ME-D200/D350
MODULE MANUAL
FOR
DA960, DA480 & DA202

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1 Introduction

The DA 202, DA 960 and DA 480 are internal option-module for the D200/D350/D350 series of data modems. The DA 202 is a Bell 202 / V23 modem that provides compatibility with existing systems. The DA 960, the GMSK modem (Gaussian filtered minimum shift keying), provides greater data speed (up to 9600 baud rate). The DA 480, the FFSK module (fast frequency shift keying), allows the use of voice spectra only, so sub-audible squelch systems can be used (also possible for DA202).

The internal module option boards consist of a Slave MCU, Modem IC, and extra circuitry. These option-boards directly communicate with DTE (Data Terminal Equipment) to send and receive data through the DB-15 connector of the digital board of the D200/D350. These modems are designed to accept RS232 serial data format.

The D200/D350 can be controlled automatically, with the receipt of data (TXD), putting the radio into transmit. N.B. not available for the Bell 202 module. The data to be transmitted is buffered while the transmitter is being activated. Before the data is transmitted, a preamble sequence is transmitted to synchronize the receiving modem. The data can be placed in data blocks (packets) with header and end data information added.

The D200/D350 can also be put into transmit using the control signal PTT. In this mode the modem will only transmit when the control signal is asserted. If dis-asserted, the modem will remain in receive.

2 Technical Specification

2.1 Specification for DA-202

Modulation type	:Bell 202 / V23
RF Baud rate	1200 for 12.5/25kHz channel spacing - V23 mode. 1200 for 12.5/25kHz channel spacing - Bell 202
Data Sensitivity	: below –110dBm for 1 in 100 error rate
Mark /Space tone freq. (for each available RF Baud rate)	1300Hz (M) / 2100Hz (S) at 1200bps – V23 mode 1200Hz (M) / 2200Hz (S) at 1200bps – Bell 202
Data input/output	: RS232 with option of TTL input/output possible on later versions
RS232 Baud input rate	: 1200
Number of Data Bits	: 8 bits
Parity	: None
Number of Stop Bits	: 1 bit
Data flow control	: None (dumb mode only)
Data Block (Packet) size	Non packet system

Channel Spacing	DTE Baud Rate	Modem Baud Rate
12.5kHz and 25kHz	1200 V23 mode	1200 V23 mode
	1200 Bell 202	1200 Bell 202

Table 2.1. Available Baud rate for Bell 202 modem

2.2 Specification for DA-960

Modulation type	: Modified GMSK
Maximum RF Baud rate	: 4800 for 12.5KHz channel spacing and 9600 for 25KHz channel spacing (Programmable, see below table)
Data Sensitivity	: => –113dBm for 1 in 100 error rate
Method for elimination of DC offset	: Data scrambling
Data input/output	: RS232
RS232 Baud input rate	: Same as the RF Baud rate (see below table)
Number of Data Bits	: 8 bits
Parity	: None
Number of Stop Bits	: 1 bit
Data flow control (programmable)	: None, Software (Xon/Xoff), Hardware (RTS/CTS)
Tx forcing mode	: Configures the modem to transmit when in auto mode, even if receiving data.
Data Block (Packet) size	: Programmable from 16 to 8192 bytes in increments of 16. (The packet doesn't include additional bits for error detection/correction.)

Channel Spacing	DTE Baud Rate	Modem Baud Rate
Narrow (12.5KHz)	4800	4800
Standard (25KHz)	4800	4800
	9600	9600

Table 2.2. Available Baud rate for GMSK modem

2.3 Specification for DA-480

Modulation type	: FFSK
Maximum RF Baud rate	: 2400 for 12.5kHz and 25kHz channel spacing 4800 for 25kHz channel spacing with reduced sensitivity due bandwidth restrictions (Programmable, see below table)
Data Sensitivity	: below –110dBm for 1 in 100 error rate
Mark /Space tone freq. (for each available RF Baud rate)	: 1200Hz (M) / 1800Hz (S) at 1200bps 1200Hz (M) / 2400Hz (S) at 2400bps 2400Hz (M) / 4800Hz (S) at 4800bps
Data input/output	: RS232
RS232 Baud input rate	: Same as the RF Baud rate (see below table)
Number of Data Bits	: 8 bits
Parity	: None
Number of Stop Bits	: 1 bit
Data flow control	: None, Software(Xon/Xoff), Hardware(RTS/CTS) (Programmable)
Tx forcing mode	: Configures the modem to transmit when in auto mode, even if receiving data.
Data Block (Packet) size	: Programmable from 16 to 8192 bytes in multiples of 16. (The packet doesn't include bits for error detection or correction.)

Channel Spacing	DTE Baud Rate	Modem Baud Rate
Narrow (12.5KHz)	1200	1200
	2400	2400
Standard (25KHz)	1200	1200
	2400	2400
	4800	4800*

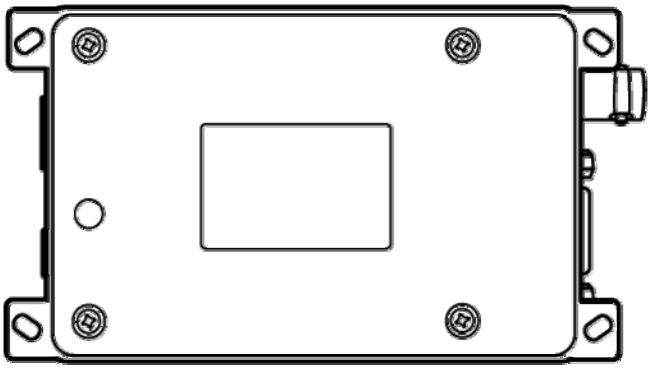
* reduced performance

Table 2.3. Available Baud rate for FFSK modem

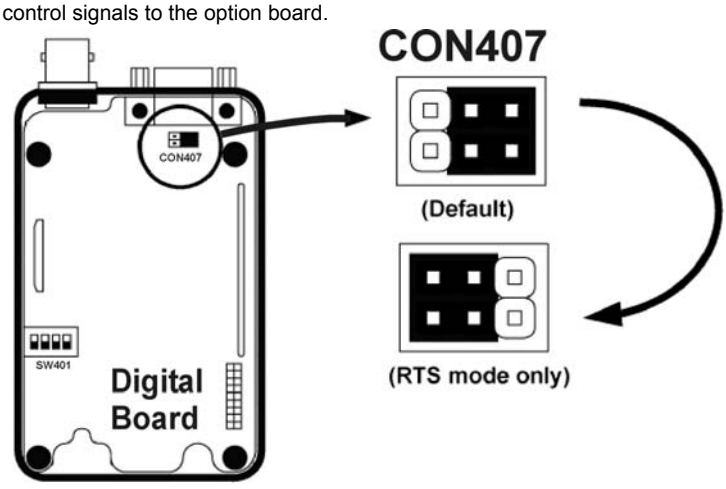
3 Fitting the module

To enable access to alignment points, the modem requires disassembly.

- Undo the 4 screws on the bottom lid and 2 pillars on the d-type connector.
- The bottom lid should drop out. If the lid does not easily drop out (due to the rubber seal), it can levered out via the largest aperture (remove grommet). Also a quick tap (lid facing down) on a soft surface will persuade it.
- To remove the digital board, gently lift from the end furthest from the d-type connector.



The connector con407 (the jumper connector) needs to have the correct links made to route the control signals to the option board.



The 2 connectors on the internal module need matching up with the digital board and then firmly pushed together to ensure a good connection.

For alignment details please refer to the Support Notes on the website. www.mobile-expertise.co.uk

The digital board then needs careful replacing ensuring a good connection with the RF board. The bottom lid is fitted with the screws put into place before replacing the hex pillar. Finally the lid is screwed into place.

4 Connection Details

This section describes the basic connections and explains important parameters for data transmission.

4.1 Serial interface: D200/D350

The 15 pin D connector serial interface with the pin outs as shown in the table below.

D200/D350/D350 DB-15 PIN descriptions with input and output levels

Pin No.	Function	Description	Signal Type	I/O
1 Program Note 1	Data modulation IN. (used with an external modem)	AC coupled signal directly injected through data low pass filter without pre-emphasis.	Input signal 1KHz audio at 60% peak dev. input level = 100 to 120mVrms	I/P
1 Program option Note 1	POCSAG input	DC coupled direct signal designed to work with TTL level signals only	TTL Levels	I/P
1 Program Opt & comp' changes Note 1	AC coupled FM direct modulation	AC coupled direct FM signal, without filtering	350mV @ 60% adjustable	I/P
1 Comp changes Note 1	DC data modulation IN	DC coupled direct FM signal, without filtering	1.9V dc offset 450-550mV @ 60%	I/P
2	Data OUT (RX disc)	Discriminator Audio, unprocessed AF signal	1KHz audio at 60% peak dev. produces 200 to 300mVrms	O/P
3	PTT In (Tx Key) / or flow control RTS	Signal, which keys the transmitter, when operating as a dumb radio. Can be used for flow control RTS/CTCS in conjunction with pin 6 when in auto mode	RS232 level +12V = Tx -12V = Rx	I/P
4	Ground	Ground connection to chassis of the radio.	0V (Chassis)	
5	Program Data Out/Serial Data Output	Programming data output / Serial data output.	TTL level (programming cable has RS232 converter)	O/P

6	Busy (CD) / flow control RTS/CTS	Logic level output to indicate presence of a carrier. / Flow control when used in auto mode see pin 3	RS232 level +12V = carrier -12V = no carrier	O/P
7 (default)	Audio IN (Mic) / Monitor	Audio signal that is filtered (high pass and pre- emph) then follows same route as data mod through LPF. Sub-audio tone is mixed with audio after the LPF / Grounding line activates monitor action	1KHz audio at 60% peak system deviation input level = 6 to 8Vrms <100k resistor to ground	I/P
7 Link option	RSSI	RSSI Level	1 to 3.5 V	O/P
8	Program data IN/ serial command	Used for serial command for radio control or is used for inputting programming data	TTL level (RS232 converter in programming cable)	I/P
9	Audio OUT	Audio output from the audio amplifier. Filtered by tone-filter and de-emphasis circuit.	1KHz audio at 60% peak dev. produces nominal 1Vrms @ 8Ω	O/P
10	RS232 Data IN for option module	Data input when the option module board is installed.	RS232 level	I/P
11	RS232 Data Out for option module	Recovered data output when the option module is installed..	RS-232 level	O/P
12 (default)	Buffer status(busy) for option module (reserved)	Indicates buffer status to prevent data loss according to buffer overrun	RS-232 level	O/P
12 Link option	Lock Detect signal	PLL lock detect signal		O/P
13	GPS data input	Data input for initial setting of GPS module. (NMEA 0183 format)	TTL level	I/P
14 (default)	VCC in +12 volts nominal	Power supply input, operation outside the stated range will be subject to degraded performance	+12 volts nominal 9v-18v extreme	I/P
14 Link option	DGPS data input	Data input for DGPS Correction of GPS module. (NMEA 0183 format)	TTL level	I/P

15	GPS data output	Position data output from the GPS module. (NMEA0183)	TTL level	O/P

Note 1 : pin 1 will not operate as an input when the module is enabled in the programming

Link Options: To be carried out with reference to the layout and must be carried without any damage to the pcb. Any damage will invalid the warranty.

Refer to the Application Notes for details of link changes. Application Notes can be found on the mobile expertise website.

4.2 Communication

The serial protocol supported by the modems is fixed at 1 start bit, 8 data bits, 1 stop bit and no parity. There is no flow control available for the Bell 202 module, but for the GMSK and FFSK modem flow control can be selected as hardware (RTS/CTS), software (XON/XOFF) or none. The serial baud rate is also user configurable for the GMSK and FFSK, but is fixed for the Bell 202 at 1200.

The radio can be connected with one or two serial communication ports. This allows a different port to be used to control the modem (such as channel change) or allows the use of different signal types. Figure 4.1. Illustrates an example interface cable. The dotted lines (pins 4, 10 and 11 on the D200/D350) indicate the minimum requirement for transmitting and receiving RS-232 data for GMSK and FFSK modem. The Bell 202 modem requires an additional line, the PTT control line. The solid lines (pins 3, 6, and 12 on the D200/D350) indicate potential additional controls for handshaking. Figure 4.2. illustrates the additional connection for radio controls via serial command (e.g. channel change), which requires an RS-232 driver for the TTL logic.

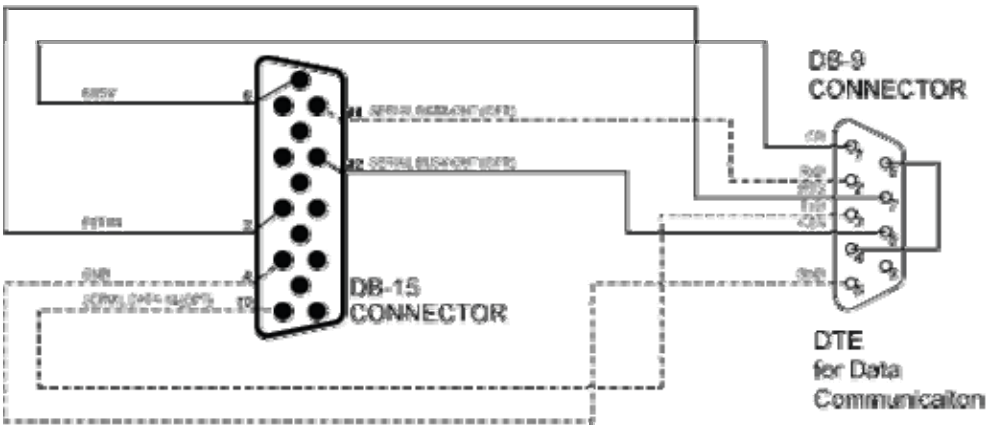


Figure 4.1. Interface cable for data communication and its inner connection

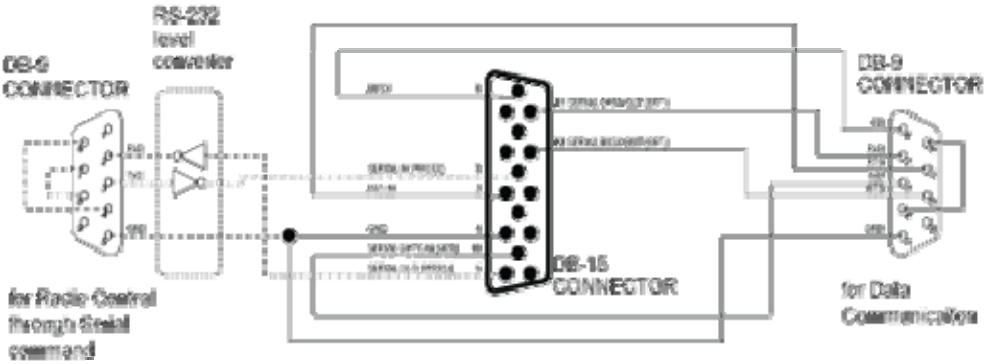


Figure 4.2. Interface cable for data communication and radio control

5 Configuring the D200/D350

5.1 Hardware set up

To route the control lines to the internal module the jumper connector requires re-positioning as detailed in see section 3. When in dumb mode these controls are used for PTT and busy. When in auto mode these control lines can be used for flow control, i.e. RTS and CTS. It is also possible to leave the jumper connector at default when in auto mode (ensure flow control is not programmed to RTS/CTS). In this scenario, the radio can be used with voice as well.

5.2 Timing Parameters

This radio is not restricted to a specific network system, so the timing parameters can be set by the user to fit their own application.

5.2.1 TX Delay time 1

This introduces an additional delay after data is inputted and when the modem goes into transmit. For details refer to the operation section. This minimises system degradation when there is a risk of frequent transmissions.

There is a minimum fixed delay (normally 28mS) between inputted data and transmitted power to ensure the PLL is stable at extremes of temperature. Any TX delay time 1 over 5mS will be added to this fixed delay. It is not possible to extend when in dumb mode, but this 28mS delay does still occur even if the PTT line is active at the same time as the data is sent.

Parameters: 5ms to 80mS in 5 ms steps. (20ms default). NB The minimum time between data being received on the RS232 port and when it is transmitted is 28mS, when the TX delay time 1 is set to 5ms. This additional time is to allow for PLL time in extreme conditions.

5.2.2 Tx Delay time 2

This is only available when using CTCSS/DCS (not available with GMSK modem) and enables the carrier only (no tones) to be transmitted at the end of transmission. This prevents squelch noise in the receiver. Parameters: 200ms to 450 ms in 50 ms steps (250ms default)

5.2.3 Tx Off Delay

Allows the carrier to continue transmitting after all the data has been sent, as required by some systems. Parameters:0 to 16mS in 2ms steps. Default is 0ms

5.2.4 Tx On Delay

This adds a delay between transmitting the carrier frequency and the data being modulated onto the carrier. This allows sufficient time for the receiving radio to be ‘open’ before any data is sent.

Minimum recommended is 10mS (or 5ms if Rx delay is set to 0 and RSSI squelch is used) with default at 20mS.

5.2.5 RX On delay

To prevent false timings for unwanted signals, a time delay is required after the squelch opens (see Figure 5.1). It is the delay between the carrier being detected and the busy line going active. Parameters: 0 to 126mS in 2ms steps. (Default is 6mS).

N.B. The RX on delay must always be less than the TX on Delay, otherwise the signal will not be received.

5.3 Data Reception

On reception of a valid signal, the Master MCU sends a 'Rx_ready' signal to the slave MCU of the modem, to prepare the modem for data. At the same time, the Master MCU outputs a 'busy detect' signal through the DB Connector.

The modem requires synchronization before receiving data, which is done by a preamble sequence. A minimum preamble is required by the modem IC to prevent data loss – see programming guide for details.

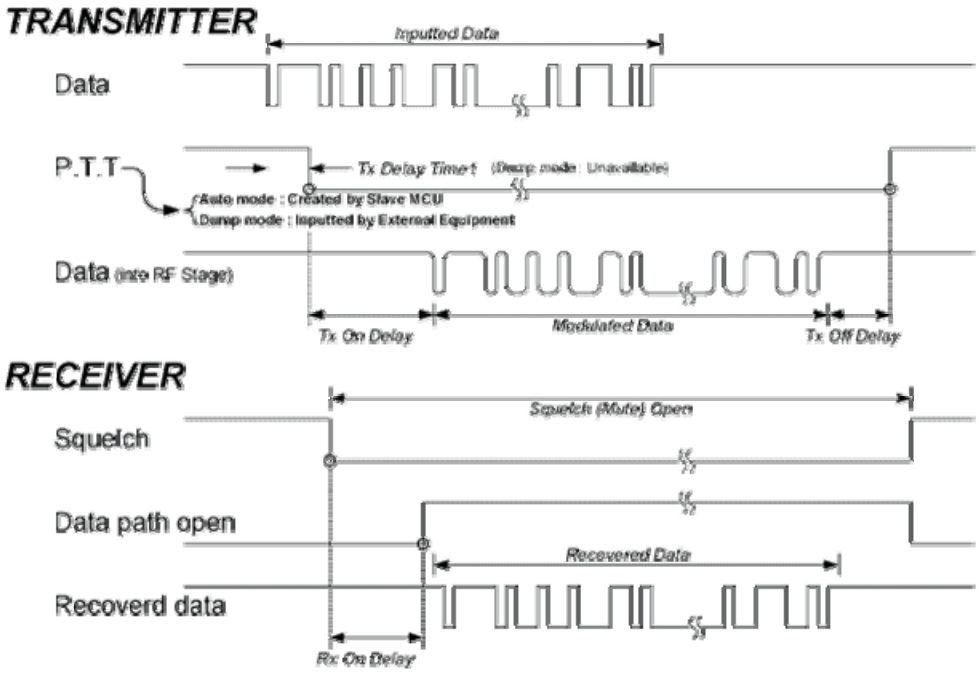


Figure 5.1. Timing parameters

6 Operation

6.1.1 Serial Commands

The modem can be controlled by using the serial command (pin 8) data in, sending commands to the radio such as PTT or change channel

The format for these commands (asynchronous) are:
Baud rate: 4800 bit/sec
Data: 8 bit,
Parity: Non parity
Stop Bit (SP): 1 bit
MSB first transmission
Each serial command consists of 3 bytes. The first byte is the command (CMD), the second is data (DATA) required by the command and the third is the check sum (CS) to validate contents

TX Command format:

CMD	DATA	CS
1st byte	2nd byte	3rd byte

N.B. Check Sum = 1st byte + 2nd byte. CS = CMD + DATA

Response format:

MD	DATA1	DATA2	...	DATAn

The response CMD is in the form of:

ACK, acknowledge, Hex: 0xAA; (then data if any)
NACK, no acknowledge (error in command) Hex: 0x55
NOK, not okay (cannot carry out command) Hex: 0x65

If command is not recognised, repeated or already in requested or wrong state e.g channel change in TX) there is no response from the radio.

6.1.2 Transmit command and data

Mode	TX Command (CMD)	Transmit Data (DATA)	Response Command (CMD)	Response Data	Remark
Channel Change	0x64	0x00 : chn 1 0x01 : chn 2	0xAA (ACK) 0X55 (NACK)		No response if in transmit mode
Request current Channel	0x53	0x66	ACK / NACK	1st byte: Chn no. 2nd byte: option board status	Chn 1 = 01 Chn 2 = 02 A0: No option board A1: GMSK A2: FFSK/AFSK
Activate prog mode / main loop	0x87	0x00	ACK / NACK No response on earlier models		Cannot receive in this mode, but clears previous serial commands. Use 0x53 to rx mode
Request current channel number, when in prog mode	0x53	0x66	ACK / NACK	1st byte: chn no. 2nd byte: software version 3rd byte: option board status	Chn 1 = 01 Chn 2 = 02 Software version 1.2 = 12 A0: No option board A1: GMSK A2: FFSK/AFSK
*Software version	0x59	0x00	ACK / NACK	1st byte main ver 2nd byte update ver	2 bytes in Hex represent version e.g. 1.10 becomes 01,0A *Firmware version 5.0 or later
Enter TX mode	0x61	0x74	ACK / NACK		No response if already TX
Enter RX mode	0x61	0.72	ACK / NACK		No response if already RX
Enter Sleep mode	0x57	0X4f	ACK / NACK		Firmware 5.0 or later
Exit Sleep mode	0x57	0x58	ACK / NACK		Firmware 5.0 or later

Check radio awake	0x6a	0x00	ACK / NACK		
Scan start	0x62	0x73	ACK / NACK		No response if already scanning
Scan start, but stopped on correct channel	0x62	0X46	0X66	Chn no., CMD+DATA	Respond once if stopped on a channel. e.g.If on channel 1 : 66,00,66 (00=chn1,01-chn2)
Scan Stop	0x62	0x46	ACK / NACK		
Scan delete	0x62	0x4f	ACK / NACK 0X65 (NOK)		NOK : e.g. when stopped not on a channel
Module Test Message Enable	0x75	0x78	ACK / NACK		
Module Test Message Disable	0x75	0x79	ACK / NACK		
A comprehensive list of serial commands is available on our web site www.mobile-expertise.co.uk/support					

6.2 Auto Mode

Auto Mode: (GMSK and FFSK only)
The D200/D350 will automatically transmit data when it receives data from the DTE. When the D200/D350 receives data via the RS232 port, the Master MCU will send a control signal to activate the RF stage to prepare for transmission. To prevent data loss, inputted data will be saved in the internal memory (buffer), in the slave MCU of the modem option board.

6.2.1 Software flow control (Xon/Xoff)

This flow control function uses three wires, RXD, TXD and GND in RS232. When DCE is receiving data from DTE, XOFF and XON commands are used to prevent received data from exceeding the buffer capacity in DCE. The DCE sends a command to halt transmission to the DTE - the XOFF code. When the buffer has enough space to receive data again, the DCE sends a command to request transmission – the XON code.

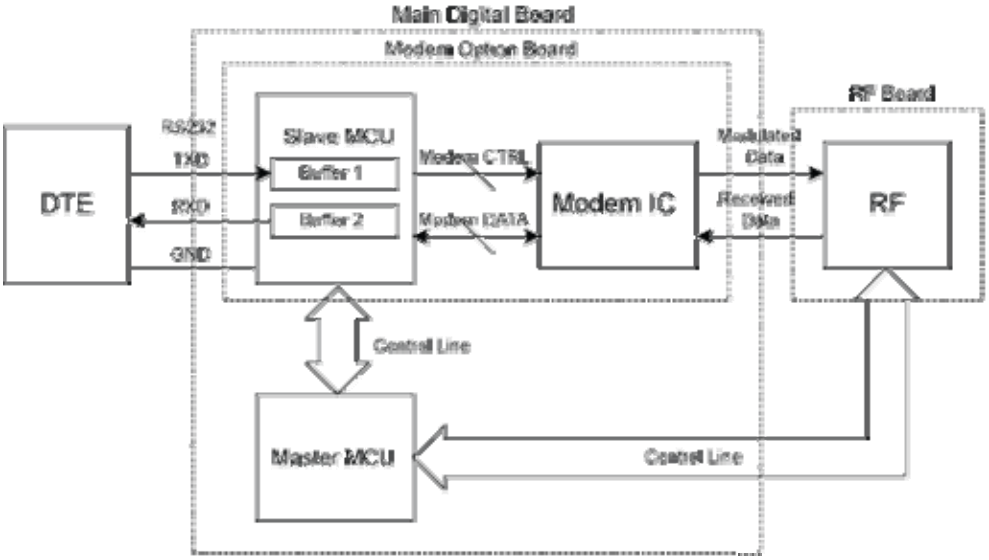


Figure 6.1. Data and Control signal flow in Software flow control

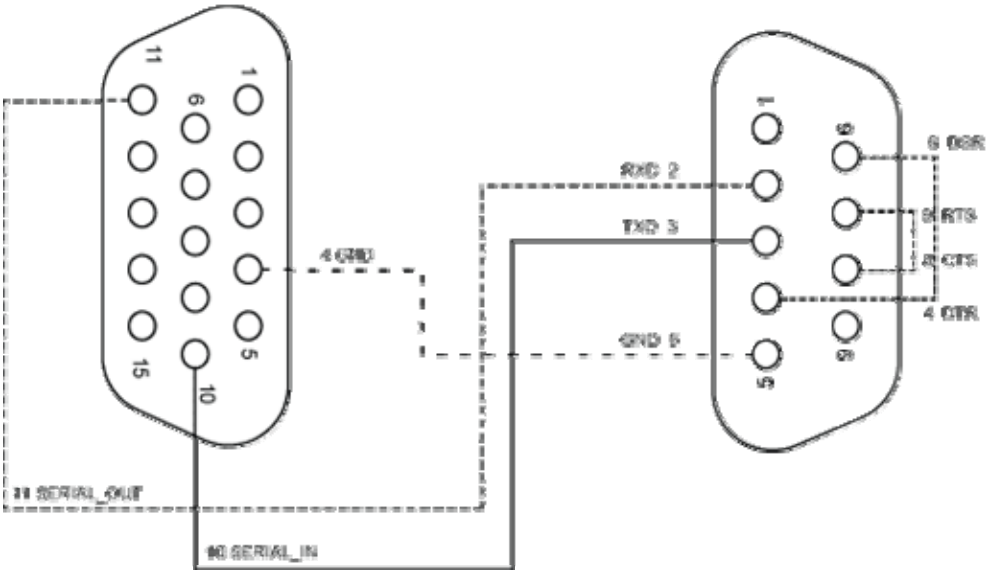


Figure 6.2. Pin connection for Software flow control

6.2.2 Hardware flow control (RTS/CTS)

The hardware flow control function is performed by using the control lines RTS (Request To Send) and CTS (Clear To Send) with TXD, RXD and GND in RS232. When the DTE has data to be transmitted, it sends an RTS signal to the DCE and waits for a CTS signal from the DCE. When receiving the data, the command to transmission halt request (CTS signal – not okay) may be used to prevent buffer overflow. When the buffers have sufficient space to receive data again, the DCE sends command of transmission request (CTS signal - okay) to the DTE.

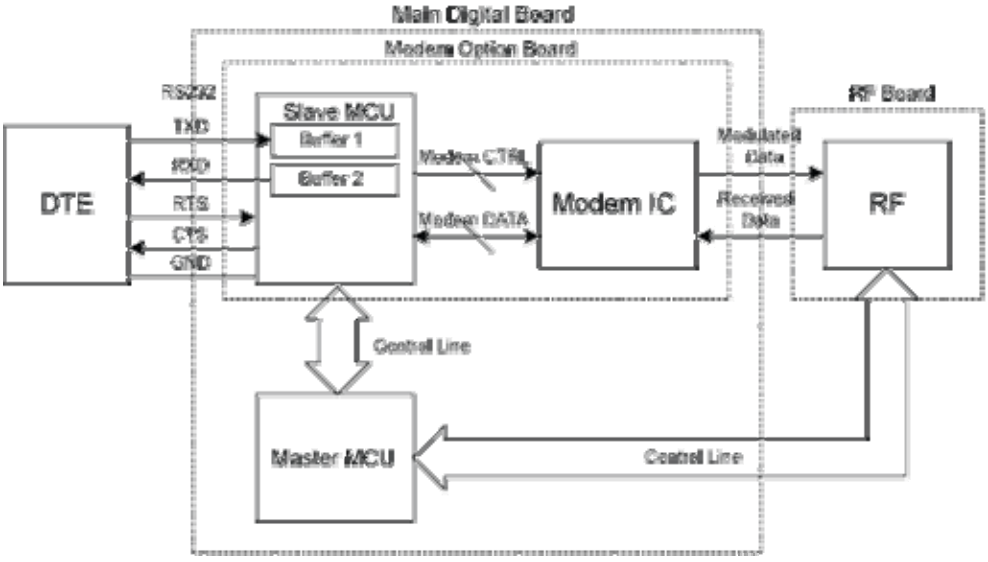


Figure 6.3. Data and Control signal flow in Hardware flow control

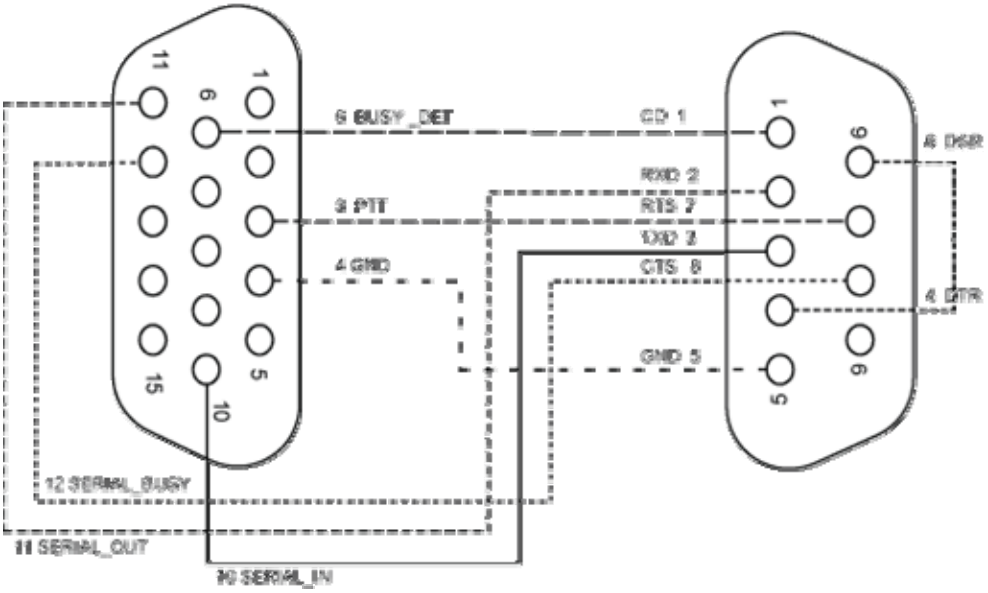


Figure 6.4. Pin connection for Hardware flow control

6.2.3 Flow control: None

It is also possible to turn off flow control when in auto mode. Without flow control there is no protection to prevent the internal buffers from overflowing. If an overflow occurs within the modem, data will be lost. To reduce the risk of lost data, the data should be limited in size, so that is less than the available buffer memory of the Slave MCU.

6.3 Dumb Mode

In dumb mode the radio will not transmit simply by the DTE sending its data. There is no flow control in dumb mode. The application should control all the processes such as Tx preparation for the RF stage and handshaking. The radio has to be put into transmit either by using the PTT control line or serial command via pin 8. The inputted data is buffered before transmission to ensure no loss of data. (28ms delay)

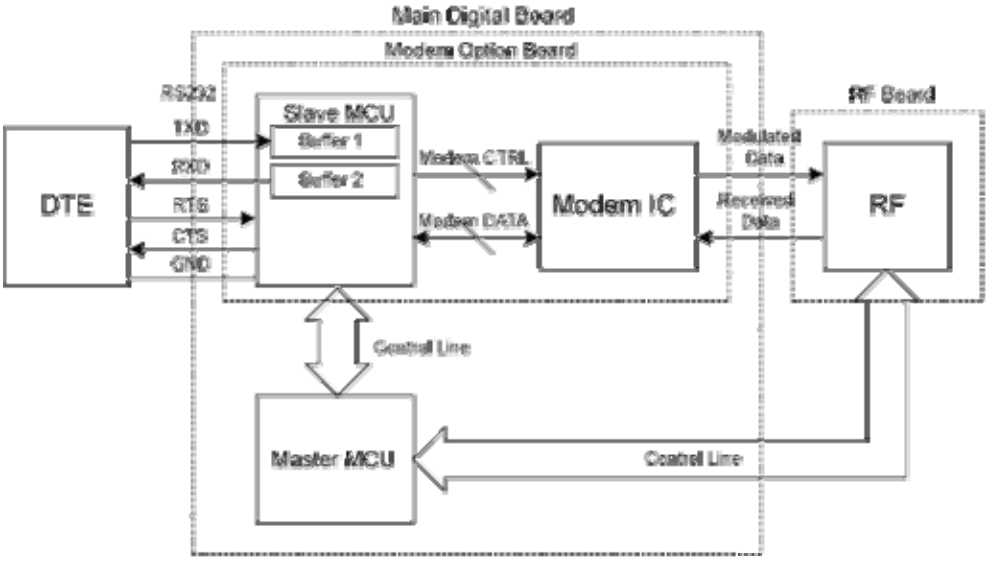


Figure 6.5. Data and Control signal flow in Dumb mode

This operating mode uses 6 wire cable and jumper position of CON407 (as in hardware flow control). If the DTE has data to transmit, the DTE applies a 2.5V high to the PTT line on pin 4 of the DB-15 connector, which will disable the receiver and switch the transmitter on, and then release data to radio. This size of data should be limited to the size of the buffer memory of the slave MCU. After all assigned data is transmitted, the DTE returns PTT signal below -2.5V to complete the transmission.

6.4 Data Flow

An example flow of data is shown in figure 6.6. If the radio has data to transmit of an assigned data block size, the receiving radio, if it receives the correct data, will transmits an ACK (acknowledge) signal as indication of successful receipt. Sequentially, the next data will be transmitted. But if an incorrect receipt occurs, then an ACK signal will not be sent. In this case, the transmitting radio sends next data after elapsing a given period of time.

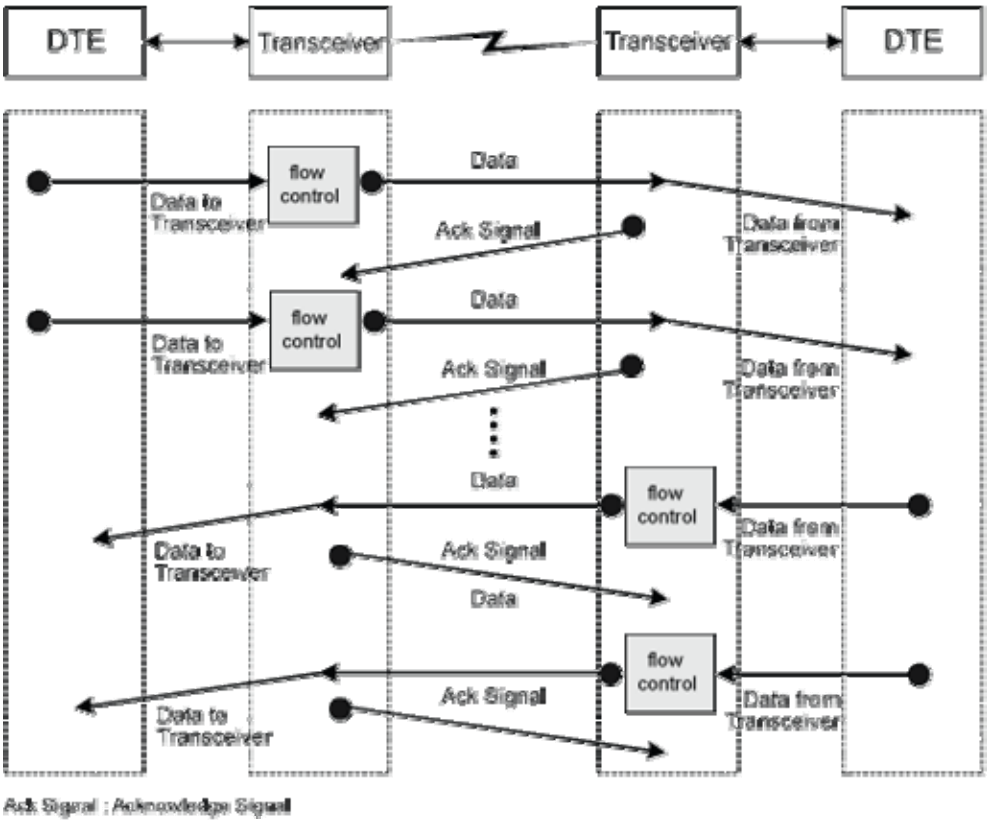


Figure 6.6. Data transmission and handshaking operation

6.5 Data Format

Each data block is assembled with a preamble, ABDS, start data, the actual data and end data.

Figure 6.7. Data block for transmission

6.5.1 Preamble

The Preamble is the data bits, which synchronize the modem IC in the receiving radio. The length of this data bit is programmable depending on the application. Refer to the programming guide for values.

6.5.2 ABDS

The 6 bits ABDS (Additional Bits to Detect Start data) are used to detect the start data more reliably.

6.5.3 Start Data

The 32 bit Start data is the beginning bits of the valid data. Only if these bits are matched with the assigned data bits is the following data block treated as valid. The maximum allowable error in this start data is 3 bits, but this is programmable down to zero.

6.5.4 Data

The size of Data is programmable as base block size when using the GMSK or FFSK modem. The Bell 202 modem has no specific block size. Refer to the programming guide for values.

6.5.5 End data

End data is the last bits of valid data and if no data is detected during a 16 bits interval, the modem terminates to receive valid data.

7 Pin-out chart for DA480/960

7.1 Pin-out for DA 960

Connector No.	Pin No.	Function	Description	Input/ Output
Connector 1	1	VCC	6V to 12V Power Input	I/P
	2	GND	Ground	
	3	PTT	Signal from the digital board to enable transmitter circuit of modem board.	I/P
	4	TXD_EN	It ensures that the radio has stabilized in transmission before the data is processed for modulation.	I/P
	5	TX_END	To finish transmission, it indicates memory buffer of Master MCU of digital board is empty.	O/P
	6	MUTE (Busy)	Logic level input from digital board to indicate whether a carrier is present or not.	I/P
	7	MODEM_EN	Modem Enable input	I/P
	8	POWER_SAVE	Power save input for modem board.	I/P
	9	CMD_EN	It indicates that command for Modem programming is effective.	I/P
	10	CMD_IN/OUT	Data Input and Output for Modem programming.	I/P, O/P
	11	CMD_CLK	Clock Input for Modem programming.	I/P
	12	MODEM_SEL	It Indicates modem type to Master MCU for programming.	O/P
	13	RX_IN	The GMSK signal input for the receiver of modem IC.	I/P
	14	TX_OUT	The GMSK filtered Tx output signal.	O/P
Connector 2	1	Serial_IN	The Serial data to be transmitted is input to this pin.	I/P
	2	Serial_OUT	The recovered asynchronous serial data output from the receiver.	O/P
	3	Busy	To eliminate data loss according to buffer overrun of slave MCU's memory, it indicates buffer status.	O/P
	4	Carrier_Detect	Handshake signal for RTS control mode. It indicates whether Slave MCU of modem has decoded data or not.	O/P
	5	PTT_IN	Handshake signal for RTS control mode. It requests data transmission to Slave MCU of modem.	I/P
	6	PROGRAM	It's reserved input for firmware upgrade.	I/P

7.2 Pin-out for DA-480

Connector No.	Pin No.	Function	Description	Input/ Output
Connector 1	1	VCC	6V to 12V Power Input	I/P
	2	GND	Ground	
	3	PTT	Signal from the digital board to transmit data key the D200/350 transmitter	I/P
	4	TXD_EN	It ensures that the radio has stabilized in transmission before the data is processed for modulation.	I/P
	5	TX_END	To finish transmission, it indicates memory buffer of Master MCU of digital board is empty.	O/P
	6	MUTE (Busy)	Logic level input from digital board to indicate whether a carrier is present or not.	I/P
	7	MODEM_EN	Modem Enable input	I/P
	8	POWER_SAVE	Power save input for modem board.	I/P
	9	CMD_EN	It indicates that command for Modem programming is effective.	I/P
	10	CMD_IN/OUT	Data Input and Output for Modem programming.	I/P, O/P
	11	CMD_CLK	Clock Input for Modem programming.	I/P
	12	MODEM_SEL	It Indicates modem type to Master MCU for programming.	O/P
	13	RX_IN	The FFSK/MSK signal input for the receiver of modem IC.	I/P
	14	TX_OUT	The FFSK/MSK signal output when the transmitter is enabled.	O/P
Connector 2	1	Serial_IN	The Serial data to be transmitted is input to this pin.	I/P
	2	Serial_OUT	The recovered asynchronous serial data output from the receiver.	O/P
	3	Busy	To eliminate data loss according to buffer overrun of slave MCU's memory, it indicates buffer status.	O/P
	4	Carrier_Detect	Handshake signal for RTS control mode. It indicates whether Slave MCU of modem has decoded data or not.	O/P
	5	PTT_IN	Handshake signal for RTS control mode. It requests data transmission to Slave MCU of modem.	I/P
	6	PROGRAM	It's reserved input for firmware upgrade.	I/P