2 Description of the Radio Interfaces

This chapter describes the characteristics of the mechanical and electrical interfaces of the radio body and the TM8115 control head or the TM8105 blank control head, which are suitable for the connection of TM8000 or application accessories and equipment.

Figure 2.1 provides an overview of the TM8000 interfaces:

Figure 2.1 TM8000 interfaces (with TM8115 control head)

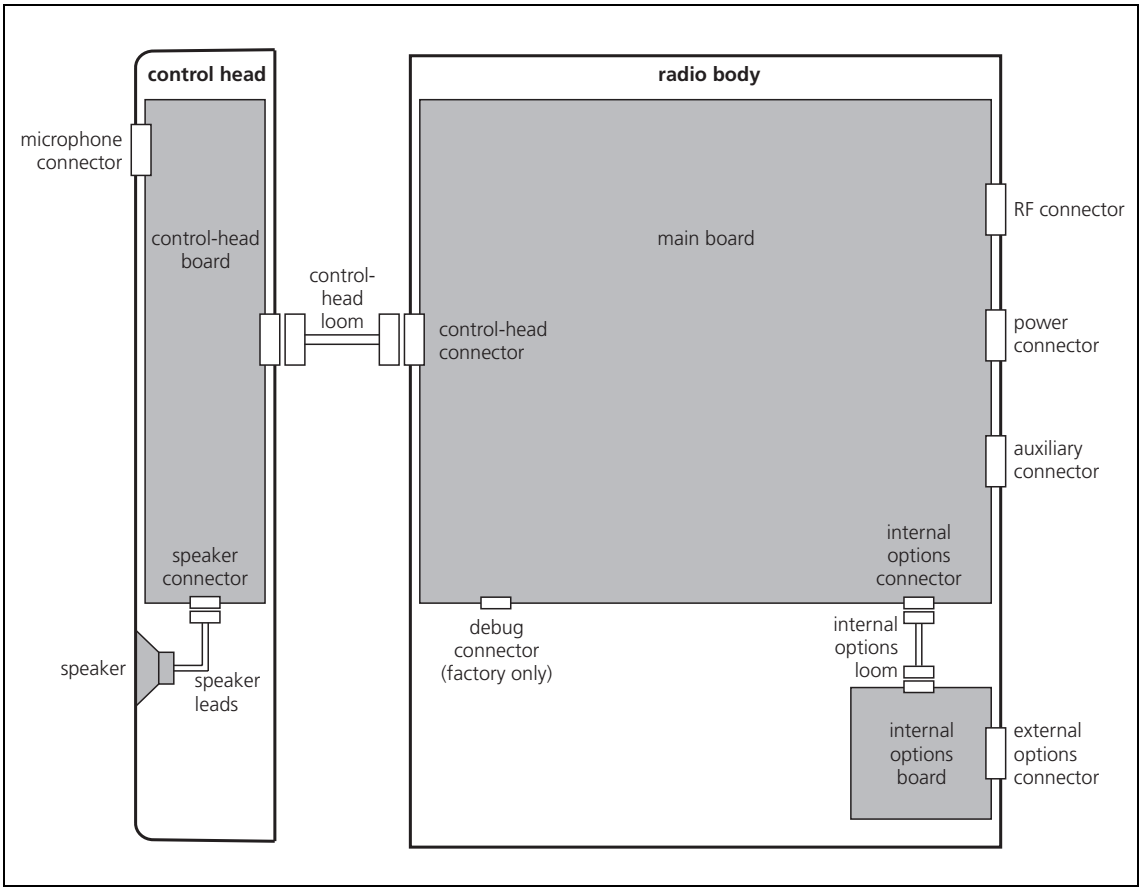


Figure 2.2 shows the connectors of the radio body.
Figure 2.3 shows the connectors of the TM8115 control head.
Figure 2.4 shows the connectors of the TM8105 blank control head.

For more block and circuit diagrams refer to the PCB Information chapter of the TM8100 Mobile Radio Service Manual.

Figure 2.2 Connectors of the radio body

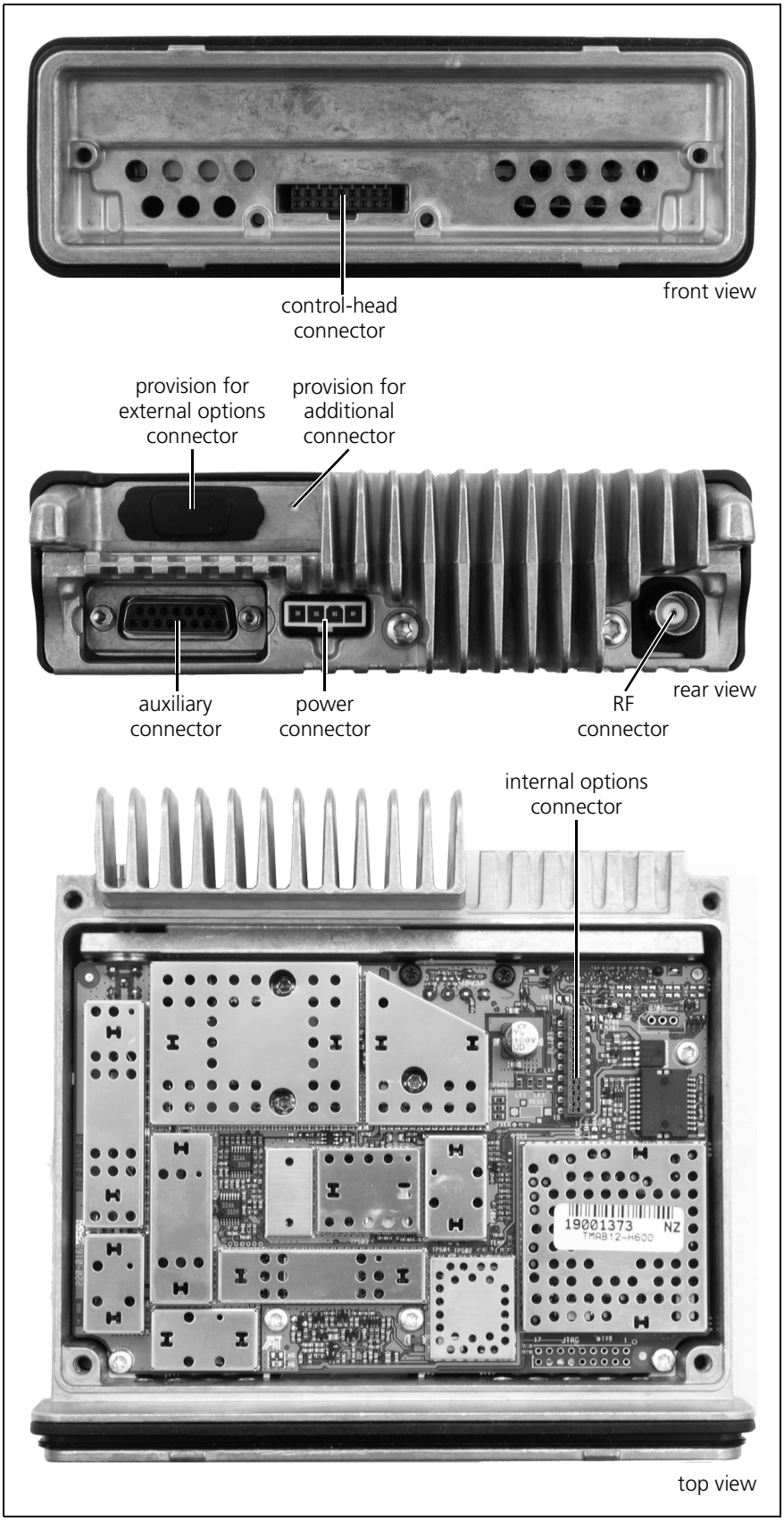


Figure 2.3 Connectors of the TM8115 control head

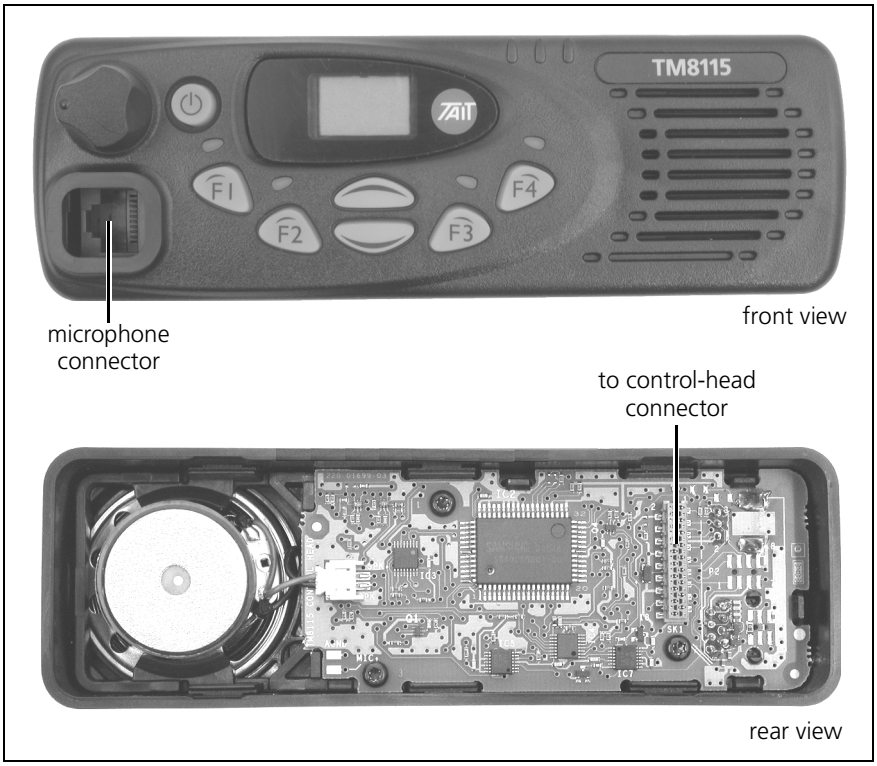
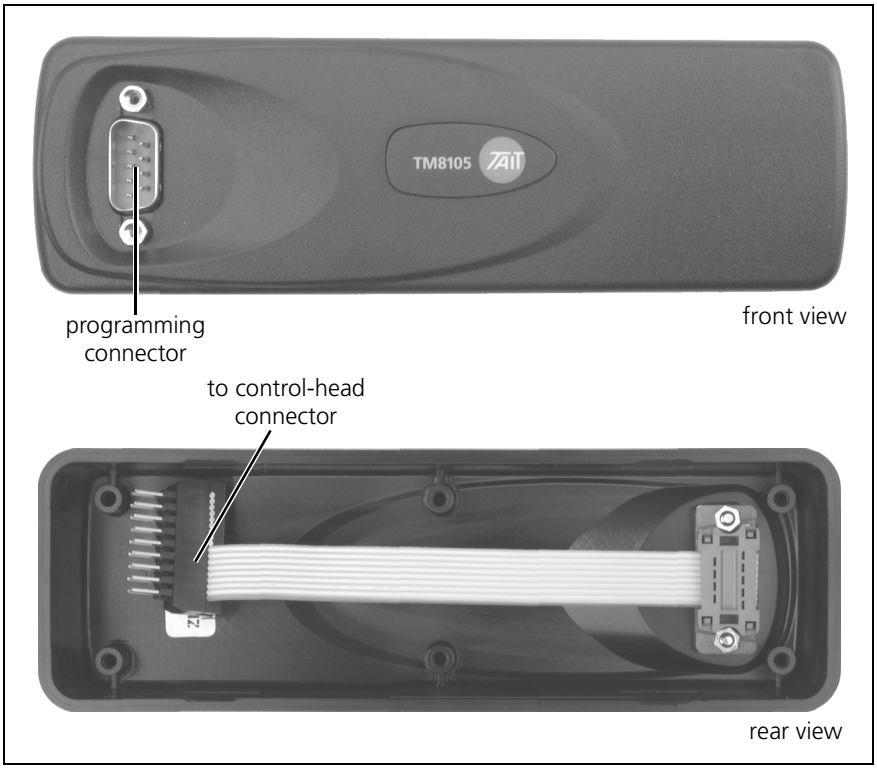


Figure 2.4 Connectors of the TM8105 blank control head

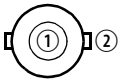


2.1 RF Connector

The RF connector is the primary RF interface to the antenna. The RF connector is a standard BNC socket with an impedance of 50Ω.

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

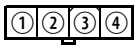
Table 2.1 RF connector - pins and signals

Pinout	Pin	Signal Name	Signal Type
 rear view	1	RF	RF analogue
	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
 rear view	1	AGND	Earth return for radio body power source.	Ground
	2	SPK–	External speaker output. Balanced load configuration.	Analogue
	3	SPK+	External speaker output. Balanced load configuration.	Analogue
	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[ab]	9.7		17.2	V		
Auto-recovery limits[b]	10.2		16.8	V	After supply voltage excursion outside the radio operating range	
Safe input range[bc]	–0.5		30	V	No hardware damage.	
Reverse polarity protection	Crowbar diode with in-line fuse					Replacement fuse: Tait IPN 265-00010-80 or Littelfuse[d] part number 314010 or equivalent.
Cranking earth current protection	In-line fuse with negative lead					

a. While the transceiver will operate over this range RF performance to specification applies over 10.8 to 16.0V.

b. 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.

c. 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.

d. Littelfuse is a registered trademark of Littelfuse Incorporated. Refer to www.littelfuse.com.

Important The speaker load configuration is balanced; no speaker output line must 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	%	1 min at maximum power: 2 min 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.

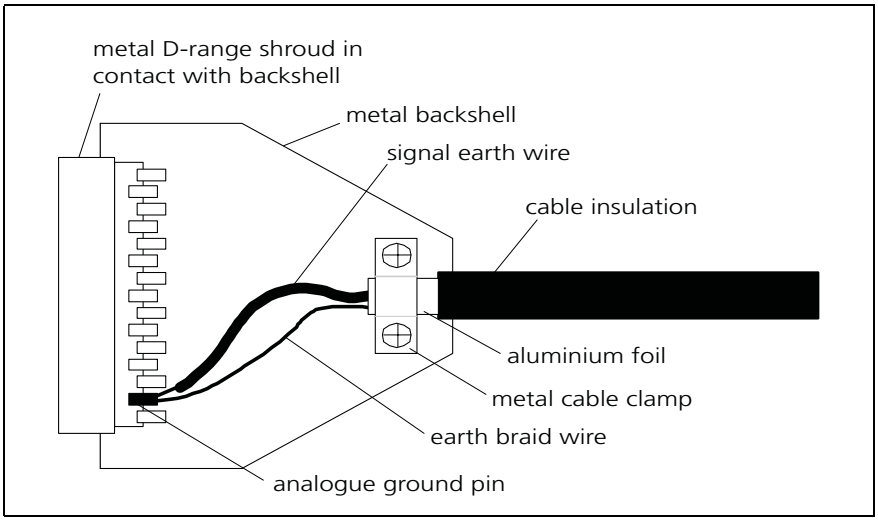
2.3 Auxiliary Connector

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 41 mm in width and 18 mm 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 89) includes a suitable plug (Tait IPN 240-00020-55).

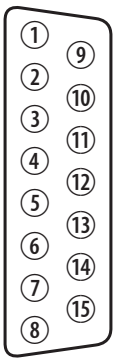
If the auxiliary cable is longer than 1 metre it is recommended to shield the cable and connector backshell. Figure 2.5 shows the recommended shielding arrangement. The earth braid wire (bare copper) and aluminium foil should only be earthed at the radio end of the cable.

Figure 2.5 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 80).

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.[a]	Digital, 3V3 CMOS
	4	AUX_GPI3	General purpose digital input. Programmable function. With LK2 fitted, GPI3 is a power sense input.[a]	Digital, 3V3 CMOS
	10	AUX_GPIO4	Programmable function and direction. Pads available to fit a higher power driver transistor on GPIO4 line.[b]	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.	Analogue
	13	AUD_TAP_OUT	Programmable tap point out of the Rx or Tx audio chain. DC-coupled.	Analogue
	14	AUX_MIC_AUD	Auxiliary microphone input. Electret microphone biasing provided. Dynamic microphones are not supported.	Analogue
	6	RSSI	Analogue RSSI output.	Analogue
	8	+13V8_SW[c]	Switched 13.8V supply. Supply is switched off when radio body is switched off.	Power
	15	AGND	Analogue ground	Ground

a. For more information on hardware links refer to "Power Sense Options" on page 121.

b. For more information on high power drive refer to "Special Purpose Outputs" on page 67.

c. Can be switched or unswitched. For more information refer to "Connector Power Supply Options" on page 131.

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[a]. 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[a]. 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[b] –500 –1	µA mA µA mA	No links fitted[a]. Default pullups[c]. 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[a]. Default pullups[c]. +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[c]. 3kΩ load.	
Safe DC input limits: AUX_GPI1-3 AUX_GPIO4-7 AUX_RXD AUX_TXD[d]	 –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.
Analogue signals						
DC output range: RSSI 13V8_SW	 0 9.7		 3 17.2	 V V	 See Table 2.9 on page 24. 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[d] AUX_MIC_AUD RSSI[d]	 –17 –0.5 –17 –17		 +17 +17 +17 +17	 V V V V		 Short circuit-safe. Input current <±20mA

a. For more information on hardware links refer to "Power Sense Options" on page 121.

b. It is recommended that this input is driven by a mechanical switch or an open collector/drain output.

c. For more information on pullups refer to "Digital Input Lines" on page 39.

d. 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, 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 T8 Tap T5 Tap T4 Tap T3	 	 1.8 1.8 9.6 11.6 11.7 11.7	 	 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	

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			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:	CCDI2					
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

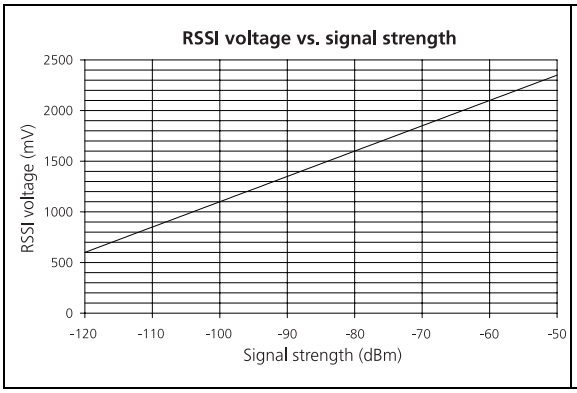


Table 2.10 Rx path tap frequency response plots

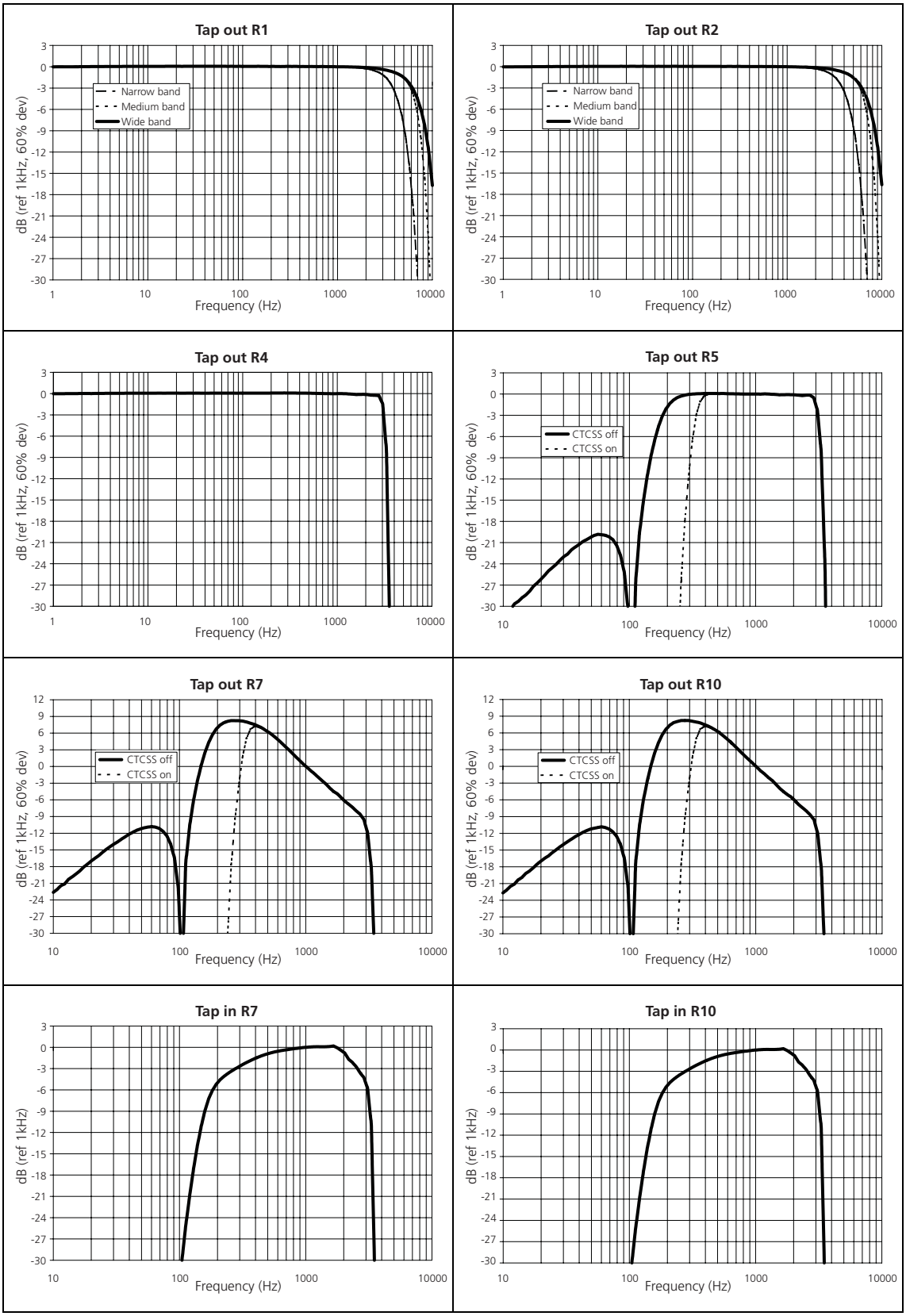


Table 2.11 Tx path tap frequency response plots

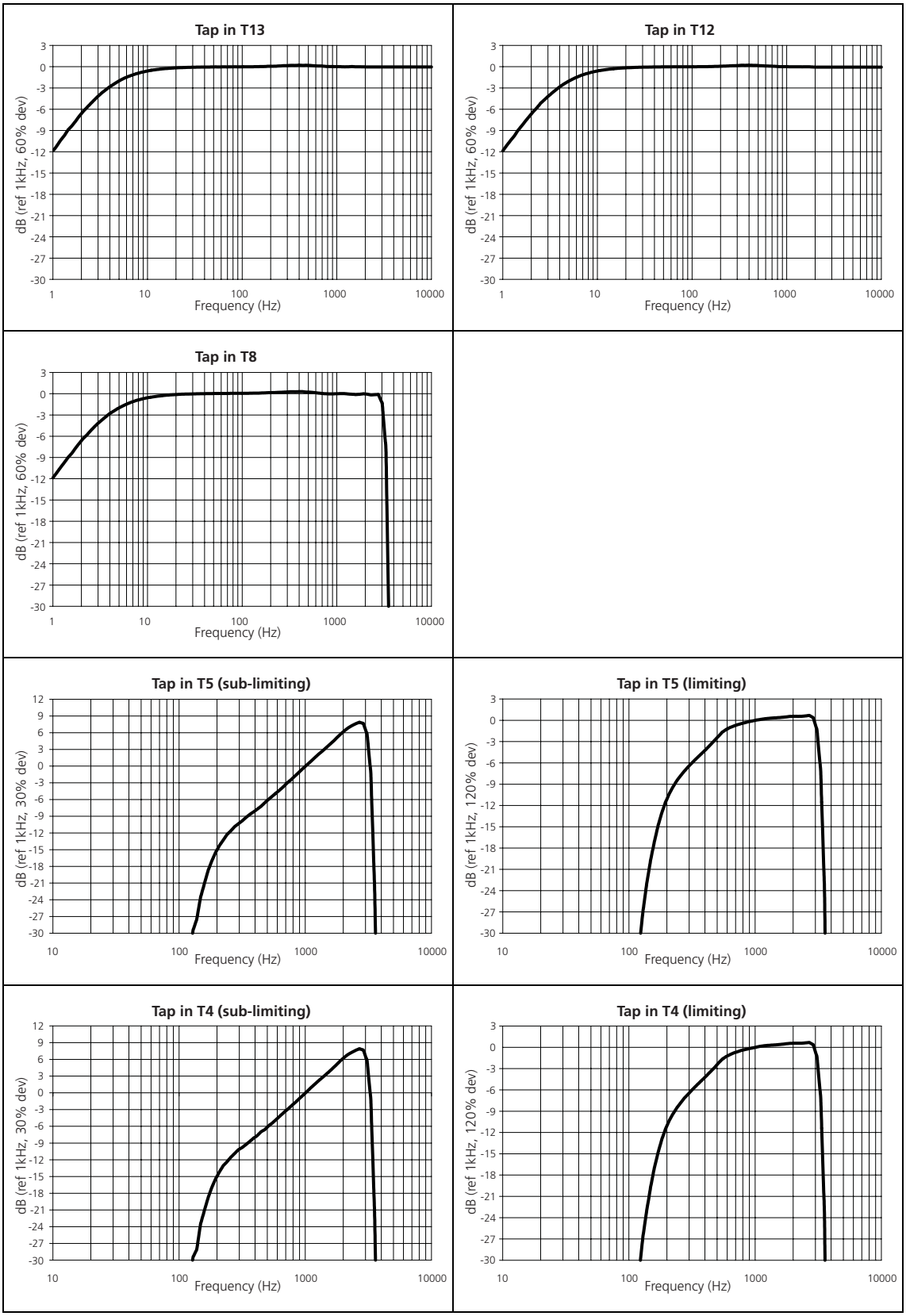


Table 2.11 Tx path tap frequency response plots (continued)

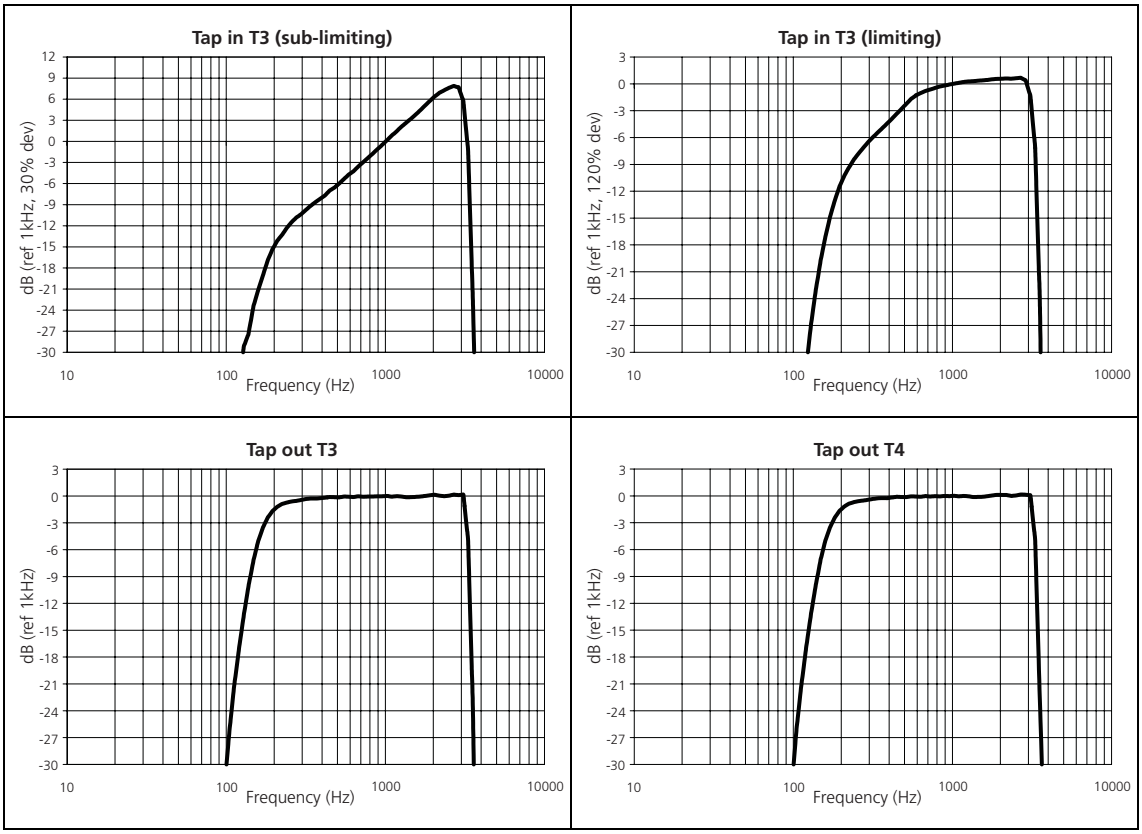


Table 2.12 Group delay distortion frequency response plots

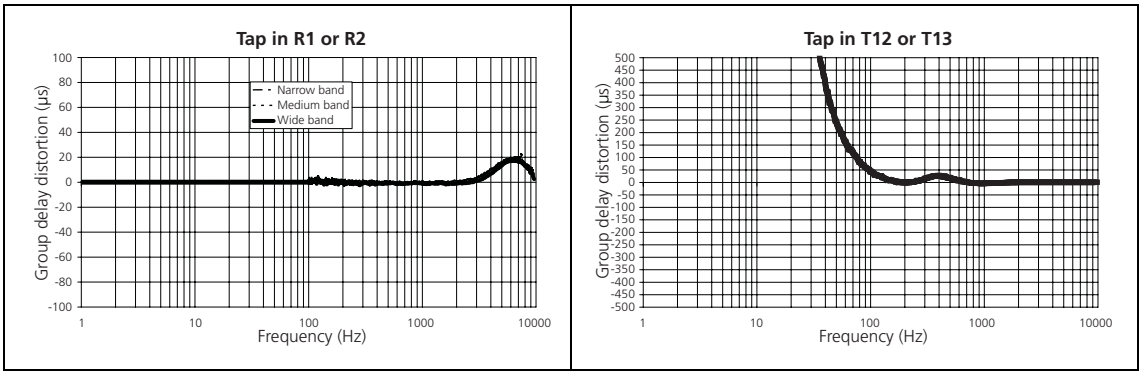
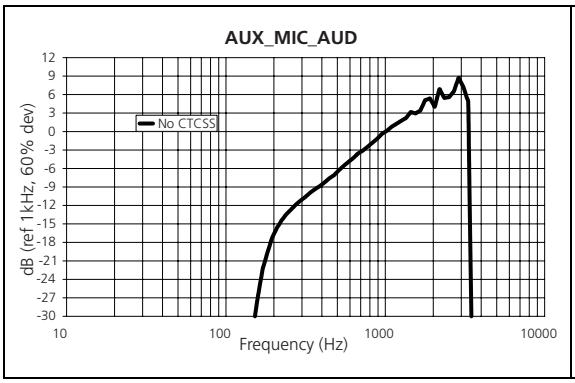


Table 2.13 AUX_MIC_AUD frequency response plot



2.4 Internal Options Connector

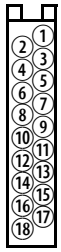
When installing an internal options board, the internal options connector is the electrical interface to the main board of the radio body.
The internal options connector provides similar I/O to the auxiliary connector. The digital signals and the serial port are independent of the auxiliary connector signals, but the AUD_TAP_IN, AUD_TAP_OUT, AUX_MIC_AUD, 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 Mobile Radio Accessories Manual.
- TMAA01-05 Options Extender Board.
  Refer to the TM8100 Mobile Radio Accessories Manual.

For information on how to create your own internal options board, refer to "Internal Options Board" on page 85.

Table 2.14 Internal options connector - pins and signals

Pinout	Pin	Signal	Description	Signal type
 top view	1	13V8_SW[a]	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.	Analogue
	3	AGND	Analogue ground.	Ground
	4	AUX_MIC_AUD	Auxiliary microphone input. Electret microphone biasing provided. Dynamic microphones are not supported.	Analogue
	5	RX_BEEP_IN	Receive sidetone input. AC-coupled.	Analogue
	6	AUD_TAP_IN	Programmable tap point into the Rx or Tx audio chain. DC-coupled.	Analogue
	7	RX_AUD	Receive audio output. Post volume control. AC-coupled.	Analogue
	8	RSSI	Analogue RSSI output.	Analogue
	9…15	IOP_GPIO1…7	Programmable function and direction. With LK4 fitted, GPIO7 is a power sense input[b].	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

a. Can be switched or unswitched. For more information refer to "Connector Power Supply Options" on page 131.
b. For more information on hardware links refer to "Power Sense Options" on page 121.

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[a].	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[a].	Configured as power sense input.
Input low current: All inputs		–100	–120	µA	No hardware links fitted[a].	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[a].	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.
Analogue 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		

a. For more information on hardware links refer to "Power Sense Options" on page 121.

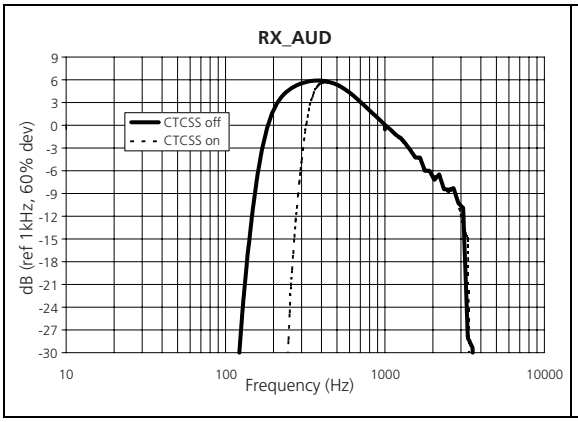
Table 2.16 Internal options connector - AC characteristics

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	10			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			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:	CCDI2					
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 Mobile Radio Accessories Manual.
- TMAA01-05 Options Extender Board.
  Refer to the TM8100 Mobile Radio Accessories Manual.

For information on how to create your own internal options board, refer to "Internal Options Board" on page 85.

2.6 Provision for Additional Connector

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 16. The maximum hole diameter is 7.5 mm, 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.

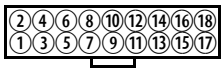
2.7 Control-Head Connector

The control-head connector is the standard interface between the radio body and the TM8115 control head or TM8105 blank control head.

You can integrate your own blank control head 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 95.

The TM8115 control head uses all 18 signals of the control-head connector. The programming connector of the TM8105 blank control head 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.	Analogue
	2	+13V8[a]	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.	Analogue
	6	AGND	Analogue 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 TM8115 volume pot wiper.	Analogue
	11	CH_SPI_DO	Data output signal to TM8115 control head.	Digital. 3V3 CMOS.
	12	CH_LE	Latch enable output to TM8115 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 TM8115 control head.	Digital. 3V3 CMOS.
	16	CH_SPI_CLK	Clock output to TM8115 control head.	Digital. 3V3 CMOS.
	17	SPK–	Speaker audio output for non-remote control head. Balanced load configuration.	Analogue
	18	SPK+	Speaker audio output for non-remote control head. Balanced load configuration.	Analogue

a. Can be switched or unswitched. For more information refer to "Connector Power Supply Options" on page 131.

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		
Analogue signals (for signals not listed here refer to the Auxiliary interface specification)						
DC input range: VOL_WIP_DC	 0 0		 0.6 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 2.2kΩ	 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			 100 1	 mA A		Specification must be derated by load amount from internal options and auxiliary interfaces.
Safe DC input limits: VOL_WIP_DC RX_AUD SPK+/– CH_MIC_AUD	 –7 –17 0 –17		 +17 +7 +17 +17	 V V V V		 Short circuit-safe.

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					

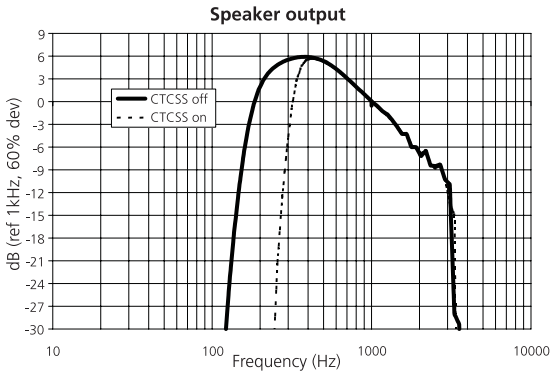
Table 2.22 Control-head connector - speaker output characteristics

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			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 CCDI2					
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

When the TM8115 control head is not installed, the radio body will receive no volume control level or power on/off signal from the control head. In order for the volume control default to work properly, the absence of a control head is detected by detecting the absence of the volume potentiometer.

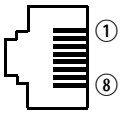
For operation with the TM8105 blank control head, the radio must be programmed always to power up when power is applied and the ignition-sense hardware link LK1 must be fitted. For more information on hardware links refer to"Power Sense Options" on page 121.

2.8 Microphone Connector

The microphone connector of the TM8115 control head is an RJ-45 socket.

When the TM8115 control head 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.	Analogue
	2	+13V8[a]	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.	Analogue
	6	AGND	Analog ground.	Analogue 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

a. Can be switched or unswitched. For more information refer to "Connector Power Supply Options" on page 131.

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

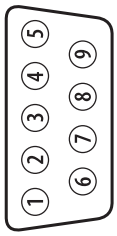
2.9 Programming Connector

The programming connector of the TM8105 blank control head is a 9-way standard-density D-range plug.

The programming connector can also be used to connect application products.

When the TM8105 blank control head is connected to the radio body, the programming connector uses the signals shown in Table 2.26:

Table 2.26 Programming connector - pins and signals

Pinout	Pin	Signal name	Description	Signal type
 front view	1	PRG_RX_AUD	Receive audio output.	Analogue
	2	PRG_TXD	Asynchronous serial port - Transmit data.	3.3V CMOS
	3	PRG_MIC_AUD	Fist microphone audio input.	Analogue
	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[a]	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	Analogue ground	Ground
	9	DGND	Digital ground	Ground

a. Can be switched or unswitched. For more information refer to "Connector Power Supply Options" on page 131.

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

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 3.7 Audio tap in and tap out lines

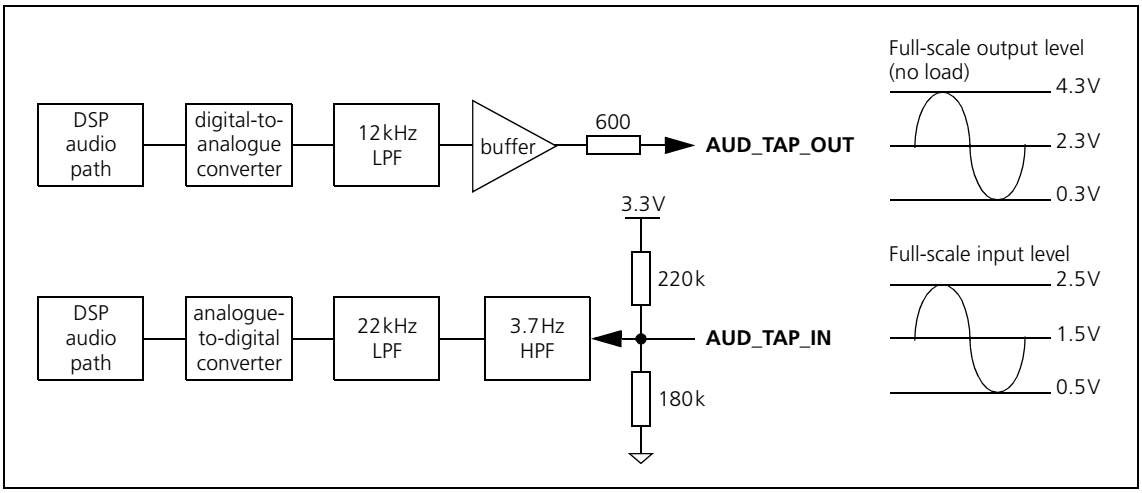
Signals	Connector	Direction
AUD_TAP_IN	auxiliary connector internal options connector	input only
AUD_TAP_OUT	auxiliary connector internal options connector	output only

For details on the connector pin-outs and electrical characteristics of these lines refer to "Description of the Radio Interfaces" on page 15.

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



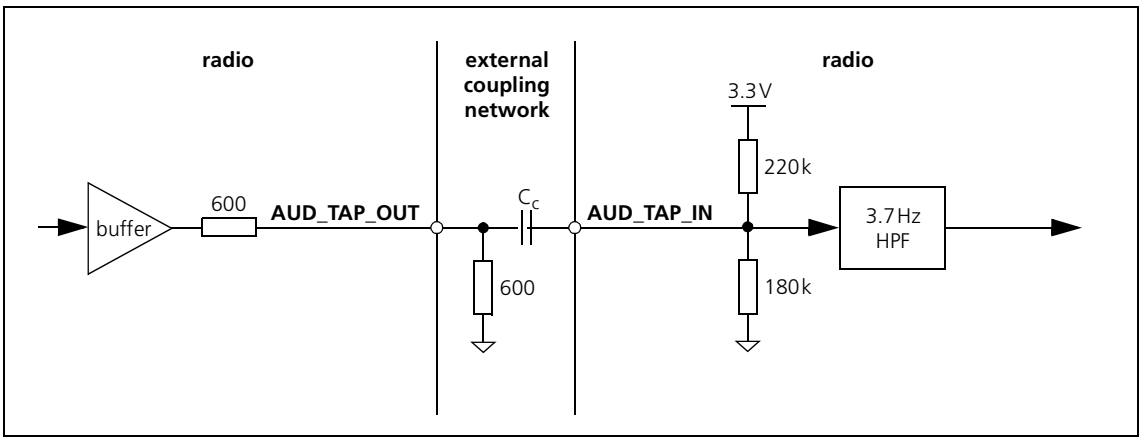
The signal source for the audio tap out line comes from the DSP audio path (refer to Figure 3.14 for details) and is fed to a digital to analogue converter at 48000 samples per second. The converter output is low pass filtered at 12kHz to remove alias components and fed to a buffer amplifier. The buffer 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 20). 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 analogue-to-digital converter at 48kHz. The analogue-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.