4 T858/859 Fault Finding

Caution: **This equipment contains CMOS devices which are susceptible to damage from static charges. Refer to Section 1.2 in Part A for more information on anti-static procedures when handling these devices.**

The following test procedures and fault finding flow charts may be used to help locate a hardware problem, however they are by no means a complete fault finding procedure. If you still cannot trace the fault after progressing through them in a logical manner, contact your nearest Tait Dealer or Customer Service Organisation. If necessary, you can get additional technical help from Customer Support, Radio Systems Division, Tait Electronics Ltd, Christchurch, New Zealand (full contact details are on page 2).

Section 4.1 describes the older design T858/859 without RF power modules, while Section 4.2 describes the newer design T858/859 with RF power modules. Figure 1.1 shows how to identify your PA design without having to remove the side cover.

Refer to Section 5 where the parts lists, grid reference index and diagrams will provide detailed information on identifying and locating components.

The following topics are covered in this section.

4.1 T858/859 Without RF Power Modules

4.1.1 Visual Checks

Remove the side cover from the T858/859 and inspect the PCB for damaged or broken components, paying particular attention to the surface mounted devices (SMDs). Also check for defective solder joints.

Refer to Section 4.1.7, Section 4.1.8 and Section 3 of Part A for more details on repair and replacement of components.

4.1.2 Component Checks

If you suspect a transistor is faulty, you can assess its performance by measuring the forward and reverse resistance of the junctions. Unless the device is completely desoldered, first make sure that the transistor is not shunted by some circuit resistance. Use a good quality EVM (e.g. Fluke 75) for taking the measurements (or a 20k ohm/V or better multimeter, using only the medium or low resistance ranges).

The collector current drawn by multi-junction transistors is a further guide to their performance.

If an IC is suspect, the most reliable check is to measure the DC operating voltages. Due to the catastrophic nature of most IC failures, the pin voltages will usually be markedly different from the recommended values in the presence of a fault. The recommended values can be obtained from either the circuit diagram or the component data catalogue.

4.1.3 DC Checks

Note: No RF power is to be applied during these checks.

Check that +13.8V is present on the collectors of Q3, Q4, Q5, Q6 and Q7. Make this measurement when the transmitter is not keyed.

Check that approximately 12-13V is present on the collector of Q1 (in the T859 the level is dependent on RV69 being set to maximum).

T858 Only Check that +13.8V is present at pin 4 of IC1 and pin 8 of IC3.

T859 Only Check that +13.8V is present at pin 4 of IC3.

Check that approximately +12V is present at pin 4 of IC1 (the level is dependent on RV69 being set to maximum).

Check that +7.0V is present at the output of regulator IC2.

4.1.4 RF Checks

4.1.4.1 General

You can measure in-circuit RF levels around Q1 and Q3 with an RF probe on which the earth lead has been shortened to a minimum (i.e. 13mm); refer to the PA Fault Finding Charts (Section 4.1.6.1 or Section 4.1.6.3 as appropriate). You must measure all other stages with a power meter at the 50Ω points in the circuit.

For problems with the power control circuitry, refer to the Power Control Fault Finding Charts (Section 4.1.6.2 or Section 4.1.6.4 as appropriate).

4.1.4.2 PA Faults

If a PA fault has occurred, or is suspected, it is easier to find if the various stages are isolated by use of the test breaks (refer to Figure 4.1) and each stage analysed individually. These 50Ω test break points have been included throughout the RF circuitry to enable individual transistor stages to be tested.

Note 1: Use good quality 50Ω coax for the "flying" test leads.

Note 2: Ensure each output is terminated in a 50Ω load of the correct power rating.

replace A4 pages D4.5/D4.6 with A3 pages D4.5/D4.6

Figure 4.1 T858/859 Test Break Point Location

replace A4 pages D4.5/D4.6 with A3 pages D4.5/D4.6

4.1.5 Voltage Chart

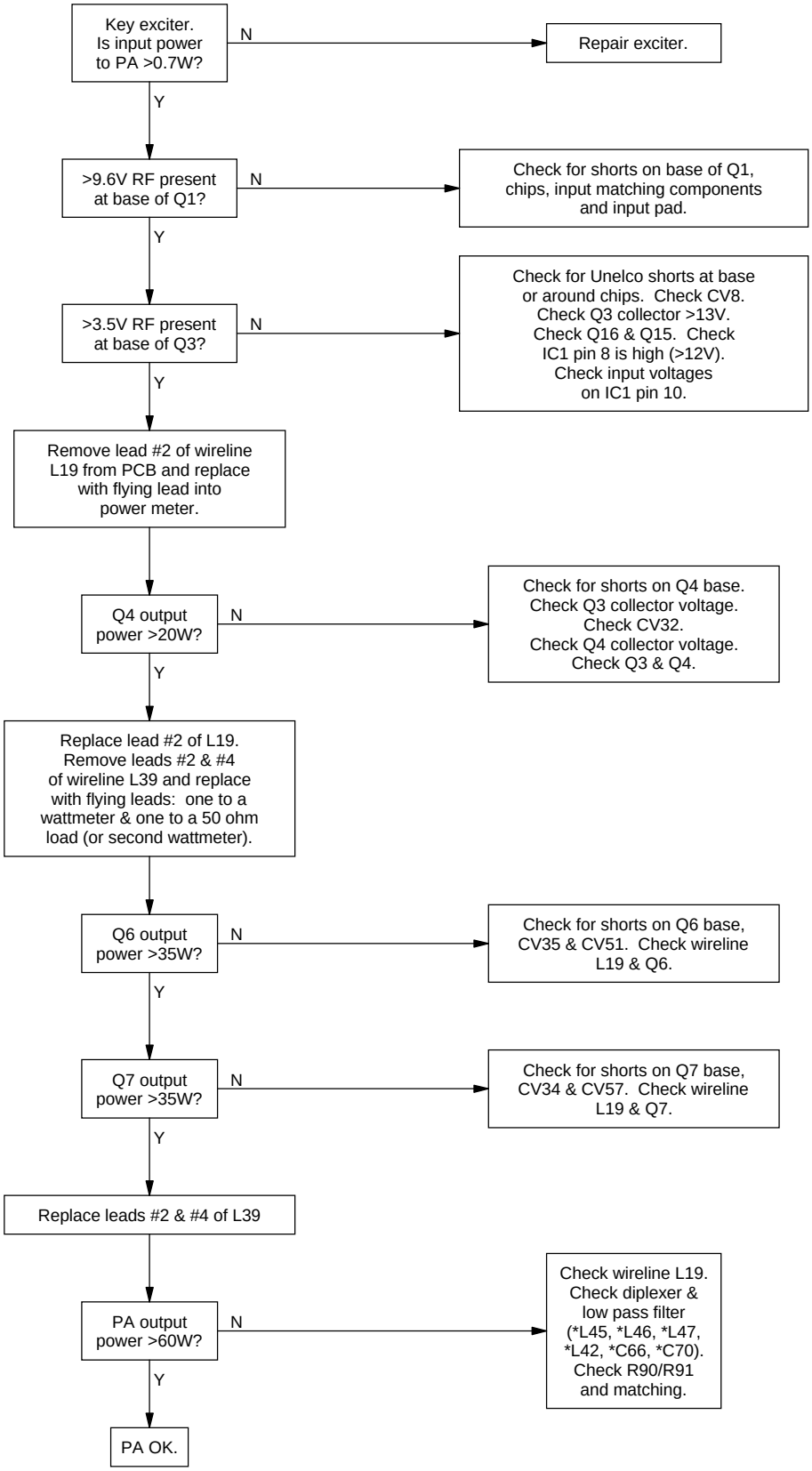
Test conditions:

- typical DC voltages measured with Fluke 77 DVM
- supply voltage 13.8V at socket
- transmitter unkeyed
- allow ±20% for spread of transistor characteristics.

Device	Emitter	Base	Collector
Q1	0.0V	0.0V	13.0V
Q3	0.0V	0.0V	13.8V
Q4	0.0V	0.0V	13.8V
Q6	0.0V	0.0V	13.8V
Q7	0.0V	0.0V	13.8V
Q11	1.8V	2.2V	5.9V
Q13	0.0V	0.0V	5.9V
Q15	13.0V	13.6V	13.6V
Q16	13.8V	13.6V	13.0V

4.1.6 Fault Finding Charts

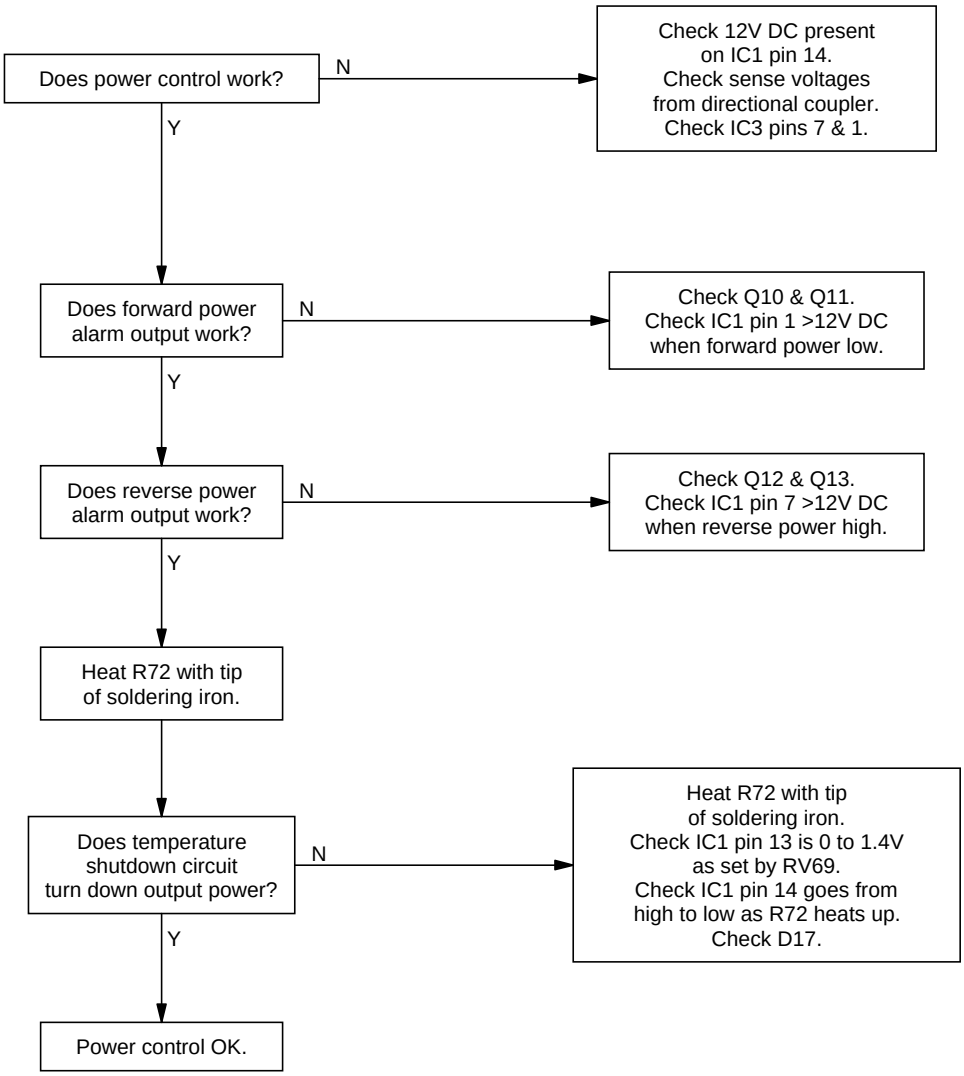
4.1.6.1 T858 PA



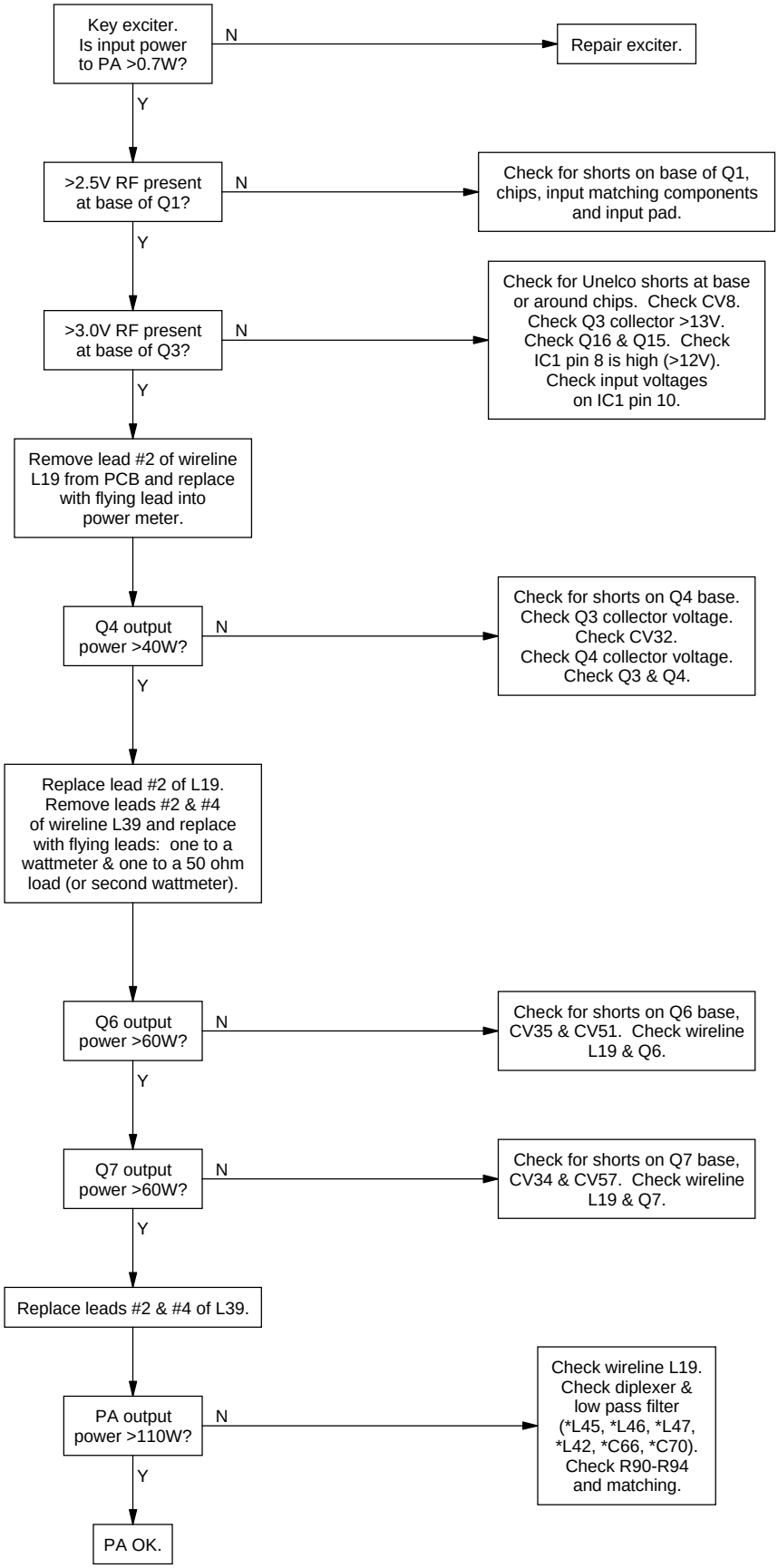
4.1.6.2 T858 Power Control

Approximate voltages under normal operating conditions:

Measurement	Output Power	
	20W	50W
forward power at "FWD-PWR" pad (beside IC3)	2.5V	4V
RV63/R64 (RV63 wiper)	1.4V	2.1V



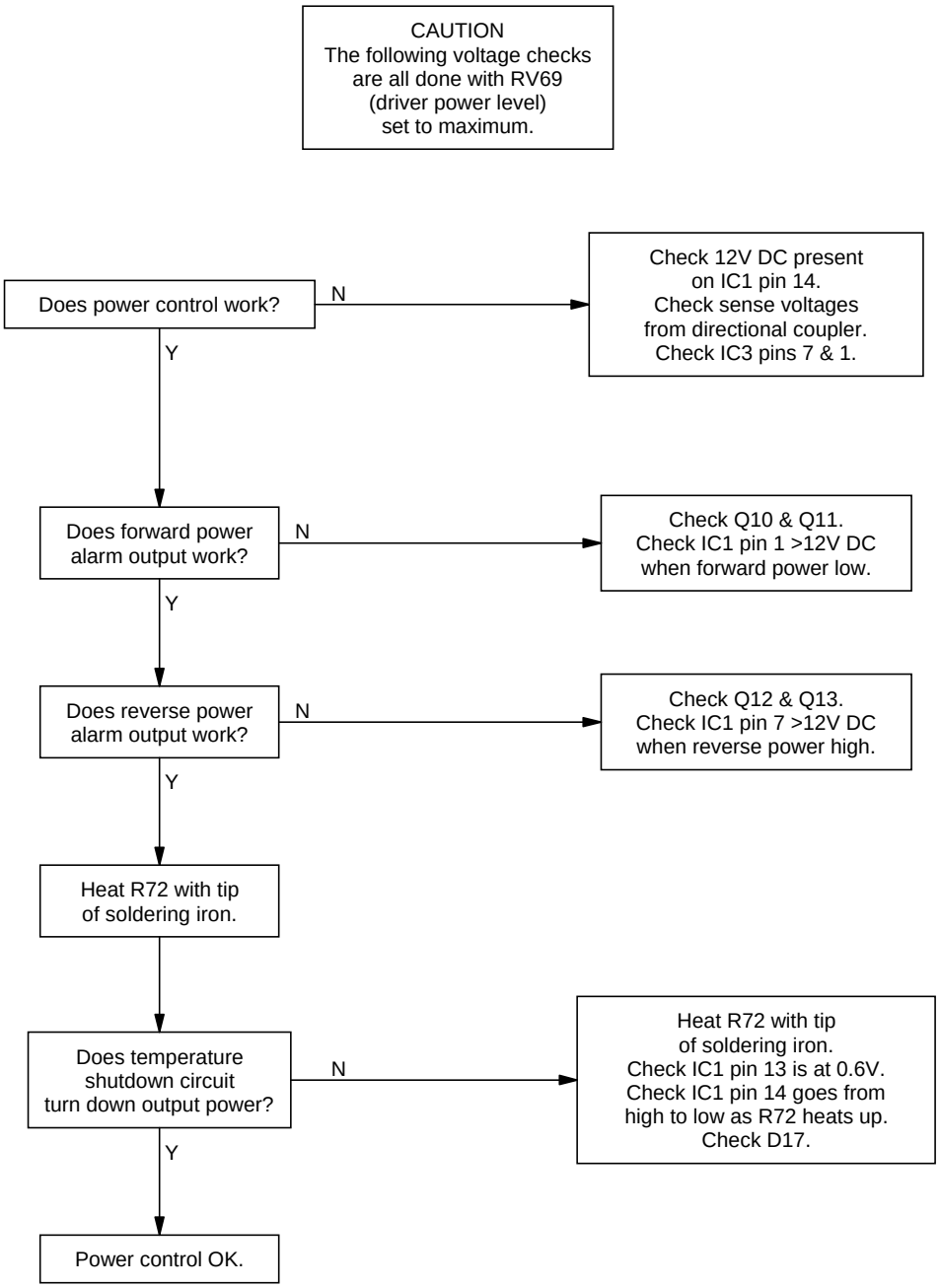
4.1.6.3 T859 PA



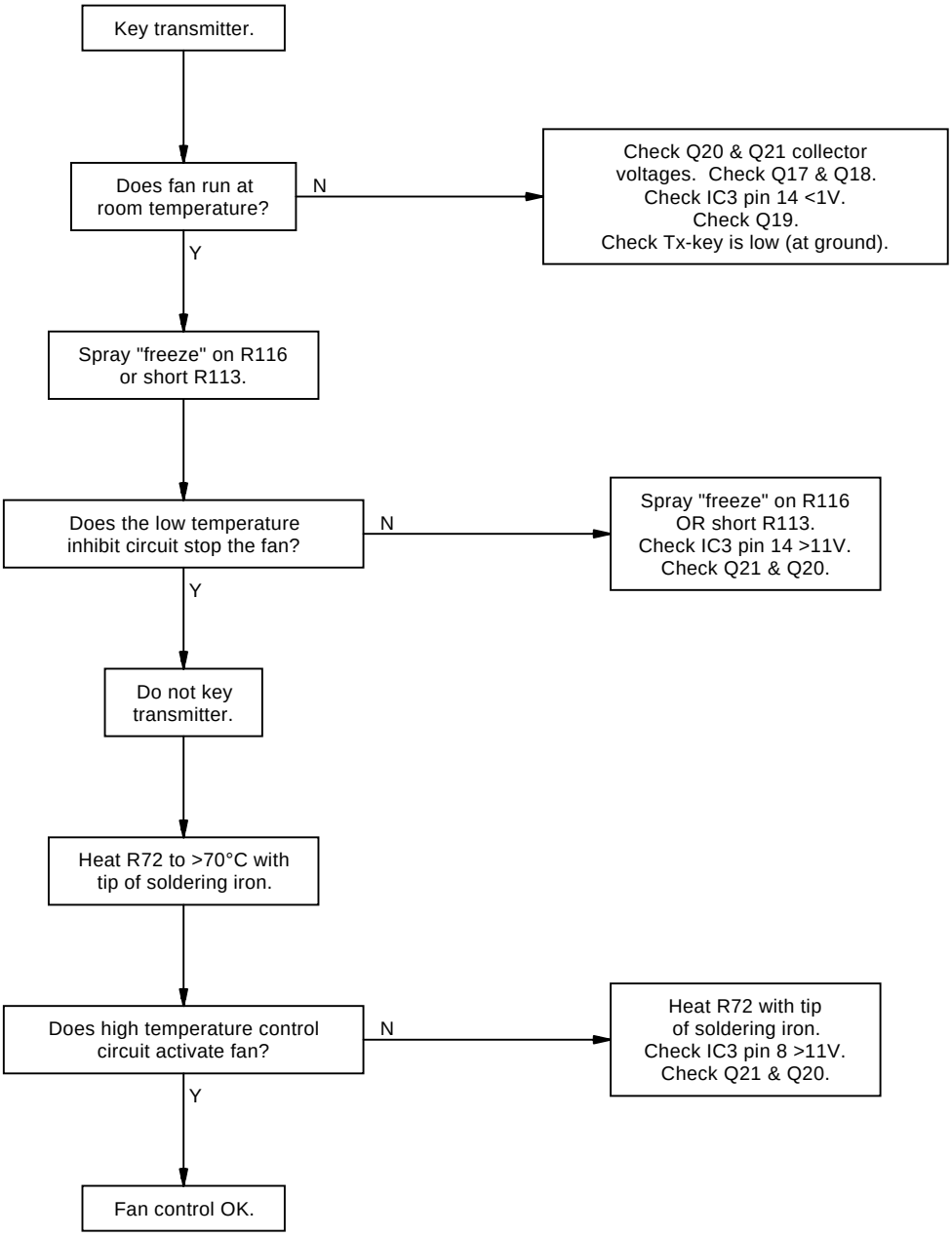
4.1.6.4 T859 Power Control

Approximate voltages under normal operating conditions:

Measurement	Output Power	
	20W	50W
forward power at "FWD-PWR" pad (beside IC3)	2.5V	4V
RV63/R64 (RV63 wiper)	1.4V	2.1V



4.1.6.5 T859 Fan Control Circuitry



4.1.7 Replacing RF Power Transistors

Caution: **Failure to comply with the following procedure can result in failure of the device due to poor heatsinking, or worse, can endanger the health of the assembler if the beryllium oxide die carrier is smashed during assembly.**

Caution: **As the location of certain components in the PA is critical to performance, it is important that any components removed or disturbed are refitted in *exactly* the same position.**

Before attempting to remove a transistor, measure the distance between the capacitors and transistor body to the nearest 0.5mm (measurement "A" in Figure 4.2) so that the capacitors can be replaced in *exactly* the same position. These measurements are shown in Figure 4.2 for the 6LFL package, however the same procedure applies for the SOE (stud) package.

Caution: **Do not apply too much heat or pressure to the PCB pads and tracks as you may damage them or lift them from the PCB, causing permanent damage to the PA.**

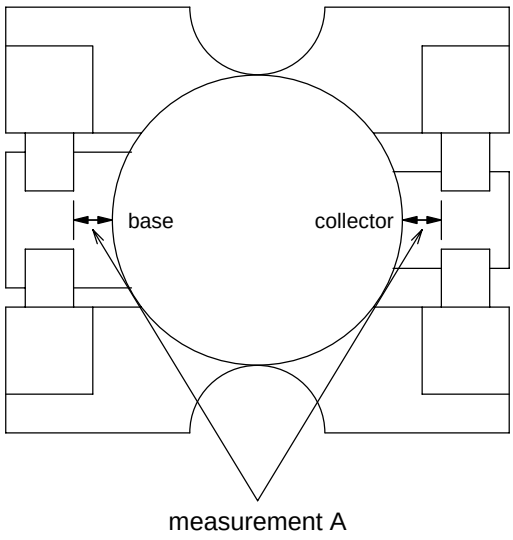


Figure 4.2 Typical Transistor/Capacitor Spacing (Not To Scale)

Desolder and remove the components from around the transistor.

Q4/Q6/Q7 Only: Desolder and remove the two solder tags.

Desolder the transistor tabs by heating with a soldering iron and lifting away from the PCB with a screwdriver or thin stainless steel spike, then remove the device.

Q1/Q3 Only: Unscrew the transistor stud nut and remove the device. In the T859 you will need to remove the fan to access the stud nuts.

Remove any excess solder from the PCB pads with solder wick.

Trim the tabs of the replacement transistor so that the device sits neatly on the PCB pads provided.

Lightly tin the underside of the transistor tabs. Remove any excess solder to leave a thin, even layer on the tabs.

Apply a small amount of heatsink compound (Dow-Corning 340 or equivalent) to the transistor mounting surface. Sufficient compound should be used to ensure an even film over the entire mounting surface.

Place the transistor on the PCB in the correct orientation and ensure the tabs are flush to the surface.

Q1/Q3 Only: Lightly solder one tab to the PCB, then torque down the retaining nut to the correct torque (0.7Nm/6in.lbf.). Refit the fan to the T859.

Caution: **Do not solder all the tabs before torquing down otherwise the device may be broken.**

Q4/Q6/Q7 Only: Refit the solder tags.

Solder all transistor tabs to the PCB.

Replace each component in exactly the same position as noted previously.

4.1.8 Removing The PCB From The Heatsink

Note: This is a lengthy procedure and should be considered only after all other checks have been carried out. There are no components on the bottom of the PCB.

Remove the harmonic filter shield lid.

T859 Only: Desolder the power feed to the fan from the PCB.

Remove the 50 ohm output N-type connector by unscrewing it from the heatsink casting and desoldering it from the PCB.

Unplug the 50 ohm input coaxial cable from the PCB, unscrew the BNC connector from the heatsink, and remove the connector and cable (cutting cable ties as required).

Desolder the positive and negative power feed wires from the PCB.

Desolder the alarm and metering wires from the PCB.

Remove the 2 screws securing the D-range connector and PCB to the heatsink and withdraw the assembly and wires from the heatsink (cutting cable ties as required).

Remove the transistor stud nuts and mounting screws. In the T859 you will need to remove the fan to access the stud nuts.

Remove the mounting screws for the TO-220 devices:

T858/859	Q16, R89, R90 and R91
T859	R92, R93 and R94.

Remove the retaining screws for the wireline couplers (L19 and L39).

Remove the PCB retaining screws:

T858	14
T859	11.

Push the three LEDs out of their front panel grommets.

Lift the PCB gently from the heatsink to gain access to the underside of the board.

Note: R89-94 and Q1-Q7 may be stuck down with heatsink compound. You may need to carefully prise them away from the heatsink with a small screw-driver.

Caution: **Keep the heatsink compound clean while the PCB is detached. Any objects caught in the heatsink compound underneath the device which prevent effective earthing and/or heatsinking may cause the device to fail.**

Caution: **Do not operate the PA with the PCB detached as the heatsink is used for earthing and heat dissipation.**

To replace the PCB, reverse the order of removal, taking care that the wiring is correctly positioned and not 'pinched'.

Q1/Q3 Only: Torque down the retaining nut to the correct torque (0.7Nm/ 6in.lbf.).

Make sure that the heatsink compound has stayed clean, and that the insulating pad for Q16 is not damaged.

If you have difficulty refitting the LEDs, try pushing the body of the LED back into the grommet with a thin screwdriver or spike.

4.2 T858/859 With RF Power Modules

Note: Where the same component has different circuit references in the T858 and T859, in this and following sections the T858 circuit reference is given first, followed by the T859 circuit reference in brackets, e.g. Q137 [Q128].

4.2.1 Visual Checks

Remove the side cover from the T858/859 and inspect the PCB for damaged or broken components, paying particular attention to the surface mounted devices (SMDs). Also check for defective solder joints.

Refer to Section 4.2.7, Section 4.2.8, Section 4.2.9 and Section 3 of Part A for more details on repair and replacement of components.

4.2.2 Shorting Links

There are seven shorting links on PL110 in the control section circuitry, as described in the table below. Ensure that these links are set as standard before starting and after completing the adjustment procedure.

Link Pins	Standard Setting	Function
1-2, 3-4, 7-8, 9-10	not linked	Not used.
5-6	not linked	Pins 5-6 are provided for simulating high operating temperatures during initial adjustment. Bridging this link shorts out R215 [R200] and R210 (NTCs), thus turning on the thermal protection circuitry. They should not be linked for normal operation.
11-12 13-14	linked	Pins 11-12 and 13-14 are provided for factory testing only. The PA will not function correctly if these settings are changed.

4.2.3 Component Checks

If you suspect a transistor is faulty, you can assess its performance by measuring the forward and reverse resistance of the junctions. Unless the device is completely desoldered, first make sure that the transistor is not shunted by some circuit resistance (e.g. a base choke). Use a good quality EVM (e.g. Fluke 75) for taking the measurements (or a 20k ohm/V or better multimeter, using only the medium or low resistance ranges).

Caution: **Before operating the PA, replace any RF base chokes removed while making measurements.**

The collector current drawn by multi-junction transistors is a further guide to their performance.

If an IC is suspect, the most reliable check is to measure the DC operating voltages. Due to the catastrophic nature of most IC failures, the pin voltages will usually be markedly different from the recommended values in the presence of a fault. The recommended values can be obtained from either the circuit diagram or the component data catalogue.

4.2.4 DC Checks

Note: No RF power is to be applied during these checks.

Check that +13.8V is present on the collectors of Q216 (T858) or Q216 and Q217 (T859). Make this measurement when the transmitter is not keyed.

Check that approximately 8-13.8V is present on pin 2 of #IC210 (the level is dependent on RV115 being set to maximum).

Check that +13.8V is present at pin 4 of IC100.

Check that approximately +12V is present at pin 8 of IC110 (the level is dependent on RV115 being set to maximum).

Check that +7.0V is present at the output of regulator IC130.

4.2.5 RF Checks

4.2.5.1 T858

The T858 PA Fault Finding Chart (Section 4.2.6.1) provides a systematic approach for locating a fault in the RF circuitry. Use this chart in conjunction with Figure 4.3 on page 4.21, which shows the locations of the 50Ω input and output test points for RF module #IC210 and RF transistor Q216.

Device	Input Connection	Output Connection
#IC210	input BNC connector or SK201	C249
Q216	C249	C250

Note 1: Use good quality 50Ω coax for the "flying" test leads.

Note 2: Ensure each output is terminated in a 50Ω load of the correct power rating.

For problems with the power control circuitry, refer to the T858 Power Control Fault Finding Chart (Section 4.2.6.3).

4.2.5.2 T859

The T859 PA Fault Finding Chart (Section 4.2.6.2) provides a systematic approach for locating a fault in the RF circuitry. Use this chart in conjunction with Figure 4.4 on page 4.22, which shows the locations of the 50Ω input and output test points for RF module #IC210 and RF transistors Q216 and Q217.

Device	Input Connection	Output Connection
#IC210	input BNC connector or SK201	C274
Q216 & Q217	L241	C250, C262

Note 1: Use good quality 50Ω coax for the "flying" test leads.

Note 2: Ensure each output is terminated in a 50Ω load of the correct power rating.

For problems with the power control circuitry, refer to the T859 Power Control Fault Finding Chart (Section 4.2.6.4).

replace A4 pages D4.21/D4.22 with A3 pages D4.21/D4.22

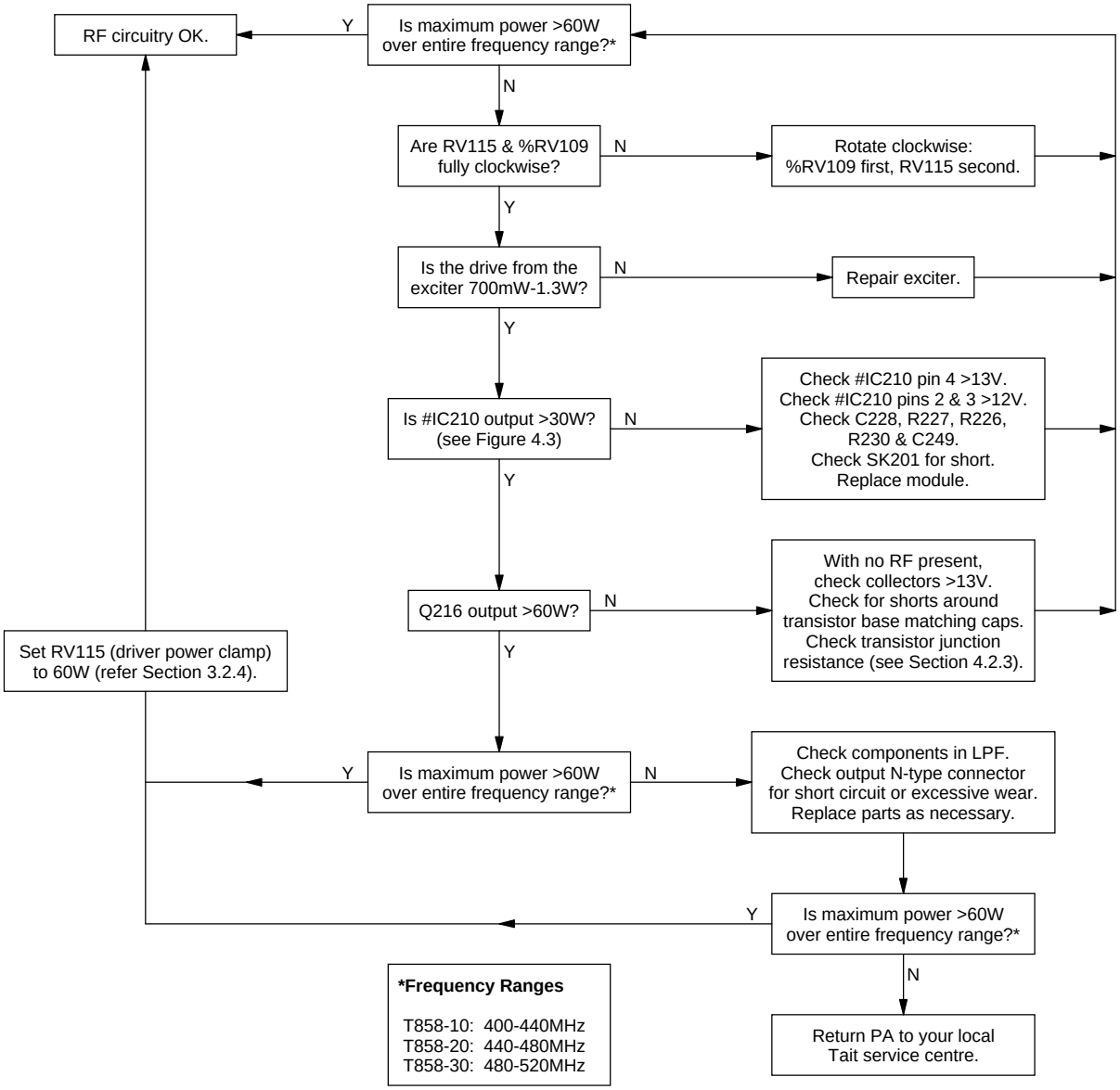
Figure 4.3 T858 Test Break Point Location

replace A4 pages D4.21/D4.22 with A3 pages D4.21/D4.22

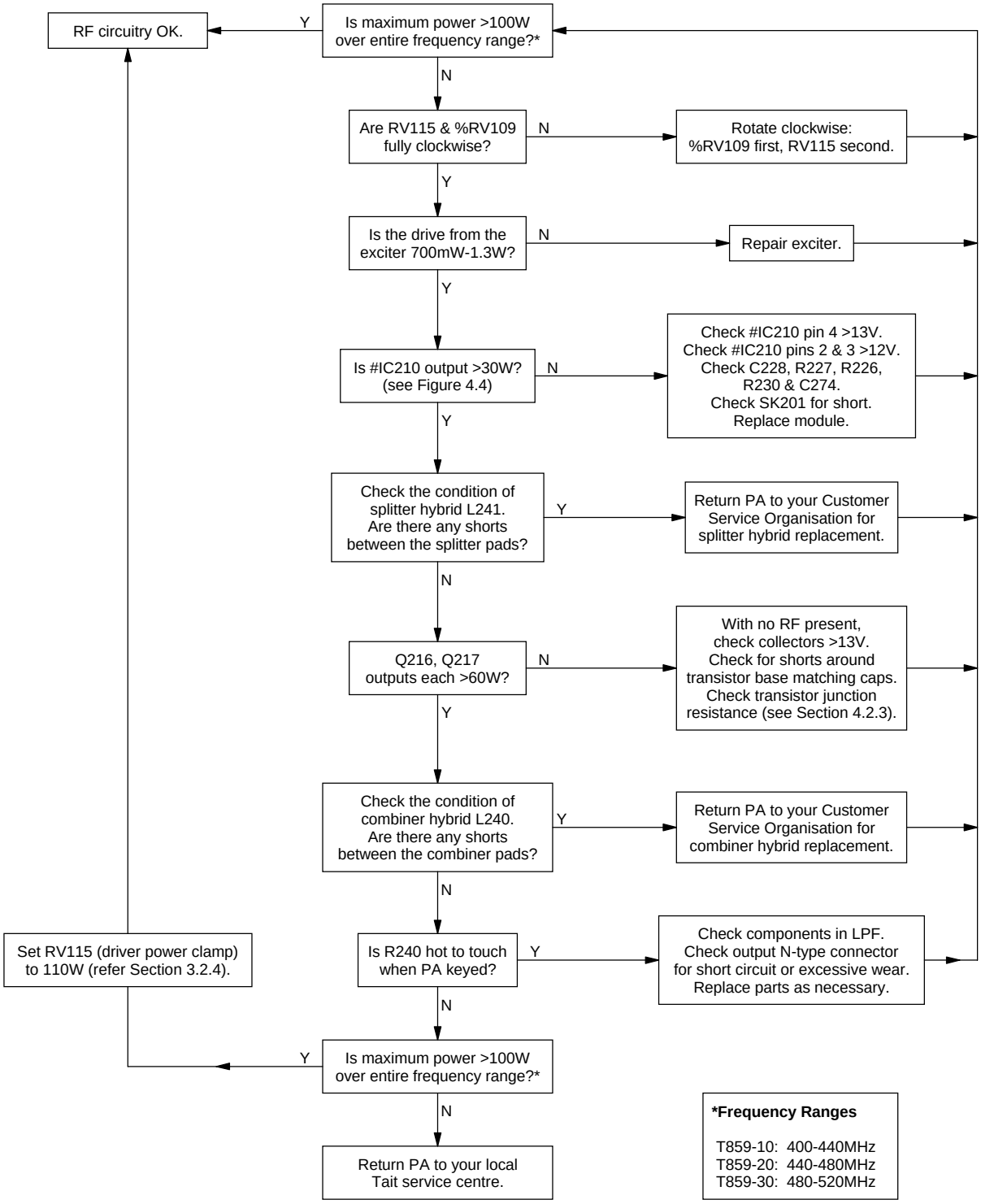
Figure 4.4 T859 Test Break Point Location

4.2.6 Fault Finding Charts

4.2.6.1 T858 PA



4.2.6.2 T859 PA



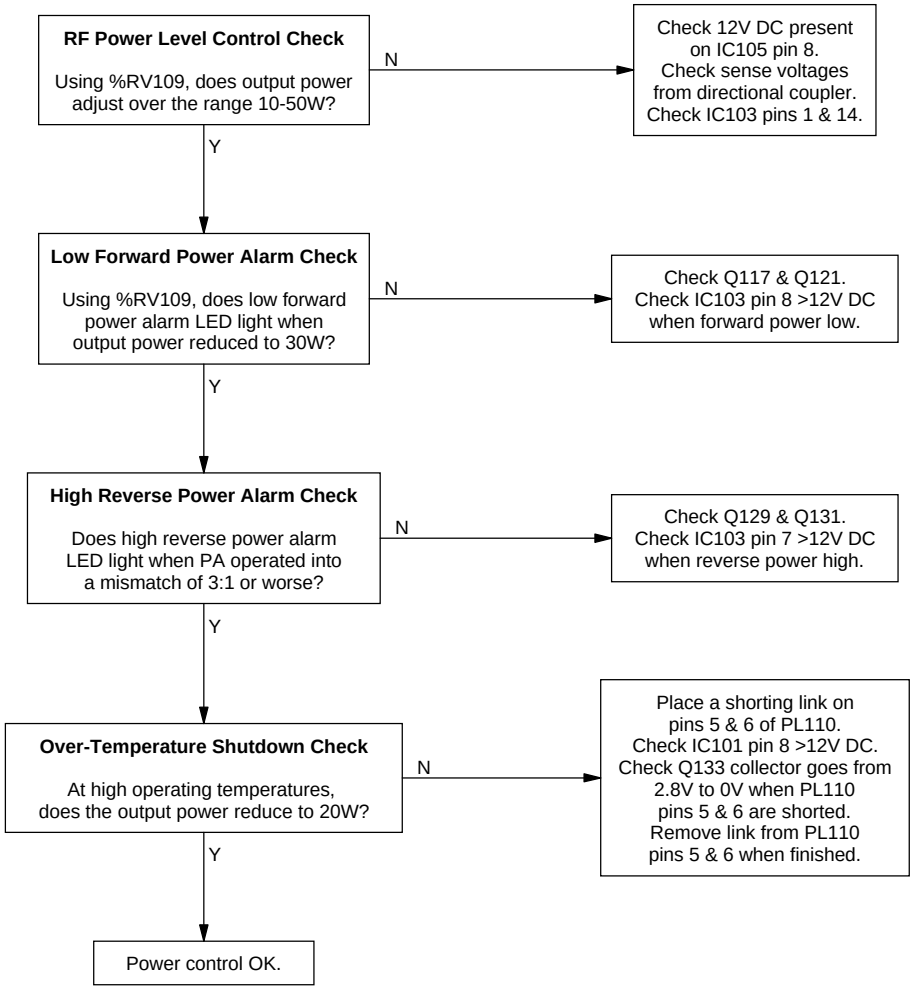
4.2.6.3 T858 Power Control

Approximate voltages (@ 480MHz) under normal operating conditions:

Forward & Reverse Power Measurement	Output Power	
	20W	50W
forward power at IC100 pin 14	1.8V	2.9V
reverse power at IC100 pin 1	0.6V	0.6V

Caution

The following voltage checks are all done with RV115 (driver power clamp) set to maximum. When these tests are finished, reset RV115 to 60W.



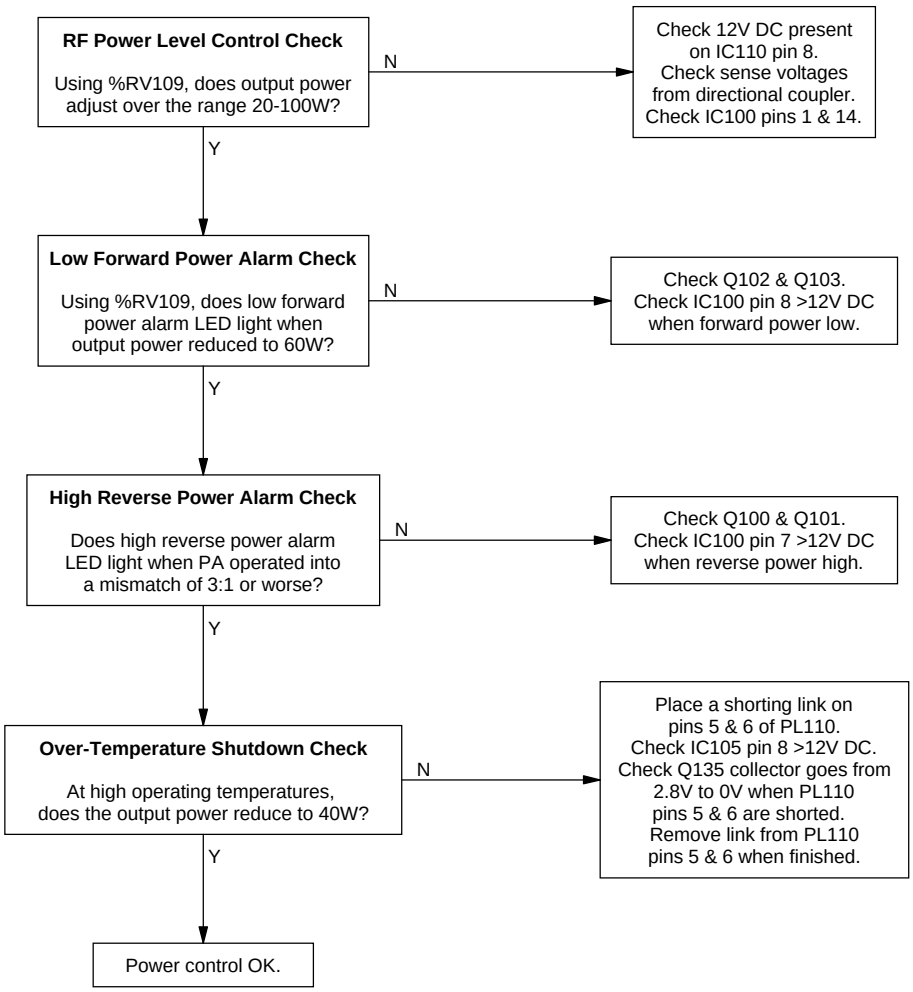
4.2.6.4 T859 Power Control

Approximate voltages (@ 480MHz) under normal operating conditions:

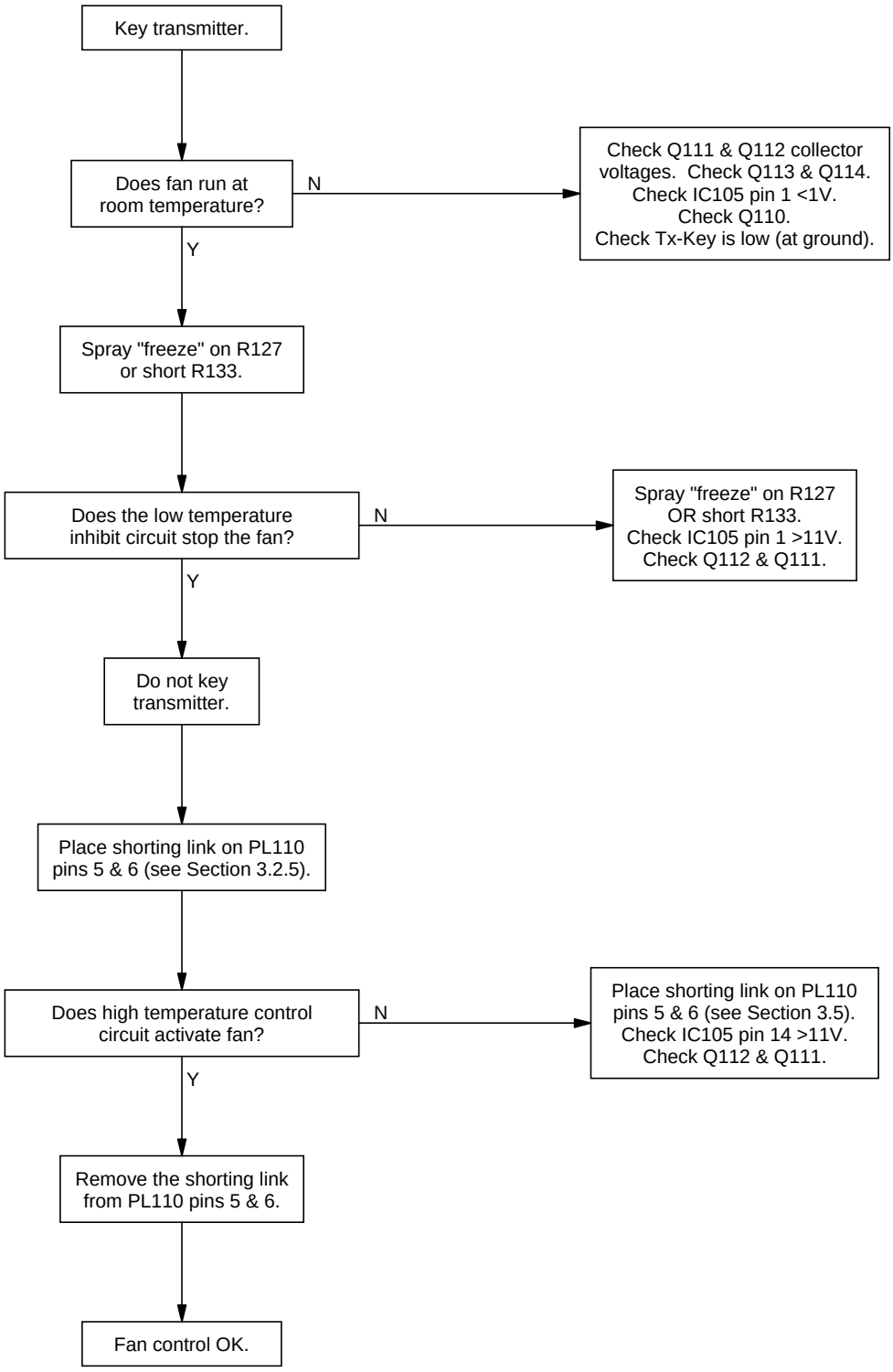
Forward & Reverse Power Measurement	Output Power	
	40W	100W
forward power at IC100 pin 14	2.5V	4.2V
reverse power at IC100 pin 1	0.6V	0.6V

Caution

The following voltage checks are all done with RV115 (driver power clamp) set to maximum. When these tests are finished, reset RV115 to 110W.



4.2.6.5 T859 Fan Control Circuitry



4.2.7 Replacing RF Power Transistors

Caution: **Failure to comply with the following procedure can result in failure of the device due to poor heatsinking, or worse, can endanger the health of the assembler if the beryllium oxide die carrier is smashed during assembly.**

Caution: **As the location of certain components in the PA is critical to performance, it is important that any components removed or disturbed are refitted in *exactly* the same position.**

Before attempting to remove a transistor, note the position, type and value of each capacitor. Measure the distance between each capacitor and the transistor body to the nearest 0.5mm (measurement "A" in Figure 4.5) so that it can be replaced in *exactly* the same position. These measurements are shown for the T858, however the same procedure applies for the T859.

Caution: **Do not apply too much heat or pressure to the PCB pads and tracks as you may damage them or lift them from the PCB, causing permanent damage to the PA.**

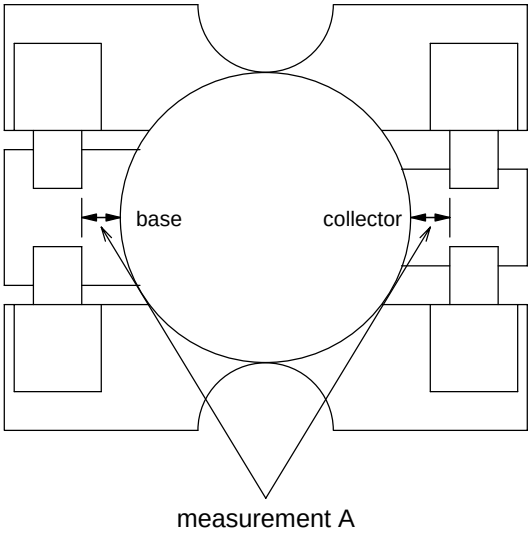


Figure 4.5 Typical Capacitor Positioning On T858/859 RF Power Transistors (Not To Scale)

Desolder and remove the capacitors from around the transistor.

Remove the two mounting screws, then desolder and remove the two solder tags.

Desolder the transistor tabs by heating with a soldering iron and lifting away from the PCB with a screwdriver or thin stainless steel spike, then remove the device.

Remove any excess solder from the PCB pads with solder wick.

Trim the tabs of the replacement transistor so that the device sits neatly on the PCB pads provided.

Lightly tin the underside of the transistor tabs. Remove any excess solder to leave a thin, even layer on the tabs.

Apply a small amount of heatsink compound (Dow-Corning 340 or equivalent) to the transistor mounting surface. Sufficient compound should be used to ensure an even film over the entire mounting surface.

Place the transistor on the PCB in the correct orientation and ensure the tabs are flush to the surface.

Solder all transistor tabs to the PCB.

Refit the solder tags and mounting screws. Tighten the screws to a torque of 90N.cm/8in.lbf.

Replace each capacitor in exactly the same position as noted previously.

4.2.8 Replacing RF Power Modules

Caution: **Follow these instructions carefully, otherwise the module can fail because of poor heatsinking or cracked substrates.**

Desolder the module legs by heating with a soldering iron and lifting away from the PCB with a screwdriver or thin stainless steel spike.

Undo the module screws and remove the thermistor assembly.

Desolder and remove both earth tags.

Gently lift the module away from the heatsink.

Note: The module may be stuck down quite firmly with heatsink compound. You may need to carefully prise it away from the heatsink with a small screwdriver. Keep the heatsink compound clean while the module is detached.

Apply a small amount of heatsink compound (Dow-Corning 340 or equivalent) to the replacement module mounting surface. Use enough compound to ensure an even film over the entire mounting surface.

Reposition the module in the correct orientation and ensure it is well pasted to the heatsink.

Replace the earth tags and thermistor assembly in their original positions and hand-tighten the screws, ensuring the tags and thermistor remain in place. Alternately tighten each screw evenly, finally torquing them down to 56N.cm/5in.lbf. with an accurate torque driver.

Caution: **It is essential that you apply the correct torque to these screws to allow the module flange to expand and contract under temperature cycling. Also, do not solder any module legs before torquing down otherwise the device may be broken.**

Solder the earth tags and all module legs to the PCB.

4.2.9 Removing The PCB From The Heatsink

Note: This is a lengthy procedure and should be considered only after all other checks have been carried out. There are no components on the bottom of the PCB.

Remove the harmonic filter shield lid.

T859 Only: Desolder the power feed to the fan from the PCB.

Remove the 50 ohm output N-type connector by unscrewing it from the heatsink casting and desoldering it from the PCB.

Unplug the 50 ohm input coaxial cable from the PCB, unscrew the BNC connector from the heatsink, and remove the connector and cable.

Desolder the positive and negative power feed wires from the D-range PCB.

Disconnect the ribbon cable from the D-range PCB.

Remove the two screws securing the D-range connector and PCB to the heatsink and withdraw the assembly from the heatsink.

Remove the mounting screws for the TO-220 devices:

T858	Q137
T859	Q128, R231 and R240.

Remove the two screws securing the power module (#IC210).

Remove the mounting screws for the power transistors:

T858	Q216
T859	Q216 and Q217.

Remove the PCB retaining screws:

T858	13
T859	17.

Push the three LEDs out of their front panel grommets.

Lift the PCB gently from the heatsink to gain access to the underside of the board.

Note: R231, R240 and #IC210 may be stuck down with heatsink compound. You may need to carefully prise them away from the heatsink with a small screwdriver.

Caution: **Keep the heatsink compound clean while the PCB is detached. Any objects caught in the heatsink compound underneath the device which prevent effective earthing and/or heatsinking may cause the device to fail.**

Caution: **Do not operate the PA with the PCB detached as the heatsink is used for earthing and heat dissipation.**

To replace the PCB, reverse the order of removal, taking care that the wiring is correctly positioned and not 'pinched'.

Make sure that the heatsink compound has stayed clean, and that the insulating pad for Q137 [Q128] is not damaged.

If you have difficulty refitting the LEDs, try pushing the body of the LED back into the grommet with a thin screwdriver or spike.

