TM8000 mobiles

TM8100 Mobile Radio
Calibration Application
User's Manual

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Calibration basics

Tait TM8000 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.

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 TM8100 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 11) and re-program with a previous calibration database if necessary.

4. Either:
   - Change deviation or squelch settings (see "Changing maximum deviation and squelch thresholds" on page 15), or
   - Complete some calibration tests (see "Calibration tests" on page 13).

5. View and check the calibration data calculated (optional – see "Viewing calibration test results" on page 11).

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.

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.

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.

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 18 for more on the information available.

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 9).

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 ![printer icon] 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.

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.

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.

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.

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 TM8000 radios, and –62dBm,
–54dBm and –44dBm for TM8000 trigger base radios.

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.

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 deliber–
ate action. See Sliders for more information.

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

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.

Changing maximum 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 for more information.

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%)

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 RF.

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.

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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.

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.

Raw data reference

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).

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).

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.

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.

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 14).
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 14).
Driver Gate Bias Clamp	Displays results of the Tx Driver Bias Limit test (see "Final Gate Bias and Tx Driver Bias Limit" on page 14).

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.

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.

Glossary

B

bandwidth
The transmitter deviation and receiver audio sensitivity. Bandwidth is set on a per–channel basis using the programming application. The field can be set to 12.5 kHz (narrow band), 20 kHz (medium band), or 25 kHz (wide band).

birdie
A birdie is a hum or whistle on a channel caused by internal interference. A birdie can be eliminated by activating a birdie killer on the channel.

C

calibration
Calibration is the process whereby a radio is manually or electronically tuned for optimal performance. Calibration is normally only carried out during product manufacture or major service.

D

DAC
Digital to analog converter. An electronic device that outputs a voltage dependent upon the value of binary data input.

database
The set of programmable data points that allows the product to be customised for a particular application or mode of operation.

FFSK
FFSK (fast frequency shift keying) is the default signalling method used when transferring data (such as short data messages or GPS location information) between two radios. Data is represented by 1 cycle of 1200 Hz (logic 1) or 1.5 cycles of 1800 Hz (logic 0), and is transmitted at rates of 1200 bps.

P

programming database
The programming database is the information that is altered using the radio programming application.

S

signalling   Signalling is non-voice coding on the channel for the purpose of identifying parties and/or segregating user groups. Signalling is either subaudible (CTCSS or DCS), or selective (DTMF, Selcall, two-tone, phone patch, or single-in-band tone).

squelch detect type   Squelch detect type is a field in the programming application, located on the Networks > Basic Settings form > Basic Network Settings tab. The field determines whether the squelch mute for each channel assigned to the network is based on noise level (dB SINAD) or signal strength (dBm sensitivity).