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## TECHNICAL NOTE TN-1022-AN

### Configuring the TB7100 for Data Operation

20th June 2005

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#### Applicability

This application note applies to anyone wanting to configure the TB7100 for either Low Speed Data or Tait High Speed Data (THSD) in either a Repeater or R.F. modem configuration (using the internal software modems of the radio).

Radio firmware version 2.08 and TB7100 PC application version 1.04 or greater is recommended for data operation.

## 1. TB7100 Overview

At the core of the TB7100 base station are two TM8100 subassemblies, where one acts as the receiver and the other as the transmitter. These modules are connected to the System Interface (SIF) PCB, which provides an interface to other equipment and is used to configure the operating mode of the TB7100. Located on the front panel of the TB7100 is the User Interface, this includes several operating controls, status indicators and the programming port.

The TB7100 supports both THSD, with data speeds of 19.2kbps WB or 12kbps NB, and standard 1200 baud Fast Frequency Shift Keying (FFSK). THSD is enabled by default therefore no Software Feature Enable (SFE) key needs to be purchased.

The TB7100 can be configured as a data repeater or RF modem and is fully compatible with the TM8000 range of mobile radio equipment.

As a standard feature, the TM8110 and TM8115 mobiles come with an internal Digital Signal Processor (DSP) 1200-baud modem.

The 19200bps (19k2bps) option can only be used on wideband channels (25kHz) and is not available in some countries due to type approval restrictions. The 12000bps (12Kbps) option is designed for both narrow and wideband band systems.

The 1200-baud standard option uses the rugged FFSK modulation scheme.

The THSD option uses a 4 level frequency shift keying modulation scheme.

The TB7100 provides an RS232 9 pin serial port, which can be used as a high-speed data Interface for connection to a DTE. This is located on the System Interface Board and is accessible from the rear of the unit. In this configuration the TB7100 can be used as an R.F. modem.

The front serial port is used for programming only, using the T2000-A19 programming lead. Which module (Transmitter or receiver) is to be programmed is selectable using the TX/RX switch to the right of this port.

The TB7100 has a number of configurable parameters, which are configured using the TB7100 radio programming software. This technical note will cover how to configure the base station for data operation and also the options available within the programming software to suit your Data application.

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**NOTE:** This technical note assumes that the user has already configured the TM8000 mobile radio for data operation. For information on how to do this please refer to TN-919-AN - Configuring the TM8100 for data operation.

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## 2. Programming the TB7100 for Data Operation

The following are instructions on how to configure the Base Station for various formats of data operation.

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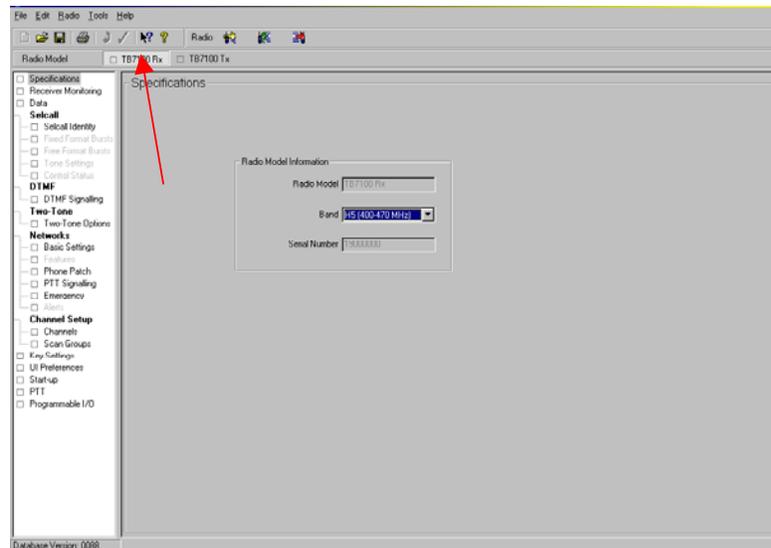
## 2.1 1200 Baud operation – R.F. Modem Configuration

This configuration will set the base station to operate as an R.F. modem operating at 1200-baud FFSK.

Any RS-232 serial data that is presented to the serial port on the SIF will be modulated and transmitted from the transmitter at 1200-baud FFSK. Any valid data received by the receiver will be output from this port as RS-232 serial data.

- **Programming the Receiver**

- Open the TB7100 Programming Application and select the 'TB7100RX' button at the top of the window as shown in **figure 1**.
- Use the 'Reset to Defaults' command under the 'File menu' to ensure all the mandatory and recommended settings are set to their correct default states.
- Set the 'Operating Band' of the radio in the 'Specifications' page also shown in **figure 1**.



**Figure 1**

- Enter in the RX channel information required under Channel Setup>Channels. No TX channel information is required. **Refer to figure 2.**
- While in the 'Channels form' select each channel then select the 'Detailed' tab and for each channel select the 'Use Channel For Data' check box.

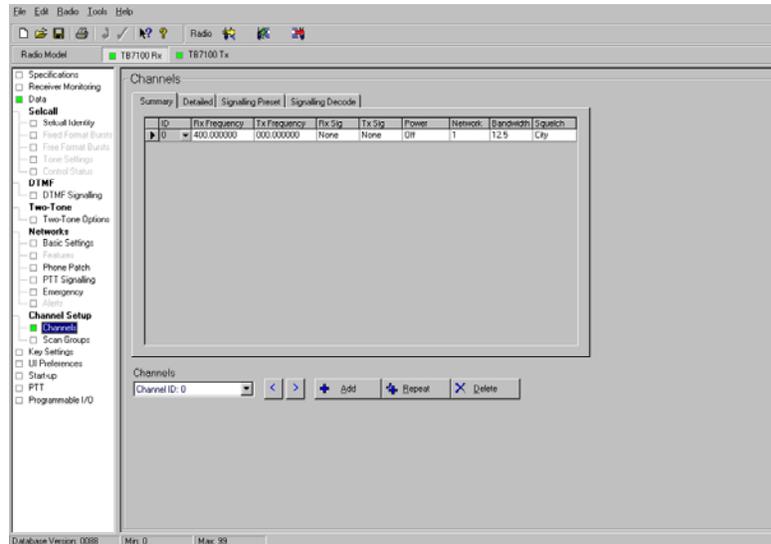


Figure 2

- Under Data>General set the 'Power up State' for FFSK transparent mode and select 'Transparent Mode Enabled'. Leave all other options unselected. Refer to figure 3.

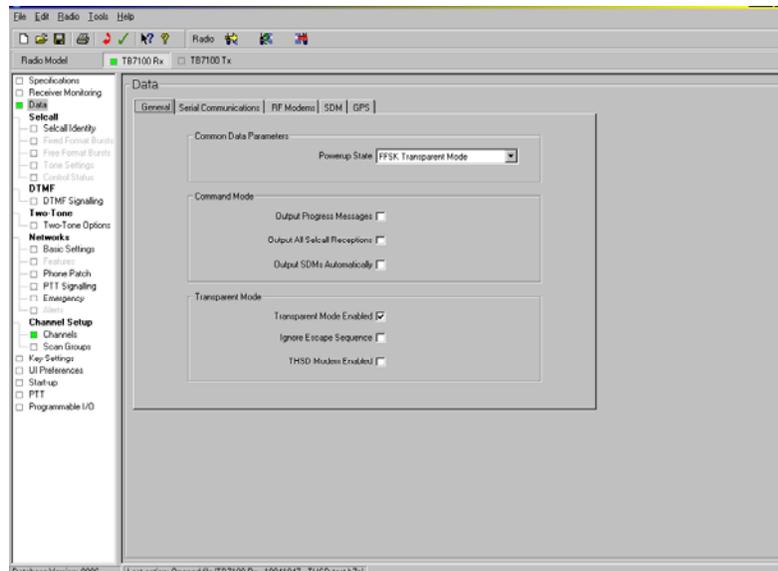


Figure 3

- Under Data>Serial Communications set the following parameters as in figure 4:
  - o 'Baud Rate' for FFSK transparent mode between the DTE and the DCE to 1200
  - o 'Flow Control' to None
  - o 'Data Port' to AUX

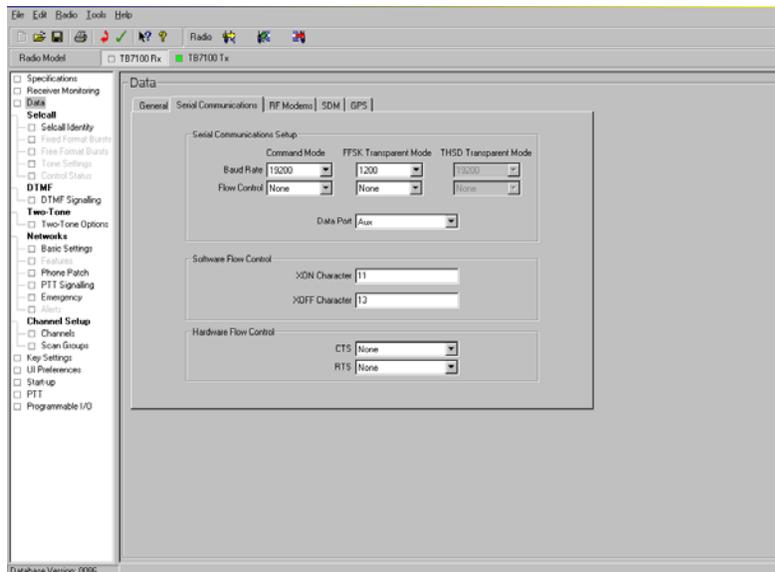


Figure 4

- Under Data> RF Modems set the following parameters as in **figure 5**:
  - o Select 'Check Packet Lengths'
  - o 'FFSK Lead-in Delay' to 500ms
  - o 'FFSK Lead-out Delay' to 200ms
  - o If CTCSS or DCS is not required then unselect 'Ignore CTCSS/DCS'
  - o Unselect 'FFSK Tone Blanking'

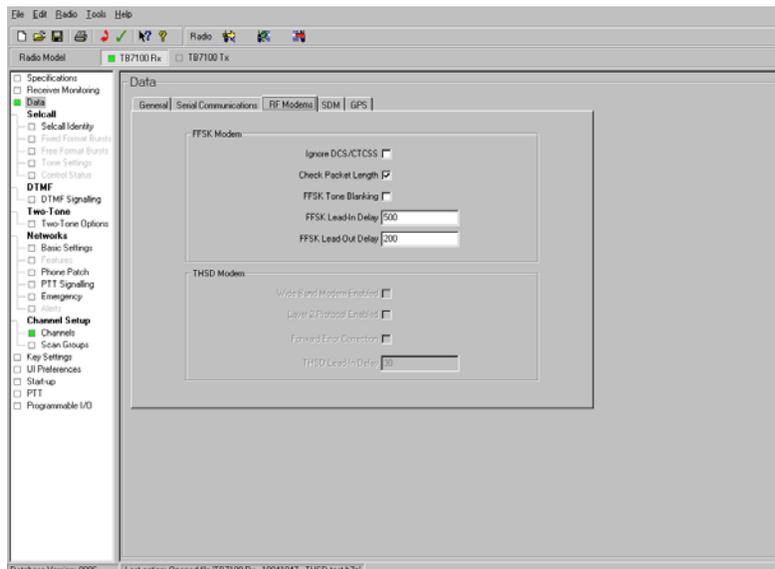
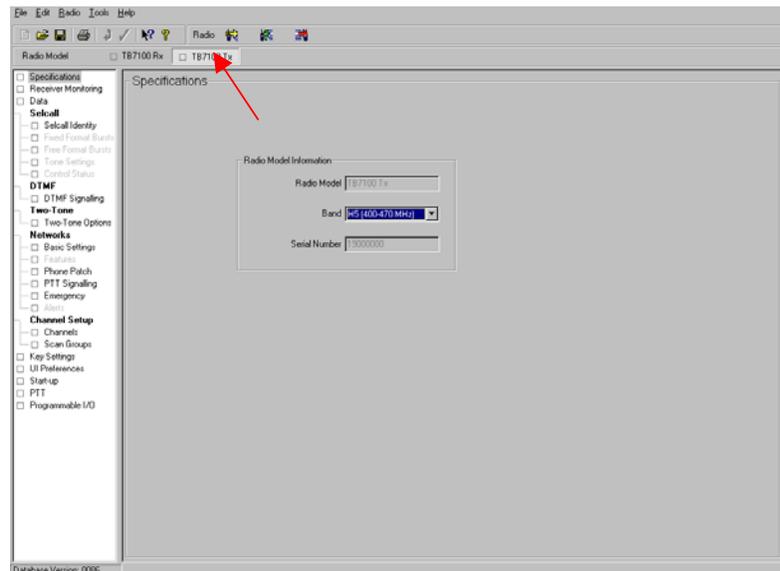


Figure 5

- If the 'Set to Defaults' option was used and there are no other options in the receiver that are required the receiver can now be programmed (Ensure the TX/RX switch on the front panel of the TB7100 is set to RX).

- **Programming the Transmitter**

- Open the TB7100 Programming Application and select the 'TB7100TX' button at the top of the window as shown in **figure 6**.
- Use the 'Reset to Defaults' command under the 'File menu' to ensure all the mandatory and recommended settings are set to their correct default states.
- Set the 'Operating Band' of the radio in the 'Specifications' page also shown in **figure 6**.



**Figure 6**

- Enter the TX Channel information required under channel Setup>Channels. No RX channel information is required. An RX frequency is not required but the 'Power' needs to be set for the required level. **Refer to figure 7**.
- While in the 'Channels form' select each channel then select the 'Detailed' tab and for each channel select the 'Use Channel For Data' check box.

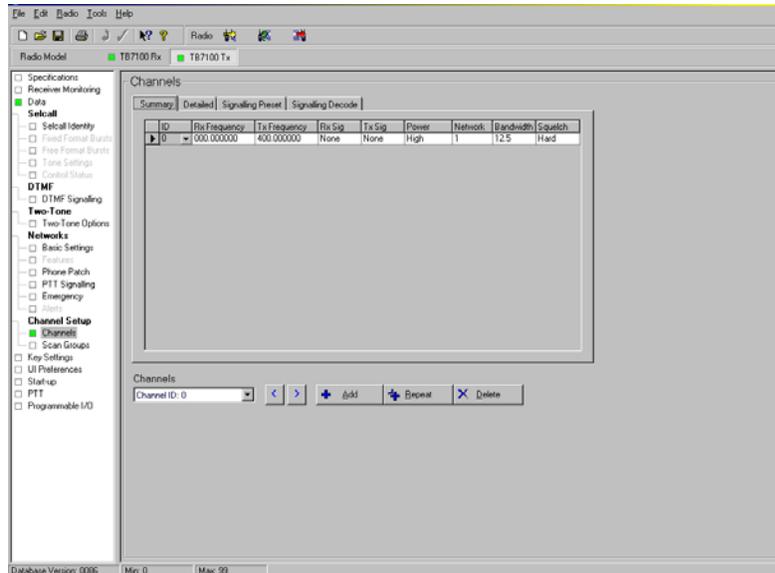


Figure 7

- Under Data>General set the 'Power up State' for 'FFSK Transparent Mode' and select 'Transparent Mode Enabled'. Leave all other options unselected. Refer to figure 8.

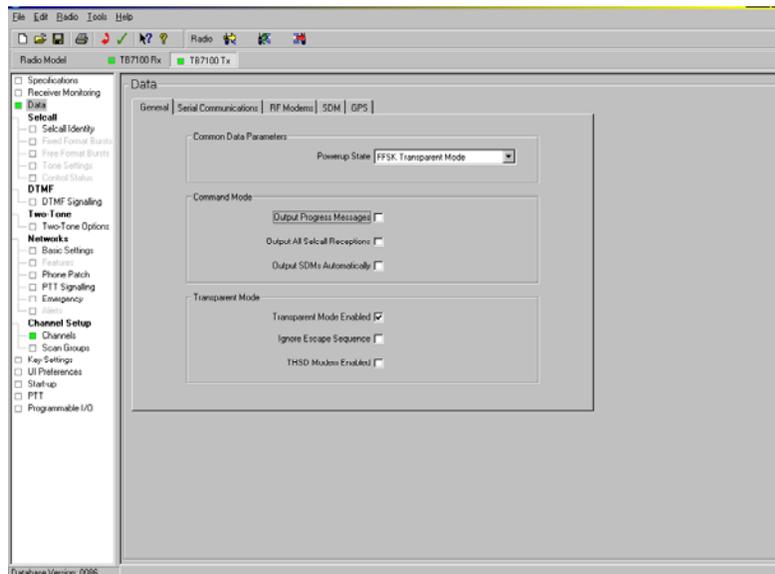


Figure 8

- Under Data>Serial Communications set the following parameters as in figure 9:
  - o 'Baud Rate' for FFSK transparent mode between the DTE and the DCE to 1200
  - o 'Flow Control' to None
  - o 'Data Port' to AUX

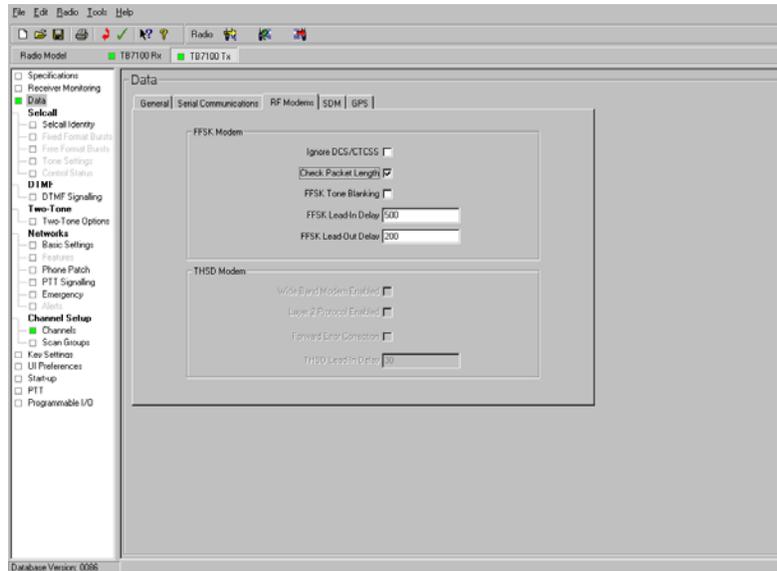


Figure 9

- Under Data> RF Modems set the following parameters as in **figure 10**
  - o Select 'Check Packet Lengths'
  - o 'FFSK Lead-in Delay' to 500ms
  - o 'FFSK Lead-out Delay' to 200ms
  - o If CTCSS or DCS is not required then unselect 'Ignore CTCSS/DCS'
  - o Unselect 'FFSK Tone Blanking'

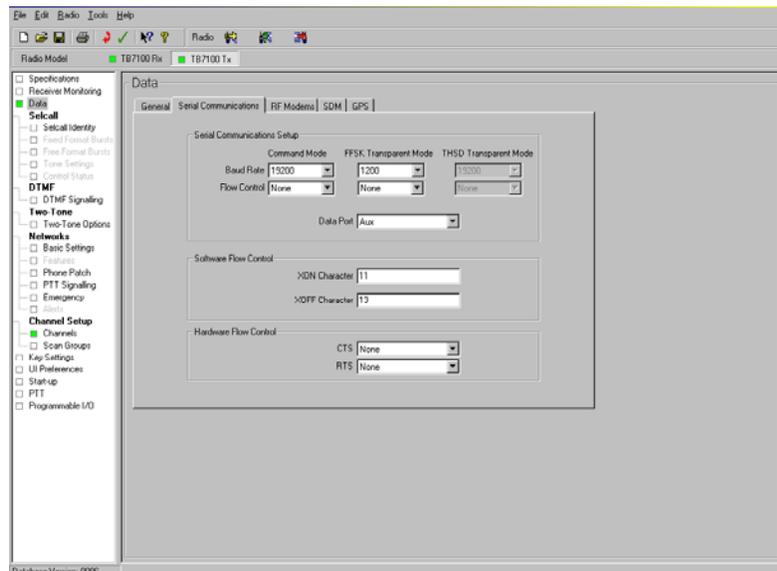


Figure 10

- If the 'Set to Defaults' option was used and there are no other options in the transmitter that are required the transmitter can now be programmed (Ensure the TX/RX switch on the Front Panel of the TB7100 is set to TX)
- Configure the Links on the SIF Board inside the TB7100 for Repeater operation as per **Table 1**

- **Link settings for the SIF Board**

<b>Link</b>	<b>Position</b>	<b>Function</b>
J221	1-2	Links RS232 data from the DTE directly to the transmitter's TX data line
J400	2-3	TX Key signal to control the transmission of the CWID

**Table 1**

## 2.2 1200 Baud FFSK – Repeater Operation

This configuration will set the base station to operate as a repeater for 1200-baud FFSK.

The TB7100 receiver will receive an FFSK signal.

It will then demodulate this signal and then send it to the transmitter via the SIF and the auxiliary connectors on the modules at 1200 baud.

The transmitter will then modulate this signal and re-transmit it as 1200-baud FFSK.

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**NOTE:** Any form of flow control is not required for this mode of operation as there is no direct communication with a DTE

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- **Programming the Receiver**

The configuration of the receiver in the TB7100 is the same as was detailed when the base station was operating as an RF modem (**See Section 2.1**).

- **Programming the Transmitter**

The configuration of the transmitter in the TB7100 is the same as was detailed when the Base station was operating as an RF modem (**See Section 2.1**).

- Configure the Links on the SIF Board inside the TB7100 for Repeater operation as per Table 2

- **Link settings for the SIF Board**

Link	Position	Function
J221	2-3	Links Aux RX Data line to Aux TX Data line
J400	2-3	Links RX Gate to TX Key to keyup the transmitter on receipt of a valid carrier

**Table 2**

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**NOTE:** On the transmission of larger text files, with the TB7100 in repeater mode, an 'Echo' may occur on the transmitting radio at the end of a transmission. An echo is described as where the last part of the transmission is received back by the transmitting radio.

This is due to the TB7100 still transmitting the last part of the data transmission after the transmitting radio has finished transmission and has switched back to receiver mode.

This needs to be considered when designing a system for data transmission through a repeater. A higher layer protocol may need to be used that incorporates headers and footers and also over the air flow control to overcome this echo seen at the DCE.

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## 2.3 THSD operation – R.F.Modem Configuration

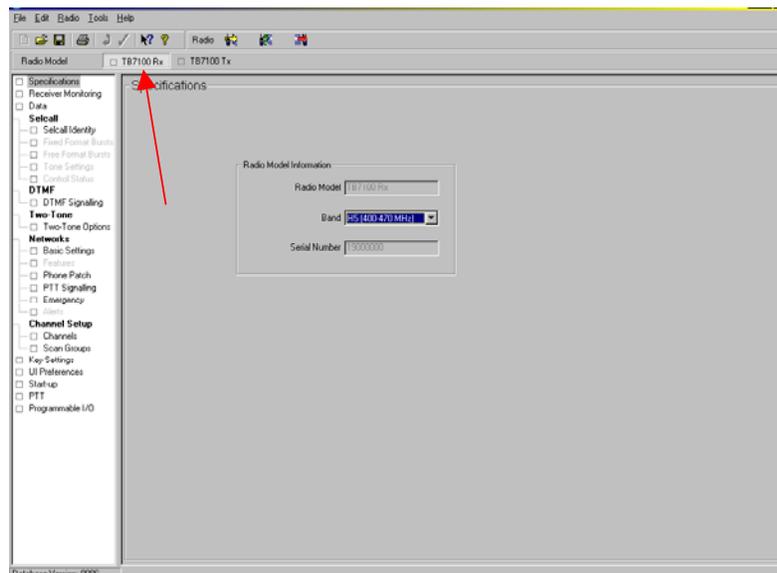
This configuration will setup the base station to operate as an R.F. modem operating at 19k2 (Wide Band THSD operation).

Any RS-232 serial data that is presented to the serial port on the SIF will be modulated and transmitted from the transmitter using THSD. Any valid data received by the receiver will be output from this port as RS-232 serial data.

For full duplex operation a TB7100 will be required at each end of the link.

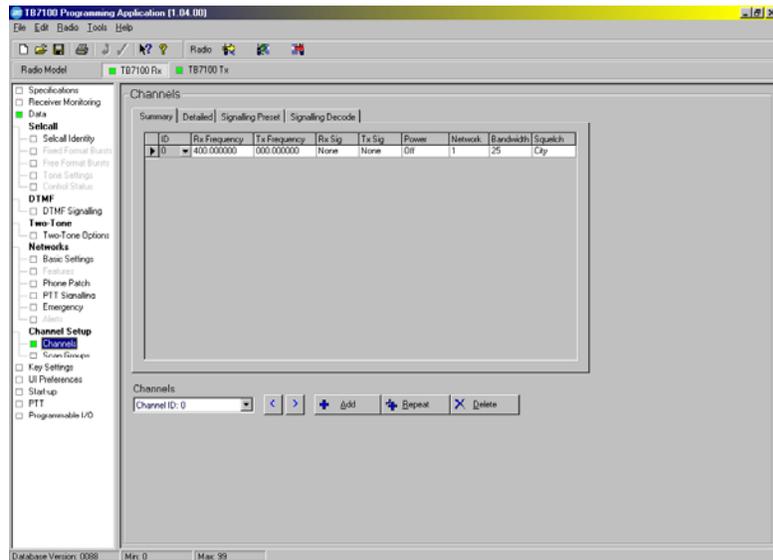
- **Programming the Receiver**

- Open the TB7100 programming application and select the 'TB7100RX' button at the top of the window as shown in **figure 11**
- Use the 'Reset to Defaults' command under the 'File menu' to ensure all the mandatory and recommended settings are set to their correct default states.
- Set the 'Operating Band' of the radio in the 'Specifications' page also shown in **figure 11**



**Figure 11**

- Enter in the RX channel information required under Channel Setup>Channels. No TX channel information is required. **Refer to figure 12.**
- While in the 'Channels' form select each channel then select the 'Detailed' tab and for each channel select the 'Use Channel For Data' check box.



**Figure 12**

- Under Data>General Only set the following parameters as shown in **figure 13**:
  - o Select 'Transparent Mode Enabled'
  - o Select 'THSD Modem Enabled'
  - o Select 'Powerup state' to 'THSD Transparent Mode'.

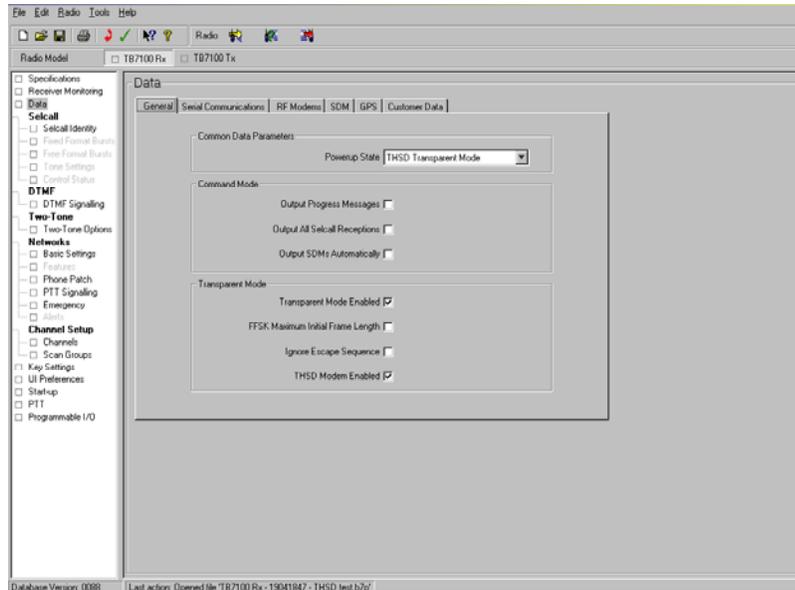


Figure 13

- Under Data>Serial Communications set the following parameters as in figure 14:
  - o Baud rate in the 'THSD Transparent Mode' field to 19k2. This baud Rate was chosen for this example because the radio is operating on a wide band channel.
  - o Refer to Section 2.5 for 'Hardware' flow control details. Select the required 'Data Port'.

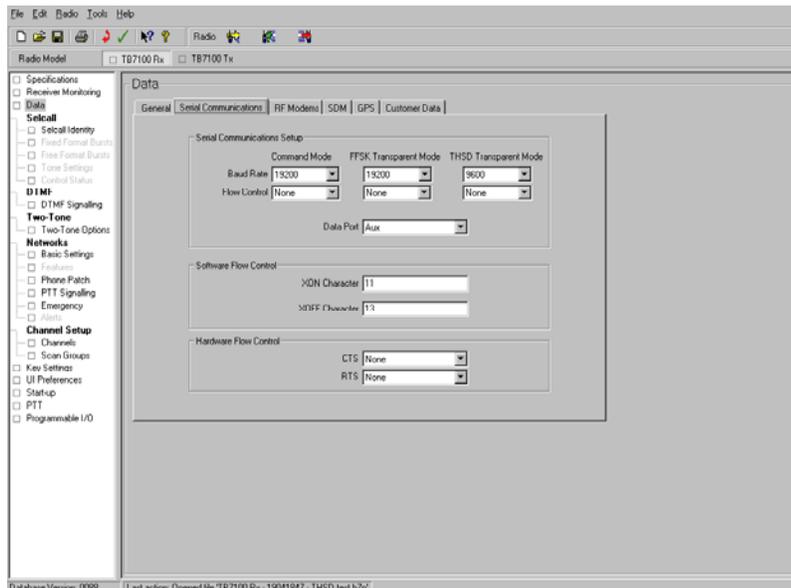
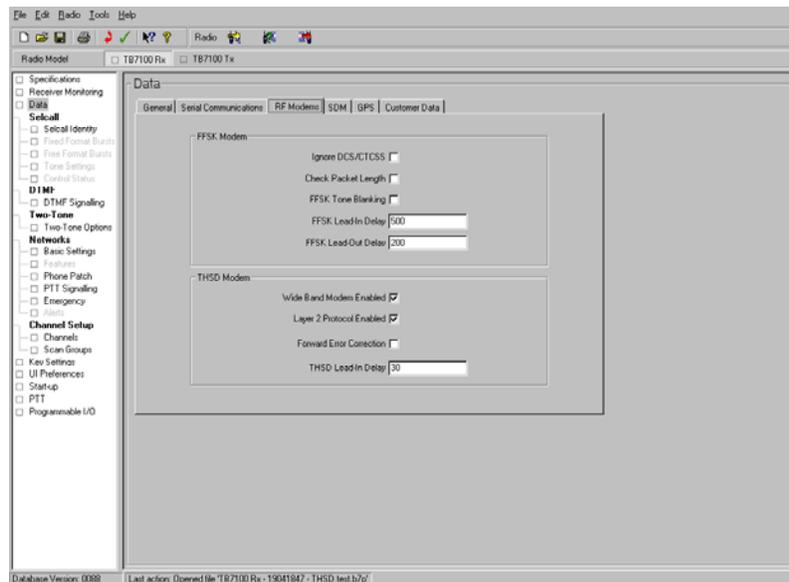


Figure 14

**NOTE:** The 19200bps (19k2bps) option is only enabled on wideband channels (25kHz) and the 12000bps (12kbps) on Narrow Band (12.5KHz) Channels. Therefore flow control may be required on the transmitting radio if the Serial Communication baud rate is equal to or higher than the 'Over the Air' baud Rate for the Channel bandwidth. For details on the supported flow control for the TB7100 and the selection of the correct Serial baud Rate refer to 'Baud Rate and Flow Control Settings' in **section 2.5** at the end of this Technical Note.

For more details on 'Over the Air' baud rates and THSD refer to 'TN855-AN TM8000 Internal Modem'

- Under Data>RF Modems set the following parameters as in **figure 15**. The FFSK modem settings do not apply and can be ignored.
  - o Select 'Wideband Modem Enabled'
  - o Select 'Layer 2 Protocol Enabled'



**Figure 15**

- If the 'Set to Defaults' option was used and there are no other options in the receiver that are required the receiver can now be programmed (Ensure the TX/RX switch on the front panel of the TB7100 is set to RX).
- Configure the links on the SIF board inside the TB7100 for 'RF Modem' operation as per **Table 3**

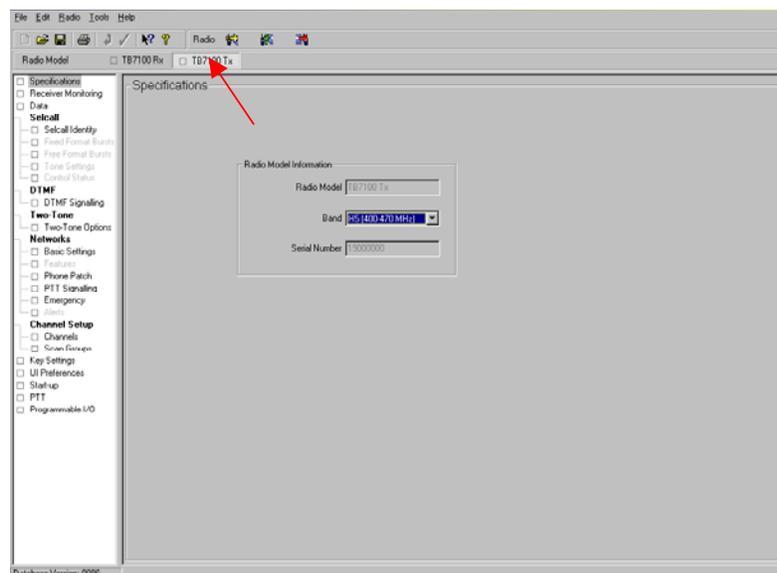
• **Link settings for the SIF board**

Link	Position	Function
J221	1-2	Links RS232 data from the DTE directly to the transmitter's TX data line
J400	2-3	TX Key signal to control the transmission of the CWID

**Table 3**

• **Programming the Transmitter**

- Open the TB7100 Programming Application and select the 'TB7100 TX' button at the top of the window as shown in **figure 16**.
- Use the 'Reset to Defaults' command under the 'File menu' to ensure all the mandatory and recommended settings are set to their correct default states.
- Set the 'Operating Band' of the radio in the 'Specifications' page also shown in **figure 16**.



**Figure 16**

- Enter the TX channel information required under channel Setup>Channels. No RX channel information is required.
- The TX 'Power' needs to be set to the required level.  
**Refer to figure 17.**
- While in the 'Channels Form' select each channel then select the 'Detailed' tab and for each channel select the 'Use Channel For Data' check box.

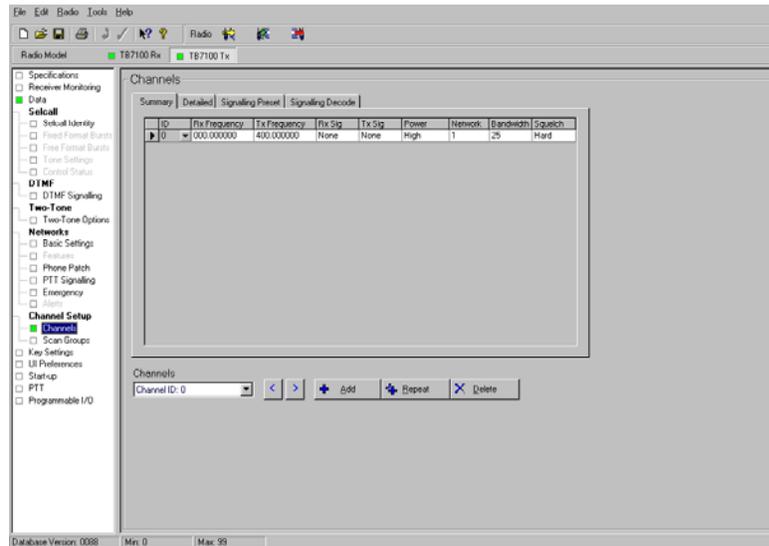


Figure 17

- Under Data>General Only set the following parameters as shown in **figure 18**:
  - o Select 'Transparent Mode Enabled'
  - o Select 'THSD Modem Enabled'
  - o Select 'Powerup state' to 'THSD Transparent Mode'.

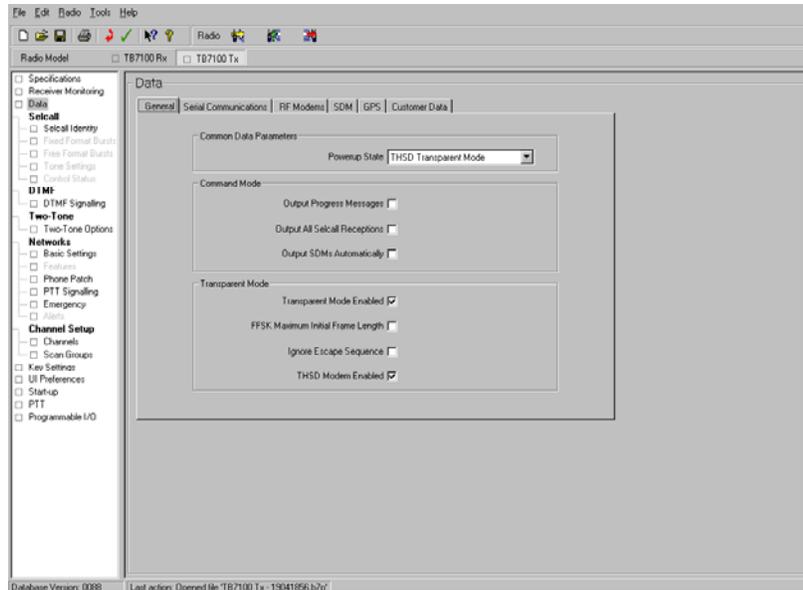


Figure 18

- Under Data>Serial Communications set the following parameters as in **figure 19**:
  - o baud rate in the 'THSD Transparent Mode' field to 19k2. This baud rate was chosen for this example because the radio is operating on a wide band channel.
  - o If required 'Hardware' flow control is setup on this page – **See section 2.5**
  - o Select the required 'Data Port'.

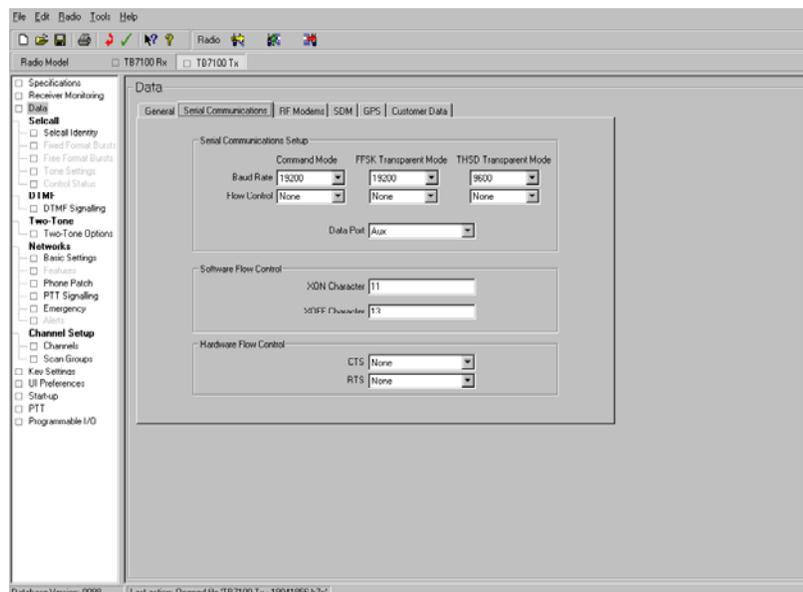


Figure 19

- Under Data>RF Modems set the following parameters as in
- **figure 20.** The FFSK modem settings do not apply and can be ignored.
  - o Select 'Wideband Modem Enabled'
  - o Select 'Layer 2 Protocol Enabled'
  - o THSD Lead-In Delay default of 30ms is acceptable

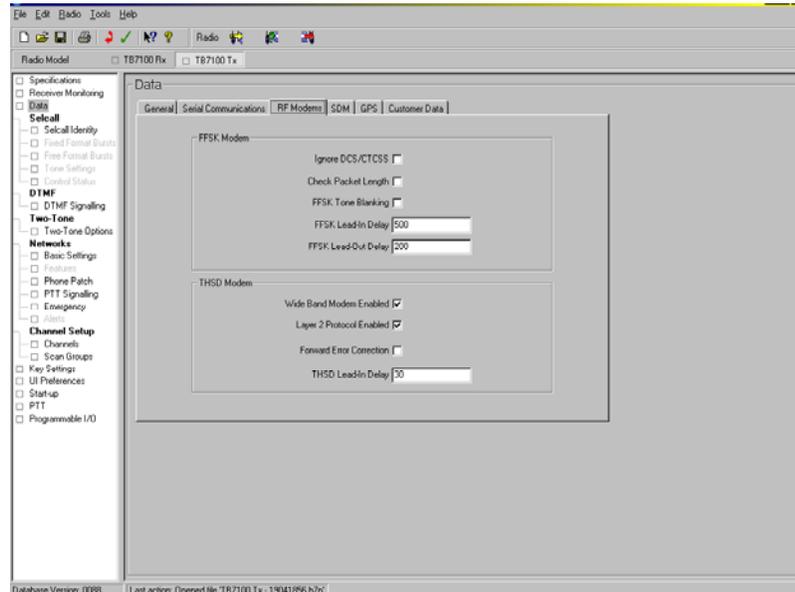


Figure 20

- If the 'Set to Defaults' option was used and there are no other options in the transmitter that are required the transmitter can now be programmed (Ensure the TX/RX switch on the Front Panel of the TB7100 is set to TX).

## 2.4 THSD – Repeater Operation

This configuration will set the base station to operate as a data repeater for 19k2 THSD for sending Text Files.

The TB7100 receiver will receive a signal modulated using THSD. It will then demodulate this signal and send it to the transmitter via the SIF and the auxiliary connectors on the modules at 19k2 baud.

The transmitter will then modulate this signal and re-transmit it as THSD.

For the transmission of binary files a higher Layer protocol may be required to overcome the Echo (Described in **section 2.2**) that is present when using a repeater. The requirement for the higher layer protocol is that it has the ability of ignoring or dumping packets that it is not expecting. This will then allow the echo to be ignored resulting in the passing of valid data between the terminals.

- **Programming the Receiver**

The configuration of the receiver in the TB7100 is the same as was detailed when the Base station was operating as an RF modem (**See Section 2.3**).

- **Programming the Transmitter**

The configuration of the transmitter in the TB7100 is the same as was detailed when the base station was operating as an RF modem (**See Section 2.3**).

- Configure the Links on the SIF Board inside the TB7100 for repeater operation as per Table 4

- **Link settings for the SIF Board**

Link	Position	Function
J221	2-3	Links Aux RX Data line to Aux TX Data line
J400	2-3	Links RX Gate to TX Key to keyup the transmitter on receipt of a valid carrier

**Table 4**

## 2.5 Baud Rate and Flow Control Settings

Different baud rates can be used between the DTE and the radio modem; from 1200 to 28800bps.

However, over-the-air data is always transmitted at 1200bps for the FFSK modem, and at 12kbps or 19k2bps for the THSD modem.

If the baud rate is programmed higher than the over-the-air rate, then flow control should be used to prevent buffer over-run.

In the FFSK examples in this document the baud rate is set to 1200 baud. For THSD 19k2 baud is used with Layer 2 protocol enabled but no forward error correction. Flow control is not used in any of the examples.

These settings can be changed. However, care must be taken to ensure that suitable values are chosen. The following short overview of the baud rate and flow control covers some of the important points to consider.

### - **Serial Port Baud Rate**

This baud rate is selected on the serial communications tab of the data form in the programming application. This baud rate is used between the TB7100 and the external equipment; it is not the over the air baud rate.

### • **Over The Air Baud Rate**

The over the air baud rate is the speed at which data is sent over the air by the TB7100. This is determined by the type of modulation being used:

- o The FFSK Transparent mode Over the Air baud rate is 1200 bps
- o The THSD over the air baud rate is determined by the channel bandwidth and is 19.2kbps for wideband and 12kbps for narrowband channels.

- **User Data Rate**

This is the speed that the data from the external equipment is transferred. The data is packetised by the TB7100 before being sent over the air, this means the user data rate will be less than the over the air baud rate; due to overheads in the packetisation process. The user data rate will also depend on the baud rate between the external equipment and the TB7100 and a number of other factors including:

- o The TB7100 RF modem setup (e.g. the number of higher layer protocols that are used).
- o The transmitter lead in delay for FFSK and THSD
- o The amount of data sent in each data transmission.
- o The time delay between each data transmission

- **Flow Control**

Flow control is an optional mechanism that can be used to prevent data loss if data is sent to the transmitter faster than it can be transmitted over the air.

The two types of flow control commonly supported by devices with RS-232 serial ports are software flow control and hardware flow control. The **TB7100 does not support software flow control** but does have limited support for hardware flow control. **Information about configuring hardware flow control will be available at a later stage and this technical note will be updated accordingly.** Flow control is optional and the TB7100 can be operated without flow control.

When operating a data connection without flow control the baud rate between the external equipment and the TB7100 may need to be reduced to less than the rate that the user data is sent over the air to prevent data loss between the DTE and the DCE (TB7100).

## 2.6 Glossary

This glossary contains a list of terms and abbreviations related to the TB7100 base station. For information about trunking, mobile, or portable terms, consult the glossary provided with the relevant documentation.

**Balanced line** A balanced line has two wires carrying equal and opposite signals. It is typically used in a line-connected base station for connecting to the dispatcher console. The system interface identifies the balanced line in as Rx+ and Rx-, and the balanced line out as Tx+ and Tx-.

**BCD** BCD (binary coded decimal) is a code in which a string of four binary digits represents a decimal number.

**Baud** is a unit of data transmission speed equal to the number of bits (or signal events) per second; 300 baud = 300 bits per second.

**Channel** A channel is:

1. A frequency pair (or just a single frequency in a simplex system).
2. A set of configuration information that defines the frequency pair and other settings. Also referred to as a channel configuration.

**Channel spacing** Channel spacing is the bandwidth that a channel nominally occupies. If a base station has a channel spacing of 12.5 kHz, there must be a separation of at least 12.5 kHz between its operating frequencies and those of any other equipment.

**Channel table** The channel table is the base station's database of channel configurations. To view it, select Configure > Base Station > Channel Table.

**Configuration file** is the file that consists of all the configuration settings needed for a base station, stored as a file in the configurations folder.

**CTCSS** (continuous tone controlled squelch system), also known as PL (private line) is a type of signaling that uses subaudible tones to segregate groups of users.

**CWID** (Continuous Wave Identification) is a method of automatically identifying the base station using a Morse code. Continuous wave means transmission of a signal with a single frequency that is either on or off, as opposed to a modulated carrier.

**DCE** (Data Communication Equipment) in this Technical note represents the TB7100

**DCS** (digital coded squelch), also known as DPL (digital private line), is a type of subaudible signaling used for segregating groups of users. DCS codes are identified by a three-digit octal number, which forms part of the continuously repeating codeword. When assigning DCS signaling for a channel, you specify the three-digit code.

**De-emphasis** is a process in the receiver that restores pre-emphasised audio to its original relative proportions.

**DTE** (Data Terminal Equipment) in most instances represents a computer.

**Duty cycle** Duty cycle is used in relation to the PA. It is the proportion of time (expressed as a percentage) during which the transmitter is operated.

**Frequency band** The range of frequencies that the equipment is capable of operating on.

**Front panel** is the front of the base station tray that has the vents for air intake and speaker sound. The user interface is also on the front panel.

**FFSK** (Fast Frequency Shift Keying) 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.

**Gating** is the process of opening and closing the receiver gate. When a valid signal is received, the receiver gate opens.

**Line-controlled base station** A TB7100 is a line-controlled base station when it receives audio (sending it out via its systems interface), transmits audio received over its systems interface, and its transmitter is keyed via the Tx Key line.

**Pre-emphasis** is a process in the transmitter that boosts higher audio frequencies.

**Reverse tone burst** Reverse tone bursts can be used with CTCSS. When reverse tone bursts are enabled, the phase of the generated tones is reversed for a number of cycles just before transmission ceases. If the receiver is configured for reverse tone burst, it responds by closing its gate.

**RSSI** RSSI (Received Signal Strength Indicator) is a level in dBm or volts that indicates the strength of the received signal.

**Subtone** (subaudible signaling tone) is a CTCSS tone or a DCS code

**Switching range** The switching range is the range of frequencies (about 10 MHz) that the equipment is tuned to operate on. This is a subset of the equipment's frequency band.

**System interface (SIF)** is the set of inputs to and outputs from the base station (excluding power and RF), provided by a module inside the tray.

**TB7100 Base Station** A Tait TB7100 base station consists of the equipment necessary to receive and transmit on one channel. Often abbreviated to TB7100 or base station.

**Talk Through Repeater** A TB7100 is a talk through repeater when its audio path is configured to pass the audio it receives on to the transmitter.

**Template file** A template file contains configuration information that can be used to create a new base station configuration. Template files have the extension \*.t7t.

**THSD** (Tait High Speed Data) modem uses a CP-4GFSK modulation scheme and is 19200bps on 25KHz channels and 12000bps on 12.5KHz channels

**Transmit lockout** The transmit lockout feature prevents the base station from transmitting for a time once the transmit timer has expired. It is designed to prevent users from monopolizing the base station.

**Unbalanced line** An unbalanced line has one wire earthed. It is typically used for short connections, for example, between a base station and a repeater on the same site. The system interface identifies the wires of unbalanced lines with Rx audio, TX audio, and audio ground. Audio ground is common to line in and line out.

<b>Compliance Issues</b>	None
<b>CSO Instruction</b>	Please inform Dealers and System Integrators involved in the configuration of the TB7100 for Data operation.

### 3. Issuing Authority

<b>Name and Position of Issuing Officer</b>	Malcolm Brown Senior Technical Support Engineer
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