TB8100 base station

Calibration Kit User's Manual

MB8100-90-00-806
June 2003

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Preface

Welcome to the TB8100 Calibration Kit User's Manual. This manual provides you with information about the Tait TB8100 Calibration Kit in PDF format. You can view it online or print it if you want a paper copy. It describes how to use Version 1.0 of the Calibration Kit.

Enquiries and Comments

Any enquiries regarding this manual as well as any comments, suggestions and notifications of errors should be sent to support@taitworld.com, or addressed to the Support Group Manager, Tait Electronics Limited, PO Box 1645 Christchurch, New Zealand.

Updates of Manual and Equipment

In the interests of improving the performance, reliability or servicing of the equipment, Tait Electronics Limited reserves the right to update the equipment or this manual or both without prior notice.

Copyright

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Disclaimer

There are no warranties extended or granted by this manual. Tait Electronics Limited accepts no responsibility for damage arising from use of the information contained in the manual or of the equipment and software it describes. It is the responsibility of the user to ensure that use of such information, equipment and software complies with the laws, rules and regulations of the applicable jurisdictions.

Typographical Conventions

'File > Exit' means 'click File on the menu bar, then select Exit'.

Associated Documentation

- *Online Help*. The Calibration Kit also has online Help. It contains more or less the same information as this manual. To view it, start the Calibration Kit, then press F1 or click the Help icon on the toolbar. If you are in a dialog box, click the Help button.
- *TB8100 Installation Guide*.
- *TB8100 Installation and Operation Manual*.
- *TB8100 Service Manual* (service centers only). A glossary of terms is available in this manual.

- *TB8100 Service Kit User's Manual*. The Service Kit is a Windows-based software program that makes it easy to monitor and configure a Tait TB8100 base station. You can also use it to carry out diagnostic tests on the base station and to update its firmware. The Service Kit also has online Help.

Technical notes are published from time to time to describe applications for Tait products, to provide technical details not included in manuals, and to offer solutions for any problems that arise. Look for them on Tait's technical support website. The following have been published or are in development:

- TN-742 Remotely Monitoring and Configuring the Tait TB8100.
- TN-743 Using the Tait TB8100 as a Talk-Through Repeater.
- TN-745 Using the Tait TB8100 in TaitNet Trunked Networks.
- TN-744 Using the Tait TB8100 as a Line-Connected Base Station.

Publication Record

Version	Date	Description
1.0	June 2003	First release of the manual for Version 1.0.0 of the Tait TB8100 Calibration Kit software.

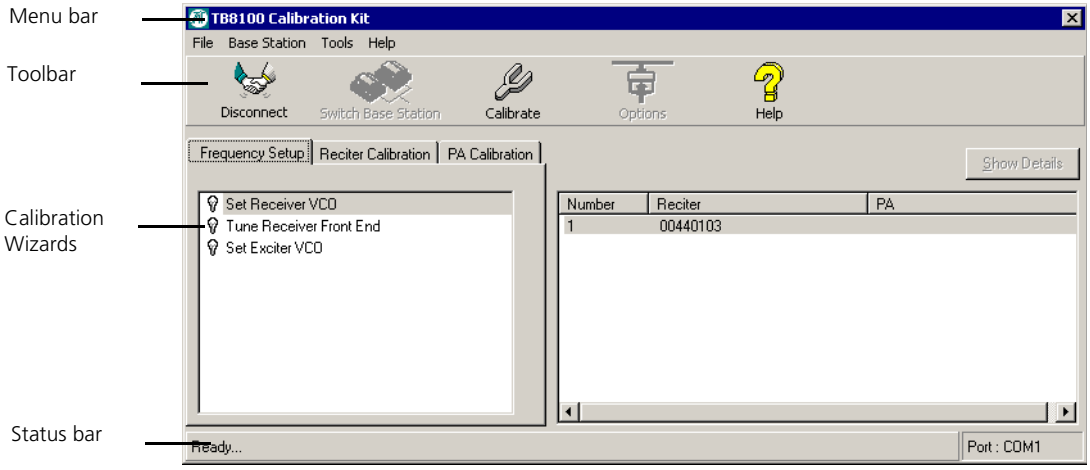
About TB8100 Calibration Kit

The TB8100 Calibration Kit is a Windows-based software program that allows you to adjust the switching ranges of the receiver and transmitter, and flatten the receiver response across the switching range.

Accredited Tait service centers can use the TB8100 Calibration Kit to calibrate the reciter and the PA after servicing.

Tour of TB8100 Calibration Kit

When you start the TB8100 Calibration Kit, the main program window appears.



The main program window has three tabs. The Calibration Wizards displayed on each tab are only visible once you are connected to the reciter and/or base station.

Frequency Setup tab

Shows the three Calibration Wizards that take you step-by-step through the frequency setup.

Reciter Calibration tab

Shows the seven calibration procedures that you can perform on the reciter. The Calibration Wizard takes you step-by-step through the procedure you have selected.

PA Calibration tab

Shows the three calibration procedures that you can perform on the power amplifier. The Calibration Wizard takes you step-by-step through the procedure you have selected.

When the TB8100 Calibration Kit is connected to the reciter or base station, you can view further details (such as module number, type, serial number, and band) about the currently selected reciter and/or PA by clicking **Show Details**.

About the Toolbar

The toolbar gives you quick access to commonly used menu commands. For example, instead of selecting Base Station > Calibrate, you can click the Calibrate icon on the toolbar.

Connect	Connects the TB8100 Calibration Kit to the base station and opens the communication channels.
Switch Base Station	Lets you select another base station to calibrate if there are multiple base stations in the rack.
Calibrate	Runs the Calibration Wizard for the currently selected task.
Options	Allows you to set the COM port and default calibration mode.
Help	Opens the online help for the window you are currently in.

About the Status Bar

The status bar provides you with useful information that supplements the display in the main window.

Basic Tasks

Before you start tuning and calibrating the base station, make sure that:

1. You have all the necessary equipment for the particular procedure(s) that you want to perform, and
2. Your PC is connected to the base station or reciter.

If you want to define the switching range for a base station (if this has not already been done), start here: "Adjusting the Frequency Setup" on page 13.

Equipment Required

You need the following equipment to tune and calibrate the base station:

- AC millivoltmeter (one with a differential input may be required for "Calibrating the Balanced Lines" on page 21)
- Calibration test unit (CTU) (order code XBA0ST1)
- Calibration test kit (order code XBA0ST1-CBL) which comprises the cables you will need to connect the CTU to the reciter/PA and the PC, and a tuning tool

- Frequency counter
- Modulation meter
- RF attenuator (optional—depends on the setup)
- RF signal source

Refer to the individual procedures for equipment setup diagrams.

For more information about the calibration test unit, please refer to the *TB8100 Service Manual*.

Tuning Tool

The recommended tuning tool (for adjusting the front-end helical filters and the VCOs in the reciter) is included in the calibration test kit (see Equipment Required). It can also be ordered separately (order code 937-00012-00)

Bit shape: ⊖

Blade diameter: 2.2 mm Blade thickness: 0.4 mm

Reciter Tuning Holes

The following topics show the location of the holes for tuning the front-end helical filters, and the VCO (Voltage Controlled Oscillator) in the reciter.

Adjusting the frequency

When you tune the VCOs and the front-end helical filters, turn the tuning tool:

- Clockwise to reduce the frequency
- Anti-clockwise to increase the frequency

Holes for Tuning the Receiver VCO and Exciter VCO

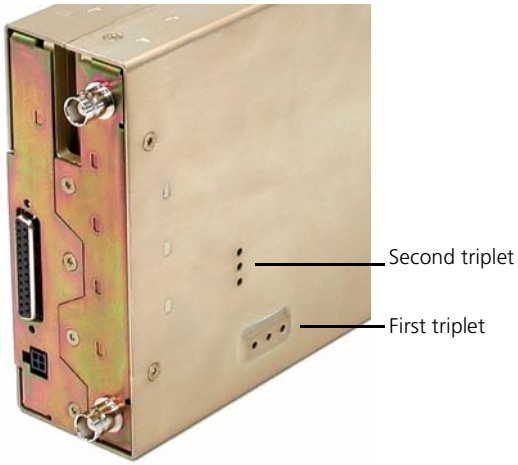
The holes for tuning the receiver VCO and exciter VCO are shown below.

Holes for Tuning the Receiver Front-End

When running the Tune Receiver Wizard, you will need to tune the front-end helical filters using the tuning tool as follows:

1. Insert the tuning tool into the first hole of the first triplet (see photograph).
2. Tune each of the resonators once to give the best response.
3. Do the same for the second triplet.

4. Repeat this procedure as necessary to refine the response.



Configuring TB8100 Calibration Kit

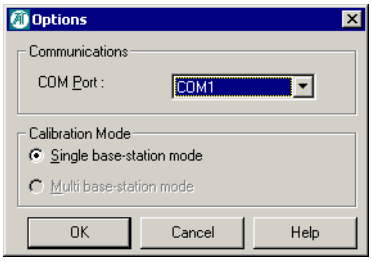
Note: For information on computer system requirements, and installing the TB8100 Calibration Kit, see the *TB8100 Installation and Operation Manual*.

Selecting the Communications Port

Before you connect to a base station, you should first define the communications (COM) port that you want to use.

To select the COM port

1. Select Tools > Options.



2. Select the port that you want to use from the COM Port list.

Note: The available COM ports are detected by the program and appear in the list.

3. Click **OK**.

The COM port you selected is now shown on the status bar.

Connecting to the Base Station

Depending on the procedure you are performing, you may need to remove the reciter from the subrack and connect to it via the calibration test unit (CTU).

The following tables summarise, for each procedure, whether or not you need to remove a module from the subrack, and what equipment (in addition to a PC and the TB8100 Calibration Kit software) you will need.

For instructions on how to connect to the reciter depending on whether it is outside or inside the subrack, refer to:

- "Connecting to the Reciter Outside the Subrack" on page 10
- "Connecting to the Reciter/PA in the Subrack" on page 11

Reciter

Procedure	Inside/Outside Subrack	Equipment Required
Adjusting receiver lock band	Outside subrack	Tuning tool, CTU
Tuning the receiver	Outside subrack	Tuning tool, CTU
Adjusting exciter lock band	Outside subrack	Tuning tool, CTU
Automatically tuning FCL	Inside subrack	None required
Calibrating the FCL modulation	Outside subrack	Tuning tool, CTU, modulation meter, RF attenuator (only if using PA)
Calibrating the VCO modulation	Outside subrack	Tuning tool, CTU, modulation meter, RF attenuator (only if using PA)
Calibrating the RSSI	Inside subrack	RF signal source
Calibrating the balanced lines	Inside subrack	CTU, AC millivoltmeter
Calibrating the unbalanced lines	Inside subrack	CTU, AC millivoltmeter
Calibrating the TCXO	Inside subrack	Frequency counter, RF attenuator (only if using PA)

Power Amplifier

Procedure	Inside/Outside Subrack	Equipment Required
Calibrating the PA bias	Inside subrack	None required
Calibrating the forward & reverse detector bias voltages	Inside subrack	None required
Calibrating the PA power	Inside subrack	None required

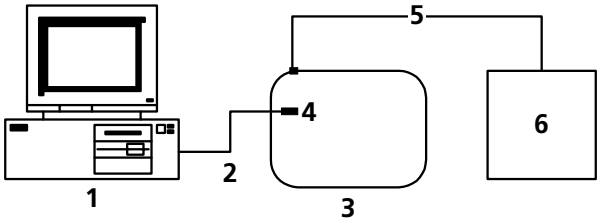
Connecting to the Reciter Outside the Subrack

For the reciter calibration procedures that require access to the tuning holes, you will need to remove the reciter from the subrack and connect to it as follows.

Equipment

- Calibration test unit (CTU)
- An IBM compatible PC
- 10-30 V DC power supply
- 16-way I^2C control bus cable
- RS-232 cable

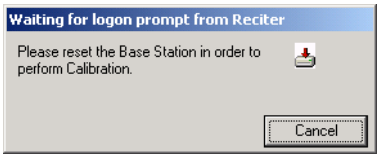
Setup



1	PC	**3**	Calibration test unit	**5**	I^2C control bus
2	RS-232 cable	**4**	Programming port	**6**	Reciter

To connect to the reciter

1. Remove the reciter from the subrack.
2. Set up the equipment as follows:
   - Connect the reciter to the calibration test unit (CTU) using the I^2C control bus cable.
   - Connect your computer to the CTU by plugging the RS-232 cable into the programming port.
   - Using the power cable supplied in the calibration test kit, connect the reciter to the 10-30 V DC power supply, but do not power it up yet.
3. Start the TB8100 Calibration Kit program, and check that the correct COM port is selected.
4. Click **Connect** to start the connection process.
5. When you see the "Waiting for logon prompt from Reciter" screen, power up the reciter.



6. When the TB8100 Calibration Kit program has successfully connected to the reciter, the Calibration Wizards are displayed in the main window.

You are now ready to tune and calibrate the reciter.

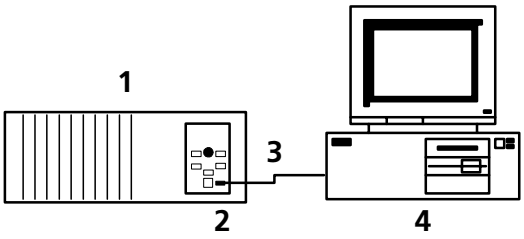
Connecting to the Reciter/PA in the Subrack

For the PA calibration procedures and the reciter calibration procedures that do not require access to the tuning holes, you can leave the modules in the subrack and connect your PC to the base station as follows.

Equipment

- An IBM compatible PC
- RS-232 cable

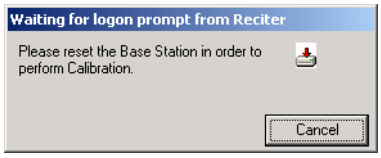
Setup



1	Base station	**3**	RS-232 cable
2	Serial port	**4**	PC

To connect to the base station

1. Connect your computer to the base station by plugging the RS-232 cable into the serial port of the base station's control panel.
2. Start the TB8100 Calibration Kit program, and check that the correct COM port is selected.
3. Click **Connect** to start the connection process.
4. As soon as you see the "Waiting for logon prompt from Reciter" screen, power up the base station.



5. When the TB8100 Calibration Kit program has successfully connected to the base station, the Calibration Wizards are displayed in the main window.

You are now ready to calibrate the reciter or PA.

Disconnecting from the Base Station/Reciter

To disconnect from the base station or reciter before closing the program, select File > Exit, or click **Disconnect**.

Important: Before disconnecting from the base station, ensure that you have completed any calibration process that you have started. If a calibration process is not completed, the base station could be left in an uncalibrated state.

Basic Troubleshooting

Application Errors

All application errors are recorded in a log file called "CalError.log". The data, time, location, and any other useful information is stored in this file, which may be helpful when troubleshooting.

The file is saved in the Logfiles folder (..\Program Files\Tait Programming Applications\TB8100 Service Kit\LogFiles), and stores up to 1000 of the most recent logged items.

Verifying the Software Version

If you need to verify the version of the TB8100 Calibration Kit, select Help > About.

Adjusting the Frequency Setup

Before the TB8100 base station is installed, connected, and configured, you must prepare it for operation by adjusting the switching range of the reciter, and flattening the receiver response across the base station's switching range.

Note: If the required switching range for the base station has already been defined, you don't need to perform these procedures.

To prepare the base station for operation

1. Adjust the receiver lock band (optional)
2. Tune the receiver
3. Adjust the exciter lock band (optional)

Tip: Use the TB8100 Service Kit software to monitor the base station and find out its current switching range.

Adjusting the Receiver Lock Band

The first step in preparing the TB8100 base station for operation is to adjust the receiver lock band (switching range). The lock band is the range of frequencies that the base station receiver or transmitter is calibrated to operate on.

Equipment

- Tuning tool
- Calibration test unit (CTU)

To adjust the receiver lock band

1. Ensure you are already connected to the reciter.
2. Select the Frequency Setup tab, and double-click **Set Receiver VCO**. The Set Receiver VCO Wizard appears.
3. Enter the center frequency (which must be a multiple of 500 kHz) of the lock band that you want to use, and click **Next**.
4. Insert the tuning tool into the receiver VCO tuning hole and adjust the receiver VCO trimmer to center the receiver VCO on the frequency you want, and then click **Finish**.

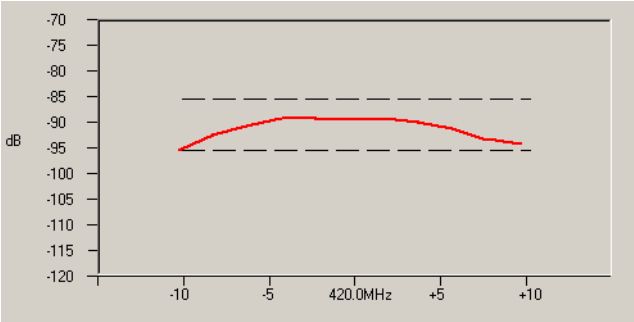
The lock band is now stored in the reciter, and the icon on the Frequency Setup tab indicates that this task is complete. You will now need to tune the receiver front end.

Tuning the Receiver

The second step in tuning the reciter frequency is to tune the receiver front end. Tuning the receiver flattens the receiver's response across its lock band (switching range).

To help you do this, there is a graph of the RSSI readings in step two of the Tune Receiver Front End Wizard. A number of RSSI readings are measured across the 10 MHz band. These readings are then continually averaged to produce the graph.

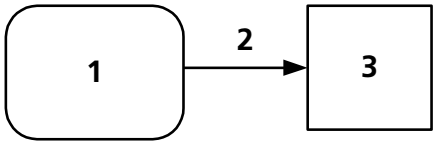
You should aim to achieve a response that looks something like this:



Equipment

- Tuning tool
- Calibration test unit (CTU)

Setup



1 CTU **2** Noise source **3** Reciter

To tune the receiver

1. Ensure you are already connected to the reciter.
2. Select the Frequency Setup tab, and double-click **Tune Receiver Front End**. The Tune Receiver Front End Wizard appears.
3. Connect the CTU's noise source to the receiver input, turn the noise source on, and then click **Next**.
4. For each set of front-end helical filters, insert the tuning tool into each tuning hole. (For the tuning sequence, refer to "Holes for Tuning the Receiver Front-End" on page 8.) Click **Coarse (fast)** and roughly adjust the front-end helical filters on the receiver. As you do so, observe the graphical RSSI readings across the lock band.

   Note: As the response gets flatter, you may find it helpful to select a more sensitive scale, so that you can see the graphical reading in more detail.

5. Once you have roughly tuned the front-end helical filters, click **Fine (slow)**. Continue to fine tune the front-end helical filters until the response is flat in the middle of the lock band and not more than -1 dB at the ends of the band (± 5 MHz).

Note: When using the Fine (slow) setting, you may notice a slight delay as the reading from tuning the front-end helical filters takes approximately one second to appear on the graph.

6. Click **Finish**.

Once you have finished tuning the receiver, the icon on the Frequency Setup tab indicates that this task is complete.

Adjusting the Exciter Lock Band

If you are preparing the base station for operation, adjusting the exciter lock band is the third step in tuning the reciter. Otherwise, this procedure can be performed independently of the other two calibration wizards on the Frequency Setup tab. Adjusting the exciter lock band defines the range of frequencies that the base station is able to transmit on.

Note: When performing this procedure, you don't need to terminate the exciter output port. An internal output pad means that there is a good impedance match at this interface.

Equipment

- Tuning tool
- Calibration test unit (CTU)

To calibrate the exciter lock band

1. Ensure you are already connected to the reciter.
2. Select the Frequency Setup tab, and double-click **Set Exciter VCO**. The Set Exciter VCO Wizard appears.
3. Enter the center frequency (which must be a multiple of 500 kHz) of the lock band that you want to use, and click **Next**.
4. Insert the tuning tool into the exciter VCO tuning hole and adjust the trimmer to roughly center the exciter VCO on the band you want. Click **Finish**.

Once you have finished adjusting the exciter lock band, the icon on the Frequency Setup tab indicates that this task is complete.

Calibrating the Reciter

The reciter is fully calibrated in the factory, but if the reciter is serviced you may need to perform the following procedures:

- Calibrating the Exciter
- Calibrating the RSSI
- Audio Calibration
- Calibrating the TCXO

These procedures can be done independently of each other, although it is recommended that you tune the receiver *before* you calibrate the RSSI.

Important: It is recommended that only accredited service centers and Tait engineers perform these procedures.

Advanced Troubleshooting

All the commands sent and received by TB8100 Calibration Kit are saved in a file called "CCTM.log". The date, time, command number, and parameters are all stored in this file, which may be helpful when troubleshooting.

The file is saved in the Logfiles folder (..\Program Files\Tait Programming Applications\TB8100 Service Kit\LogFiles), and stores up to 1000 of the most recent logged items.

Calibrating the Exciter

You will need to calibrate the exciter if you have made component-level repairs to it. There are three steps:

1. Auto-tune the FCL
2. Calibrate the FCL modulation
3. Calibrate the VCO modulation

Automatically Tune the Frequency Control Loop (FCL)

This is step one of calibrating the exciter.

Low frequencies (CTCSS and DCS) are modulated using the FCL (frequency control loop). The FCL forms a loop that allows the reference frequency to be modulated.

To automatically tune the FCL

1. Ensure you are already connected to the reciter.
2. Select the Reciter Calibration tab, and double-click **FCL Auto Tuning**. The FCL Auto Tuning Wizard appears.
3. Click **Calibrate** to automatically tune the FCL.

The icon on the Reciter Calibration tab indicates that this task is complete.

You will now need to calibrate the FCL modulation.

Calibrating the FCL Modulation

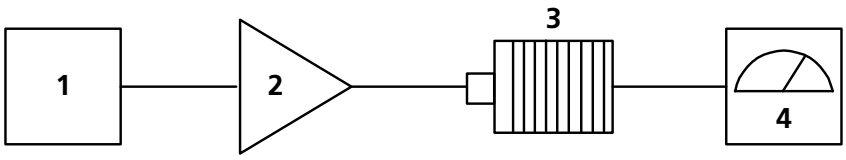
This is step two of calibrating the exciter. Once you have auto-tuned the FCL, you should calibrate the FCL modulation.

Equipment

- Tuning tool

- Calibration test unit (CTU)
- Modulation meter
- RF attenuator (only required if you are using a PA)

Setup



1	Reciter	**3**	RF attenuator (only required if using a PA)
2	PA (optional)	**3**	Modulation meter

To calibrate the FCL modulation

1. Ensure you are already connected to the reciter.
2. Select the Reciter Calibration tab, and double-click **FCL Calibration**. The FCL Calibration Wizard appears.
3. Attach an appropriate Load and Modulation meter to the PA or exciter output, set the meter to measure the RMS deviation, and then click **Next**. (If you are using a PA, it will now transmit.)
4. Insert the tuning tool into the exciter VCO tuning hole and adjust the trimmer to roughly center the exciter VCO on the band specified. Click **Next**.
5. Use the slider to adjust the deviation at 30 Hz until it is 2121 Hz RMS (3 kHz peak).
6. Select the 1 kHz Modulation Test and adjust the deviation at 1 kHz until it is 2121 Hz RMS (3 kHz peak).
7. Repeat steps 6 and 7 until the modulation is 2121 Hz RMS at both 30 Hz and 1 kHz.
8. Click **Finish**. (If you are using a PA, it will now stop transmitting.)

When you have finished calibrating the FCL modulation, the icon on the Reciter Calibration tab indicates that this task is complete.

You will now need to calibrate the VCO modulation.

Calibrating the VCO Modulation

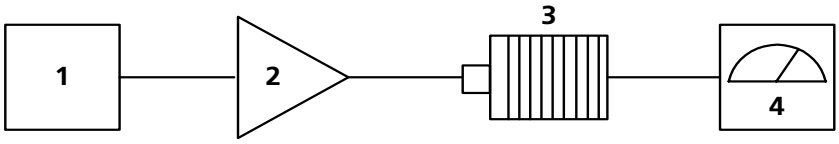
This is step three of calibrating the exciter.

Once you have tuned and calibrated the FCL, you should calibrate the VCO at frequencies across the band.

Equipment

- Tuning tool
- Calibration test unit (CTU)
- Modulation meter
- RF attenuator (only required if you are using a PA)

Setup



1	Reciter	**3**	RF attenuator (only required if using a PA)
2	PA (optional)	**4**	Modulation meter

To calibrate the VCO modulation

1. Ensure you are already connected to the reciter.
2. Select the Reciter Calibration tab, and double-click **VCO Calibration**.
3. Attach an appropriate Load and Modulation meter to the PA or exciter output, set the meter to measure the RMS deviation, and then click **Next**. (If you are using a PA, it will now transmit.)
4. Using the scale in the dialog box to help you, adjust the exciter lock band trimmer to center the exciter VCO on the sub-band indicated and then click **Next**.
5. For each of the seven frequencies shown, adjust the slider until the deviation shown on the modulation meter is 2121 Hz RMS. When you have finished, click **Next Band**.
6. For each sub-band repeat steps 4 and 5.
7. Click **Finish**. (If you are using a PA, it will now stop transmitting.)

When you have finished calibrating the VCO modulation, the icon on the Reciter Calibration tab indicates that this task is complete.

You should now adjust the exciter lock band because it was re-tuned several times during this procedure. This means that the exciter is no longer on the required frequency.

Calibrating the RSSI

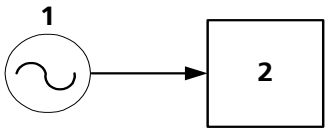
Calibrating the RSSI (received signal strength indicator) ensures that the reciter's internal RSSI values accurately reflect the actual received signal strength. Changing the receiver's lock band can alter the calibration accuracy by about 1 dB.

Note: Ensure that the receiver's lock band has already been adjusted to the required setting before carrying out this procedure. (See "Adjusting the Receiver Lock Band" on page 13.)

Equipment

- RF signal source

Setup



1 RF signal source

2 Reciter

To calibrate the RSSI

1. Ensure you are already connected to the reciter.
2. Select the Reciter Calibration tab, and double-click **RSSI Calibration**. The RSSI Calibration Wizard appears.
3. Apply a signal (modulated at 1 kHz tone, 3kHz deviation peak) at the base station's center frequency, and then click **Next**.
4. Set the RF input signal to a level of -80 dBm, and then click **Next**.
5. Vary the RF level, and check that the value shown in the RSSI Gain Setting box corresponds with the value shown on your test instrument. This is to make sure the RSSI is correctly calibrated. Click **Finish**.

When you have finished calibrating the RSSI, the icon on the Reciter Calibration tab indicates that this task is complete.

Audio Calibration

You should calibrate the audio outputs/inputs if the system interface has been replaced or changed at all.

Note: The balanced and unbalanced lines can be calibrated independently of each other.

Calibrating the Balanced Lines

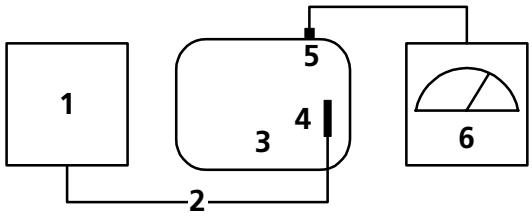
Calibrating the balanced lines adjusts their gain, so that when you set line levels using the TB8100 Service Kit software, the actual line level correctly reflects the Service Kit settings. (Refer to the *TB8100 Service Kit User's Manual* for further information.)

Equipment

- Calibration test unit (CTU)
- AC millivoltmeter

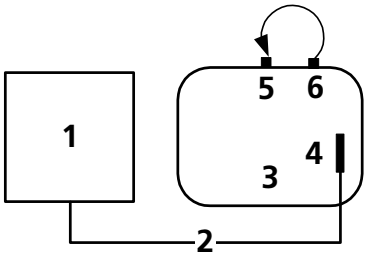
Important: If the reciter you are calibrating has either the product code TBA4xxx-0A0x or TBA5xxx-0A0x, its balanced line output is not transformer isolated. Ensure that the line meter you are using has a differential input otherwise the balanced line output will not be calibrated properly.

Setup for Balanced Line Out



1	Reciter	**3**	CTU	**5**	Line output
2	25-way cable	**4**	System interface port	**6**	AC millivoltmeter

Setup for Balanced Line In



1	Reciter	**3**	CTU	**5**	Line input
2	25-way cable	**4**	System interface port	**6**	Line output

To calibrate the balanced input and output lines

1. Ensure you are already connected to the reciter.

2. Select the Reciter Calibration tab, and double-click **Balanced Line Calibration**. The Balanced Line Calibration Wizard appears.
3. Attach an AC millivoltmeter and terminate the balanced output in 600 ohms (*either* using the load on the CTU *or* looping the balanced output to the balanced input), and then click **Next**.
4. Adjust the slider in the dialog box until the audio level on the millivoltmeter reads 1 VPP (0.354 VRMS) to calibrate the balanced line output, and then click **Next**.

Note: Click **Coarse** to roughly adjust the audio level, and once you get within range, click **Fine** for more precise control over the settings. To move up or down 10 mVPP, click either side of the slider bar.

The balanced output is now calibrated.

5. Ensure that the 600 ohm load on the CTU is turned *off*, and then connect the balanced output to the balanced input. Click **Finish**.

The balanced input is now calibrated.

When you have finished calibrating the balanced lines, the icon on the Reciter Calibration tab indicates that this task is complete.

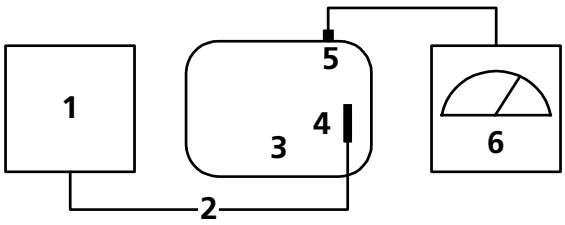
Calibrating the Unbalanced Lines

Calibrating the unbalanced lines adjusts their gain, so that when you set line levels using the TB8100 Service Kit software, the actual line level correctly reflects the Service Kit settings. (Refer to the *TB8100 Service Kit User's Manual* for further information.)

Equipment

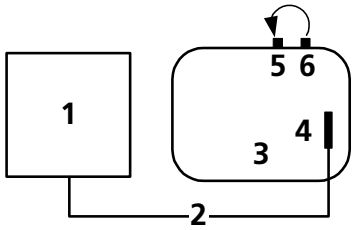
- Calibration test unit (CTU)
- AC millivoltmeter

Setup for Unbalanced Line Out



1	Reciter	**3**	CTU	**5**	Unbalanced line output
2	25-way cable	**4**	System interface port	**6**	AC millivoltmeter

Setup for Unbalanced Line In



1	Reciter	**3**	CTU	**5**	Unbalanced line input
2	25-way cable	**4**	System interface port	**6**	Unbalanced line output

To calibrate the unbalanced input and output lines

1. Ensure you are already connected to the reciter.
2. Select the Reciter Calibration tab, and double-click **Unbalanced Line Calibration**. The Unbalanced Line Calibration Wizard appears.
3. Attach an AC millivoltmeter to the unbalanced line output, and then click **Next**.
4. Adjust the slider in the dialog box until the audio level on the millivoltmeter reads 1 VPP (0.354 VRMS) to calibrate the unbalanced line output, and then click **Next**.

Note: Click **Coarse** to roughly adjust the audio level, and once you get within range, click **Fine** for more precise control over the settings. To move up or down 10 mVPP, click either side of the slider bar.

The unbalanced output is now calibrated.

5. Connect the unbalanced output to the unbalanced input, and then click **Finish**.

The unbalanced input is now calibrated.

When you have finished calibrating the unbalanced lines, the icon on the Reciter Calibration tab indicates that this task is complete.

Calibrating the TCXO

The TCXO (temperature compensated crystal oscillator) provides a reference frequency from which all other RF frequencies are derived.

You will need to calibrate the TCXO if you suspect that the reciter (specifically, the transmitter and receiver) is off-frequency. (Off-frequency is defined as being outside the range of -1 to +1 ppm.) This may occur for a variety of reasons. Over time the reciter frequency will become less accurate, so it is a good idea to calibrate the TCXO every few years. Exactly how often you do this will depend on the harshness of the conditions in which the base station is operating.

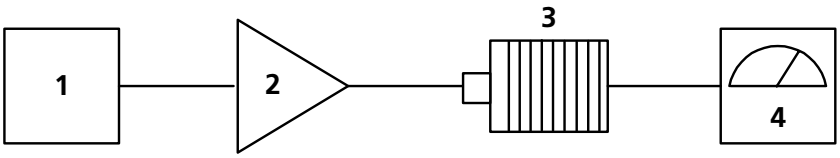
Ideally, you should calibrate the TCXO at a room temperature of 25 ±5 degrees Celsius. Complete the calibration as quickly as possible since extended transmission times increase temperature, which makes the calibration less accurate.

Equipment

- Frequency counter
- RF attenuator (only required if you are using a PA)

Important: The accuracy of the calibrated TCXO frequency is only as good as the accuracy of the frequency counter.

Setup



1	Reciter	**3**	RF Attenuator pad (optional)
2	PA (optional)	**4**	Frequency counter

To calibrate the TCXO

1. Ensure you are already connected to the reciter.
2. Select the Reciter Calibration tab, and double-click **TCXO Calibration**. The TCXO Calibration Wizard appears.
3. Attach an appropriate load and frequency counter (or a test set) to the exciter or PA output, and then click **Next**. (If you are using a PA, it will now transmit.)
4. Using the slider, adjust the TCXO until the actual frequency is exactly the same as the selected frequency value. Click **Coarse** to roughly (and quickly) adjust the output frequency, and then click **Fine** to fine-tune it. When you have finished, click **Finish**. (If you are using a PA, it will now stop transmitting.)

When you have finished calibrating the TCXO, the icon on the Reciter Calibration tab indicates that this task is complete.

Calibrating the Power Amplifier

The PA is fully calibrated in the factory, but if the PA is serviced you may need to perform the following procedures:

- Calibrating the PA Bias
- Calibrating the PA Power
- Calibrating the Forward and Reverse Detector Bias Voltages

Important: It is recommended that only accredited service centers and Tait engineers perform these procedures.

Note: The PA is calibrated by the microprocessor via the Calibration Kit. You do not need to make any manual adjustments.

The power amplifier (PA) receives the RF signal from the reciter and amplifies it to the required level, in watts, as requested by the reciter. The desired output power is determined by the reference voltage for the power control loop.

Calibrating the PA Bias

The driver and final transistors of the power amplifier must be biased at a constant current. Since the characteristics of individual transistors vary slightly, the bias current is calibrated for each device.

If either the driver or final transistor, or the PCB modules themselves, are replaced during servicing, you should perform this procedure to calibrate the bias current for the new device.

The bias current required for each amplifier stage is stored within the PA. During the calibration process, the microprocessor adjusts the gate bias voltage to obtain the required bias current for each stage.

The stage bias calibration sets up the amplifier's DC operating conditions. These DC conditions will be upset if there is RF present during calibration. It is therefore important to ensure that when you perform this procedure:

- RF is not connected to the PA input
- No other Calibration Wizards are running

To calibrate the PA stage bias current

1. Ensure you are already connected to the base station.
2. Select the PA Calibration tab, and double-click **Calibrate PA Bias**.
3. Ensure that the exciter RF is isolated from the PA by disconnecting the SMA connector on the PA front panel.
4. Select the individual stage that you want to calibrate or select **Calibrate**.
5. Click **Calibrate** to calibrate the PA bias.

Note: If any of the bias settings are not available, "Not Fitted" is shown.

When you have finished calibrating the power amplifier bias, the icon on the PA Calibration tab indicates that this task is complete.

Calibrating the PA Power

Important: *Before* you perform this procedure, you must calibrate the PA bias and the forward and reverse detector bias voltages.

The PA power control loop is calibrated at a single frequency, generally in the center of the operating band. Factory calibration is performed at 460 MHz.

You perform the calibration procedure to define—for each power level—the reference DAC (Digital-to-Analogue Converter) value and forward detector voltage.

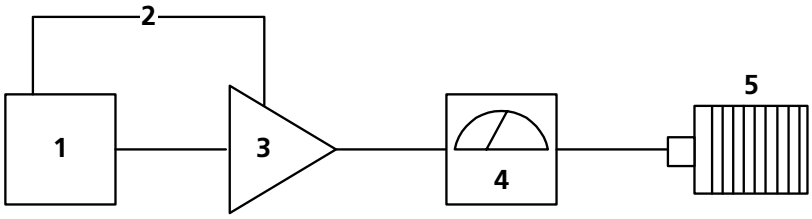
You should only need to re-calibrate the PA power if:

- The Low Pass Filter (LPF)/directional coupler PCB module is replaced
- Any repairs are carried out on the forward and reverse detector circuitry on the Low Pass Filter/directional coupler PCB module
- You require a more accurate power calibration on a specific frequency

Equipment

- *Either* an inline power meter and 50 ohm load with a high power rating, *or*
- A terminating power meter and appropriate 50 ohm attenuator with a high power rating

Setup for Inline Power Meter



1 Reciter **3** PA **5** Load
2 I^2C control bus **4** RF Power Meter

To calibrate the PA transmit power

1. Ensure you are already connected to the base station.
2. Select the PA Calibration tab, and select **Calibrate PA Power**.
3. Ensure that the power meter and a 50 ohm load (VSWR < 1.2:1) with a high power rating are connected to the power amplifier RF output, and then click **Next**.
4. Check that the PA RF input is connected to the reciter RF output, and that the PA and the reciter are connected by a control bus, and then click **Next**.
5. For each power level shown, use the slider to adjust the DAC setting to get the required power output, and then click **Next Power** to move to the next line.

Note: Click **Coarse** to roughly adjust the DAC setting, and once you get within range, click **Fine** for more precise control over the settings. To move up or down one DAC value, click either side of the slider bar.

Note: You must perform the calibration in sequence from the lowest to the highest step. The DAC setting must be greater than the previous one otherwise the value will not be stored in the PA, and you cannot move to the next line.

6. When you have completed adjusting the DAC settings, click **Finish**.

When you have finished, the icon on the PA Calibration tab indicates that this task is complete.

Troubleshooting Tips

DAC Settings

When you adjust the DAC settings, the values for the DAC Setting, Coupler Fwd Voltage, and Control Voltage should always increase as the power level increases. If these values do not increase, there is either a fault with the PA or the previous step was not calibrated correctly. If you make a mistake in the calibration table, you must start again from step 1.

Control Voltage

The Control Voltage is shown in the table to indicate the operation point within the power control loop. The range of the control voltage is from 0 V to 7.5 V. If the control voltage reaches its limit before achieving maximum power in the table, this indicates either a faulty gain stage in the PA or low RF input power to the PA.

VSWR

The VSWR (Voltage Standing Wave Ratio) is monitored at the RF output of the PA during calibration. The software will not allow calibration into a load VSWR > 1.3:1. If a calibration step cannot be stored, check that the load VSWR is <1.3:1. It is recommended that the load should have an input VSWR <1.2:1.

Calibrating the Forward and Reverse Detector Bias Voltages

The RF detectors, used for measuring the forward and reverse power, operate with a small bias current. The resulting bias voltage from each detector (with no RF present) is read and stored inside the PA. These voltages are used when calculating the Antenna VSWR (Voltage Standing Wave Ratio).

You should calibrate the forward and reverse detector bias voltages:

- If the Low Pass Filter (LPF)/directional coupler PCB module is replaced
- After servicing of any components in the detector circuitry (such as the detector diodes) on the LPF/ directional coupler PCB

To calibrate the forward and reverse detector bias voltages

1. Ensure you are already connected to the base station.
2. Select the PA Calibration tab, and double-click **Calibrate Fwd/Rev Detector Bias Voltages**.
3. Ensure that the PA is not transmitting and that there is no RF source present at the PA RF input or output by disconnecting the input SMA connector on the PA front panel and the 'N' type output connector from the rear of the PA. Click **Finish**.

When you have finished, the icon on the PA Calibration tab indicates that this task is complete.

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