TM9100 mobiles

Tuneup info for compliance

Tuneup
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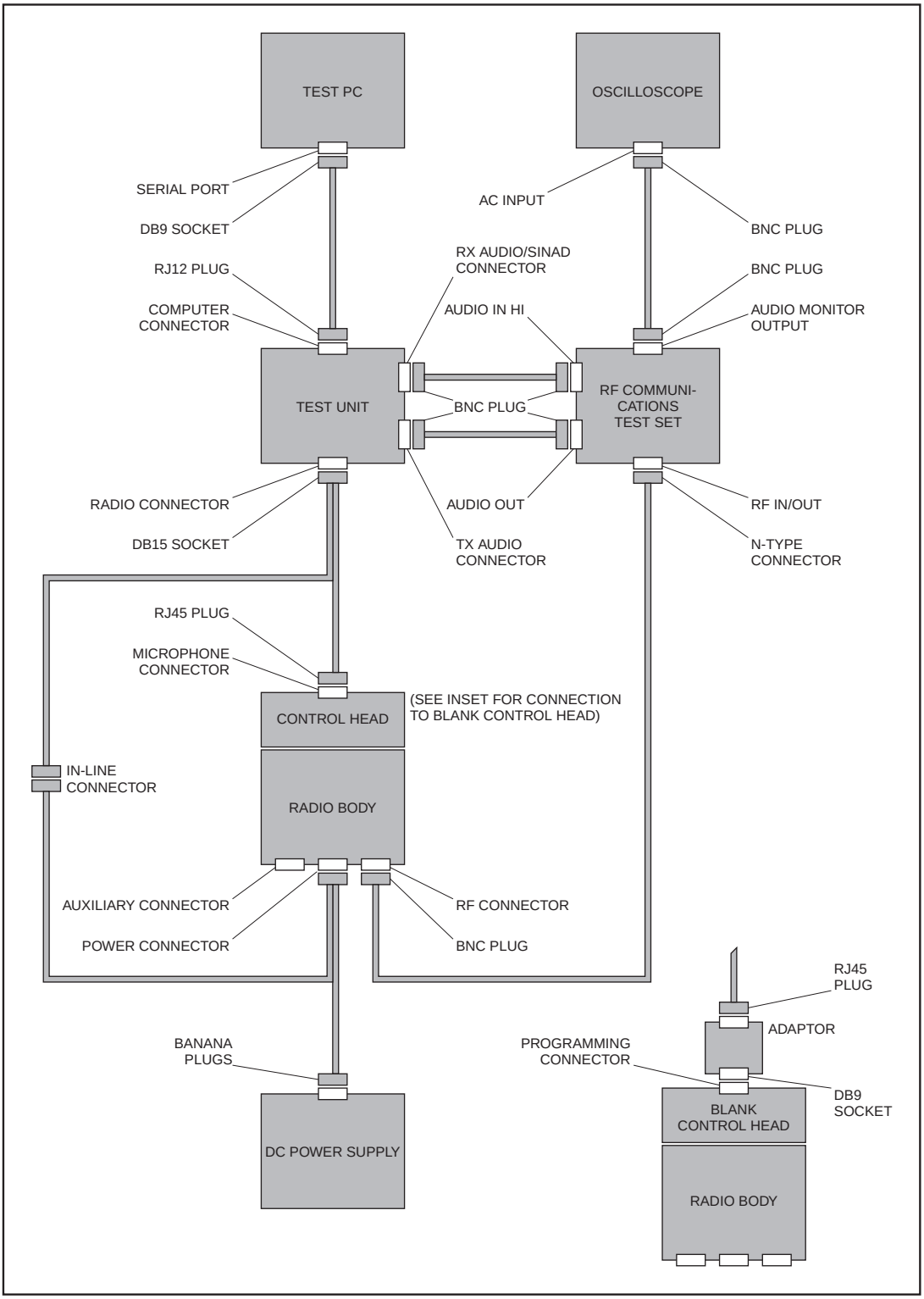
Contents

1 General Information

Figure 1.1 Test equipment for servicing radios



Introduction

This subsection covers the setting up of the test equipment for servicing the radios, as well as related aspects:

- setting up of test equipment, including test unit
- use of test unit
- installing programming and calibration applications
- basic programming and calibration tasks
- invoking CCTM (computer-controlled test mode)
- summary tables of CCTM commands and error codes
- visual and aural indications provided by radio

The last-named aspect applies to control heads with UI, and concerns the STATUS LEDs and LCD screen, and the various alerts and confidence tones emitted from the speaker.

Connect Equipment

Connect the test equipment to the radio as shown in Figure 1.1. Use the test unit, cables and adaptor of the service kit. The face of the test unit is fitted with a speaker, five switches, and the following connectors:

- "RADIO" connector (DB15 plug)
- "COMPUTER" connector (RJ12 socket)
- "TX AUDIO" connector (BNC socket)
- "RX AUDIO/SINAD" connector (BNC socket)

These connectors are all required for connecting the test equipment and radio. Figure 1.2 illustrates the face of the test unit.

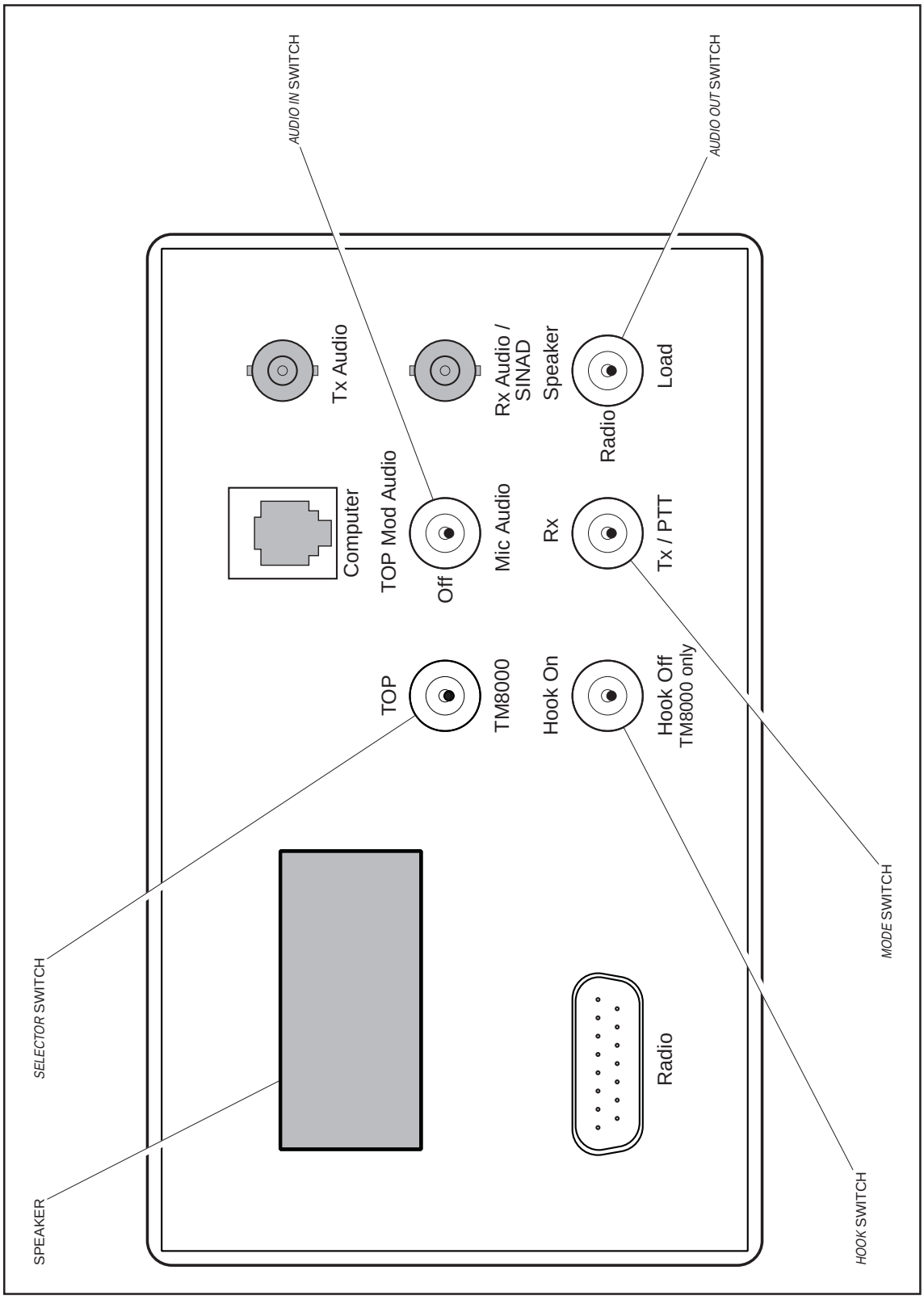
Use of Test Unit

The test unit facilitates the testing of the receive and transmit functions of radios. When the switches are set for the required mode, the test unit automatically routes all signals to the appropriate destinations. The unit may be used with both mobile and portable radios. A full description is given in the accessories manual. As shown in Figure 1.2, the switches are:

- SELECTOR switch
- HOOK switch
- MODE switch
- AUDIO IN switch
- AUDIO OUT switch

For servicing TM9100 radios set the SELECTOR switch to "TM9100". For testing receive and transmit functions respectively, the remaining switches must be set as described below. (When programming or calibrating radios the switches have no effect, although it is good practice to set the MODE switch to "RX".)

Figure 1.2 Illustration of the face of the test unit



Settings for Receive Tests

For receive tests set the switches on the test unit as follows:

- HOOK switch : "HOOK OFF"
- MODE switch : "RX"
- AUDIO IN switch : "OFF"
- AUDIO OUT switch: "SPEAKER" or "LOAD"

In the last-named case, with the switch in the "SPEAKER" position, the received audio is output from the test unit's speaker. In the "LOAD" position a 16 Ω load is switched into the circuit in place of the test unit's speaker. Note, however, that the AUDIO OUT switch has no effect on the radio's speaker.

Settings for Transmit Tests

For transmit tests set the switches on the test unit as follows:

- HOOK switch : "HOOK OFF"
- MODE switch : "RX" initially
- AUDIO IN switch : "MIC AUDIO"
- AUDIO OUT switch: (immaterial)

When ready to transmit, set the MODE switch to the "TX/PTT" position. This switch functions in the same way as the PTT switch on the microphone.

Product Support CD

After setting up the test equipment for the first time, install the programming and calibration applications on the test PC. These applications are included on the product support CD supplied with the service kit. Access the contents of the CD as follows:

1. Insert the product support CD in the CD-ROM drive of the test PC.
2. The *Contents* window of the CD should appear; the window is illustrated in Figure 1.3. If the *Contents* window fails to appear, proceed as follows:
3. Click *"Start"* > *"Run"*. The *"Run"* dialogue box appears.
4. Type ***d***:*menu.exe*, where ***d*** is the letter designating the CD-ROM drive.
5. Click the *"OK"* button. The *"Run"* dialogue box is closed and the *Contents* window appears.

Figure 1.3 The *Contents* window of the product support CD

Install Applications

The upper two buttons in the *Contents* window of the product support CD allow for the installation of the programming and calibration applications:

1. Click the *"Programming"* button. Installation of the programming application begins automatically. Follow the instructions on the screen to complete the installation.

2. Click the *"Calibration"* button. Installation of the calibration application begins automatically. Follow the instructions on the screen to complete the installation.

3. The *Contents* window remains open following installation of the above applications. Investigate the remaining features of the product support CD as described below, or click the *Close* button to remove the window.

4. Remove and store the product support CD.

View Documents

The middle six buttons in the *Contents* window of the product support CD give access to the documents stored on the CD:

- user's guide
- service manual
- operator's manual
- PCB information packs
- accessories manual
- licence agreement

To view any document click the corresponding button. The Adobe Acrobat Reader application needs to be installed on the test PC.

Access TaitWorld Website

Of the two lower and remaining buttons in the *Contents* window of the product support CD, the *"Miscellaneous"* button is currently unused. Clicking the *"TaitWorld"* button opens the default browser installed on the test PC and accesses the TaitWorld website.

Programming Application

The programming application is typically used to read the programming file of a radio, change settings in the various forms constituting the file, and reprogram the radio. Alternatively, the application can be used to open a new file, select the required settings, and program one or more radios. To run the application and become familiar with its features, proceed as follows:

1. Click *"Start"* > *"Programs"* > *"Tait Programming Applications"* > *"TM9100 Programming Application"*. The programming application is opened.
2. On the menu bar, click *"Help"* > *"Contents and Index"*. The on-line help facility is opened.
3. Read the information provided by the on-line help facility.
4. Close the on-line help facility and close the programming application.

Calibration Application

The calibration application is used to read radio calibration files, perform diagnostic functions, change certain settings, perform calibration tests, view and check calculated calibration data, and program radios with calibration files. To run the application and become familiar with its features, proceed as follows:

1. Click *"Start"* > *"Programs"* > *"Tait Programming Applications"* > *"TM9100 Calibration Application"*. The calibration application is opened.
2. On the menu bar, click *"Help"* > *"Contents and Index"*. The on-line help facility is opened.
3. Read the information provided by the on-line help facility.
4. Close the on-line help facility and close the calibration application.

Computer-controlled Test Mode

The servicing procedures require a radio to be placed in the computer-controlled test mode. In this mode CCTM commands can be entered at the test PC. These commands are then relayed via the test unit to the radio. Certain CCTM commands cause the radio to carry out particular functions; others read particular settings and parameter values in the radio. The CCTM commands of use in servicing radios are listed in Table 1.1 to Table 1.5, grouped according to category.

Terminal Program for CCTM

To place a radio in CCTM requires the use of a terminal program on the test PC. An example is HyperTerminal, which is supplied with Microsoft Windows. As a preliminary, first select the settings for the communications port as follows:

1. Open the terminal program. (In the case of HyperTerminal, click *"Start"* > *"Programs"* > *"Accessories"* > *"Communications"* > *"HyperTerminal"*.)
2. In the terminal program first select the COM port to which the radio is connected. Then select the following settings for the port:
   - bits per second : 19 200
   - data bits : 8
   - parity : none
   - stop bits : 1
   - flow control : none
3. Click the *"OK"* button (or equivalent).
4. Save the file with the port settings under a suitable name. For subsequent sessions requiring the terminal program, open this file.

Table 1.1 CCTM commands in the audio category

Command	Usage	
	Entry at keyboard	**Response on screen**
Audio category		
20 – Mute received audio Forces muting of the received audio signal	*20*	None
21 – Unmute received audio Forces unmuting of the received audio signal	*21*	None
22 – Mute microphone Mutes transmit modulation (effectively mutes microphone audio)	*22*	None
23 – Unmute microphone Unmutes transmit modulation (effectively unmutes microphone audio)	*23*	None
74 – Audio PA Controls the state of the audio PA (and hence enables or disables the speaker)	*74* ***x*** where ***x*** is the required state (0=stand-by, 1=on, 2=mute)	None
110 – Audio volume Sets the level of the audio volume	*110* ***x*** where ***x*** defines the required level (any integer from 0 to 255)	None
138 – Select microphone Selects the microphone required	*138* ***x*** where ***x*** is the required microphone (0=control-head microphone; 1=auxiliary microphone)	None
323 – Audio tap in Generates the audio tone AUD TAP IN at the specified tap point	*323* ***x y*** where ***x*** specifies the tap point (*r2*, *r5*, *t1* or *t5*) and ***y*** the tap type (A=bypass in, B=combine, E=splice) (the default is A when ***y*** is omitted)	None
324 – Audio tap out Outputs the audio signal at the specified tap point to AUD TAP OUT	*324* ***x y*** where ***x*** specifies the tap point (*r1*, *r2*, *r3*, *r4*, *r5*, *t1*, *t2*, *t3* or *t7*) and ***y*** the tap type (C=bypass out, D=split, E=splice) (the default is D when ***y*** is omitted)	None

Table 1.2 CCTM commands in the radio-information, radio-control and system categories

Command	Usage	
	Entry at keyboard	**Response on screen**
Radio-information category		
94 – Radio serial number Reads the serial number of the radio	*94*	***x*** where ***x*** is the serial number (an eight-digit number)
96 – Firmware version Reads the version number of the radio firmware	*96*	*QMA1F_**x**_**y*** where ***x*** is a three-character identifier and ***y*** is an eight-digit version number
97 – Boot-code version Reads the version number of the boot code	*97*	*QMA1B_**x**_**y*** where ***x*** is a three-character identifier and ***y*** is an eight-digit version number
98 – FPGA version Reads the version number of the FPGA	*98*	*QMA1G_**x**_**y*** where ***x*** is a three-character identifier and ***y*** is an eight-digit version number
133 – Hardware version Reads the product code of the radio body and the hardware version number	*133*	***x*** ***y*** where ***x*** is the product code and ***y*** is the version number (a four-digit number)
134 – FLASH serial number Reads the serial number of the FLASH memory	*134*	***x*** where ***x*** is the serial number (a 16-digit hexadecimal number)
Radio-control category		
400 – Select channel Changes the current channel to that specified	*400 **x*** (alternatively ****x***) where ***x*** is a valid channel number	None
System category		
46 – Supply voltage Reads the supply voltage	*46*	***x*** where ***x*** is the supply voltage in millivolts
203 – Clear system error Clears the last recorded system error	*203*	None
204 – Read system error Reads the last recorded system error and the associated data	*204*	*SysErr: **x*** ***y*** where ***x*** is the error number and ***y*** represents the associated data

Table 1.3 CCTM commands in the frequency-synthesizer and receiver categories

Command	Usage	
	Entry at keyboard	**Response on screen**
Frequency-synthesizer category		
72 – Lock status Reads the lock status of the RF PLL, FCL and LO2 respectively	*72*	***x y z*** where ***x*** is the RF PLL, ***y*** the FCL, and ***z*** the LO2 lock status (0=not in lock, 1=in lock)
101 – Radio frequencies Sets the transmit and receive frequencies to specified values	*101* ***x y*** *0* where ***x*** is the transmit and ***y*** the receive frequency in hertz (any integer from 50 000 000 to 1000 000 000)	None
334 – Synthesizer power Switches the frequency synthesizer on or off via the DIG SYN EN line	*334* ***x*** where ***x*** is the required state (0=off, 1=on)	None
335 – Synthesizer switch Switches the transmit-receive switch of the frequency synthesizer on or off via the DIG SYN TR SW line	*335* ***x*** where ***x*** is the required state (0=off, 1=on)	None
Receiver category		
32 – Receive mode Sets the radio in the receive mode	*32*	None
63 – RSSI level Reads the averaged RSSI level	*63*	***x*** where ***x*** is the averaged level in multiples of 0.1 dBm
376 – Front-end tuning Sets or reads the tuning voltage for the front-end circuitry of the receiver	*376* (to read voltage)	***x*** where ***x*** is the front-end tuning voltage in millivolts
	376 ***x*** (to set voltage) where ***x*** is the front-end tuning voltage in millivolts (any integer from 0 to 3000)	None
378 – Receiver output level Reads the signal power at the output of the channel filter (the square of the amplitude)	*378*	***x*** where ***x*** is the signal power

Table 1.4 CCTM commands in the transmitter category (part 1)

Command	Usage	
	Entry at keyboard	**Response on screen**
Transmitter category		
33 – Transmit mode Sets the radio in the transmit mode	*33*	None
47 – Temperature Reads the temperature in the vicinity of the PAs	*47*	***x*** ***y*** where ***x*** is the ADC value of the tem-perature (an integer from 0 to 1023) and ***y*** is the corresponding voltage in millivolts (a value from 0 to 1200 mV)
114 – Transmitter power Sets or reads the transmitter power setting (compare command 326)	*114* (to read value)	***x*** where ***x*** is the current power setting (an integer from 0 to 1023)
	114 ***x*** (to set value) where ***x*** is the required power setting (an integer from 0 to 1023)	None
304 – Driver bias Sets or reads the clamp current at the gate of the PA driver	*304* (to read value)	***x*** where ***x*** is the DAC value of the clamp current (an integer from 0 to 255)
	304 ***x*** (to set value) where ***x*** is the required DAC value of the clamp current (an integer from 0 to 255)	None
318 – Forward power Reads the forward-power level	*318*	***x*** where ***x*** is the voltage in millivolts corresponding to the power level (a value from 0 to 1100 mV)
319 – Reverse power Reads the reverse-power level	*319*	***x*** where ***x*** is the voltage in millivolts corresponding to the power level (a value from 0 to 1100 mV)
326 – Transmitter power Sets the power level of the transmitter	*326* ***x*** where ***x*** specifies the level (0=off, 1=very low, 2=low, 3=medium, 4=high, 5=maximum)	None

Table 1.5 CCTM commands in the transmitter category (part 2)

Command	Usage	
	Entry at keyboard	**Response on screen**
Transmitter category		
331 – Final bias 1 Sets or reads the bias voltage for the first PA	*331* (to read value)	***x*** where ***x*** is the DAC value of the bias voltage (an integer from 0 to 255)
	331 ***x*** (to set value) where ***x*** is the DAC value of the required bias voltage (any integer from 0 to 255)	None
332 – Final bias 2 Sets or reads the bias voltage for the second PA	*332* (to read value)	***x*** where ***x*** is the DAC value of the bias voltage (an integer from 0 to 255)
	332 ***x*** (to set value) where ***x*** is the DAC value of the required bias voltage (any integer from 0 to 255)	None

Invoking CCTM

Using the terminal program, place the radio in CCTM as follows:

1. Enter the character ^ to reset the radio.
2. As soon as the radio is reset, the letter *v* is displayed. (If an uppercase letter *V* appears, this implies a fault.)
3. Immediately the letter *v* is displayed, enter the character *%*. (The character *%* must be entered within half a second of the letter *v* appearing.)
4. If the character *%* is accepted, the character – is displayed in response, and the message *CL* (two-digit display) or *C* (one-digit display) appears on the radio's LCD screen. This implies that the radio has entered CCTM. If the attempt fails, repeat Steps 1 to 3.

CCTM Error Codes

Once the radio is in CCTM, the CCTM commands may be entered as shown in Table 1.1 to Table 1.5. Depending on the command, a response might or might not be displayed. If an error occurs, an error code will be displayed. Possible error codes are listed in Table 1.6.

Table 1.6 CCTM error codes

Error code	Description
C01	An invalid CCTM command has been received. Enter a valid CCTM command.
C02	A valid CCTM command with invalid parameters has been received. Re-enter the CCTM command with valid parameters.
C03	A valid CCTM command has been received but cannot be processed at this time. Enter the CCTM command again. If the error persists, power the radio down and up again, and re-enter the CCTM command.
C04	An error occurred on entry into CCTM. Power the radio down and up again, and place the radio in CCTM again.
C05	The radio has not responded within the specified time. Re-enter the CCTM command.
X04	The DSP is not responding. Check the DSP pin connections. If the error persists, replace the DSP.
X05	The version of the DSP is incompatible with the version of the radio firmware. Replace the DSP with a later version.
X06	The internal configuration of the MCU is incorrect. Adjust the configuration.
X31	There is an error in the checksum for the model configuration.
X32	There is an error in the checksum for the radio's database.
X35	The radio temperature is above the T1 threshold and a reduction in the transmit power is impending. To avoid damaging the radio, stop transmitting until the radio has cooled down sufficiently.
X36	The radio temperature is above the T2 threshold and the inhibiting of transmissions is imminent.
X37	The supply voltage is less than the V1 threshold.
X38	The supply voltage is less than the V2 threshold and the radio has powered itself down. The radio will not respond to the reset command character ^.

Visual and Aural Indications

In radios that have a control head with UI, visual and aural indicators give information about the state of the radio. Visual indications are provided by the STATUS LEDs, function-key LEDs, and LCD screen on the front panel. The information conveyed by the STATUS LEDs is listed in Table 1.7. The behaviour of the function-key LEDs depends on the way the function keys are programmed; further information is not appropriate in this manual. The LCD screen normally displays only the number of the channel to which the radio is tuned. Other displays will be mentioned where necessary but are not summarised here. Aural indications are provided in the form of different tones emitted from the speaker. The information conveyed by the tones is given in Table 1.8. Not all of the tones listed are relevant to the servicing of radios but they are included for the sake of completeness.

Table 1.7 Visual indications provided by the STATUS LEDs of control heads with UI

LED colour	LED name	Indications	Meanings
Red	Transmit	LED is on	The radio is transmitting
		LED flashes	(1) The transmit timer is about to expire (2) The radio has been stunned
Green	Receive and monitor	LED is on	There is activity on the current channel, although it might not be audible
		LED flashes	(1) The radio has received a call with valid special signalling (2) The monitor has been activated (3) The squelch override has been activated
Amber	Scanning	LED is on	The radio is scanning a group of channels for activity
		LED flashes	The radio has detected activity on a certain channel and scanning has halted on this channel

Table 1.8 Aural indications emitted from the speaker of control heads with UI

Type of tone	Meanings
One short beep	(1) After power-up — Radio is locked; PIN is required (2) On power-down — Radio is off (3) On pressing key — Key-press is valid (4) On pressing function key — Function has been initiated
One short low-pitched beep	On pressing function key again — Function has been terminated
One short high-pitched beep	While powered up — Radio has been stunned
One long low-pitched beep	(1) On pressing key — Key-press is invalid (2) On entry of PIN — PIN is invalid (3) On pressing PTT switch — Transmission is inhibited
Two short beeps	(1) On power-up — Radio is ready to use (2) On entry of PIN — PIN has been accepted and radio is ready to use (3) After radio has been stunned — Radio has been revived and is ready to use
Two low-pitched beeps	While powered up — Temperature of radio is high
Two high-pitched beeps	While powered up — Temperature of radio is very high and all transmissions will be at low power; if temperature rises further, transmissions will be inhibited
Three short beeps	While powered up — Previously busy channel is now free
Three beeps	During transmission — Transmit time-out is imminent; transmission will be terminated in 10 seconds
Warble	While powered up — Frequency synthesizer is out of lock on current channel; LCD will usually be flashing *OL* (two-digit display) or *L* (one-digit display)
Continuous low-pitched tone	While powered up — System error has occurred and radio might be inoperable; LCD usually displays *E1* or *E2* (two-digit display) or *E* (one-digit display)

2 Calibration basics

Tait TM9000 radios are designed to be totally electronically tuned. No physical tuning is required, as all tuning is done by electronic trimming usually in the form of a digital-to-analog converter (DAC). The calibration process uses a PC running the calibration software, which is connected to a radio via an RS232 programming cable. RF in/out and audio in/out from the radio are also provided for connection to test equipment.

2.1 Calibrating the radio

To calibrate the radio

1. Connect a radio to your PC and test equipment. For more information, refer to the section on calibration equipment setup in the TM9100 Service Manual.
2. Read the radio.
3. Select the File > Save menu command to save the radio's current calibration database to disk. This will enable you to view data (see "Viewing calibration files" on page 21) and re-program with a previous calibration database if necessary.
4. Either:
   - Change deviation or squelch settings (see "Deviation and squelch thresholds" on page 27), or
   - Complete some calibration tests (see "Calibration tests" on page 22).
5. View and check the calibration data calculated (optional - see "Viewing calibration test results" on page 21).
6. Program the radio.

Note Before performing some tests, the radio must contain at least approximate receiver calibration settings. If the radio being calibrated has had settings deleted or default data programmed, then program another radio's calibration database into the radio before starting the tests.

2.2 Using the calibration application

The following controls are unique to the Calibration Application.

- Sliders
- Option buttons
- Instruction boxes
- Radio Model toolbar.

Sliders

Sliders typically modify a DAC setting in the radio. A slider appears as a line with a movable button, and two arrow buttons either side. Moving the button will alter a value in a box to the right of the slider.

To adjust a slider

- Keyboard: select a slider using the Tab key. Press the left and right arrow keys to adjust the value in the box in steps of 1, or the Page Up and Page Down keys to adjust the value in steps of 10. To move the slider above the upper safe limit of a field, hold shift and the right arrow key. The box will turn red.
- Mouse: select a slider by clicking on it. Click the < and > buttons to adjust the value in the box in steps of 1, click on the line either side of the movable button to adjust the value in steps of 10, or click and drag the movable button. To move the slider above the upper safe limit of a field, hold shift and click the > button. The box will turn red.

Important The purpose of the upper safe limit is to protect the radio from component damage. Only move sliders over this limit if you are certain that it is necessary for the radio being calibrated.

Option buttons

Option buttons are round buttons used to select one of a group of mutually exclusive options. They are typically used to select a current state.

To change data in a group of option buttons:

- Keyboard: select an option button using the Tab key. Select the radio

button by pressing the Space bar.

- Mouse: select an option button by clicking on it.

Instruction boxes

An instruction box contains text that describes the steps for a calibration task. After completing each step, select or click the Next> button to move to the next step.

Radio Model toolbar

When you read a radio, the type of radio will be displayed on the radio model toolbar. There are currently three types of radio available for calibration, Standard, Trigger Base, and Mid Power.

The following are the main differences between the radio models:

- Trigger Base radios use power levels approximately 6dB higher for each of the three AGC (automatic gain control) test points, during the Receiver test.
- The target power levels for mid-power radios are higher than for other models during the Tx Power Control test.
- Mid-power radios use a lower current limit for each of the bias and power tests.

2.3 Specifications form

You can use the Specifications form to view the Radio Model and Band. To view the radio's version and product code, select the Radio > Interrogate menu command.

Before beginning the calibration tests:

1. From the forms tree, select Specifications.
2. Select the Radio > Read menu command.

Radio Model Displays the type of radio. This is a read-only field, and is set automatically after reading the radio or opening a file, or manually using the Radio Model toolbar.

Band Displays the frequency band in which the radio operates, as indicated by the sixth and seventh characters in the product code. For example, TMAB1-**H6**00.

2.4 Viewing calibration test results

After you have finished one or more calibration tests, you can preview the results of those tests. This can be useful before programming the radio to send the new calibration data to the radio.

To view calibration data, navigate to the Raw Data form and click on the various tab pages. See "Raw data reference" on page 30 for more on the information available.

2.5 Viewing calibration files

Before and after calibrating a radio, it is recommended that you save the radio's calibration database to file (see "Calibrating the radio" on page 18).

To open and view a file saved to disk

1. Select the File > Open menu command, or click the Open button  on the toolbar.
2. Navigate to the folder where the file is located.
3. Select the desired file to open.
4. Click the Open button.
5. View the data. You can either view a print output of the file's data, or view the data on-screen.

Print output:

a. Select the File > Print menu command, or click the Print button  on the toolbar.

b. Click the Select All button.

c. Click Print.

Screen output:

a. Connect a radio to the PC.

The radio does not have to match the file saved to disk - it can be any radio that the Calibration Application recognises.

b. View the data on the Specifications, Deviation/Squelch, and Raw Data forms.

Note The data on these forms will belong to the file opened, not the attached radio.

3 Calibration tests

Each calibration test includes step-by-step instructions on how to carry out the test. Once an instruction has been carried out, select the Next> button.

Forms in which a number of steps must be repeated have an additional button that loops back to the first instruction that must be repeated.

The calibration test unit's external PTT should be set to Rx for all tests. Some tests are frequency dependent and so must be carried out across a range of test frequencies.

Once a test is finished, click on another form or select Edit > Validate Form to exit the form and save the data, or Edit > Revert Form to exit the form without saving the data.

3.1 AD6521 Volt Ref

The AD6521 CODEC has a single 1.20V bandgap reference for all its analog-to-digital (ADC) and digital-to-analog (DAC) converters.

AD6521 voltage reference is calibrated using the main power supply voltage. This is measured at the radio terminals using a multimeter. The result is entered into the Supply Voltage field, and is used to calculate the AD6521 Voltage Reference Offset.

1) Ensure the voltage supply to the radio is 13.8V (+/- 10 percent). Measure the exact voltage at the radio terminals with a multimeter that will read out to 2 decimal places with +/- 0.3 percent or higher accuracy, and enter this voltage into the Supply Voltage field.

2) Click the 'Set' button.

3) From the toolbar, click Accept button to save changes or Reject to cancel.

3.2 TCXO/VCO Mod Dev

The TCXO (temperature compensated crystal oscillator) provides the reference frequency from which all other RF frequencies are derived. The TCXO requires careful alignment to ensure that the transmitter and receiver are on frequency.

During this test the modulation deviation is also calibrated.

1) Provide a unmodulated RF input signal at greater than -20dBm from an accurate (< 0.1ppm) RF signal generator, set to the test frequency identified below.
2) Click the 'Calibrate' button.

3) From the toolbar, click Accept button (green tick) to save changes or Reject (red u-bent arrow) to cancel.

3.3 Receiver

The front end (FE) tuning voltage sets the centre of the bandpass filter in the receiver section of the radio. The received signal strength indicator (RSSI) must be calibrated to give an accurate measurement of received signal strength.

The automatic gain control (AGC) is used to adjust the radio's gain in relation to various power levels. The AGC will begin to reduce gain when the combined signal power of the wanted signal and first adjacent channels is greater than –70dBm approximately. The calibration test is run at -68dBm, -60dBm and -50dBm for standard TM9000 radios.

1) Connect a signal generator and prepare it to generate a signal on the first frequency identified in the test frequency box, with the power to the level indicated in the Signal Input Level box, with 3kHz deviation, and a 1kHz modulated tone; then turn the RF signal on.
2) Click the 'Calibrate' button.

3) Increase the power level to the new power level identified on the Signal Input Level box. Do not increase it past this value, then wind the signal generator power back down; if you overshoot, you will need to repeat the test from Step 1.
4) Click the 'Calibrate' button.

5) Increase the power level again to the new power level identified on the Signal Input Level box. Do not increase it past this value then wind the signal genorator power back down; if you overshoot, you will need to repeat the test from Step 1.
6) Click the 'Calibrate' button.

7) Increase the power level again to the new power level identified on the Signal Input Level box. Do not increase it past this value, then wind the signal generator power back down; if you overshoot, you will need to repeat the test from Step 1.
8) Click the 'Calibrate' button.

9) Adjust the signal generator to generate a signal on the next frequency identified in the test frequency box, with the power to the revised level indicated in the Signal Input Level box, with 3kHz deviation, and a 1kHz modulated tone.
10) Click the 'Calibrate' button.

11) If the final frequency has not been calibrated, loop back to instruction 9 and repeat for the next test frequency. If the last frequency has been calibrated, click the Next button.

12) From the toolbar, click Accept button to save changes or Reject to cancel.

3.4 Mute

The Mute test will calibrate the radio's squelch (carrier) mute, at an RF input level resulting in an audio measurement of 12 dB SINAD. The calibration application will take an average of 35 noise measurements, to determine accurate opening and points for Country, City, and Hard.

Note Closing points are also calculated from this test.

1) Set RF Signal Generator to generate a signal at the frequency indicated below, with a modulated 1kHz tone and 3kHz deviation.

2) Adjust RF level until SINAD reads 12dB, then click the 'Calibrate' button.

3) From the toolbar, click Accept button to save changes or Reject to cancel.

3.5 Final Gate Bias and Tx Driver Bias Limit

The final transistor in the radio must be biased at a constant current. Each transistor is different and so requires a different voltage to obtain the same current.

The Final Gate Bias 1 test must be completed first before the Final Gate Bias 2 test.

Important Jumping to a high DAC setting (the slider will change to red) can cause overheating and component damage. You can only force a slider into this danger zone with a deliberate action. See Sliders for more information.

It should not be necessary to change these settings, unless there are specific requirements.

Final Gate Bias 1

1) Adjust Digital Power Supply to current limit at 3 A

2) Read the current in mA drawn by the radio from the digital power supply's ammeter. Enter this number in Field labelled 'Standby Current' and click SET button.

3) Increase the level on each DAC slider slowly until the target current level is reading on the digital power supply's ammeter - or as close as possible, within 10mA (Be cautious not to raise the DAC too high or damage can occur).

4) From the toolbar, click Accept button to save changes or Reject to cancel.

Final Gate Bias 2

1) Adjust Digital Power Supply to current limit at 3 A

2) Read the current in mA drawn by the radio from the digital power supply's ammeter. Enter this number in Field labelled 'Standby Current' and click SET button.

3) Increase the level on each DAC slider slowly until the target current level is reading on the digital power supply's ammeter - or as close as possible, within 10mA (Be cautious not to raise the DAC too high or damage can occur).

4) From the toolbar, click Accept button to save changes or Reject to cancel.

Tx Driver Bias Limit

1) Adjust Digital Power Supply to current limit at 1.5 A

2) Read the current in mA drawn by the radio from the digital power supply's ammeter. Enter this number in Field labelled 'Standby Current' and click SET button.

3) Increase DAC slowly until Transmitter Driver Bias target current reached on digital power supply's ammeter - or as close as possible, within 10mA. (Be cautious not to raise the DAC too high or damage can occur).

4) From the toolbar, click Accept button to save changes or Reject to cancel.

Tx Power Cycle

1) Adjust Digital Power Supply to current limit at 12 A

2) Connect an RF Power meter to the antenna connector.

3) Set each of the DAC sliders in turn until the RF Power meter reads the target power level next to the slider. You will not need to Accept when changing between each slider.

4) If not all frequencies have been calibrated, select the next frequency and click the Go To Instruction 2 button. You will not need to Accept the data when changing frequency. When all frequencies are calibrated, click Next.

5) From the toolbar, click Accept button to save changes or Reject to cancel.

3.6 Tx Power Control

Power control must be calibrated for high, mid and low and very low power at five points across the radio's frequency band to ensure a flat power output across the operating band.

The Power Control test requires a total of 20 adjustments, four at each test frequency.

4 Deviation and squelch thresholds

The Deviation/Squelch form contains text fields for entering in values that require no test equipment. You can enter different values here for parameters such as the squelch (carrier) mute opening points, the scanning RSSI threshold level, and signalling deviation levels.

These settings should only be adjusted for special system requirements. See "Calibrating the radio" on page 18 for more information.

4.1 Deviation Settings tab

Tx Peak Deviation

Sets the maximum transmit deviation for narrow, medium, and wide band channels. Each value can be changed from 0 to 7000Hz for specific system requirements.

The default values are:

- first row: 2500Hz (for channels with a bandwidth of 12.5kHz)
- second row: 4000Hz (for channels with a bandwidth of 20kHz), and
- third row: 5000Hz (for channels with a bandwidth of 25kHz).

Rx Peak Deviation

Sets the maximum receive bandwidth for narrow, medium, and wide band channels. Each value can be changed from 0 to 10085Hz for specific system requirements.

The default values are:

- first row: 2500Hz (for channels with a bandwidth of 12.5kHz)
- second row: 4000Hz (for channels with a bandwidth of 20kHz), and
- third row: 5000Hz (for channels with a bandwidth of 25kHz).

Signalling Deviation

Sets maximum transmit deviation levels for non-voice signalling on the radio. Each value is a percentage of the equivalent voice deviation level (Tx Peak Deviation and Rx Peak Deviation), and can be changed within certain limits above or below the default value for specific system requirements.

Recommended ranges and defaults are:

- Selcall: 40 to 80% (default 60%)
- DTMF: 40 to 80% (default 60%)
- DCS: 10 to 25% (default 15%)
- CTCSS: 10 to 25 % (default 12%)
- FFSK (1200 baud modem): 40 to 80% (default 60%)

4.2 Squelch and Signalling Thresholds tab

Squelch Detect Type: Noise Level

Sets the squelch mute opening points of country, city, and hard when the squelch detect type is set to noise level. Each value can be changed from 8 to 20 dB SINAD for specific system requirements.

The default values for each are:

- Country: 8 dB SINAD.
- City: 12 dB SINAD.
- Hard: 20 dB SINAD

Note The hysteresis when the squelch detect type is set to noise level is fixed at a preset level, approximately 2dB R.F.

Opening Pt for Squelch Detect Type: Signal Strength

Sets the squelch mute opening points of country, city, and hard when the squelch detect type is set to signal strength. Each value can be changed from -30 to -119 dBm for specific system requirements.

The default values for each are:

- Country: -115dBm
- City: -113dBm
- Hard: -107dBm

Hysteresis for Squelch Detect Type: Signal Strength

Sets the hysteresis of country, city, and hard when the squelch detect type is set to signal strength. The hysteresis determines how much lower than the opening point the mute closing point will be.

The default values for each are:

- Country: 9dB
- City: 8dB
- Hard: 4dB

Each value can be changed from 2 to 20dB for specific system requirements. However, as a guideline use a higher hysteresis value for lower opening points, and a lower hystersis value for higher opening points.

Opening Pt and Hysteresis for Signalling Modems

Determines the threshold and hysteresis for the radio's various signalling modems. The In-band Signalling Modem includes Selcall, Two-tone, and Single In-band tone signalling. The hysteresis determines how much lower than the opening point the mute closing point will be.

The default value for each opening point is -119dBm, and can be changed from -30 to -119dBm for specific system requirements.

The default value for hysteresis is 10dB, and can be changed from 2 to 20dB for specific system requirements.

Scanning Opening Pt

Sets a threshold that will be used in an initial check for busy channel activity, when scanning. If activity on a channel satisfies this threshold, then the radio will check to see if the channel is suitable for capture. The default value is set to the equivalent of the country signal strength opening point (-119dBm), but can be set from -30 to -119dBm for specific system requirements.

Scanning Hysteresis

Sets the hysteresis that will be used in an initial check for busy channel activity when scanning. The default value is 10dB, but can be changed from 2 to 20dB for specific system requirements.

Opening Pt and Hysteresis for Front End Gain Switching

Sets the point at which the gain is lowered in the receiver path (Opening Pt), and the point at which the gain will be restored to the original level (Hysteresis). These fields only apply to VHF radios (A, B, C and D-band), and should not be changed from the default values of -30dBm and 20dB respectively.

4.3 Advanced tab

Birdie Killer On/Off

Shows DAC values that are used for identifying birdie (Birdie Killer On) and non-birdie (Birdie Killer Off) channels. The radio will activate birdie killer circuitry on channels that are determined to have a birdie (a hum or whistle caused by internal interference). These fields are for information only, and must not be changed from their default values of 20 and 200.

FFSK Sync. Sequence

Sets a synchronisation sequence that is sent with every FFSK transmission. The sequence is a 16-bit hexidecimal number (four characters using 0 to 9 and A-F), and by default is set to 3B28. This value can be changed for specific system requirements. However, all transmitting and receiving radios must use the same sequence.

5 Raw data reference

5.1 Volt Ref/TCXO/VCO/VCXO tab

AD6521 Volt Reference Offset Shows the result of the AD6521 Volt Ref test.

Tx TCXO and Rx TCXO Show the results of calibrating the TCXO during the TCXO/VCO Mod Dev test.

VCO Mod Dev Constant Shows the result of calibrating the VCO deviation, during the TCXO/VCO Mod Dev test.

VCXO Offset 0 to 4 These values specify the five VCXO offset frequencies (in Hz), used during the radio's power-up auto-calibration sequence.

KVCXO Chk Val 1 to 4 These values show the VCXO calculated gain (Hz/V).

5.2 VCO Auto Cal Check tab

VCO Freq Cal Pt 0 to 8 These values specify the VCO calibration frequencies (in Hz), used during the radio's power-up auto-calibration sequence.

KVCO Chk Val 1 to 8 These values show the VCO calculated gain (kHz/V).

5.3 Receiver tab

RSSI Receiver Gain Factor Sets a receiver gain factor (in dB) that is used during the calibration of RSSI.

RSSI Front End Gain Correction Factor Sets the amount of gain that is lowered, when thresholds stated in the Opening Pt and Hysteresis for Front End Gain Switching fields (Dev/Squelch/Birdies form) are met.

Rx FE Tune BPF Settings Show the results of front-end tuning at various frequencies during the Receiver test. Each row corresponds with the equivalent frequency stated in the Rx FE Tune Cal Freq Pts grid (Test Freqs tab). Note that the Rx FE

Tune Voltage is equal to this DAC value divided by 255, multiplied by 3.0 volts.

Rx Delta Gain Values Show the results of calibrating the receiver gain at each frequency specified in the Rx FE Tune Cal Freq Pts grid (Test Freqs tab), relative to the receiver gain measured at the first frequency in the grid. Each row is in 0.1 dBm.

AGC Voltage Cal Pts Show the results (in mV) of calibrating the automatic gain control voltage points at various power levels during the Receiver test. Each row corresponds with the equivalent power level stated in the Signal Input Level box during the test.

AGC Delta Gain Values Show the results of calibrating the automatic gain control delta gain (in 0.1 dBm) at various power levels during the Receiver test. Each row corresponds with the equivalent power level stated in the Signal Input Level box during the test.

5.4 Mute tab

Mute Noise Pt Min and Max (12.5kHz BW) Sets the narrow band minimum and maximum points (in dB SINAD), from which rows 1 and 2 of the Mute Point Readings grid are derived.

Mute Noise Pt Min and Max (20kHz BW) Sets the medium band minimum and maximum points (in dB SINAD), from which rows 3 and 4 of the Mute Point Readings grid are derived.

Mute Noise Pt Min and Max (25kHz BW) Sets the wide band minimum and maximum points (in dB SINAD), from which rows 5 and 6 of the Mute Point Readings grid are derived.

Mute Point Readings Displays narrow, medium, and wide-band mute point readings at 8 dB SINAD and 20 dB SINAD, calculated as a result of the Mute test. Each row is the reading taken at the equivalent mute noise point, indicated to the left of the grid.

5.5 Tx Gate Biasing tab

Final Gate Bias 1 (Very Low to Max Power) Displays the results of the Final Gate Bias 1 test (see "Final Gate Bias and Tx Driver Bias Limit" on page 24).

Final Gate Bias 2 (Very Low to Max Power) Displays results of the Final Gate Bias 2 test (see "Final Gate Bias and Tx Driver Bias Limit" on page 24).

Driver Gate Bias Clamp

Displays results of the Tx Driver Bias Limit test (see "Final Gate Bias and Tx Driver Bias Limit" on page 24).

5.6 Power tab

Tx Power Control Grid

Each column displays various power levels at points spaced evenly across the radio's band (as shown in the Frequency Cal Pnt a to e fields, Test Freqs tab). Each row displays results of the Tx Power Control test at the various frequency points, at the power levels of Very Low, Low, Medium, and High. These values will be the DAC settings from the test, from 0 to 1023.

Coupler Cal Power

Shows what is calculated for the forward and reverse power of the directional coupler, as a result of the Tx Power Control test. These values are calculated using the DAC settings from the Tx Power Control Grid, at very low and high power, at the bottom and top frequencies of the band.

Power Level Sqrt 0 to 4

Shows constants that are used by the radio during certain power-related calculations. These values are derived from the square root of each desired power level, multiplied by 1000.

5.7 Test Freqs tab

Rx FE Tune Cal Freq Pts

Displays frequency points (in Hz) at which the Receiver is calibrated.

Frequency Cal Pnt a to e

Displays frequency points (in Hz) from which power levels ('Tx Power Control Grid', Power tab) are calculated. Point 'a' and point 'e' are also used to calculate the forward and reverse power settings (Coupler Cal Power).

Temperature values

Shows high temperature thresholds (in °C) that the radio will use to warn the user. These values are factory only, and can only be viewed with a hasp key attached to your PC.

The thresholds are:

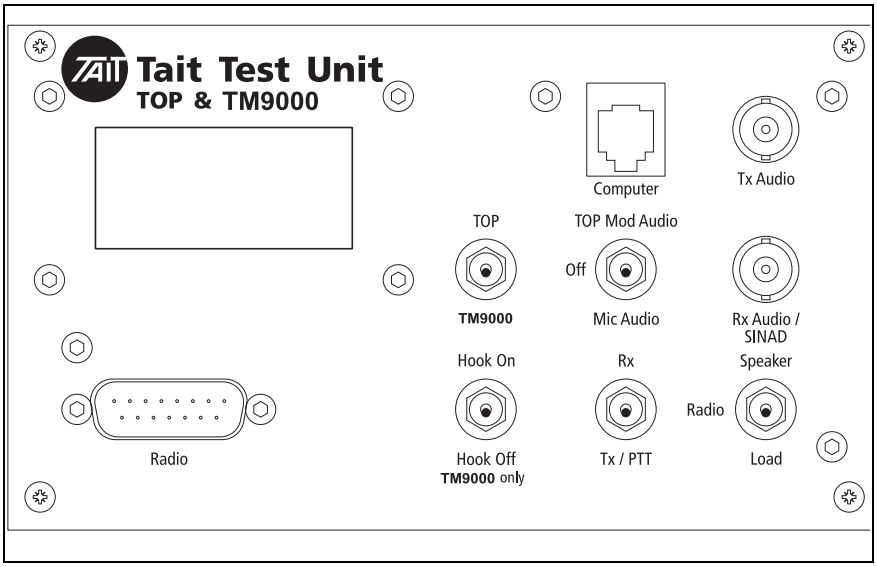
- pending high temperature shutdown,
- shutdown to very low power,
- shut off, and
- the hysteresis value that the radio must return to before the transmitter is re-enabled.

6 TOPA-SV-024 Test Unit

The TOPA-SV-024 test unit is used to test and maintain Tait Orca portables (TOP) and TM9100 radios by providing an interface between the radio, a test PC, and an RF communications test set.

The diagram below shows the front panel of the test unit.

Figure 6.1 TOPA-SV-024 test unit



6.1 Test Equipment Setup

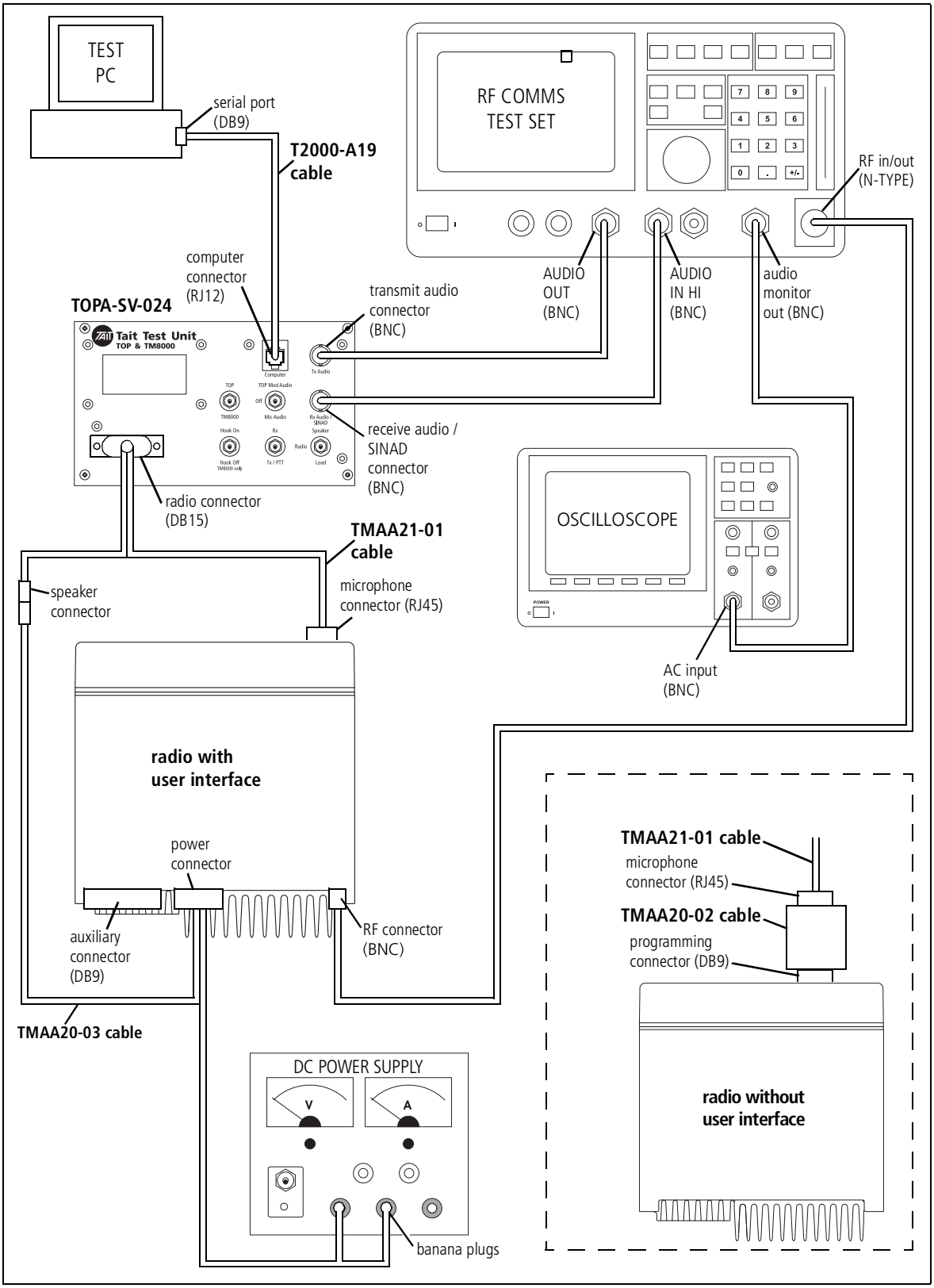
The diagram on the following page shows how the test unit is connected to the radio, the test PC, and the RF communications test set.

Note The test unit can also be connected to a T2000 radio using the T2000-11 cable. Use with T2000 radios is not described in this document.

6.2 Operation

This section explains the function of the TOPA-SV-024 test unit controls. The procedure for using the test unit is described in the section of the TM9100 Service Manual covering test equipment.

Figure 6.2 Test setup



TOP / TM9000 switch

This 2-way toggle switch is used to switch attenuation resistors (R4, R5, R6) in and out of the line from the radio's positive speaker output to the positive receive audio/SINAD output of the test unit (before the isolating transformer).

- When set to **TOP**, the attenuation resistors are switched out.
- When set to **TM9000**, the attenuation resistors are switched in (attenuation 10:1).

Important Selecting the wrong switch position can result in incorrect SINAD readings.

TOP Mod Audio / Off / Mic Audio switch

This 3-way toggle switch is used to switch between **Mod Audio** (Tait Orca portables only), **Mic Audio**, and **Off** (no audio signal).

- With the Tait Orca portables, this switch can be used for setting up dual point modulation by applying modulation to different parts of the radio.
- For normal transmit deviation tests (Tait Orca portables and TM9000), this switch is set to **Mic Audio**.

Hook On / Hook Off switch

Important When using the test unit with Tait Orca portables, the **Hook On** / **Hook Off** toggle switch **must** be set to **Hook Off**. Tait Orca portables do not have a hookswitch, and if the switch is set to **Hook On**, the Tait Orca portable F1 function is activated.

This 2-way toggle switch is used to simulate the microphone hookswitch opening ("hook off") and closing ("hook on"). This is done by switching a 12kΩ resistor (R3) in or out of the MIC_PTT line.

- When set to **Hook Off**, the 12kΩ resistor (R3) is switched out of the MIC_PTT line. This simulates the microphone being removed from the microphone clip.
- When set to **Hook On**, a 12kΩ resistor (R3) is switched into the MIC_PTT line. This simulates the microphone being placed on the microphone clip.

Rx / Tx/PTT switch

This 2-way toggle switch is used to switch between receive and transmit mode.

- When set to **Rx**, the PTT line is switched to high impedance.
- When set to **Tx/PTT**, the PTT line is pulled to ground.

Speaker / Radio / Load switch

This 3-way toggle switch is used during receive audio tests to switch the audio to the test unit speaker (**Speaker**), to the radio's internal speaker (**Radio**) or to a dummy load consisting of R1 and R2 (**Load**).

Note This switch does not disconnect the radio's internal speaker on M8100 radios with a user interface. If the switch is set to **Speaker** or **Load**, this simulates an external speaker being connected in parallel to the radio's internal speaker. TM9100 radios without a user interface do not have an internal speaker.

With all settings, a low level audio signal is available for testing through the SINAD port.

Tait Orca portables

- When set to **Speaker**, only the speaker of the test unit is active.
- When set to **Radio**, only the speaker of the Tait Orca portable is active.
- When set to **Load**, no speaker is active. The audio signal is terminated in the test unit dummy load.

TM9100 radios with user interface

- When set to **Speaker**, the speakers of the test unit and the TM9100 are both active. The speaker of the TM9100 cannot be disconnected.
- When set to **Radio**, only the speaker of the TM9100 is active.
- When set to **Load**, the TM9100 speaker remains active.

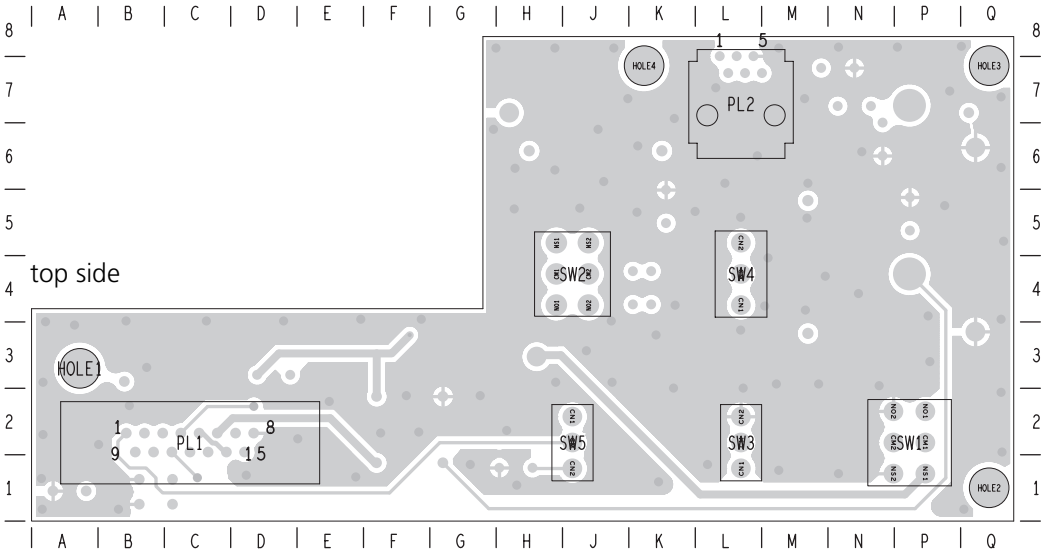
6.3 PCB Information (PCB IPN 220-01418-02A)

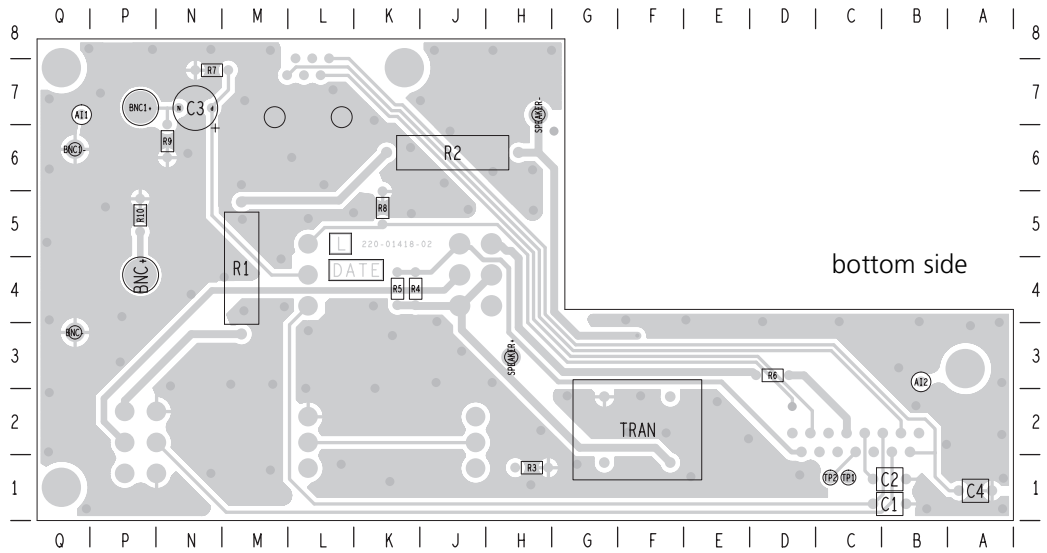
Parts List (Rev. 4)

Ref.	IPN	Description
BNC1	240-02100-11	Skt Coax BNC 3.5mm Pnl N/Tag
BNC2	240-02100-11	Skt Coax BNC 3.5mm Pnl N/Tag
C1	011-54100-01	Cap Cer Al 1n 10% T/C B 50v
C2	011-54100-01	Cap Cer Al 1n 10% T/C B 50v
C3	020-59100-06	Cap Elec Rdl 100m 16v 6.3x11
C4	011-54100-01	Cap Cer Al 1n 10% T/C B 50v
PL1	240-00010-55	Plg 15w Drng W-Wrap Pnl Mtg
PL2	240-04021-60	Skt 6w Modr Ph Vrt T-Ent
R1	032-31820-01	Res M/F Pwr 17x5 8e2 5% 2.5w
R2	032-31820-01	Res M/F Pwr 17x5 8e2 5% 2.5w
R3	030-55120-20	Res Flm 4x1.6 12k 5% 0.4w
R4	030-53560-20	Res Flm 4x1.6 560e 5% 0.4w
R5	030-54270-20	Res Flm 4x1.6 2k7 5% 0.4w
R6	030-52560-20	Res Flm 4x1.6 56e 5% 0.4w
R7	030-55100-20	Res Flm 4x1.6 10k 5% 0.4w

Ref.	IPN	Description
SW1	230-00010-42	Sw Tgl On Off On Dpdt Ms500hb
SW2	230-00010-57	Sw Tgl Dpdt On-On Pnl Mtg
SW3	230-00010-03	Sw Tgl Spst Mini Pnl Mtg
SW4	230-00010-16	Sw Tgr Spst 3-Pos Pnl Mtg
SW5	230-00010-03	Sw Tgl Spst Mini Pnl Mtg
TRAN	054-00010-17	Xfmr Line 600 Ohm 1:1
Not part of the PCB:		
SPKR	032-31820-01	Res M/F Pwr 17x5 8e2 5% 2.5w
	250-00010-19	Spkr C/W Rubber Sealing Ring

PCB Layout





Circuit Diagram