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**TM8000** mobiles

TM8100 Computer Controlled Data Interface (CCDI)  
**Protocol Manual**



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# Preface

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## Scope of Manual

This manual contains reference information about the TM8100 CCDI protocol.

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If you have any enquiries regarding this manual, or any comments, suggestions and notifications of errors, please contact support at one of the addresses listed [on page 2](#)).

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## Associated Documentation

TM8100 Mobile Radio User's Guide (MM8100-00-03-804)

TM8100 Mobile Radio Service Manual (MM8100-00-00-812)

TM8000 Mobile Radio Accessories Manual (MMAA00-00-00-812)

TM8000 3DK Hardware Developer's Kit Application Manual  
(MMAA30-01-00-807)

TM8000 3DK Resource CD (TMAA30-01)

TMAA30-02 TM8000 3DK Application Board Service Manual  
(MMAA30-02-00-812)

TMAA30-02 TM8000 3DK Application Board Software Manual  
(MMAA30-02-00-429)

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1	September 2003	new manual

## Alert Notices

Within this manual, three types of alerts are given to the reader: warning, 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.

## Abbreviations

<b>Abbreviation</b>	<b>Description</b>
3DK	Third-Party Developer's Kit
ASCII	American Standard Code for Information Interchange
CCDI	Computer Controlled Data Interface
CRC	Cyclic Redundancy Check
CTCSS	Continuous Tone Coded Squelch System
CTS	Clear to Send
DCS	Data Carrier System
DTE	Data Terminal Equipment
DTMF	Dual Tone Multi-Frequency
FFSK	Fast Frequency Shift Keying
GPIO	General Purpose Input/Output
IPN	Internal Part Number
LED	Light-Emitting Diode
MSD	Most Significant Digit
PC	Personal Computer
PTT	Press To Talk
RTS	Request to Send
Rx	Receive
RXD	Receive Data
SDM	Short Data Message
Tx	Transmit
TXD	Transmit Data
UART	Universal Asynchronous Receiver-Transmitter
XON	Transmitter On
XOFF	Transmitter Off



# 1 Introduction

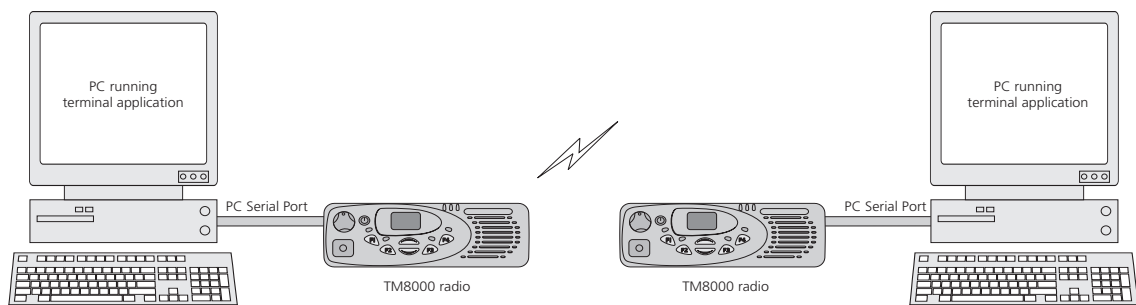
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The Computer Controlled Data Interface (CCDI) protocol is a Tait proprietary command protocol embedded in the TM8100 and used for communicating with the TM8100 via asynchronous serial ports.

The TM8100 is the DCE (Data Circuit-Terminating Equipment) and is connected directly to the DTE (Data Terminal Equipment), usually a PC, via the serial port.

Two modes of operation are available using the serial ports:

- Command mode
- Transparent mode



When in Command mode, commands and response messages are passed between the PC and the TM8100 using the CCDI protocol. The Command mode baud rate is selectable using the TM8000 Programming Application to either 1200, 2400, 4800, 9600, 14400 or 19200 baud.

When in Transparent mode, communication between the PC and the TM8100 is Fixed Frequency Shift Keying (FFSK) data and is selectable using the TM8000 Programming Application to either 1200, 2400, 4800, 9600, 14400 or 19200 baud.

The over-air data rate is always fixed at 1200 bps for FFSK data.

CCDI2 refers to CCDI version 2.XX.

## 1.1 Serial Ports

There are three ports available for CCDI asynchronous serial communication with the TM8100. The microphone and auxiliary ports are accessed externally, and the internal options connector is internal to the radio.

Only one of these ports can be used for CCDI transmission and reception at any time and the port is selected in the Data form of the TM8000 Programming Application. Select “Mic”, “Aux” or “Internal Connector”.

- Mic: the radio will transmit and receive data via the MIC\_TXD and MIC\_RXD lines on the microphone connector. Refer to “[Microphone Connector](#)” for signal details.
- Aux: the radio will transmit and receive data via the AUX\_TXD and AUX\_RXD lines on the auxiliary connector. Refer to “[Auxiliary Connector](#)” for signal details.
- Internal Connector: the radio will transmit and receive data via the IOP\_TXD and IOP\_RXD lines on the internal options connector. This connector is used to fit an internal options board into the TM8100. Refer to the TM8000 3DK Hardware Developer’s Kit Application Manual for more details.

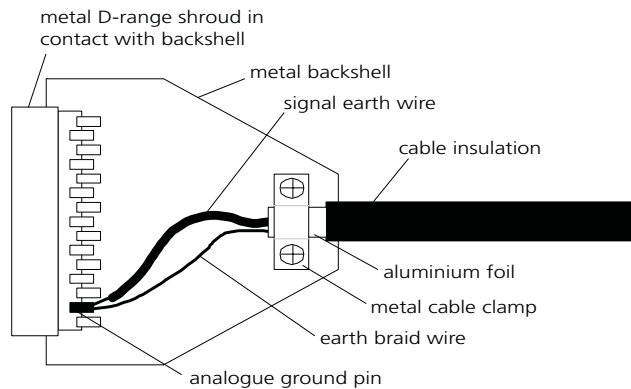
### 1.1.1 Auxiliary Connector

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. The AUX\_TXD and AUX\_RXD lines are used to transmit and receive data from the radio.



**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 that you test the plug to be used before manufacturing a cable. The internal options kit available from Tait 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. The diagram 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.



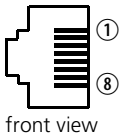
Pinout	Pin	Signal name	Description	Signal type
<p>rear view</p>	12	AUX_GPI1	General purpose digital input. Programmable function.	Digital. 3V3 CMOS.
	5	AUX_GPI2	General purpose digital input. Programmable function. With LK3 fitted, GPI2 is an emergency power sense input.	Digital. 3V3 CMOS.
	4	AUX_GPI3	General purpose digital input. Programmable function. With LK2 fitted, GPI3 is a power sense input.	Digital. 3V3 CMOS.
	10	AUX_GPIO4	Programmable function and direction. Pads available to fit a higher power driver transistor on GPIO4 line.	Digital. 3V3 CMOS input.
	2	AUX_GPIO5		Open collector output with pullup.
	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	Switched 13.8V supply. Supply is switched off when radio body is switched off.	Power.
	15	AGND	Analogue ground	Ground.

Refer to the TM8000 3DK Hardware Developer's Kit Application Manual for more details about the auxiliary connector.

## 1.1.2 Microphone Connector

The microphone connector on the TM8100 control head is an RJ-45 socket.

When the TM8100 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:

Pinout	Pin	Signal name	Description	Signal type
 <p>front view</p>	1	MIC_RX_AUD	Receive audio output.	Analogue
	2	+13V8_SW	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	First 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

The MIC\_TXD and MIC\_RXD lines are used to transmit and receive data from the radio. Refer to the TM8000 3DK Hardware Developer's Kit Application Manual for more details about the microphone connector.

## 1.1.3 Data Characteristics

Parameter	Standard				Comments
	min.	typ.	max.	units	
<b>Serial port</b>					
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				
<b>GPIO</b>					
Delays: I/O mirror to IOP UI key delay			500 50	$\mu$ s ms	

## 1.1.4 Logic Level Compatibility

The following table show the compatibility of the TM8000 digital I/O used for CCDI with common industry logic standards.

### Digital Input Compatibility and Tolerance

Digital Input Line	Logic standard input compatibility and tolerance			
	3.3V CMOS	5V CMOS	5V TTL	RS-232
AUX_RXD	Yes	Yes	Yes	Yes
IOP_RXD	Yes	Yes	Yes	No <sup>a</sup>
CH_RXD MIC_RXD PRG_RXD	Yes	Yes	Yes	Yes

a. Level compatible but not tolerant. Inputs can be made RS-232 tolerant by using 3.3kOhm series resistance inserted at the radio end.

### Digital Output Compatibility

Digital Output Line	Logic standard input compatibility and tolerance			
	3.3V CMOS	5V CMOS	5V TTL	RS-232
AUX_TXD	Yes	No	Yes	No
IOP_TXD	Yes	No <sup>a</sup>	Yes	No
CH_TXD MIC_TXD PRG_TXD	Yes	No	Yes	No

a. These outputs can be made 5V CMOS compatible using a 3.3k Ohm pull-up resistor to 5V that is provided by the device being driven.

## 1.2 Before Operating

Before using CCDI, the following may be useful to check.

- The radio must be correctly programmed for use with the CCDI protocol. See [“Radio Programming” on page 17](#) for configuration information.
- At power on, the radio will select its default channel. To change the channel, select the channel using the normal radio interface or using the CCDI Go\_to\_Channel command (see [“GO\\_TO\\_CHANNEL” on page 32](#)).  
Note that some channels are designated data channels in the Details tab of the Channels form which means they are optimised for data.
- The radio will power on into the mode selected in the ‘Powerup State’ field in the Data form.
- Power, Tx and Rx LED indicators are helpful for establishing proper operation. The radio speaker can be used to listen to data coming in.

- Data flow is controlled either by the customer's embedded computer system or by a PC running a data-sending application such as Hyperterminal.



**Note** In accordance with RS-232 specifications, the radio should be within 15m of the computer equipment for optimum performance.

## 1.3 Limitations



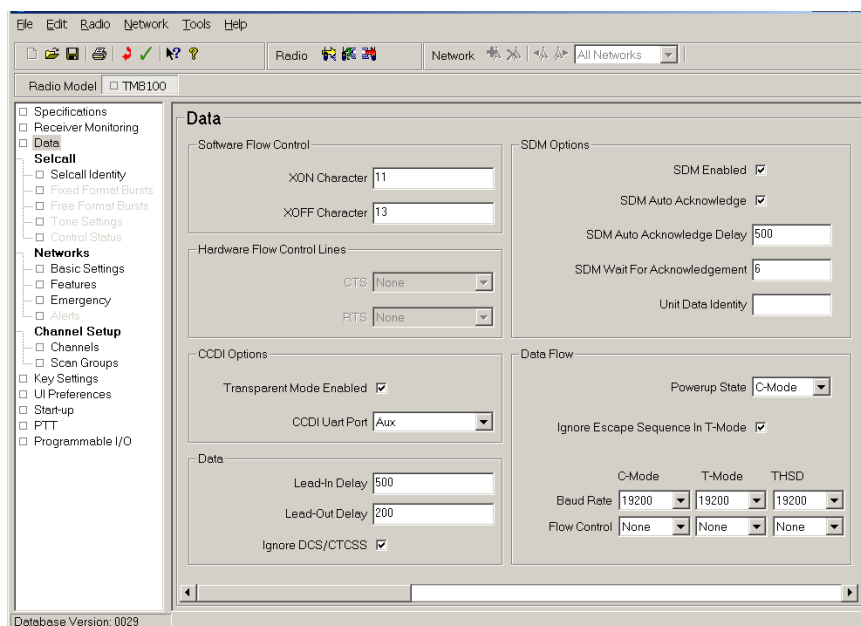
**Important** Some data applications require extended transmission times. This may be for larger file transfers or for real-time telemetry information. This may put undue stress on the radio transmitter and care must be taken to control transmission times using flow control. See [“XON/XOFF Software Flow Control”](#) on page 24.

## 2 Radio Programming

This section describes how to configure the TM8100 radio using the TM8000 programming application, for use with CCDI and data.

### 2.1 Data form

The Data form is used for setting up the majority of the parameters affecting data.



#### 2.1.1 Software Flow Control

Software Flow Control assigns the XON and XOFF characters used for software handshaking. See [“XON/XOFF Software Flow Control”](#) on page 24.

Software Flow Control is only enabled when the flow control is set to ‘Software’ in the Data Flow section of the Data form in the TM8100 Programming Application. The type of flow control is applied to each mode independently, although flow control has no affect in Command mode as commands are generally smaller than the input buffer.

## 2.1.2 CCDI Options

<b>Transparent Mode Enabled</b>	If this is enabled, the radio is able to enter Transparent mode. See <a href="#">“Transparent Mode” on page 21</a> for more information.
<b>CCDI UART Port</b>	Specifies the UART port to be used for CCDI transmission and reception.  ‘Internal Connector’ means that data will flow via the internal options connector using the IOP-TXD and IOP_RXD lines.  ‘Mic’ means that data will flow via the front panel serial interface (microphone connector) using the MIC_TXD and MIC_RXD lines.  ‘Aux’ means that data will flow via the auxiliary serial interface (rear auxiliary connector) using the AUX_TXD and AUX_RXD lines.

## 2.1.3 Data

<b>Lead In Delay</b>	The Lead-In Delay begins after the transmitter key-up time. It gives the receiver at the other end time to open before data is sent.  Set the Lead-In Delay to a suitable value depending on flow control settings and subaudible signalling and data requirements. See <a href="#">“Lead-In Delay” on page 23</a> for more information.
<b>Lead-Out Delay</b>	The Lead-Out Delay is the time that the transmitter stays keyed-up after a data block is sent. This parameter is sometimes know as the Tail Time.
<b>Ignore DCS/CTCSS</b>	This option applies to all FFSK Transparent mode and SDM data transmissions. It is only relevant if the current channel is programmed for subaudible signalling.  Leave this option unchecked if you want the radio to only process over-air data that is accompanied by valid subaudible signalling.  Checking this option will deactivate validation of CTCSS and DCS subaudible signalling. This means that when the TM8100 receives data, it will be processed regardless of the subaudible signalling. The advantage of this is faster decoding of the incoming data, as subaudible signalling does not require decoding.  The default radio setting at power on is set by this option. The CCDI Function command can be used after power on to change subaudible signal decoding. See <a href="#">“FUNCTION” on page 33</a> .

## 2.1.4 SDM Options

<b>SDM Enable</b>	Must be checked for the TM8100 to send and receive Short Data Messages (SDMs).
<b>SDM Auto Acknowledge</b>	If checked, an SDM Auto Acknowledge is sent by the radio to the PC, when it receives an SDM.
<b>SDM Auto Acknowledge Delay</b>	Sets the delay between receiving an SDM and sending an Auto Acknowledge, if configured to do so.
<b>SDM Wait For Acknowledge</b>	The maximum time that the radio will wait for an Auto Acknowledge before sending a Progress message to say that no SDM Auto Acknowledge was received.
<b>Unit Data Identity</b>	Sets the radio's identity for operation in CCDI mode. Enter an identity of 8 characters from A to Z, 0 to 9 or the wildcard character *.

## 2.1.5 Data Flow

<b>Powerup State</b>	Determines the data state the radio defaults to at power on. We recommend that this field is set to "C-Mode" (Command Mode) so that the radio will be in Command mode at power on. Set to "T-Mode" for Transparent mode.
<b>Ignore Escape Sequence in T-Mode</b>	If this field is checked, the radio will ignore all incoming escape sequences instructing it to exit Transparent mode and change to Command mode. We recommend that this field is unchecked.
<b>Baud Rate</b>	Determines the data transfer rate in bits per second (bps) between radio and computer equipment.  Note that the over-air data rate is always 1200 bps for FFSK data and selecting higher baud rates requires Flow Control to be enabled unless the amount of data per transmission is restricted to 100 bytes or less.



## 3 Transparent Mode

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In Transparent mode, the radio acts as a modem, automatically transmitting in FFSK format the serial data received from the PC. In this mode, the baud rate between the PC (DTE) and the radio (DCE) can be set to either 1200, 2400, 4800, 9600, 14400 or 19200 baud using the TM8000 Programming Application. The over-air data rate is always fixed at 1200 bps for FFSK data.

The TM8100 serial data input buffer is 128 bytes to adequately cope with the data flow.

CTCSS and DCS subaudible signalling is available in Transparent mode but other programmable features such as Selcall and DTMF are unavailable.

Communication in Transparent mode is free-format, with the protocol determined entirely by the PC and the modem. It is transparent to the CCDI, allowing the PC to send and receive data without passing through CCDI.

If an SDM is received in Transparent mode, it is tested for SDM validity by checking the leading 's', the checksum, the SDM identity and the size. If it is found to be a valid SDM, it is saved in the SDM buffer for later retrieval.

### 3.1 Entering Transparent Mode

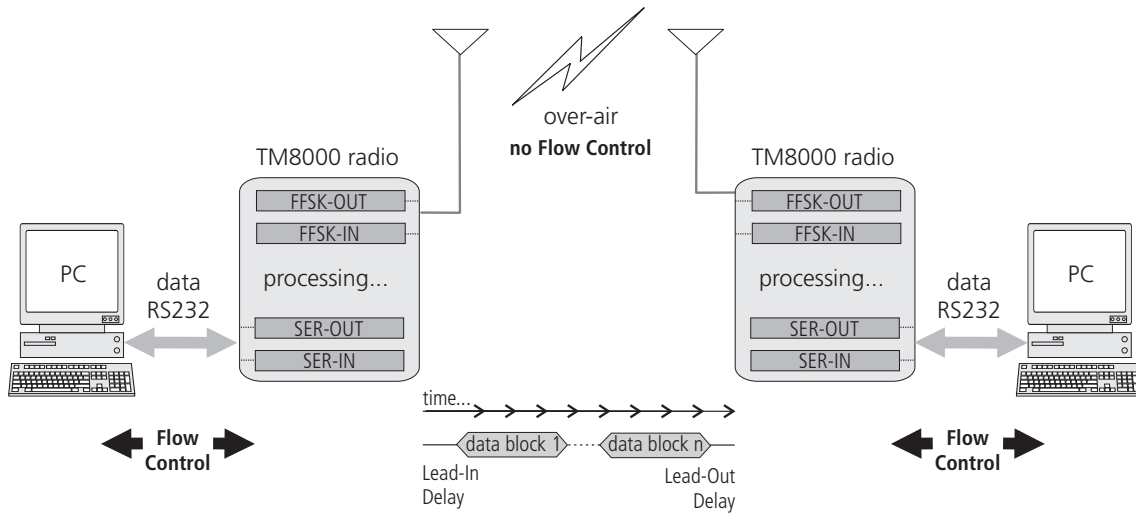
Transparent mode can be set as the default mode at power on by selecting "T-Mode" in the 'Powerup State' field in the Data form of the TM8000 Programming Application. See "[Powerup State](#)" on page 19.

To change to Transparent mode while operating in Command mode, the PC must send a TRANSPARENT command to the radio. E.g. t01zB1 sends a TRANSPARENT command, requesting that the radio be put into Transparent mode. The escape character specified here is "z" (ASCII code = \$7A). Once acknowledged, any further data is linked directly to the radio in Transparent mode.

If the radio default is set to Transparent mode at power on, the default escape character is "+".

## 3.2 Transparent Mode Format

### 3.2.1 Transparent Mode Packetisation



Transparent mode data is packetised into data blocks before it is sent over-air. The start and stop bits are removed and a header is sent at the start of each data block.

### 3.2.2 FFSK Transmission Format

The Transparent Mode transmission format is as follows:

#### Single Data Block

LID	preamble 2 bytes	sync 2 bytes	size 2 bytes	FFSK data block max 46 bytes	CRC 2 bytes (00)	Tail Time
-----	---------------------	-----------------	-----------------	---------------------------------	------------------------	-----------

H E A D E R

#### Multiple Data Blocks

LID	HEADER 6 bytes	FFSK data block max 46 bytes	.....	HEADER 6 bytes	FFSK data block max 46 bytes	CRC 2 bytes (00)	Tail Time
-----	-------------------	---------------------------------	-------	-------------------	---------------------------------	------------------------	-----------

### 3.2.3 Effective Over-Air Data Rate

Data rate varies depending on the quantity of data. For example, assuming 460 byte data is being sent, with a Lead-In Delay of 100ms and Lead-Out Delay of 20ms, the effective data rate is calculated below. Note that these calculations are theoretical only as there are other real-life factors not being considered.

**Bytes sent:**

460 bytes / 46 bytes per data block = 10 data blocks

2 bytes preamble + 2 sync + 2 size + 2 CRC = 8 bytes for Header and CRC per data block

8 bytes overhead x 10 data blocks = 80 total overhead bytes

460 bytes of data + 80 bytes overhead = 540 total bytes sent

540 bytes sent x 10 bits per bytes = 5400 bits

5400 - 1080 (start and stop bits removed) = 4320 bits sent over-air

**Time taken:**

4320 / 1200 = 3.6 seconds time to send bits

3.6 seconds + 120 ms = 3.72 seconds including Lead-In and Lead-Out Delay

**Data Rate (effective):**

460 bytes x 8 bits = 3680 bits to be sent

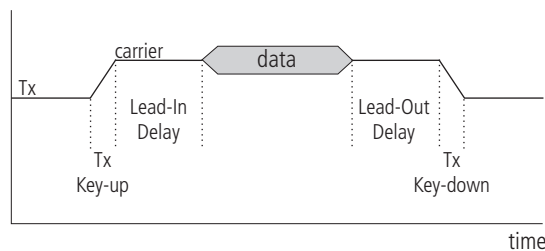
3680 bits / 3.72 seconds = 989 bits / second



**Note** If 461 bytes are sent, then the number of data blocks rounds up to 11. This reduces the effective data rate significantly to 915 bits / second.

### 3.2.4 Lead-In Delay

The Lead-In Delay begins after the transmitter key-up time. It gives the receiver(s) at the other end time to open before data is sent.



When data is detected at the TM8100 input buffer, the following occurs:

- The transmitter keys up.
- A carrier is sent from the transmitter. When the carrier reaches its full potential, the Lead-In Delay begins.
- If the receiving base station is set to Repeater mode, the carrier is detected and Rx Gate becomes active (opens), which in turn makes the PTT line active.
- The active PTT line keys up the transmitter.

This sequence is repeated with as many base stations as are in the chain. The optimum length of the Lead-In Delay should be set keeping in mind the number of Base Stations that need to be activated before any data is sent.

The Lead-In Delay must also allow for subaudible signalling decoding, if it is enabled, when used in conjunction with FFSK data.

### 3.3 XON/XOFF Software Flow Control

XON/XOFF software handshaking is used for flow control in Transparent mode and becomes active when the data flow is set for software flow control. This is set in the Data Flow section of the Data form of the TM8000 Programming Application. See [“Software Flow Control” on page 17](#).

The XOFF character is sent to the PC:

- when the serial input data buffer has reached approximately 2/3 of its 128 byte capacity.

The XON character is sent to the PC:

- after the XOFF character has been sent and then the serial input data buffer becomes empty
- when entering Transparent mode if the channel is not busy

The data rate is set depending on the value set by the Transparent mode Baud Rate set in the Data form. Since the over-air FFSK data is transmitted or received at 1200 baud regardless, if the radio is set to a higher baud rate than 1200 baud, XON/XOFF software handshaking must be used otherwise some part of the data stream will be lost.

If 1200 baud is selected as the Transparent mode baud rate and the Lead-In Delay is short (less than 300 ms) in Transparent mode, XON/XOFF software handshaking is not necessary. Even if higher baud rates are used, as long as the data throughput rate is slow enough (less than 40 bytes in one transmission) then XON/XOFF is not necessary, assuming the Lead-In Delay is short enough.



**Important** When using XON/XOFF software handshaking, the data stream (or the data file) must not include the programmed XON and XOFF characters. If these characters are received by the PC of the receiving radio, there is no way to differentiate between data and XON/XOFF characters.

ASCII text files or data work well with XON/XOFF flow control but binary files or data may have problems. When sending and receiving binary files or data, 1200 baud rate must be selected in the Transparent mode. If the Lead-In Delay is programmed longer than 300 ms with 1200 baud selected, XON/XOFF flow control must be used, otherwise some data in the initial part may be lost.



**Note** Communication standards typically set XON = [CTRL] Q = 11 Hex; XOFF = [CTRL] S = 13 Hex; XON/XOFF values must be set in the Data form of the TM8000 Programming Application.



## 4 Command Mode

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Command mode uses the Tait proprietary Computer Controlled Data Interface (CCDI), a command protocol embedded in the radio firmware. It is accessed using the serial port lines from the PC. In this mode, the baud rate between the computer equipment (DTE) and the radio (DCE) can be set to either 1200, 2400, 4800, 9600, 14400 or 19200 baud using the TM8000 Programming Application

In Command mode, the PC sends command sequences to the radio and waits for a prompt before beginning the next transaction. Some commands require the radio to send a CCDI message in response, before the prompt character '.' is sent to the PC to indicate that it is ready to accept a new command. Messages sent to the radio will always be responded to by the prompt.

Unsolicited messages such as PROGRESS or ERROR messages are sent by the radio if there is a significant change in its state that the PC should be aware of. When errors are detected, an unsolicited ERROR message is sent by the radio to the PC. The radio cannot send messages that require a reply.

The SEND\_SDM and GET\_SDM commands require that SDMs are sent and received as over-air FFSK data by the radio while in Command mode. If an SDM is received from the over-air interface while the radio is in Command mode, the SDM data is buffered and both an 'FFSK Data Received' PROGRESS message and a 'SDM Received' RING messages are generated by the radio to indicate that SDM data has been received. See ["SEND\\_SDM" on page 36](#).

### 4.1 Entering Command Mode

Command mode can be set as the default mode at power on by selecting C-Mode in the 'Powerup State' field in the Data form of the TM8000 Programming Application. See ["Powerup State" on page 19](#).

To change to Command mode while operating in Transparent mode, send the escape sequence. The escape sequence consists of a 2 second idle time, followed by three escape characters (sent within 2 seconds), followed by a further 2 second idle time i.e. [2 second idle] +++ [2 second idle].

In Transparent mode, when the escape sequence is detected in the data stream, the radio is forced back to Command mode.

## 4.2 CCDI Command Format

The Tait Computer Controlled Data Interface (CCDI) protocol provides the means of controlling a TM8100 from a PC, to allow either a semi- or fully automatic communications system. CCDI is embedded in the radio software, and accessed via the serial lines on the programming lead between the PC and the TM8100.



**Note** What is transmitted over-air is an analogue version of CCDI suitable for R.F.

All CCDI message packets take the general form:

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

- [IDENT] = The message identifier. Identifiers are single ASCII characters (lower-case alphabetical) which categorise the message type.
- [SIZE] = The number of characters which make up the [PARAMETERS] field. [SIZE] is an 8-bit number expressed in ASCII hex notation (two characters).
- [PARAMETERS] = An optional field, depending upon the command. Parameter values are generally character strings unless explicitly stated otherwise. Parameter type is dependent upon the command, and often has multiple parts.
- [CHECKSUM] = An 8-bit checksum of the [IDENT], [SIZE] and [PARAMETERS] fields. Expressed in two character ASCII hex notation.
- <CR> = The carriage return packet terminator.

### Restrictions

- All characters in a message are printable ASCII.
- Where numeric values are represented in ASCII hex notation (two characters per byte), characters A to F are upper case.
- The minimum length of a command packet is 5 characters. For example q002F is the QUERY command where [SIZE] = 00 as there is no [PARAMETERS] field required.
- The maximum length of the [PARAMETERS] field is 42 characters. The maximum length of the command packet is therefore 47 characters.

## 4.3 Calculating the CCDI [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 to 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.

### 4.3.1 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

## 4.4 Commands to the TM8100

The following commands are available to send from the PC to control the radio.

Command	IDENT	Function
DIAL	d	initiate a call
GO_TO_CHANNEL	g	sets the radio to a particular channel
CANCEL	c	abort current activities
FUNCTION	f	controls various hardware and miscellaneous radio functions
QUERY	q	requests information from the radio
TRANSPARENT	t	change to transparent mode
SEND_SDM	s	send a Short Data Message (SDM)

In all cases, if a command is received without error by the TM8100 and all parameters are valid, the command is executed. The prompt character '.' is then returned to the PC after the TM8100 completes the current transaction, to signify that another may begin. If an error arises, the PC is notified with an appropriate ERROR response.

## 4.4.1 DIAL

The DIAL command allows access to the full dialling capability of the radio. Selcall and DTMF sequences can be dialled on the current channel. It has the format:

### d [SIZE] [DTYPE] [NUMBER\_STR] [CHECKSUM]

- 'd' is sent as a single ASCII character and represents the DIAL command.
- [DTYPE] is a single ASCII character representing the type of dialling required.

[DTYPE]	Function
0	Selcall
1	DTMF
2	Reserved for Trunked radio dialling

- [NUMBER\_STR] represents the dialled sequence. The range of allowed characters depends upon the value of [DTYPE].

[DTYPE]	[NUMBER_STR]
0 (Selcall)	0...9, A...F, -, V (maximum of 32 digits). Selcall strings usually use the digits 0 to 9 as some of the tones A to F have special meaning, e.g. A = Group; C = Reset; E = Repeat. Selcall calls are made within the bounds of the following parameters, as programmed into the TM8100: tone period, tone set and Lead-In Delay, etc.
1 (DTMF)	0...9, A...D, *, #, -(maximum of 32 digits) DTMF calls are made within the bounds of the following parameters, as programmed into the TM8100 e.g. key-up delay, tone period and inter-tone gap.



**Note** The DIAL command initiates the calling process only. The call may take some time to get through, especially if the channel is busy or the system heavily loaded. The receiver will return a prompt as soon as the DIAL command is accepted, but the PC may have to wait for a PROGRESS message advising successful call set-up before proceeding.

Examples of DIAL commands are:

d0601234507      a command to initiate Selcall dialling of the number  
1 2 3 4 5.

d0611234506      a command to initiate DTMF dialling of the number  
1 2 3 4 5.

## 4.4.2 GO\_TO\_CHANNEL

The GO\_TO\_CHANNEL command tells the TM8100 to change to another channel. It has the following format:

**g [SIZE] [CHANNEL\_NO] [CHECKSUM]**

- 'g' is sent as a single ASCII character and represents the GO\_TO\_CHANNEL command.
- [CHANNEL\_NO] is a maximum of three characters representing the new channel number. The range of allowed characters is 0 to 9, and must be a valid channel for the radio.

Examples of GO\_TO\_CHANNEL commands are:

g0223D2          go to channel 23.

g0299C5          go to channel 99.

## 4.4.3 CANCEL

The CANCEL command tells the PC to abort the current action that the radio is performing. It has the following format:

**c [SIZE] [CANCEL\_TYPE] [CHECKSUM]**

- 'c' is sent as a single ASCII character and represents the CANCEL command.
- [CANCEL\_TYPE] is a single ASCII character representing the cancelling type.

[CANCEL_TYPE]	Function
0	Cancel Call Cancel call can do the following: clear down a Selcall call, including retries cancel deferred calling take the radio out of emergency operation if in Emergency Tx/Rx cycles by resetting the radio
1	Delete SDM data of the last received SDM (if any)
2	Reset menu to first menu item



**Note** If no [CANCEL\_TYPE] is sent, then the CANCEL command will default to CANCEL\_TYPE = 0.

Examples of CANCEL commands are:

c0100C          a command to cancel the existing call.

c003D          also a command to cancel the existing call.

c0110B          a command to delete the currently held SDM.

#### 4.4.4 FUNCTION

The FUNCTION command provides access to various hardware and miscellaneous functions. It has the following format:

**f [SIZE] [CATEGORY] [QUALIFIER] [CHECKSUM]**

- ‘ f ’ is sent as a single ASCII character and represents the FUNCTION command.
- [CATEGORY] is a single ASCII characters representing the required function category.
- [QUALIFIER] is a single ASCII character representing the action to be taken, depending on the value of [CATEGORY].

[CATEGORY]	[QUALIFIER]	Action
0	none	Reserved for future use
1	none	Reserved for future use
2	none	Reserved for future use
3	none	Reserved for future use
4 (User Controls)	0	Disable all user controls, display and indicators. The TM8100 will indicate "CCDI BUSY" indication.
	1	Disable user input only. Display and indicators still operational. Any attempt on user input will result in the invalid keypress tone being sounded.
	2	Enable all user controls except when CCDI commands are being processed when TM8100 indicates "CCDI BUSY" Set as default at power on.
5 (Rx Audio Mute Control)	0	Cancel CCDI request for Rx audio mute.
	1	Request mute of Rx audio. Can only be overridden by Squelch Override.
6	none	Reserved for future use
7 (Subaudible Signalling)	0	Deactivate validation of CTCSS and DCS subaudible signalling. Incoming data will be processed regardless of the subaudible signalling. The default radio setting at power on depends on the 'Ignore DCS/CTCSS' option set in the Data form of the programming application. The Function command is only valid during power on.
	1	Activate validation of CTCSS and DCS subaudible signalling. Incoming data will only be processed if the subaudible signalling matches. Only effective if current channel is programmed for subaudible signalling.
8 (Monitor)	0	Deactivate monitor function.
	1	Activate monitor function.

9 (Rx/Tx)	0	Forces radio into a Rx state.
	1	Forces radio into a Tx state.

Examples of FUNCTION commands are:

- f0241D3 a command to disable the user input.
- f0250D3 a command to mute the receiver audio.
- f0271D0 a command which specifies the validation of sub signalling.
- f0281CF a command to activate the monitor function.
- f0291CE a command to activate the transmitter.
- f0290CF a command to deactivate the transmitter following an “activate transmitter” command.

#### 4.4.5 QUERY

The QUERY command requests information from the radio. It has the following format:

**q [SIZE] [QUERY\_TYPE] [CHECKSUM]**

- ‘ q ‘ is sent as a single ASCII character and represents the QUERY command.
- [QUERY\_TYPE] is a single ASCII character representing the query type required.

[QUERY_TYPE]	Function
0	<b>Query Model</b> Identity data is returned as a MODEL message.
1	<b>Query SDM</b> Buffered SDM data is returned to the PC as a GET_SDM message.



**Note** If no [QUERY\_TYPE] is sent, then the QUERY command will default to [QUERY\_TYPE] = 0.

Examples of QUERY commands are:

- q010FE a command requesting a MODEL message.
- q002F also a command requesting a MODEL message.
- q011FD a command requesting a GET\_SDM message.

## 4.4.6 TRANSPARENT

The TRANSPARENT command changes the radio to Transparent mode and sends the escape character required to change it back to Command mode. It has the following format:

**t [SIZE] [ESC\_CHAR] [CHECKSUM]**

- ‘ t ‘ is sent as a single ASCII character and represents the TRANSPARENT command.
- [ESC\_CHAR] is a single ASCII character representing the escape character. The escape sequence is three consecutive escape characters sent within two seconds, with two seconds of idle time each side. When the escape sequence is sent to the radio, it is forced into Command mode. See [“Entering Transparent Mode” on page 21](#) for details.



**Note** When data is transmitted in Transparent mode it has a Lead-In Delay set in the Data form of the TM8000 Programming Application.

Examples of TRANSPARENT commands are:

t01zB1      a command requesting that the radio be put into Transparent mode. The escape character specified here is “z” (ASCII code = \$7A).

## 4.4.7 SEND\_SDM

The SEND\_SDM command tells the radio to send a Short Data Message (SDM) and has the format:

**s [SIZE] [LEAD\_IN\_DELAY] [DATA\_MESSAGE\_ID]  
[MESSAGE] [CHECKSUM]**

- ‘s’ is sent as a single ASCII character and represents the SEND\_SDM command.
- [LEAD\_IN\_DELAY] is two ASCII hex characters representing the delay after the radio transmitter keys-up and the start of data transmission, while the radio is in Command mode.  
The range is 00 to FFh. The actual delay is calculated by multiplying the number by 20 ms. A minimum of at least 100 ms of Lead-In Delay is required, so 00 to 04 will always be treated as 05. This corresponds to a Lead-In Delay between 100 ms and 5.1 seconds, in steps of 20 ms.
- [DATA\_MESSAGE\_ID] is an 8-character string representing the SDM data identity of the radio to which the SDM is being sent. It can be any alphanumeric characters. “★” is the wildcard for any character. e.g. 12★★5678. The first four bytes are generally the fleet identity, the second four the radio identity.  
When a radio receives a SDM message, the data identity is checked against the ‘Unit Data Identity’ set in the Data form of the TM8000 Programming Application. If the data identity matches, the received SDM data is stored and the radio sends a response. If the data identity does not match then the SDM data is ignored.
- [MESSAGE] is optional and contains SDM text with commands to the TM8100. The field is limited to 32 hex characters in standard ASCII range 20h to 2Fh. Characters between 00 and FFh can be sent but characters above 7Fh can not be displayed.  
A valid SDM with a [MESSAGE] component will cause the TM8100 to generate a ‘SDM Received’ RING message to the PC. If no [MESSAGE] component is received, RING will be type DATA.  
Any SDM, whether valid or not, will cause an ‘FFSK Data Received’ PROGRESS message to be generated.



**Note** The radio can not receive any further SDMs if one is already stored in the buffer. The buffer must be cleared using a CANCEL command.

Examples of SEND\_SDM commands are:

s0A051234567813

This message transmits data identity “12345678” with 100 msec Lead-In Delay through current channel.

s0CFF12345678Hi39

This message transmits data identity “12345678” and SDM data “Hi” with 5.1 sec Lead-In Delay through current channel.

## 4.5 Messages from the TM8100

The following messages are sent from the TM8100 to the PC. Some are solicited by commands from the PC, while others are unsolicited and are sent because of changes within the radio.

Command	Ident	Function
ERROR	e	Transaction processing error
MODEL	m	Identify TM8100 type
RING	r	Incoming call alert
PROGRESS	p	Call progress report
GET_SDM	s	Get SDM data

In all cases, the prompt character ‘?’ will be sent after the TM8100 message, to terminate the transaction and signify that another may begin.

## 4.5.1 ERROR

Solicited and Unsolicited.

The ERROR message advises the PC that the TM8100 has detected an error condition and cannot proceed with the current transaction. In some cases, an exception condition in the TM8100 may cause an ERROR message to be sent to the PC independently of any control transactions. This is a system error, which is an unsolicited message.

The ERROR message has the following format:

**e [SIZE] [ETYPE] [ERRNUM] [CHECKSUM]**

- ' e ' is sent as a single ASCII character and represents the ERROR command.
- [ETYPE] is a single character representing the error category.
- [ERRNUM] is two ASCII hex characters which identify the specific error condition.

[ETYPE]	[ERRNUM]	Error
0 (Transaction Error)	01	<b>Unsupported Command</b> Unsupported command errors can arise when the PC expects a later version of CCDI than is attached and attempts to use a command which is not recognised by the TM8100.
	02	<b>Checksum Error</b> A checksum error indicates that the checksum calculated by the TM8100 did not match the one received in the command packet.
	03	<b>Parameter Error</b> Parameter errors encompass values out of range or missing fields.
	04	<b>Invalid Terminating Character</b> A character terminating error can occur on a packet sent to the TM8100.
	05	<b>TM8100 Not Ready Error</b> TM8100 not ready error occurs when another new message is receiving from PC even before a prompt character "." is sent from TM8100.
	06	<b>Command Error</b> The command has not been accepted. E.g. an SDM was sent but SDMs are not enabled in the Programming Application.
	0Ah	<b>Communication Failure</b> Communication failure errors encompass all low level mechanisms, i.e. framing error, overrun error, parity error etc.
1 (System Error)	Fatal system error - contact Tait Technical Support	

An example of an ERROR response message is:

e03003A5 This message indicates that the parameters of the currently received message are incorrect.

## 4.5.2 MODEL

Solicited.

The MODEL message is sent to the PC in response to a QUERY command. It identifies the type of TM8100 and the version of CCDI software operating in the TM8100. It has the following format:

**m [SIZE] [RUTYPE] [RUMODEL] [RUTIER] [VERSION] [CHECKSUM]**

- ' m ' is sent as a single ASCII character and represents the MODEL command.
- [RUTYPE] is a single character representing the type of radio.

Char	Function
1	Conventional radio
2	Reserved for Trunked radio
3	North American Signalling Conventional radio

- [RUMODEL] is a single character representing the model of the radio.

Char	Function
1	Tait Orca Portable (TOP) conventional unit
2	TOP Orca Mobile conventional unit
3	TM8100 Mobile

- [RUTIER] is a single character representing the tier of the radio.

Char	Function
1	Tait Orca Elan radio or TM8100 FMx (small display)
2	Tait Orca Excel radio or TM8100 MFx (large display)
3	Tait Orca Eclipse radio
4	Tait Orca 5010/5011 radio
5	reserved
6	Tait Orca 5020/5021 radio
7	Tait Radio Modem (TRM)
8	Tait Orca 5015 radio

- [VERSION] CCDI software version. A character string, in the format of XX.XX, identifying the capabilities of the TM8100 operating in CCDI mode.

An example of the MODEL response message is:

m0813102.03A3

This message is sent in response to a QUERY q002F command. It indicates that the radio is a Conventional, TM8100 radio of FMx model with a small display, and the CCDI version is 02.03.

### 4.5.3 RING

Unsolicited.

The RING message advises the PC that an incoming call has been received. It has the following format:

**r** [SIZE] [PARAMETERS] [RCATEGORY] [TYPE1] [TYPE2] [TYPE3] [TYPE4] [STATUS] [CALLER\_ID] [CHECKSUM]

- 'r' is sent as a single ASCII character representing the RING command.
- [RCATEGORY] is a single character representing the category of the incoming call.

Character	Function
0	Selcall
1	Undefined
2	Reserved for Trunked system call

- The RING type is a four character string qualifying the type of call received.

Type	Character	Function
[TYPE1]	0	Voice Call received
	1	reserved for Trunked non-prescribed data call
	2	Status Call received
	3	Interrogation Call received
	4	SDM received
	5	Data Call received
	6	Remote Monitor Call received
[TYPE2]	0	Normal Priority Call received
	1	Emergency Priority Call received
[TYPE3]	0	Individual Call received
	1	Group Call received
[TYPE4]	0	reserved for 'not an include call' (Trunked radio only)
	1	reserved for 'include call' (Trunked radio only)

- [STATUS] is a two digit string representing the received status for status calls. If [STATUS] value is not received then [STATUS] will be "FF".
- [CALLER\_ID] is a caller's ID which has a variable length. Optional and of variable length.



**Note** By checking [SIZE] in RING message, PC will be able to know if the whole [CALLER\_ID] part is missed or not.

An example of a RING response message is:

r0714000FFA6 This message indicates that the received call is an SDM call.

## 4.5.4 PROGRESS

Unsolicited.

The PROGRESS message advises the PC of the TM8100 status when some significant change of state in the radio occurs (typically during call processing). PROGRESS messages are not sent by the TM8100 while the radio is in Transparent mode.

### p [SIZE] [PTYPE] [PARA1] [CHECKSUM]

- ' p ' is sent as a single ASCII character and represents the PROGRESS command.
- [PTYPE] is two ASCII hex characters which identify the progress message category.

Character	Function
00	<b>Selcall Answered</b> A standard Selcall has been answered. This message will be sent when the call has been answered either by the PC or manually by the user.
01	<b>Deferred Calling</b> Deferred calling is in progress. This message will be sent every three seconds while the radio is still waiting to make the deferred call.
02	<b>Tx Inhibited</b> Transmission has been inhibited. This message will be sent whenever transmission is requested but is inhibited.
03	<b>Emergency Mode Initiated</b> The TM8100 has been put into emergency mode. This message will be sent when the TM8100 emergency mode switch is activated.
04	<b>Emergency Mode Terminated</b> The TM8100 is no longer in emergency mode. This message will be sent when the TM8100 receives a "reset" to take it out of emergency mode. The reset can be a Remote Monitor Reset (enabled in programming application), a power off and on, or a CANCEL command.
05	<b>Receiver Busy</b> The receiver has detected an RF signal on the current channel. This message will be sent when the current channel becomes busy.
06	<b>Receiver Not Busy</b> The receiver no longer detects an RF signal on the current channel. This message will be sent when the current channel becomes not busy.
07	<b>PTT Mic Activated</b> The PTT has been pressed. This message will be sent whenever the PTT is pressed in an attempt to transmit.
08	<b>PTT Mic Deactivated</b> The PTT has been released. This message will be sent whenever the PTT is released after attempting to transmit.
09 - 15	reserved for trunked radios
16	Selcall Retry

17	Radio Stunned
18	Radio Revived
19	<p><b>FFSK Data Received</b>  Indicates to that the radio has received valid FFSK data in Command mode.  Note that if FFSK data is received in Transparent mode, it will be sent directly to the PC without sending this progress message.</p>
1C	<p><b>Selcall Auto-acknowledge</b>  Indicates whether an auto-acknowledge was received from the last Selcall call.  <b>0</b> = no acknowledge received  <b>1</b> = acknowledge received.  Note that this progress message will only be generated if the radio has been programmed to transmit Selcall Auto Acknowledge in the programming application.</p>
1D	<p><b>SDM Auto-acknowledge</b>  Indicates whether an Auto Acknowledge was received from the last SDM call.  <b>0</b> = no acknowledge received  <b>1</b> = acknowledge received.  Note that this progress message will only be generated if the radio has been programmed to transmit SDM Auto Acknowledge in the programming application.</p>

- [PARA1] is a single digit string:

Character	Function
0	Not Received
1	Received

An example of a PROGRESS response message is:

p0202CC This message sends the progress message to say that Tx has been inhibited.

## 4.5.5 GET\_SDM

Solicited.

The GET\_SDM message is sent to the PC in response to a QUERY command. It sends the buffered SDM data the TM8100 and has the following format:

**s** [SIZE] [SDM\_DATA] [CHECKSUM]

- 's' is sent as a single ASCII character and represents the GET\_SDM command.
- [SDM\_DATA] is an optional string of up to 32 characters.



**Note** If no [SDM\_DATA] is sent, then the GET\_SDM command will default to [SDM\_DATA] = 0 and no [PARAMETERS].  
If there is buffered SDM data in the TM8100, the SDM data will be sent to the PC.

Examples of the GET\_SDM response message are:

s002D      This message indicates that the TM8100 has no SDM data available.

s02Hi7A    This message indicates that the TM8100 has a valid SDM data "Hi".

