5 Fault Finding

This Section provides general fault finding assistance, and is intended to be used in conjunction with the circuit descriptions and block diagrams in Section 2 and the circuit diagrams and PCB information in Section 7.

The following topics are covered in this Section:

Section	Title	Page
5.1	**Servicing Warning**	**5.2**
5.2	**Visual Checks**	**5.2**
5.3	**Component Checks**	**5.2**
5.5.1	Transistor Check	5.2
5.3.2	Integrated Circuit (IC) Check	5.2
5.4	**DC Checks**	**5.3**
5.5	**Receiver RF Checks**	**5.4**
5.5.1	VCO Frequency	5.4
5.5.2	Control Line Voltages	5.4
5.5.3	RF Sensitivity	5.5
5.6	**Transmitter RF Checks**	**5.5**
5.7	**Trunked Radios: System Check**	**5.6**
5.7.1	Base Station Check	5.6
5.7.1.1	T2030 Radios	5.6
5.7.1.2	T2040 Radios	5.6
5.7.2	Base Station Control Channel Hunt	5.6
5.8	**Trunked Radios: Test Mode**	**5.7**
5.8.1	Test Mode Overview	5.7
5.8.2	Manual Test Mode (MTM)	5.7
5.8.2.1	T2030 & T2035 MTM Operation	5.8
5.8.2.2	T2040 & T2050 MTM Operation	5.9
5.8.3	Computer Controlled Test Mode (CCTM)	5.9
5.8.3.1	CCTM Selection	5.10
5.8.3.2	CCTM Protocol	5.10
5.8.4	Power-Up State	5.11
5.8.5	Test Facilities Available	5.11
5.8.5.1	Resetting The Radio	5.11
5.8.5.2	Test Facilities Table	5.12
5.8.6	Trunked Radios: Radio Mode / Status Display Codes	5.15
5.9	**Options Interface Specifications**	**5.17**
5.10	**Fault Finding Charts**	**5.20**

5.1 Servicing Warning

T2000 Series II radios require specialised servicing techniques. Before attempting any disassembly or repair, refer to Section 3, "Introduction To Servicing".

Repairs attempted with incorrect equipment or by untrained personnel may result in permanent damage. If in doubt, contact Tait Electronics Ltd or your nearest Tait Branch or Subsidiary.

5.2 Visual Checks

Check that the radio is suitable for the required frequency range and IF bandwidth (refer to Section 1.4, "Product Codes").

Check that the programmed frequencies are correct.

Remove the covers from the T2000 and inspect the PCBs for damaged or broken components, paying particular attention to the surface mounted devices (SMDs).

Check for obvious mechanical faults in the PCBs, controls, microphone, etc.

Check for defective solder joints.

Note: If repair or replacement is considered necessary, refer to Section 3.4, "Repair".

5.3 Component Checks

5.3.1 Transistor Check

Measure the forward and reverse resistance of the transistor junctions, first making sure that the transistor is not shunted by some circuit resistance.

Note: A 20kΩ/V or better multimeter should be used for taking the measurements, using only the medium or low resistance ranges.

Check the collector current drawn by the transistor.

5.3.2 Integrated Circuit (IC) Check

Measure the DC operating voltages if the IC. 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.

 Copyright TEL

5.4 DC Checks

Refer to the “Radio Won’t Switch On” fault finding chart in Section 5.10.1.

Check all regulated supply voltages for the correct voltage levels. DC levels can be checked using the voltage information on the circuit diagrams.

5.5 Receiver RF Checks

5.5.1 VCO Frequency

Check that the VCO is phase locked.

Connect a frequency counter (level +10dBm) to the VCO input to the mixer (junction of C241 and L109).

Monitor the local oscillator frequency and check that it is above or below the required receive frequency according to the following list:

Model	Local Oscillator Frequency
T2000-100	27.7MHz below
T2000-200	10.7MHz above
T2000-300	27.7MHz above
T2000-400	27.7MHz below
2000-500	49.1MHz below
T2000-600	49.1MHz below
T2000-700/900	49.1MHz below
T2000-800	61.9MHz below

5.5.2 Control Line Voltages

The following table gives approximate control line voltage for receive and transmit at the band edges.

Model	Frequency (MHz)	Receive Control Line		Transmit Control Line	
		VCO Frequency (MHz)	Control Line Voltage (V)	VCO Frequency (MHz)	Control Line Voltage (V)
T2000-100	220 270	192.3 242.3	4.5±0.5 9.8±1	220 270	7.6±0.5 12.7±1
T2000-200	66 88	76.7 98.7	7.3±0.6 13.8±1	66 88	4.5±0.6 11±1
T2000-300	136 174	163.7 201.7	7.5±0.6 13±1	136 174	4.5±0.6 9.2±1V
T2000-400	175 225	147.3 197.3	4.5±0.6 10.6±1	175 225	7.8±0.7 13.8±1
2000-500	400 470	350.9 420.9	2.5±0.5 13±1	400 470	3±0.6 13.5±0.7
T2000-600	450 520	400.9 470.9	2.5±0.5 13±1	450 520	2.2±0.5 13.5±1
T2000-700	330 360	280.9 310.9	2.5±0.5 6.3±0.7	330 360	8.5±0.7 12.3±0.7
T2000-800	851 870	789.1 808.1	1.8±0.5 4.5±0.5	806 825	3.8±0.5 6.5±0.5
				851 870	9.5±0.5 12.0±0.5
T2000-900	360 400	310.9 350.9	2±0.5 7.5±1	360 400	8±1 12.5±1

Copyright TEL

5.5.3 RF Sensitivity

Refer to the “Synthesiser Faults”, “Receiver Front End Faults” and “Receiver IF Faults” fault finding charts in Section 5.10.

Check that the VCO is on the correct frequency, and that the receiver is correctly aligned.

Check that the sensitivity into the front end is -119dBm (typical).

If the sensitivity is low (less than -117dBm), the fault can be traced by measuring the sensitivity into successive circuit blocks. Prepare a test cable by connecting a 1nF capacitor to the end of a length of coaxial cable, as shown below.

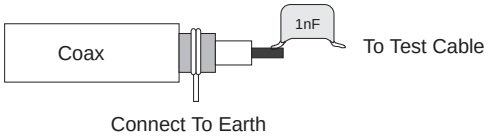


Figure 5.1 RF Test Cable

Note: Before using the test cable, ensure the coax braid is connected to an earth point on the PCB.

Using the RF test cable, apply a modulated signal to test points in the first IF section, at the first IF frequency, as follows:

Model	First IF Frequency (MHz)
T2000-100	27.7
T2000-200	10.7
T2000-300	27.7
T2000-400	27.7
2000-500	49.1
T2000-600	49.1
T2000-700 / 900	49.1
T2000-800	61.9

Alternatively, apply an on-channel RF signal to the front end test points.

Poor sensitivity indicates a fault in one of the circuit blocks following the test point. For typical sensitivity levels, refer to the fault finding charts.

Note: Poor sensitivity at the mixer input can be caused by lack of drive level from the VCO.

5.6 Transmitter RF Checks

Measure in-circuit RF levels with an RF probe. Typical RF levels can be found in the “Transmitter RF Low Power Faults” fault finding chart, in Section 5.10.8.

Note: Shorten the RF probe earth lead to a minimum.

5.7 Trunked Radios: System Check

5.7.1 Base Station Check

This checks that the local base station repeater is on air and checks that the correct base station frequency is programmed into the radio.

5.7.1.1 T2030 Radios

Reprogram the first normal hunt channel to be the base station repeater channel number.

Enter test mode (refer to Section 5.8, “Trunked Radios: Test Mode”).

Press the front panel C4 key, and the FFSK should be audible.

5.7.1.2 T2040 Radios

Enter test mode (refer to Section 5.8, “Trunked Radios: Test Mode”).

Enter the base station repeater channel number, and the FFSK should be audible.

5.7.2 Base Station Control Channel Hunt

This checks that the radio is hunting the base station control channel. Refer to the “Trunked Radios: Radio Won’t Acquire A Control Channel” fault finding chart in Section 5.10.11.

Note: Do ***not*** enter test mode.

Monitor pin 15 of IC510 (modem IC) on the T2030 or T2040 logic PCB, with a scope probe.

FFSK should be visible for 100ms as the radio scans (hunts) through the channels.

If the radio does not lock onto the required channel, this indicates one of the following faults:

- The parameters on the network identity page are incorrect.
- The acquisition authorisation is incorrect.
- The signal is not opening the mute (receiver mute fault, refer to the “Receiver Mute Faults” fault finding chart in Section 5.10.6).
- The programmed logical channel number is incorrect (even if the frequencies are correct).

 Copyright TEL

5.8 Trunked Radios: Test Mode

5.8.1 Test Mode Overview

The test mode facility enables the trunked radio to emulate a multichannel radio, utilising the frequencies reserved for trunking. The radio can then be tested and aligned, as described in Section 4 and Section 6.

There are two test modes provided: manual and computer controlled.

- **Manual Test Mode (MTM):** Commands are entered and test results are displayed using the keys, LEDs and the display on the control head.
- **Computer Controlled Test Mode (CCTM):** Test commands are accepted via the serial port of the radio, and test results are returned as required. Although this mode is primarily intended for automated production testing, it may also be useful in the field.

No test facilities have been provided for functions relating to non-trunked operating mode (e.g. CTCSS), as these functions can be easily tested in non- trunked mode.

Within this Section, the following conventions apply:

- Characters within " " indicate a string sent or received via the serial communications port of the radio, e.g. a command code or an error code.
- Numbers without " " are function numbers, manually entered via the control head in MTM to select particular test functions.

Caution: When in test mode, connect the antenna socket to a dummy load to prevent interference with trunking systems. Avoid testing on channels in use locally.

5.8.2 Manual Test Mode (MTM)

Switch the radio off and remove the top cover.

Place a temporary link across the two pads labelled **TEST MODE** on the logic PCB.

Switch on the radio:

- **T2030 radios:** all the front panel indicators will illuminate briefly.
- **T2035 and T2060 radios:** the display will show "- -" for a short time.
- **T2040 radios:** the control head will display **"TEST MODE"** for a short time.

Remove the link. The radio will remain in test mode until it is next switched off.

In MTM, the following operations are common to T203X, T2040 and T2060 radios:

- A short beep is sounded after every key press.
- All models accept the reset command character (^).
- The microphone PTT switch functions as in normal operation, i.e. a PTT press / release selects transmit and receive respectively.
- LEDs or LCD annunciators are used to indicate transmit, synthesiser lock status and receive signal detect status (refer to Table 5.2, “Radio Mode / Status Display”).

Note 1: MTM can also be selected by sending the MTM select command while in CCTM or program mode (refer to Table 5.1, “T2000 Test Facilities”), then switching the radio off then on again.

Note 2: This mode selection is ‘sticky’, in that the radio will always power- up in MTM if no serial device logs on, regardless of the state of the test link. This automatic mode selection can only be cleared by sending the appropriate command (refer to Table 5.1, “T2000 Test Facilities”).

Note 3: Increment channels in MTM by shorting S14 pin 10 (/EMRGNCY) to ground. When the highest channel is reached, the next increment selects the lowest channel.

5.8.2.1 T2030 & T2035 MTM Operation

T2030 Radios

Four preset channels are available via the four preset keys C1 to C4 , and their associated LEDs show the current channel. All four channels can be programmed to any frequency within the full coverage band of the radio.

- C1 selects the channel with the lowest number (i.e. the lowest channel in the network).
- C2 selects halfway between the highest and lowest channels available, rounding up to the nearest channel.
- C3 selects the channel with the highest number (i.e. the highest channel in the network).
- C4 selects the first channel in the normal hunt list.

T2035 Radios

- To select a channel, enter the channel number required using the front panel keys, and press the **call** key ♪ .
- The **clear** key ⊗ enables & disables the minimum shift keying (MSK) modem transmit, and the **clear** LED momentarily shows status. Action of the key is push-on / push-off. When the modem transmit is enabled, the microphone audio is muted and when the modem transmit is disabled, the microphone audio is unmuted.

  When the radio is in receive, the modem transmit is temporarily disabled (and the microphone audio is muted), but this is not shown by the **clear** LED.

 Copyright TEL

- The **despatch** key selects MSK modem transmit test patterns. The **despatch** LED is off for zeros, on for ones and flashing when preamble is being sent. Successive depressions of the key will scroll through the three states. Whenever the **despatch** key is pressed, the modem transmit is enabled unless the radio is in receive, in which case the **clear** LED will illuminate momentarily.

- The **queue** key controls the transmit power output of the radio. The **queue** LED is off for low power, on for high power and flashes when maximum power has been selected. Successive depressions of the key will scroll through the three states.

  Each time the channel is changed, the transmit power is reset to the level programmed for the new channel and is indicated by the **queue** LED.

5.8.2.2 T2040 & T2050 MTM Operation

Test functions are selected by entering a two digit number followed by the **terminator** key .

Channels are selected by pressing the key ("Chan" will appear in the display), followed by a one to four digit channel number and terminated with the **terminator** key.

After every valid command execution, a confirmation will appear in the control head display in the form of a message. A confirmation tone is also sounded. Entries that are invalid for any reason, e.g. an invalid function or channel number, result in a displayed message and a warning tone.

5.8.3 Computer Controlled Test Mode (CCTM)

In CCTM, test commands are accepted via the serial port of the radio and test results are returned as required. To send and receive commands from the radio it is necessary to run a 'dumb terminal' emulation program on a PC.

The serial communications port parameters are as follows:

- Logic levels:
  Out: 0V = '1', +5V = '0'
  In: -12V to 0V = '1', +3V to +12V = '0'
- A programming lead may be used to convert the output to RS232 voltage levels.
- No handshaking (RTS, CTS etc. not implemented).
- Full duplex.
- 4,800 baud.
- One start bit, eight data bits, one stop bit, no parity.
- Flow control: X_{on} / X_{off}

5.8.3.1 CCTM Selection

After power-up, a reset command or a hardware reset, the radio sends the logon prompt character “v”. Replying with an ASCII “%” within 500ms of the prompt will put the radio in CCTM.

The radio will confirm engagement of CCTM by sending the prompt “-”, preceded by a “CR”.

Note: If no reply is received within the required period, the radio will engage normal trunked mode, or MTM if the test link is fitted or the ‘sticky’ MTM is active.

If CCTM is engaged when the test link is fitted, the radio sends an error message and gives a unique error indication (refer to Table 5.2, “Radio Mode / Status Display”).

While in CCTM, MTM can be selected (refer to Section 5.8.2). This will not come into effect until after the next power-up or reset. To re-engage CCTM without switching the radio off then on, a reset command can be sent to reset the radio and restart logon prompting.

5.8.3.2 CCTM Protocol

- The radio accepts commands in any of the following formats:
  - A two digit ASCII string selects the corresponding test function.
  - A “*” character followed by a one to four digit channel number (in ASCII) sets the radio to that channel.

- Each command must be terminated with an ASCII “CR” character to initiate execution of the command.
  - If the command requires no reply, the radio then responds with a “-” prompt character.
  - If a reply is required, the radio responds with a data string followed by a “CR” and a “-” prompt . The “-” prompt indicates that the radio is ready to accept the next command.

- There is only ever a single reply string to any command.

- Invalid commands, e.g. an invalid function number or channel number or invalid characters in a command, cause a “{C01}”, followed by “CR” and “-”, to be sent in reply, indicating a command error.

- In CCTM the radio will accept a reset command character (refer to Section 5.8.5).

- ASCII line feed characters are permitted at any time, but are ignored so that test commands may be terminated with “CR” or “LF”.

- All switches (including PTT, hook etc), keys and displays on the front panel or control head of the radio are disabled while in CCTM, and no tones are sounded.

 Copyright TEL

5.8.4 Power-Up State

When manual or automated test mode is engaged after logon, the radio will be in the following state, where applicable to particular radio models. The numbers in brackets refers to the test facility, as described in Table 5.1, “T2000 Test Facilities”.

- Synthesiser programmed to the last selected channel.
- Modem transmit off (13).
- Force receive audio muted if in transmit mode (20).
- Force receive audio unmuted if in receive mode (21).
- Microphone audio muted if in receive mode (22).
- Microphone audio unmuted if in transmit mode (23).
- Radio power amplifier enabled (31).
- Radio set to receive if PTT released on power-up (32).
- Radio set to transmit if PTT pressed at power-up (33).
- 13.8V switched supply on / ECN off (43).
- Radio not in state for current measurement test (45).
- Microprocessor clock rate set as programmed for the channel if in receive mode.
- Microprocessor clock rate ‘normal’ if in transmit mode (70).
- Radio transmit power set as programmed for the channel.

The behaviour of the front panel or control head digital display and/or LEDs is described in Table 5.2, “Radio Mode/Status Display”.

5.8.5 Test Facilities Available

5.8.5.1 Resetting The Radio

The radio may be reset at any time in any of the following ways:

- Switch the radio off then on again.
- Momentarily connect the microprocessor ‘reset’ pin to ground (pads are provided on the enhanced control PCB).
- Send a reset command character (^) over the serial communications port (refer to Table 5.1).

Note: The radio will not respond to the reset character after an EPROM or RAM test failure.

5.8.5.2 Test Facilities Table

The following table lists the test facilities available in MTM and CCTM for the T203X, T2040 and T2050. Facilities for the T2010, T2015 and T2020 are also listed for comparison, and further information about the tests is listed following the table.

Within the table, a '-' indicates the corresponding facility is not available, and "nnnn" is a one to four digit channel number (leading zeros are permitted).

	T2010/T2015		T2020		T203X		T2040/T2050	
	Normal	**CCTM**	**Normal**	**CCTM**	**Man**	**Auto**	**Man**	**Auto**
Signalling functions:								
10. set modem to send zeros	-	-	-	-	}	10	10	"10"
11. set modem to send ones	-	-	-	-	} &	11	11	"11"
12. set modem to send preamble	-	-	-	-	}	12	12	"12"
13. disable modem Tx	-	-	-	-	keys	13	13	"13"
14. read modem Rx state	-	-	-	-	-	14	-	"14"
15. disable subaudible signal	} by	-	} by	"15"	-	-	-	-
16. enable subaudible signal	} channel	-	} channel	"16"	-	-	-	-
17. read signalling decode status	speaker	"17"	speaker	"17"	-	-	-	-
Mute functions:								
20. force Rx audio muted	-	-	-	"20"	-	"20"	20	"20"
21. force Rx audio unmuted	l-MON*	"21"	l-MON	"21"	Fn	"21"	21	"21"
22. mute microphone audio	-	"22"	-	"22"	-	"22"	22	"22"
23. unmute microphone audio	-	"23"	-	"23"	-	"23"	23	"23"
24. let squelch control Rx audio	s-MON	"24"	s-MON	"24"	Fn	"24"	24	"24"
25. read squelch Rx busy status	-	-	-	"25"	-	"25"	-	"25"
26. relax Rx audio mute control	s-MON	"26"	s-MON	"26"	-	-	-	-
Radio Rx/Tx functions:								
30. inhibit the PA (Tx mode)	-	-	-	-	-	"30"	30	"30"
31. enable the PA (Tx mode)	-	-	-	-	-	"31"	31	"31"
32. set radio to Rx	see	"32"	see	"32"	-	"32"	32	"32"
33. set radio to Tx	below	"33"	below	"33"	-	"33"	33	"33"
34. set PA to low power		"34"		"34"	use	"34"	34	"34"
35. set PA to high power	} by	"35"	} by	"35"	or	"35"	35	"35"
36. set PA to max power	} channel	"36"	} channel	"36"	key	"36"	36	"36"
37. relax PA power control	-	"37"	-	"37"	-	-	-	-
Power supply functions								
42. 13.8VSW off /ECN on	-	-	-	"42"	-	"42"	42	"42"
43. 13.8VSW on /ECN off	-	-	-	"43"	-	"43"	43	"43"
44. set radio state for current measurement	-	-	-	-	-	"44"	-	"44"
45. cancel current measurement state	-	-	-	-	-	"45"	-	"45"
RSSI functions:								
61. Set L1 threshold	-	-	-	-	-	"61"	61	"61"
62. set L2 threshold	-	-	-	-	-	"62"	62	"62"
63. read averaged RSSI level	-	-	-	"63"	-	"63"	63	"63"
64. read L1	-	-	-	-	-	"64"	64	"64"
65 read L2	-	-	-	-	-	"65"	65	"65"
Miscellaneous functions:								
70. select normal µP clock rate	-	-	} by	"70"	-	"70"	70	"70"
71. select birdie µP clock rate	-	-	} channel	"71"	-	"71"	71	"71"
72. read synth. lock status	-	-	-	"72"	-	"72"	-	"72"
73. relax µP clock control	-	-	-	"73"	-	-	-	-

Copyright TEL

	T2010/T2015		T2020		T203X		T2040/T2050	
	Normal	**CCTM**	**Normal**	**CCTM**	**Man**	**Auto**	**Man**	**Auto**
Special functions:								
92. set 'sticky' MTM	-	-	-	-	-	"92"	-	"92"
93. clear 'sticky' MTM	-	-	-	-	-	"93"	-	"93"
94. read serial number	-	"94"	-	"94"	-	"94"	-	"94"
95. read factory model ID	-	"95"	-	"95"	-	"95"	-	"95"
99. get current channel number	-	-	-	-	-	-	-	-
Radio channel control: select a channel	T2010: (1) to (4)				T2030: (C1) to (C4)			
	T2015: ▲ ▼ keys	"*n"	chan	"*nnn"	T2035: Select channel & press (♪)	"*nnn"	*nnn	"*nnn"
Single character commands:								
reset the radio	"^"	"^"	"^"	"^"	"^"	"^"	"^"	"^"
select programming mode	"#"	"#"	"#"	"#"	"#"	"#"	"#"	"#"
select auto test mode	"%"	"%"	"%"	"%"	"%"	"%"	"%"	"%"
Radio controls & indicators:								
PTT press = select Tx mode	yes	-	yes	-	yes	-	yes	-
PTT release = select Rx mode	yes	-	yes	-	yes	-	yes	-
channel increment input	-	-	-	-	pin 10, S14	-	ECR	-
Tx indicator	Tx	Tx	Tx	-	TX	-	TX	-
synth. out of lock indicator	flash chan LED	flash chan LED	flash TX & BUSY	-	SVC	-	SVC	-
RF signal detected indicator	BUSY	BUSY	BUSY	-	GO	-	GO	-

* '**l-MON**' & '**s-MON**' indicate a long (>1s) and a short (<1s) press of the **monitor** key (MON) , respectively.

Table 5.1 T2000 Test Facilities

- In MTM, functions **10 - 13, 21**, channel selection and PTT control of receive / transmit are all required for MPT1352 testing. Type approval testing requires the channel increment facility using an external input.

- All test function requests are valid when the radio is in either receive or transmit but some functions (**10, 11, 12, 21, 23** and **24**) take effect only when the radio is in the appropriate mode.

- **10 - 13, 22, 23**: When any of the functions which set the modem sending test data are selected (functions **10 - 12**), the microphone audio is automatically muted. When the microphone audio is unmuted using function **23**, the modem transmit is disabled.

  When the radio is in receive, the microphone audio is temporarily muted and the modem transmit is temporarily disabled. This prevents any unwanted TCXO modulation which may occur on radios with dual point modulation.

  These automatically selected states can be overridden until the next transmit to receive transition. If microphone unmute or modem transmit enable is requested when the radio is in receive, these functions will not be actioned until the radio is in transmit.

- **10, 11, 12**: The two modem data states selected by functions 10 and 11 are '0' = 1800Hz tone and '1' = 1200Hz tone respectively. Preamble, selected by function 12, is alternating 1800 and 1200Hz tones at a rate of 1200 baud.

- **14, 25, 72**: These functions return a Boolean radio status value, either a '0' or a '1', as follows:

Return Value	'0'	'1'
14 - read modem Rx state	data = 0	data = 1
25 - read Rx busy state	no RF signal detected	RF signal detected
72 - read synth lock status	out of lock	in lock

- **20**: The receive audio is muted temporarily to quieten the speaker whenever the radio is in transmit. This state may be temporarily overridden until the next receive to transmit transition. If 'force Rx audio unmuted' **(21)** or 'let squelch control Rx audio' **(24)** is requested when the radio is in transmit, the function will not be selected until after the radio is in receive.

- **32, 33**: Functions 32 and 33 are provided in MTM so that the radio transmit state can be sustained without the need to hold the PTT depressed. Caution must be exercised to prevent the power amplifier from overheating.

- **42, 43**: Select economy / non-economy state. In economy state the audio power amplifier is disabled and the front panel backlighting is set to its programmed economy state. In non-economy state, the audio power amplifier is enabled and the backlighting is set to its normal programmed state.

- **44, 45**: Engage / disengage radio state for measurement of typical trunked mode supply current drain. In this state only the 'SVC' and 'C1' LEDs are switched on and non-economy state is selected (function **43**). Upon disengagement, the previous display is reinstated but the economiser state is not altered.

- **61, 62**: To set up the RSSI thresholds, apply an RF signal to the radio (on an appropriate receive channel) at the threshold level. Allow at least 400ms for the RSSI averaging to settle, then select function **61** or **62** as required.

  The averaged RSSI threshold value (in decimal full scale = 255) is either displayed if in MTM or returned via the serial port if the radio is under computer control. The value is also stored in the radio's database (in the microprocessor EEPROM) and the database checksum is automatically updated.

- **63**: In MTM, function 63 gives a regularly updated display of the averaged RSSI value. The leftmost decimal point will light when the RSSI level equals or exceeds L1, and the rightmost decimal point will light when the RSSI level equals or exceeds L2.

  In CCTM a single averaged RSSI value is returned.

  At least 400ms should be allowed after any change in signal level for the returned value to be accurate.

- **94**: Returns the serial number part of the radio's ESN as a number of up to 6 digits with leading zeros suppressed.

- **95**: Returns the factory programmed 'factory model ID' as a string of six decimal digits.

- **99**: This function is intended to allow easy modification of the current channel number via the number entry keys.

 Copyright TEL

5.8.6 Trunked Radios: Radio Mode/Status Display Codes

The mode or status of the radio is indicated by the behaviour of:

- the monitor LEDs (ML1 and ML2) on the top side of the logic PCB
- the radio control head LEDs.

Unless otherwise stated, the two monitor LEDs behave as in normal operation:

- ML2 is off
- ML1 flashes at a rate of 1Hz to indicate watchdog timer 'kick' activity
- In normal trunked radio mode, ML2 flashes at a rate of several Hertz. This indicates control channel hunt or codeword reception on a control channel.

A value in brackets { } with a mode / status description indicates that the radio sends an error message via the serial port upon engaging that mode / status.

This table identifies display states for trunked radios, with non-trunked models for comparison.

Mode/State	T2010/T2015	T2020	T2030/T2035	T2040
CONFIG error		Monitor LEDs flashing together. Display shows "CONF-ERR"	Monitor LEDs flashing together. Top & bottom row LEDs flashing. C1 LED on (if fitted)	Monitor LEDs flashing together. Display shows "CONF-ERR"
CONFIG register programmed		Display shows "CONF-PGM"	Display undefined	Display shows "CONF-PGM"
ROM or RAM test failure	CTCSS output toggling. Display undefined	Tone output toggling. Display undefined	Tone output toggling. LEDs undefined	Tone output toggling. Display undefined
ESN checksum error {X31} (go to program mode)			As for program mode + CLR LED flashing. T2035: display shows "-U1"	Display shows "ESN-ERR"
Database checksum error {X32} (go to program mode)	As for program mode. 2010: all channel LEDs on 2015: display shows "00"	Display shows "-PROG-" Top row LEDs on	As for program mode + DESP LED flashing. T2035: display shows "-U2"	Display shows "-DATA-ERR-" Top row LEDs on.
System error {Enn}		Monitor LEDs alternately flashing "-ERROR nn" in display (nn = error mumber)	Monitor LEDs & top row LEDs flashing. 2 digit BCD error number on bottom rows. T2035: display flashes error number	Monitor LEDs alternately flashing. "ERROR nn" in display (nn = error mumber)
MOBD link left in & CONFIG register OK {X06}		Display error shows "MODB-ERR"	Top & bottom row LEDs flashing + C2 LED on (if fitted)	Display shows "MODB-ERR"
Logon with test link in {X07}			Top & bottom row LEDs flashing + C3 LED on (if fitted)	Display shows "TLINK-ERR"
Key/LED test failure {X04}			LED flashing shows error - all LEDs to right & below on	

Mode/State	T2010/T2015	T2020	T2030/T2035	T2040
Program mode	2010: all channel LEDs on 2015: display shows "00"	Display shows "-PROG-" Top row LEDs on	Top row + C1 LEDs all on (if fitted) T2033/35: display shows "-UU"	Display shows "-PROG-" Top row LEDs on
Cloning mode	AUX LED flashing. AUX/SCAN LEDs flash if clone failed. Target radio in programming mode.	Display shows "CLONING" Top row LEDs on. Target radio in programming mode.		
Manual Test Mode (MTM)			All LEDs on for a short time then indicate radio status. C1 to C4 show last channel (if fitted). T2035: display shows "- - -" briefly	Display shows "chan xxxx" (xxxx = last channel number). LEDs indicate radio status
Key pressed at power-up (control head test)	[AUX] = clone [CALL] = program	Any key on the control head & any mode. All LEDs & all LCD segments are set flashing indefinitely	C1 key (if fitted) in MTM - a front panel key/LED test is initiated - all LEDs on initially	Any key on the control head & any mode. All LEDs & all LCD segments are set flashing indefinitely
Computer Controlled Test Mode (CCTM)	Front panel shows normal radio state (not a separate mode)	Display shows "-AUTOTEST-" Top row LEDs on	Top row + C2 LEDs (if fitted) all on. T2035: display shows "- - -" continuously	Display shows "AUTOTEST" Top row of LEDs on
CCI mode		Normal display "CCI BUSY" & top row LEDs on when processing a command or in 'lockout all' mode		Normal display "CCI BUSY" & top row LEDs on when processing a command or in 'lockout all' mode.
Normal radio mode	No special power-up sequence - normal radio state immediatly displayed	Programmable power-up message displayed for a short time then normal radio display (default mode)	T2030: own number as CD on 3 rows of LEDs, then last number on C1 to C4 & DESP LEDs. Others as labelled. T2035: Own number briefly on display, then last number called.	Own number displayed for a short time after power-up then programmable power-up message followed by normal radio display
PTT on power-up in MTM or normal mode	Software version # indicated for a short time as "h.nn". "h" is shown with the Busy and TX LEDs as a hex number. "n's" are indicated by the two lower rows of LEDs (2010), or by the channel display (2015).	Display shows "xxxx nn.mm" for a short time, nn = major, mm = minor version number	T2030: 3 rows of LEDs display the software version # for a short time as h.nn (h is a hex number) then as per selected mode. T2035: software version number on display.	Display shows "xxxx nn.mm" for a short time, nn = major mm = minor version number, then as per selected mode

Table 5.2 Radio Mode/Status Display

Copyright TEL

5.9 Options Interface Specifications

The options connectors, S13 and S14, are located on the top side of the T2000 logic PCBs, and are provided for use with plug-on accessory PCBs.

The following tables describe the signals available on these connectors, and also on S15 (T2010 & T2015 logic PCB).

Connection (to/from)	Pin No.	Used for	Level for 1kHz AF 60% FM	Z_1 Ω	Z_0 Ω	Min. Z_L	DC Level	Slope dB/8	LF -3dB Hz	HF -3dB Hz
DET-AF-OUT (from detector via 3kHz LPF)	S13-1	CTCSS data, DCS, Selcall	400mVp-p		<1k	1k	3.3V	flat	10	3.4k
ALC-IN (to compressor)	S13-2		0.2Vp-p	2.2k			0V	+6	0.25k	3.4k
RX-LINE-OUT (de-emphasised receiver audio)	S13-3	to accessory line interface	0.4Vp-p		100	10k	3.3V	-6	0.23k or 0.35k	3.4k
TX-LINE-OUT (from ALC)	S13-4	to accessory	1.2Vp-p		<1k	1k	3.3V	flat	70	33k
RX-LINE-IN (to squelch element)	S13-5	from accessory	0.4Vp-p	5k*			3.3V	flat	0.18k	20k
TX-LINE-IN (to pre-emphasis)	S13-6	from accessory line interface	1.2Vp-p	5k*			3.3V	+6V	0.25k	3k
RX-GTD-AF (Rx Audio from after squelch)	S13-7	line interface	0.4Vp-p		10k	0.2M	3.3V	flat	0.23k or 0.35k	3.4k
TX-SIG-IN (to limiter)	S13-8	data Selcall	2.5Vp-p	470k			3.3V	flat	4	3.4k
RX-BEEP (to AF PA with min. volume stop)	S13-9	sidetone	0.5Vp-p	470k			AC	flat	0.18k	20k
TX-LF-SIG (to LPF)	S13-10	CTCSS, DCS	5.0Vp-p for 12% deviation	2.2k			3.3V	flat	4	3.4k
OPTIONS-GND (connected to ground on RF PCB)	S13-11									

* An accessory with low impedance outputs (<10Ω) may be connected without removing 10kΩ links R638 and R673

Table 5.3 Options Connectors - Audio Signal Specifications

Connection (to/from)	Pin No.	Function	Available Current
+13.8V-UNSW	S13-12	- emergency: to bypass the on/off switch	0.5A
+13.8V	S14-1	- supply to options with own regulators	200mA (remote loom resistance = 0.43Ω/loop meter)
+5V	S14-2	supply to options	150mA

Table 5.4 Options Connectors - Supply Voltage Specifications

Connection	Pin No.	Function	Logic Levels	Logic Sense	Sink I_{max}	Source I_{max}	Z_{in}
BUSY	S14-3	carrier detect opening time: <35ms closing time: <20ms (8dB sinad, 6dB margin)	0V 5V	0V = busy	0.5mA	0.1mA	
RX-GATE	S14-4	Rx audio gate information	5V CMOS	5V = audio	1.5mA	0.3mA	
/PTT-TO-OPT	S14-5	from mic.; linked to 18	pull-up	0V = Tx	1.5mA	50µA	2k7
/PTT-FRM-OPT	S14-6	Tx	5V CMOS	0V = Tx			CMOS
/IN-LOCK	S14-7	synthesiser lock detect (lock-up time: <20ms)	0V 5V	0V = lock	0.2mA	0.2mA	
MIC-MUTE	S14-8	disables AF from mic. only	5V CMOS	5V = mute			200k
/SIG-SQLCH	S14-9	Rx audio gate control	open c.	0V = AF muted			47k
/EMERGNCY	S14-10	starts s / w sequence	open c.	0V = emergency			10k
CALL-SW	S14-11	front panel control	5V CMOS		1.5mA	0.3mA	
HUSH	S14-12	car radio mute output	5V CMOS		1.5mA	0.3mA	
AUX-ON / OFF	S14-13	front panel control	5V CMOS		1.5mA	0.3mA	
HORN	S14-14	Selcall horn alert	5V CMOS		1.5mA	0.3mA	
RSSI	S14-15	Rx signal strength	0 - 50µA	0.8µA / dB			
EXTERNAL	S14-16	line to power plug					
BCD0 BCD1 BCD2 BCD3 BCD4 BCD5	S15-9 S15-10 S15-11 S15-12 S15-13 S15-13	channel change option on T201X*	0 - 5V CMOS	0V = 0 5V = 1			10k

* Refer to BCD selection table.

Table 5.5 Options Connectors - Logic Signal Specifications

The following table shows the BCD codes for T2010 and T2015 radios under external channel control.

Note: T2010 has 4 channels accessible by BCD and T2015 has 24 channels accessible by BCD

BCD Channel Number Codes						BCD Number	Channel Number
BCD-5	BCD-4	BCD-3	BCD-2	BCD-1	BCD-0		
0	0	0	0	0	0	0	1
0	0	0	0	0	1	1	2
0	0	0	0	1	0	2	3
0	0	0	0	1	1	3	4
0	0	0	1	0	0	4	5
0	0	0	1	0	1	5	6

Copyright TEL

BCD Channel Number Codes						BCD Number	Channel Number
BCD-5	BCD-4	BCD-3	BCD-2	BCD-1	BCD-0		
0	0	0	1	1	0	6	7
0	0	0	1	1	1	7	8
0	0	1	0	0	0	8	9
0	0	1	0	0	1	9	10
0	1	0	0	0	0	10	11
0	1	0	0	0	1	11	12
0	1	0	0	1	0	12	13
0	1	0	0	1	1	13	14
0	1	0	1	0	0	14	15
0	1	0	1	0	1	15	16
0	1	0	1	1	0	16	17
0	1	0	1	1	1	17	18
0	1	1	0	0	0	18	19
0	1	1	0	0	1	19	20
1	0	0	0	0	0	20	21
1	0	0	0	0	1	21	22
1	0	0	0	1	0	22	23
1	0	0	0	1	1	23	24

Table 5.6 BCD Channel Selection (T2010 & T2015 only)

Connectors S16, S17 and S18

Additional microprocessor control signals are available on the T2020, T203X, T2040, T2050 and T2060 HC11 logic PCB (PCB IPN 220-01344-0X), on connectors S16, S17 and S18.

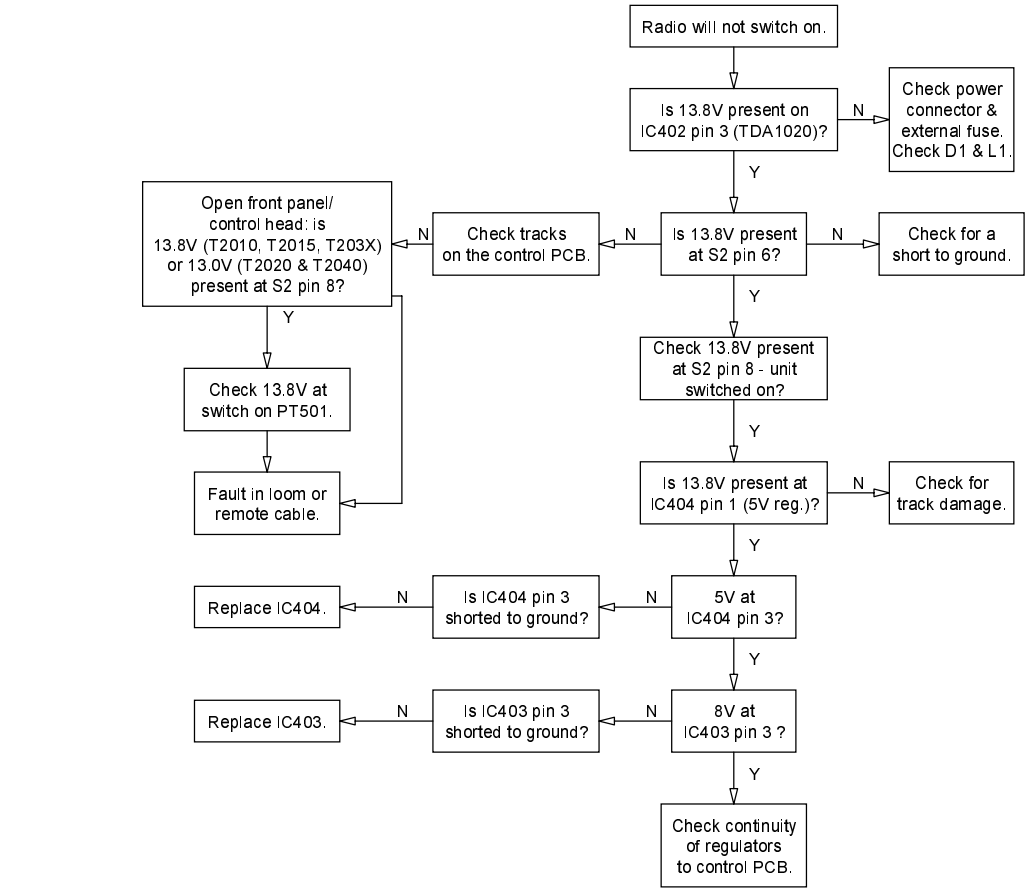
5.10 Fault Finding Charts

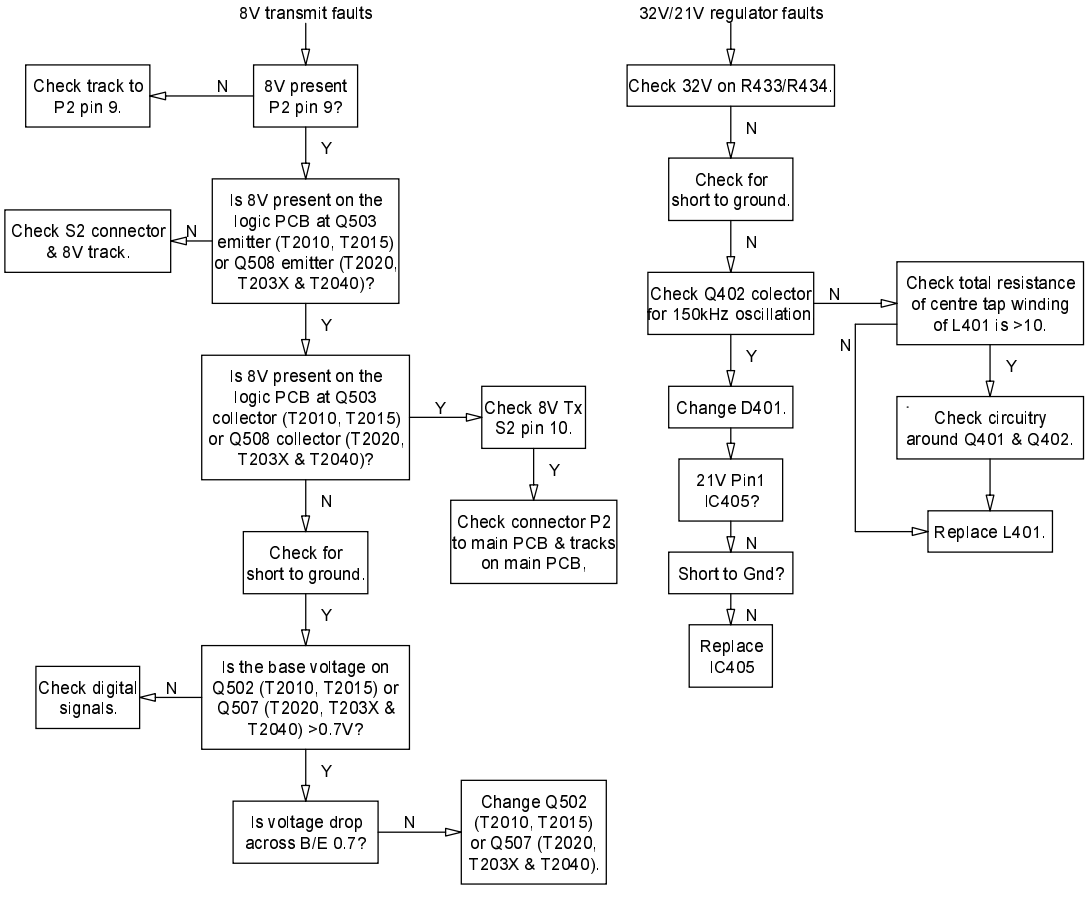
The fault finding charts listed below are intended to be used in conjunction with the circuit diagrams and other PCB information found in Section 7, and with the circuit descriptions and block diagrams found in Section 2.

Section	Title	Page
5.10.1	Radio Won't Switch On	5.21
5.10.2	Radio Won't Program	5.22
5.10.3	Synthesiser Faults	5.23
5.10.4	Receiver Front End Faults	5.24
5.10.5	Receiver IF Faults	5.25
5.10.6	Receiver Mute Faults	5.26
5.10.7	No Audio On Receive	5.27
5.10.8	Transmitter RF Low Power Faults	5.28
5.10.9	Transmitter Power Control Faults	5.30
5.10.10	Transmit Audio Absent	5.31
5.10.11	Trunked Radios: Radio Won't Acquire A Control Channel	5.32

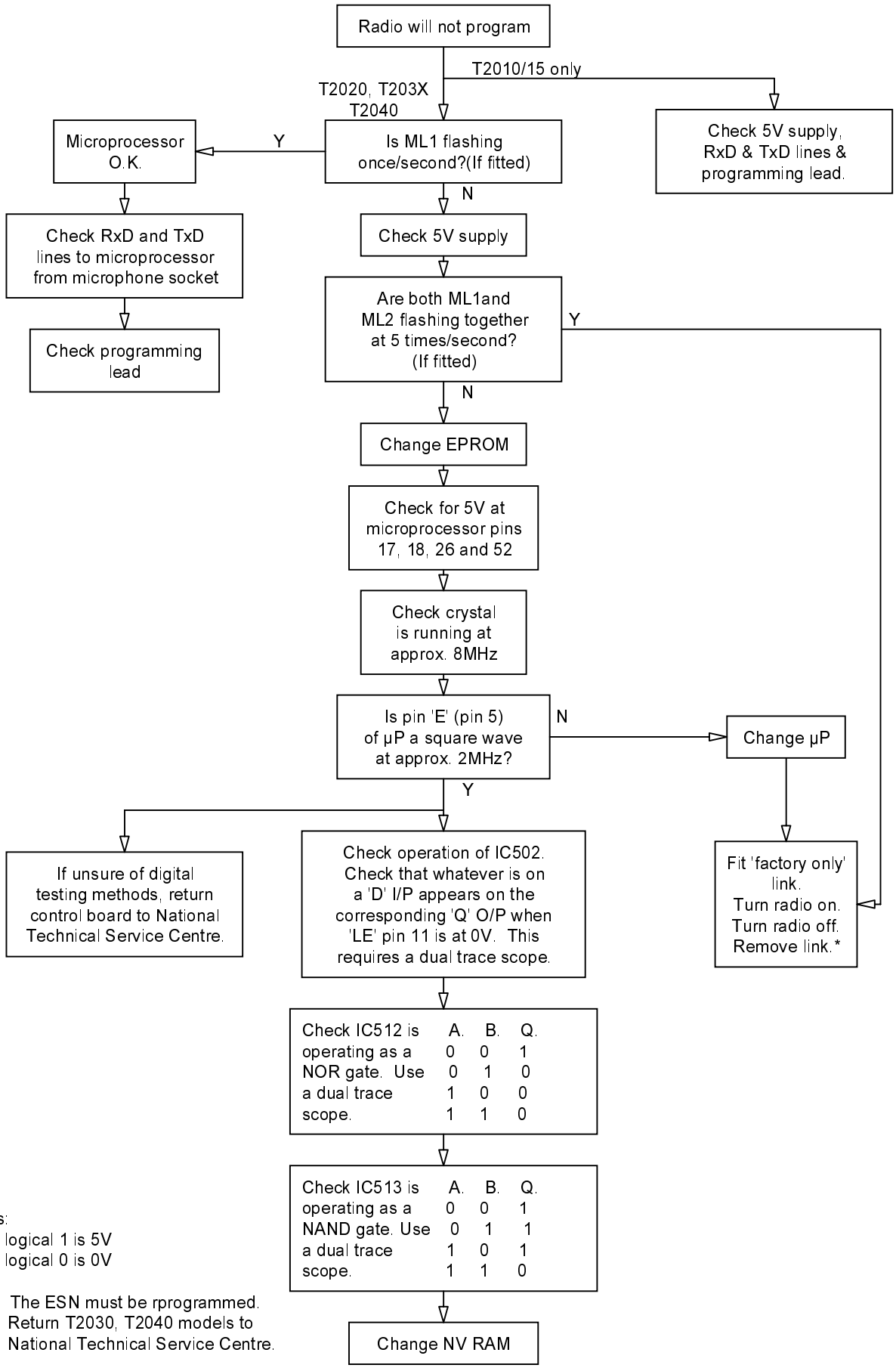
 Copyright TEL

5.10.1 Radio Won't Switch On





5.10.2 Radio Won't Program



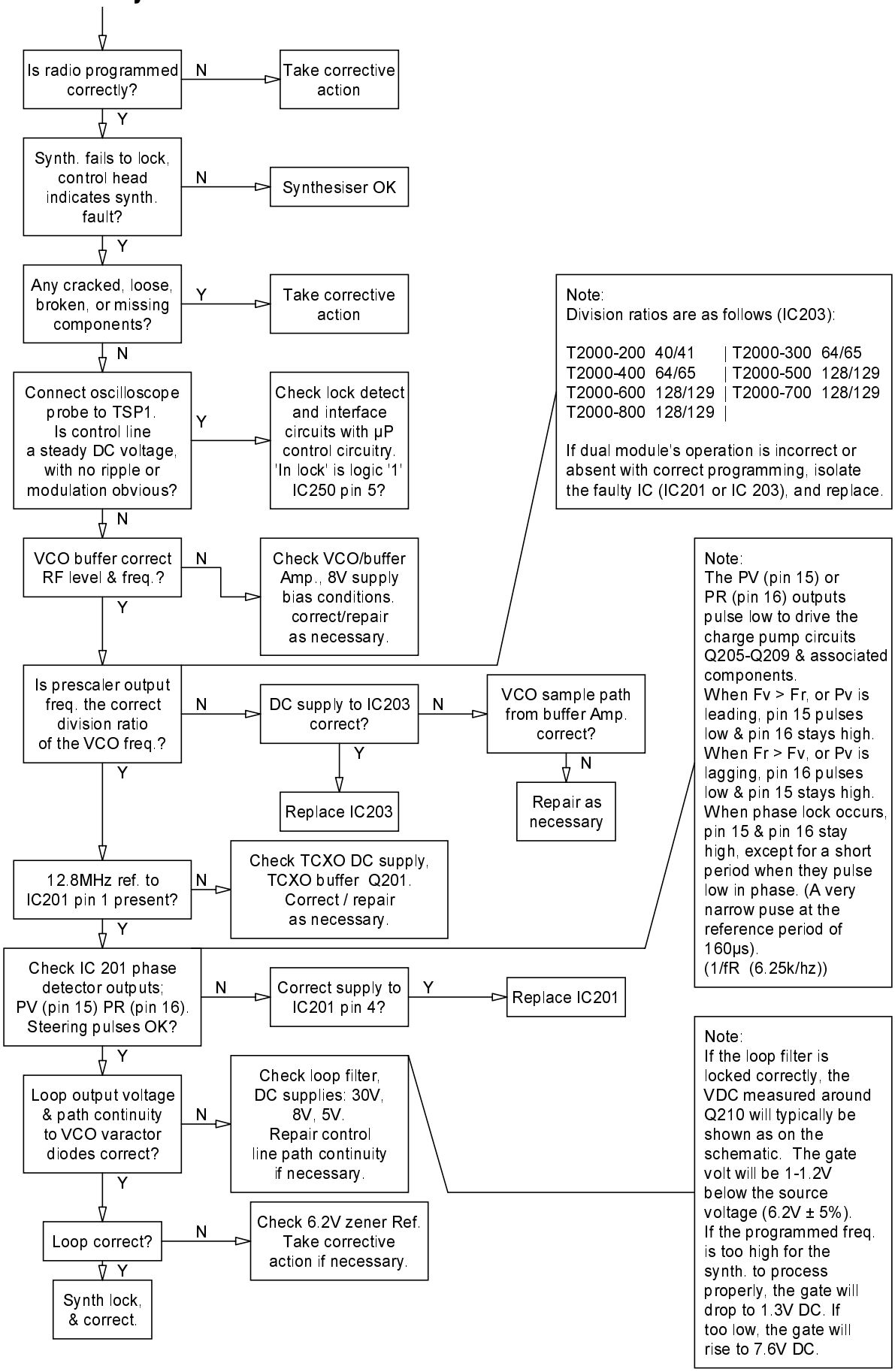
Notes:

1. A logical 1 is 5V
   A logical 0 is 0V

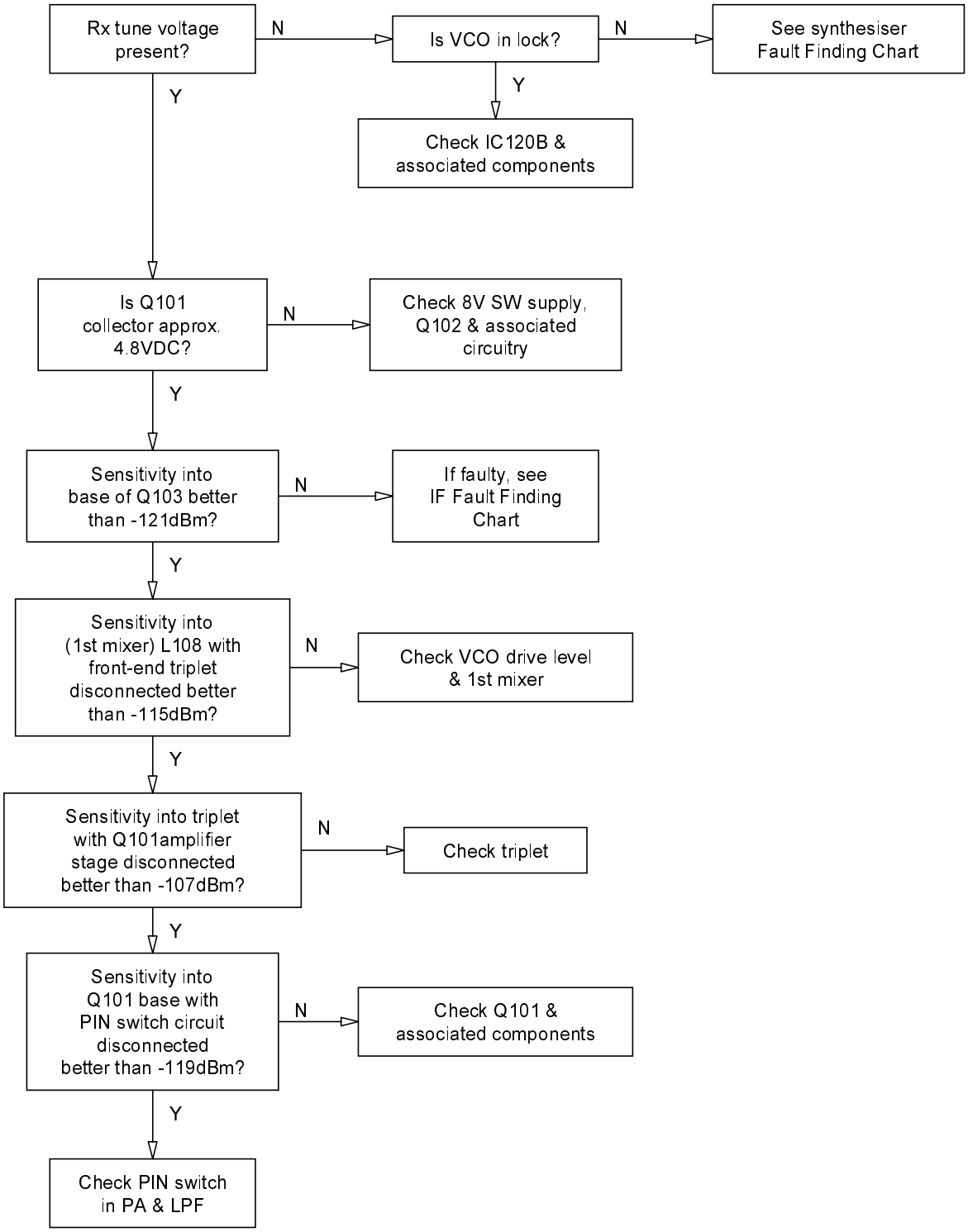
2. * The ESN must be rprogrammed. Return T2030, T2040 models to National Technical Service Centre.

Copyright TEL

5.10.3 Synthesiser Faults

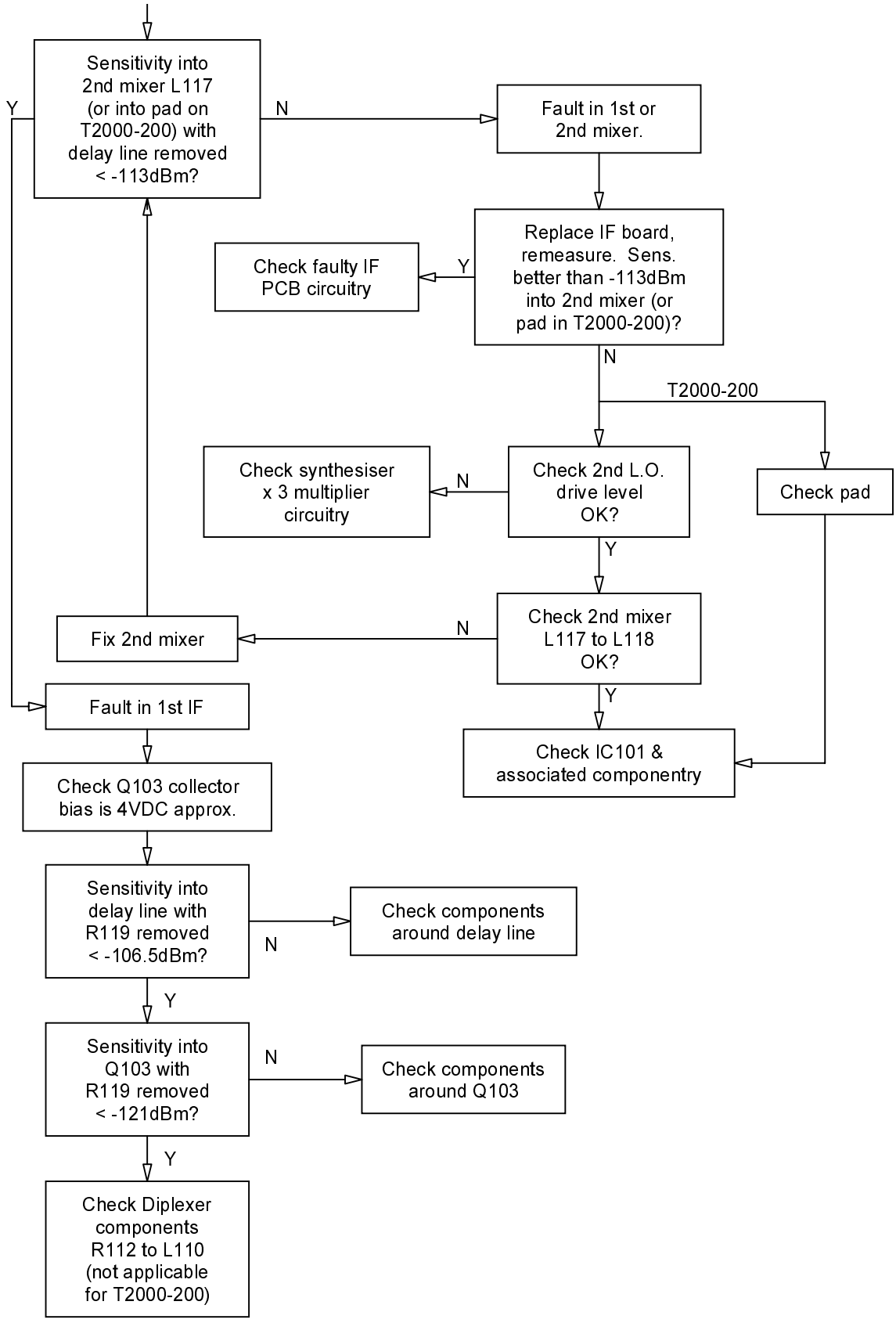


5.10.4 Receiver Front End Faults

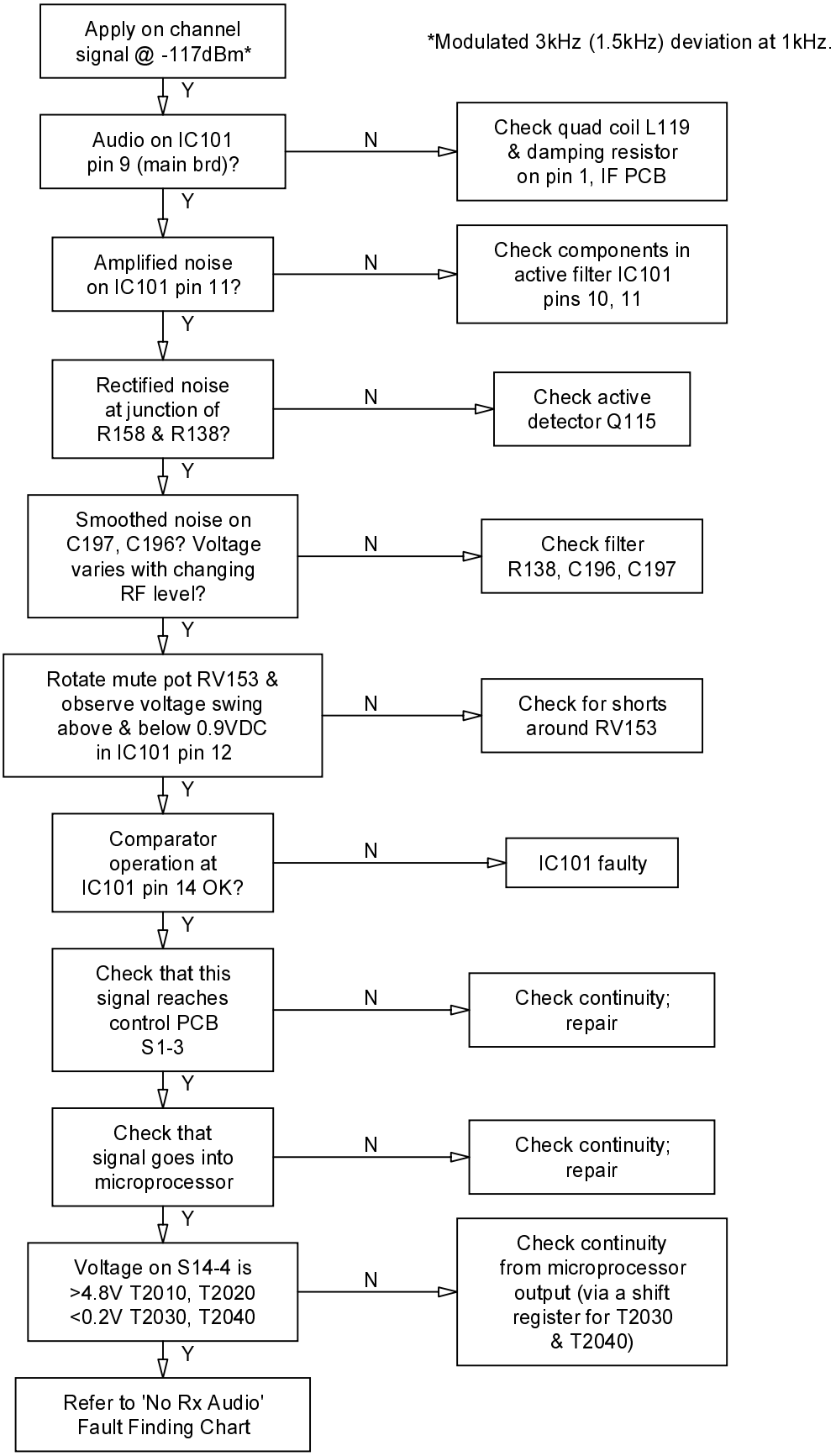


 Copyright TEL

5.10.5 Receiver IF Faults

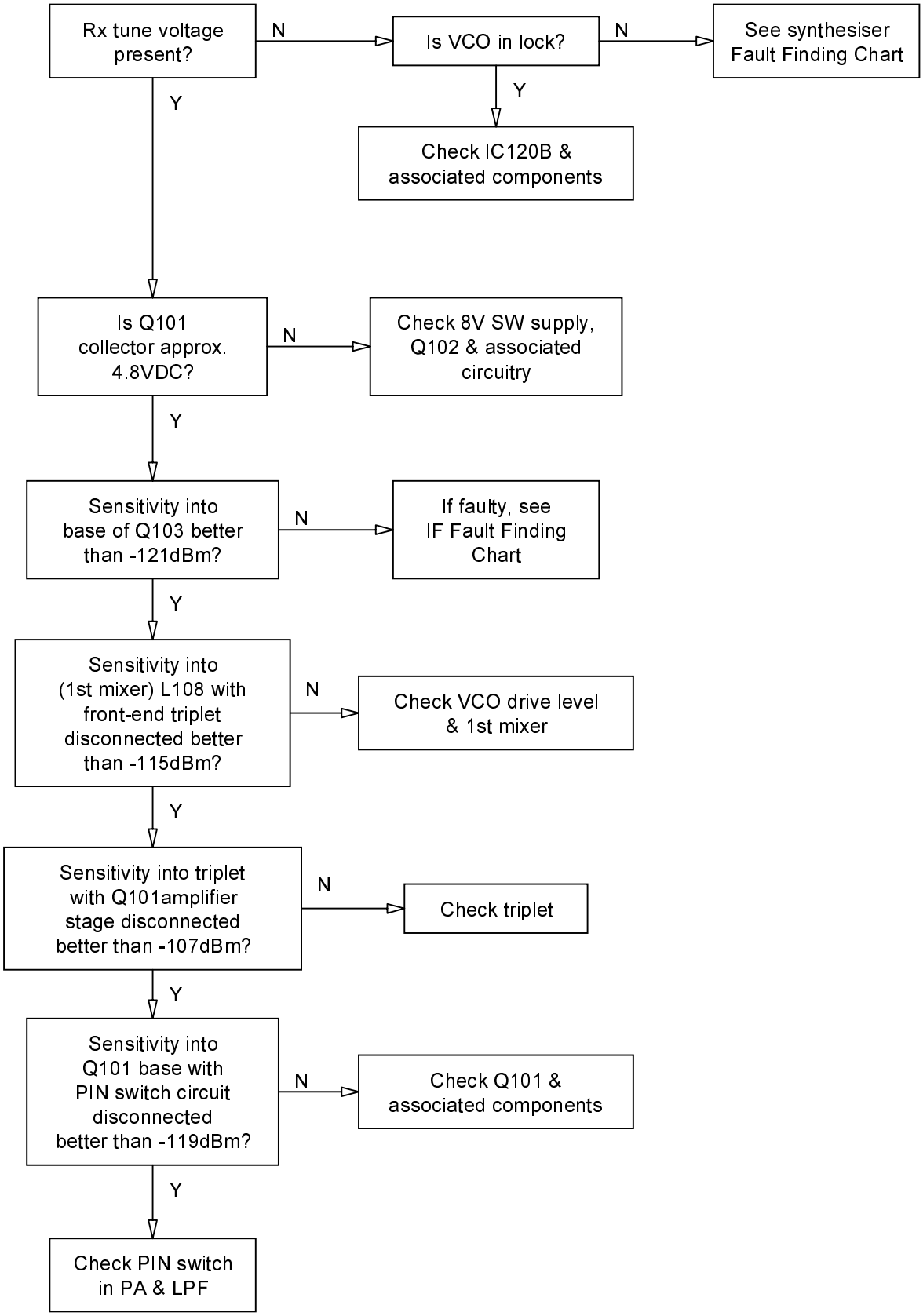


5.10.6 Receiver Mute Faults

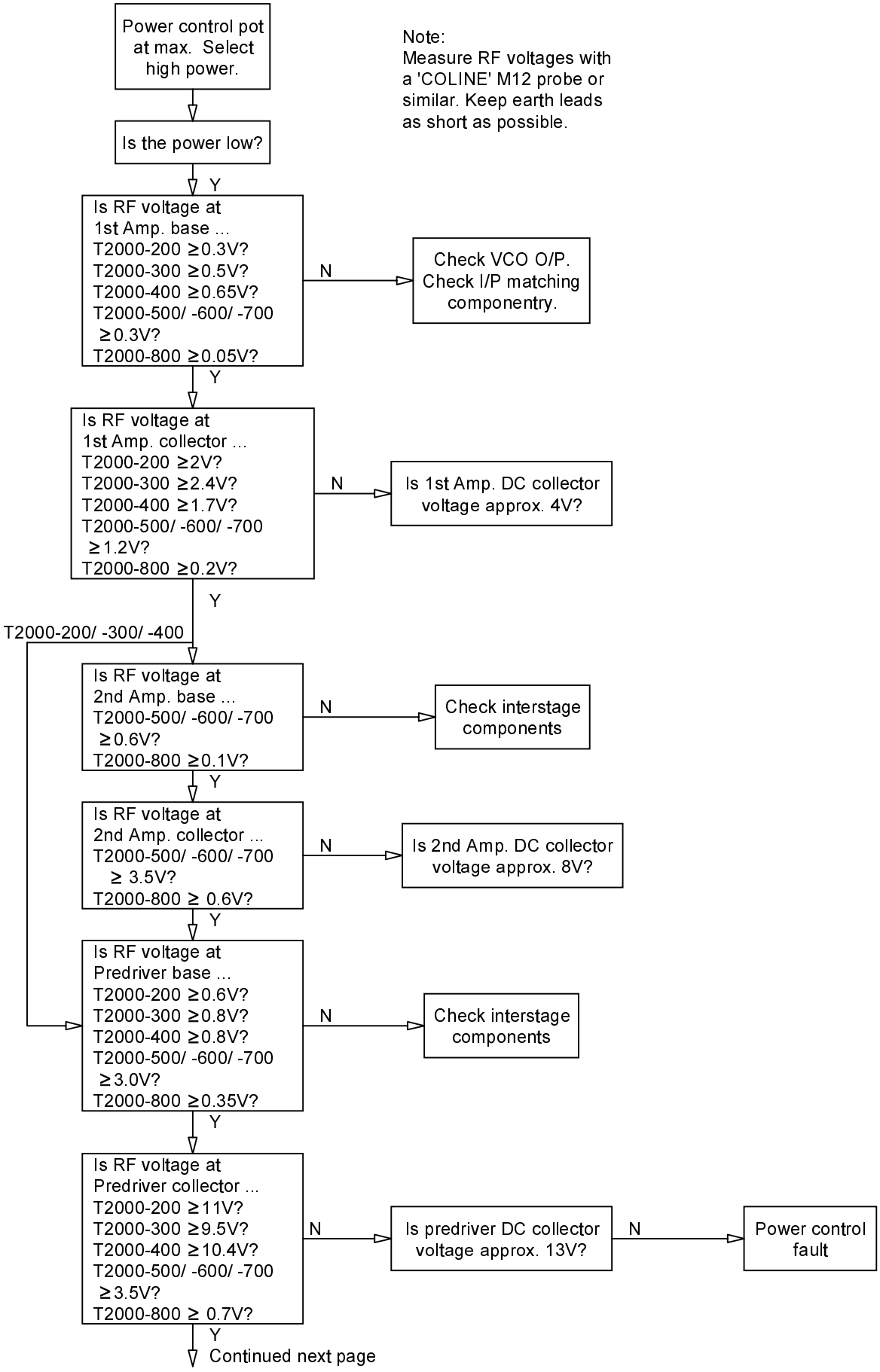


 Copyright TEL

5.10.7 No Audio On Receive

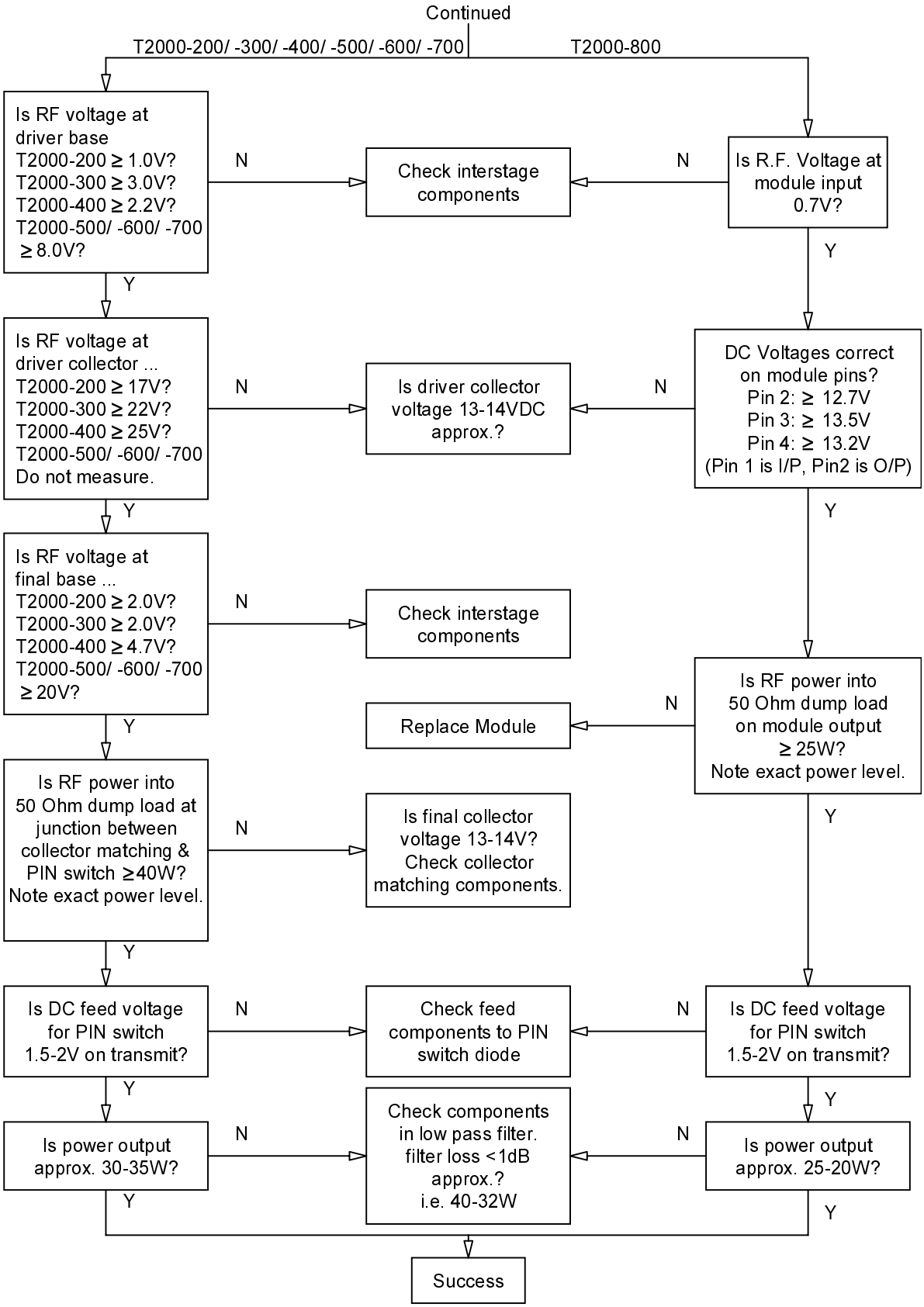


5.10.8 Transmitter RF Low Power Faults

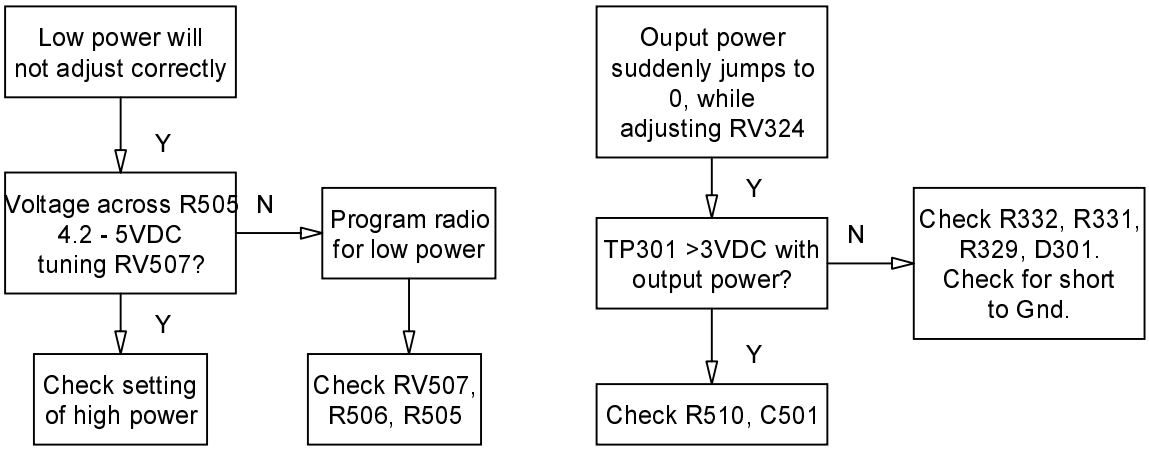


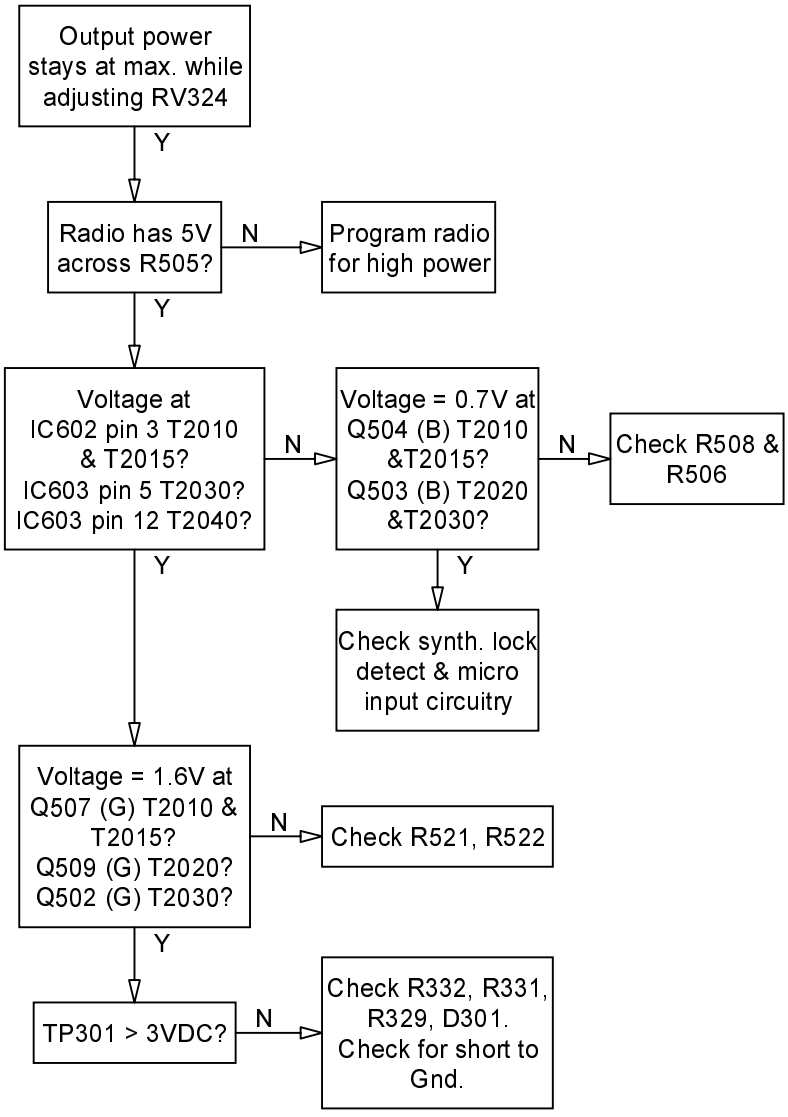
Note:
Measure RF voltages with a 'COLINE' M12 probe or similar. Keep earth leads as short as possible.

Copyright TEL


Continued
T2000-200/ -300/ -400/ -500/ -600/ -700
T2000-800
Is RF voltage at driver base T2000-200 ≥ 1.0V? T2000-300 ≥ 3.0V? T2000-400 ≥ 2.2V? T2000-500/ -600/ -700 ≥ 8.0V?
N
Check interstage components
N
Is R.F. Voltage at module input 0.7V?
Y
Y
Is RF voltage at driver collector ... T2000-200 ≥ 17V? T2000-300 ≥ 22V? T2000-400 ≥ 25V? T2000-500/ -600/ -700 Do not measure.
N
Is driver collector voltage 13-14VDC approx.?
N
DC Voltages correct on module pins? Pin 2: ≥ 12.7V Pin 3: ≥ 13.5V Pin 4: ≥ 13.2V (Pin 1 is I/P, Pin2 is O/P)
Y
Y
Is RF voltage at final base ... T2000-200 ≥ 2.0V? T2000-300 ≥ 2.0V? T2000-400 ≥ 4.7V? T2000-500/ -600/ -700 ≥ 20V?
N
Check interstage components
Y
N
Replace Module
Is RF power into 50 Ohm dump load on module output ≥ 25W? Note exact power level.
Y
Is RF power into 50 Ohm dump load at junction between collector matching & PIN switch ≥40W? Note exact power level.
N
Is final collector voltage 13-14V? Check collector matching components.
Y
Is DC feed voltage for PIN switch 1.5-2V on transmit?
N
Check feed components to PIN switch diode
N
Is DC feed voltage for PIN switch 1.5-2V on transmit?
Y
Y
Is power output approx. 30-35W?
N
Check components in low pass filter. filter loss <1dB approx.? i.e. 40-32W
N
Is power output approx. 25-20W?
Y
Y
Success

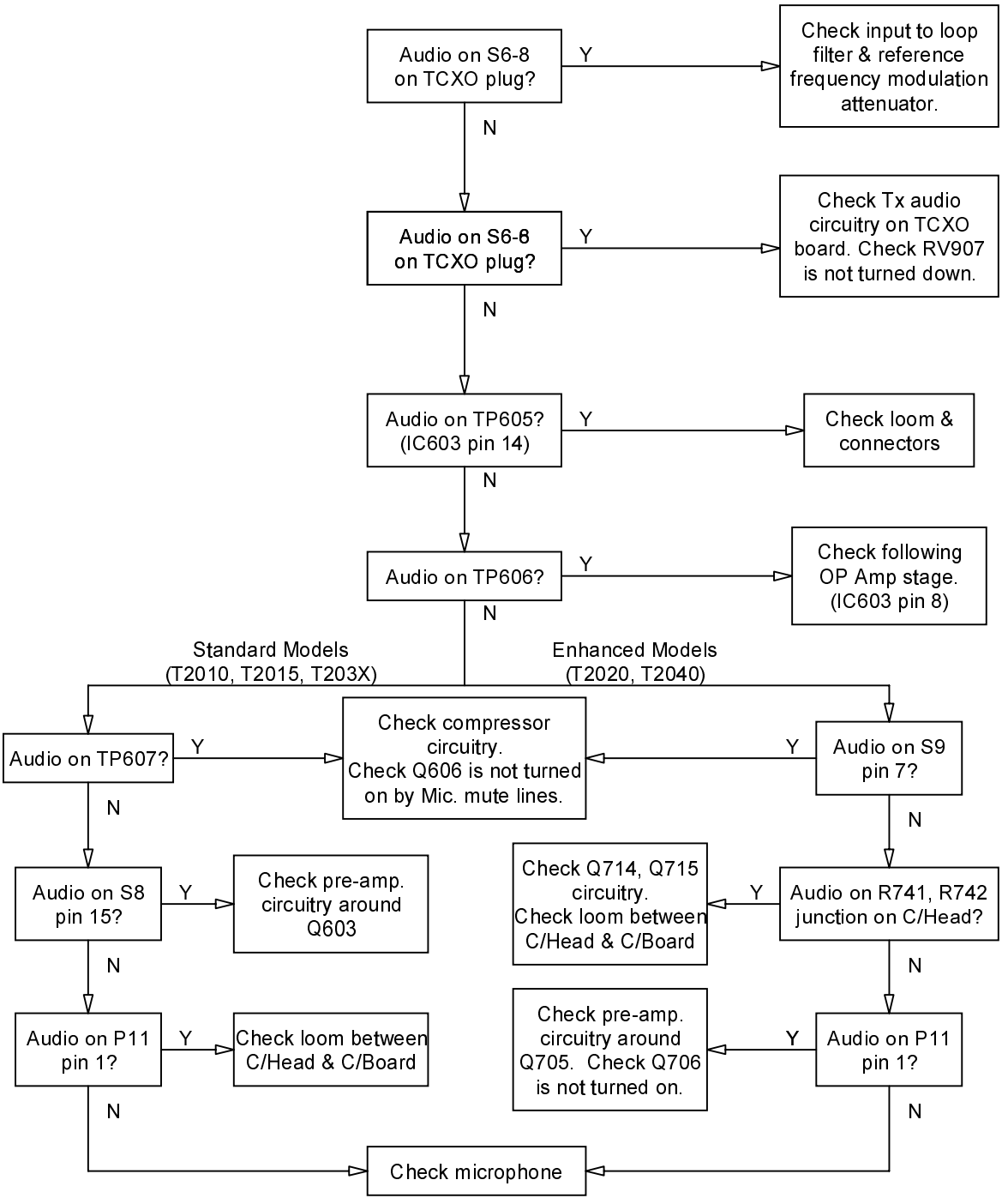
5.10.9 Transmitter Power Control Faults



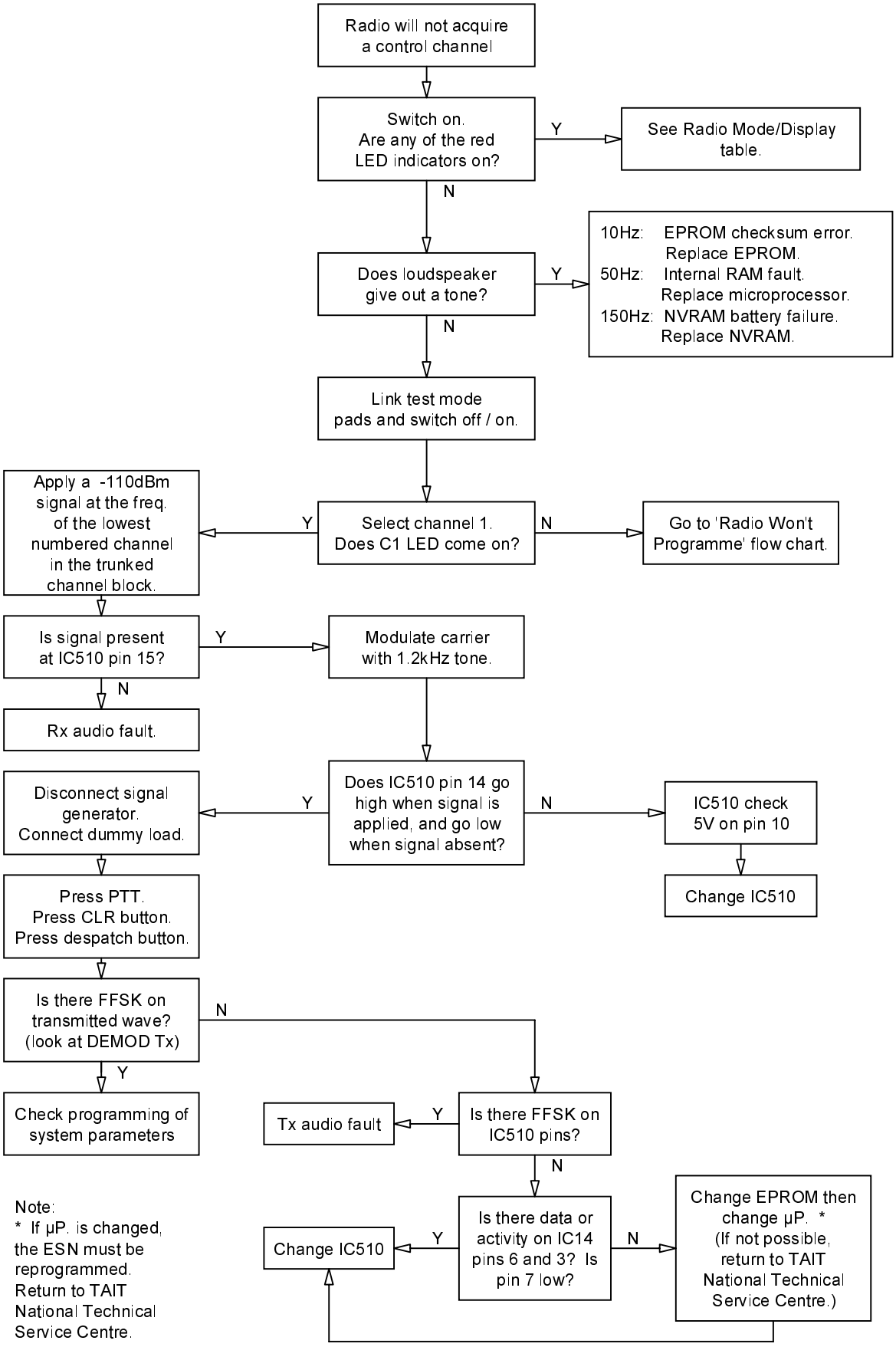


 Copyright TEL

5.10.10 Transmit Audio Absent



5.10.11 Trunked Radios: Radio Won't Acquire A Control Channel



 Copyright TEL