TM8100 mobiles
TM8200 mobiles

3DK Hardware Developer's Kit Application Manual

MMA-00011-01
Issue 1a (TEA)
March 2006

Contact Information

Tait Radio Communications
Corporate Head Office

Tait Electronics Ltd
P.O. Box 1645
Christchurch
New Zealand

For the address and telephone number of regional offices, refer to the TaitWorld website:

Website: http://www.taitworld.com

Technical Support

For assistance with specific technical issues, contact Technical Support:

E-mail: support@taitworld.com
Website: http://support.taitworld.com

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Contents

Preface

Scope of Manual

This manual contains a description of the radio interfaces and information on how to integrate third-party products and create internal and control head options boards for TM8100 and TM8200 radios.

Purchase of the 3DK Hardware Developer's Kit entitles you to telephone support from your regional Tait service organisation (for telephone numbers refer to the TaitWorld website). Tait also offers the ability to log questions via the internet using the Tait FOCUS call management system. Please contact your local Tait service organisation for login details. The Tait FOCUS system allows you to raise technical enquiries directly on Tait via the Internet and view the progress of that issue through to resolution. This application allows you to contribute to the issue resolution and also to upload and download any required files to speed up the problem resolution process.

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Associated Documentation

The following associated documentation is available for this product:

- MMA-00002-**xx** TM8100 User's Guide
- MMA-00003-**xx** TM8200 User's Guide
- MMA-00028-**xx** TM8100/TM8200 Installation Guide
- MMA-00005-**xx** TM8100/TM8200 Service Manual
- MMA-00013-**xx** TMAA30-02 TM8000 3DK Application Board Service Manual
- MMA-00014-**xx** TMAA30-02 TM8000 3DK Application Board Software Manual

- MMA-00038-**xx** TM8100/TM8200 Computer-Controlled Data Interface (CCDI) Protocol Manual

The characters **xx** represent the issue number of the documentation.

- Technical Note TN-1075-AN MAP27 Implementation Form
- Technical Note TN-1110 USB to Serial Adaptors
- Tecnical Note TN-1140 TM8000 Horn Alert Setup

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.[1]

Publication Record

Issue	Publication Date	Description
1	March 2006	1st release

Alert Notices

Within this manual, four types of alerts are given to the reader: warning, caution, important, and note. The following paragraphs illustrate each type of alert and its associated symbol.

Warning!! **This alert is used when there is a potential risk of death or serious injury.**

Caution **This alert is used when there is the risk of minor or moderate injury to people.**

Important This alert is used to warn about the risk of equipment damage or malfunction.

Note This alert is used to highlight information that is required to ensure that procedures are performed correctly.

1. Technical notes are available in PDF format from the Tait support website. Consult your nearest Tait Dealer or Customer Service Organization for more information.

Abbreviations

Abbreviation	Description
3DK	Third-Party Developer's Kit
AGND	Analog Ground
ALC	Automatic Level Control
ANI	Automatic Number Identification
AUD	Audio
AUX	Auxiliary
BCD	Binary-Coded Decimal
BIN	Binary
BNC	Bayonet Neill Concelman (RF connector)
CCDI	Computer-Controlled Data Interface
CH	Control Head
CMOS	Complementary Metal Oxide Semiconductor
COM	Communication (Port)
CTS	Clear to Send
DGND	Digital Ground
DSP	Digital Signal Processor
DTE	Data Terminal Equipment
EMC	Electromagnetic Compatibility
ESD	Electrostatic Discharge
ESR	Equivalent Series Resistance
FFSK	Fast Frequency Shift Keying
GND	Ground
GPIO	General Purpose Input/Output
GPS	Global Positioning System
I/O	Input/Output
IOP	Internal Options Port
IPN	Internal Part Number
LED	Light-Emitting Diode
LK1…LK4	Hardware Link 1…4
LSB	Least Significant Bit
MB	Medium Band
MIC	Microphone
N/A	Not Applicable
NB	Narrow Band
NMEA	National Marine Electronics Association
OTAR	Over-the-Air Rekeying
PA	Power Amplifier
PCB	Printed Circuit Board
PRG	Program
PSU	Power Supply Unit
PTT	Press To Talk

Abbreviation	Description
RF	Radio Frequency
RSD	Rated System Deviation
RSSI	Received Signal Strength Indicator
RTS	Request to Send
Rx	Receive
RXD	Receive Data
S/N	Signal/Noise
SCADA	Supervisory Control and Data Acquisition
SDM	Short Data Message
SMD	Surface-Mounted Device
SPK	Speaker
THSD	Tait High Speed Data
TTL	Transistor-Transistor Logic
Tx	Transmit
TXD	Transmit Data
UART	Universal Asynchronous Receiver/Transmitter
USB	Universal Serial Bus
WB	Wide Band

1 Introduction

1.1 Overview

This manual provides you with the information required to:

- interface to the radio and configure the programmable I/O lines:
  - "Description of the Radio Interfaces" on page 13
  - "Programmable I/O Lines" on page 39
- build your own options boards:
  - "Creating Your Own Options Board" on page 97
- interface application devices:
  - "Description of the Radio Interfaces" on page 13
  - "Programmable I/O Lines" on page 39
  - "Connecting Third-Party Products" on page 109
- connect an external alarm to the radio:
  - "Connecting an External Alert Device" on page 129
- use Computer-Controlled Radio (CCR) commands to control a radio unit from Data Terminal Equipment:
  - "Computer-Controlled Radio" on page 133

Refer to the technical support website for the latest information on the integration of application devices (refer to "Tait Radio Communications Corporate Head Office" on page 2).

1.2 Serial Ports - Notice to all System Integrators

1.2.1 Serial Line Polarity in Tait Radios

The serial lines in all Tait radios are negative logic.

This means that a logic high is 0V and a logic low is 3V3, which is the same polarity as RS232, and is opposite to TTL/CMOS. No negative voltage is provided on these lines.

1.2.2 Line Lengths

The voltage levels in Tait radios are low and have been designed to drive limited cable lengths.

It is not recommended that a radio drive any line longer than 3.0m.

1.2.3 RS232 Compatibility

Although the serial port TXD line only changes from 0V to +3V3, it will drive most modern RS232 receivers satisfactorily, providing the cable length used is within the limit specified above.

The RXD input is capable of accepting signals up to the full RS232 levels.

1.2.4 RS232 Drivers

If full RS232 drive levels are required, or longer cable lengths are used, the TMAA01-05 Options-Extender Board should be fitted to the radio.

2 Description of the Radio Interfaces

This chapter describes the characteristics of the mechanical and electrical interfaces of the radio body and the various control heads that are suitable for the connection of TM8100/TM8200 or application accessories and equipment.

Figure 2.1 provides an overview of the radio interfaces:

Figure 2.1 Radio interfaces (with TM8115 control head)

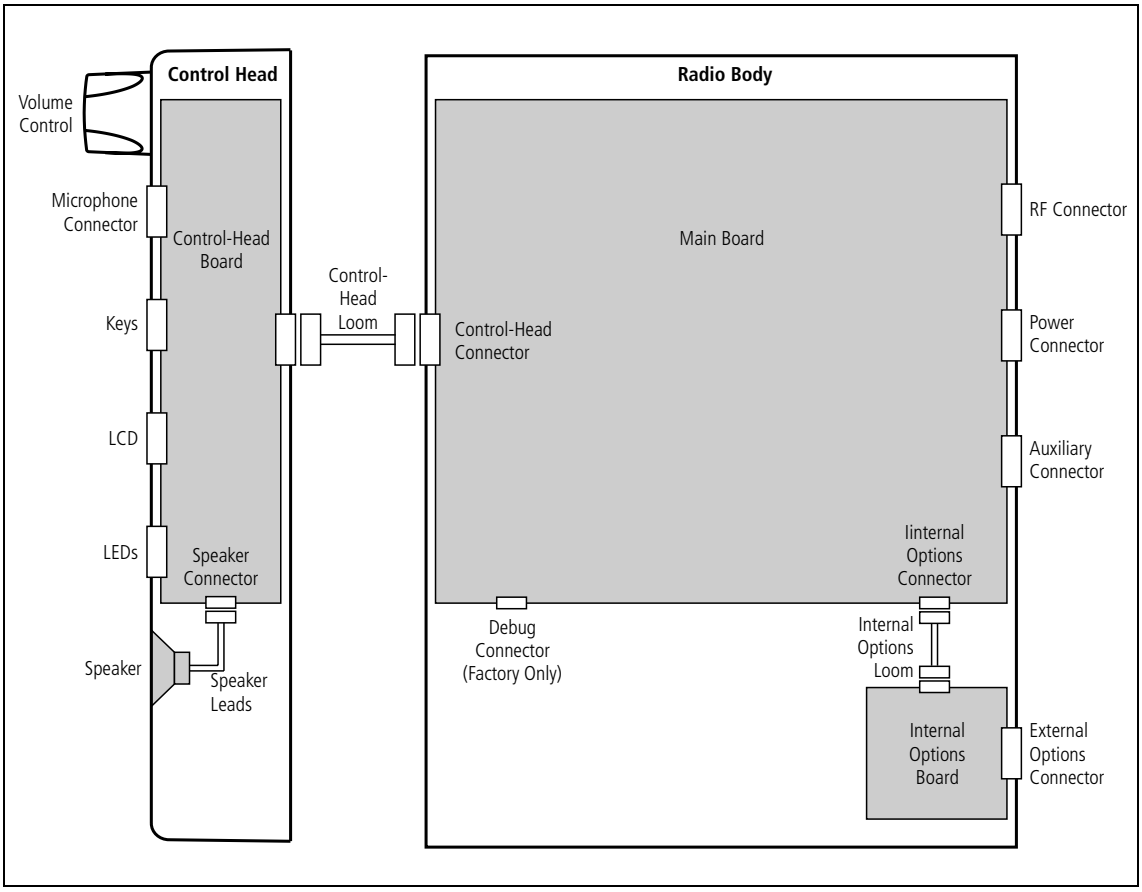


Figure 2.2 shows the connectors of the radio body.
Figure 2.3 shows the connectors of the TM8115 two-digit display control head. (The TM8110 one-digit display control head is the same as this, except that the LED display is only one digit wide.)
Figure 2.4 shows the connectors of the TM8105 blank control head.
Figure 2.5 shows the connectors of the TM8255 graphical-display control head.
Figure 2.6 shows the connectors of the TM8252 RJ45 control head.

For more block and circuit diagrams refer to the PCB information for your radio.

Figure 2.2 Connectors of the radio body

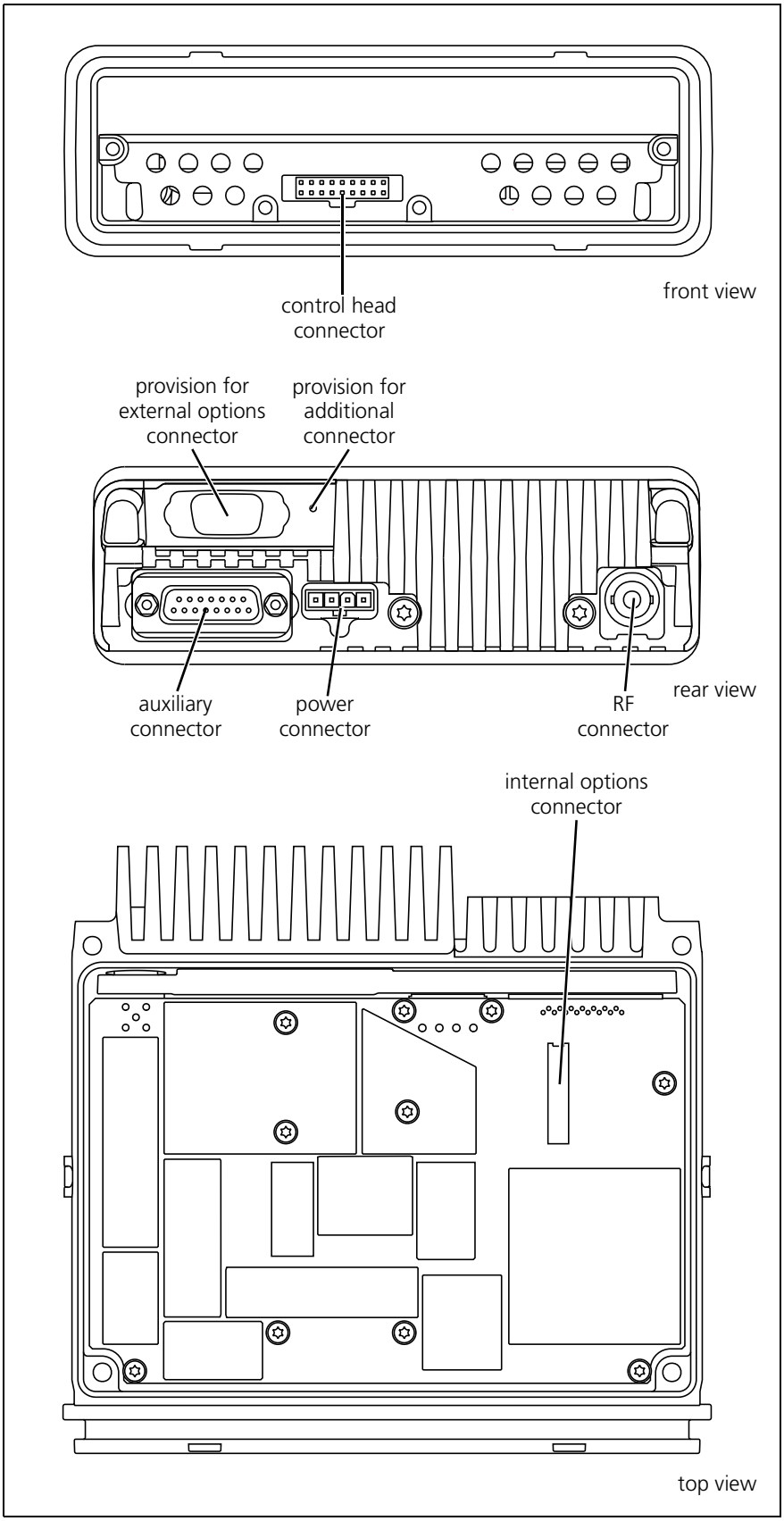


Figure 2.3 Connectors of the TM8115 two-digit display control head

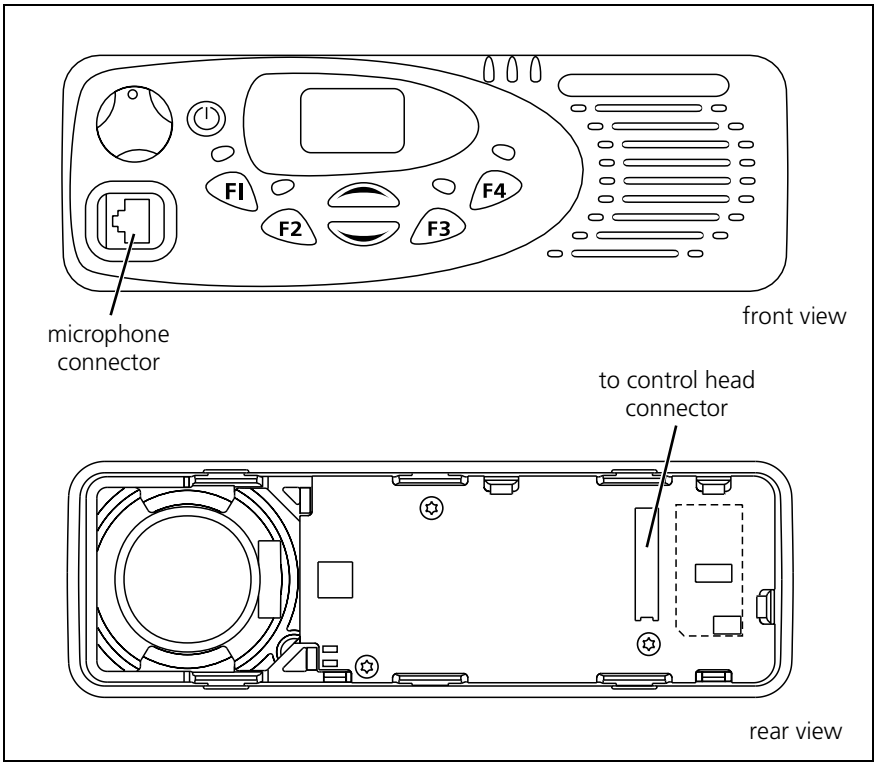


Figure 2.4 Connectors of the TM8105 blank control head

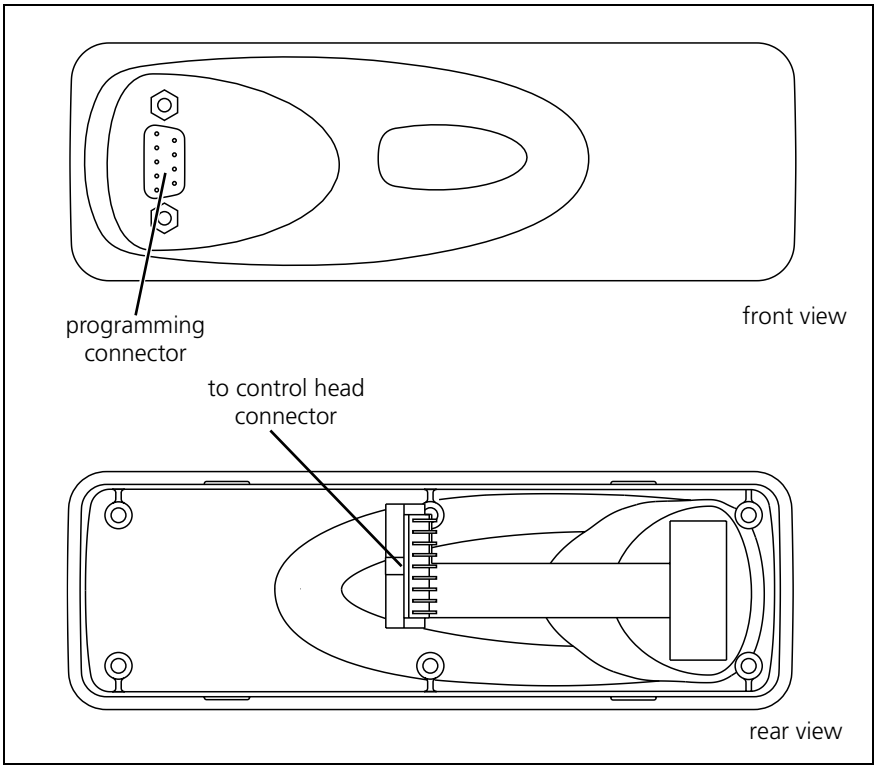


Figure 2.5 Connectors of the TM8200 graphical-display control head

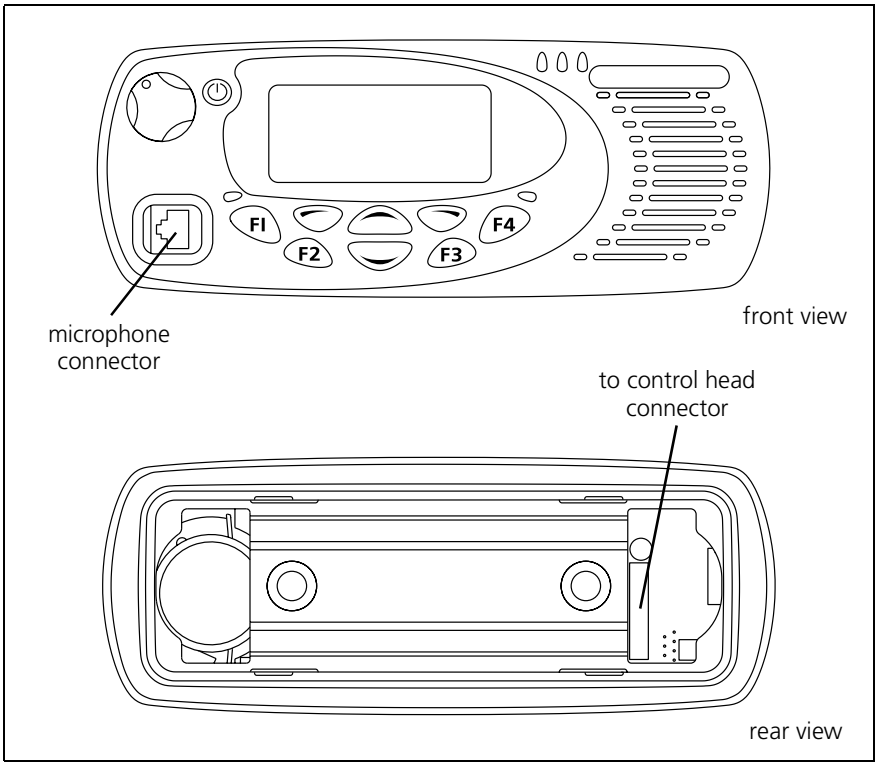
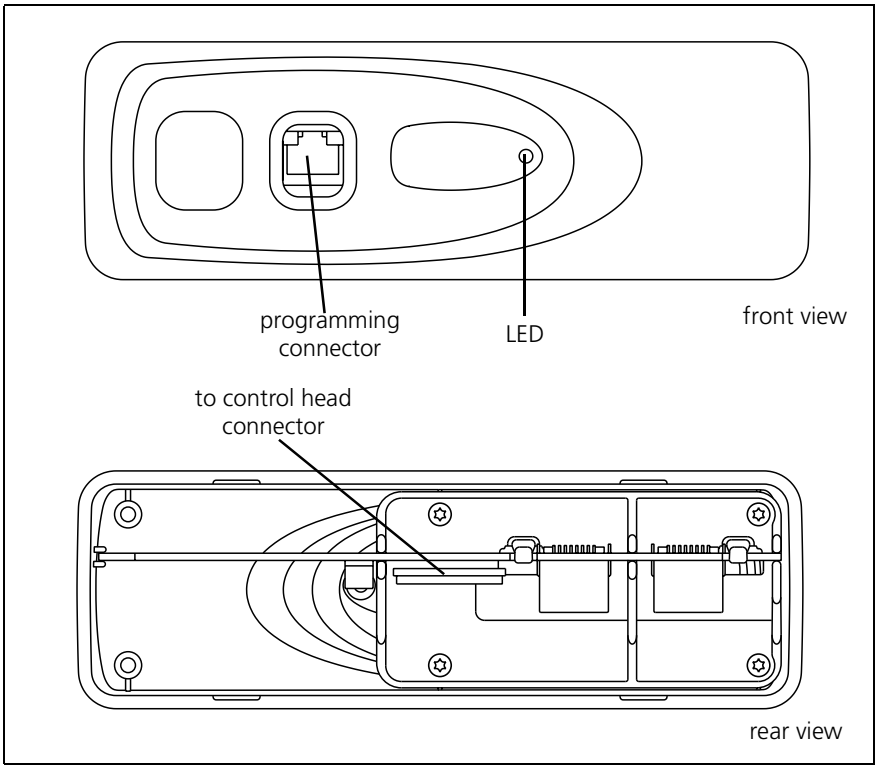


Figure 2.6 Connectors of the TM8252 RJ45 control head

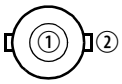


2.1 RF Connector

The RF connector is the primary RF interface to the antenna. The RF connector is either a standard BNC, or mini-UHF, or TNC socket with an impedance of 50Ω.

Important The maximum RF input level is +27dBm. Higher levels may damage the radio.

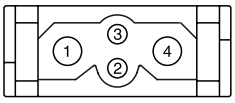
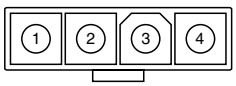
Table 2.1 RF connector - pins and signals

Pinout	Pin	Signal Name	Signal Type
 rear view	1	RF	RF analog
	2	GND	RF ground

2.2 Power Connector

The power connector is the interface for the primary 13.8V power source and the external speaker. The primary power source can be the vehicle battery or a mains-fed DC power supply. The power connector provides connection for an external speaker.

Table 2.2 Power connector - pins and signals

Pinout	Pin	Signal name	Description	Signal type
50W/40W  external view **25W**  external view	1	AGND	Earth return for radio body power source.	Ground
	2	SPK–	External speaker output. Balanced load configuration.	Analog
	3	SPK+	External speaker output. Balanced load configuration.	Analog
	4	13V8_BATT	DC power input for radio body and control head.	Power

Warning!! **Danger of Fire! The protection mechanisms in Table 2.3 rely on the correct fuses in both the negative and positive power supply leads being present. Failure to fit the correct fuses may result in fire or damage to the radio.**

Table 2.3 Power connector - power supply input characteristics

Parameter	Standard				Test method and conditions	Comments
	min.	typ.	max.	units		
Radio operating range[1][2]	9.7		17.2	V		
Auto-recovery limits[2]	10.2		16.8	V	After supply voltage excursion outside the radio operating range	
Safe input range[2][3]	–0.5		30	V	No hardware damage.	
Reverse polarity protection	Crowbar diode with in-line fuse					Refer to the Service Manual for details on replacing fuses.
Cranking earth current protection	In-line fuse with negative lead					

1. While the transceiver will operate over this range RF performance to specification applies over 10.8 to 16.0V.
2. Outside the radio operating range the radio will shutdown. Auto recovery will occur if the supply voltage returns to within the auto recovery limits specified. Depending on the power sense option selected, auto recovery may not occur if supply voltage drops below 4V prior to returning to within the auto recovery limits.
3. Application of steady state voltage higher than 30V will cause the crowbar diode (D600) to fail short circuit and in-line fuse to blow. The radio will survive transients above 30V within the 95/54/EC standard.

Important The speaker load configuration is balanced; the speaker output lines must **not** be connected to ground. Connecting a speaker output line to ground will cause audio power amplifier shutdown

Table 2.4 Power connector - speaker output characteristics

Parameter	Standard				Test method and conditions	Comments
	min.	typ.	max.	units		
Load configuration	Balanced					
Load	3.2			Ω		
Maximum power	10			W	Into 4Ω.	
Rated duty cycle			33	%	1min at maximum power: 2min Rx standby	
Rated audio power	3			W	Into 16Ω via external speaker port. Internal speaker is disconnected.	This is 'rated audio power' for the purposes of all external standards.

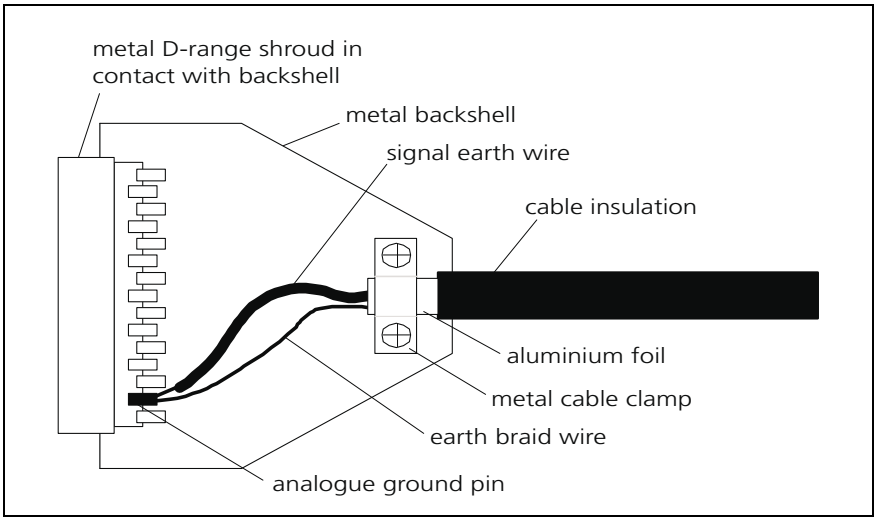
2.3 Auxiliary Connector

The auxiliary connector is the standard interface for external devices that are typically connected to a radio. The auxiliary connector is a 15-way standard-density D-range socket. The auxiliary connector provides a serial port, three programmable input lines, four programmable digital I/O lines and audio I/O.

Note The space for a mating plug is limited to 41mm in width and 18mm in height. Although most plugs will fit this space, it is recommended to test the plug to be used before manufacturing a cable. The internal options kit (described on page 101) includes a suitable plug (Tait IPN 240-00020-55).

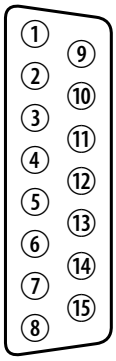
If the auxiliary cable is longer than 1 metre it is recommended that the cable and connector backshell be shielded. Figure 2.7 shows the recommended shielding arrangement. The earth braid wire (bare copper) and aluminium foil should only be earthed at the radio end of the cable.

Figure 2.7 Recommended auxiliary cable and connector shielding



The I/O lines can be programmed for a variety of functions, logic levels, and in some cases, direction (refer to "Programmable I/O Lines" on page 39). Audio lines can also be programmed to tap into, or out of, different points in the audio processing chain (refer to "Audio Tap In and Tap Out Lines" on page 91).

Table 2.5 Auxiliary connector - pins and signals

Pinout	Pin	Signal name	Description	Signal type
 rear view	12	AUX_GPI1	General purpose digital input. Programmable function.	Digital, 3V3 CMOS
	5	AUX_GPI2	General purpose digital input. Programmable function. With LK3 fitted, GPI2 is an emergency power sense input.[1]	Digital, 3V3 CMOS
	4	AUX_GPI3	General purpose digital input. Programmable function. With LK2 fitted, GPI3 is a power sense input.[1]	Digital, 3V3 CMOS
	10	AUX_GPIO4	Programmable function and direction. Pads available to fit a higher power driver transistor on GPIO4 line.[2]	Digital, 3V3 CMOS input; open collector output with pullup
	2	AUX_GPIO5		
	9	AUX_GPIO6		
	1	AUX_GPIO7		
	11	AUX_TXD	Asynchronous serial port - Transmit data	Digital, 3V3 CMOS
	3	AUX_RXD	Asynchronous serial port - Receive data	Digital, 3V3 CMOS
	7	AUD_TAP_IN	Programmable tap point into the Rx or Tx audio chain. DC-coupled.	Analog
	13	AUD_TAP_OUT	Programmable tap point out of the Rx or Tx audio chain. DC-coupled.	Analog
	14	AUX_MIC_AUD	Auxiliary microphone input. Electret microphone biasing provided. Dynamic microphones are not supported.	Analog
	6	RSSI	Analog RSSI output.	Analog
	8	+13V8_SW[3]	Switched 13.8V supply. Supply is switched off when radio body is switched off.	Power
	15	AGND	Analog ground	Ground

1. For more information on hardware links refer to the Service Manual.
2. For more information on high power drive refer to "Special Purpose Outputs" on page 73.
3. Can be switched or unswitched. For more information refer to the Service Manual.

Table 2.6 Auxiliary connector - DC characteristics

Parameter	Standard				Test method and conditions	Comments
	min.	typ.	max.	units		
Digital signals						
Input low level: All inputs AUX_GPI2			0.7 V_s–4	V V	No hardware links fitted[1]. LK3 fitted.	Includes AUX_GPI3 with LK1/2 fitted. Configured as emergency power sense input.
Input high level: All inputs AUX_GPI2 AUX_GPI3	1.7 V_s–1.5 2.6			V V V	No hardware links fitted[1]. LK3 fitted. LK1 and/or 2 fitted.	 Configured as emergency power sense input. Configured as power sense input.
Input low current: All other inputs AUX_GPI2 AUX_GPI3 AUX_RXD		–100	–120 –13[2] –500 –1	µA mA µA mA	No links fitted[1]. Default pullups[3]. LK3 fitted. V_s=13.8V LK1 and 2 fitted. –8V input.	Default pullup resistance is 33kΩ. Configured as emerg. power sense input. Configured as power sense input.
Input high current: AUX_RXD All other inputs			 1 10 100	 mA µA µA	No links fitted[1]. Default pullups[3]. +8V input. 3.3V input. 5V input.	Default pullup resistance is 33kΩ.
Output low level: AUX_GPIO4-7 AUX_TXD			50 600 200	mV mV mV	100µA sink current. 10mA sink current. 100µA sink current.	Current limit occurs at 20mA typ.
Output high level: AUX_GPIO4-7 AUX_TXD	3.1 2.4			V V	No load. Default pullups[3]. 3kΩ load.	
Safe DC input limits: AUX_GPI1-3 AUX_GPIO4-7 AUX_RXD AUX_TXD[4]	 –0.5 –0.5 –25V –10		 V_s+0.5 V_s+0.5 V_s+0.5 V_s+0.5	 V V V V		Input current must not exceed ±50mA. This is the rating of the clamping diodes.
Analog signals						
DC output range: RSSI 13V8_SW	 0 9.7		 3 17.2	 V V	 See Table 2.9 on page 23. Follows V_s.	 Output switches off outside this range.
DC bias: AUD_TAP_IN AUD_TAP_OUT AUX_MIC_AUD	 1.4 2.1 2.9	 1.5 2.3 3.0	 1.6 2.5 3.1	 V V V	 No load. Zero Rx frequency error. Via 2.2kΩ.	 Bias for electret microphone.
Input impedance: AUD_TAP_IN AUX_MIC_AUD	 50 2.1	 100 2.2	 150 2.3	 kΩ kΩ	 DC to 10kHz	
Output impedance: AUD_TAP_OUT RSSI	 590 950	 600 1000	 650 1050	 Ω Ω	 DC to 10kHz	
Safe DC input limits: AUD_TAP_IN AUD_TAP_OUT[4] AUX_MIC_AUD RSSI[4]	 –17 –0.5 –17 –17		 +17 +17 +17 +17	 V V V V		 Short circuit-safe. Input current <±20mA
Output load: 13V8_SW (switched) 13V8_SW (switched) 13V8_SW (unswitched) 13V8_SW (unswitched)			 1 2 1 2	 A A A A	 Continuous load Peak for <1sec Continuous load Peak for <1sec	Specification must be derated by the load amount drawn from the control head and internal options interfaces

1. For more information on hardware links refer to the service manual.
2. It is recommended that this input is driven by a mechanical switch or an open collector/drain output.

3. For more information on pullups refer to "Digital Input Lines" on page 39.
4. These outputs are protected against accidental input to the limits specified.

Table 2.7 Auxiliary connector - AC characteristics

Parameter	Standard				Test method and conditions	Comments
	min.	typ.	max.	units		
AUD_TAP_IN (refer to note 4)						
Nominal input level: Tap T3, T4, T5, T8, T9, T12 Tap T13 Tap R7, R10	 0.62 0.78 0.62	 0.69 0.87 0.69	 0.76 0.96 0.76	 V_{p-p} V_{p-p} V_{p-p}	 Level for 60% RSD@1kHz. Level for 3kHz dev.@1kHz. Refer to note 3.	Equivalent to –10dBm into 600Ω.
Full scale input level		2.0		V_{p-p}		
Frequency response: All tap-points	Refer to the plots in Table 2.10 and Table 2.11.					
Group delay - absolute: Tap T13 Tap T12 Tap T9 Tap T8 Tap T5 Tap T4 Tap T3	 	 1.8 1.8 6.6 9.6 11.6 11.7 11.7	 	 ms ms ms ms ms ms ms	At 1kHz. Refer to note 2. Refer to note 1. Refer to note 1.	
Group delay - distortion: Tap T12 and Tap T13	Refer to the plots in Table 2.12.					
AUD_TAP_OUT						
Nominal output level: All Rx tap-points except R1 Tap R1 Tap T3	 0.62 0.54 0.62	 0.69 0.60 0.69	 0.76 0.66 0.76	 V_{p-p} V_{p-p} V_{p-p}	Rload=600Ω. Level at 60% RSD@1kHz. Level at 3kHz dev.@1kHz Refer to "Microphone sensitivity"of AUX_MIC_AUD.	Equivalent to –10dBm into 600Ω.
Full scale output level		2.0		V_{p-p}	Rload=600Ω.	
Frequency response: All tap-points	Refer to the plots in Table 2.10 and Table 2.11.					
Group delay - absolute: Tap R1 Tap R2 Tap R4 Tap R5 Tap R7 Tap R10	 	 1.8 1.8 6.6 6.7 8.5 8.7	 	 ms ms ms ms ms ms	At 1kHz. Refer to note 2. Refer to note 1.	
Group delay - distortion: Tap R1 and Tap R2	Refer to the plots in Table 2.12.					
AUX_MIC_AUD						
Rated System Deviation NB MB WB	 –2.5 –4.0 –5.0	 	 +2.5 +4.0 +5.0	 kHz kHz kHz	EIA-603B	Units are peak frequency deviation from nominal carrier frequency in kHz.
Modulation frequency response	Refer to the plot in Table 2.13.				EIA-603B	
Microphone sensitivity	6.0	7.5	9.0	mV rms	EIA-603B	

Table 2.7 Notes:

1. Optional processing blocks are bypassed in the above specification.
2. For AUD_TAP_IN and AUD_TAP_OUT specifications the following signal paths apply:

Case	Input	Output
Tap into Rx chain	AUD_TAP_IN	RX_AUD
Tap out of Rx chain	Modulation at antenna	AUD_TAP_OUT
Tap into Tx chain	AUD_TAP_IN	Modulation at antenna
Tap out of Tx chain	AUX_MIC_AUD	AUD_TAP_OUT

3. For tap into the Rx path, nominal level refers to the level required to give output at RX_AUD that is same as the 60% dev level from the receiver. The level specified applies at 1 kHz only.
4. AUD_TAP_IN uses a DC-coupled analog-to-digital converter and the bias voltage specified in Table 2.6 should be used to maximise dynamic range. The DC bias is removed internally by a digital high-pass filter so the Tx carrier frequency will not be affected by any bias error. it is recommended to use external AC-coupling for applications which do not require modulation to very low frequencies.

Table 2.8 Auxiliary connector - data characteristics

Parameter	Standard				Test method and conditions	Comments
	min.	typ.	max.	units		
Serial port						
Baud rate:	1200, 2400, 4800, 9600, 14400, 19200, 28800			bit/s		All UART parameters are fixed and common to all UARTs except for the baud rate which is configurable and different for different modes/ applications
Data bits:	8					
Start bit:	1					
Stop bit:	1					
Parity:	None					
Protocol:	CCDI3					
Flow control: Software	XON/XOFF					
GPIO						
Delays: I/O mirror to IOP UI key delay			500 50	µs ms		

Table 2.9 RSSI voltage vs. signal strength

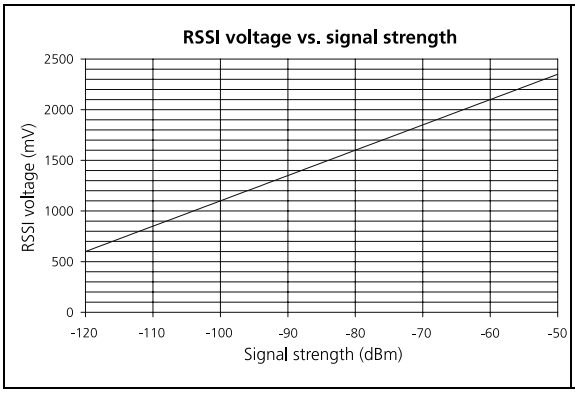
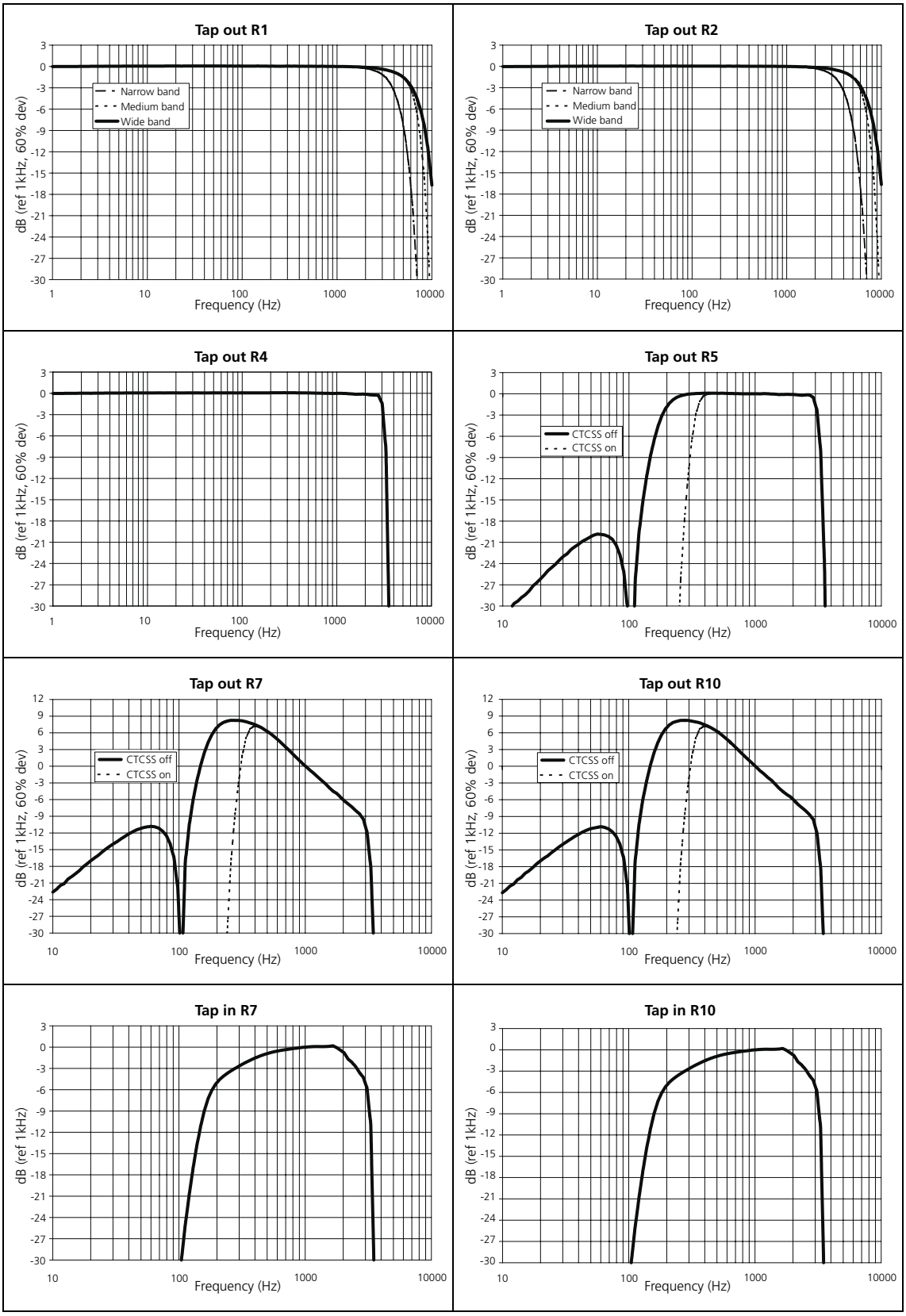


Table 2.10 Rx path tap frequency response plots



Note Audio response output is based on testing at 60% deviation.

Table 2.11 Tx path tap frequency response plots

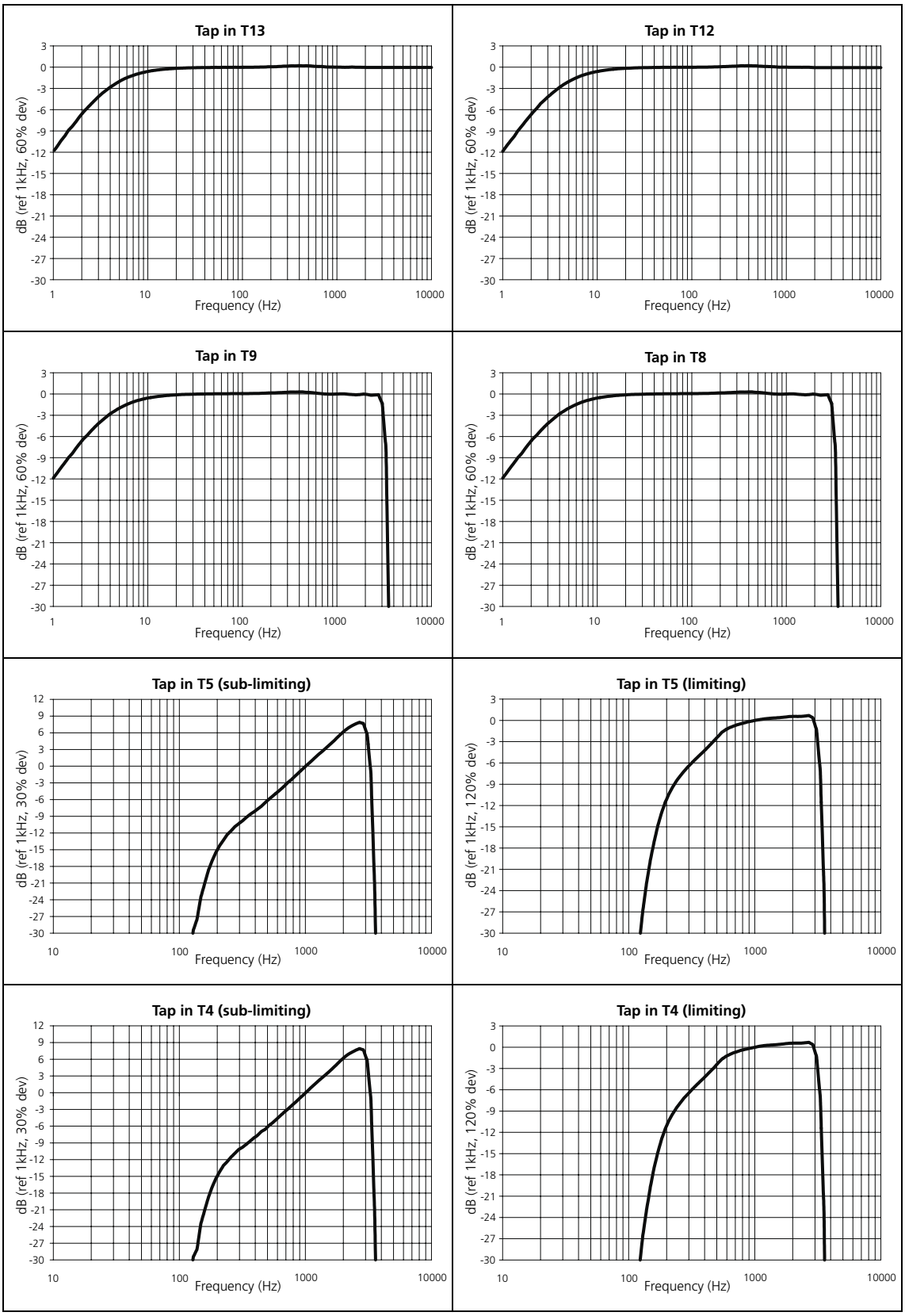


Table 2.11 Tx path tap frequency response plots (Continued)

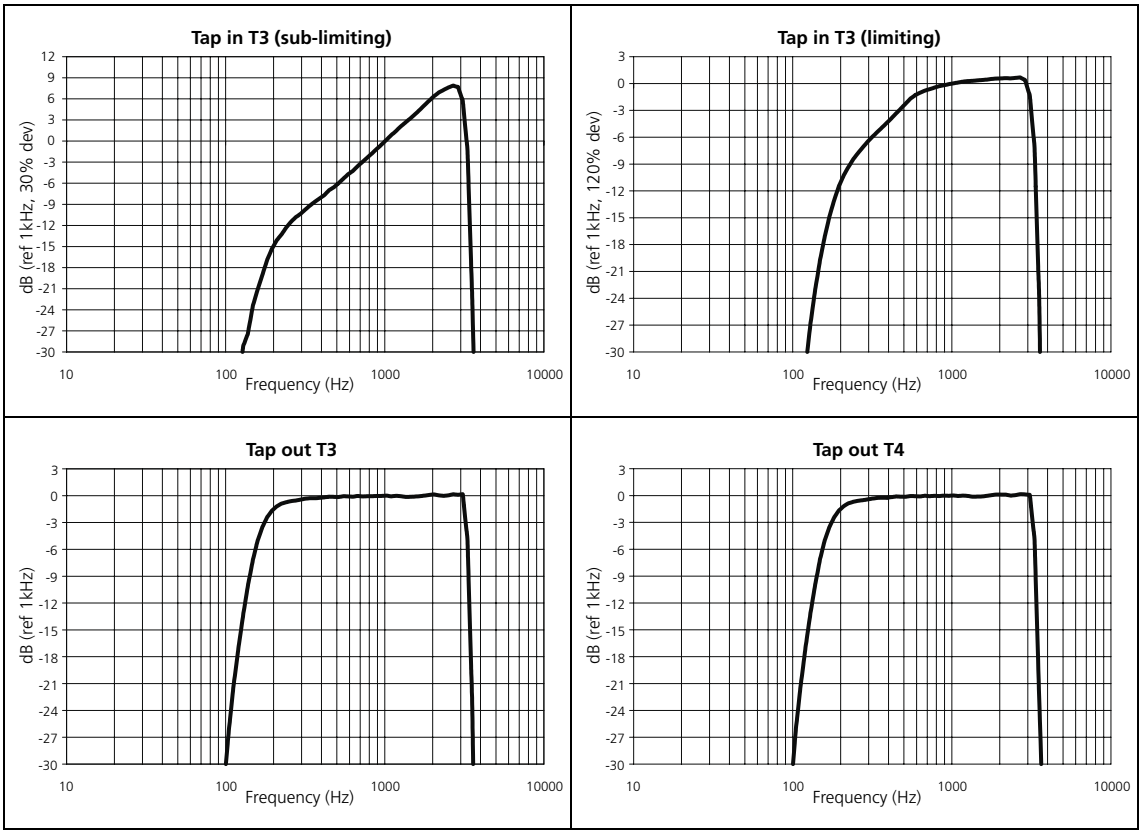


Table 2.12 Group delay distortion frequency response plots

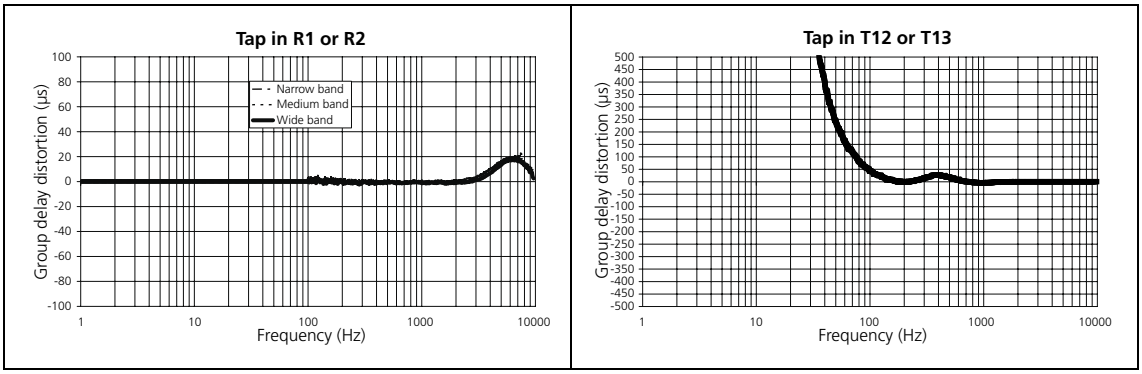
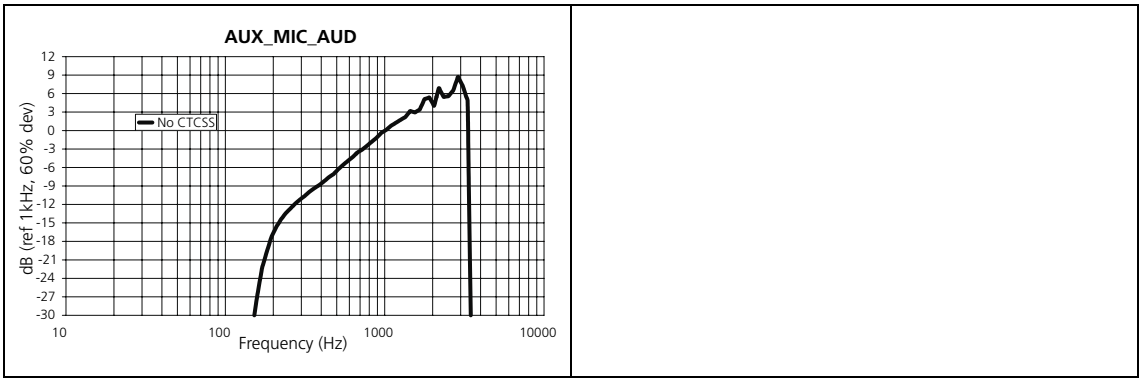


Table 2.13 AUX_MIC_AUD frequency response plot



2.4 Internal Options Connector

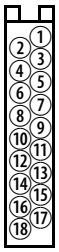
When installing an internal options board, the internal options connector is the electrical interface to the main board of the radio body.
The internal options connector provides similar I/O to the auxiliary connector. The digital signals and the serial port are independent of the auxiliary connector signals, but the AUD_TAP_IN, AUD_TAP_OUT, AUX_MIC_AUD, and RSSI signals are shared with the auxiliary connector. The internal options connector is an 18-pin 0.1in pitch Micro-MaTch connector.

Examples of internal options boards:

- TMAA30-02 3DK Application Board.
  Refer to the TM8000 3DK Application Board Service Manual.
- TMAA01-01 Line-Interface Board.
  Refer to the TM8100/TM8200 Service Manual.
- TMAA01-05 Options Extender Board.
  Refer to the TM8100/TM8200 Service Manual.

For information on how to create your own internal options board, refer to "Internal Options Board" on page 97.

Table 2.14 Internal options connector - pins and signals

Pinout	Pin	Signal	Description	Signal type
 top view	1	13V8_SW[1]	Switched 13V8 supply. Supply is switched off when the Radio Body is switched off.	Power
	2	AUD_TAP_OUT	Programmable tap point out of the Rx or Tx audio chain. DC-coupled.	Analog
	3	AGND	Analog ground.	Ground
	4	AUX_MIC_AUD	Auxiliary microphone input. Electret microphone biasing provided. Dynamic microphones are not supported.	Analog
	5	RX_BEEP_IN	Receive sidetone input. AC-coupled.	Analog
	6	AUD_TAP_IN	Programmable tap point into the Rx or Tx audio chain. DC-coupled.	Analog
	7	RX_AUD	Receive audio output. Post volume control. AC-coupled.	Analog
	8	RSSI	Analog RSSI output.	Analog
	9…15	IOP_GPIO1…7	Programmable function and direction. With LK4 fitted, GPIO7 is a power sense input[2].	Digital. 3V3 CMOS
	16	DGND	Digital ground.	Ground
	17	IOP_RXD	Asynchronous serial port - Receive data.	Digital. 3V3 CMOS
	18	IOP_TXD	Asynchronous serial port - Transmit data.	Digital. 3V3 CMOS

1. Can be switched or unswitched. For more information refer to the service manual.
2. For more information on hardware links refer to the service manual.

Important The digital I/O signals are intended to interface directly with compatible logic signals only. Do not connect these signals to external devices without appropriate signal conditioning and ESD protection.

Table 2.15 Internal options connector - DC characteristics

Parameter	Standard				Test method and conditions	Comments
	min.	typ.	max.	units		
Digital signals						
Input low level: All inputs			0.7	V	No hardware links fitted[1].	Also applies to IOP_GPIO7 with LK4 fitted.
Input high level: All inputs IOP_GPIO7	 1.7 2.8			 V V	 No hardware links fitted. LK4 fitted[1].	 Configured as power sense input.
Input low current: All inputs		–100	–120	µA	No hardware links fitted[1].	Also applies to IOP_GPIO7 with LK4 fitted.
Input high current: All inputs IOP_GPIO7			 10 1500 250	 µA µA µA	 3.3V input. 5V input. 3.3V input. LK4 fitted[1].	 Configured as power sense input.
Output low level: All outputs			120	mV	100µA sink current.	1kΩ series R on all outputs.
Output high level: All outputs	3.1			V	100µA source current.	1kΩ series R on all outputs.
Safe DC input limits: All inputs/outputs	–0.5		+5.5	V		Input current must not exceed ±10mA.
Analog signals (for signals not listed here refer to the auxiliary connector specification)						
Safe DC input limits: RX_AUD RX_BEEP_IN	 –17 –17		 +7 +17	 V V		
Output load: 13V8_SW (switched) 13V8_SW (switched) 13V8_SW (unswitched) 13V8_SW (unswitched)			 1 2 1 2	 A A A A	 Continuous load Peak for <1sec Continuous load Peak for <1sec	Specification must be derated by the load amount drawn from the control head and auxiliary interfaces. See Service Manual.

1. For more information on hardware links refer to the service manual.

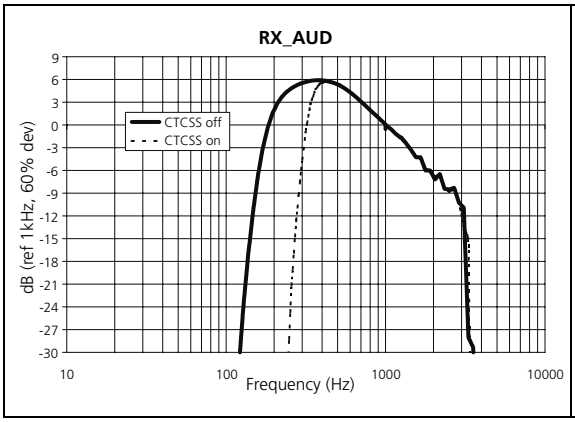
Table 2.16 Internal options connector - AC characteristics

Parameter	Standard				Test method and conditions	Comments
	min.	typ.	max.	units		
RX_BEEP_IN						
Nominal input level		0.76		V_{p-p}	For 6.2V_{p-p} at speaker @1kHz.	Level for 10dB below rated power.
Full scale input level			2.5	V_{p-p}	For onset of clipping at 13.8V.	
Frequency response	0.3 to 3kHz				–3dB with respect to level at 1kHz.	
Input impedance	1			kΩ	DC–10kHz	
RX_AUD						
Nominal output level		1.0		V_{p-p}	At 1kHz, 60% dev. Full volume	
Full scale output level:		2.0		V_{p-p}	At 1kHz, 120% dev. Full volume	
Output impedance:		100		Ω	At 1kHz.	
Frequency response:	Refer to plot in Table 2.18.					

Table 2.17 Internal options connector - data characteristics

Parameter	Standard				Test method and conditions	Comments
	min.	typ.	max.	units		
Serial port						
Baud rate:	1200, 2400, 4800, 9600, 14400, 19200, 28800			bit/s		All UART parameters are fixed and common to all UARTs except for the baud rate which is configurable and different for different modes/applications
Data bits:	8					
Start bit:	1					
Stop bit:	1					
Parity:	None					
Protocol:	CCDI3					
Flow control: Software	XON/XOFF					
GPIO						
Delays: I/O mirror to AUX UI key delay			500 50	µs ms		

Table 2.18 RX_AUD frequency response plot



2.5 Provision for External Options Connector

The radio has a mechanical interface for the external connector of an internal options board. This external options connector can be a 9-way standard-density or 15-way high-density D-range connector. If no internal options board is installed (standard configuration), the hole for the external options connector is sealed by a bung.

Examples of internal options boards:

- TMAA30-02 3DK Application Board.
  Refer to the TM8000 3DK Application Board Service Manual.
- TMAA01-01 Line-Interface Board.
  Refer to the TM8100/TM8200 Service Manual.
- TMAA01-05 Options Extender Board.
  Refer to the TM8100/TM8200 Service Manual.

For information on how to create your own internal options board, refer to "Internal Options Board" on page 97.

2.6 Provision for Additional Connector (SMA)

The radio has a provision to fit an additional round connector or cable exit next to the external options connector on the rear of the radio. The position is indicated in Figure 2.2 on page 14. The maximum hole diameter is 7.5mm, suitable for an SMA connector or a cable grommet.

Important When fitting an additional connector, it is the integrator's sole responsibility to provide adequate sealing.

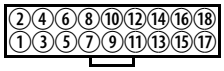
2.7 Control Head Connector

The control head connector is the standard interface between the radio body and the TM8100 and TM8200 control heads.

You can integrate your own options board into the cavity between the radio body and the TM8105 blank control head. For information on how to create your own blank control head options board, refer to "Blank Control Head Options Board" on page 107.

The one-digit, two-digit, RJ45, and graphical-display control heads use all 18 signals of the control head connector, whilst the programming connector of the blank control head only uses the signals 1 to 9.

Table 2.19 Control head connector - pins and signals

Pinout	Pin	Signal	Description	Signal type
 front view	1	RX_AUD	Receive audio output. Post volume control. AC-coupled.	Analog
	2	+13V8[1]	Power supply output from radio body power source.	Power
	3	CH_TXD	Asynchronous serial port - Transmit data.	Digital. 3V3 CMOS.
	4	CH_PTT	PTT input from microphone. Also carries the hookswitch signal.	Digital
	5	CH_MIC_AUD	Fist microphone audio input.	Analog
	6	AGND	Analog ground.	Ground
	7	CH_RXD	Asynchronous serial port - Receive data.	Digital. 3V3 CMOS.
	8	DGND	Digital ground.	Ground
	9	CH_ON_OFF	Hardware power on/software-controlled power off input. Active low.	Digital
	10	VOL_WIP_DC	DC signal from volume pot wiper.	Analog
	11	CH_SPI_DO	Data output signal to control head.	Digital. 3V3 CMOS.
	12	CH_LE	Latch enable output to control head.	Digital. 3V3 CMOS.
	13	CH_GPIO1	General purpose digital input/output.	Digital. 3V3 CMOS input. Open collector output with pullup.
	14	+3V3	Power supply to control head digital circuits.	Power
	15	CH_SPI_DI	Data input from control head.	Digital. 3V3 CMOS.
	16	CH_SPI_CLK	Clock output to control head.	Digital. 3V3 CMOS.
	17	SPK–	Speaker audio output for non-remote control head. Balanced load configuration.	Analog
	18	SPK+	Speaker audio output for non-remote control head. Balanced load configuration.	Analog

1. Can be switched or unswitched. For more information refer to the service manual.

Table 2.20 Control head connector - DC characteristics

Parameter	Standard				Test method and conditions	Comments
	min.	typ.	max.	units		
Digital signals						
Input low level:						
CH_SPI_DI			0.7	V		
CH_RXD			0.7	V		
CH_GPIO1			0.7	V		
CH_PTT			0.7	V		
CH_ON_OFF			V_s–4	V		
Input high level:						
CH_SPI_DI	1.7			V		
CH_RXD	1.7			V		
CH_GPIO1	1.7			V		
CH_PTT	1.7			V		
CH_ON_OFF	V_s–1.5			V		
Input low current:						
CH_SPI_DI			10	µA		
CH_RXD			–1	mA	V_{in}=–8V	
CH_GPIO1			–120	µA		
CH_PTT			–800	µA		
CH_ON_OFF			–13	mA	V_s=13.8V	
Input high current:						
CH_SPI_DI			10	µA	V_{in}=3.3V	
CH_RXD			1	mA	V_{in}=8V	
CH_GPIO1			10	µA	V_{in}=3.3V	
CH_PTT			10	µA	V_{in}=3.3V	
CH_ON_OFF			10	µA	V_{in}=V_s	
Output low level:						
All outputs except			200	mV	100µA sink current	
CH_GPIO1			50	mV	100µA sink current	
CH_GPIO1			600	mV	10mA sink current	Current limit occurs at 20mA typ.
Output high level:						
All outputs except	3.1				100µA source current	
CH_TXD	2.4				3kΩ load	
CH_GPIO1	3.1				No load	33kΩ pullup to 3.3V.
Hookswitch resistance:						
CH_PTT	5.6		13.2	kΩ		Microphone on hook resistance.
Safe DC input limits:						
CH_SPI_X	–0.5		+4.1	V		I_{in} must not exceed ±10mA.
CH_LE	–0.5		+4.1	V		I_{in} must not exceed ±10mA.
CH_TXD	–10		V_s+0.5	V		I_{in} must not exceed +50/–10mA.
CH_RXD	–25		V_s+0.5	V		I_{in} must not exceed +50mA.
CH_GPIO1	–0.5		V_s+0.5	V		I_{in} must not exceed ±50mA.
CH_PTT	–17		+17	V		
CH_ON_OFF	–0.5		V_s+0.5	V		I_{in} must not exceed ±50mA.

Table 2.20 Control head connector - DC characteristics (Continued)

Parameter	Standard				Test method and conditions	Comments
	min.	typ.	max.	units		
Analog signals (for signals not listed here refer to the Auxiliary interface specification)						
DC input range: VOL_WIP_DC	 0 0		 1.2 10	 V kΩ	Voltage/resistance for min/ max volume respectively.	This line is used for control head detection. An open-circuit input is considered as no head fitted.
DC bias: SPK+/– CH_MIC_AUD	 2.9	 0.5Vs 	 3.1	 V V	 Audio PA on. Via 2.2 kΩ	 Bias for electret microphone.
Input resistance: CH_MIC_AUD	 2.1	 2.2	 2.3	 kΩ		
Output resistance: SPK+/–		 0.5		 Ω	Audio PA on.	
Output load: +3V3 +13V8 (switched) +13V8 (switched) +13V8 (unswitched) +13V8 (unswitched)			 100 1 2 1 2	 mA A A A A	 Continuous load Peak for <1sec Continuous load Peak for <1sec	 Specification must be derated by load amount from internal options and auxiliary interfaces. See Service Manual.[1]
Safe DC input limits: VOL_WIP_DC RX_AUD SPK+/– CH_MIC_AUD	 –17 –10 0 –0.5		 +17 +17 +17 +17	 V V V V		 Short circuit-safe. With TM811x head connected, max input via mic interface is Vs+0.5V.

1. The TM8255 graphical-display control head can draw 1A continuous load.

Table 2.21 Control head connector - AC characteristics

Parameter	Standard				Test method and conditions	Comments
	min.	typ.	max.	units		
RX_AUD	refer to Table 2.16					
CH_MIC_AUD	refer to AUX_MIC_AUD in Table 2.7					
SPK+/–	refer to Table 2.22					

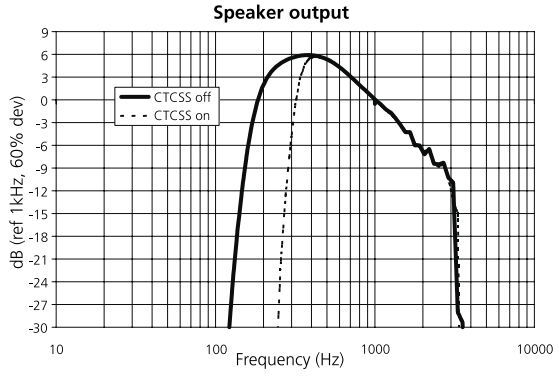
Table 2.22 Control head connector - speaker output characteristics

Parameter	Standard				Test method and conditions	Comments
	min.	typ.	max.	units		
Mute ratio	70	75		dB	With respect to maximum output power. Noise measured in 0.3-3kHz bandwidth.	Signal path muted. Audio PA on.
Receive audio frequency response	Refer to plot in Table 2.24.				EIA-603B	
Internal speaker output:						
Load configuration	Balanced					
Load	12.8	16	19.2	Ω	At 1kHz.	
Maximum power	3			W	Into 16Ω.	
Rated duty cycle			100	%	At maximum power.	
Concurrent speaker output:						
Rated duty cycle			33	%	1min at maximum power 2min Rx standby	The internal and external speaker loads are connected in parallel (not switched).

Table 2.23 Control head connector - data characteristics

Parameter	Standard				Test method and conditions	Comments
	min.	typ.	max.	units		
Serial port						
Baud rate:	1200, 2400, 4800, 9600, 14400, 19200,28800			bit/s		All UART parameters are fixed and common to all UARTs except for the baud rate which is configurable and different for different modes/ applications
Data bits:	8					
Start bit:	1					
Stop bit:	1					
Parity:	None					
Protocol:	RPI CCDI3					
Flow control: Software	XON/XOFF					
GPIO						
Delays: I/O mirror to IOP UI key delay			500 50	µs ms		

Table 2.24 Speaker frequency response plot



Detection of Control Head

The radios detect the presence or absence of a control head and automatically configure the default receive audio volume accordingly. If a control head with a user interface is connected, either in local or remote configuration, then the volume potentiometer setting will determine receive audio level. If a blank control head is connected, or no control head is used at all, then the receive audio level will default to the programmed Minimum Volume Level

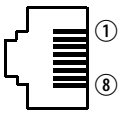
For operation with the TM8105 blank control head or TM8252 RJ45 control head, the radio must be programmed always to power up when power is applied and the ignition-sense hardware link LK1 must be fitted. For more information on hardware links refer to the service manual.

2.8 Microphone Connector

The microphone connector of the control heads with user interface is an RJ-45 socket.

When one of these control heads is connected to the control head connector of the radio body using the loom provided, the microphone connector uses the following eight control head connector signals:

Table 2.25 Microphone connector - pins and signals

Pinout	Pin	Signal name	Description	Signal type
 front view	1	MIC_RX_AUD	Receive audio output.	Analog
	2	+13V8[1]	Power supply output. Switched off when radio body is switched off.	Power
	3	MIC_TXD	Asynchronous serial port - Transmit data.	3.3V CMOS
	4	MIC_PTT	PTT input from microphone. Also carries hookswitch signal.	Digital
	5	MIC_AUD	Fist microphone audio input.	Analog
	6	AGND	Analog ground.	Analog ground
	7	MIC_RXD	Asynchronous serial port - Receive data.	3.3V CMOS
	8	MIC_GPIO1	General purpose digital input/ output.	Open collector out 3.3V CMOS in

1. Can be switched or unswitched. For more information refer to the service manual.

For characteristics refer to the corresponding signals of the control head connector.

Note THSD cannot be used with the Microphone port on TM8200 radios. The microphone port is not available when sending or receiving THSD. If you intend to send and receive high speed data (the Wideband Modem Enabled check box is selected), select either Aux or Internal Options in this field.

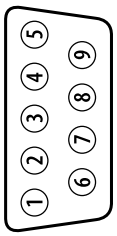
2.9 Blank Control Head Programming Connector

The programming connector of the blank control head is a 9-way standard-density D-range plug.

This connector can also be used to connect application products, and for other purposes, as required.

When the blank control head is connected to the radio body, the programming connector uses the signals shown in Table 2.26:

Table 2.26 TM8105 Programming connector - pins and signals

Pinout	Pin	Signal name	Description	Signal type
 front view	1	PRG_RX_AUD	Receive audio output.	Analog
	2	PRG_TXD	Asynchronous serial port - Transmit data.	3.3V CMOS
	3	PRG_MIC_AUD	Fist microphone audio input.	Analog
	4	PRG_RXD	Asynchronous serial port - Receive data.	3.3V CMOS
	5	PRG_ON_OFF	Hardware power on/software-power off input. Active low.	Digital
	6	+13V8[1]	Power supply output. Switched off when radio body is switched off.	Power
	7	PRG_PTT	PTT input from microphone. Also carries hookswitch signal.	Digital
	8	AGND	Analog ground	Ground
	9	DGND	Digital ground	Ground

1. Can be switched or unswitched. For more information refer to the Service Manual.

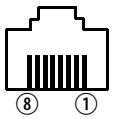
For characteristics refer to the corresponding signals of the control head connector.

2.10 RJ45 Control Head Programming Connector

The RJ45 control head has an RJ45 socket for programming (or other purposes, as required), and a power on/off LED.

Note The pins of the programming connector is connected in parallel, so care needs to be taken when connecting external devices to this connector.

Table 2.27 RJ45 Programming connector - pins and signals

Pinout	Pin	Signal name	Description	Signal type
 front view	1	RX_AUD	Receive audio output (after volume control	Analog
	2	+13.8V	Unswitched 13.8 V power supply	Power
	3	TXD	Asynchronous serial port - transmit data	3.3V CMOS
	4	PTT	PTT input	Digital
	5	MIC_AUD	Microphone audio input	Analog
	6	AGND	Analog ground	Ground
	7	RXD	Asynchronous serial port - receive data	3.3V CMOS
	8	ON/OFF	Hardware power on/software power off	Digital

3 Programmable I/O Lines

This chapter describes the programmable

- digital input lines
- digital output lines
- audio tap out lines
- audio tap in lines

These input and output lines can be configured using the Programmable I/O form of the programming application. When configuring an input line, the Mirrored To column can be used to reflect an input to an output line. For more information refer to the online help of the programming application.

The connectors and electrical characteristics of the programmable I/O lines are described in "Description of the Radio Interfaces" on page 13.

3.1 Digital Input Lines

This section describes the general design principles for use of the programmable I/O lines configured as inputs, and the input signals that can be set for them.

Available Input Lines

The following lines are available to be used as inputs:

Table 3.1 Digital input lines

Signals	Connector	Direction
AUX_GPI1…3	auxiliary connector	input only
AUX_GPIO4…7	auxiliary connector	input or output
IOP_GPIO1…7	internal options connector	input or output
CH_GPIO1 MIC_GPIO1[1] PRG_GPIO1[1]	control head connector microphone connector programming connector	input or output

1. CH_GPIO1 of the control head connector is the same signal as MIC_GPIO1 of the microphone connector (control heads with user interface) and PRG_GPIO1 of the programming connector (blank control head).

For details on the connector pin-outs and electrical characteristics of these lines refer to "Description of the Radio Interfaces" on page 13.

Compatibility and Tolerance

Table 3.2 describes the compatibility of the input lines with common industry logic standards:

Table 3.2 Digital input lines - compatibility and tolerance

Input line	Logic standard input compatibility and tolerance			
	3.3V CMOS	5V CMOS	5V TTL	RS-232
AUX_GPI1	Yes	Yes	Yes	No[1]
AUX_GPI2[2]	Yes	Yes	Yes	No[1]
AUX_GPI3[3]	Yes	Yes	Yes	No[1]
AUX_GPIO4…7	Yes	Yes	Yes	No[1]
AUX_RXD	Yes	Yes	Yes	Yes
IOP_GPIO1…7	Yes	Yes	Yes	No[1]
IOP_RXD	Yes	Yes	Yes	No[1]
CH_RXD MIC_RXD PRG_RXD	Yes	Yes	Yes	Yes
CH_GPIO1 MIC_GPIO1	Yes	Yes	Yes	No[1]

1. Level compatible but not tolerant. Inputs can be made RS-232-tolerant by using 3.3 kΩ series resistance inserted at the radio end.
2. Hardware link LK3 not fitted.
3. Hardware link LK2 not fitted.

Input Philosophy

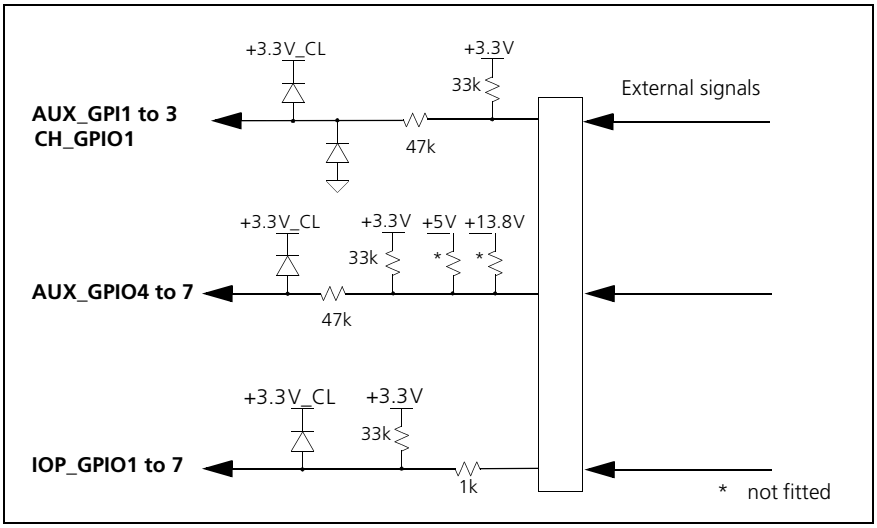
The digital inputs are designed to simplify the interfacing to a wide range of signal sources, broadly encompassing directly wired switches, open-collector transistors, opto-isolators, digital logic, and direct microprocessor drive. In many cases, the amount of interfacing circuitry can be kept to a minimum, thus reducing design effort and keeping down both cost and circuit board area.

Input Circuitry

Figure 3.1 shows a simplified circuit diagram of the digital input lines (ESD protection not shown). For full circuit diagrams, refer to the PCB Information chapter of the service manual for your radio, or to the technical support website.

The input lines of the auxiliary connector and the control head connector are protected against both over-voltage and under-voltage drive via the clipping diodes and 47 kΩ current-limiting resistor. The input lines of the internal options connector are only protected against minor over-voltage conditions (refer to "Internal Options Connector" on page 27).

Figure 3.1 Digital input lines - simplified circuit diagrams



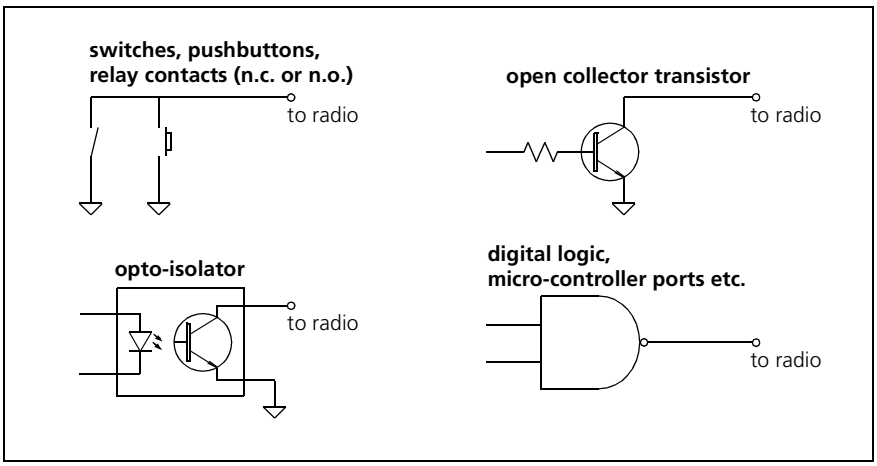
Pullup Resistors

Pullup resistors are provided on all digital input lines. For the input lines of the internal options connector and the auxiliary connector this is 33kΩ to 3.3V. For the auxiliary input/output lines, several pullup options are available for the hardware (refer to "Pullup Resistors" on page 72).

Driving the Inputs

Figure 3.2 shows some possible input drive circuits and illustrates the relative simplicity of connection to the radio.

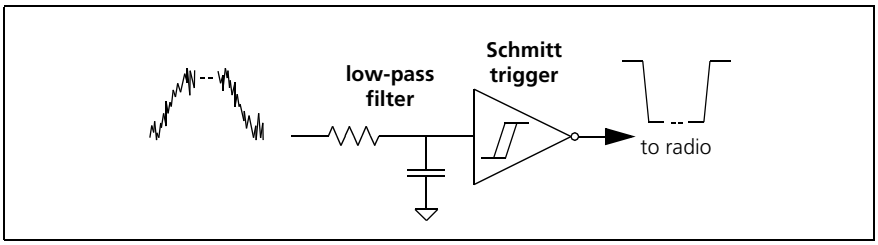
Figure 3.2 Digital input lines - input drive circuits



Signal Conditioning

Although the radio can apply some debouncing to inputs, excessively noisy signals may require pre-conditioning to eliminate the worst of the noise. A simple low-pass filter and hysteresis switch (Schmitt trigger) as shown in Figure 3.3 will usually be adequate.

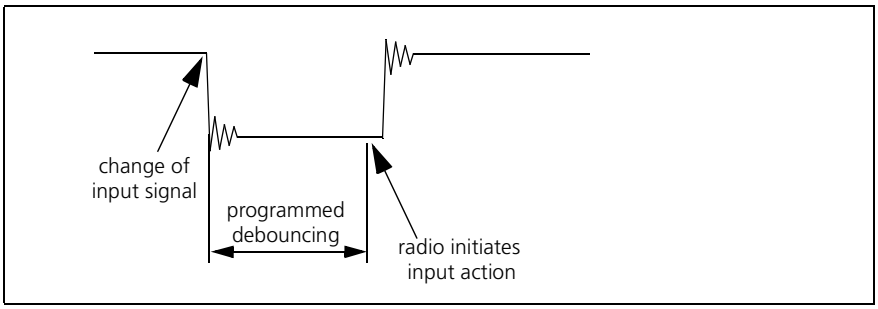
Figure 3.3 Digital input lines - signal conditioning



Debouncing

Physical switches with bounce or jitter make it necessary to introduce a delay before the input is recognised, in order to prevent multiple activation. We recommend that you measure this jitter and program the input line accordingly. If the jitter cannot be measured, we recommend that you set the debounce time to between 50 and 100ms. If the radio exhibits erratic behaviour upon closing or opening a switch, try increasing the debounce time further. Signals from logic circuits or microprocessors generally do not require debouncing. The input signal must be applied for at least the duration of the debouncing programmed. Figure 3.4 shows the debouncing characteristics.

Figure 3.4 Digital input lines - debouncing



Active Logic Level

The active and inactive logic levels can be programmed to high or low in the Programmable I/O form of the programming application

Important Because of the pullups, setting the active state to High will cause the action to commence if the connector is removed or dislodged while the radio is on. To prevent this happening, set the active state to Low.

Special Purpose Inputs

AUX_GPI2, AUX_GPI3, and IOP_GPIO7 can be used as general purpose inputs but can also be configured for the following dedicated purposes:

- AUX_GPI2 can be set to power the radio up into emergency mode (refer to "Enter Emergency Mode" on page 48).
- AUX_GPI3 can be set to control radio power-up/power-down via an ignition sense signal or similar (refer to "Power Sense (Ignition)" on page 47).
- IOP_GPIO7 can be set to control radio power-up/power-down via a logic signal (refer to "Power Sense (Ignition)" on page 47).

The use of these inputs for power sensing requires that certain hardware links be placed on the main board assembly. For more information refer to the service manual.

Note Conversely, if these inputs are used for other purposes it is important to check that the hardware links are removed. If the hardware links are not removed the radio may power up or down unexpectedly. Note that some of these links may have been fitted in the factory.

Input Signals

Table 3.3 gives a brief description of the input signals available for programming of the digital input lines, and indicates whether the input signals are valid for conventional radio systems, trunked radio systems, or both.

Note The Mode column refers to the Mode field on the Programmable I/O form.

Following the table are more detailed notes on each input signal.

Table 3.3 Digital input signals

Input action	Mode	Description
"Activate THSD Modem" on page 68	Conventional	Activates the radio's high speed data (THSD) modem, ready to send or receive high speed data. This action is only valid if a license has been obtained and entered, and the Modem Enabled check box is selected. When the line is deactivated, the radio will exit THSD transparent mode.
"BCD Pin 0 to 4" on page 57	Conventional	A combination of up to 5 BCD lines selects a channel (Zone and Channel fields) or status (Status field) as entered on the BCD tab. Set whether the user can use the radio to access channels using the Front Panel Channel Selection Lockout check box.
"Decrement Channel" on page 54	Conventional	The radio goes to the previous channel. Hidden channels will not be selected.

Table 3.3 Digital input signals (Continued)

Input action	Mode	Description
"Enter Emergency Mode" on page 48	All / Conventional / Trunked	When the line is activated, the radio will enter emergency mode. The radio can optionally enter emergency mode from a powered-off state, by assigning the action to AUX_GPI2, setting Active to Low, and fitting hardware link LK3. You can also add this action to a line on the Internal Options interface (pins beginning with IOP), but the radio will not enter emergency mode from a powered-off state. If LK3 is not fitted, then AUX_GPI2 can be used for other actions. If activated while in conventional mode, select whether the radio enters a stealth or a non-stealth emergency in the Action Parameters > Emergency Mode field.
"External Call (ECR)" on page 50	Trunked	When the line is activated, the radio will set up a call to the ECR Call String. The call will end when the line is deactivated (if the ECR Call Clear check box is selected).
"External PTT 1 and 2" on page 51	All / Conventional / Trunked	A nominated digital input line acts as an external PTT (EPTT). When the line is activated, the behaviour of the radio will follow the settings on the Global > PTT form > External PTT (1) or External PTT (2) tabs. Up to two external PTT input lines may be assigned using the Auxiliary and the Internal Options interfaces. All PTT lines can be active at any one time. The PTT with the highest priority (PTT Priority) will control the audio path.
"Force Audio PA Off" on page 65	All / Conventional / Trunked	Forces the audio power amplifier (PA) off. Received audio will be processed as normal up to the PA, allowing that audio to be routed to another source (such as a handset). When the line is deactivated, the radio will resume control of the PA and speaker.
"Force Audio PA On" on page 64	All / Conventional / Trunked	Forces the audio power amplifier (PA) on. This allows the speaker to be accessed for other purposes (such as a beep from an application device). When the line is deactivated, the radio will resume control of the PA and speaker.
"Home Channel" on page 56	Conventional	The radio goes to a home channel. The home channel is used with Decrement Channel and Increment Channel, so the radio can select a new channel from a known point. Select the home channel in the Action Parameters > Home Zone and Home Channel fields. When the line is deactivated, the radio will remain on the home channel.
"Increment Channel" on page 55	Conventional	The radio goes to the next channel. Hidden channels will not be selected.

Table 3.3 Digital input signals (Continued)

Input action	Mode	Description
"Inhibit PTT" on page 52	Conventional	Returns the radio to receive mode, and enables or disables total PTT operation (including monitor activation, call setup, and voice or data transmission). This applies to any PTT type with the Inhibit PTT When External PTT Inhibit Active check box selected.
"Lock Radio UI (PIN to unlock)" on page 69	All / Conventional / Trunked	Locks the radio. The radio user must press the Security PIN sequence to return the radio to a normal state. This option is only valid if the Security Lock on Power Up check box is selected.
"Mute Audio Output Path" on page 62	All / Conventional / Trunked	Closes the mute of selected audio paths so audio will not be received. Select Speaker Audio Path, Auxiliary Audio Path, or All Audio Paths in the Action Parameters group box.
"Mute External Audio Input" on page 61	All / Conventional / Trunked	Opens or closes the mute of selected audio paths so audio will or will not be transmitted. Select Audio Tap In, Mic Inputs or All Inputs from the Action Parameters group box.
"Power Sense (Ignition)" on page 47	All	The radio will attempt to power up when the line is activated, according to the Power On Mode setting. When the line is deactivated, the radio will power down. This action is only valid for the pins AUX_GPI3 or IOP_GPIO7. If this action is assigned to AUX_GPI3, the hardware link LK2 must be fitted. If added to IOP_GPIO7, LK4 must be fitted. To use these pins for other actions, the respective links must be removed.
"Preset Channel" on page 60	All / Conventional / Trunked	If in conventional mode, the radio goes to a temporary preset channel. When the line is deactivated, the radio will revert to the channel the radio was on when the line was activated. While activated, certain user functions related to the preset channel are not available, such as preset calls. If in trunked mode, the radio changes to conventional mode, and goes to a permanent preset channel. The radio will remain on that channel, even after the line is deactivated. Select the preset channel in the Action Parameters > Preset Zone and Preset Channel fields.
"RTS Control (DCE)" on page 68	Conventional	Sets the input line on the radio for hardware flow control (handshaking). DCE stands for data communication equipment, and refers to the radio. The data terminal equipment (DTE) activates this line to indicate that it is ready to receive serial data from the radio. Compare with the output CTS Control (DCE). If this action is assigned to a pin, the RTS field (Data form) will be automatically updated.

Table 3.3 Digital input signals (Continued)

Input action	Mode	Description
"Send Channel Preset Call" on page 49	Conventional	Sends one of the first four preset calls for the current channel. If the currently selected channel is assigned to a Selcall network, this action will send a call on the Channels form > Selcall Preset Calls tab. If the currently selected channel is assigned to a DTMF network, this action will send a sequence on the Channels form > DTMF Preset Calls tab. Select preset ID 1, 2, 3, or 4 in the Action Parameters > Channel Preset Call field.
"Send Mic Audio to Spkr" on page 63	All / Conventional / Trunked	Sends microphone audio to the radio's speaker. This action, when assigned to CH_GPIO1, can be used with a DTMF microphone to generate DTMF side tones. When a key is pressed on the microphone, DMTF tones being transmitted are fed to the radio's speaker, at a reduced volume. This gives the radio user confidence that the tones are being transmitted.
"Send Network Preset Call 1" on page 50	Conventional	Sends one of the first four preset calls for the network assigned to the current channel. If the currently selected channel is assigned to a Selcall network, this action will send a preset call on the Network Preset Calls tab (Selcall > Free Format Bursts form). If the currently selected channel is assigned to a DTMF network, this action will send a sequence on the Network Preset Calls tab (DTMF > DTMF Signalling form). Select preset ID 1, 2, 3, or 4 in the Action Parameters > Network Preset Call field.
"Simulate F1 to F4 Key" on page 66	All / Conventional / Trunked	Initiates the action assigned to a function key, creating an external function key. Short and long presses of the input line will reflect short and long presses of the function key. If there is no action assigned to the function key, then no action will result.
"Toggle Alarm Mode" on page 67	Conventional	Begins or ends GPS alarm mode. When the line is activated, the radio will switch to the GPS channel (if the Poll Response Channel Type is Dedicated), and begin sending the radio's current GPS location data every Callout Interval. Alarm mode will end when the Maximum Number of Callouts is reached, or this line is deactivated.
"Toggle F1 to F4 Key LED" on page 67	All / Conventional / Trunked	Results in one of the function key LEDs displaying. This action can be used when the F1 or F4 key has activated an output line (F1 to F4 Key Status), to indicate the status of an application device.
"Toggle Stand-by Mode" on page 47	All / Conventional / Trunked	When the line is activated, the radio exits stand-by mode into a powered-on state. When the line is deactivated, the radio enters stand-by mode where the radio appears off. If this action is assigned to CH_GPIO1, then the line can only be active low (the Active field must not be set to High).

Table 3.3 Digital input signals (Continued)

Input action	Mode	Description
"Toggle Tx RF Inhibit" on page 53	Conventional	Toggles the ability of the radio's transmitter to generate radio frequency (RF) power. If the radio is restricted from generating RF, it will still enter and exit the transmit state, indicate transmit to the user, count down any Tx Timer Duration, and send signalling through the transmit audio path. The state of this line will not restrict the radio's ability to transmit in emergency mode.
"Unmute Audio Output Path" on page 63	All / Conventional / Trunked	Opens the mute of selected audio paths so audio will be received. Select Speaker Audio Path. Auxiliary Audio Path or All Audio Paths in the Action Parameters group box.

3.1.1 Toggle Stand-by Mode

Application

This input signal is used to toggle between a powered-on state, and a stand-by state where the radio appears off. The radio will draw approximately 28mA when in stand-by mode.

Configuration

Configure an input line and associate it with this action. Set the active state to high and the debounce time (0 to 100ms).

Note If using the CH_GPIO port however, this function can only work when the active state is set to low.

Timing

The input line must be activated for at least 5s.

Description

When the input line is activated, the radio exits stand-by mode.

When the input line is deactivated, the radio enters stand-by mode.

Related Actions

The 'Power Sense (Ignition)' input signal can be used to power the radio down to a consumption of <1mA.

3.1.2 Power Sense (Ignition)

Application

If AUX_GPI3 is configured for 'auxiliary power sense' or IOP_GPIO7 is programmed for 'internal options power sense', these input lines can no longer be used as general inputs. In order to prevent any other action to be accidentally programmed for one of these input lines, these input lines should be set to 'Power Sense (Ignition)'. This setting itself has no function.

For more information refer to the service manual.

3.1.3 Enter Emergency Mode

Application

This input signal is used to enter the emergency mode. For more information on emergency mode refer to the online help of the programming application.

Use this action with the AUX_GPI2 line to configure the 'emergency power sense' option to power up the radio into emergency mode. The 'emergency power sense' is completely independent of any other power sense option configured in the radio. For more information refer to the service manual.

Note The 'Enter Emergency Mode' action can be programmed on AUX_GPI2 or IOP_GPIO1…7, but only AUX_GPI2 provides the ability to also power up the radio.

Configuration

1. If required, configure the 'emergency power sense' option as described in the service manual.
2. Configure the additional parameters required for the emergency mode (stealth, emergency call settings etc.).
3. Configure an input line (AUX_GPI2 with emergency power sense) and associate it with this action. Set the active state to low.
   As the emergency input driver is usually a mechanical switch, to prevent accidental activation, set the debounce time to 100ms.

Timing

The input line must be activated for at least 2s.

Description

If 'emergency power sense' is configured and the radio is off, activation of AUX_GPI2 for >2s will power up the radio and enter it into emergency mode immediately. If 'emergency power sense' is not configured and the radio is off, activation of the programmed input line will have no effect.

If 'emergency power sense' is **not** configured and the radio is on, activation of the programmed input line will enter it into emergency mode immediately.

The radio will ignore further assertions of this input line until emergency mode has been exited at which point another assertion of this line would cause emergency mode to be initiated again.

If this input is active when the radio is powered on, the radio will enter emergency mode immediately.

Related Actions

None.

3.1.4 Send Channel Preset Call

Application

When activated, this action sends a fixed-format Selcall call, or DTMF call, for the current channel.

Note Only channel preset call 1 can be sent for TM8200.

Configuration

1. Configure channel preset call sequences associated with each network/channel.
2. Configure the additional parameters required to make a preset call.
3. Configure an input line and associate it with this action. Set the active state (high or low) and the debounce time.

Timing

Call duration depends on the programmed signalling scheme timing.

Description

When the input line is activated, the leading edge triggers the attempt to transmit an outgoing call using the signalling scheme associated on this channel.

The radio will ignore state changes on this input line until the transmission has completed. Once the transmission has completed, assertion of this input line will be acted upon as normal.

This input line is of a momentary type and therefore no action is performed on its deactivation.

Related Actions

The PTT can be programmed to initiate a call on PTT press.

3.1.5 Send Network Preset Call 1

Application

When the nominated input line is activated, the radio transmits a predefined free-format sequence over the air.

For both Selcall and DTMF calls, four free format preset sequences can be specified per network. This input signal is used to send the free format preset 1 sequence over the air. For more information on free format preset sequences refer to the online help of the programming application.

Note Only free-format preset 1 can be sent with this input signal.

Configuration

1. Configure the parameters required to send the free format preset 1 sequence.
2. Configure an input line and associate it with this action. Set the active state (high or low) and the debounce time.

Timing

Call duration depends on the programmed signalling scheme timing.

Description

When the input line is activated, the radio determines the current channel and network and sends free format preset 1 sequence.

Tip Use the input signals for channel selection (e.g. 'Home Channel') to select the channel with the desired network before activating this signal.

The radio will ignore state changes on this input line until the transmission has completed. Once the transmission has completed, assertion of this input line will be acted upon as normal.

This input line is of a momentary type and therefore no action is performed on its deactivation.

Related Actions

To send other configured free format preset calls, program them to any of the function keys and use the 'Simulate F1 to F4 Key' action to simulate the key press (refer to "Simulate F1 to F4 Key" on page 66).

3.1.6 External Call (ECR)

Application

When the line is activated, the radio will set up a call to the ECR Call String. The call will end when the line is deactivated (if the ECR Call Clear check box is selected). Refer to the programming application online help for more details.

Configuration

1. Configure the Fleet Parameters to enable 'External Call Required'.
2. Configure an input line and associate it with this action. Set the active state (high or low) and the debounce time.

Timing Call duration depends on the programmed signalling scheme timing.

Description The radio will ignore state changes on this input line until the transmission has completed. Once the transmission has completed, assertion of this input line will be acted upon as normal.

This input line is of a momentary type and therefore no action is performed on its deactivation.

Related Actions This is the MPT trunked equivalent of "Send Network Preset Call 1" on page 50.

3.1.7 External PTT 1 and 2

Application This input signal is used to configure an input line as an external PTT. Up to two external PTT input lines can be assigned using the auxiliary and the internal options connectors. All PTT lines may be active at any time, and the PTT line with the highest priority controls the audio path. For more information on PTT refer to the online help of the programming application.

Configuration Configure an input line and associate it with this action. Set the active state (high or low) and the debounce time.

Timing The response time is less than 8ms to 90% of full power plus debounce time.

Description When the input line is activated, the radio executes the PTT operation.

If the 'Toggle Tx RF Inhibit' or 'Inhibit PTT' actions are active, no action will result. If 'Toggle Tx RF Inhibit' or 'Inhibit PTT' action is activated within 300µs following an activation of Activate External PTT action, the external PTT action will not be initiated.

If the input line is active while the radio is powered up, it must be re-applied for the action to be carried out.

Related Actions The 'Reflected PTT Status' reports the PTT status by generating a logic OR of all PTT sources programmed to reflect their status.

3.1.8 Inhibit PTT

Application

This input signal is used to stop any current PTT transmissions, return to receive state and inhibit any further PTT transmission requests. This allows external applications to interrupt user-initiated transmissions, and prevents users from interrupting e.g. a data transmission.

Configuration

1. In the PTT form, configure the 'Inhibit PTT When External PTT Inhibit Active' check box for each PTT type.
2. In the Programmable I/O form, configure an input line and associate it with this action. Set the active state (high or low) and the debounce time (0 to 100ms).

Timing

If this line is activated within 300µs following an activation of any one of the PTT sources, the PTT action will not be initiated.

Description

When this input line is activated, the radio stops any current PTT transmissions and inhibits any further PTT requests.

If the input line is active while the radio is powered up, it must be re-applied for the action to be carried out.

Note Non-PTT transmission such as calls programmed on a function key will be carried out, even when this signal is active.

Emergency Mode Transmission

If an emergency mode transmission is requested, the 'Inhibit PTT' action will be ignored. Once the emergency mode transmission is complete, the 'Inhibit PTT' action will be restored if the input line is still active.

Related Actions

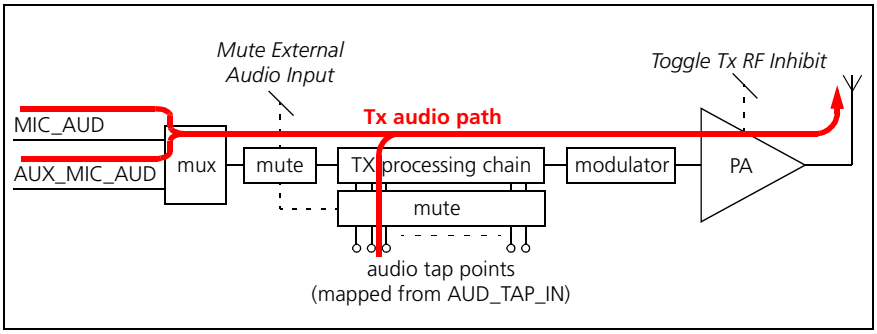
The 'Toggle Tx RF Inhibit' input signal allows the radio to be in transmit mode but inhibits transmitting.

3.1.9 Toggle Tx RF Inhibit

Application

This input signal is used to prevent the RF carrier from being radiated while in transmit mode. This can be used e.g. for precise timing of data transmissions such as GPS.

Figure 3.5 Toggle Tx RF Inhibit



Activation of one or more 'Toggle Tx RF Inhibit' input lines will inhibit the radios transmitter PA from generating RF power. The radio is otherwise unaffected by this input (i.e. the radio will still enter and exit transmit state, indicate transmit to the user, time transmit duration, send signalling through the transmit audio path and in all other respects act as per normal).

Configuration

Configure an input line and associate it with this action. Set the active state (high or low) and the debounce time. This action can be programmed to both the auxiliary and the internal options connector at the same time (logical OR).

Timing

The input line has a response time of less than 2.5 ms.

If this line is activated within 300 µs following an activation of any one of the PTT sources, the PTT action will not be initiated.

Description

When any 'Toggle Tx RF Inhibit' input line is activated and the radio is in transmit mode (on any channel and independent of the type of transmission), the radio will ramp down the RF power to <–10 dBm (100 µW), but it will remain in the transmit state.

Note If the transmitting radio is RF inhibited, there is no inhibit beep.

If the input line is active while the radio is powered up, it must be re-applied for the action to be carried out.

When all 'Toggle Tx RF Inhibit' input lines are deactivated and the radio is in transmit mode, the radio will ramp up the RF power to its previous setting.

If the radio starts transmission while one or more 'Toggle Tx RF Inhibit' input lines are active, the radio will enter transmit state as normal, but will not ramp up the RF power.

The radio is able to leave the transmit state (e.g. to return to receive state) irrespective of the state of the 'Toggle Tx RF Inhibit' input lines.

Emergency Mode Transmission

If an emergency mode transmission is requested, the 'Toggle Tx RF Inhibit' input line will be ignored. Once the emergency mode transmission is complete, the 'Toggle Tx RF Inhibit' action will be restored if the input line is still active.

Related Actions

The 'Inhibit PTT' input signal stops any current PTT transmissions, returns to receive state and inhibits any further PTT transmission requests.

3.1.10 Decrement Channel

Application

This input signal is used to select the next lowest channel. This action uses the same restrictions for channel wrap around as programmed.

Configuration

1. Configure a list of channels.
2. Enable or disable the front panel lockout as desired (BCD tab).
3. Configure an input line and associate it with this action. Set the active state (high or low) and the debounce time.
4. Select a defined channel, if desired, using the 'Home Channel' actions.

Timing

The time between pulses should be at least 20ms. The minimum pulse width is the debounce time plus 2ms.

Description

When this input line is activated, the radio decrements the current channel. If the radio is at the start of the channel list and wrap around is disabled, the radio ignores the channel change request.

Note The one-digit control head restricts user mode selection of fixed channels or a group to those channels in the range 0 to 9. If a channel that is not permitted for the one-digit control head is requested, then the radio shall select the first/last permitted channel (wrap around).

This input line is of a momentary type and therefore no action is performed on its deactivation.

Related Actions

The 'Increment Channel' input signal performs the corresponding action of incrementing the channel.

The 'BCD Pin 0 to 4' input signal is used to change to a specified channel number.

The 'Home Channel' input signal is used to change to a specified reference channel, which can be used to increment or decrement from.

3.1.11 Increment Channel

Application

This input signal is used to select the next highest channel. This action uses the same restrictions for channel wrap around as programmed.

Configuration

1. Configure a list of channels.
2. Enable or disable the front panel lockout as desired (BCD tab).
3. Configure an input line and associate it with this action. Set the active state (high or low) and the debounce time.
4. Select a defined reference channel, if desired, using the 'Home Channel' action.

Timing

The time between pulses should be at least 20ms. The minimum pulse width is the debounce time plus 2ms.

Description

When this input line is activated, the radio increments the current channel. If the radio is at the end of the channel list and wrap around is disabled, the radio ignores the channel change request.

Note The one-digit control head restricts user mode selection of fixed channels or a group to those channels in the range 0 to 9. If a channel that is not permitted for the one-digit control head is requested, then the radio shall select the first/last permitted channel (wrap around).

This input line is of a momentary type and therefore no action is performed on its deactivation.

Related Actions

The 'Decrement Channel' input signal performs the corresponding action of decrementing the channel.

The 'BCD Pin 0 to 4' input signal is used to change to a specified channel number.

The 'Home Channel' input signal is used to change to a specified reference channel, which can be used to increment or decrement from.

3.1.12 Home Channel

Application

This input signal is used to change to a specified reference channel, which can then be used to increment or decrement from.

Configuration

1. Configure a list of channels.
2. Configure an input line and associate it with this action. Set the active state (high or low) and the debounce time.
3. On the same form, select the home channel.

Timing

Allow 10ms before applying another channel change action.

Description

When this input line is activated, the radio changes to the home channel.

This input line is of a momentary type and therefore no action is performed on its deactivation.

If the input line is active while the radio is powered up, it must be re-applied for the action to be carried out.

Note The one-digit control head restricts user mode selection of fixed channels or a group to those channels in the range 0 to 9. If a channel that is not permitted for the one-digit control head is requested, then the request shall be ignored and the radio shall remain on the original channel.

Related Actions

The 'Preset Channel' input signal is used to temporarily select a pre-programmed channel

The 'BCD Pin 0 to 4' input signal is used to change to a specified channel number.

The 'Increment Channel' and 'Decrement Channel' input signals are used to increment or decrement the current channel by one.

3.1.13 BCD Pin 0 to 4

Application

These signals are used by TM8100 and TM8200 radios to select a discrete channel using a bit pattern on up to five input lines. With TM8200 radios they can also be used to select Selcall status.

TM8100 BCD/BIN Operation

The bit pattern can be decoded in BCD or binary (BIN) operation.

In BCD operation, the bit pattern is divided into a block of four signals (pin 0 to 3) to provide the decimal numbers 0 to 9 (0000 to 1001), and a most significant bit (pin 4) to indicate 0 or 1. This allows five lines to represent the decimal channel numbers 0 to 19. Invalid BCD bit patterns are ignored.

In BIN operation, the bit pattern represents the decimal channel numbers 0 to 31.

Table 3.4 shows a list of BCD pin signals and their equivalent BCD and BIN channel numbers for TM8100 radios.

When any of these input lines changes, the corresponding channel will be selected.

Table 3.4 TM8100 BCD pin signals and BCD/binary channels

BCD Pin					Channel	
4	**3**	**2**	**1**	**0**	**BCD**	**BIN**
0	0	0	0	0	0	0
0	0	0	0	1	1	1
0	0	0	1	0	2	2
…	…	…	…	…	…	…
0	1	0	0	1	9	9
0	1	0	1	0	Prev[1]	10
0	1	0	1	1	Prev[1]	11
…	…	…	…	…	…	…
0	1	1	1	1	Prev[1]	15
1	0	0	0	0	10	16
1	0	0	0	1	11	17
…	…	…	…	…	…	…
1	1	0	0	1	19	25
1	1	0	1	0	Prev[1]	26
…	…	…	…	…	…	…
1	1	1	1	1	Prev[1]	31

1. 'Prev' means that the input is ignored (invalid BCD) and that the previously selected channel remains selected.

TM8200 BCD/BIN Operation

The bit pattern can be decoded in BCD or binary (BIN) operation.

In BCD operation, the bit pattern is divided into a block of four signals (pin 0 to 3) to provide the decimal numbers 0 to 9 (0000 to 1001), and a most

significant bit (pin 4) to indicate 0 or 1. This allows five lines to represent the decimal channel numbers 1 to 19. Invalid BCD bit patterns are ignored.

In BIN operation, the bit pattern represents the decimal channel numbers 1 to 31.

When channel 0 is selected in either BCD or BIN mode, no channel change occurs.

Table 3.5 shows a list of BCD pin signals and their equivalent BCD and BIN channel numbers for TM8200 radios.

When any of these input lines changes, the corresponding channel will be selected.

Table 3.5 TM8200 BCD pin signals and BCD/binary channels

BCD Pin					Channel	
4	**3**	**2**	**1**	**0**	**BCD**	**BIN**
0	0	0	0	0	No change	
0	0	0	0	1	1	1
0	0	0	1	0	2	2
…	…	…	…	…	…	…
0	1	0	0	1	9	9
0	1	0	1	0	Prev[1]	10
0	1	0	1	1	Prev[1]	11
…	…	…	…	…	…	…
0	1	1	1	1	Prev[1]	15
1	0	0	0	0	10	16
1	0	0	0	1	11	17
…	…	…	…	…	…	…
1	1	0	0	1	19	25
1	1	0	1	0	Prev[1]	26
…	…	…	…	…	…	…
1	1	1	1	1	Prev[1]	31

1. 'Prev' means that the input is ignored (invalid BCD) and that the previously selected channel remains selected.

Configuration

1. Configure up to 5 input lines and associate them with this action. Set the active state (high or low) and the debounce time (preset to 10ms). Lines must be assigned in order, starting with pin 0 (LSB). Unassigned signals are assumed to be logic 0.
2. Select BCD or BIN operation (BCD tab).
3. Enable or disable the front panel lockout as desired (BCD tab).
4. Configure a list of channels corresponding to the BCD or binary values.

Timing

A fixed debounce time of 4ms is applied to all BCD inputs to ensure that all lines have settled to their new state before being read. This is adequate for logic-driven inputs but additional debounce time needs to be programmed if a BCD switch or similar is used.

Description

When the current state of the BCD input lines is changed, the radio determines the new channel according to Table 3.4 and selects it for use.

When the radio is turned on, the BCD input lines are read. If the BCD input lines are not set to zero, the radio will select the corresponding channel. If they are set to zero, the radio will select the last saved channel.

If the bit pattern in BCD operation does not represent a valid BCD number (from 01010 to 01111, and from 11010 to 11111), the radio will remain on the current channel.

When the current state of the BCD input lines is changed while the radio is in transmit mode, the channel change will be carried out as soon as the radio returns to receive mode.

Note The one-digit control head restricts user mode selection of fixed channels or a group to those channels in the range 0 to 9. If a channel that is not permitted for the one-digit control head is requested, then the request shall be ignored and the radio shall remain on the original channel.

Related Actions

The 'Increment Channel' and 'Decrement Channel' input signals are used to increment or decrement the current channel by one.

The 'Home Channel' input signal is used to change to a specified reference channel, which can be used to increment or decrement from.

3.1.14 Preset Channel

Application

This input signal is used to temporarily select a pre-programmed channel. When this input line is deactivated, the radio returns to the channel it was on at the time the input line was activated. This allows temporary channel change for purposes such as transmitting GPS data on a data channel instead of the voice channel.

Note On MPT trunked systems, this input signal selects the channel permanently. It will not change back on deactivation. Refer to the programming application online help for more details.

Configuration

1. Configure a list of channels.
2. Configure an input line and associate it with this action. Set the active state (high or low) and the debounce time.
3. On the same form, select the preset channel. Hidden channels are also available for selection. Scan group IDs are not available.

Timing

Allow debounce time plus 2ms plus time for channel change (typically 10ms) for the preset channel to be selected or to return to the previous channel. If timing is critical in your application, then this will need to be measured with the frequency step you intend to use.

Description

When the input line is activated, the currently selected channel ID is stored for future use and the radio changes to the preset channel.

When the input line is deactivated, the radio returns to last selected channel.

While the input line is activated, the channel selection keys on the control head are not functional.

If the input line is active while the radio is powered up, it must be re-applied for the action to be carried out.

If a preset channel is selected, and the radio powers down and up again, then the last selected channel will be selected, not the preset channel.

Note The one-digit control head restricts user mode selection of fixed channels or a group to those channels in the range 0 to 9. If a channel that is not permitted for the one-digit control head is requested, then the request shall be ignored and the radio shall remain on the original channel.

Related Actions

The 'BCD Pin 0 to 4' input signal is used to change to a specified channel number.

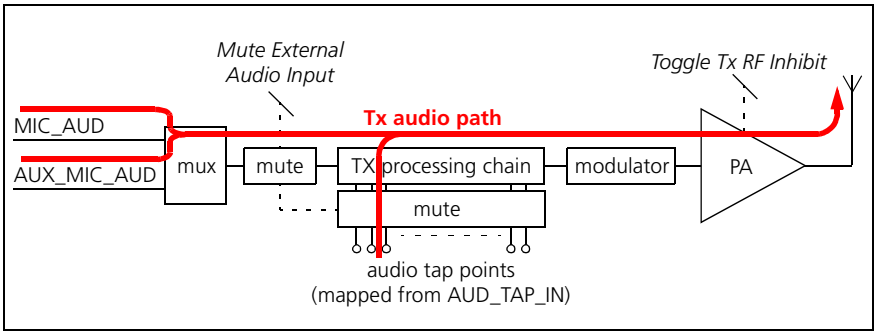
The 'Home Channel' input signal is used to permanently change to a specified reference channel, which can be used to increment or decrement from.

3.1.15 Mute External Audio Input

Application

This input signal is used to open or close the mute of selected audio inputs to allow or prevent transmission of unwanted audio. This can be useful in cases where a controller wants to send information and does not want to be interrupted by incoming audio.

Figure 3.6 Mute External Audio Input



Configuration

1. Configure an input line and associate it with this action. Set the active state (high or low) and the debounce time.
2. On the same form, configure an option to mute the audio from the microphone inputs, the audio tap inputs, or all audio inputs.

Timing

The response time for both activation and deactivation is approximately 2ms plus debounce time.

Description

When the input line is activated, the radio mutes the audio input(s) selected. If a higher priority unmute condition exists, activation of this line will have no effect.

When the input line is deactivated, the audio input path reverts to its previous state. If a higher priority mute condition exists, deactivation of this line will have no effect.

If the input line is active while the radio is powered up, it must be re-applied for the action to be carried out.

Related Actions

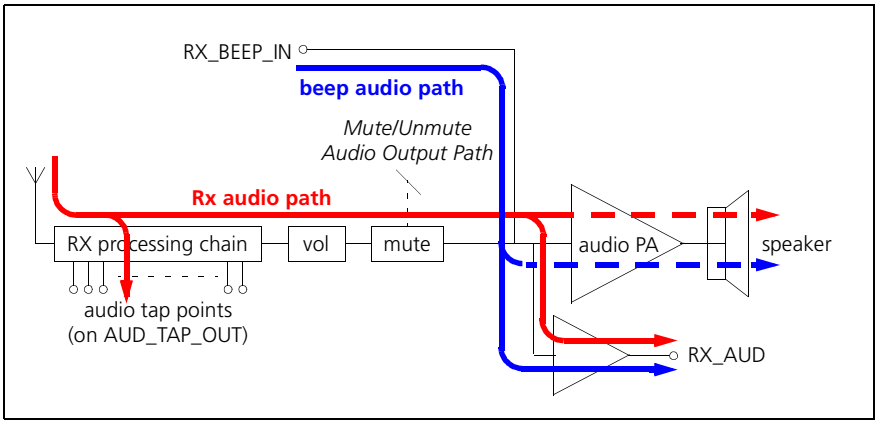
None.

3.1.16 Mute Audio Output Path

Application

This input signal is used to close the mute of selected audio paths to prevent audio from being output. This allows an external device to turn off audio to the speaker (e.g. for a data channel) or other audio equipment.

Figure 3.7 Mute/Unmute Audio Path



Configuration

1. Configure an input line and associate it with this action. Set the active state (high or low) and the debounce time.
2. On the same form, configure an option to mute the audio output of the speaker output path, the auxiliary output path, or all output paths.

Timing

The response time for both activation and deactivation is approximately 2ms plus debounce time.

Description

When this input line is activated, the radio mutes the configured audio output path(s). If a higher priority unmute condition exists, activation of this line will have no effect.

When this input line is deactivated, the audio output path(s) reverts to its (their) previous state. If higher priority mute condition exists, deactivation of this line will have no effect.

If the input line is active when the radio is powered up, it must be re-applied for the action to be carried out.

Related Actions

The 'Unmute Audio Output Path' input signal activates the Rx audio path only.

The 'Force Audio PA Off' input signal deactivates the audio PA.

The 'Force Audio PA On' input signal activates the audio PA.

3.1.17 Unmute Audio Output Path

Application

This input signal is used to open the mute of selected audio paths to allow audio to be received. This allows the signal to go through to the speaker (e.g. for beeps of an external device, a public address system, or an external voice recorder). Please refer also to Figure 3.7 on page 62.

Configuration

1. Configure an input line and associate it with this action. Set the active state (high or low) and the debounce time.
2. On the same form, configure an option to unmute the audio output of the speaker output path, the auxiliary output path, or all output paths.

Timing

The response time for both activation and deactivation is approximately 2ms plus debounce time.

Description

When this input line is activated, the radio unmutes the configured audio output path(s). If a higher priority mute condition exists, activation of this line will have no effect.

When this input line is deactivated, the audio output paths revert to their previous state. If higher priority unmute condition exists, deactivation of this line will have no effect.

Related Actions

The 'Mute Audio Output Path' input signal deactivates the Rx audio path only.

The 'Force Audio PA Off' input signal deactivates the audio PA.

The 'Force Audio PA On' input signal activates the audio PA.

3.1.18 Send Mic Audio to Spkr

Application

Sends microphone audio to the radio's speaker.

Configuration

Configure an input line and associate it with this action. Set the active state (high or low) and the debounce time.

Timing

The response time for both activation and deactivation is approximately 2ms plus debounce time.

Description

When this input line is activated, the radio routes the microphone audio path to the speaker.

When this input line is deactivated, the microphone path to the speaker is removed.

If this input line is active at power-up, the configured action on activation has to be executed after startup, on transition to user mode.

This action, when assigned to CH_GPIO1, can be used with a TM8100 or TM8200 DTMF microphone to generate DTMF side tones. When a key is pressed on the microphone, DTMF tones being transmitted are fed to the radio's speaker, at a reduced volume. This gives the radio user confidence that the tones are being transmitted.

Related Actions

The 'Mute Audio Output Path' input signal activates the Rx audio path only.

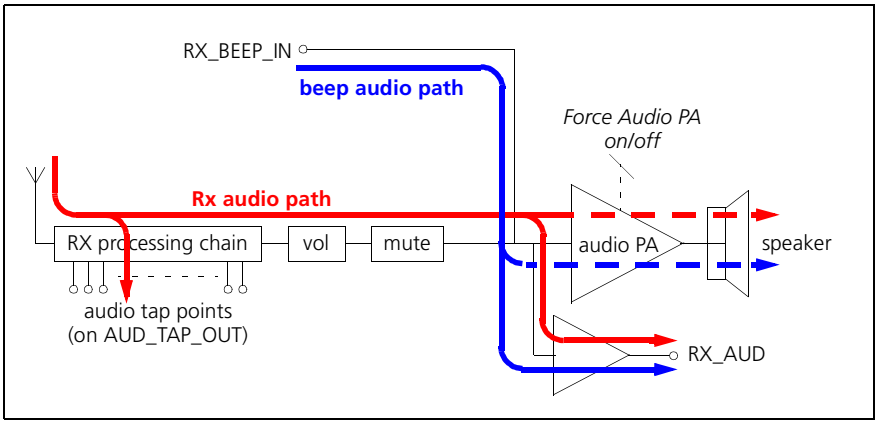
The 'Unmute Audio Output Path' input signal deactivates the Rx audio path only

3.1.19 Force Audio PA On

Application

This input signal is used to activate the audio PA. This action is required to allow any audio on the RX_BEEP_IN line of the internal options connector to be heard from the speaker when no other audio unmute conditions exist.

Figure 3.8 Force Audio PA on/off



Configuration

Configure an input line and associate it with this action. Set the active state (high or low) and the debounce time.

Timing

When this input line is activated and the audio PA is off, there will be a delay of 50ms before audio PA output is unmuted. This delay prevents undesired transient noise (audible 'pop') caused by the audio PA powering up. If the audio PA is already on or there has been speaker audio within 100ms prior to activation there is no significant unmute delay.

Description

When this input line is activated, the radio unmutes the audio PA. If the audio PA is already unmuted, no action occurs. If a higher priority mute condition exists, activation of this line will have no effect.

When this input line is deactivated, the audio PA reverts to its previous state. If a higher priority unmute condition exists, deactivation of this line will have no effect.

If the input line is active while the radio is powered up, it must be re-applied for the action to be carried out.

Related Actions

A related 'Force Audio PA Off' input signal exists, for which another input line can be assigned. Separate input lines are needed because deactivation of each line should release the corresponding action rather than forcing the audio PA into the opposite state.

The 'Mute Audio Output Path' input signal activates the Rx audio path only.

The 'Unmute Audio Output Path' input signal deactivates the Rx audio path only.

3.1.20 Force Audio PA Off

Application

This input signal is used to deactivate the audio PA. This action is required, for example, to allow the use of a telephone handset for which - when it is taken off hook - the audio PA should be deactivated to prevent the audio from coming out of the internal or remote speaker. Please refer also to Figure 3.8 on page 64.

Configuration

Configure an input line and associate it with this action. Set the active state (high or low) and the debounce time.

Timing

When this input line is activated and the audio PA is on, there will be no significant delay before the speaker audio is muted. After 100ms the audio PA will be fully powered down and current consumption will reduce by 50mA.

Description

When this input line is activated, the radio mutes the audio PA. If the audio PA is already muted, no action occurs.

When this input line is deactivated, the audio PA reverts to its previous state.

If the input line is active while the radio is powered up, it must be re-applied for the action to be carried out.

Activation of 'Force Audio PA Off' input line takes precedence over the 'Force Audio PA On' input line. When both inputs are active at the same time, the speaker is disabled but any audio signal present is still output through RX_AUD.

Related Actions

A related 'Force Audio PA On' input signal exists, for which another input line can be assigned. Separate input lines are needed because deactivation of each line should release the corresponding action rather than forcing the audio PA into the opposite state.

The 'Mute Audio Output Path' input signal activates the Rx audio path only. The 'Unmute Audio Output Path' input signal deactivates the Rx audio path only.

3.1.21 Simulate F1 to F4 Key

Application

These input signals are used to simulate the press of function keys on the control head. Both short and long key presses can be simulated.

These input lines do not perform any pre-defined actions, but only simulate the press of specific function keys. This means that when the associated function key is re-programmed to carry out a different function, activation of this line will also carry out the new function.

Configuration

Configure an input line and associate it with this action. Set the active state (high or low) and the debounce time.

Timing

When a function key has only one function assigned, the key press will be actioned as soon as it is sensed.

When a function key is assigned different functions for short and long key press:

- The short key press function will be actioned as soon as the signal is released, if the signal has been active for between 100 and 750 ms.
- The long key press function will be actioned as soon as the signal has been active for 750 ms.

Description

When any of these input lines is activated, the function associated with the corresponding function key is carried out. Short/long activations of this input line will have the same effect as short/long function key presses.

Related Actions

The 'Toggle F1 to F4 Key LED' input signals are used to turn the LEDs of the control head on and off for display purposes, e.g. for key functions that have no LED assigned.

The 'F1 to F4 Key Status' output signals are used to reflect the press of function keys on the control head.

3.1.22 Toggle F1 to F4 Key LED

Application

These input signals are used to turn the LEDs of the control head on and off for display purposes, e.g. for key functions that have no LED assigned. When any of these lines are active, no other source will be able to control the associated LED.

Note The graphical-display control head only has two LEDs, for the F1 and F4 key.

Configuration

Configure an input line and associate it with this action. Set the active state (high or low) and the debounce time.

Timing

The display is updated every 50ms. The response time of the LED can therefore be between 2 and 52ms plus debounce time.

Description

When this input line is activated, the associated LED lights up.

When this input line is deactivated, the associated LED goes out.

If the input line is active while the radio is powered up, it must be re-applied for the action to be carried out.

Related Actions

The 'Simulate F1 to F4 Key' input signals are used to simulate the press of function keys on the control head. Both short and long key presses can be simulated.

The 'F1 to F4 Key Status' output signals are used to reflect the press of function keys on the control head.

3.1.23 Toggle Alarm Mode

Application

Begins or ends GPS alarm mode.

When the line is active, the radio will switch to the channel indicated by the Channel Type, and begin sending the radio's current GPS location data every Callout Interval.

Alarm mode will end when the Maximum Number of Callouts is reached, or the line is deactivated.

Configuration

1. Configure the Emergency Mode and Channel Type parameters required, as well as the SDM Enabled and GPS Alarm Mode parameters.
2. Configure an input line and associate it with this action. Set the active state (high or low) and the debounce time.

Timing

The response time for both activation and deactivation is approximately 2ms plus debounce time.

Description The input line is activated by a third party device.

The radio immediately begins the Alarm Mode operation according to the characteristics defined for the network and channel.

The radio will cancel Alarm Mode operation once this input is deactivated.

If this input is active at power-up, the Alarm Mode is entered immediately at startup.

Related Actions None

3.1.24 Activate THSD Modem

Application Activates the radio's high speed data (THSD) modem, ready to send or receive high speed data.

Configuration Configure an input line and associate it with this action. Set the active state (high or low) and the debounce time.

Timing The response time for both activation and deactivation is approximately 2ms plus debounce time.

Description When the nominated input line is activated, the radio will activate the THSD modem. This will select the protocol according to the database settings for THSD protocol and FEC.

This action is only valid if a Software Feature Enabler (SFE) license has been obtained, and entered, and the Modem Enabled check box has been selected. When the line is deactivated, the radio will exit THSD transparent mode.

Note If the radio is configured to startup in THSD transparent mode, then deactivation of the input 'Activate THSD Mode' will not exit THSD transparent mode after the radio is powered up.

Related Actions Powerup State "THSD Transparent Mode".

3.1.25 RTS Control (DCE)

Application Sets the input line on the radio for hardware flow control (handshaking). DCE stands for data communication equipment, and refers to the radio. The data terminal equipment (DTE) activates this line to indicate that it is ready to receive serial data from the radio.

Note If this action is assigned to a pin, the RTS field will be automatically updated.

Important Inputs selected for this purpose will need to have a 3K3 resistor placed in series with the input, to make them RS232 level compatible.

Configuration

1. Configure Serial Communications - Flow Control in Command Mode and/or Transparent Mode for "Hardware".
2. Select Hardware Flow Control I/O Pins for both CTS (DCE) and RTS (DCE).
3. Configure Active Low/High for RTS and CTS.
4. Configure Debounce time for RTS and CTS.

Timing The input response time for both activation and deactivation of RTS (DCE) is less than 1ms.

Note Debounce time for RTS (DCE) should be set to '0'.

Description The external third party device (DTE) activates this RTS control line to indicate to the radio that it is ready to receive serial data from the associated TXD line of the radio.

Related Actions 'CTS Control (DCE)' sets the output line on the radio for hardware flow control.

3.1.26 Lock Radio UI (PIN to unlock)

Application Locks the radio. The radio user must press the Security PIN sequence to return the radio to a normal state. This option is only valid if the Security Lock on Power Up check box is selected.

Configuration

1. Configure the security PIN.
2. Configure an input line and associate it with this action. Set the active state (high or low) and the debounce time.

Timing Allow debounce time plus 2 ms.

Description When the input line is activated, the radio UI goes into secure mode.

Related Actions None.

3.2 Digital Output Lines

This section describes the general design principles for use of the programmable I/O lines configured as outputs, and the output signals that can be set for them.

Available Output Lines

The following lines are available to be used as outputs:

Table 3.6 Digital output lines

Signals	Connector	Direction
AUX_GPIO4…7	auxiliary connector	input or output
IOP_GPIO1…7	internal options connector	input or output
CH_GPIO1 MIC_GPIO1[1] PRG_GPIO1[1]	control head connector microphone connector programming connector	input or output

1. CH_GPIO1 of the control head connector is the same signal as MIC_GPIO1 of the microphone connector (control heads with user interface) and PRG_GPIO1 of the programming connector (blank control head).

For details on the connector pin-outs and electrical characteristics of these lines refer to "Description of the Radio Interfaces" on page 13.

Compatibility

Table 3.2 describes the compatibility of the output lines with common industry logic standards:

Table 3.7 Digital output lines - compatibility

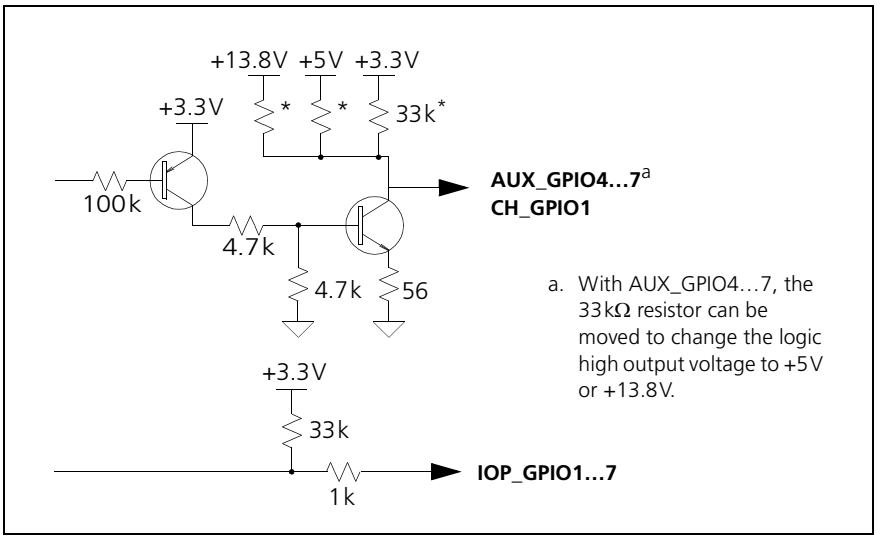
Output line	Logic standard output compatibility			
	3.3V CMOS	5V CMOS	5V TTL	RS-232[1]
AUX_GPIO4…7	Yes	Yes[2]	Yes	No
AUX_TXD	Yes	No	Yes	No
IOP_GPIO1…7	Yes	No[3]	Yes	No
IOP_TXD	Yes	No[3]	Yes	No
CH_TXD MIC_TXD PRG_TXD	Yes	No	Yes	No
CH_GPIO1 MIC_GPIO1	Yes	No[3]	Yes	No

1. While the output levels do not comply with the RS-232 standard, almost all modern RS-232 level conversion devices are 3.3V/5V CMOS or TTL level-compatible. Therefore, it usually possible to drive modern external RS-232 devices directly without level conversion if the length of the connection cable is <3m.
2. Yes, provided internal pullups to 5V are selected.
3. These outputs can be made 5V CMOS-compatible using a 3.3kΩ pullup resistor to 5V that is provided by the device being driven.

Output Circuitry

The digital outputs are designed to interface to application circuitry in a straightforward manner. Figure 3.9 shows a simplified diagram of the digital output lines (ESD protection not shown). For full details of the interface, refer to the PCB information or to the technical support website.

Figure 3.9 Digital output lines - simplified circuit diagrams



The internal logic circuitry of the radio operates at 3.3V. Unless application circuitry is able to operate at this voltage level, some form of level conversion will normally be required. With the AUX and CH output lines, conversion to 5V or 13.8V can be selected by moving the pullup resistor as indicated in Figure 3.9.

Note These resistors only provide a weak pullup and hence the output is only able to source a very small current. In the logic low state, the outputs can sink a higher current. For more information refer to "Description of the Radio Interfaces" on page 13.

The IOP output lines always operate at 3.3V logic levels and any level conversion is the responsibility of the application circuit designer.

Pullup Resistors

For the output lines AUX_GPIO4 to AUX_GPIO7 the output configuration is open collector with pullup. The hardware provides several pullup options.

Placeholder pullup resistors to 3.3V, 5V or 13.8V are provided. Table 3.8 gives an overview of the output lines and their placeholder pullup resistors.

Table 3.8 Placeholder pullup resistors

Output line	3.3V pullup	5V pullup	13.8V pullup
AUX_GPIO4	R769[1]	R778	R782
AUX_GPIO5	R770[1]	R779	R783
AUX_GPIO6	R771[1]	R780	R784
AUX_GPIO7	R772[1]	R781	R785

1. Factory default.

At power up and power off, the voltage of the output lines will be determined by the fitting of the pullup resistors.

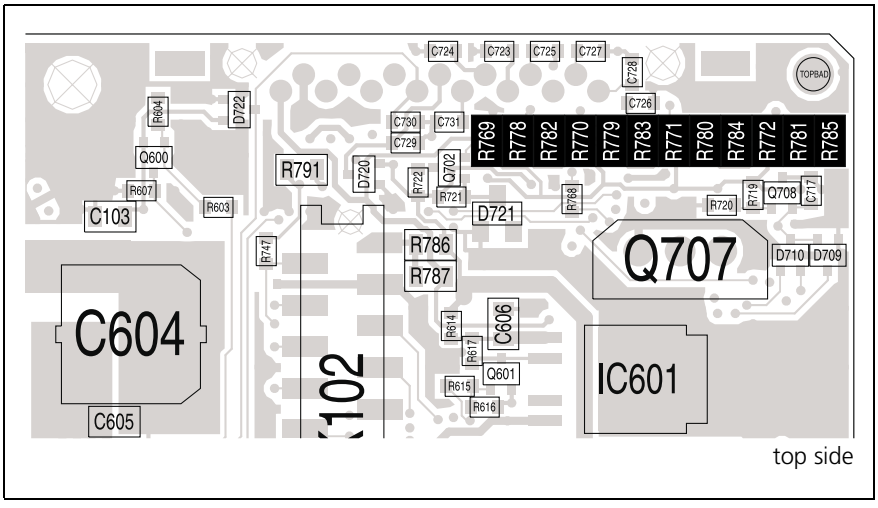
Figure 3.10 shows the positions of these placeholders on the main board assembly.

Follow the instructions of the service manual for your radio on removing and fitting the radio lid, the main board assembly, and SMD components.

For any I/O line, exactly one pullup resistor must be fitted. To change the pullup option it is recommended to move the factory-fitted pullup resistor to the desired location.

If you require a different pullup resistance value, remove the factory-fitted resistor and fit your own in the desired location. The current through the pullup resistor must not exceed 5mA when the output is low. For example, the value of a pullup resistor to 5V must be >1kΩ.

Figure 3.10 Positions of placeholder pullup resistors on main board assembly



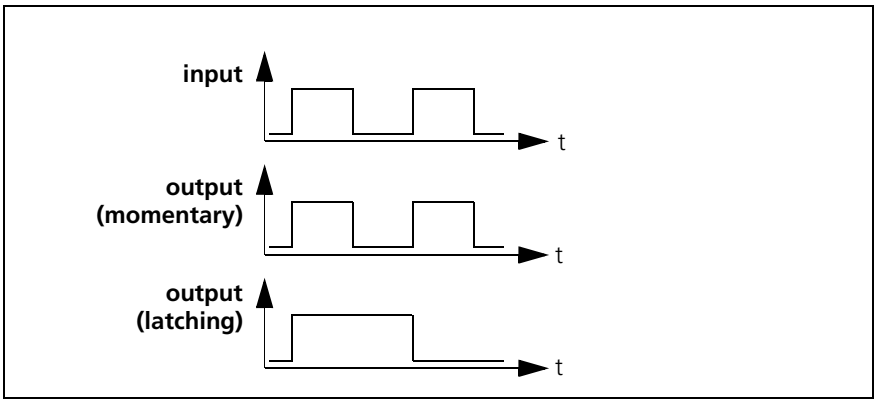
Special Purpose Outputs

AUX_GPIO4 can be used as a general purpose output with normal drive levels, or it can be configured as a high current sink output capable of directly driving external devices. To configure high current sink, a high power transistor must be soldered to the main board assembly. For more information refer to "Connecting an External Alert Device" on page 129.

Momentary or Latching

Output signals are latching or momentary, depending on their function. Examples: 'Control Status Rx (Line 1 to 3)' is always latching. Most of the other output signals are momentary. 'F1 to F4 Key Status' can be either latching or momentary.

Figure 3.11 Momentary and latching output signals



Power-Up Considerations

During power-up of the radio, any I/O lines configured as outputs are in an uncontrolled and high-impedance state. The pullup resistors have a dominant effect and thus all outputs will appear as if they are indicating logic high during this period.

The radio will not actively control these lines for up to 1 to 2 seconds after power is first applied, or the radio has been switched on. It is therefore important to consider how this will affect application circuitry interfaced to the radio, and to take measures to manage what happens during this transition.

Defining the active state of the outputs as logic low may provide suitable protection, as outputs will appear inactive during radio power-up. In other cases it may be necessary to buffer the outputs with suitable circuitry to isolate application circuits from the radio signals during this transition.

Output Signals

Table 3.9 gives a brief description of the output signals available for programming of the digital output lines, and indicates whether the output signals are valid for conventional radio systems, trunked radio systems, or both.

Note The Mode column refers to the Mode field on the Programmable I/O form.

Following the table are more detailed notes on each output signal.

Table 3.9 Digital output signals

Output action	Mode	Description
"Busy Status" on page 77	Conventional	Activates the output line when the radio detects a carrier signal (the busy detect LED indicator is on). When the carrier ends, the line will deactivate.
"Call Setup Status" on page 84	Conventional	Activates the output line when a call is set-up (monitor opens due to a sequence sent or received). When monitor closes, the line will deactivate.
"Channel Locked Status" on page 79	All / Conventional / Trunked	Activates the output line when the radio displays OL (the synthesiser is out-of-lock). This means the radio cannot transmit due to being out of band, and can indicate hardware failure. When the radio is able to transmit on a channel, the line will deactivate.
"Control Status Rx (Line 1 to 3)" on page 85	Conventional	Activates the output line when a Selcall sequence is received that contains a control status set to Activate Digital Line (after the Digital Line Control Status Delay). The line will deactivate when a control status is received set to Deactivate Digital Line.
"CTS Control (DCE)" on page 89	Conventional	Sets the output line on the radio for hardware flow control (handshaking) while in conventional mode. DCE stands for data communication equipment, and refers to the radio. The radio activates this line to indicate that it is ready to receive serial data from the Data Terminal Equipment (DTE). Compare with the input RTS Control (DCE). If this action is assigned to a pin, the CTS field (Data form) will be automatically updated.
"External Alert 1 and 2" on page 80	All / Conventional / Trunked	Activates one or both output lines (in a programmed pattern and after a programmed delay) when certain call types are received. In conventional mode, this applies to Selcall or two-tone calls received with External Alert 1 or External Alert 2 programmed. In trunked mode, this applies to call types that are selected on the MPT Alerts form > External Alerts tab. The line will deactivate and stay deactivated when the call is answered, or the programmed duration expires.
"F1 to F4 Key Status" on page 87	All / Conventional / Trunked	Activates the output line when the function key is pressed. Select the Signal State as Momentary or Latching, and assign the Action Digital Output Line option to the function key on the Key Settings form. The line will deactivate when the key is released (momentary), or pressed a second time (latching).

Table 3.9 Digital output signals (Continued)

Output action	Mode	Description
"FFSK Data Received Status" on page 88	Conventional	Activates the output line at the beginning of a valid fast frequency shift keying (FFSK) data reception. The line will deactivate when the data is no longer valid (for example, the signal has ended).
"Hookswitch Status" on page 83	All / Conventional / Trunked	Activates the output line when the microphone is removed from the hookswitch. When the microphone is placed back on the hook, the line will deactivate.
"Monitor Status" on page 83	Conventional	Activates the output line when monitor is open, due to a call setup, a function key press, the menu, or a PTT press. When monitor closes, the line will deactivate. If monitor opens when the microphone is removed from the hook (Hookswitch Monitor), the line will not be asserted.
No Action	All / Conventional / Trunked	The radio will not activate the output line, unless the output is selected for an input pin's Mirrored To field.
"On Data Traffic Channel" on page 83	Trunked	Activates the output line when the radio is on a traffic channel and ready to send or receive data. The line will deactivate when the call ends.
"Public Address Status" on page 81	Conventional	Activates the output line when the radio is in public address mode and a PTT is active (pressed). The line will deactivate when the PTT is no longer active (released). If using the Tait Public Address options board, this action must be assigned to IOP_GPIO2, and Active set to high.
"Radio Has Service" on page 77	Trunked	Activates the output line when a the radio has service and is able to communicate with the network. The line will deactivate if the radio loses service (the service symbol is flashing).
"Radio Idle" on page 84	Trunked	Activates the output line when the radio is idle and ready to accept an incoming or outgoing call request. The line will deactivate when the radio is no longer idle (for example, is involved in a call).
"Radio On Traffic Channel" on page 83	Trunked	Activates the output line when the radio is on a voice or data traffic channel. The line will deactivate after the call ends.
"Radio Ready" on page 90	All / Conventional / Trunked	Activates the output line when the radio is powered up and fully initialised in either conventional mode or trunked mode. The line will deactivate when the radio powers down, or during a change of mode.

Table 3.9 Digital output signals (Continued)

Output action	Mode	Description
"Radio Stunned" on page 86	All / Conventional / Trunked	Activates the output line when the radio is stunned, and deactivates the line when the radio is revived. In conventional mode, the radio is stunned when a Selcall call is received that contains a control status set to Full Stun or Tx Stun, and is revived when a control status is received that is set to Revive. Stun and revive is not valid in trunked mode for this release.
"Radio Transmission Status" on page 78	All / Conventional / Trunked	Activates the output line when the radio is transmitting. The line will deactivate when the radio ends RF transmission.
"Ready For NPD" on page 89	Trunked	Activates the output line when the radio is able to set up a data call, or is on a data traffic channel. The line will deactivate when the radio is unable to transmit data over-the-air from the terminal equipment (for example, during a hunting or a call setup procedure).
"Reflected PTT Inhibit Status" on page 81	Conventional	Activates the output line when the current PTT is inhibited (according to the settings on the PTT form). The line will deactivate when the PTT is no longer inhibited.
"Reflected PTT Status" on page 79	All / Conventional / Trunked	Activates the output line when a PTT is active. This applies to any PTT with the PTT State is Reflected check box selected. When the PTT is released, the line will deactivate.
"Reflect THSD Modem Status" on page 82	Conventional	Activates the output line whenever the THSD modem has been activated, and the radio is in THSD transparent mode. The radio can enter THSD transparent mode via the programmable input Activate THSD Modem, the Powerup State, or a CCDI command. The line will deactivate when the radio exits THSD transparent mode.
"Serial Data Tx In Progress" on page 89	Conventional	Activates the output line whenever the radio is transmitting serial data. This does not apply to GPS data sent via the GPS Port. This option can be used with the Line Interface board to provide RS 485 support. The line will deactivate when the radio stops transmitting data via the TXD line.
"SIBT Received" on page 86	Conventional	Activates the output line when a single in-band tone is detected as valid on a channel. The line will deactivate as soon as the carrier ends.
"Signalling Audio Mute Status" on page 82	Conventional	Activates the output line when valid traffic is detected. If there is no subaudible or selective signalling on a channel, then activity detected is always valid and the line asserted. The line will deactivate when the audio mute closes.

3.2.1 Busy Status

Application

This output signal is used to reflect the busy status, i.e. whether or not the receiver detects an RF carrier (busy detect LED is on). The detection of the RF carrier can be based on either signal strength (RSSI) or noise level. This allows the radio to wake up a receiving modem or start voice recording (for example).

Note The detection method can be set in the Squelch Detect Type field of the Networks / Basic Settings form (Basic Networks Settings tab) of the programming application. For more information refer to the online help of the programming application

Configuration

Configure an output line and associate it with this action. Set the active state to be high or low (as required).

Timing

The response time of this output line is <5ms for signal strength (RSSI), and <20ms for noise level.

Description

When the radio detects a change in the state of the busy-detect circuitry, the radio sets the state of this output line to reflect the busy detect state. When 'busy', the output line is active. When 'not busy', the output line is inactive.

Related Actions

An indication of received signal strength is available from the RSSI output.

The 'Signalling Audio Mute Status' output signal indicates that a signal is being received which also has valid signalling.

3.2.2 Radio Has Service

Application

Activates the output line when a the radio has service and is able to communicate with the network. The line will deactivate if the radio loses service (the service symbol is flashing).

Configuration

Configure an output line and associate it with this action. Set the active state to be high or low (as required).

Related Actions

This is the MPT equivalent of "Busy Status" on page 77.

3.2.3 Radio Transmission Status

Application

This output signal indicates whether the radio is in transmission mode.

This can be used

- with external modems as a gate for the start of data transmission
- with external applications, instead of looking at the PTT status, in order not to interrupt a transmission by the user
- to switch scramblers from receive to transmit

Configuration

Configure an output line and associate it with this action. Set the active state to be high or low (as required).

Timing

Rx to Tx: The GPIO output changes state 4.0+/-0.5msec before radio reaches 90% Tx power output.

Tx to Rx: The GPIO output changes state 7.5+/-0.5msec after Tx power output falls to -10dBm.

Description

When the radio starts an RF transmission, this output line is activated. When the radio stops the RF transmission, this output is deactivated.

While the 'Toggle TX RF Inhibit' input line is active, the RF output will be inhibited, but the radio stays in transmit mode (refer to "Toggle Tx RF Inhibit" on page 53). The 'Radio Transmission Status' input line is not affected by the 'Toggle TX RF Inhibit' input line.

Related Actions

The 'Reflected PTT Inhibit Status' output signal reports transmission requests via any of the PTT input signals.

3.2.4 Channel Locked Status

Application

This output signal is used to indicate the frequency lock status of the synthesizer and is constantly activated during normal operation. The output is deactivated if the radio synthesizer is unable to "lock" to the current channel frequency, which can be caused by a hardware fault.
The deactivation of this output always coincides with the "OL" (out of lock) control head display.

Note During channel change, although the synthesizer has to re-synchronise with the new channel frequency, this output will not be temporarily deactivated.

Configuration

Configure an output line and associate it with this action. Set the active state to be high or low (as required).

Timing

The maximum time out of lock before this action is activated (e.g. during channel change) is 50ms.

Description

When the radio detects a change of the synthesizer lock detect state, the radio sets the state of this output line to reflect the lock detect state. When the synthesizer is locked, the output line is active. When the synthesizer is not locked, the output line is inactive.

Related Actions

None.

3.2.5 Reflected PTT Status

Application

This action is used to report the PTT status by generating a logic OR of all PTT sources programmed to reflect their status. The priority does not affect the logic OR.

Configuration

1. In the PTT form, configure the 'PTT State is Reflected' check box for each PTT type.
2. In the Programmable I/O form, configure an output line and associate it with this action. Set the active state to be high or low (as required).

Timing

The response time of this output line is less than 2ms.

Description

When the radio detects a change in PTT state, it sets the state of this output line to reflect the PTT state. When any PTT state changes to active, the output line is active. When all PTT states change to inactive, the output line is inactive.

Related Actions

The external PTTs can be monitored directly by the external application.

3.2.6 External Alert 1 and 2

Application

These two output signals are used to indicate the reception of a call to an externally connected device. The alert can be programmed to occur for specific call types.

The AUX_GPIO4 line of the auxiliary connector can be fitted with a power MOSFET in order to connect signal indicators directly to the radio (e.g. flashing light, buzzer, horn relay). With the other GPIO lines, if no power MOSFET is fitted to the AUX_GPIO4 line, the signal characteristics specified in "Description of the Radio Interfaces" apply.

Two different external alert types (external alert 1 and 2) can be specified, and either none, external alert 1, external alert 2 or both can be activated.

For more information on external alerts refer to the online help of the programming software.

Configuration

1. If you want to connect to an external alert device such as horn or lights relay, follow the instructions in "Connecting an External Alert Device" on page 129.
2. Configure AUX_GPIO4 (when connection to an external alert device) or any other output line and associate it with this action. Set the active state to be high or low (as required).
3. On the Alerts form, configure external alert 1 and/or 2 (delay, duration, mode).

Note When programming this output line for TM8200 radios, the 'Mode' field can be used to define different ring patterns and assign priorities for each call type.

Timing

The timing of the external alert signal activation and deactivation is determined by the settings in the programming application.

Description

When the radio receives a call (individual call 1 or 2, priority call, group call or emergency call), which goes unanswered for the specified amount of time, the radio indicates the incoming call to the external device via the output line according to the currently programmed settings for the call alert function.

When the call is answered (i.e. external PTT activated or PTT pressed), the radio will stop indicating the incoming call to the external device.

Note Once the external alert function has been configured, it has to be manually activated by the user (via function key or radio menu), or the line will not activate when a call is received. If the radio is powered off then on again, the user has to activate the external alert function again.

Related Actions

None.

3.2.7 Public Address Status

Application

Activates the output line when the radio is in public address mode and a PTT is active (pressed).

The line will deactivate when the line is no longer active (released).

Configuration

Configure an output line and associate it with this action. Set the active state to be high or low (as required).

Note If using the Tait Public Address Board, this action must be assigned to IOP_GPIO2, and Active set to high.

Timing

The response time for both activation and deactivation is approximately 2ms plus debounce time.

Description

When the radio is in Public Address mode, the radio PTT state changes from off to on (caused by highest priority PTT), and the nominated output line is activated.

When the radio exits Public Address mode, or when the radio PTT state changes back to off, the output line is deactivated.

Related Actions

None

3.2.8 Reflected PTT Inhibit Status

Application

This output signal is used to report the current PTT inhibit status by generating a logic OR of all PTT sources programmed to reflect their status. The priority does not affect the logic OR.

Configuration

1. In the PTT form, configure the 'PTT Inhibit State is Reflected' check box for each PTT type.
2. In the Programmable I/O form, configure an output line and associate it with this action. Set the active state to be high or low (as required).

Timing

The response time of this output line is less than 2ms.

Description

When the PTT inhibit status changes from on to off, or from off to on, this status is reflected on the output line.

Related Actions

The 'Inhibit PTT' input signal is used to stop any current PTT transmissions, return to receive state and inhibit any further PTT transmission requests.

3.2.9 Reflect THSD Modem Status

Application

Asserts the output line whenever the THSD modem has been activated, and the radio is in THSD transparent mode. The radio can enter the THSD transparent mode via the programmable input 'Activate THSD Modem', the Powerup State, or a CCDI command. The line will deactivate when the radio exits THSD transparent mode.

Configuration

1. In the Programmable IO form select the Digital tab.
2. Select a GPIO pin which is to reflect the state of THSD activity
3. Set the Direction field to Output.
4. Set the Action field to Reflect THSD Modem Status.
5. Set the Active output state to either High or Low.

Timing

The output is asserted within 1ms of entering THSD transparent mode.

Description

When configured to Reflect THSD Modem Status, the output line will go to the selected Active state when THSD transparent mode is entered. The output line will go back to its inactive state when THSD transparent mode is exited.

Related Actions

None

3.2.10 Signalling Audio Mute Status

Application

This output signal is used to indicate valid traffic on a channel (e.g. to quieten a car stereo).

Configuration

Configure an output line and associate it with this action. Set the active state to be high or low (as required).

Timing

The response time of this output line is less than 2ms.

Description

If the radio receives a carrier and either signalling is valid or the monitor is active, this output line becomes active.

If the radio receives a carrier, and the channel is not programmed to have signalling, this output line becomes active.

Any condition that would cause audio mute to close will cause deactivation of this signal.

Related Actions

The 'Busy Status' output signal also detects the carrier but ignores signalling.

3.2.11 Radio On Traffic Channel

Application Activates the output line when the radio is on a voice or data traffic channel. The line will deactivate after the call ends.

Related Actions This is the MPT trunked equivalent of "Signalling Audio Mute Status" on page 82.

3.2.12 On Data Traffic Channel

Application Activates the output line when the radio is on a traffic channel and ready to send or receive data. The line will deactivate when the call ends.

Related Actions "Radio On Traffic Channel" on page 83

3.2.13 Monitor Status

Application This output signal is used to indicated the state of the monitor function. This allows an external application to determine whether the user has activated the monitor.

Note This output line only indicates the monitor function and not the hookswitch monitor function.

For more information on the monitor function refer to the user guide and the online help of the programming application.

Configuration Configure an output line and associate it with this action. Set the active state to be high or low (as required).

Timing The response time of this output line is less than 2ms.

Description When the radio detects a change in state of the monitor function, the radio sets the state of this output line to reflect the state of the monitor function. When monitor is active, the output line is active. When monitor is inactive the output line is inactive.

Related Actions The 'Hookswitch Status' output signal indicates the state of the hookswitch.

3.2.14 Hookswitch Status

Application This output signal is used to indicate the state of the hookswitch.

Configuration Configure an output line and associate it with this action. Set the active state to be high or low (as required).

Timing The response time of this output line is less than 2ms.

Description When the radio detects a change in state of the hookswitch, the radio sets the state of this output line to reflect the state of the hookswitch. When the hookswitch is off the hook, the output line is active. When the hookswitch is on the hook, the output line is inactive.

Related Actions None.

3.2.15 Call Setup Status

Application This output signal is activated when the radio is busy in a voice call. It remains active as long as the call is in progress, and may be used to trigger an application such as a voice recorder, or to quieten external audio equipment during the call.

Configuration

1. Configure an output line and associate it with this action. Set the active state to be high or low (as required).
2. Configure the Monitor function to activate on both call reception and call initiation. Set the Monitor Auto-Quiet timer to minimise the chance of turning the Monitor off in the middle of a call.

Timing The call setup status signal will respond within 2ms of monitor activation during call setup or reception.

Description This output signal is activated when the monitor function is activated by either a call setup or call reception.

The signal will be deactivated when the call is finished i.e. when the monitor is deactivated again due to auto-quiet tomato or reset signalling.

Note The monitor function does not get activated if the call is determined to be non-voice e.g. contains a control status.

Related Actions None.

3.2.16 Radio Idle

Application Activates the output line when the radio is idle and ready to accept an incoming or outgoing call request. The line will deactivate when the radio is no longer idle (for example, is involved in a call).

Configuration Configure an output line and associate it with this action. Set the active state to be high or low (as required).

Related Actions This is the MPT equivalent of "Call Setup Status" on page 84.

3.2.17 Control Status Rx (Line 1 to 3)

Application

These three output signals indicate that a call has been received which contains a pre-defined status code, causing the signal to either activate or deactivate. Up to three separate signals may be defined, each having unique activation and deactivation status control codes.

These outputs may be used in Simple Telecommand type systems to remotely control application devices by radio command. Example applications might include remote activation or deactivation of outstation equipment (beacons, pumps, generators etc.) from a central control point.

Configuration

1. Set up the radio to operate with Selcall on the intended operating channel.
2. Set an alert and/or a delay (in Detailed tab of the Selcall / Selcall Identity form).
3. Define the required control status values to activate and deactivate the desired control status signal (in the Selcall / Control Status form). For TM8200, define alpha labels in the Status Labels form.
4. Configure an output line and associate it with this action. Set the active state to be high or low (as required).

Note The signal state of this signal can be set to latching only.

Timing

The control status signal will respond within 2ms of receiving the last digit of the call sequence. If an alert and/or delay is configured, 500 ms for the alert and/or the programmed delay will be added to the response time.

Description

The output signal is activated upon reception of a valid Selcall sequence containing the pre-defined control activation status value.

The signal remains active until another valid Selcall sequence is received which contains the pre-defined control deactivation status value.

Related Actions

None.

3.2.18 SIBT Received

Application

This output signal indicates reception of a defined audio band (single in-band) tone.

This signal might be used to alert an application device to the presence of a pilot tone prior to other traffic being received.

Configuration

1. Set up the radio to operate with single in-band tone signalling on the intended operating channel.
2. Configure the single in-band tone parameters: tone frequency, minimum duration, and tone hold time
3. Configure an output line and associate it with this action. Set the active state to be high or low (as required).

Timing

The output signal response time is dominated by the settings of minimum tone duration and tone hold time.

Note The detection response time may lengthen if the S/N of the incoming signal is poor.

Description

This output signal is activated once the presence of the pre-defined in-band tone has been detected for the configured minimum duration.

The signal will remain active until the tone has not been detected for the duration of the configured tone hold time.

Related Actions

None.

3.2.19 Radio Stunned

Application

This output signal is used to indicate whether the radio has been stunned by receiving a Selcall containing a control status set to full stun or Tx stun. This can be used to indicate to external applications that the radio is unusable, or it can be used to control an external device to disable other equipment.

Configuration

Configure an output line and associate it with this action. Set the active state to be high or low (as required).

Timing

The response time of all output lines is less than 2ms after the last tone in the sequence was received.

Description

When the radio becomes stunned, this output line becomes active.

When the radio is revived, this output line becomes inactive.

Related Actions

None.

3.2.20 F1 to F4 Key Status

Application

These output signals are used to reflect the press of function keys on the control head. The actions can be programmed to be either:

- momentary – reflects the state of the function key (active when the function key is pressed, inactive when the function key is released)
- latching – one short press of the function key activates the output line, which then stays active until next short press of function key

These signals allow user interaction with an application device.

Configuration

1. Program any function to the function key (including 'None'). The function key LED will reflect the function key state.

Note If the function key is programmed to 'None' and an output line has been configured to reflect the function key state, the LED associated with this function key will not be affected.

2. It is recommended that the key be configured to Action Digital Output Line (Key Settings form), in order for the corresponding LED to reflect the key status.
3. Configure an output line and associate it with this action. Set the active state to be high or low (as required).
4. Configure the signal state to be either momentary or latching.

Timing

The response time of this output lines is less than 50ms.

Description

When the relevant function key is pressed, the output line becomes active.

Depending on the programmed mode, the output line remains active until the function key is released (momentary) or until the next key press (latching).

Related Actions

The 'Simulate F1 to F4 Key' input signals are used to simulate the press of function keys on the control head. Both short and long key presses can be simulated.

The 'Toggle F1 to F4 Key LED' input signals are used to turn the LEDs of the control head on and off for display purposes, e.g. for key functions that have no LED assigned.

3.2.21 FFSK Data Received Status

Application

This output signal indicates that the internal 1200 baud modem is detecting valid FFSK signalling i.e. indicating data reception.

This signal might be used to alert application devices to the presence of data.

Configuration

1. Configure the radio to expect FFSK data. On the Data form, check either the CCDI Options/Transparent Mode Enabled checkbox or the SDM Options/SDM Enabled check box.
2. Configure an output line and associate it with this action. Set the active state to be high or low (as required).

Timing

The output will indicate the presence of FFSK data within 2ms of the preamble/sync sequence being successfully decoded. Note that the preamble/sync sequence is 32 bit periods long (approximately 27ms duration).

The output will indicate the absence of FFSK once the channel is no longer busy.

Description

The output is activated when the radio successfully decodes an FFSK preamble/sync sequence.

Important The output will remain active as long as the channel remains busy (even if FFSK signalling disappears) and will become inactive once the incoming transmission ceases.

Related Actions

None.

3.2.22 CTS Control (DCE)

Application

Sets the output line on the radio for hardware flow control (handshaking). DCE stands for data communication equipment, and refers to the radio. The data terminal equipment (DTE) activates this line to indicate that it is ready to send serial data from the radio.

Note If this action is assigned to a pin, the CTS field will be automatically updated.

Configuration

1. Configure Serial Communications - Flow Control in Command Mode and/or Transparent Mode for "Hardware".
2. Select Hardware Flow Control I/O Pins for both CTS (DCE) and RTS (DCE).
3. Configure Active Low/High for RTS and CTS.
4. Configure Debounce Time for RTS and CTS.

Timing

Not applicable

Description

The radio activates the CTS control line (DCE) to indicate the third party device (DTE) that it is ready to receive serial data on the associated RXD line of the radio.

Related Actions

'RTS Control (DCE)' sets the input line on the radio for hardware flow control.

3.2.23 Ready For NPD

Application

Activates the output line when the radio is able to set up a data call, or is on a data traffic channel. The line will deactivate when the radio is unable to transmit data over-the-air from the terminal equipment (for example, during a hunting or a call setup procedure).

Related Actions

This is the MPT trunked equivalent of "CTS Control (DCE)" on page 89.

3.2.24 Serial Data Tx In Progress

Application

Sets the output line active when sending data out of the serial port. This can be used to control simplex RS485 and RS422 drivers.

Configuration

Configure an output line and associate it with this action.

Timing

The output line will become active 2ms before the data is sent.

Description Sets the output line active for data to transmit over serial port. Becomes inactive when data is no longer available to send.

Related Actions Used for CCDI/CCR control in two-wire simplex mode.

Note Simplex control may miss data due to nature of action.

3.2.25 Radio Ready

Application Activates the output line when the radio is powered up and fully initialised in either conventional mode or trunked mode.

Configuration Configure an output line and associate it with this action.

Timing The output line will become active when the radio is fully initialised.

The line will deactivate when the radio powers down, or during a change of mode.

3.3 Audio Tap In and Tap Out Lines

This section describes the general design principles for use of the programmable audio tap in and tap out lines.

Audio Tap Point Philosophy

The radio provides the ability to input and output audio at various tap points in the transmit and receive audio paths. This removes the need of tapping wires into the circuitry of the radio. The tap points and the type of tap are programmed into the radio and cannot be modified by the radio user.

Available Audio Tap In and Tap Out Lines

The following lines are available to tap into and tap out of the audio paths:

Table 3.10 Audio tap in and tap out lines

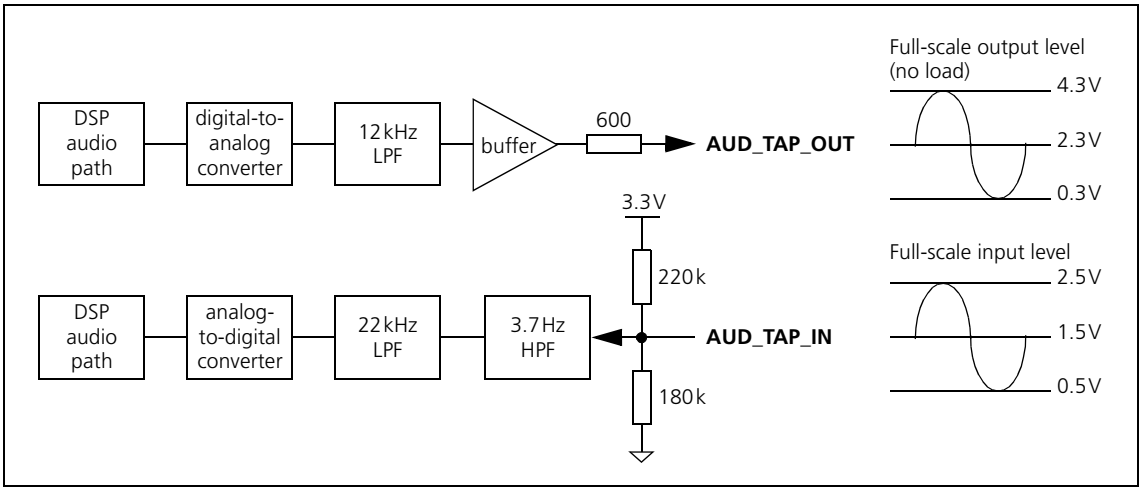
Signals	Connector	Direction
AUD_TAP_IN	auxiliary connector internal options connector	input only
AUD_TAP_OUT	auxiliary connector internal options connector	output only

For details on the connector pin-outs and electrical characteristics of these lines refer to "Description of the Radio Interfaces" on page 13.

Input/Output Circuitry

Figure 3.12 shows a simplified circuit diagram of the audio tap in and tap out lines. Protection circuits are not shown.

Figure 3.12 Audio tap input and output - simplified circuit diagram



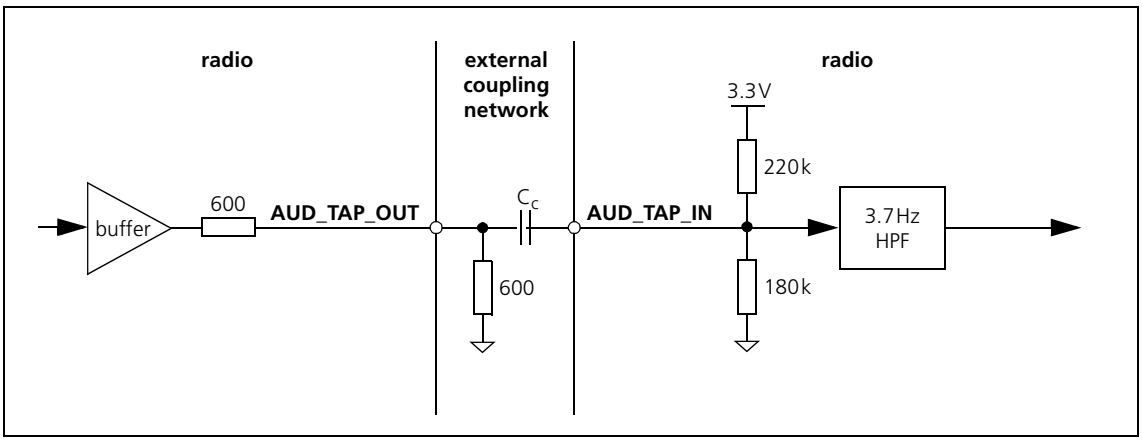
The signal source for the audio tap out line comes from the DSP audio path (refer to Figure 3.14 for details) and is fed to a digital to analog converter at 48000 samples per second. The converter output is low pass filtered at 12kHz to remove alias components and fed to a buffer amplifier. The buffer amplifier output is DC coupled to the AUD_TAP_OUT line and has a DC offset of nominally 2.3V. The DC offset is affected by Rx carrier frequency error for taps R1, R2 and R4. Full scale output level is nominally $4V_{p-p}$ with no load (for more information refer to "Auxiliary Connector" on

page 19). The buffer amplifier has an output impedance of nominally 600Ω that is constant across frequency.

The audio tap in line is also DC-coupled. A DC bias network provides a bias of nominally 1.5V. The valid DC input signal range is 0.5 to 2.5V nominally regardless of bias voltage. Therefore, to avoid asymmetrical clipping and reduced dynamic range, it is important that the input bias voltage is preserved when driving the input. This can be achieved by simply AC-coupling the drive signal. For data applications, DC-coupling may be desirable so, in this case, the driver must provide a DC bias signal as close as possible to 1.5V. After input biasing, the AUD_TAP_IN signal is fed to a switched capacitor high-pass filter with a cut frequency of 3.7Hz. This prevents the DC bias affecting the transmitter carrier frequency. The high-pass-filtered signal is then low-pass-filtered to prevent aliasing, and sampled by an analog-to-digital converter at 48kHz. The analog-to-digital converter output is then fed to the DSP audio path (refer to Figure 3.14 for details)

For some applications, such as a crossband link or fitting an encryption module, it is necessary to connect the audio tap out line to the audio tap in line. The two are not directly compatible but can be made so using a simple external coupling network as shown in Figure 3.13.

Figure 3.13 Connecting audio tap out and audio tap in

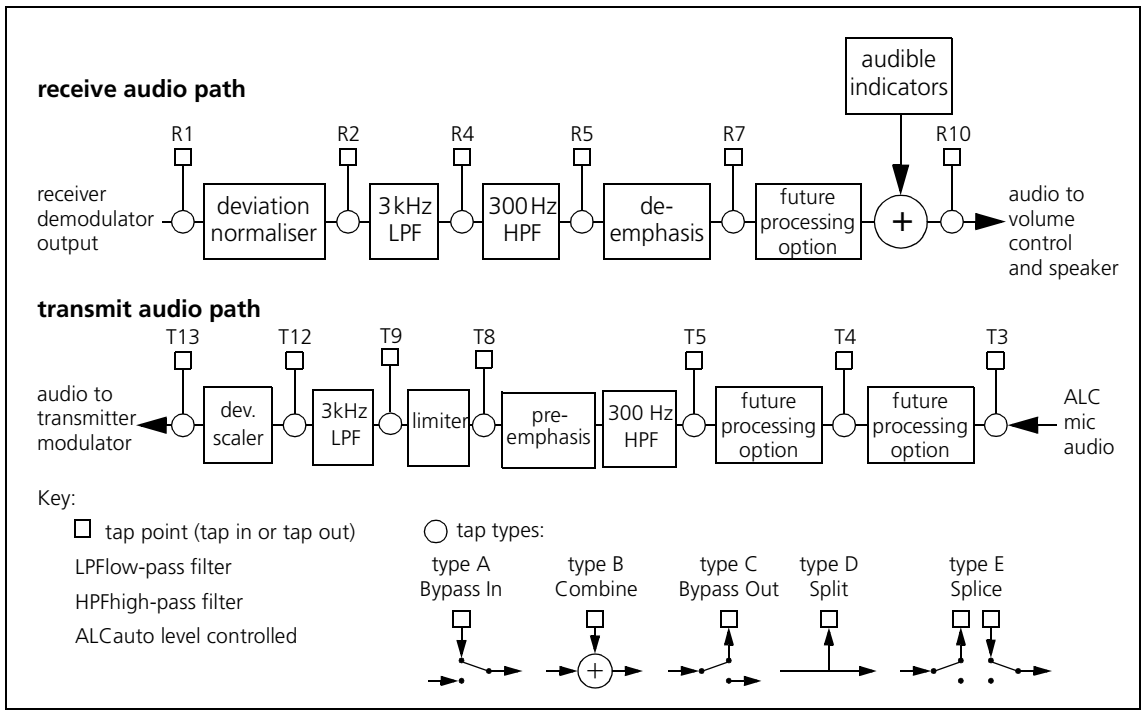


The 600Ω shunt resistor reduces the maximum level of audio tap out to nominally $2V_{p-p}$ to match the maximum input level of audio tap in. The coupling capacitor removes the DC offset. For voice applications, C_C should be at least 100nF. If high-speed baseband data modulation throughput is required, C_C of at least 4.7µF is recommended. The C_C capacitor should be a non-polarised type.

Audio Paths

Figure 3.14 shows a simplified block diagram of the receive and transmit audio paths, the locations of the tap points available, and the tap types.

Figure 3.14 Receive and transmit audio paths - simplified block diagram



Audio Configuration

The audio configuration consists of the following elements:

- audio source associated with each PTT (CH_MIC_AUD, AUX_MIC_AUD, AUD_TAP_IN)
- Rx/PTT type (Rx, Mic PTT, EPTT1, EPTT2)
- tap out point (R1, R2, R4, R5, R7, R10, T3, T4)
- tap out type (C-Bypass Out, D-Split, E-Splice)
- tap out unmute condition
- tap in point (T3, T4, T5, T8, T9, T12, T13, R7, R10)
- tap in type (A-Bypass In, B-Combine, E-Splice, H-Combine 0dB)
- tap in unmute condition

Audio Source

For each PTT (Mic PTT, EPTT1 and EPTT2) a different audio source can be selected. These audio sources are CH_MIC_AUD, AUX_MIC_AUD and AUD_TAP_IN.

Note You can allocate an audio tap input at the same time as a microphone input by setting the audio source for a PTT to CH_MIC_AUD or AUX_MIC_AUD, and defining a tap in and out point for the same PTT. However, audio samples from the audio tap input will overwrite those from the microphone input, unless the tap in type and tap out type are set to 'Combine'.

Rx/PTT Type

The radio can be programmed to tap into and out of the respective audio path when the radio is receiving or transmitting (initiated by one of the PTTs).

Tap Out and Tap In Points and Types

Table 3.11 lists the available tap points and the tap types available for them. The tap points and tap types are illustrated in Figure 3.14.

Select a tap out point to feed audio to an application device, and a tap in point to feed audio from an application device.

Important Do not use 'Bypass Out' on R1, R2 and R4 with subaudible or inband signalling schemes, as this may prevent correct operation of the signalling decoder.

The same tap point can be selected for both tap in and tap out. This is referred to as a 'Splice' tap type as it allows an audio processing device to be inserted into the radio's audio path. This tap type is primarily used for encryption applications (refer to "Encryption Module (Scrambler)" on page 119).

The 'Combine' tap type is intended for the injection of sidetone beeps into the Rx path.

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Table 3.11 Tap out points and tap out types

Rx/PTT type	Tap in points	Tap in types	Tap out points	Tap out types
Rx	R7	E - Splice	R1	C - Bypass Out D - Split
	R10	A - Bypass In B - Combine	R2	C - Bypass Out D - Split
			R4	C - Bypass Out D - Split
			R5	C - Bypass Out D - Split
			R7	C - Bypass Out D - Split E - Splice
			R10	C - Bypass Out D - Split
PTT, EPTT1, EPTT2	T3	A - Bypass In	T3	C - Bypass Out D - Split
	T4	E - Splice	T4	E - Splice
	T5	A - Bypass In	R10	C - Bypass Out D - Split
	T8	A - Bypass In		
	T9	A - Bypass In		
	T12	A - Bypass In		
	T13	A - Bypass In		
	R10	A - Bypass In B - Combine		

Note If a tap type is set to 'Splice', then the corresponding tap in or tap out type must also be set to 'Splice'. Both tap points and both unmute conditions must also be identical.

Tap In and Tap Out Unmute

For the Rx path, the settings for unmuting the tap in and the tap out points are:

- Busy Detect
- Busy Detect and Subaudible
- Rx Mute Open
- Except on PTT (not available for tap type E - Splice)

For all PTT types, the only setting for unmuting the tap in and the tap out points is On PTT

Applications

For application examples refer to:

- "External Modem" on page 110

- "Encryption Module (Scrambler)" on page 119
- "ANI Module" on page 125

4 Creating Your Own Options Board

TM8100 and TM8200 radios provide space for the following options boards:

- an internal options board inside the radio body using the internal options connector and (optional) the hole provided for the external options connector
- a blank control head options board (TM8105 only) between the radio body and the blank control head using the control head connector

This chapter describes the mechanical envelopes of these options boards, common design practices and EMC guidelines and the Internal Options Kit available from Tait.

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4.1 Internal Options Board

TM8100 and TM8200 radios provide space inside the radio body to accommodate an internal options board.

The internal options board is connected to the internal options connector and can also use the hole provided for the external options connector.
The internal options connector is described on page 27.
The provision for the external options connector is described on page 30.

Examples of internal options boards available from Tait:

- TMAA30-02 3DK Application Board.
  Refer to the TM8000 3DK Application Board Service Manual.
- TMAA01-01 Line-Interface Board.
  Refer to the TM8100/TM8200 Service Manual.
- TMAA01-05 Options Extender Board.
  Refer to the TM8100/TM8200 Service Manual.

4.1.1 Mechanical Envelope

Figure 4.1 and Figure 4.2 show the mechanical envelope available for internal options boards. Nine screw points are provided on the inside of the lid of the radio body.

Internal options boards can be sized and shaped as required and can use any combination of fixing parts to suit. Figure 4.3 shows an installation example.

Note Unless stated otherwise, all dimensions are given in millimetres.

Figure 4.1 Internal options board - maximum dimensions

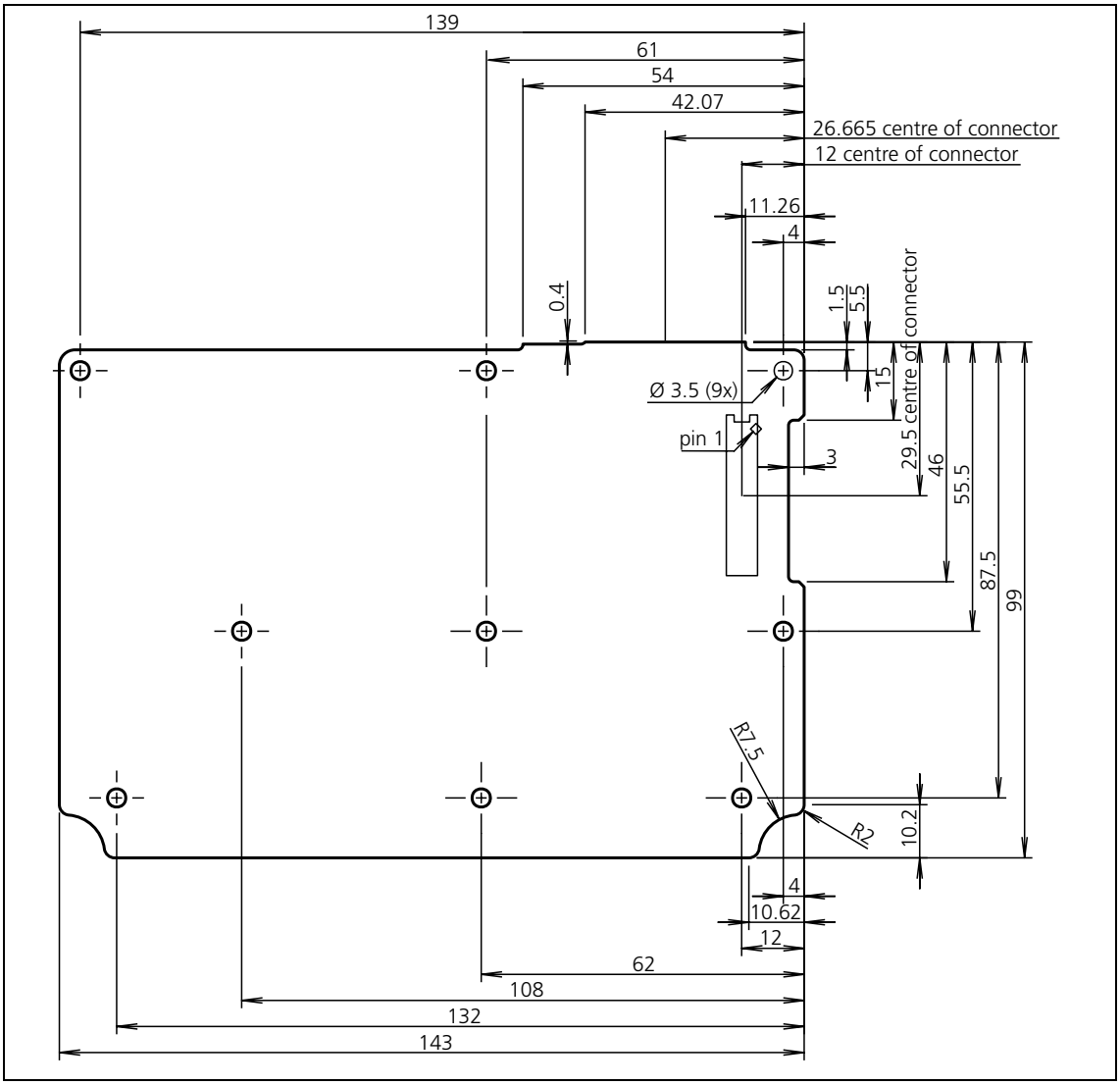


Figure 4.2 Internal options board - component height restrictions

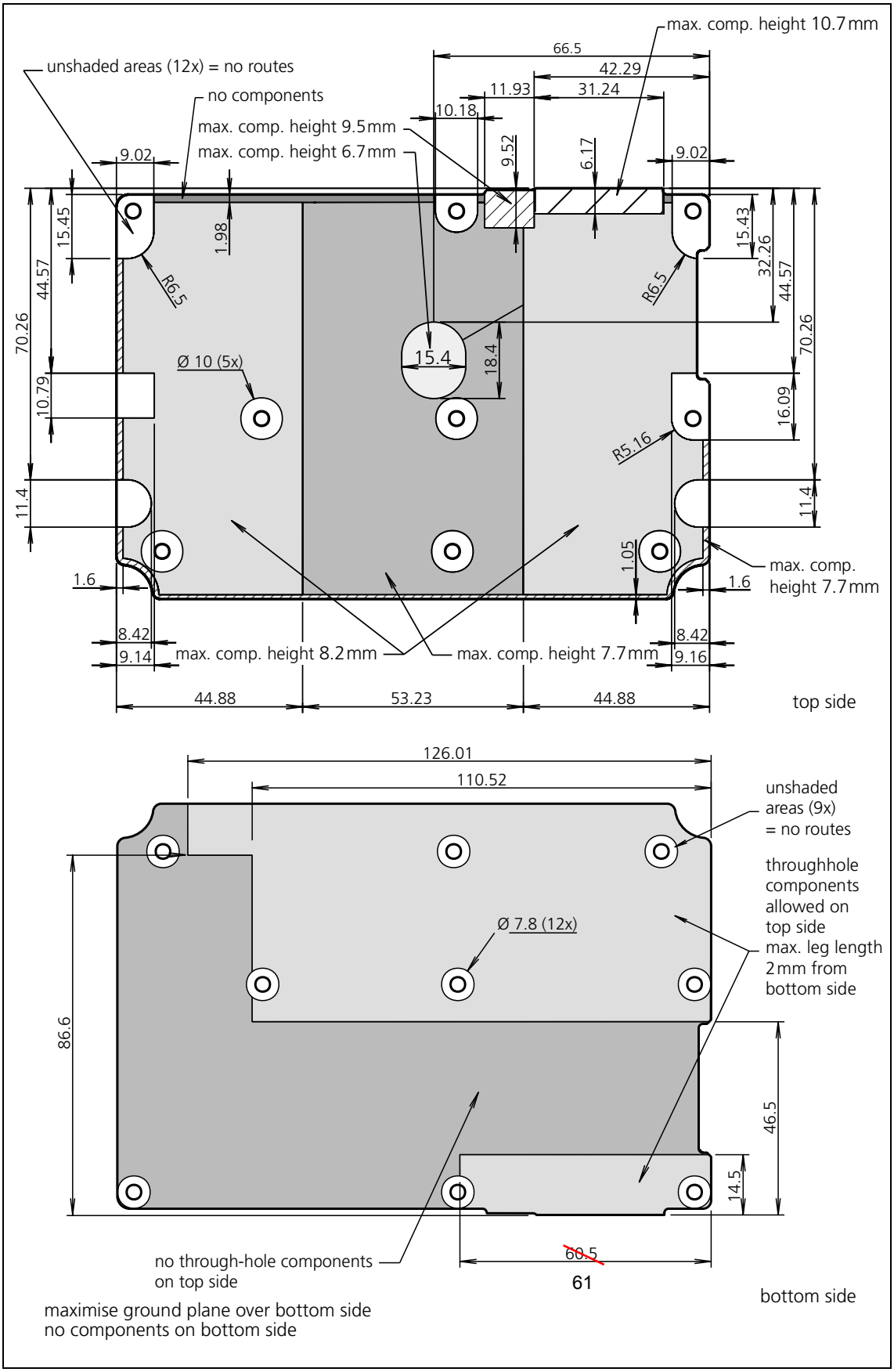
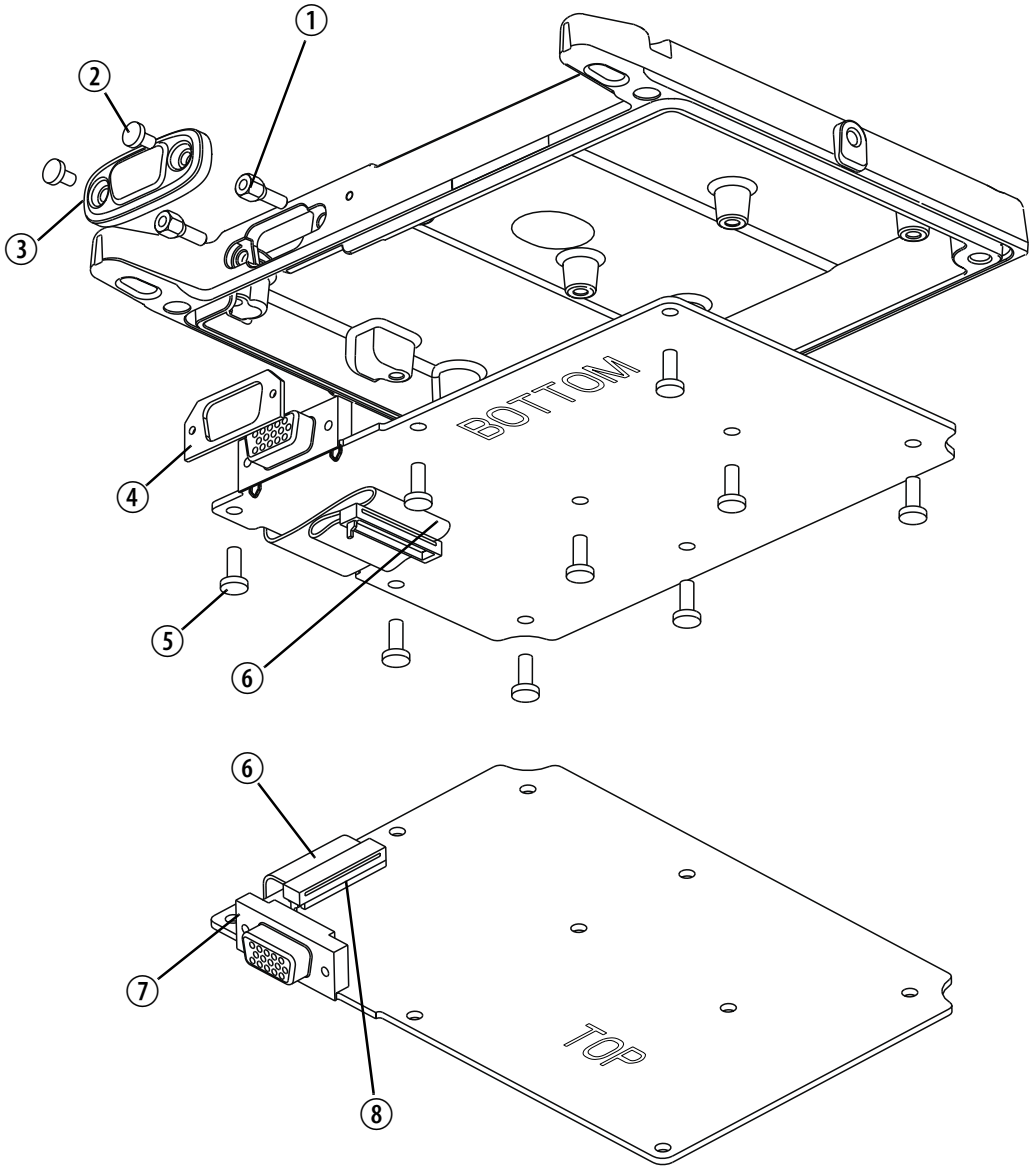


Figure 4.3 Internal options board - installation example

Important Assemble and tighten the two hexlocks (tightening torque 0.9N·m=8lbf·in) before screwing the internal options board to the lid.



Note The labelled parts are available with the TM8000 internal options kit described on page 101.

1. D-range hexlok-style fastener 4–40 (2x) (tightening torque 0.9N·m=8lbf·in)
2. screw 4-40x3/16 (2x)
3. protective rubber cap
4. foam seal for D-range connector
5. screw M3x10, self-tapping (9x)
6. loom with 18-way Micro-MaTch plugs
7. 15-way high-density D-range socket, PCB-mount
8. 18-way Micro-MaTch socket, SMD, PCB-mount

4.1.2 TM8000 Internal Options Kit

The TM8000 internal options kit (product code TMAA30-06) includes all special connectors, a loom, seals and screws required to connect to the internal options connector, the external options connector and the screw points inside the radio body.

The components of the TM8000 internal options kit, that are fitted to the radio, are illustrated in Figure 4.3.

Table 4.1 TM8000 internal options kit - bill of material

Tait IPN	Qty.	Description	Pos. in Figure 4.3
354-01043-00	2	Fsnr Scrw Lok 1pr 4-40	①
347-00011-00	2	Scrw 4-40*3/16 Unc P/P Blk	②
362-01108-00	1	Seal Drng Cvr 9way TMA	③
362-01111-00	1	Seal Drng 9way TMA	④
349-02062-00	9	Scrw M3*8 T/T P/T Conti Rmnc	⑤
219-00329-00	1	Loom TMA Int Opt	⑥
240-00011-67	1	Skt 15w Drng Ra Slim Dsub 7912 (footprint see Figure 4.4)	⑦
240-10000-11	1	Conn SMD 18w Skt M/Match (footprint see Figure 4.5)	⑧
240-00010-80	1	Plg 15w Drng Hi-D	not illustrated
240-06010-29	1	Conn 9w Hood/Cvr Lets	not illustrated

Figure 4.4 Footprint of 15-way D-range socket, PCB-mount

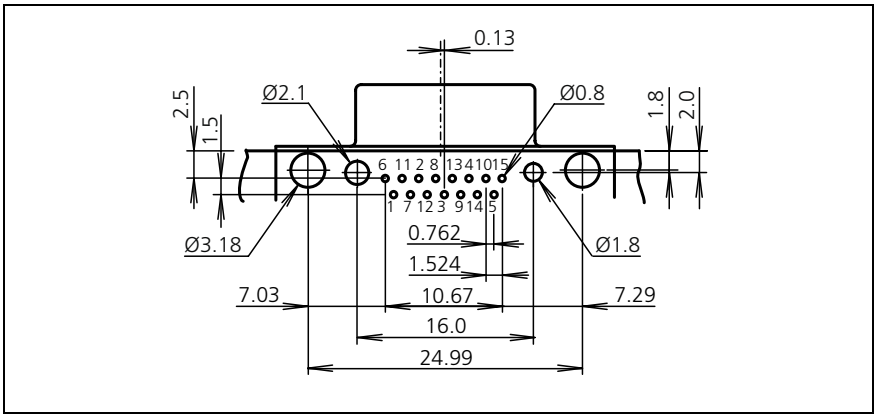
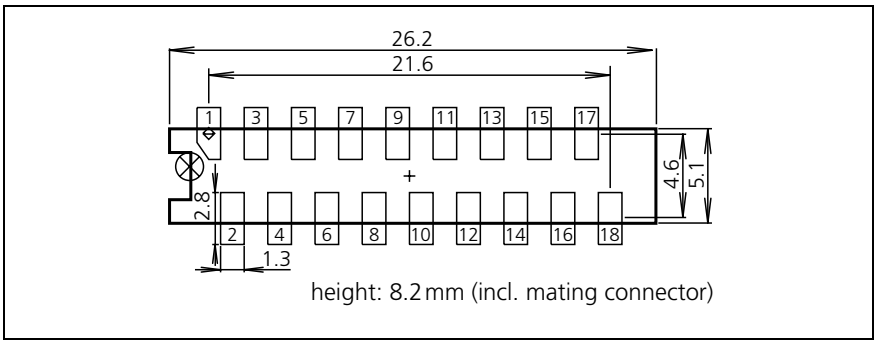


Figure 4.5 Footprint of 18-way Micro-MaTch socket, SMD, PCB-mount



4.1.3 Common Practices for Internal Options Board Design

Thermal Considerations

Select components which withstand the temperatures inside the radio body, in particular during high duty cycles and high ambient temperatures. Tait recommends the use of industrial-grade components (<85 °C).

Heat dissipation added by an internal options board can reduce the radio's operating temperature range or duty cycle. Keep heat dissipation to a minimum.

Sealing

The IP54 protection class no longer applies when the external options connector or an additional connector are used. When fitting one of these connectors, it is the integrator's sole responsibility to provide adequate sealing.

Electromagnetic Compatibility

It is important that the internal options board is electro-magnetically compatible (EMC) with the radio itself and the external environment. This means that the internal options board is not affected by and does not interfere with the radio or the external environment. An EMC problem has three components: a source, a coupling mechanism and a receiver. The coupling mechanism can be conducted and/or radiated.

Key things to consider are as follows:

Susceptibility to Interference

If the internal options board has connections via the external options connector and the radio's antenna is located close to the options cable, significant RF pick up on to the cable may occur.

If the internal options board contains sensitive analog circuits (particularly microphone circuits), digital ground noise may be a problem if the internal options board is not earthed correctly.

Electrostatic discharge (ESD) onto the options cable may cause damage to the internal options board or malfunction if proper protection is not provided.

Emissions from the Internal Options Board

The radio's receiver is extremely sensitive and radiation from the internal options board on the desired channel frequency may cause interference.

If the internal options board has connections via the external options connector and the radio's antenna is located close to the cable, radiation from the cable may be picked by the antenna as interference.

Radiation from the options cable, if strong enough, may interfere with other devices near the radio or cause failure to comply with EMC regulations in your country or region. The cable creates a good antenna at high frequencies.

Follow the guidelines in "Guidelines for EMC Design" on page 103.

4.1.4 Guidelines for EMC Design

Earthing

Figure 4.6 and Figure 4.7 show the recommended earthing of the internal options board. The earthing used depends on the type of circuitry on the internal options board.

Figure 4.6 Internal options board - earthing for low-speed circuits

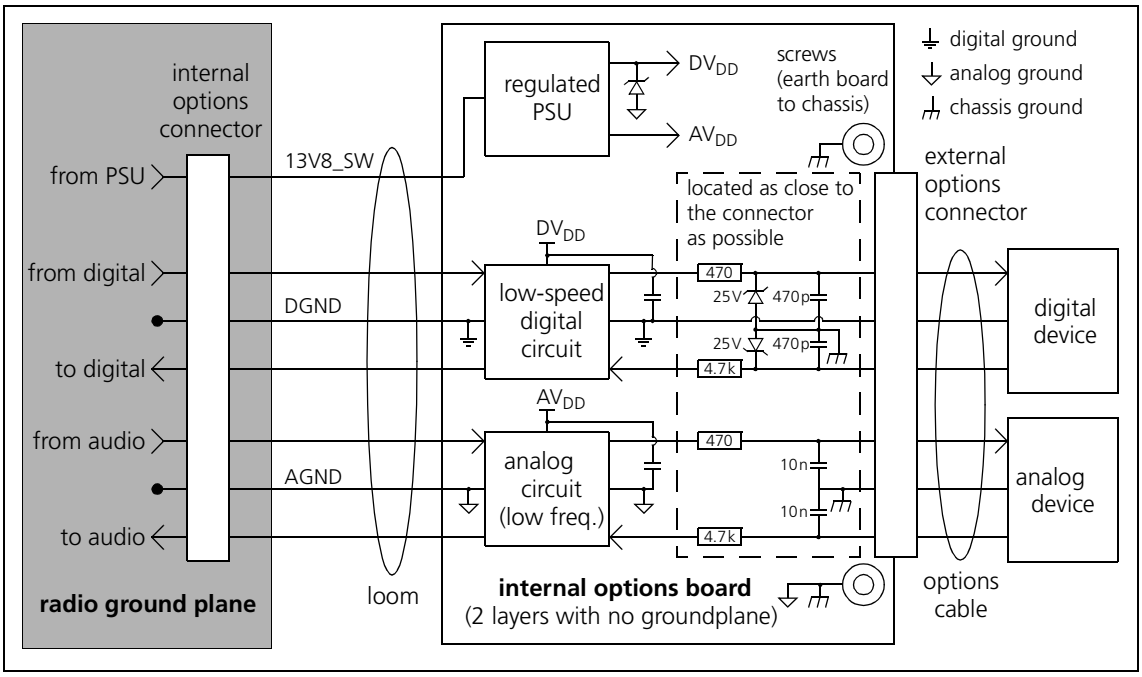
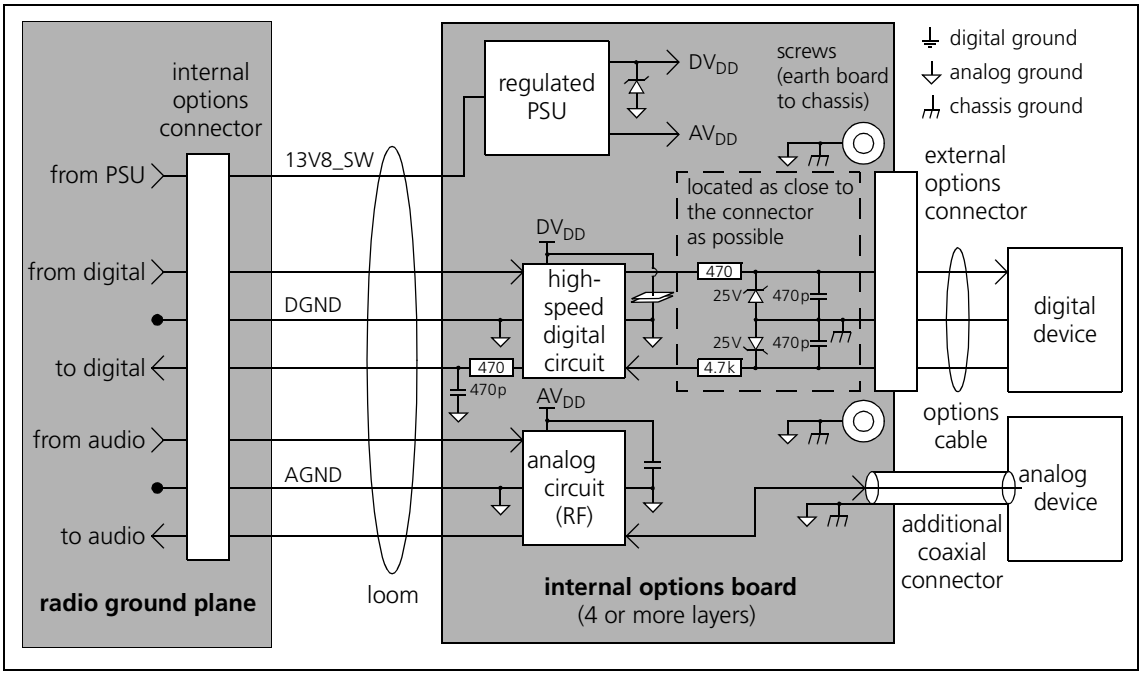


Figure 4.7 Internal options board - earthing for high-speed circuits



For low-speed digital designs or audio designs, a two layer board with plated through holes is usually sufficient. Low-speed digital devices have relatively long rise and fall times, this includes standard CMOS logic gates and low power 5V 8-bit micro-controllers. Tracked earthing is usually sufficient but ground fill should be used where possible.

For high-speed digital designs or RF designs it is strongly recommended that a PCB with four or more layers is used. High-speed digital devices have short rise and fall times, this includes most Digital Signal Processors and 16/32-bit micro-controllers. The board should have one layer reserved as a ground plane. No signal tracks should be placed on this layer.

The internal options connector has separate analog and digital earth pins. These are connected together on the radio PCB through a low impedance ground plane. Separate ground signals allow digital I/O and analog ground current to flow in different wires on the loom. This is important because the loom wire has relatively high impedance and so significant earth noise voltage due to digital I/O activity can be developed across the length of the wire. Having two earth wires also halves the impedance of the earth connection where the earths are common at the internal options board end.

On the internal options board, the earth signals can either be connected together or kept separate and fed to the appropriate digital and analog circuitry. For low-speed designs it is practical to keep them separate but for high-speed design this is not usually the case, due to ground plane requirements.

It is recommended that the internal options board is earthed to the chassis lid as close as possible to the external options connector. This can be achieved via the mounting screws closest to the external options connector. For the screw hole, use a plated through hole diameter 3.5mm with pad diameter 7mm on both sides. The resist should be cleared from the pad and the pad connected to analog earth or the ground plane. Other mounting screws may also be connected to the chassis lid but this is not essential.

Shielding

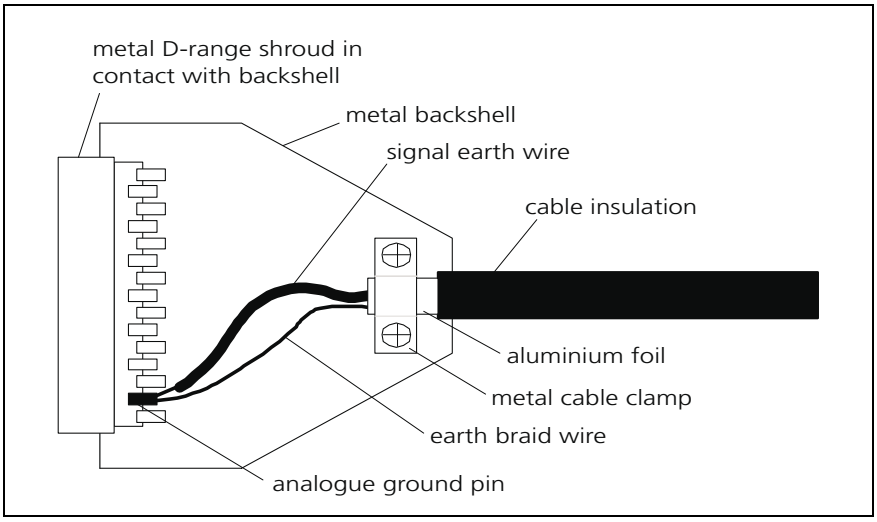
For low-speed designs shielding is usually not necessary. For high-speed designs shielding may be necessary. For RF designs it is usually essential.

Cable Shielding

If the external options cable is longer than 1 metre it is recommended that the cable and connector backshell be shielded. Figure 4.8 shows the recommended shielding arrangement. The earth braid wire (bare copper) and aluminium foil should only be earthed at the radio end of the cable.

For RF signals, coaxial cable must be used and the shield must be earthed at both ends of the cable.

Figure 4.8 Recommended auxiliary cable and connector shielding



Input/Output Filtering

The recommended filtering for input and output (I/O) lines from the internal options board is shown in Figure 4.6 and Figure 4.7 on page 103. The component values shown are for guidance but should be suitable for most applications.

For the I/O lines to or from the radio, filtering is usually not necessary. The exception is when the internal options board contains high-speed digital circuits. In this case, the outputs to the radio should be RC-filtered on the internal options board as close as possible to the connector to minimise noise on the loom.

It is recommended that filtering is applied on all I/O signals of the external options connector. They also need ESD protection. The filtering shown in Figure 4.6 and Figure 4.7 on page 103 provides both ESD protection and high frequency filtering. For the audio, 10nF capacitors are recommended because they are large enough to keep the voltage developed by electrostatic discharge to a safe level, while not significantly affecting audio frequency response. The capacitors are earthed to the chassis to provide a low impedance return path for large ESD currents. High frequency filtering is provided by the series resistance and 10nF capacitor.

Large decoupling capacitors cannot be used for digital signals because they round the wave form edges to an unacceptable extent. Therefore for ESD protection, a small 470pF decoupling capacitor in parallel with a zener diode clamp is recommended. The capacitor reduces the slew rate of the ESD pulse so that the zener diode clamps without overshoot. Again, the capacitor and zener diode are earthed to the chassis to provide a low impedance return path for large ESD currents. It is also recommended that a zener diode is placed on the digital supply, as some current will flow back into the supply via the series resistance and digital IC clamping diodes during an ESD event. The zener voltage should be approximately 0.5V higher than the supply voltage. High frequency filtering is provided by the series resistance and 470pF capacitor.

It is essential that all I/O filter components are located as close as possible to the connector. This minimises the possibility of noise bypassing the filters.

Power Supply Decoupling

Power supply decoupling is most effective when the decoupling is placed close to the load. For high-impedance loads, some resistance in series with the load can be beneficial. For most applications a single 100nF capacitor is sufficient to remove high-frequency noise.

For high-speed digital designs, the use of a power plane for each digital supply rail is strongly recommended. The power plane enables many decoupling capacitors and device power pins to be connected together with very low impedance. The inter-plane capacitance is usually not sufficient by itself for decoupling. Low ESR tantalums for low-frequency decoupling are recommended. Multiple ceramic 100nF capacitors are recommended for high-frequency decoupling. Design analysis should be undertaken to ensure that decoupling is effective up to at least 500MHz.

Separate power supply rails for digital and analog circuitry are recommended.

Note High-speed digital design requires a high level of design experience, appropriate design tools and high bandwidth test equipment to be successful. This should not be undertaken without all of the above.

4.2 Blank Control Head Options Board

The radio with blank control head provides space between the blank control head and the radio body for accommodating an options board. Six screw points are located on the inside of the blank control head.

Figure 4.9 and Figure 4.10 show the mechanical envelope available. Six screw points are located on the inside of the blank control head. Figure 4.11 shows an installation example.

Figure 4.9 Blank control head options board - maximum dimensions

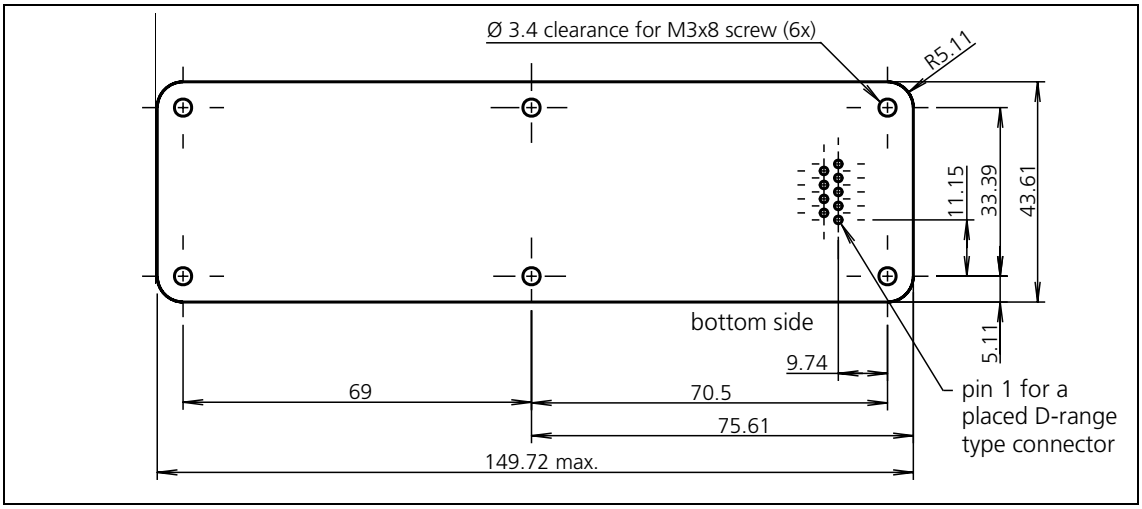


Figure 4.10 Blank control head options board - component height restrictions

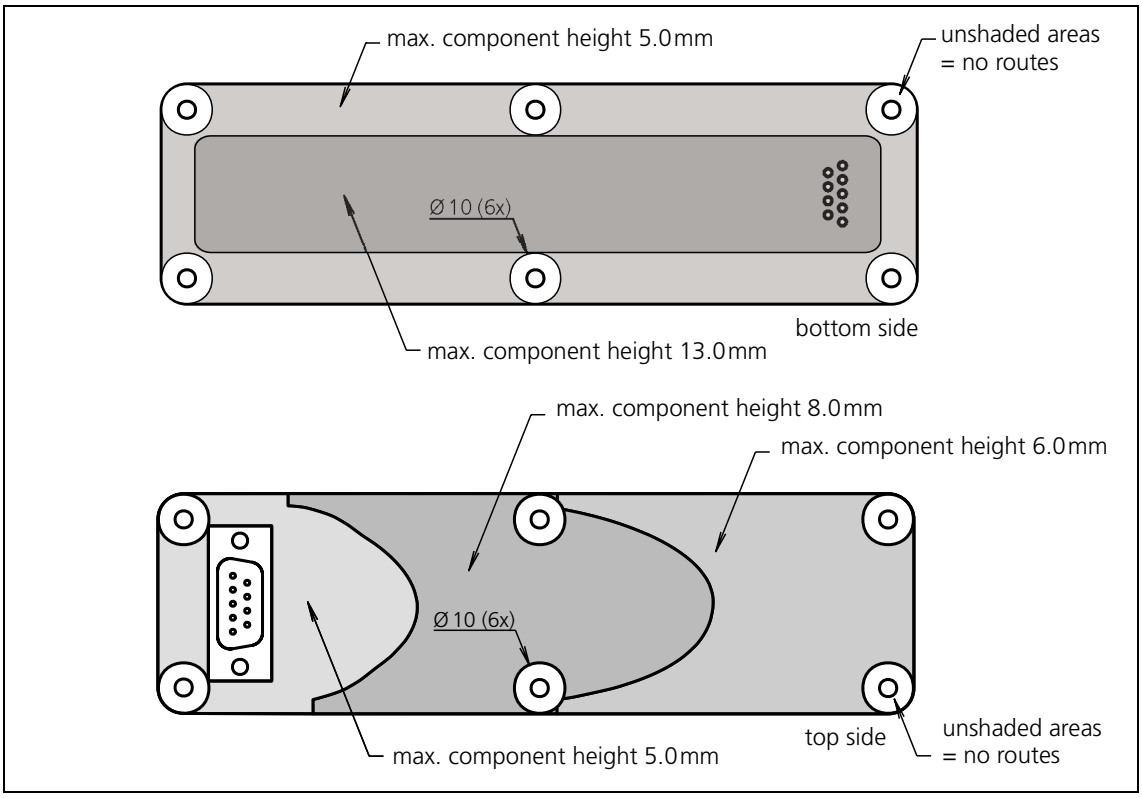
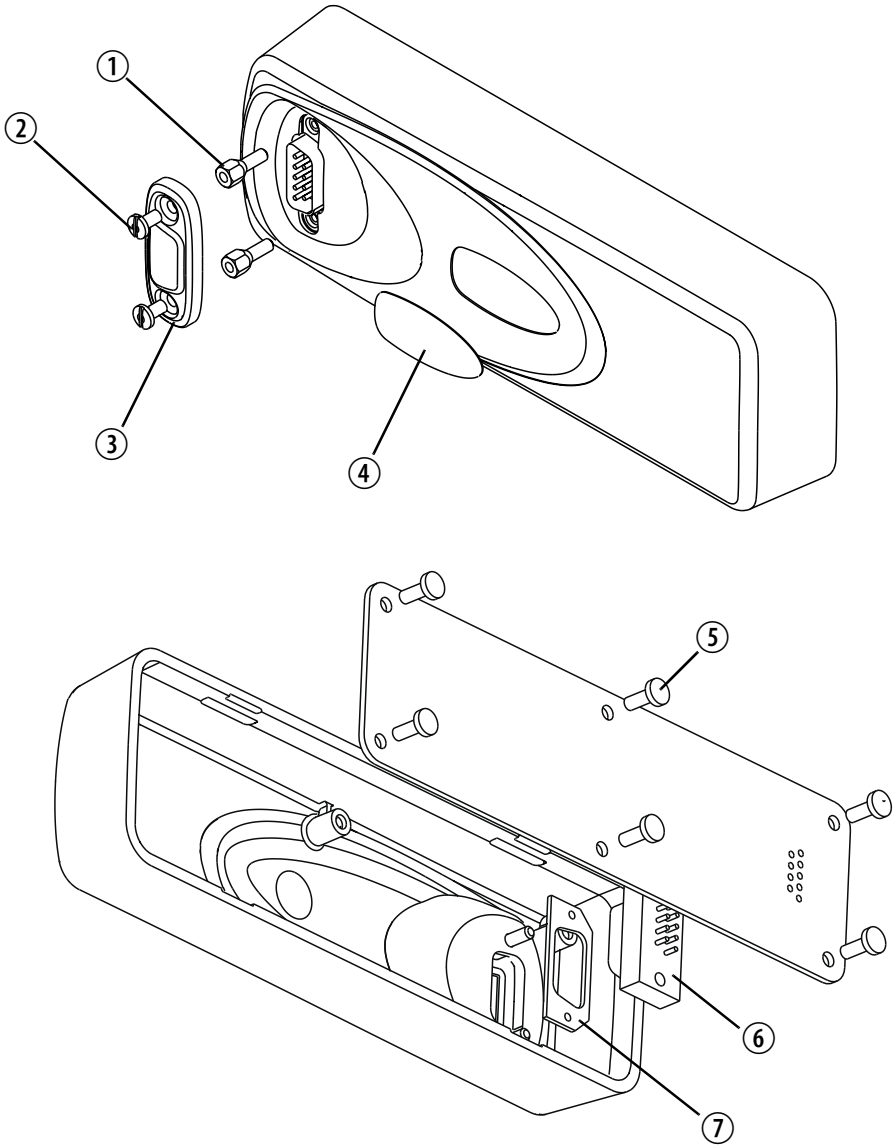


Figure 4.11 Blank control head options board - installation example



1. D-range hexlok-style fastener 4–40 (2x) (tightening torque 0.45N·m=4lbf·in)
2. screw 4-40x3/16 (2x)
3. D-range cover seal
4. branding label
5. screw M3x8 plastic type (6x)
6. 9-way D-range socket, vertical PCB mounting with threaded inserts on connector
7. foam seal for D-range connector

5 Connecting Third-Party Products

This chapter describes, in examples, the connection of external and internal products of third-party manufacturers to the TM8000 radio.

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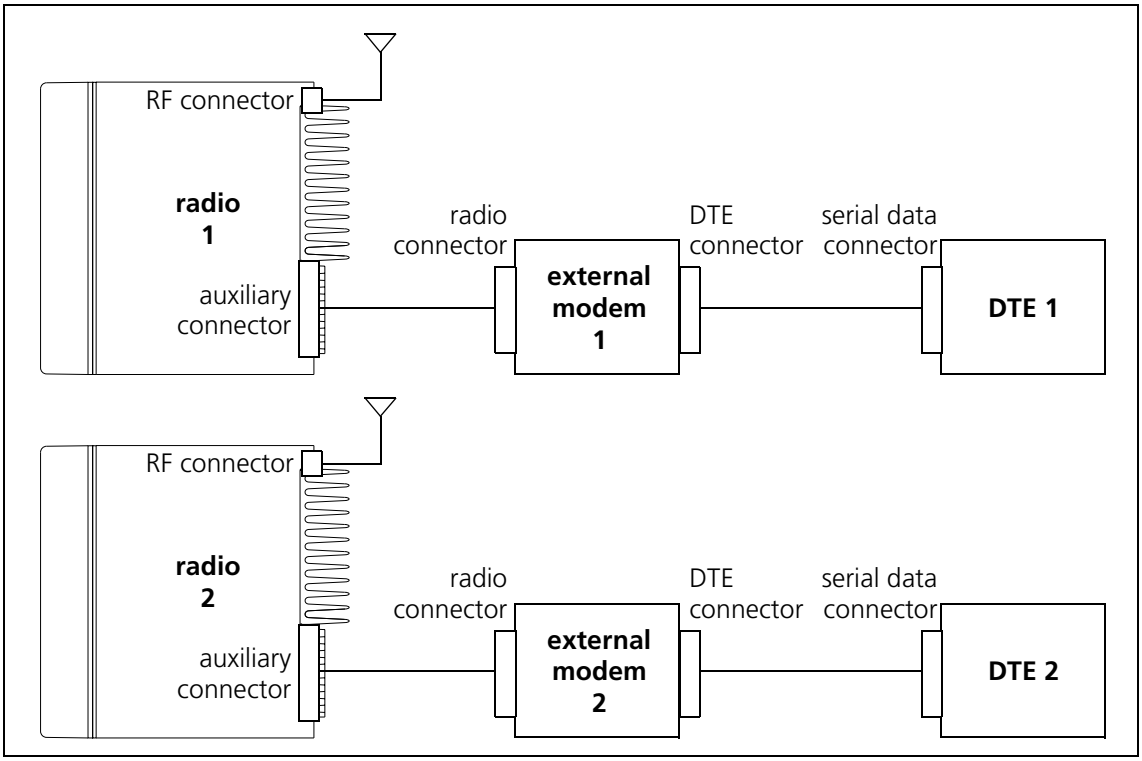
5.1 External Products

5.1.1 External Modem

Data Flow

Figure 5.1 shows a simple point-to-point data link system using two radios and external modems.

Figure 5.1 Basic system configuration using two external modems and radios



1. DTE 1 transmits the source data in serial form to the external modem 1. The DTE can be a PC or a data head.
2. The modem encodes the data into a baseband modulation signal which is suitable for over-the-air transmission, and feeds it to radio 1.
3. Radio 1 uses the baseband modulation signal for frequency modulation of the RF carrier signal, and then sends the modulated signal over the air (via a repeater, if necessary).
4. Radio 2 receives the modulated signal, recovers the baseband modulation signal from the RF carrier, and then feeds the baseband modulation signal to external modem 2.
5. External modem 2 decodes the baseband modulation signal into serial digital form and feeds it to DTE 2.

DTE 2 can also be the source and DTE 1 the destination, however, because the radios are simplex, simultaneous data flow in opposite directions is not possible.

Interface Specification

The external modem is connected to the auxiliary connector, which is described on page 19. For the interface specification of the external modem to the DTE please refer to the manufacturer's documentation.

Table 5.1 shows how to connect the lines of the external modem to the auxiliary connector.

Table 5.1 External analog modem interface specification

External modem	Auxiliary connector		Description/parameter	Specification
Signal	**Pin**	**Signal**		
Power	8	13V8_SW	Power supply to modem. Max. current draw: Operating voltage range:	 must be <1A 9.7V to 17.2V
Ground	15	AGND	Analog ground.	
Baseband modulation output	7	AUD_TAP_IN	Baseband modulation to radio. Format[1]: Audio tap input point: Audio tap input muting: Signal level: DC bias required: AUD_TAP_IN input impedance:	 GMSK, FFSK, 4-level FSK 1200-9600baud Use T13-A or T12-A for GMSK/4FSK Use T8-A for low-baud modems. Use 'on PTT' associated with EPTT1 T13-A: 870mVp-p (3kHz dev.) T12-A: 690mVp-p (60% RSD[2]) T8-A: 690mVp-p (60% RSD[2]) 1.5±0.2V[3] 100kΩ typical
Baseband modulation input	13	AUD_TAP_OUT	Baseband modulation from radio. Format: Audio tap input point Audio tap input muting: Signal level into 600Ω: AUD_TAP_OUT output impedance:	 Constant envelope. GMSK, FFSK, 4-level FSK 1200-9600baud Use R1-D or R2-D for GMSK/4FSK Use R4-D for low-baud modems. Use 'except on PTT' R1-D: 600mVp-p (3kHz dev.) R2-D: 690mVp-p (60% RSD[2]) R4-D: 690mVp-p (60% RSD[2]) 600Ω typical
Push-to-talk	12	AUX_GPI1	PTT signal to radio. Function: Active state: Logic output levels required:	 EPTT1 or EPTT2 Low 3.3V CMOS-compatible
Carrier detect	10	AUX_GPIO4	Carrier detect. Some modems may not need this signal. Function: Active state: Modem input logic threshold required:	 Busy status based on RSSI High 3.3V CMOS-compatible[4]

1. The modulation formats listed may not comply with transmit spectral emission mask regulations in some countries. It is the integrator's responsibility to ensure that the system complies with the relevant regulations.
2. RSD = Rated System Deviation
3. While AUD_TAP_IN is DC-coupled, it has a digital HPF in the modulation path to prevent DC bias error affecting the transmit carrier frequency. The HPF has a –3dB point of 3.7Hz which is low enough for GMSK. If the modem cannot provide the bias voltage required then a large coupling capacitor, typically 10µF, should be used.
4. If the modem input is 5V CMOS, the pullup output on AUX_GPIO4 should be linked to 5V. For more information refer to "Digital Output Lines" on page 70.

Radio Programming

Use the programming application to configure the radio.

1. In the Digital tab of the Programmable I/O form, carry out the following settings:

Pin	Direction	Action	Active	Debounce	Signal state
AUX_GPI1	Input	External PTT1	Low	0	None
AUX_GPIO4	Output	Busy Status	High	None	Momentary

2. In the PTT / External PTT (1) form, set the Advanced EPTT1 group to:
   - PTT Transmission Type: Data
   - PTT State Is Reflected: cleared
   - PTT Priority: Highest
   - Audio Source: Audio Tap In
3. In the Networks / Basic Settings / Basic Network Settings form, set the Squelch Detect type to Signal Strength.
4. In the Audio tab of the Programmable I/O form, carry out the following settings:

Rx / PTT Type	Tap In	Tap In Type	Tap In Unmute	Tap Out	Tap Out Type	Tap Out Unmute
Rx	None			R1	D - Split	Except on PTT
EPTT1	T13	A - Bypass In	On PTT	None		

Tap out R1 is the tap point closest to the demodulator. Tap in T13 is the tap point closest to the modulator. For more information on the tap points refer to "Auxiliary Connector" on page 19 and "Audio Tap In and Tap Out Lines" on page 91.

If not all the channels that the modem will be communicating on have the same channel spacing or bandwidth, tap in T12 and tap out R2 should be used. The signal levels on these taps are automatically scaled to match the channel spacing, i.e. 3kHz deviation on a 25kHz channel and 1.5kHz deviation on a 12.5kHz channel will result in the same tap in and tap out signal levels.

For modems operating at 2400baud or less, tap in T8 and tap out R4 should be used. These tap points have linear-phase 3kHz low-pass filtering applied.

5. All channels that the modem uses for communication should be assigned to one network and all voice channels should be assigned to a second network. This ensures that the data and voice channel settings are independent of each other.

Modem Configuration

Refer to the manufacturer's documentation.

Setup and Testing

1. Configure the modem and DTE.
2. Test the modem and DTE configuration. The simplest means is usually a loop-back test. For this test a loop-back plug is required. This consists of a 15-way female plug with modem baseband modulation in and out connected together. Disconnect the modem from the radio and connect the loop-back plug onto the end of the cable between modem and radio. Send a large amount of data and check that the data received on the DTE is error-free. This test requires the DTE to be full duplex capable and the baseband modulation levels in and out of the modem to be equal.
3. Configure the radio as per described above.
4. Connect the modem and set up deviation levels as per the modem manufacturer's documentation.
5. Check that the transmit spectrum meets regulatory requirements in the country of sale. Not necessary if tap in point T8 is used.
6. Use a second system to confirm end-to-end communication over-the-air. Initially it is recommended to do this with strong signal conditions.

System Delays through the Radio

It is important for data applications to know the system delays through the radio. Table 5.2 shows the system delays through the radio.

Table 5.2 System delays through the radio

System delay through the radio	Specification
EPTT assertion (zero debounce) to full carrier power with valid modulation: via tap T12 and T13 via tap T9 via tap T8	 14.8±0.5ms 14.3±0.5ms 17.8±0.5ms
EPTT de-assertion (zero debounce) to valid baseband modulation at AUD_TAP_OUT: via tap R1 and R2 via R4	 12.3±0.5ms 16.9±0.5ms
Modulation delay - antenna to AUD_TAP_OUT: via tap R1 and R2 via tap R4	 1.8ms typical 6.6ms typical
Modulation delay - AUD_TAP_IN to antenna: via tap T12 and T13 via tap T8	 1.8ms typical 9.6ms typical
Valid RF signal arriving at the antenna to carrier detect active:	3ms typical

5.1.2 Audio Headset

Headsets provide a private and hands-free means of using a two-way radio and are typically used by dispatchers or users in high-noise environments. PTT is normally provided with a foot switch.

Interface Specification

The audio headset is connected to the microphone connector of the control head. The microphone connector is described on page 35. It can also be connected to the corresponding lines of the programming connector of the blank control head.

Figure 5.2 shows the diagram of an audio headset interfaced with the microphone connector of the TM8115 two-digit display control head.

Figure 5.2 Diagram of an audio headset connected to the radio

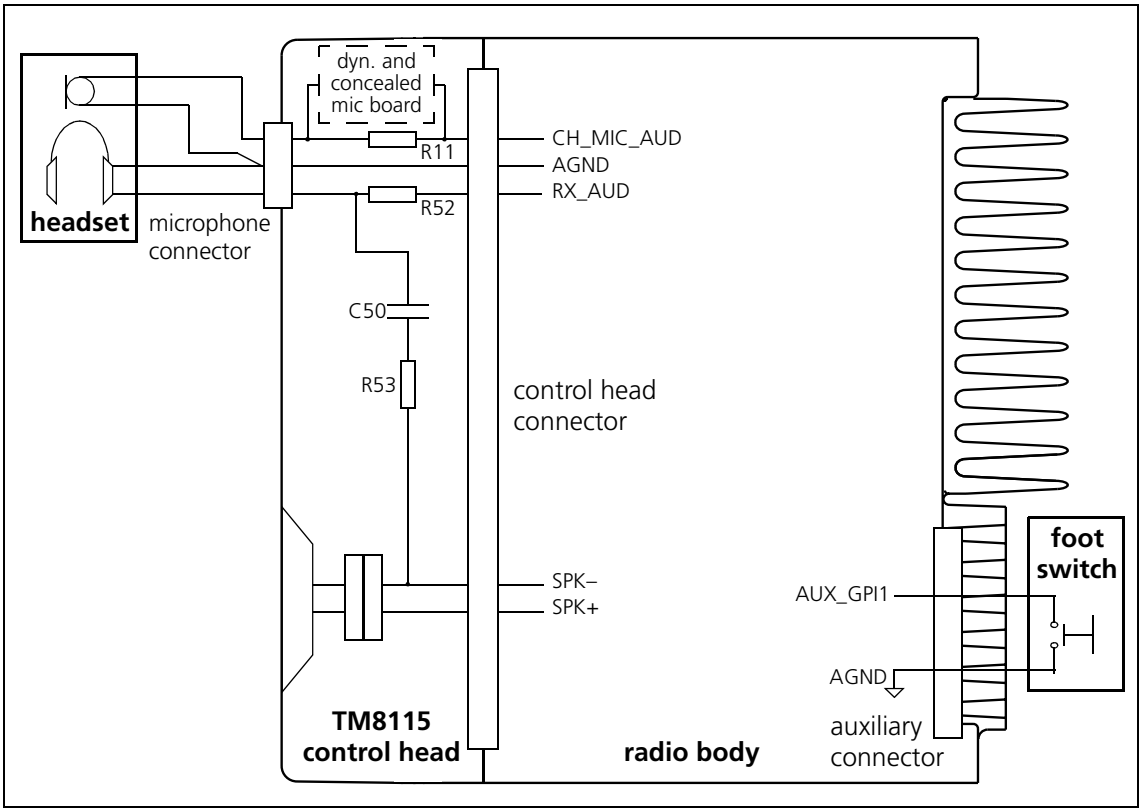


Table 5.3 shows how to connect the audio headset to the radio:

Table 5.3 Audio headset interface specification

Lines of audio headset	Microphone connector		Description/parameter
Signal	**Pin**	**Signal**	
Earphone Audio (+)	1	MIC_RX_AUD	Audio to earpiece.
Microphone Audio (+)	5	MIC_AUD	Microphone audio from headset.
Earphone Audio (–)	6	AGND	Analog ground for earpiece.
Microphone Audio (–)	6	AGND	Analog ground for microphone.

Table 5.4 shows how to connect the footswitch to the radio:

Table 5.4 Footswitch interface specification

Lines of footswitch	Auxiliary connector		Description/parameter
Signal	**Pin**	**Signal**	
Switch output	12	AUX_GPI1	External PTT input
Switch ground	15	AGND	analog ground

Earphone Interface

If the headset is stereo, ensure both earphones are connected in parallel. The earphones are connected to pin 1 of the microphone connector.

As headset earphones vary widely in their impedance and power ratings, two different driver options are available in the radios with user interfaces. If you are unsure of the headsets drive requirements, try the factory default hardware configuration first.

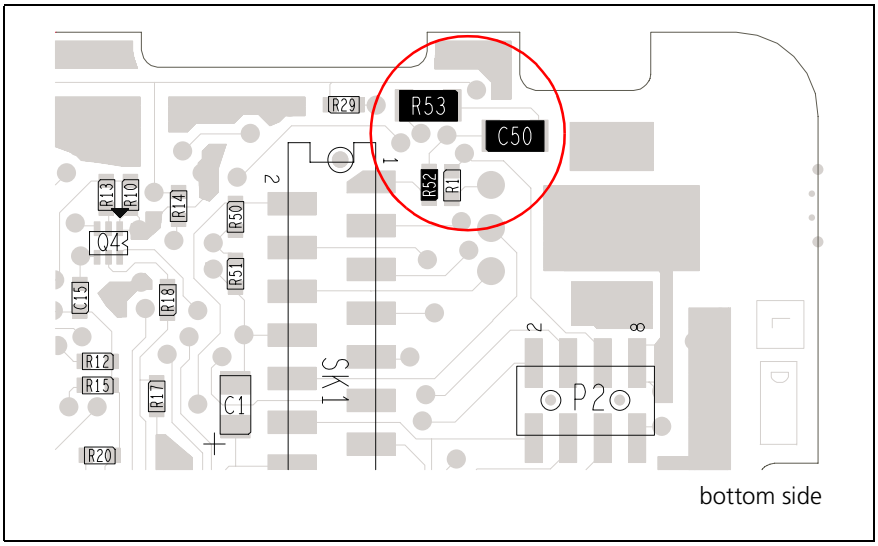
For headsets with low drive or volume requirements, the factory default hardware configuration can be used (R52 fitted, C50 and R53 not fitted). The earphone DC resistance in this case should be greater than 100Ω.

For headsets with high drive or volume requirements, one of the radios internal speaker outputs should be used to drive the earphones. To connect an internal speaker output to pin 1 on the microphone connector, remove R52 and fit C50 and R53 on the control head board.

Figure 5.3 on page 116 shows the positions of C50, R52 and R53 on the control head board.

Follow the instructions of the service manual for your radio on removing and fitting the control head, the control head board, and standard and SMD components.

Figure 5.3 Positions of C50, R52 and R53 on the control head board



Choose values for C50 and R53 as follows:

1. Measure the earphone DC resistance R_E using a multimeter.
2. Choose C50 to be at least 10µF and R53 to be approximately equal to R_E.
3. Select an on-air channel with frequent voice activity and disconnect the internal speaker.
4. Turn the volume to **minimum** and plug the headset into the microphone socket.
5. Select and test the value of R53 until the desired headset volume is achieved when the radio's volume control is turned up to maximum. Ensure the radio is powered down when making changes to the value of R53.
6. Select the value of C50 to be $1/(1900 \cdot (R53 + R_E))$
7. Round this result to the nearest preferred value.

The radio's internal speaker should be left disconnected.

Microphone Interface

If the headset microphone is an electret type, the factory default hardware configuration (R11 fitted) can be used. DC bias for the headset microphone is provided by the radio. Noise-cancelling electret microphones do not require a different configuration.

If the headset microphone is a dynamic type, the TMAA02-06 Support Kit for Concealed and Dynamic Microphones must be fitted in the control head. For information on how to fit this kit refer to the service manual.

PTT Interface

Connect a footswitch or gear-lever PTT between AUX_GPI1 (pin 12) and AGND (pin 15) on the radio's auxiliary connector.

Radio Programming

Use the programming application to configure the radio.

1. In the PTT /External PTT (1) form, set the /Advanced EPTT1 group to:
   - PTT Transmission Type: Voice
   - Audio Source: CH_MIC
2. In the Digital tab of the Programmable I/O form, carry out the following settings:

Pin	Direction	Action	Active	Debounce	Signal state
AUX_GPI1	Input	External PTT1	Low	10	None
AUX_GPIO4	Output	Busy Status	High	None	Momentary

3. To eliminate mute and unmute 'pop' when the earphone is driven by an internal speaker output, the audio PA needs to be forced on. Configure the CH_GPIO1 line as follows.

Pin	Direction	Action	Active	Debounce	Signal state
CH_GPIO1	Input	Force Audio PA On	High	10	None

Ensure that nothing is connected to pin 8 of the microphone connector.

Note This setting will cause the receive standby current to increase by approximately 50mA.

5.1.3 USB Adaptor

An increasing number of computers (in particular laptop computers) no longer provide serial COM ports and instead provide USB connections. To connect the radio to a USB port, a USB adaptor is required.

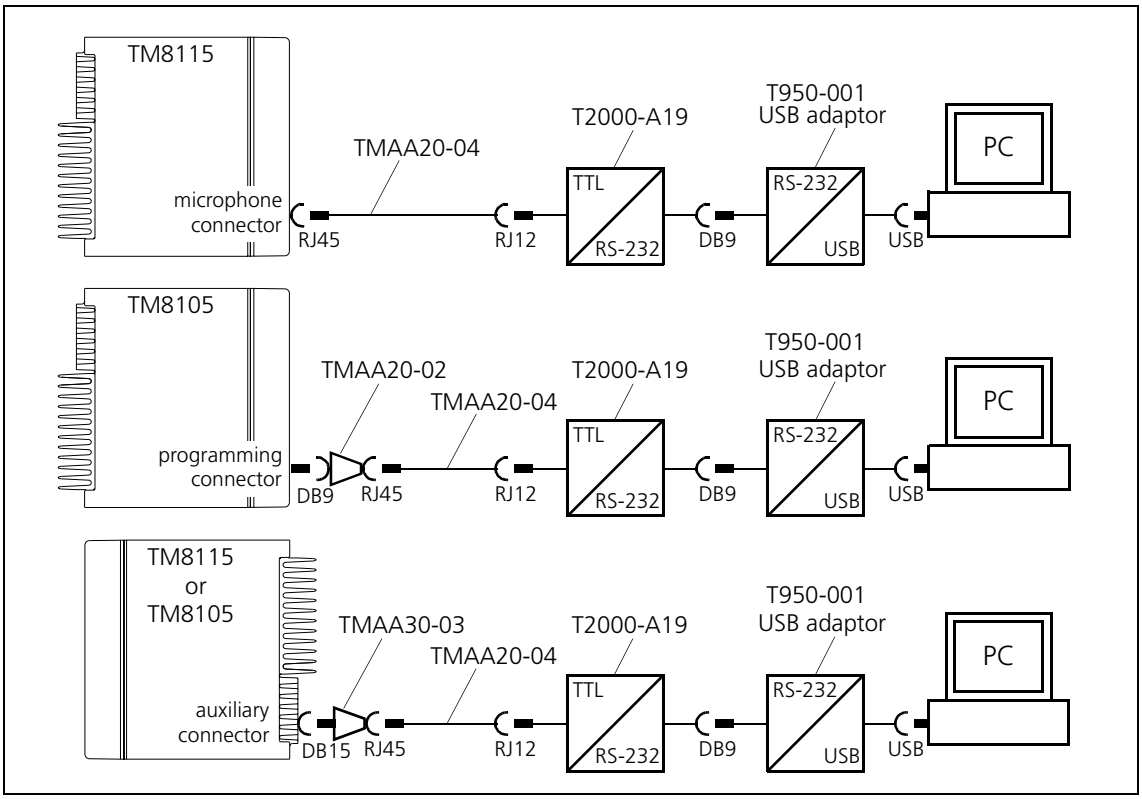
Note If the PC has a COM port, the T2000-A19 cable can be connected directly to the PC without using a USB adaptor.

The PC is typically connected to the microphone connector of the control head or to the programming connector of the blank control head. The PC can also be connected to the auxiliary connector or, if an options extender board is installed, to the external options connector.

The Rx and Tx signals of these connectors have TLL levels and are described in "Description of the Radio Interfaces". The TLL level must be converted to RS-232 level using the Tait T2000-A19 cable. The T2000-A19 cable does not support CTS/RTS hardware handshaking.

Figure 5.4 shows typical connections between the radio and the USB port of the PC, and the cables and adaptors required (including Tait product codes):

Figure 5.4 Diagram of radio connected to the USB port of a PC



When installing the USB adaptor, follow the manufacturer's instructions on how to install the necessary device driver. The PC will typically see the USB adaptor as a COM port.

5.2 Internal Products

Important The maximum operating temperature specified for third-party internal modules can be lower than the temperature generated inside the radio in the ambient temperature range specified for the radio. This may require a reduction in the radio's operating temperature range or duty cycle. Suitable provisions for heat dissipation must be implemented.

5.2.1 Encryption Module (Scrambler)

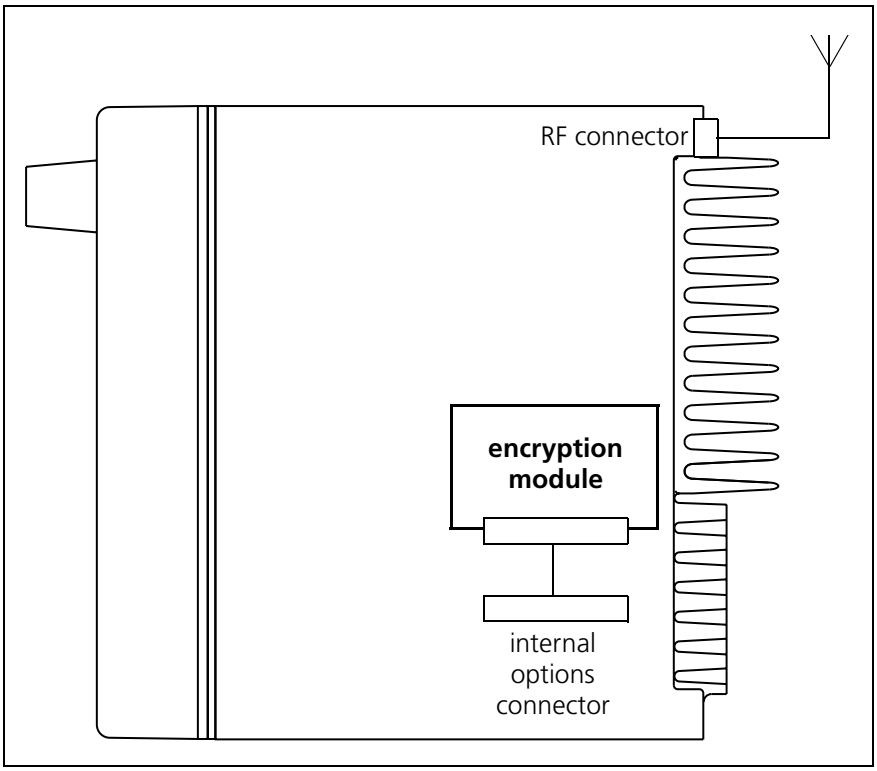
Important The installation and configuration of encryption modules is a complex task and should only be attempted by persons with in-depth knowledge of the installation and commissioning of encryption systems.

Interface Specification

The encryption module can be mounted inside the radio body where it connects to the internal options connector via a standard 1.27mm pitch ribbon cable. The internal options connector is described on page 27. The audio lines are described in "Audio Tap In and Tap Out Lines" on page 91.

Figure 5.5 shows the diagram of an encryption module interfaced with the internal options connector inside the radio body.

Figure 5.5 Diagram of encryption module connected to radio



Configure the interface between the encryption module and the internal options connector as described in Table 5.5.

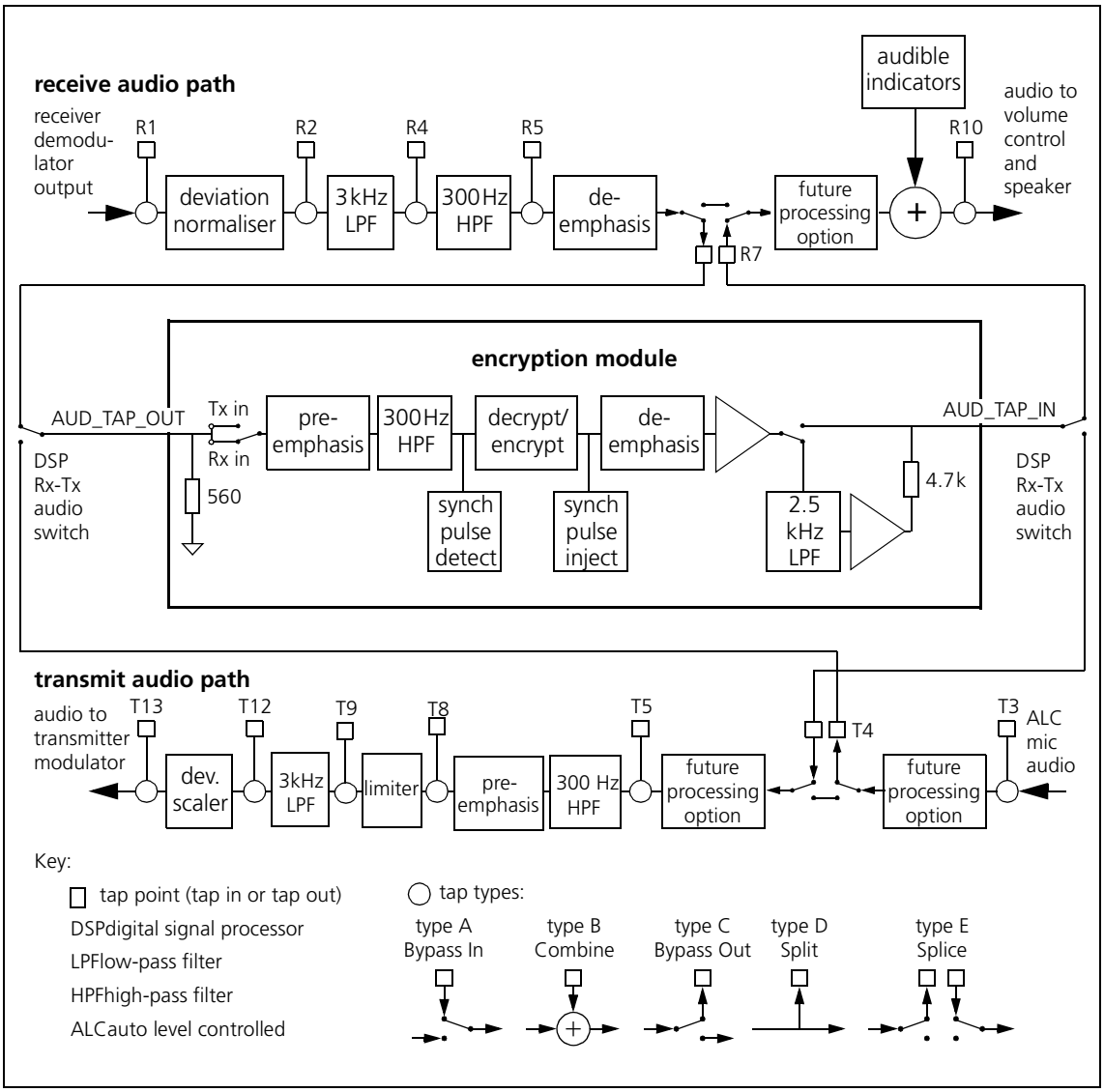
Table 5.5 Encryption module interface specification

Encryption module	Internal options connector		Description/parameter	Specification
Signal	**Pin**	**Signal**		
Power	1	13V8_SW	Switched and unregulated power from radio.	
GND	3	AGND	analog ground.	
PTT to options	9	IOP_GPIO1	Control head PTT signal from radio. Action: Active State: Module logic threshold required:	 Reflect PTT Status Low 3V3 CMOS-compatible[1]
Clear/code mode	10	IOP_GPIO2	Mode select from radio. Toggled by radio function key. Action: Active State: Module logic threshold required:	 F1…F4 Key Status Low 3V3 CMOS-compatible[1]
Secure mode	11	IOP_GPIO3	Mode indicator to radio. Action: Active State:	 Toggle F1…F4 Key LED High
Radio Tx audio to module	2	AUD_TAP_OUT	Tx audio from radio. Audio tap input point: Audio tap input unmuting: Signal level into 600Ω: AUD_TAP_OUT output impedance:	 Use T4-E Use 'on PTT' 690mVp-p (60% RSD[2]) 600Ω typical
Module Tx audio to radio	6	AUD_TAP_IN	Tx audio to radio. Audio tap input point: Audio tap input unmuting: Signal level into 600Ω: AUD_TAP_IN input impedance:	 Use T4-E Use 'except on PTT' 690mV_{p-p} (60% RSD[2]) 100kΩ typical
Radio Rx audio to module	2	AUD_TAP_OUT	Rx audio from radio. Audio tap input point: Audio tap input unmuting: Signal level into 600Ω: AUD_TAP_OUT output impedance:	 Use T4-E Use 'on PTT' 690mV_{p-p} (60% RSD[2]) 600Ω typical
Module Rx audio to radio	6	AUD_TAP_IN	Rx audio to radio. Audio tap input point: Audio tap input unmuting: Signal level into 600Ω: AUD_TAP_IN input impedance:	 Use T4-E Use 'except on PTT' 690mV_{p-p} (60% RSD[2]) 100kΩ typical

1. If the module input is 5V CMOS then a 3.3kΩ pullup to 5V on the module will be required for compatibility. For more information refer to "Digital Output Lines" on page 70.
2. RSD = Rated System Deviation

Figure 5.6 shows the audio interfacing between the radio and the encryption module specified in Table 5.5.

Figure 5.6 Encryption module - audio interfacing

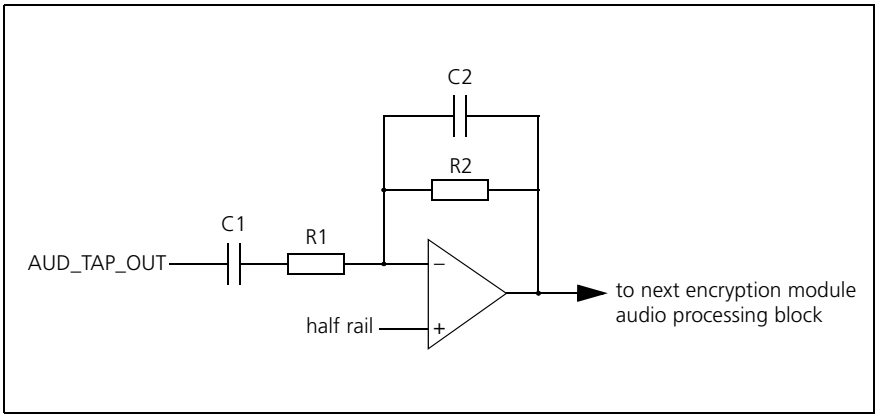


The audio interfaces in Figure 5.6 are recommended and best suit Transcrypt SC20-4xx series encryption modules. This configuration maximises system flexibility by not excluding other hardware options and system configurations from being used with encryption. For example, the encryption module could be used in a radio that is cross-band linked with a second radio.

Encryption Module Hardware Configuration

1. Configure the encryption module hardware as shown in Figure 5.6.
2. Adjust encryption module for unity through-gain. At least 11dB headroom above the 1kHz 60% rated system deviation level will be required throughout the audio processing chain on the module to avoid clipping with speech signals.
3. Input pre-emphasis is required. A typical pre-emphasis circuit is shown in Figure 5.7. If this not available on the module it will need to be added as a separate circuit at the module input. Alternatively the input buffer on the module can be modified if its topology matches that of Figure 5.7.

Figure 5.7 Encryption module - typical pre-emphasis circuit



Use the following procedure to choose the component values in Figure 5.7:

a. Choose C1. 1nF is a typical value.
b. Determine R1: R1 = 1 / (35300 * C1)
c. Determine R2: R2 = 5.9 * R1 for unity gain. Scale R2 proportionally to change gain.
d. Ensure that C2 is zero.
e. Use the nearest preferred component values.

4. Ensure that de-emphasis is applied on both transmit and receive. If this cannot be done via software then the de-emphasis control line will need to be overridden by a hardware modification.

Encryption Module Software Configuration

To make configuration changes via over-the-air rekeying (OTAR), the module needs to be installed in the radio and be operational.

Key Management

For key management refer to the relevant sections of the encryption module manufacturer's documentation.

Radio Programming

Use the programming application to configure the radio.

1. In the Key Settings form, set one function key to Action Digital Output Line.
2. In the PTT / PTT form, set the Advanced PTT group to:
   - PTT Transmission Type: Voice
   - PTT State Is Reflected: checked
   - PTT Priority: Highest
   - Audio Source: CH_MIC
3. In the Digital tab of the Programmable I/O form, carry out the following settings:

Pin	Direction	Action	Active	Debounce	Signal state
IOP_GPIO1	Output	Reflect PTT Status	Low	None	Momentary
IOP_GPIO2	Output	F1 Key Status	High	None	Momentary
IOP_GPIO3	Input	Toggle F1 Key LED	High	0	None

4. In the Audio tab of the Programmable I/O form, carry out the following settings:

Rx / PTT Type	Tap In	Tap In Type	Tap In Unmute	Tap Out	Tap Out Type	Tap Out Unmute
Rx	R7	E - Splice	Busy Detect	R7	E - Splice	Busy Detect
EPTT1	T4	E - Splice	On PTT	T4	E - Splice	On PTT

Operation

With the radios with user interfaces, one function key can be programmed to toggle between Clear and Secure mode. The Secure LED lights up when the radio is in Secure mode. The radio has no facility to change the decryption/encryption code via the user interface.

When the radio is set to Clear mode (unencrypted), the encryption module does not affect the radio operation.

Unencrypted messages received while the radio is in Secure mode will be received as normal, i.e. the radio does not apply any decryption.

To initiate a secure call:

1. Press the Clear/Secure function key (if not already in Secure mode). The Secure LED lights up.
2. Press PTT to set up a call (assuming the other party has valid decryption). You must wait at least 0.5s before speaking to allow the receiving encryption module to synchronise.
3. Carry out the call in standard manner.

The radio will stay in Secure mode until the Clear/Secure function key is pressed again.

The coding or setup of the encryption module can only be changed via the over-the-air rekeying protocol (OTAR) provided by the module manufacturer. For further information refer to the manufacturer's documentation.

Radio performance degradation is to be expected when encryption is active. The main effects are reduced radio range and audio quality.

Testing

With encryption off:

1. Check that the radio powers up normally, with the normal display messages and confirmation tones.
2. Check that receive and transmit audio are functioning, using a service instrument or another radio on the same channel.

With encryption on:

1. Check that the radio receives and transmits, using another TM8000 radio with the same encryption module, programmed with the same codes, on the same channel.
2. Listen for the synchronisation pulses that occur approximately once a second, added by encryption, to confirm encryption is active.

5.2.2 ANI Module

Automatic Number Identification (ANI) modules can be installed in portable or mobile radios. When the ANI module is installed, each radio transmission can have a unique number attached to it to assist dispatchers in identifying the source of transmission.

Note The radios also offer built-in ANI capabilities. For more information refer to the online help of the programming application.

Interface Specification

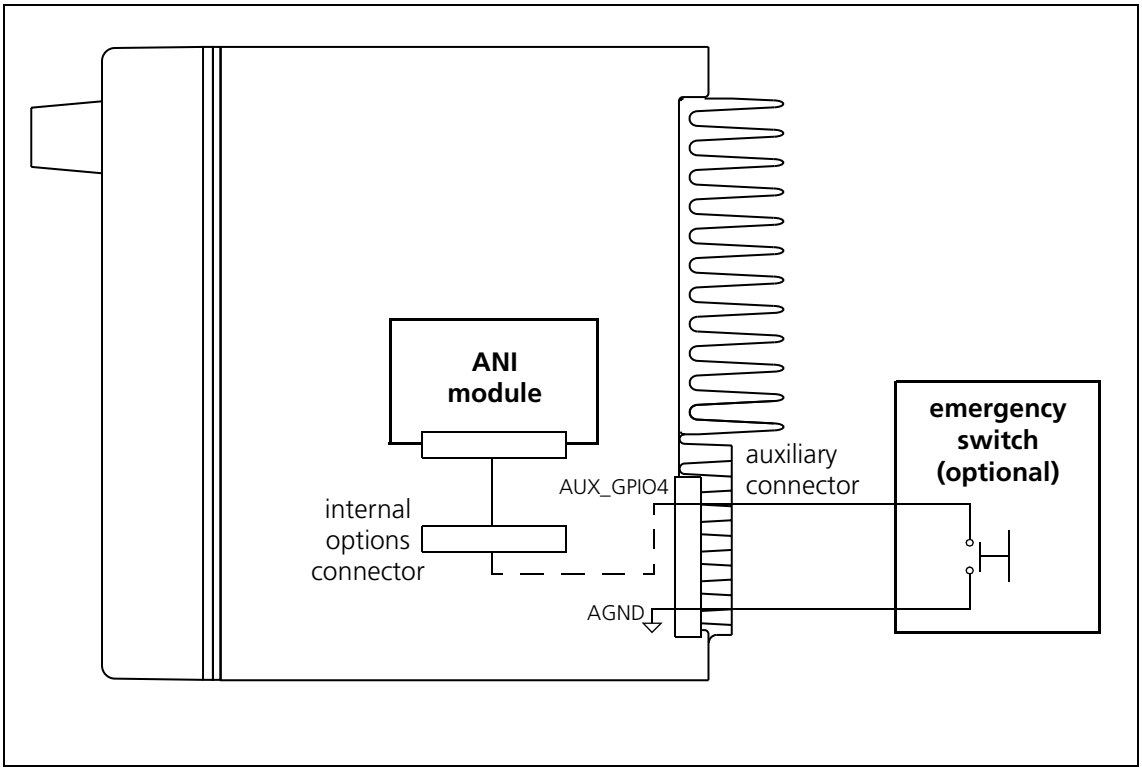
The ANI module is mounted inside the radio body where it connects to the internal options connector via a standard 1.27 mm pitch ribbon cable.

An optional emergency switch can be connected to AUX_GPIO4 and AGND of the auxiliary connector.

The internal options connector is described on page 27.

Figure 5.8 shows the diagram of an ANI module interfaced with the internal options connector inside the radio body.

Figure 5.8 Diagram of ANI module connected to radio



Configure the internal options interface as described in Table 5.6:

Table 5.6 ANI module interface specification

ANI module	Internal options connector		Description/parameter	Specification
Signal	**Pin**	**Signal**		
Power	1	13V8_SW	Switched and unregulated power from radio.	
GND	3	AGND	analog ground.	
PTT in/out[1]	9	IOP_GPIO1	Control head PTT signal from radio. Action: Active State: Module logic threshold required:	 Reflect PTT Status Low 3V3 CMOS-compatible[2]
Emergency input	10	IOP_GPIO2	Emergency signal from radio. Signal mirrored from auxiliary connector. Action: Active State: Module logic threshold required:	 Mirrored from AUX_GPIO4[3] Low 3V3 CMOS-compatible[2]
Mic mute	11	IOP_GPIO3	Mic mute signal to radio. Used as PTT input in order to switch audio source from radio mic to ANI. Action: Active State:	 External PTT2 Low
Module tone out	6	AUD_TAP_IN	Tone output to radio. Audio tap input point: Audio tap input unmuting: Signal level required: AUD_TAP_IN input impedance:	 Use T5-A Use 'on PTT' 690mV$_{p-p}$ (60% RSD[4]) 100kΩ typical

1. If the ANI module has separate PTT in and out signals, tie these together on the module. This will disable the modules on-board Tx timer. Ensure the radios Tx timer duration is set as you require.
2. If the module input is 5V CMOS, a 3.3kΩ pullup to 5V must be fitted on the module.
3. The radio's emergency mode should be disabled if the modules emergency features are used.
4. RSD = Rated System Deviation

Radio Programming

Use the programming application to configure the radio.

1. In the Digital tab of the Programmable I/O form, carry out the following settings:

Pin	Direction	Action	Active	Debounce	Signal state	Mirrored to
AUX_GPIO4	Input	No action	High	100	None	IOP_GPIO2
IOP_GPIO1	Output	Reflect PTT Status	None	None	Momentary	None
IOP_GPIO2	Output	No action	None	None	Momentary	None
IOP_GPIO3	Input	External PTT2	None	0	None	None

2. In the Audio tab of the Programmable I/O form, carry out the following settings:

Rx / PTT Type	Tap In	Tap In Type	Tap In Unmute	Tap Out	Tap Out Type	Tap Out Unmute
EPTT2	T5	A - Bypass In	On PTT	None	C - Bypass Out	On PTT

3. In the PTT / PTT form, set the Advanced PTT group to:
   - PTT Transmission Type: Voice
   - PTT State Is Reflected: checked
   - PTT Priority: Medium
   - Audio Source: CH_MIC
4. In the PTT / External PTT1 form, set the Advanced EPTT1 group to:
   - PTT Transmission Type: None
   - PTT State Is Reflected: cleared
5. In the PTT / External PTT2 form, set the Advanced EPTT2 group to:
   - PTT Transmission Type: Voice
   - PTT State Is Reflected: cleared
   - PTT Priority: Highest
   - Audio Source: Audio Tap In

ANI Module Programming

Refer to the manufacturer's documentation.

6 Connecting an External Alert Device

The TM8100 and TM8200 radios allows for output to external alert devices using the digital GPIO lines of the auxiliary connector, the internal options connector and, with the blank control head, the programming connector.

The AUX_GPIO4 line of the auxiliary connector can be fitted with a power MOSFET in order to directly connect external alert devices (e.g. flashing light, buzzer, horn relay) to the radio. With the other GPIO lines and if no power MOSFET is fitted to the AUX_GPIO4 line, the signal characteristics specified in "Description of the Radio Interfaces" apply.

This chapter describes the connection of an external alert device to the AUX_GPIO4 line of the auxiliary connector and the programming of the radio for an external alert signal.

Important Modifications to radio-frequency transmitting equipment can void the user's authority to operate the equipment. By distributing the TM8000 3DK Hardware Developer's Kit, Tait Electronics Limited. does not accept liability for any non-compliance or infringement of intellectual property rights resulting from the application or use of this kit or information. Any person modifying Tait radio-frequency transmitting equipment is responsible for ensuring that the modified equipment meets all legal and regulatory requirements in the country of use or supply.

To connect an external alert device to the AUX_GPIO4 line of the auxiliary connector, the following steps must be carried out:

1. Fit power MOSFET Q707 and remove resistor R768.
2. Program the radio.
3. Connect the external alert device.

6.1 Fitting Power MOSFET Q707 and Removing Resistor R768

Before connecting an external alert device to the AUX_GPIO4 line, a 12A, 60V, logic level power MOSFET (ON Semiconductor[1] product NTD3055L104, www.onsemi.com [Tait IPN 000-03055-00]) must be fitted to position Q707 and resistor R768 must be removed from the main board assembly.

Figure 6.1 shows the circuit diagram of the AUX_GPIO4 line in factory configuration. For a complete circuit diagram of the main board assembly refer to the service manual for your radio.

Figure 6.1 Circuit diagram of the AUX_GPIO4 line (factory configuration)

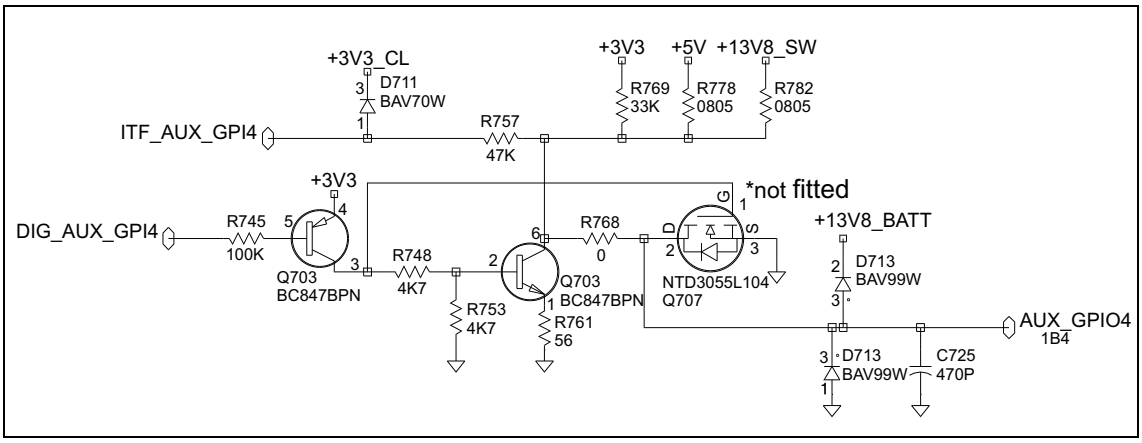
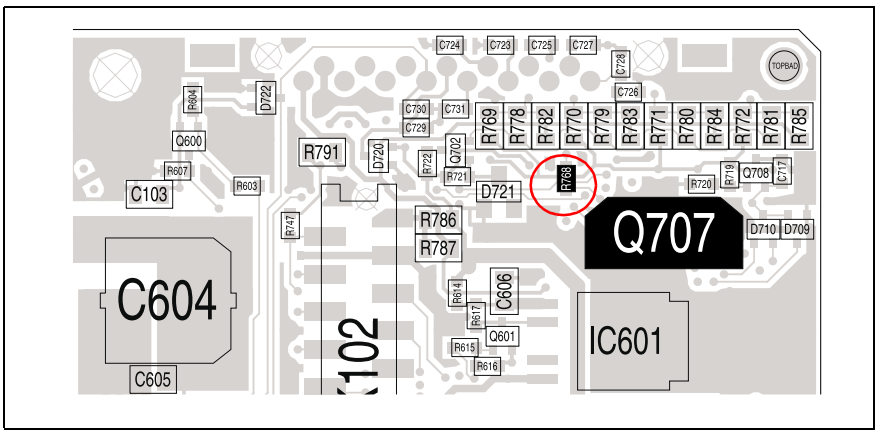


Figure 6.2 shows the positions of Q707 and R768. For a complete layout of the main board assembly refer to the service manual for your radio.

Follow the instructions of the service manual for your radio on removing and fitting the radio lid, the main board assembly, and standard and SMD components.

Figure 6.2 Positions of Q707 and R768 on the main board assembly



1. ON Semiconductor is a trademark of Semiconductor Components Industries, L.L.C.

6.2 Radio Programming

Programmable I/O Form

In the Digital tab of the Programmable I/O form, select the AUX_GPIO4 pin and set Direction to Output, Action to External Alert 1 or 2, Active to Low and Signal State to Momentary.

For further information on the External Alert action refer to "External Alert 1 and 2" on page 80.

Networks / Alerts Form

In the General and External Alerts tab of the Networks / Alerts form, configure the settings of the external alerts.

For further information on how to configure the Alerts form refer to the online help of the programming software.

6.3 Connecting the External Alert Device

Important While MOSFET Q707 is rated at 12A (with heat sink), the maximum allowable current of the connector and radio's earthing system is 2A. Therefore, a horn must not be connected directly to the radio. A horn relay must be used.

Connect the external alert device to pin 10 (AUX_GPIO4) and pin 8 (13V8_SW) of the auxiliary connector (or a different positive battery connection).

7 Computer-Controlled Radio

7.1 Introduction

7.1.1 Overview

This chapter provides details of the Computer-Controlled Radio (CCR) protocol, version 2.00. It describes the radio to Data Terminal Equipment (DTE) protocol. This is an advanced radio control feature.

Note CCR applies to TM8100 radio terminals only.

The CCR protocol is intended to provide a means of controlling a radio unit from some form of DTE via a serial interface (PC, AVL application, Telemetry Application, MDT).

In CCR mode, the radio no longer uses a non-volatile database. A number of radio parameters are uploaded and changed during run-time from an external application. In this way, the external application provides the non-volatile data storage.

All serial ports on the radio support CCR (Microphone, Auxiliary and Internal Options).

The TM8100 CCR mode is a sub-mode of CCDI. Entry into CCR is via a CCDI command ("f0200D8"). Once, in CCR mode the radio will accept serial CCR commands and will no longer process CCDI commands.

The TM8100 series of radios are able to support USER, CCDI Transparent and CCR modes of operation.

7.1.2 Benefits

Most of the radio functionality can be controlled by the external device operating over a serial communications link. This allows system integrators to develop their own intelligent control device. They can develop complex solutions with a low cost RF platform.

In essence, a radio which has access to all the channels in its operating range could be made. The limit is no longer in the mobile but in the external intelligence driving it. A wider range of methods can be employed to alter or modify the way the radio is controlled by the user; a step forward in control evolution.

7.1.3 Configurable Parameters

Channel information:

- Tx/Rx frequencies
- Tx & Rx CTCSS/DCS frequencies
- Tx power level
- Channel bandwidth

The unit can accept or send Selcall in:

- All the international tone formats
- Between 2 and 8 tones per sequence.
- Tone durations from 20 - 100ms
- ANI leading/trailing sequence

Other features:

- Audio volume level
- Enable/disable monitor

7.1.4 Potential Applications

- Complex conventional radio units (multi-system)
- MDT controlled radio
- Remote off-air monitoring
- System integration
- Self healing RF networks
- Rapid deployment - inter operability
- Hybrid solutions

7.2 Programmable Parameters

CCR depends on the same programmable parameters as those used to configure CCDI command mode.

7.2.1 Requirements

The following needs to be enabled as a minimum:

- Enable CCDI
- Enable a serial port for communications (**Auxiliary**, Mic or Internal Options connector) as follows:

Parameter	Value
Baud rate	1200, 2400, 4800, 9600, 14400, or **19200**
Number of data bits	**8**
Parity	**None**
Number of stop bits	**1**

Note The recommended configuration parameters are in Bold.

Note The serial port on the TM8100 is capable of driving only a limited cable length. See "Line Lengths" on page 12.

Radio operation while in CCR mode also requires, as a minimum, the following to be defined:

- Enable at least one channel
- Enable at least one PTT & microphone for voice

For selcall commands it is also necessary to enable at least one network using selcall signalling, as follows:

- Enable network to be selcall

The radio will, upon entry to CCR, inherit programmable parameters from the channel that was active when CCR was entered. Modifications while in CCR mode to channel/network characteristics will be compared to this baseline. All CCR changes are temporary, nothing is saved to the database, therefore they are lost on power cycling.

7.3 Command Protocol

The DTE is connected to the RU via a serial link. Command and response messages are generated between the DTE and the RU.

7.4 Command Description

This section details the standard messages.

7.4.1 Message Format

All CCR mode message packets take the following general form:

[IDENT][SIZE][PARAMETERS][CHECKSUM]<CR>

Where:

Parameter	Value
[IDENT]	is the message identifier. Identifiers are single ASCII characters which categorise the message type
[SIZE]	is the number of characters which make up the [PARAMETERS] field. [SIZE] is an 8-bit number expressed in ASCII-hex notation (two characters)
[PARAMETERS]	is an optional field, depending upon the command. Parameter values are generally character strings unless explicitly stated otherwise. Parameter type is dependent upon the command - there is no explicit type definition.
[CHECKSUM]	s an 8-bit checksum of the [IDENT], [SIZE] and [PARAMETERS] fields. It is expressed in ASCII-hex notation (two characters)
<CR>	is the packet terminator. It is the ASCII "carriage return" character (0Dh).

General characteristics of the message format worth noting are as follows:

- All characters in a message are printable ASCII
- Where numeric values are represented in ASCII-hex notation (two characters per byte), digits A...F are upper case
- The minimum length of a command packet is 5 characters; i.e. when [SIZE] = 00. For example, c003D is the CANCEL command which is 5 characters.
- The maximum length of the [PARAMETERS] field is 32 characters, so that the maximum length of the command packet is therefore 37 ([SIZE]="20") characters

7.4.2 Calculating [CHECKSUM]

[CHECKSUM] is calculated by applying the following algorithm:

1. Take the modulo-2 sum of all message bytes preceding [CHECKSUM].
2. Retain bits 0...7, discarding any higher order bits resulting from the summation.
3. Form the two's complement of the remainder.
4. Convert the binary number into two ASCII-hex digits, MSD first.

Checksum Example s0D050800TESTHi!DA

1. Take the modulo-2 sum of all message bytes preceding [CHECKSUM].
   - s = 73h, 0 = 30h, D = 44h etc. therefore the modulo-2 sum is:

73 + 30 + 44 + 30 + 35 + 30 + 38 + 30 + 30 + 54 + 45 + 53 + 54 + 48 + 69 + 21 = 426h

2. Retain bits 0 to 7, discarding any higher order bits resulting from the summation.
   26h

3. Form the two's complement of the remainder.
   26h = 0010 0110
   two's complement = 1101 1010

4. Convert the binary number into two ASCII hex digits, MSD first.
   1101 1010 = DA

7.5 CCR Mode Commands

7.5.1 Entering CCR Mode

CCR mode is entered from CCDI with the function zero command, "f0200D8". This command is described in the CCDI specifications.

Entry to CCR mode will be denied if the radio is busy scanning, transmitting or processing emergency mode activities. CCR mode is not, however, blocked when the radio is stunned; CCR can run in this state.

7.5.2 CCR/CCDI Mode Independence

CCDI and CCR are independent from each other in that commands and responses for either command interpreter can only be processed in its own mode. There are, for instance, no CCDI progress messages when the radio is in CCR mode.

7.5.3 CCR Mode Activated

The radio sends the string "M01R00" to the DTE when CCR mode is activated.

7.5.4 CCR Mode Busy

It is possible to program an output line for busy detect status in CCR mode.

7.5.5 Blocked Functions

CCR mode denies the following functions (that are available in user mode) and indicates them as invalid if they are attempted from a front panel or programmable input:

- Channel selection
- Scanning
- Emergency
- SDM (No GPS)
- User mode selcalling:
    - No call setups with the front panel controls, programmable I/O or PTT
    - No selcall alerting for identities defined in the database

CCR is intended for headless radio units. Third parties can, upon integration, add their own implementations for things like scanning & selcall alerts.

Note PTT initiated functionality will only be suppressed, not indicated, notably, PTT call setup.

7.5.6 CCR Persistence

When a radio is reset nothing is saved from the current CCR session to the next power up. Third party devices can check that the radio is alive with the pulse command and "reprogram" it when a power outage has been detected.

7.5.7 CCR Response Time

The receive frequency in CCR mode can be changed at least every 20ms.

7.6 CCR Positive Acknowledgements

The radio validates the received strings since the last command on the serial port versus the CCR protocol when it sees an instance of the terminating character <CR>. It returns either a positive or negative acknowledgement. The positive acknowledgement has the following format.

Response +ssxCC

Where:

Parameter	Value
+	the ASCII '+' character indicates that the command was accepted
ss	ASCII hex number ss is the size of the ack (always "01")
x	echoes back the command identity, the first letter (R, T, A, B, S, M…)
CC	ASCII hex number CC is the checksum

Effect

An ACK response is sent back when a command has been accepted, the radio does not wait until the command has been executed. The ACK may be delayed, in some cases, but usually it is sent back immediately.

7.7 CCR Negative Acknowledgements

The radio validates the received strings since the last command on the serial port versus the CCR protocol when it sees an instance of the terminating character <CR>. It returns either a positive or negative acknowledgement. The negative acknowledgements are as follows.

7.7.1 Invalid CCR Command

If a string does not conform to the protocol, or there is something else inhibiting its execution, it is rejected and a negative acknowledgement is sent to the user. The negative acknowledgement has the following format.

Response

-ssrrxCC

Where:

Parameter	Value
-	the ASCII '–' character indicates that the command was rejected
rr	indicates the reason for rejecting the command as follows: ■ '02' Checksum error ■ '01' Invalid command ■ '03' Parameter error in command ■ '05' Radio is busy ■ '06' Command is not accepted
x	echoes back the command identity, but only if the checksum in the command was correct
CC	ASCII hex number CC is the checksum

Note A command is only ever rejected with one error code.

Effect

The implementation exits the validation as soon as an error has been struck - it will not check the parameters if the command does not pass the checksum test.

7.7.2 Validation Checksum Error

If the input string does not have the correct checksum, a checksum error is immediately reported and no further checks are done.

7.7.3 Invalid Validation Command

If the input string passes the checksum test but the identity contained is not a recognised CCR command, an invalid command is reported.

7.7.4 Validation Parameter Error

If the input string passes the general message format but not the command specific tests, a parameter error is sent. For details on validation rules see the specific commands.

- data length check
- range check on message data
- correct sequence of commands

7.7.5 Radio Busy Message

If the input string passes both the general and command specific validation criteria, it is processed only if the following conditions are true:

- Radio is not in transmitting state
- Radio is not busy processing the last sent command

The radio rejects the commands and returns the busy error code in these instances.

7.7.6 Command Not Accepted Message

Some commands trigger sequence errors if they are sent when the radio cannot process the command, for example:

- Radio is attempting to use a selcall command when there is no selcall configuration defined.

This error is, for instance, sent if a selcall command is received, but the CCR channel is not activated with a network using selcall signalling.

7.8 CCR Commands

7.8.1 Summary and Examples

The messages in the following table are sent from the DTE to the RU.

Message	Cmd	Function
RssxxxxxxxxxCC	R	Go to receive frequency
TssxxxxxxxxxCC	T	Load transmit frequency
HssxCC	H	Set bandwidth
JssxxxCC	J	Set volume level
AssxxxxCC	A	Receive ctcss value
BssxxxxCC	B	Transmit ctcss value
CssxxxxCC	C	Receive dcs code value
DssxxxxCC	D	Transmit dcs code value
SssxxxxxCC	S	Encode Selcall sequence
IsstplCC	I	Set Selcall Parameters
NsspxxxxxCC	N	Set ANI
PssxCC	P	Set Power
QssxCC	Q	Query Commands
EssCC	E	Exit CCR Mode

In all cases, if the command is received without error by the RU and all the parameters are valid, the command will be executed and the prompt will be returned to the DTE. If an error arises, the DTE will be notified with an appropriate response.

Examples

f0200D8	Enter ccr from ccdi
E005B	Exit - same effect as "^"
R0945320000087	Set Rx frequency to 453.2MHz
T0945320000085	Set Tx frequency to 453.2MHz
Q01PFE	Pulse command, returns "P" when minimum config exists
P0111E	Set power to Very Low
P0141B	Set power to High
H01324	Set bandwidth to Wide
H01126	Set bandwidth to Narrow
A0406708E	Set Rx ctcss to 67Hz
A0400009B	Set Rx ctcss to 0Hz
B0406708D	Set Tx ctcss to 67Hz
B0400009A	Set Tx ctcss to 0Hz
C03023C5	Set Rx DCS to 23

C03000CA	Set Rx DCS to 0
D03023C4	Set Tx DCS to 23
D03000C9	Set Tx DCS to 0
S051234549	Dial 12345
I03015BE	Select toneset 0, ccir, 20ms tones and 5 tones notify
N04112387	Set ani to leading and tones 123
M01D0E	Monitor "on"
M01E0D	Monitor "off"
J03000C3	Volume level 0 (range is 0-255)
J03104BE	Volume level 104 (range is 0-255)

7.8.2 Go to Receive Frequency

Description

On receipt of this command, the radio checks the format and does a range check on the frequency. If it is valid, the radio sends an ACK response and then initialises the synthesizer with the new frequency. One should allow 20ms for the synthesizer to settle at the new frequency. If the command is invalid, a NAK response will be sent and the receiver will remain at the last selected frequency. If the radio is transmitting then a NAK response will also be sent.

Command

RssxxxxxxxxxCC

Where:

Parameter	Value
R	ASCII letter R denotes the go to Receive frequency
ss	ASCII hex number ss is the number of x characters "08" or "09"
xxxxxxxxx	ASCII number xxxxxxxxx is the receive frequency, as follows: ■ Minimum is a number representing the bottom of the radio model frequency band ■ Maximum is a number representing the top of the radio model frequency band
CC	ASCII hex number CC is the checksum

Effect

This command has immediate effect with the receiver retuning to this channel. If the synthesizer is out of lock then a NAK response will be sent.

7.8.3 Load Transmit Frequency

Description

On receipt of this command, the radio checks the format and does a range check on the frequency. If it is valid, the radio sends an ACK response. If the command is invalid, a NAK response will be sent and the transmit frequency will not change. If the radio is transmitting then a NAK response will also be sent.

Command

TssxxxxxxxxxCC

Where:

Parameter	Value
T	ASCII letter T denotes the Load Transmit Frequency command
ss	ASCII hex number ss is the number of x characters "08" or "09"
xxxxxxxxx	ASCII number xxxxxxxxx is the transmit frequency, as follows: ■ Minimum is a number representing the bottom of the radio model frequency band ■ Maximum is a number representing the top of the radio model frequency band
CC	ASCII hex number CC is the checksum

Effect

This command loads the transmit frequency into a memory location for use when the PTT or Selcall encoder is next active. The radio will not transmit if the synthesizer is out of lock.

7.8.4 Set Volume Level

Description

This command sets the volume level for received audio. If the index number is out of range the radio does not act on the command and sends a NAK (range error) back.

Command

JssxxxCC

Where:

Parameter	Value
J	ASCII letter J denotes the Set Volume Level command
ss	ASCII hex number ss is the number of x characters (always "03")
xxx	ASCII number xxx is a volume level value in the range of 0 to 255 (255 is the maximum)
CC	ASCII hex number CC is the checksum

Effect This command has immediate effect.

If there is a volume knob on the radio there is no guarantee that the value set with this command will be the volume. The radio will use the level last set with any control.

7.8.5 Receive CTCSS Value

Description This command disables (if xxxx=0), or enables (if xxxx>0), Rx CTCSS. If enabled, the audio mute is opened only when a given subaudible CTCSS tone is being received (otherwise the audio mute is closed). If disabled, muting on CTCSS is disabled. If the frequency is out of range, the radio does not act on the command and sends a NAK (range error) back.

Command AssxxxCC

Where:

Parameter	Value
A	ASCII letter A denotes the Receive CTCSS Value load command
ss	ASCII hex number ss is the number of x characters (always "04")
xxxx	ASCII number xxxx is a receive subaudible frequency in 0.1Hz. The valid range is 67Hz to 254.1 Hz.
CC	ASCII hex number CC is the checksum

Effect This command has immediate effect and closes the mute to signals without a valid CTCSS tone if enabled, or opens the mute on disabling CTCSS muting.

7.8.6 Transmit CTCSS Value

Description This command disables (if xxxx=0) or enables (if xxxx>0), Tx CTCSS. If enabled, a CTCSS tone is transmitted whenever the radio is transmitting audio. If the reference number is out of range, the radio does not act on the command and sends a NAK (range error) back to the radio. If the radio is already transmitting then a NAK response will also be sent.

Command BssxxxCC

Where:

Parameter	Value
B	ASCII letter B denotes the transmit CTCSS value to be sent on transmit
ss	ASCII hex number ss is the number of x characters (always "04")
xxxx	ASCII number xxxx is a transmit CTCSS frequency in 0.1Hz. The valid range is 67Hz to 254.1 Hz.
CC	ASCII hex number CC is the checksum

Effect On receipt of the request the radio stores the CTCSS tone to generate. The radio will then generate the tone at the next PTT or Selcall encode activity.

7.8.7 Receive DCS Value

Description This command disables the DCS filter if the code is "000". If the code is not recognized as an octal, the radio does not act on the command and sends a NAK (range error) back.

Command CssxxxCC

Where:

Parameter	Value
C	ASCII letter C denotes the Receive DCS Value load command
ss	ASCII hex number ss is the number of x characters (always "03")
xxx	ASCII number xxx represents a DCS code in octal
CC	ASCII hex number CC is the checksum

Effect This command has immediate effect and closes the mute to signals without a valid DCS tone.

7.8.8 Transmit DCS Value

Description This command disables the DCS encoding if the code is "000". If the code is not recognized as an octal, the radio does not act on the command and sends a NAK (range error) back.

Command DssxxxCC

Where:

Parameter	Value
D	ASCII letter D denotes the transmit DCS value to be sent on transmit
ss	ASCII hex number ss is the number of x characters (always "03")
xxx	ASCII number xxx represents a DCS code in octal
CC	ASCII hex number CC is the checksum

Effect This command loads the value into memory ready for the next PTT or Selcall encode activity.

7.8.9 Encode Selcall Sequence

Description This command turns the transmitter on and sends the Selcall string following a short delay (network 1 lead-in delay). If the number of tones is incorrect the command is rejected (NAK-format error).

Command Sssxx..xxCC

Where:

Parameter	Value
S	ASCII letter S denotes the Transmit Selcall tone sequence
ss	ASCII hex number ss is the number of x characters
xx..xx	ASCII number xx..xx is the tone sequence. Minimum is 2 tones and maximum is 33.
CC	ASCII hex number CC is the checksum

The Set Selcall Parameter command (see below) allows the user to change the Selcall parameter defaults.

Effect This command has immediate effect, provided that the receiver and transmitter frequency values have been initialised and the radio is not transmitting at the time (PTT active causes busy error)

7.8.10 Set Selcall Parameters

Description This command allows the user to modify the Selcall default parameters (tone set to use, tone period, number of tones in Tx sequence and number of tones in Rx sequence). If any of the command parameters are out of range, a NAK (range error) will be sent back to the control head.

Command

IsstplCC

Where:

Parameter	Value
I	the ASCII letter I denotes the Set Selcall Parameter command
ss	ASCII hex number ss is the number of parameters (always "03")
t	specifies the Tone Set to use. This can be one of the following: ■ '0' CCIR ■ '1' EIA ■ '2' EEA ■ '3' ZVEI-I ■ '4' ZVEI-II ■ '5' ZVEI-III ■ '6' PZVEI ■ '7' NATEL ■ '8' DZVEI
p	specifies the Tone Period to use. This can be one of the following: ■ '1' 20ms ■ '2' 33ms ■ '3' 40ms ■ '4' 50ms ■ '5' 60ms ■ '6' 70ms ■ '7' 100ms
l	sets the decode buffer time and message filter as defined in "Notify Buffer Size" on page 153 and "Selcall Decode Sequence" on page 153.
CC	ASCII hex number CC is the checksum

Effect

The Selcall modem is immediately re-initialised with the new decode parameter map. These new parameters are applied for the next Selcall decode/encode sequence.

CCR default parameters are those loaded from the network associated to the selected channel when the radio enters CCR mode. This includes selcall parameters like 'lead in delay', which it is not possible to alter in CCR mode.

7.8.11 Set ANI

Description

This command disables or enables ANI. It configures what ANI sequence is to be sent and when the ANI sequence is to be sent. If p is not '0', the tone sequence gets stored.

If the number of tones (xx...xx) does not match the currently configured length, then the command is rejected (NAK- format error). It is also rejected if p is out of range (range error).

Command

Nsspxx..xxCC

Where:

Parameter	Value
N	ASCII letter N denotes the Automatic Number Identification command
ss	ASCII hex number ss is the number of parameters
p	denotes the ANI position with regard to PTT presses. Valid values are: ■ '0' disables ANI (in this case the tone sequence xx..xx is not required) ■ '1' leading ANI (ANI is sent soon after PTT is pressed) ■ '2' trailing ANI (ANI is sent when PTT is released) ■ '3' combination of 1 and 2
xx..xx	is the 5 to 8 tone sequence. It is optional if p is set to 0.
CC	ASCII hex number CC is the checksum

Effect

If enabled, the ANI tones get stored and any subsequent use of the PTT button activates ANI.

7.8.12 Monitor

Description

This command is the same as the monitor function available on the function keys in normal user mode. When it is active, it overrides any active subaudible signalling filters. The squelch mute is not overridden.

Command

MssxCC

Where:

Parameter	Value
M	ASCII letter M indicates it is a monitor command
ss	ASCII hex number ss is the number of parameters (always "01")
x	is the mute state wanted, as follows: ■ 'D' for disable mute (monitor) ■ 'E' for enable mute
CC	ASCII hex number CC is the checksum

Effect

Immediate.

If there is a front panel key or programmable input with monitor configured, there is no guarantee that the value set with this command will represent the monitor state. The radio will use the state last set with any control.

7.8.13 Transmitter Output Power

Description

The transmitter output power is set to the value selected. If the index is incorrect the command is rejected (NAK-format error).

Command

PssxCC

Where:

Parameter	Value
P	ASCII letter P indicates it is a power command
ss	ASCII hex number ss is the number of parameters (always "01")
x	is an index to transmit power level, as follows: ■ '1' very low power ■ '2' low power ■ '3' medium power ■ '4' high power
CC	ASCII hex number CC is the checksum

Effect

The modified power level takes effect on the next Tx activity; either PTT or Selcall.

Note If there is a front panel key or programmable input with low power configured, there is no guarantee that the value set with this command will represent the effective output power. The radio will use the state last set with any control.

7.8.14 Set Bandwidth

Description

This command sets the operating transmit/receive bandwidth. If the index number is out of range, the radio does not act on the command and sends a NAK (range error) back.

Command

HssxCC

Where:

Parameter	Value
H	ASCII letter denotes the Set Bandwith command
ss	ASCII hex number ss is the number of x characters (always "01")
x	is the Bandwith Index, as follows: ■ '1' narrowband ■ '2' mediumband ■ '3' wideband
CC	ASCII hex number CC is the checksum

Effect

This command has immediate effect.

7.8.15 Query Radio Pulse

Description

The purpose of this command is to give the user a way to "ping" the radio.

The radio pulse command allows you to check that the radio is still responding. The control device may use the radio pulse command every ten seconds in the absence of other activity.

Command

Q01PFE

Where:

Parameter	Value
Q	ASCII letter Q indicates it is a query command as opposed to a set-up command
01	ASCII hex number 01 indicates it has 1 parameter
P	ASCII letter P indicates it is the radio pulse command
FE	ASCII letters FE are the checksum

Response The radio will send back one of two responses:

- QssPCC - if the radio has got its minimum configuration, which typically consists of having received a 'set receive frequency' command.
- QssDCC - is returned if the radio has loaded its default set-up and has not yet received a 'set receive frequency' command.

Effect These commands invoke an immediate reply.

7.8.16 Exit CCR Mode

Description The radio initiates a software reset (same as for "^"), and exits CCR mode.

Command E005B

Where:

Parameter	Value
E	ASCII letter E indicates it is an exit command
00	ASCII hex number "00" indicates it has no parameter
5B	ASCII characters "5B" are the checksum

Effect This command is immediate. The radio will reset.

7.9 Unsolicited Messages from the Radio

7.9.1 Summary and Examples

The following messages may be returned to the DTE without user intervention.

Message	Cmd	Function
Vssxx..xxCC	V	Selcall decode sequence
MsspCC	MP	Ptt exceeds max transmit limit
MssrCC	MR	CCR initialised

Examples:

V0612345-18 Sequence 12345 detected

V065E5E5-EE Sequence 55555 detected (E is repeat tone in this case)

M01P02 Transmit timeout warning (10s before inhibit)

M01R00 CCR mode entered

7.9.2 PTT exceeds max transmit limit

Description

The radio uses this response to advise the control head that PTT is about to timeout.

For control heads with user interfaces, the warning threshold is the duration timer configured for the network minus 10s.

Response

MsspCC

Where:

Parameter	Value
M	ASCII letter M denotes the message
ss	ASCII hex number ss is the number of parameters (always "01")
P	ASCII letter P denotes a PTT being applied that has exceeded the default transmit timer warning threshold
CC	ASCII hex number CC is the checksum

Effect

Whenever the radio reaches its maximum transmit period the radio will inform the control head. After a further short delay the radio will turn off the transmitter.

7.9.3 Selcall Decode Sequence

Description

The radio sends this message every time the decoder tone buffer is emptied, in accordance with the notification criteria set by the "I" command. See "Set Selcall Parameters" on page 146 and "Notify Buffer Size" on page 153.

The sequences received are represented with the tones from the toneset. Repeat tones and gaps will be forwarded as is.

Response

Vssxx..xxCC

Where:

Parameter	Value
V	ASCII letter V denotes the Selcall decode message
ss	ASCII hex number ss is the number of parameters
xx..xx	are the tones decoded within the time window specified by the notify parameters as follows: ■ ASCII digits 0 to 9 ■ Special tones are represented with ASCII letters A to F ■ Gap. A gap in CCR is equal to the tone period set by the Selcall Parameter command
CC	ASCII hex number CC is the checksum

- CC is the checksum as defined

Effect

When the radio receives the given SELCALL sequence the radio sends the decoded sequence to the DTE.

7.9.4 Notify Buffer Size

Description

The number of tones to notify, set by the selcall parameter command, allow the user to define the size of the decode tone buffer. This buffer sets the maximum time period that the radio will decode and log tones before reporting to the user, when continuously receiving valid selcall tones. The timer is calculated as follows:

$$Tmax = (N \times P) + P$$

Where:

Parameter	Value
Tmax	Notify buffer maximum time
N	Number of tones
P	Tone period

The buffer timer is started after at least one valid tone has been detected.

The buffer timer is reset if a gap is detected prior to expiry.

The notify parameter also sets a filter that allows the user to suppress decode sequences from being reported if they consist of less than the selected number of tones in a continuous sequence, as follows:

- If the decode buffer contains less than the selected number of tones when it is reset the contents shall be discarded.

If a radio in CCR receives a speech call it is very likely that the user will see this response with garbage decode sequences (1 or 2 tones) if the filter is removed.

The additional tone period added to the buffer time allows the radio to detect and report if a gap was present or not after the sequence detected.

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THIS AGREEMENT SHALL BE SUBJECT TO AND CONSTRUED IN ACCORDANCE WITH NEW ZEALAND LAW AND DISPUTES BETWEEN THE PARTIES CONCERNING THE PROVISIONS HEREOF SHALL BE DETERMINED BY THE NEW ZEALAND COURTS OF LAW. PROVIDED HOWEVER TAIT MAY AT ITS ELECTION BRING PROCEEDINGS FOR BREACH OF THE TERMS HEREOF OR FOR THE ENFORCEMENT OF ANY JUDGEMENT IN RELATION TO A BREACH OF THE TERMS HEREOF IN ANY JURISDICTION TAIT CONSIDERS FIT FOR THE PURPOSE OF ENSURING COMPLIANCE WITH THE TERMS HEREOF OR OBTAINING RELIEF FOR BREACH OF THE TERMS HEREOF.

No Dealings

THE LICENSEE MAY NOT SUBLICENSE, ASSIGN OR TRANSFER THE LICENCE OR THE PROGRAM EXCEPT AS EXPRESSLY PROVIDED IN THIS AGREEMENT. ANY ATTEMPT OTHERWISE TO SUBLICENSE, ASSIGN OR TRANSFER ANY OF THE RIGHTS, DUTIES OR OBLIGATIONS HEREUNDER IS VOID.

No Other Terms

THE LICENSEE ACKNOWLEDGES THAT IT HAS READ THIS AGREEMENT, UNDERSTANDS IT AND AGREES TO BE BOUND BY ITS TERMS AND CONDITIONS. THE LICENSEE FURTHER AGREES THAT SUBJECT ONLY TO ANY EXPRESS WRITTEN TERMS OF AGREEMENT TO THE CONTRARY BETWEEN TAIT AND THE LICENSEE THIS IS THE COMPLETE AND EXCLUSIVE STATEMENT OF THE AGREEMENT BETWEEN IT AND TAIT IN RELATION TO THE SOFTWARE OR FIRMWARE WHICH SUPERSEDES ANY PROPOSAL OR PRIOR AGREEMENT, ORAL OR WRITTEN AND ANY OTHER COMMUNICATIONS BETWEEN THE LICENSEE AND TAIT RELATING TO THE SOFTWARE OR FIRMWARE.