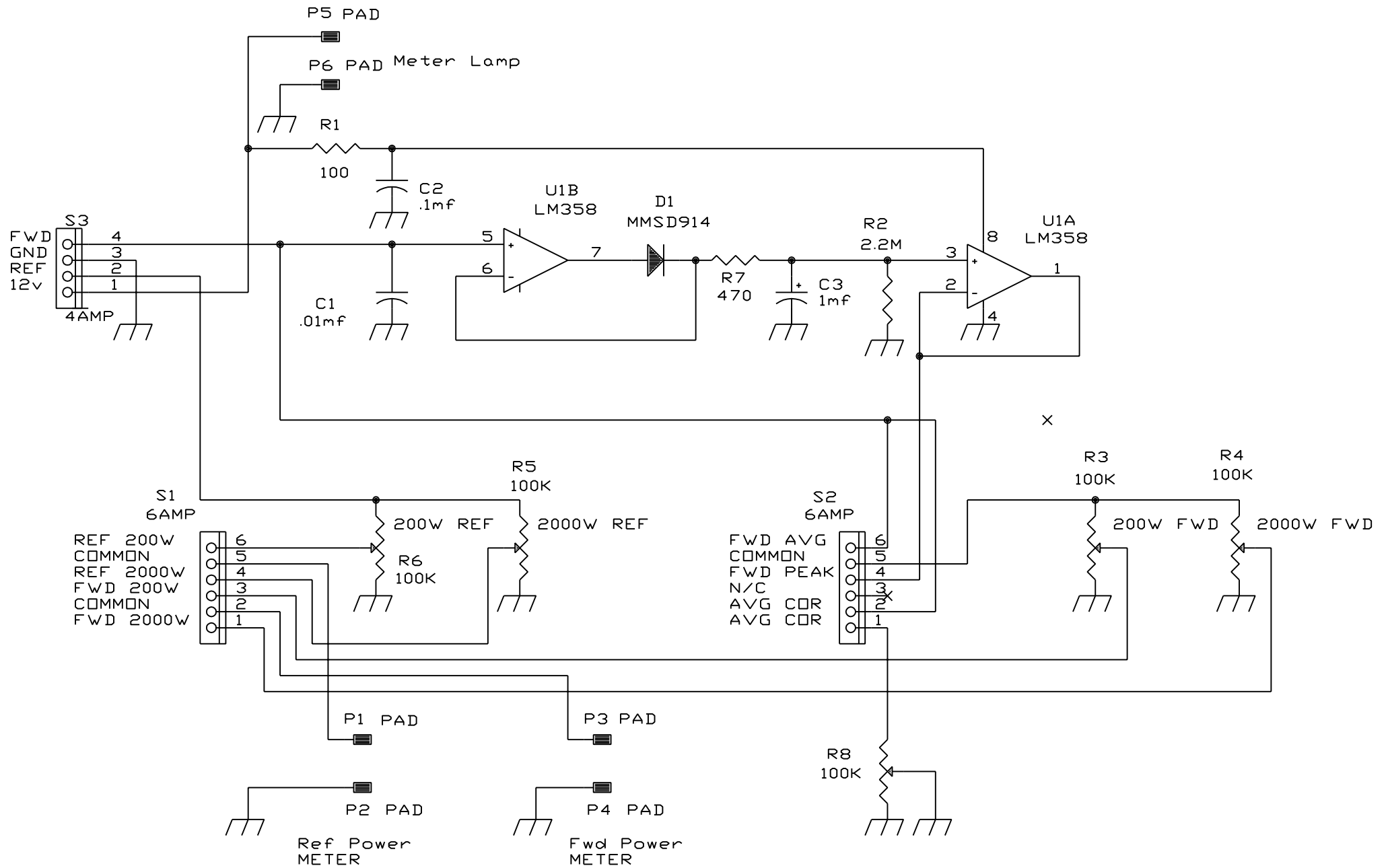
Remove the 4 screws that hold the metal plate in place and the metal plate itself. Behind the metal plate are two plastic screws for each meter movement. Adjust each as needed to reset the indication to '0'. Re-install metal plate and reconnect DC power.



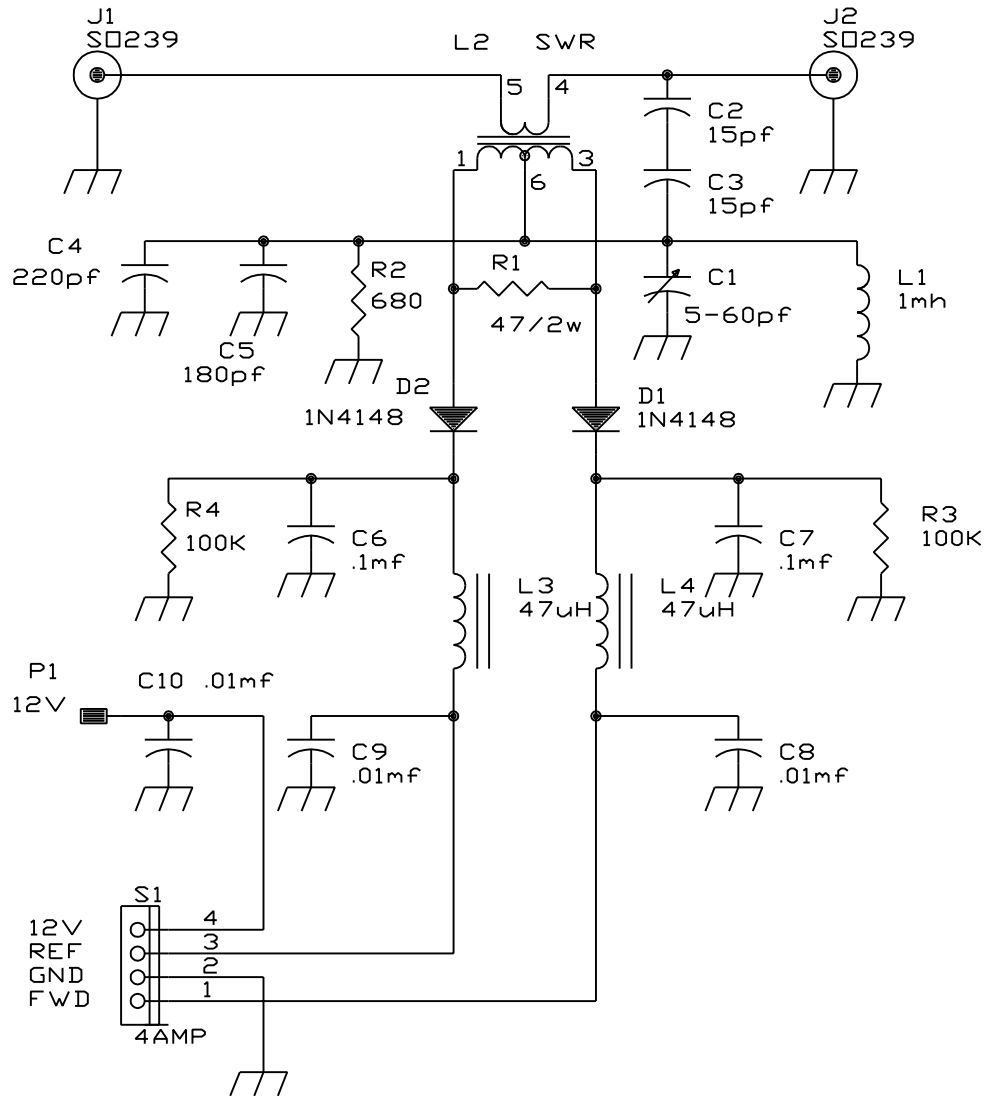
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