RADIO MODEM

B1474

OPERATION MANUAL

BARNETT ENGINEERING LTD.

April, 1998
Manual Revision 4.1
(for Version 2.1 Hardware)

TABLE OF CONTENTS

FCC REQUIREMENTS

This equipment generates, uses, and can radiate radio frequency energy and, if not used in accordance with the instruction manual, may cause interference to radio communications.

It has been tested and found to comply with the limits for a Class A computer device pursuant to sub-part J of Part 15 of FCC Rules, which are designed to provide reasonable protection against interference when operated in a commercial environment. Operation of this equipment in a residential area is likely to cause interference, in which case the user, at his own expense, will be required to take whatever measures may be required to correct the interference.

This device was tested using a shielded cable connected to the data port. The unit must be operated using a shielded cable on the data line, with the shield grounded.

1 INTRODUCTION

The B1474 Radio Modem provides a reliable method of sending 1200 baud data signals over radio or cable facilities. Digital information is converted to tone format for transmission over the communication channel. Received tones are converted back to RS232 digital format. Hardware handshaking using RTS and CTS signals allows the radio channel to be transparent to the connected equipment. Warm-up and power down delay times required by the radio do not affect the data signals. Alternatively, XON/XOFF or data buffering may be used where hardware handshaking is not available.

The communication channel can be a single pair cable, two pair cable or two-way radio. Conventional land mobile radio equipment can be used or, if specified at time of order, GE trunking radios may be used.

Power and audio signals are connected to compression terminals inside the modem; the digital interface is through a DB-25S connector. The B1474 requires 12 to 30 VDC, negative ground, and approximately 60 mA to operate.

Features available in the B1474 are:

Hardware or Software Handshaking

Either RTS and CTS hardware signals or software XON and XOFF characters can be used to pause the transmitting station while waiting for the radio system to respond. If short data streams are to be sent, full data buffering may be used to render the radio system transparent.

RTS/CTS Delay

This adjustable delay allows the radio to warm up before data is sent. The delay is active regardless of whether hardware handshaking or data buffering is used.

PTT

A low going push-to-talk signal is active whenever the modem is transmitting data.

Squelch Detect

If the radio channel is currently being used, the modem will not return the CTS signal until the channel is available. If XON/XOFF signaling is selected, XOFF will be returned to indicate a busy channel; then XON will be issued when the channel is free. (This feature may be disabled using a DIP switch.)

PTT Drop Delay

This adjustable delay prevents squelch tails from disturbing the received data at the other end of the system.

Level Selection

Transmit levels are adjustable from 0 to -20 dBm. The receive section has selectable gain of 10 dB, if required, to boost low incoming signal levels.

Indicators

Modem status condition is indicated by front panel LEDs. The LEDs may be disabled to conserve power.

2 SPECIFICATIONS

GENERAL

Transmission Rate: 1200 Baud (Bell 202 signaling) or V.23 if factory installed

Transmission Format: 8 data bits, no parity, 1 stop bit if modem buffering is selected; otherwise transparent

Power Requirement: Operates from 12 to 30 VDC. Current drain is 110 mA with the LEDs on, 65 mA with the LEDs off.

Temperature Range: $-30^{o}C$ to $+50^{o}C$

Physical Size: Approx. 10" x 5" x 1", inside a metal enclosure

Radio and Wireline: Compression screw terminals located inside the enclosure

Data Connector: RS232-C compatible, connections available through a DB-25S socket located on the side of the enclosure

Indicators: Power ON, TXD, RXD, CD, RTS, CTS, BUSY

Receive Audio: Single ended, AC coupled, -30 dBm to 0 dBm

Transmit Audio: Single ended, AC coupled, -20 dBm to 0 dBm

Squelch Detection: Single ended, 1M ohm impedance, DC coupled, detection range 0 to 10 volts, polarity is DIP switch selectable

PTT: Closure to ground for active, 0.5 A @ 50 volts max.

4 Wire Receive: Balanced, 600 ohm impedance, -30 dBm to 0 dBm (operates full or half duplex)

4 Wire Transmit: Balanced, 600 ohm impedance, -20 dBm to 0 dBm (operates full or half duplex)

DIP SWITCH SETTINGS

Transmitter Level: -20 dBm to 0 dBm

Receiver Level: -30 dBm to 0 dBm

Squelch Polarity: Selects high or low going squelch monitor signals.

Carrier Detect Delay: 5 or 50 msec

Assert RTS: Forces RTS on.

RTS/CTS Delay: 20, 35, 50, 100, 200, 300, 500, or 1000 msec. Allows the transmitter time to reach full power before data is transmitted.

PTT Drop Delay: 0, 10, 20, 50, 75, 100 or 250 msec. Keeps transmitter keyed long enough to ensure squelch tail noise doesn't interfere with data at the receiving terminal.

Handshaking: Specifies the type of flow control used.

2/4 Wire: Selects 2 or 4 wire cable operation.

LED Control: Disables LEDs to save power.

Equalization:

Full/Half Duplex:

3 NOTATION

Throughout this manual, abbreviations will be used. These abbreviations are explained here for clarity.

CD	Carrier Detect
COS	Carrier Operated Switch
CTS	Clear To Send
DCE	Data Communications Equipment
DTE	Data Terminal Equipment
FCC	Federal Communication Commission
GND	Ground
PTT	Push To Talk
RFCTS	RF Clear To Send (used in trunking systems only)
RTS	Request To Send
SQL	Squelch
SW1.8	This signifies a DIP switch. The given example describes the eighth position on DIP switch number one.
XOFF	ASCII 13h sent by a receiving station instructing the sending station to halt any transmission
XON	ASCII 11h sent by a receiving station instructing the sending station to resume transmission

4 OPERATION

The B1474 operates from 12 to 30 VDC to provide an interface between two computer devices and the communications channel. In the descriptions below it is assumed that the sending device uses a DCE configuration.

Four different types of operation may be configured:

Hardware Handshaking

Basic operation and timing using hardware handshaking are as follows:

- The sending device asserts its RTS and waits.
- Upon receiving the RTS, the associated modem performs the following functions:
  - checks the channel, if this feature is enabled. If the channel is free, it asserts its PTT to power up the radio's transmitter.
  - presents a mark tone (carrier) onto the channel.
  - sets its RTS/CTS delay timer (from 20 to 1000 msec). RTS/CTS delay must be greater than the carrier detect delay at the receiving end.
- The modem at the receiving end senses carrier on the line and asserts its CD. The received data is muted for 5 or 50 msec to ensure that transients do not affect the received data.
- At the sending end, once the RTS/CTS delay timer has expired, the modem returns a CTS to the sending computer.
- Data is transmitted; any format may be used.
- Once all the data has been transmitted, the sending computer drops its RTS.
- Upon sensing the dropped RTS, the sending modem does the following:
  - drops CTS immediately.
  - sets its PTT drop delay timer (0 to 250 msec).
- Once the PTT drop delay timer has expired, the sending modem releases the radio transmitter, turns off the modem carrier and returns to receive mode.

For hardware handshaking, set XON/XOFF signaling off, assert RTS (continuous) off and buffering off. Set RTS/CTS delay and PTT drop delay as required.

Refer to Figure 1 for a summary of the modem timings.

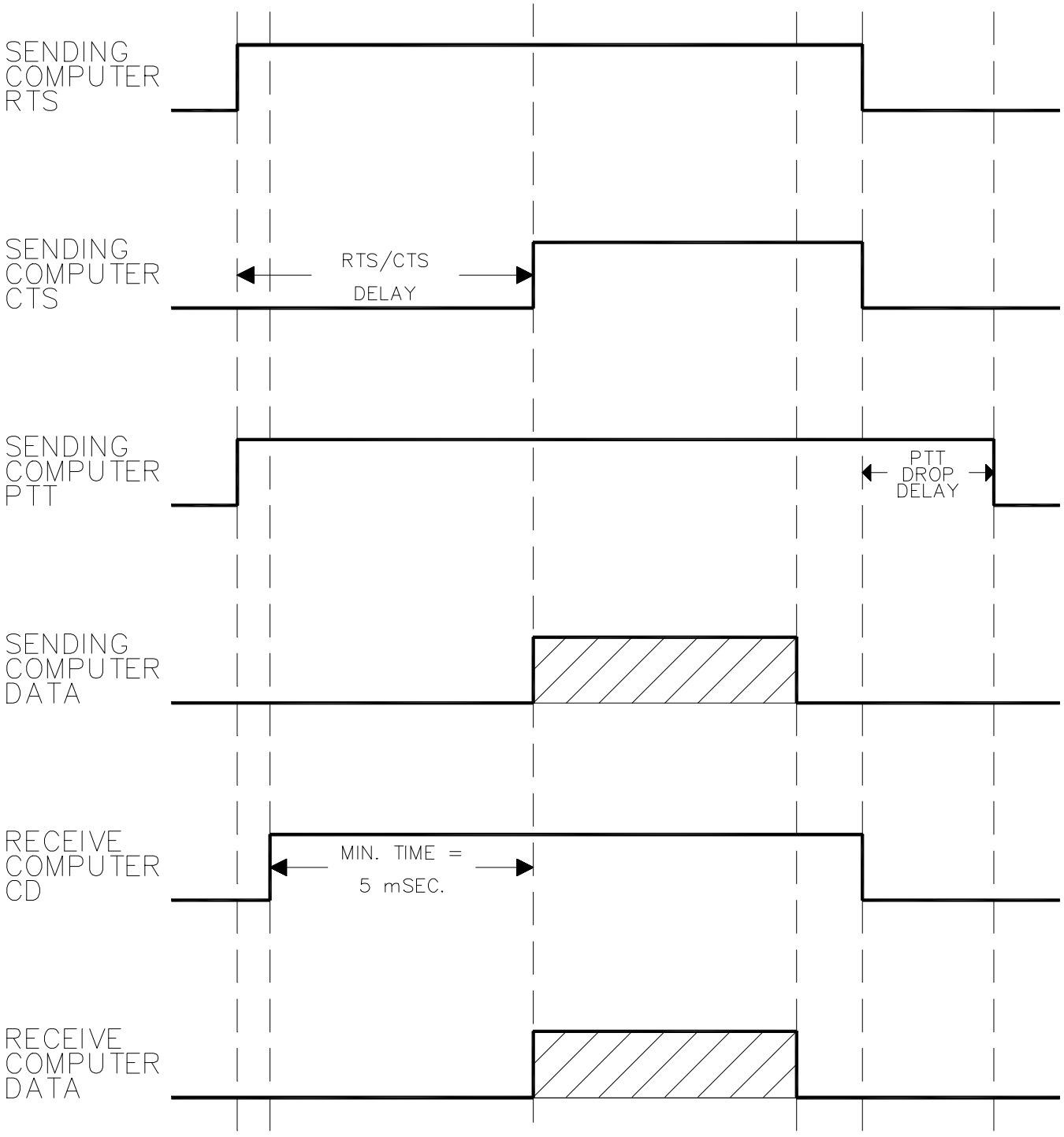


FIGURE 1 MODEM TIMING USING RTS AND CTS

Software Handshaking Using XON/XOFF

Basic operation and timing using XON/XOFF software handshaking are as follows:

- The sending computer begins sending data. The format must be 8 data bits, no parity, 1 stop bit.

- Upon detecting data, the sending modem performs the following:

  – checks the channel, if this feature is enabled. If the channel is free, it asserts its PTT to power up the radio's transmitter. If the channel is busy, it returns XOFF to the sending computer, which halts the transmission of data. When the channel becomes free, the modem sends XON to the computer, which resumes sending data. The modem buffers the data while it continues with the following:

  – presents a mark tone (carrier) onto the channel.

  – sets its RTS/CTS delay timer (from 20 to 300 msec). RTS/CTS delay is a misnomer in this case as software handshaking does not use RTS and CTS signals. It is actually a buffering time between when the modem starts receiving data from the computer and when it starts transmitting. This delay must be greater than the carrier detect delay at the receiving end.

- The modem at the receiving end senses carrier on the line and asserts its CD. The received data is muted for 5 or 50 msec to ensure that transients do not affect the received data.

- At the sending end, once the RTS/CTS delay timer has expired, data is transmitted.

  – The sending modem's PTT drop delay timer is started at the end of the last transmitted character.

- Once the PTT drop delay timer has expired, the modem releases the radio transmitter, turns off the modem carrier and returns to receive mode.

This configuration can buffer 500 msec worth of characters. To prevent internal data buffer overflow, it is important that the RTS/CTS delay timer be set to a value less than 500 msec and that the computer respond to XOFF immediately.

For software handshaking, set XON/XOFF signaling on, assert RTS (continuous) off, and buffering on. Do not connect hardware RTS and CTS. Set RTS/CTS delay and PTT drop delay as required.

No Handshaking, Buffered

Basic operation and timing with data buffering (no handshaking) are as follows:

- The sending computer begins sending data. Data format must be 8 bits, no parity, 1 stop bit.

- Upon detecting data, the sending modem performs the following:

- checks the channel, if this feature is enabled. If the channel is free, it asserts its PTT to power up the radio's transmitter. If the channel is busy, it buffers the received data until the channel becomes free.

- presents MARK tone (carrier) onto the channel.

- sets its RTS/CTS delay timer (from 20 to 300 msec). RTS/CTS delay is a misnomer in this case as handshaking is not used. It is actually a buffering time between when the modem starts receiving data from the computer and when it starts transmitting. RTS/CTS delay must be greater than the carrier detect delay at the receiving end.

- The modem at the receiving end senses carrier on the line and asserts its CD. The received data is muted for 5 or 50 msec to ensure that transients do not affect the received data.

- At the sending end, once the RTS/CTS delay timer has expired, data is transmitted.

- Receipt of any character from the sending device, or transmission of any buffered character, restarts the sending modem's PTT drop delay timer (from 0 to 250 msec).

- Once the PTT drop delay timer has expired, the modem releases the radio transmitter and returns to receive mode.

This configuration can buffer 500 msec worth of characters. To prevent internal data buffer overflow, it is important that the radio system will be available within 500 msec (RTS/CTS delay plus maximum channel busy time) or the maximum amount of buffered data be less than 50 characters.

For no handshaking, buffered operation, set XON/XOFF signaling off, assert RTS (continuous) off, and buffering on. Do not connect the hardware RTS and CTS. Set RTS/CTS delay and PTT drop delay as required.

No Handshaking, Non-Buffered

Basic operation and timing with no handshaking, no data buffering are as follows:

- RTS is always asserted. Do not connect the hardware RTS.

- PTT is always asserted, i.e. the radio's carrier is always on. There is no RTS/CTS delay or PTT drop delay.

- Data generated by the sending device is passed directly through the modem without handshaking, buffering or time delays. Data may be any format.

For no handshaking, non-buffered operation, set XON/XOFF signaling off, assert RTS (continuous) on, and buffering off. Do not connect the hardware RTS and CTS, and do not set RTS/CTS or PTT drop delays.

5 SETUP PROCEDURES

The semiconductors can be damaged by static discharge. Proper handling procedures must be followed. Do not touch any of the devices inside the modem, and work only in a static free, clean, and dry environment.

(1) Remove The Top Cover

Remove the two center screws on the top cover of the modem to release it from the base. Pull straight up on the cover to expose connections and internal DIP switches.

(2) CONNECTIONS

Line Interface

Connect the audio wires in accordance with the configurations below:

4 wire cable: Connect the two transmit wires into pins 4 and 5 of P1. The receive wires connect into pins 7 and 8 of P1. SW3.3 and SW3.4 must be OFF.

2 wire cable: Connect the two wires into pins 4 and 5 of P1. Ensure that SW3.3 and SW3.4 are ON.

Radio

If the radio is equipped with a 600 ohm balanced interface, connect the transmit and receive audio lines as shown above for a cable interface.

For a single-ended radio interface, connect P1-3 to the transmit line of the radio and P1-6 to the receive line. Connecting the receive input to an unsquelched source in the radio will result in extraneous characters at the data port, unless the squelch detector is set properly.

PTT: The B1474 provides an open collector driver for the radio PTT at P1-10.

Squelch: The radio's receive carrier operated switch (COS) can be monitored to detect when the radio is receiving a signal by connecting the COS line to P1-7. This signal is used to inhibit transmissions over a busy channel.
The input is capable of monitoring a level from 0 to 10 VDC.
See "Squelch Polarity" under DIP switch settings to set the COS polarity and level, or to disable this feature.

If using the Option 002 trunking software, connect the radio's RFCTS into the squelch input.

Digital Connection

A DB-25S socket on the side of the unit is used to interface with the computer equipment.

The RS232 interface provides a DCE interface using the following signals:

GND (Chassis)	Pin 1	
TXD	Pin 2	
RXD	Pin 3	
RTS	Pin 4	(connect only if using hardware handshaking)
CTS	Pin 5	(connect only if using hardware handshaking)
GND (Signal)	Pin 7	
CD	Pin 8	

The cable and housing on the DB-25S socket must be shielded to conform to FCC, part 15-J/A standards for emissions. Using a non-shielded cable may result in undesirable radio interference.

(3) DIP SWITCH SETTINGS

The following section describes the function of each DIP switch on the modem. The settings are summarized in a table in Section 7 - Configuration.

LED Control

The LED indicators may be disabled to conserve power. Set SW1.1 OFF to disable the LEDs.

RTS/CTS Delay

When the sending device requests transmission, a preset delay is inserted before the modem transmits. This delay allows the two-way radio to warm up, or, on a cable system, allows the tones to settle on the channel before data transmission begins. When hardware handshaking is used, the modem pauses the sending device by delaying return of the CTS signal. When XON/OFF or no handshaking are used, the RTS/CTS delay specifies the amount of data which will be buffered. Set DIP switches SW1.2, SW1.3, and SW1.4 for the desired delay, from 20 to 1000 msec, as specified in Section 7 - Configuration.

PTT Drop Delay

When transmission is no longer requested by the sending computer, a selectable delay is inserted before the PTT on the radio is released. This delay prevents the squelch tail at the receiving radio from interfering with the data. Set DIP switches SW1.5, SW1.6, and SW1.7 for the desired drop delay, between 0 and 500 msec, as specified in Section 7 - Configuration.

XON / XOFF Controls

SW1.8 controls whether the modem will send XON and XOFF to the sending computer when the radio channel is busy (software handshaking). If the sending computer does not understand these characters, the switch must be OFF.

Squelch Polarity

If the modem is connected to a radio, the channel can be monitored for RF carrier. SW1.9 is changed depending upon the polarity of the carrier operated switch (COS) signal. If the COS goes high when carrier is present, and low when the channel is free, set SW1.9 OFF. If the opposite occurs, set SW1.9 ON. While the channel is busy, the modem will wait, sending only when the channel is clear.

Adjust R12 so that the modem waits when the channel is busy, and transmits when the channel is free. When the BUSY light is ON, the modem is waiting for the channel.

To disable this feature, leave P1-9 unconnected and SW1.9 OFF.

If Option 002 trunking software is used, set SW1.9 according to the polarity of the RFCTS signal connected into P1-9. Set SW1.9 and R12 so that the data is only transmitted once the channel has been assigned.

Send/Receive

When using the Option 002 trunking software and data buffering, use SW1.10 to configure the modem for send or receive mode. Normally, all modems within a system should be set for send mode, meaning that they will key the trunking radio and wait for RFCTS when data transmission is required. Setting SW1.10 ON sets the modem into receive mode. In this mode, the modem will only hit PTT if the channel has already been established by another modem. Having one modem in send mode and another in receive mode will ensure that both modems do not try to acquire the channel at the same time.

Set SW1.10 to OFF if using hardware handshaking or conventional radios.

Transmit Level

To adjust the output level of the modem to between 0 and -20 dBm, set DIP switches SW2.1, SW2.2 and SW2.3 as specified Section 7 - Configuration.

The output levels given are referenced into 600 ohms. Should the output be driven into a high impedance, the level will be approximately 6 dB higher than expected.

If a high level is required into a single-ended input, connect P1-5 to ground, and use P1-4 to drive the input.

Receive Gain

DIP switch SW2.5 is used to boost the received signal. To insert 10 dB of gain, turn SW2.5 ON. This will amplify all incoming signals (including all valid data tones).

Equalization (Mode 1)

To enable the internal amplitude equalizer, set SW2.6 ON. To leave this feature disabled, set SW2.6 OFF. Use equalization when there is a large discrepancy in levels between the two tones.

Carrier Detect Delay (Mode 2)

When the receiving modem detects carrier, it mutes the RXD line for a short time to ensure that transients do not affect the received data. Set SW2.7 OFF to delay the received data for 5 msec, ON to delay the received data for 50 msec. Carrier detect delay should be less than the RTS/CTS delay at the sending end.

Full/Half Duplex (Mode 3)

To operate full duplex, leave SW2.8 OFF. To operate half duplex, set switch SW2.8 ON. If a 2 wire circuit is used, the modem will only operate half duplex.

RTS Control

SW3.1, when ON, will assert RTS continuously. This causes PTT to be asserted and transmit tones to be generated. The switch should be on for a no handshaking, non-buffered configuration. The continuous RTS is also useful for testing purposes.

Buffer

If hardware handshaking is desired, connect the RTS and CTS signals to the DB-25S connector and set SW3.2 OFF. If XON/XOFF control (software handshaking) or no handshaking with full buffering is desired, set SW3.2 ON and remove connections from the RTS and CTS positions in the DB-25S connector.

2/4 Wire

Set SW3.3 and SW3.4 OFF if 4 wire communications are used. Set SW3.3 and SW3.4 ON if 2 wire communications are used. If a 2 wire circuit is used, the modem will only operate half duplex.

(4) Replace The Top Cover

Place the top cover back onto the base and tighten the two center screws.

(5) Apply Voltage

Apply the proper voltage to the unit. If the LEDs are enabled, the run lamp will illuminate, indicating that power is available at the modem.

6 INDICATORS

The LED indicators on the front case are used to indicate modem status:

RUN	Power is on the modem.
BUSY	The modem is waiting to transmit but is held back by the squelch detector.
RTS	Request To Send from the computer is present or characters have been received into the buffer.
CTS	Clear To Send is active.
CD	Carrier is detected on the incoming channel.
RXD	On when a mark is received and off when a space is received.
TXD	On when a mark is transmitted.

The LEDs may be disabled to conserve power by setting SW1.1 off.

SWITCH 1

LED CONTROL

1	
	LEDS OFF
X	LEDS ON

RTS/CTS DELAY

2	3	4	msec
			20
X			35
	X		50
X	X		100
		X	200
X		X	300
	X	X	500
X	X	X	1000

PTT DROP DELAY

5	6	7	msec
			0
X			10
	X		20
X	X		50
		X	75
X		X	100
	X	X	250

XON/XOFF

8	
	NO XON/XOFF
X	USE XON/XOFF

SQUELCH POLARITY

9	
	LOW = CHANNEL FREE
X	HIGH = CHANNEL FREE

SEND/RECEIVE (TRUNKING ONLY)

10	
	PTT REGARDLESS OF RFCTS
X	PTT ONLY WITH RFCTS

SWITCH 2

TX LEVEL (INTO 600 OHMS)

1	2	3	Radio (dBm)	Bal-
			-4	0
X			-6	-2
	X		-8	-4
X	X		-10	-6
		X	-12	-8
X		X	-14	-10
	X	X	-20	-16
X	X	X	-24	-20

RX GAIN

5	dB
	0
X	10

MODE 1 (EQUALIZATION)

6	
	NO RECEIVE EQUALIZATION
X	RECEIVE EQUALIZATION

MODE 2 (CD DELAY)

7	
	CD DELAY = 5 msec
X	CD DELAY = 50 msec

MODE 3 (DUPLEX)

8	
	FULL DUPLEX
X	HALF DUPLEX

SWITCH 3

RTS ON

1	
	EXTERNAL RTS
X	RTS ON AT ALL TIMES

BUFFER

2	
	USE RTS/CTS CONTROL
X	USE BUFFER

RTS ON

3	4	
		4 WIRE CABLE
X	X	2 WIRE CABLE

8 CONNECTIONS

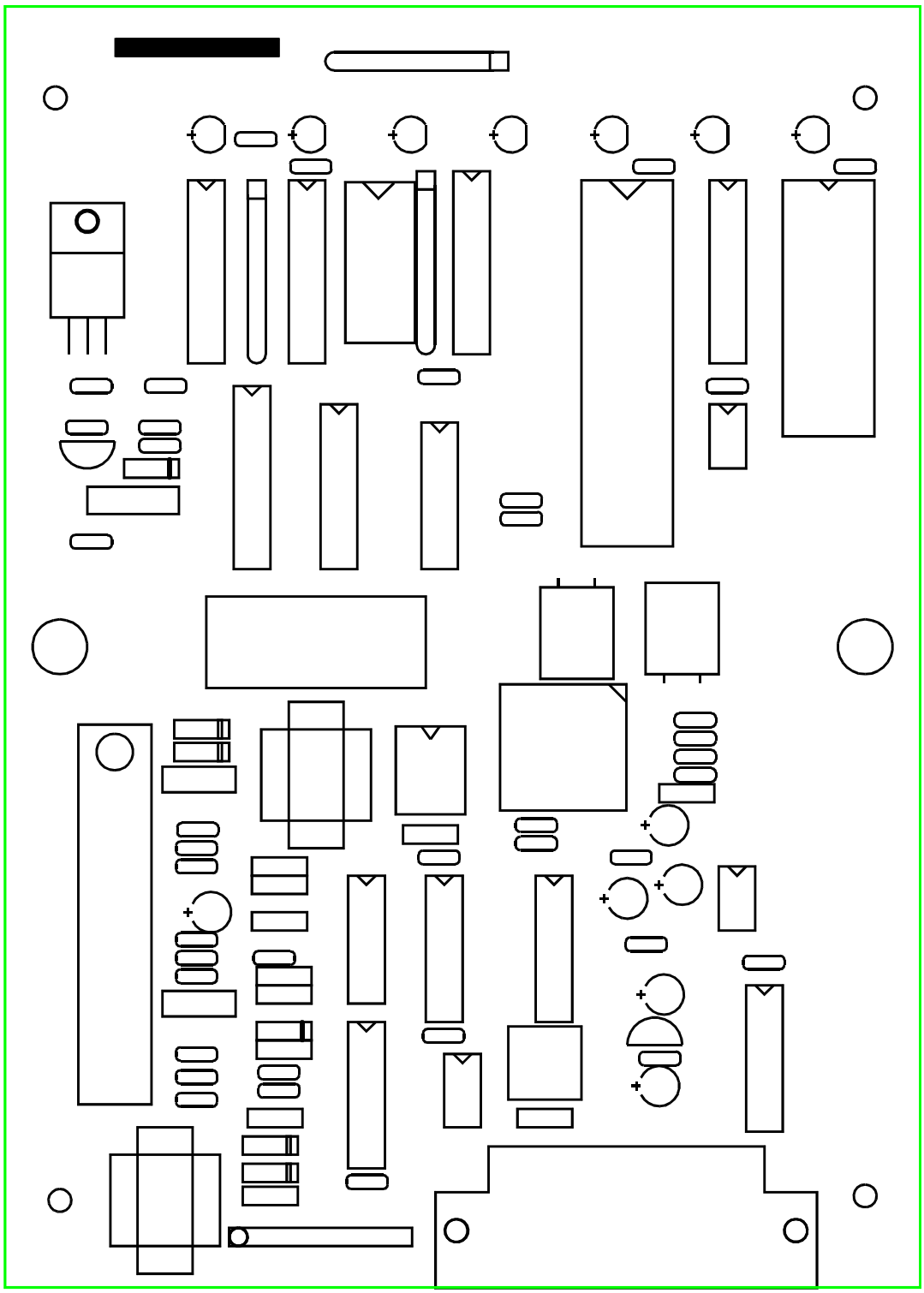
P1 AUDIO

PIN	SYMBOL	DESCRIPTION
1	+V	INPUT VOLTAGE
2	GND	GROUND
3	TX RADIO	TRANSMIT OUTPUT, SINGLE ENDED
4	TX WL	} TRANSMIT OUTPUT, BALANCED
5	TX WL	
6	RX RADIO	RECEIVE INPUT, SINGLE ENDED
7	RX WL	} RECEIVE INPUT, BALANCED
8	RX WL	
9	SQL	SQUELCH DETECTOR INPUT
10	PTT	PUSH TO TALK OUTPUT

P3 DIGITAL

PIN	SYMBOL	
1	GND	CHASSIS GROUND
2	TXD	TRANSMIT DATA
3	RXD	RECEIVE DATA
4	RTS	REQUEST TO SEND
5	CTS	CLEAR TO SEND
7	SIG GND	SIGNAL GROUND
8	CD	CARRIER DETECT

9 BOARD LAYOUT



Barnett Engineering Product Warranty

WARRANTY STATEMENT

Barnett Engineering Ltd. warrants that all equipment supplied shall be free from defects in material or workmanship at the time of delivery. Such warranty shall extend from the time of delivery for a period of one year. Buyer must provide written notice to Barnett Engineering Ltd. within this prescribed warranty period for any defect. If the defect is not the result of improper usage, service, maintenance, or installation and the equipment has not been otherwise damaged or modified after delivery, Barnett Engineering Ltd. shall either replace or repair the defective part or parts of equipment or replace the equipment or refund the purchase price at Barnett Engineering Ltd.'s option after return of such equipment by the buyer to Barnett Engineering Ltd. Shipment to Barnett Engineering Ltd.'s facility shall be borne on account of the buyer.

(1) Consequential Damages

Barnett Engineering Ltd. shall not be liable for any incidental or consequential damages incurred as a result of any defect in any equipment sold hereunder and Barnett Engineering Ltd.'s liability is specifically limited to its obligation described herein to repair or replace a defective part or parts covered by this warranty.

(2) Exclusive Warranty

The warranty set forth herein is the only warranty, oral or written, made by Barnett Engineering Ltd. and is in lieu of and replaces all other warranties, expressed or implied, including the warranty of merchantability and the warranty of fitness for particular purpose.

11 APPENDIX A - OPERATION WITH A GE MARC V TRUNKING SYSTEM

When ordered with the Option 002 trunking software, the B1474 will handle the special timing and control requirements of a GE Marc V trunking system. The following sections describe the connections to a trunking radio, and the slightly different operation of the radio modem.

CONNECTIONS

The modem connects into the Marc V system the same as it would to a conventional radio, as described in section 5, using the PTT, RX data and TX data pins. The only difference is that the squelch monitor is tied to RFCTS within the radio to determine when the channel is assigned.

To ensure that these connections are made correctly and the proper signals are supplied to each unit, order the Option 001 interface cable from Barnett Engineering Ltd. Otherwise, refer to the manual for the Ericsson GE radio to determine the correct interface points.

OPERATION

The trunking modem operates with some slight timing differences from the conventional modem.

Hardware Handshaking

The sequence followed in obtaining a trunked channel and transmitting the sending computer's data using hardware (RTS/CTS) handshaking is described below. Refer to Figure 2 for an illustration of the timing relationships.

1. The sending computer asserts its Request to Send (RTS), causing the modem to key the radio and wait for a channel to be assigned.

2. When the channel is assigned, the trunking radio returns RF Clear to Send (RFCTS) to the modem. The signal is connected to the SQUELCH input on the modem.

3. The modem produces tones onto the channel and waits the specified RTS/CTS delay. This delay is a minimum of 5 msec to ensure that all tones have stabilized before any data is sent.

4. When the RTS/CTS delay has expired, CTS is returned to the sending computer and the transmission of data begins. When all of the data has been transferred, the sending computer drops its RTS signal, causing the modem to drop its CTS signal.

5. The modem holds the radio's Push To Talk (PTT) on the radio until the PTT Drop Delay has expired. The channel assignment will not be lost immediately on releasing PTT, so the receiving computer can use the same channel to respond.

The receiving computer receives a Carrier Detect (CD) followed by the data some interval later
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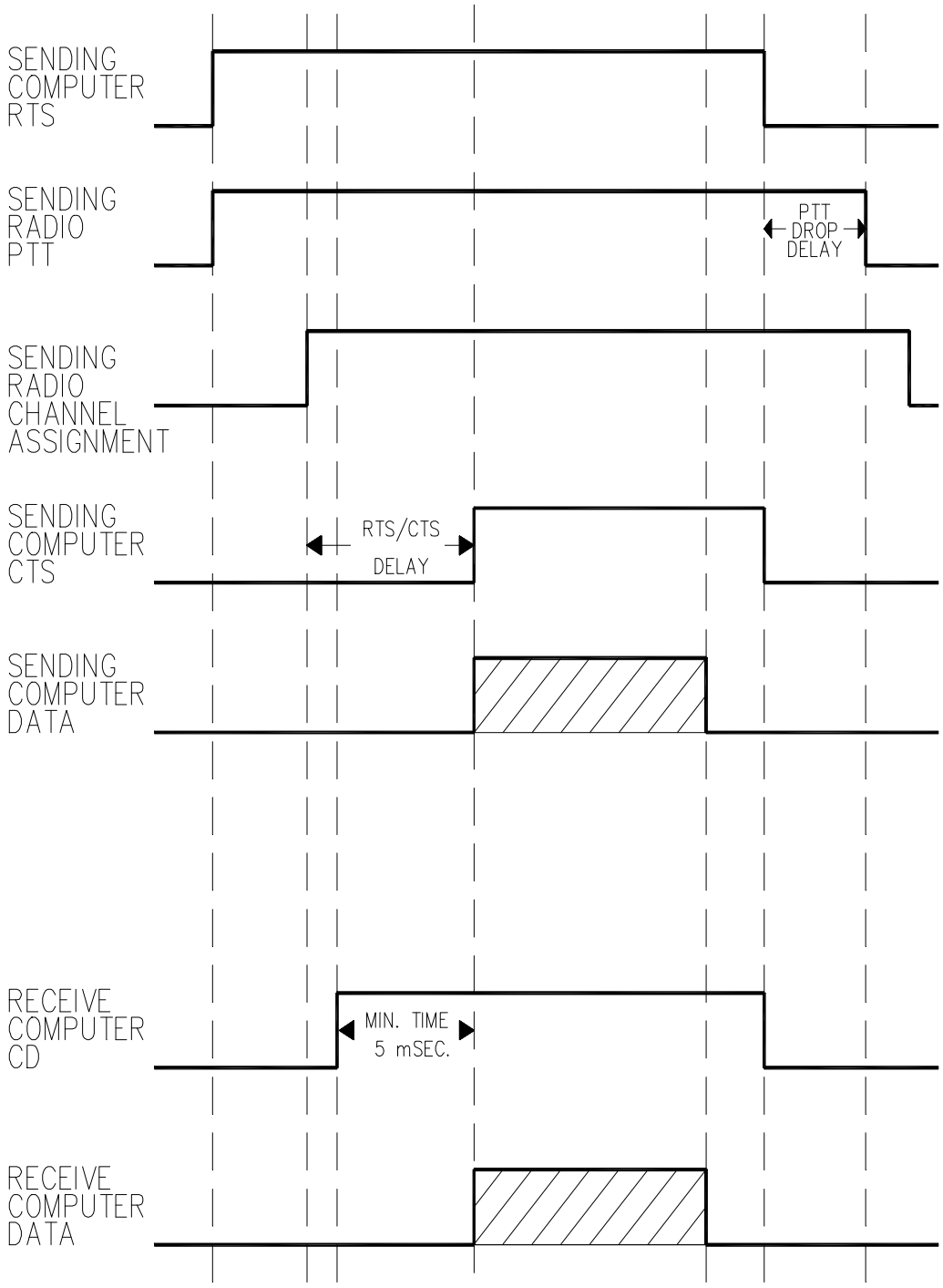

FIGURE 2 MODEM TIMING FOR A GE MARC V
TRUNKING SYSTEM USING RTS/CTS HANDSHAKING

Software Handshaking Using XON/XOFF

Basic operation and timing using XON/XOFF software handshaking in a trunking system is as follows:

- The sending computer begins sending data. The format must be 8 data bits, no parity, 1 stop bit.
- Upon detecting data, the sending modem performs the following:
  - checks the channel. If RFCTS has already been assigned (the channel is available), it asserts its PTT to power up the radio's transmitter. If the channel has not been assigned yet, it sends XOFF to the sending computer and asserts PTT to obtain the channel. When the channel gets assigned, it sends XON to the computer and continues.
  - presents tones onto the channel.
  - sets its RTS/CTS delay timer.
- The receiving modem senses carrier on the line and asserts its CD. The received data is muted for 5 or 50 msec to ensure that transients do not affect the received data.
- After the RTS/CTS delay timer has expired, data is transmitted.
- Whenever the modem receives a character from the sending device or transmits any buffered character, it restarts the PTT drop delay timer.
- Once the modem stops receiving characters and the PTT drop delay timer has expired, the modem releases the radio transmitter and returns to receive mode.

This configuration can buffer 500 msec worth of characters. To prevent internal data buffer overflow, it is important that the RTS/CTS delay timer be set to a value less than 500 msec and that the computer respond immediately to an XOFF command.

No Handshaking

Basic operation and timing with data buffering (no handshaking) in a trunking system is as follows:

- The sending computer begins sending data. Data format must be 8 bits, no parity, 1 stop bit.
- Upon receiving data, the modem performs the following:
  - checks the channel for RFCTS - if the channel has been assigned already, it asserts its PTT to power up the radio's transmitter. If the channel is busy, it asserts PTT to obtain the channel and buffers the received data until the channel becomes assigned.
  - presents tones onto the channel.
  - sets its RTS/CTS delay timer.
- The receiving modem senses carrier on the line and asserts its CD. The received data is muted for 5 or 50 msec to ensure that transients do not affect the received data.
- After the RTS/CTS delay timer has expired, data is transmitted.
- Receipt of any character or transmission of any buffered character restarts the modem's PTT drop delay timer.
- Once the modem stops receiving characters and the PTT drop delay timer expires, the modem releases the radio transmitter and returns to receive mode.

This configuration can buffer 500 msec worth of characters. To prevent internal data buffer overflow, it is important that the radio system will be available within 500 msec (RTS/CTS delay plus maximum channel busy time) or the maximum amount of buffered data is less than 50 characters.