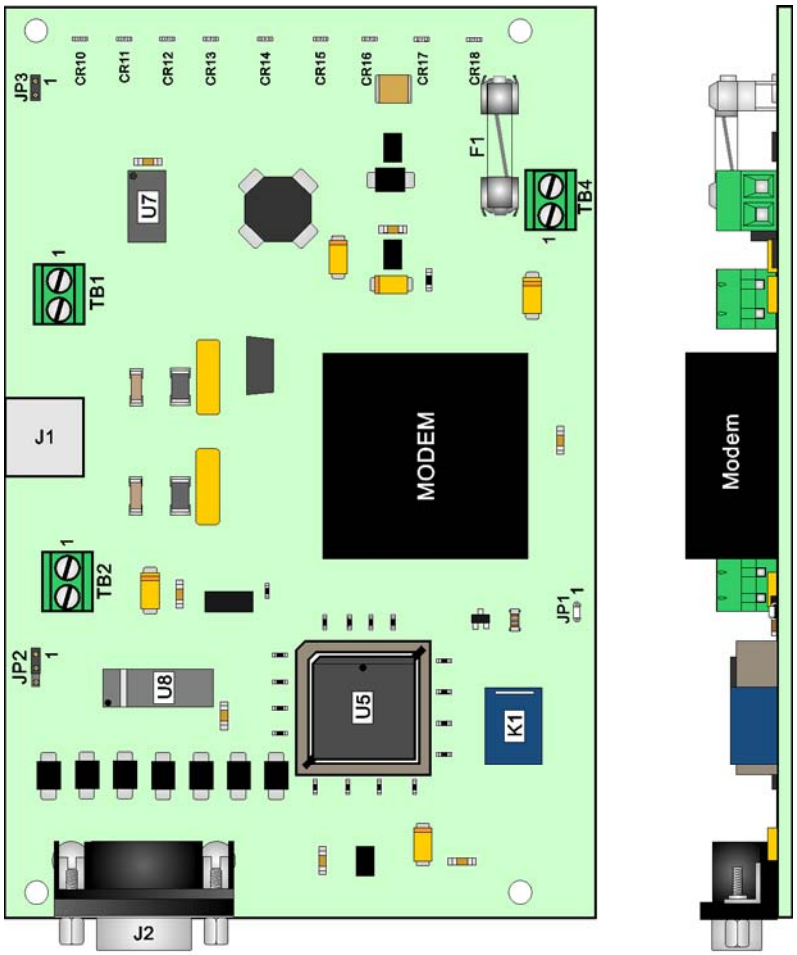
Instruction Manual
Doc Number D301734X012
December 2013

9600 bps PSTN Modem

Used with:

- **ControlWave Corrector**
- **ControlWave ExpressPAC**
- **ControlWave GFC**
- **ControlWave GFC Plus**



EMERSON
Process Management

IMPORTANT! READ INSTRUCTIONS BEFORE STARTING!

Be sure that these instructions are carefully read and understood before any operation is attempted. Improper use of this device in some applications may result in damage or injury. The user is urged to keep this book filed in a convenient location for future reference.

These instructions may not cover all details or variations in equipment or cover every possible situation to be met in connection with installation, operation or maintenance. Should problems arise that are not covered sufficiently in the text, the purchaser is advised to contact Emerson Process Management, Remote Automation Solutions for further information.

EQUIPMENT APPLICATION WARNING

The customer should note that a failure of this instrument or system, for whatever reason, may leave an operating process without protection. Depending upon the application, this could result in possible damage to property or injury to persons. It is suggested that the purchaser review the need for additional backup equipment or provide alternate means of protection such as alarm devices, output limiting, fail-safe valves, relief valves, emergency shutoffs, emergency switches, etc. If additional information is required, the purchaser is advised to contact Remote Automation Solutions.

RETURNED EQUIPMENT WARNING

When returning any equipment to Remote Automation Solutions for repairs or evaluation, please note the following: The party sending such materials is responsible to ensure that the materials returned to Remote Automation Solutions are clean to safe levels, as such levels are defined and/or determined by applicable federal, state and/or local law regulations or codes. Such party agrees to indemnify Remote Automation Solutions and save Remote Automation Solutions harmless from any liability or damage which Remote Automation Solutions may incur or suffer due to such party's failure to so act.

ELECTRICAL GROUNDING

Metal enclosures and exposed metal parts of electrical instruments must be grounded in accordance with OSHA rules and regulations pertaining to "Design Safety Standards for Electrical Systems," 29 CFR, Part 1910, Subpart S, dated: April 16, 1981 (OSHA rulings are in agreement with the National Electrical Code).

The grounding requirement is also applicable to mechanical or pneumatic instruments that include electrically operated devices such as lights, switches, relays, alarms, or chart drives.

EQUIPMENT DAMAGE FROM ELECTROSTATIC DISCHARGE VOLTAGE

This product contains sensitive electronic components that can be damaged by exposure to an electrostatic discharge (ESD) voltage. Depending on the magnitude and duration of the ESD, this can result in erratic operation or complete failure of the equipment. Read supplemental document S14006 for proper care and handling of ESD-sensitive components.

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Chapter 1 – Introduction

1.1 General Description

Emerson Remote Automation Solutions' 9600 bps - PSTN modem transmits and receives digital data at 9600 bps over "public switched telephone networks" (PSTN). The modem transfers data synchronously or asynchronously and supports the modulation schemes listed in *Table 1-1*.

This modem is used with the following ControlWave devices:

- ControlWave GFC
- ControlWave GFC Plus
- ControlWave Corrector
- ControlWave ExpressPAC (EPAC)

Table 1-1 - Configurations, Signaling Rates & Data Rates

Configuration	Modulation	Carrier Freq. (Hz) ±0.01%	Data Rate (bps) ±0.01%	Baud Symbols/Sec.	Bits Per Symbol		Constellation Points
					Data	TCM	
V.32 bis 9600	TCM	1800	9600	2400	4	1	32
V.32 bis 7200	TCM	1800	7200	2400	4	1	16
V.32 bis 4800	QAM	1800	4800	2400	4	1	4
V.32 9600	QAM	1800	9600	2400	4	1	16
V.32 4800	QAM	1800	4800	2400	4	1	4
V.22 bis 2400	QAM	1200/2400	2400	600	4	1	16
V.22 bis 1200	DPSK	1200/2400	1200	600	4	1	4
V.22 1200	DPSK	1200/2400	1200	600	4	1	4
V.22 600	DPSK	1200/2400	600	600	4	1	4
V.21 300	FSK	1080/1750	300	300	4	1	-
Bell 212A	DPSK	1200/2400	1200	600	4	1	4
Bell 103J	FSK	2225/1270(M) 2025/1070(S)	0-300	300	4	1	-

A typical example of where these modems are used in a PSTN is shown in *Figure 1-1*. This network contains four ControlWave flow computers equipped with 9600 bps - PSTN modems operating in a master/slave configuration. During operation, the master controller dials up and communicates with each slave (remote) at prescribed intervals to send and receive data. The interval of dialing is a function of the application software that is executed by the master device.

The modem's transmitter output, as measured with 600-ohm termination (typical for telephone lines) is -10 dBm (fixed). This qualifies the modem for use with any voice grade PSTN hookup in compliance with FCC loop start requirements.

The 9600 bps - PSTN modem provides the following features:

- Operates on 2-wire (loop start) switched networks (PSTN) only.
- CCITT compatibility (see *Table 1-1*.)
- Compatible with Bell 212A @ 1200 bps (600 baud) and Bell 103J @ 0-300 bps.
- Autodial/Auto-answer operation.
- Smart programming based on the Hayes “AT” command set.
- Storage of all parameters in non-volatile memory.
- Standby Mode - Consumes minimal power until activated by phone or DTE.
- MNP Class 2-4, MNP 10 & V.42 error correction.
- MNP 5 & V.42 bis data compression.
- Data access arrangement (DAA) with 1000 Vac Isolation.
- Surge withstand of 100A with 10 x 160μS waveform.
- FCC Part 68 approved.
- 0.5 Ampere fast blow fuse (F1)

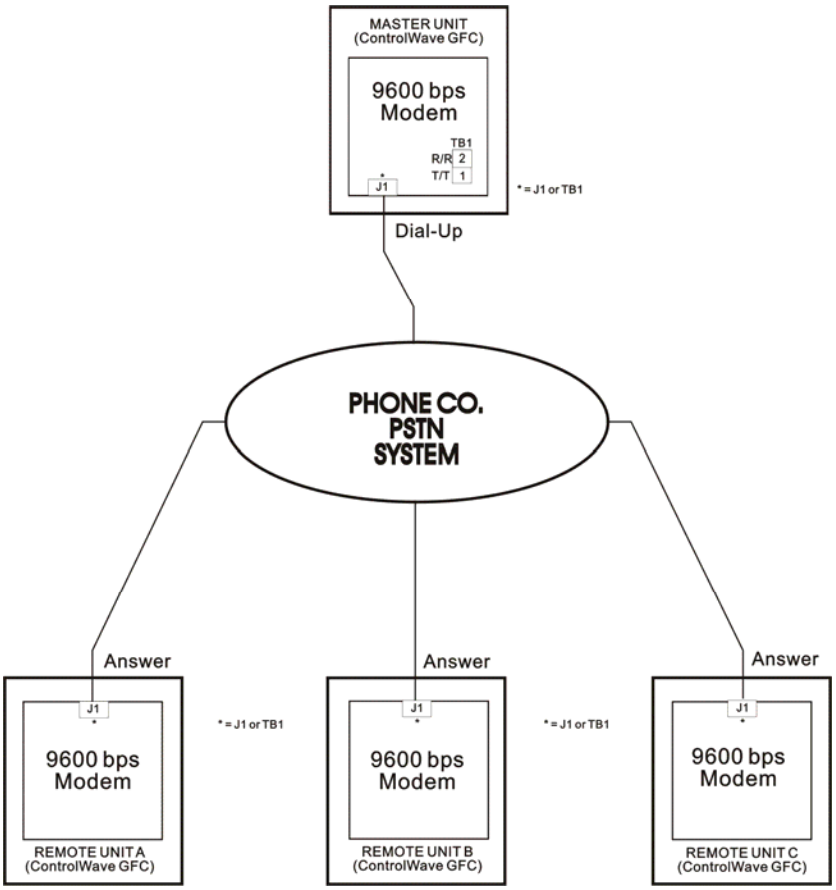
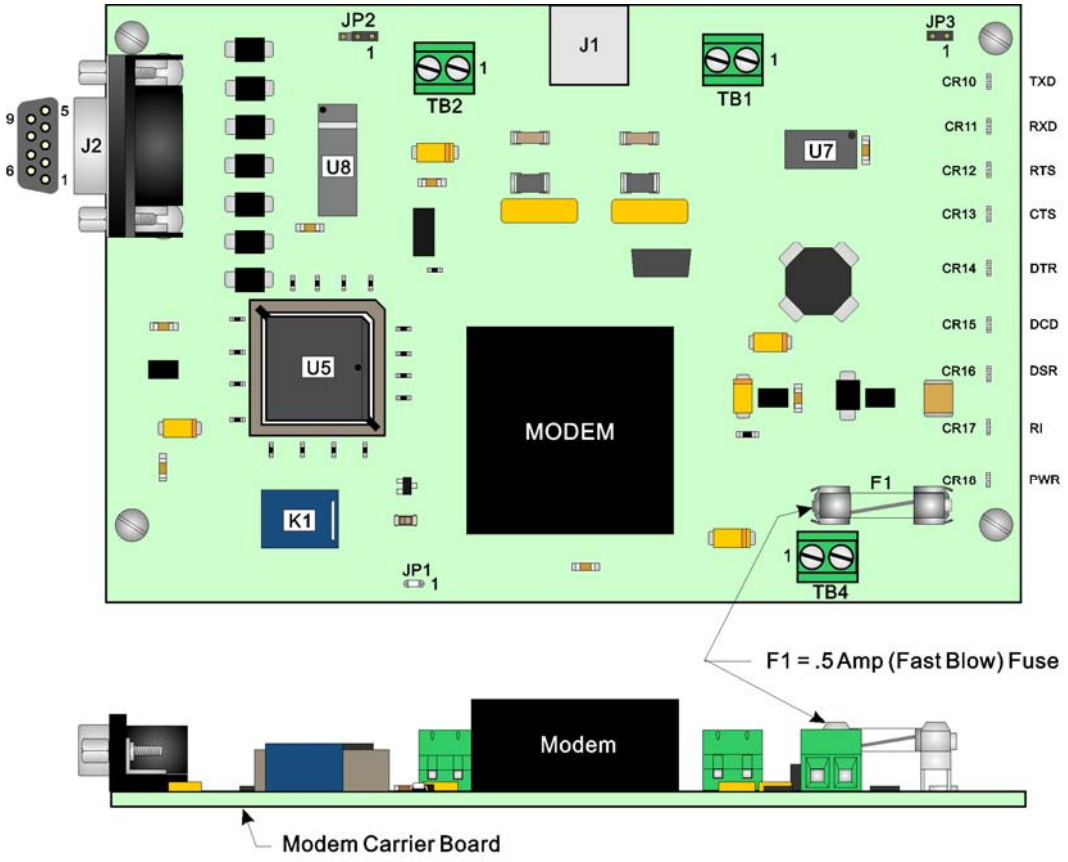


Figure 1-1. Typical 9600 BPS - PSTN Modem Network

1.2 Modem Component Identification

Modem components discussed in this manual are previewed below. These components include connectors, configuration jumpers, LEDs, fuse F1 and switch SW1.

Interconnection connectors are listed in *Table 1-2*. Specific connector pin number and signal name descriptions are provided in *Chapter 5*.



TB1 = PSTN Tip/Ring Term. Block
TB1-1 = Tip to Tip of Phone Co. Term. Block
TB1-2 = Ring to Ring of Phone Co. Term Block

TB2 = DAA Isolator Grounds Term. Block
TB2 Ground Connections are shorted together and connected to the 3530-XXX Ground Lug.

TB4 = +6/12V Input Power Terminal Block
Modem to **Control**Wave **GFC**
TB4-1 to **Control**Wave **GFC** CPU TB1-6
TB4-2 to **Control**Wave **GFC** CPU TB1-5

LEDs
CR10 = TXD - Transmit Data
CR11 = RXD - Receive Data
CR12 = RTS - Request to Send
CR13 = CTS - Clear to Send
CR14 = DTR - Data Terminal Ready
CR15 = DCD - Data Carrier Detect
CR16 = DSR - Data Set Ready
CR17 = RI - Ring Indicator
CR18 = PWR- Power

J1 = RJ11 - Primary Telephone Connector
(6-Pins - only Pins 3 & 4 are used)
J1-3 = T/R_1 to T/R_1 of RJ-11 Phone Co. Jack
J1-4 = T/R_2 to T/R_2 of RJ-11 Phone Co. Jack

J2 = RS-232 Data/Configuration Port
Modem to **Control**Wave **GFC**
J2-1 = DCD (to **Control**Wave **GFC** CPU TB3-1)
J2-2 = RXD (to **Control**Wave **GFC** CPU TB3-2)
J2-3 = TXD (to **Control**Wave **GFC** CPU TB3-3)
J2-4 = DTR (to **Control**Wave **GFC** CPU TB3-4)
J2-5 = GND (to **Control**Wave **GFC** CPU TB3-5
J2-6 = DSR
J2-7 = RTS (to **Control**Wave **GFC** CPU TB3-7)
J2-8 = CTS
J2-9 = N/A

Configuration Jumpers

Jumper JP1 - Modem Sleep Selection (Factory Setting - Fixed)
Installed = Enable Sleep Mode
Removed = Disable Sleep Mode

Jumper JP2 - RTS to CTS Loopback Selection
JP2-1 to JP2-2 = CTS from Modem (Factory Setting)
JP2-2 to JP2-3 = CTS Connected to RTS

Jumper JP3 - LED Enable Selection
Installed = Enable LEDs
Removed = Disable LEDs

Figure 1-2. 9600 PSTN Modem Assembly - P/N 400000-01-6

Table 1-2. 9600 bps Modem Connector Identification

ID	Purpose	# of Pins	Notes
J1	Telco interface	6	RJ11 pins 3 & 4 Used
J2	RS232 interface & configuration	9-Pin D-Type Connector	Standard RS-232 port
TB1	Telco interface	2-Pin TB	TB1-1 = tip, TB1-2 = ring0
TB2	DAA Iso. Gnds.	2-Pin TB	TB2-1 or TB2-2 To ControlWave GFC ground lug
TB4	Input Power	2-Pin TB	6V or 12V (dc) from ControlWave GFC CPU/system controller board

- PSTN RJ11 modem connector (J1) provides the interface to the PSTN network via a modular phone cord and the telephone company RJ11 jack.
- A 9-pin D-type connector (J2) is used for configuring the modem and as the RS-232 interface data port.
- Terminal block (TB1) (2-pin) provides the interface to the PSTN in lieu of an RJ11 cable connector.
- Terminal block (TB2) (2-pin). TB2-1 is shorted to TB2-2. TB2-1 provides the ground connection between the ControlWave device's ground lug and the modem.
- Terminal block (TB4) accommodates input power (+6/12Vdc and ground).

The 9600 bps PSTN modem contains up to three factory-set configuration jumpers. These are described in *Table 3-1*.

Chapter 2 – PC Configurable Options

The modem ships from the factory pre-configured with stored profile information.

If you want to view or change any modem parameters in the profile, you must do this using software. Configuration requires an ASCII terminal (or a PC equipped with terminal emulator software such as HyperTerminal or PROCOMM) and the modem's RS-232 configuration/data which is the 9-pin D-type connector (J2).

Notes:

- Use a standard RS-232 cable, i.e., pin 1 to pin 1, pin 2 to pin 2, etc. The RS-232 configuration/data port will not respond to configuration messages during an active phone connection
- The PC/terminal emulator must be set for 9600 bps DTE speed while configuring the modem. The modem remembers the last DTE speed at which it communicated with the terminal.
- The modem will normally (by default) force stored profile 0 to become active on power-up.

To view/verify the active and stored profiles follow these steps:

1. With the cable connected and the terminal emulation software running, type AT&V, then press ENTER. The following data should appear on screen.

```
ACTIVE PROFILE:
```

(Should match the stored profile below. Other "S" registers may be included)

```
STORED PROFILE 1:
```

```
B1 E0 L1 M1 N0 Q0 T V1 W0 X4 Y0 &C1 &D0 &G0 &J0 &K0
&Q5 &R1 &S0 &T5 &X0 &Y1 (note: &Y1 in Active Profile
ONLY)  S00:001  S02:043  S06:002  S07:050  S08:002
S09:006  S10:014  S11:095  S12:050  S18:000  S36:007
S40:104 S41:192 S46:136 S95:000
```

If you see this profile, you can skip the remaining steps.

2. If the NVRAM is not installed or is not operational as detected by the NVRAM test, the following message is displayed:

```
NVRAM FAILED OR NOT INSTALLED.
```

3. If different profile data appears, the you must enter the following command string to re-profile the modem:

```
AT&F  S0=1  &C1  &D0  &K0  %C0  E0\V1 (press ENTER)
```

```
AT +A8E=,,,0 (press ENTER)
```

```
AT&Y1  &W1 ENTER
```

4. Power down the modem and then re-apply power to ensure that Stored Profile 1 is placed into the Active Profile.
5. If re-profiling was performed repeat step 1 to observe and verify the correct profile data.

2.1.1 14.4 Kbps Operation

If desired, you can increase network performance somewhat by allowing a maximum modem line speed of 14.4 Kbps without re-profiling. You can modify the master and any or all slave nodes for this feature. Follow steps 1 through 3 below to achieve this capability:

1. Using the Flash Configuration utility, modify the speed of the ControlWave port used by the modem to at least 19.2 Kbps (38.4 Kbps maximum).
2. Using a PC running terminal emulation software such as HyperTerminal, PROCOMM, or using an ASCII terminal connected to the modem's configuration port, access each modem *at the network speed specified in the flash configuration* using the AT&V ENTER command.
3. If possible, configure the cold start default rate for each slave node, so that cold-downloads via the PSTN network are possible.

Chapter 3 – Modem Installation and Setup Procedures

Caution **Printed circuit board (PCB) components can be damaged by electrostatic discharge (ESD) during handling (disassembly, reassembly, test) Use grounded wrist straps and surface pads when working near or handling any PCB. Refer to supplement document S14006 for proper ESD grounding and handling techniques.**

The 9600 bps - PSTN modem is intended for use on the public switched telephone network (PSTN) operating in North America as illustrated in *Figure 1-1*.

The **a**uxiliary power output connector on the CPU/system controller board of the ControlWave device powers the modem. Units shipped from the factory with a modem installed have the auxiliary power output set ON in the standard application.

If you want the modem powered continuously, *and* you have since re-downloaded your standard load, *-or-* you are installing a modem for a unit which originally shipped without a modem, then you must set the auxiliary power output to ON. This can be accomplished, for standard applications, on the Radio Control Configuration page by setting the Radio Control Mode to Always On (See the *ControlWave Flow Measurement Applications Guide* (D5137)).

3.1 Installing a 9600 bps Modem into the ControlWave unit

For a ControlWave GFC (*Figure 3-3*), ControlWave Corrector (*Figure 3-4*), or ControlWave Express PAC (*Figure 3-5*), the 9600 bps PSTN modem mounts on a modem mounting plate which in turn is installed on a battery cover/radio mounting plate. See *Figure 3-1* and *Figure 3-2* to see the mounting location.

For a ControlWave GFC Plus, the 9600 bps PSTN modem mounts on a universal radio/mounting plate which in turn mounts to the fabrication panel. See *Figure 3-6* and *Figure 3-7* to see the mounting location.

To install the modem into any of these units, follow steps 1 through 14 below.

Caution **Shut down or place under manual control any critical processes controlled by the ControlWave unit.**

1. Disconnect power from the ControlWave unit.
2. Open the unit's front cover.
3. GFC, Corrector, EPAC: Loosen the four screws that secure the battery cover/radio mounting plate to the one piece/battery mounting bracket; then slide the battery cover/radio mounting plate upward and remove it. Now proceed to step 4.

   GFC Plus only: Skip to Step 4 (GFC Plus only)

4. GFC, Corrector, EPAC: Align the modem with the four standoffs on the modem mounting plate and secure it via four screws. Install the modem mounting plate (with modem installed) onto the battery cover/radio mounting plate (using four 4-40 x 1/4 screws). Install the battery cover/radio mounting plate (with modem installed) onto the one piece/battery mounting bracket (removed in step 3). Tighten the screws loosened in step 3.

   GFC Plus only: Align the modem with the four standoffs on the modem mounting plate and secure it via four (4) 4-40 x ¼" pan head screws. Install the modem mounting plate (with modem installed) onto the universal radio/modem mounting plate (using four 6-32 x 5/16 SEM screws).

5. *Configure the modem's jumpers (if not already configured) as follows:*

Table 3-1. Configuration Jumpers

ID	Purpose	Jumper Position	Notes
JP1	Modem Sleep (Power Save) selection	Installed = Enable Sleep (Power Save Mode) Removed = Disable Power Save Mode	With JP1 installed, the modem shuts off power if there is no activity for 10 seconds. The modem's power reconnects if it detects pulses at the ring indicator pin or if it detects activity at the DTR pin. Note: The modem requires 2-3 seconds after power restoration before it can receive AT commands.
JP2	RTS to CTS Loopback Selection (field configurable)	JP2-1 to JP2-2 CTS from modem (factory default) JP2-2 to JP2-3 CTS connected to RTS	
JP3	LED enable selection (field configurable)	Installed = Enable LEDs (factory default) Removed = Disable LEDs (low power mode)	

6. GFCPlus only: Using two (2) 10-32 x 3/8 pan head screws, install the universal radio/modem mounting plate (with modem installed) to the fabrication panel. Now proceed to step 7.

   GFC, Corrector, EPAC: Skip to step 7.

7. Connect the modem interface cable to TB3 (COM2) on the ControlWave's CPU/system controller board (see *Table 3-2*).

8. Connect the other end of the modem interface cable to its mating 9-pin D-type connector (J2) on the modem.

9. Connect the modem power cable to the modem as follows:

   Red wire = modem board connector TB4-1

   Blk wire = modem board connector TB4-2

10. Connect the other end of the modem power cable to the CPU/system controller board's power connector as follows:

Red wire = to J1-5 = AUX PWR

Blk wire = to J1-6 = GND

11. Circuitry associated with the telephone line interface provides over voltage and surge protection to Earth ground (via the ControlWave unit's ground lug) at modem connector TB2-1.Connect modem connector TB2-1 to the ground lug (see). Use a separate #16 AWG wire (green) to connect to the local Earth ground *(*see *Supplement Guide S1400CW - ControlWave Site Considerations for Equipment Installation, Grounding & Wiring.)*

12. Route the phone cord through the 1/2"(GFC, GFC Corrector, EPAC) 1" (GFCPlus) on conduit fitting on the bottom of the ControlWave unit. Install the cord far enough to accommodate connection of the wires to the modem.

13. Connect one end of the modular phone cord to the modem's modular RJ-11 connector J1. Connect the other end of the modular phone cord to the wall jack provided by the phone company (see *Section 3.2*). Connections to the modem are J1-3 = PSTN-tip and J1-4 = PSTN-ring. If the unit is to be hardwired to the phone line, use connector TB1 as follows: TB1-1 = PSTN-tip, TB1-2 = PSTN-ring.

14. Install the violet jumper wire between TB3-7 and TB3-8 on the CPU/system controller board (RTS to CTS loopback).

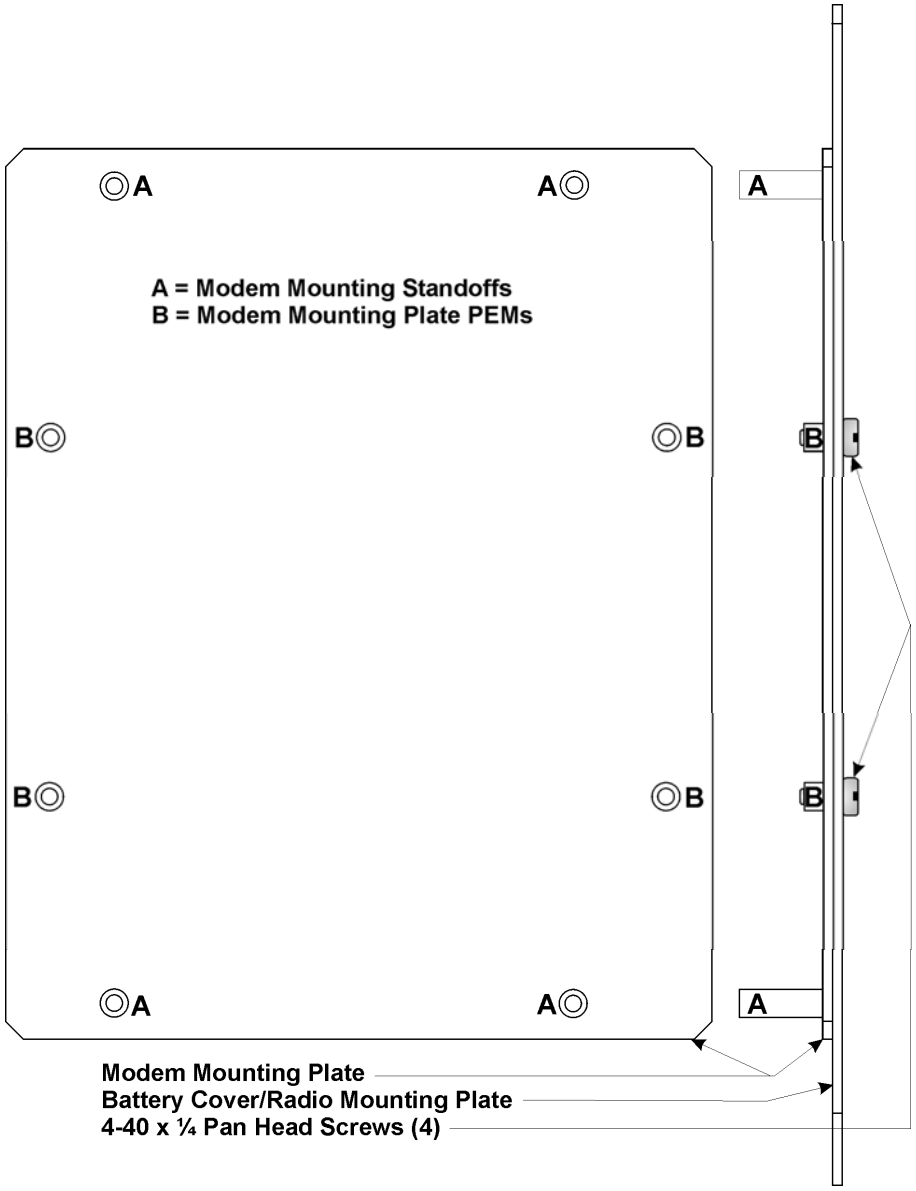


Figure 3-1. Modem Mounting Plate and Battery Cover/Radio Mounting Plate (GFC, Corrector, EPAC)

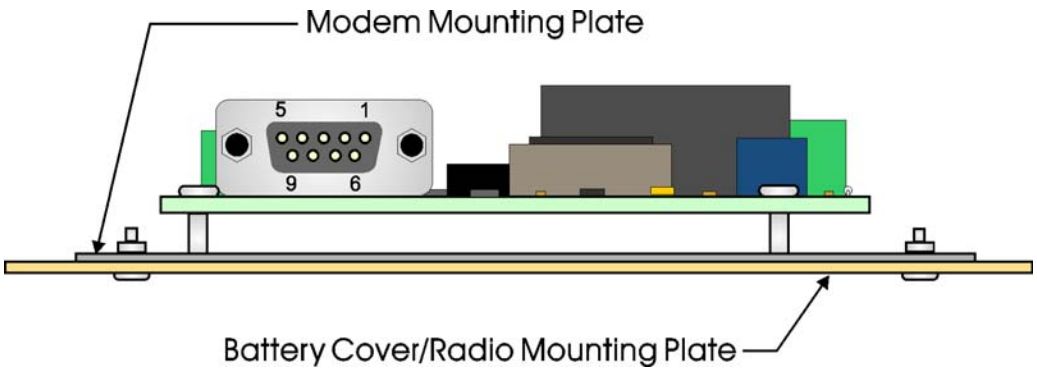


Figure 3-2. Modem Installed on Battery Cover/Radio Mounting Plate (GFC, Corrector, EPAC)

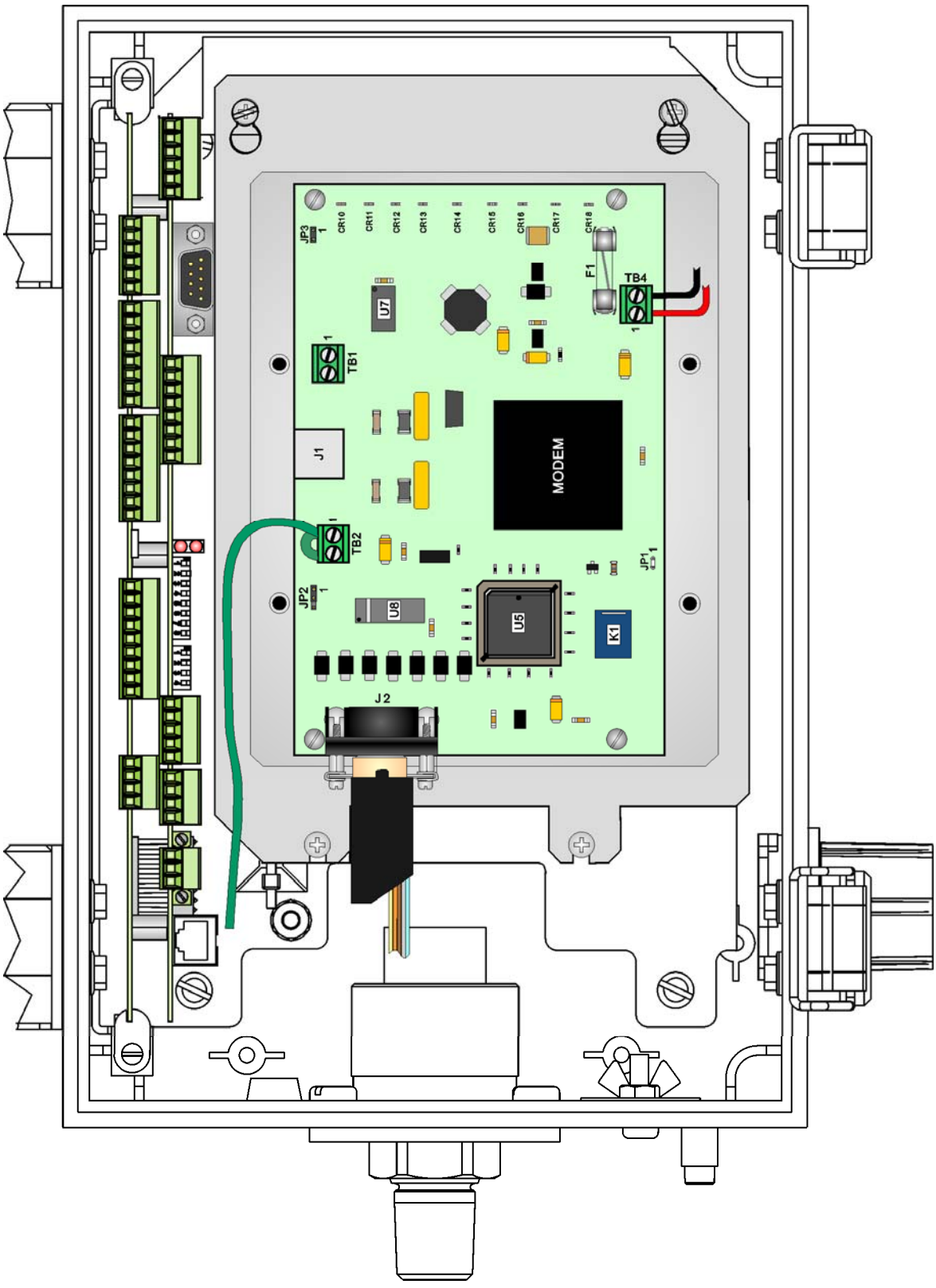


Figure 3-3. 9600 bps - PSTN Modem Installed in ControlWave GFC (Front View)

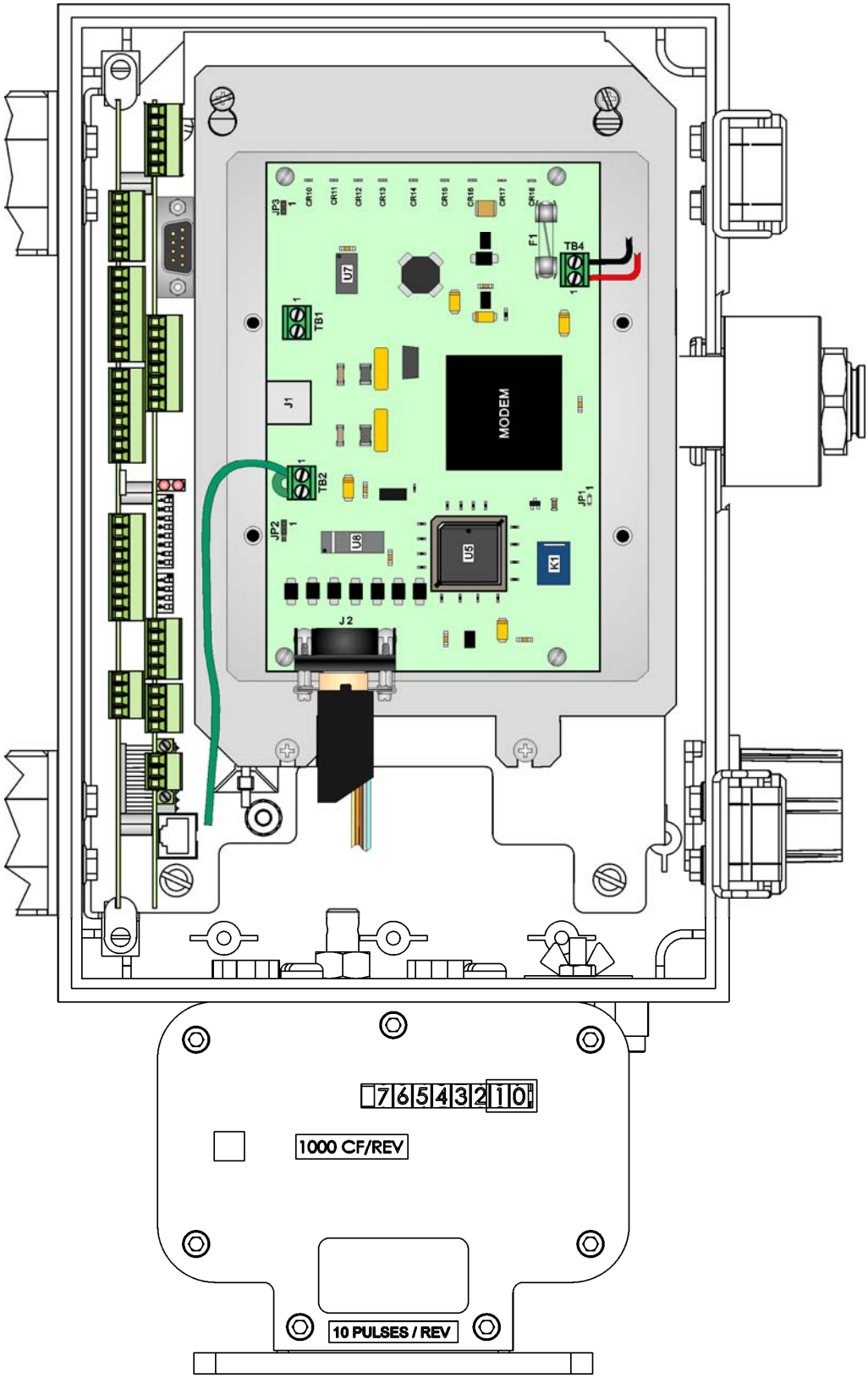


Figure 3-4. 9600 bps - PSTN Modem Installed in ControlWave Corrector (Front View)

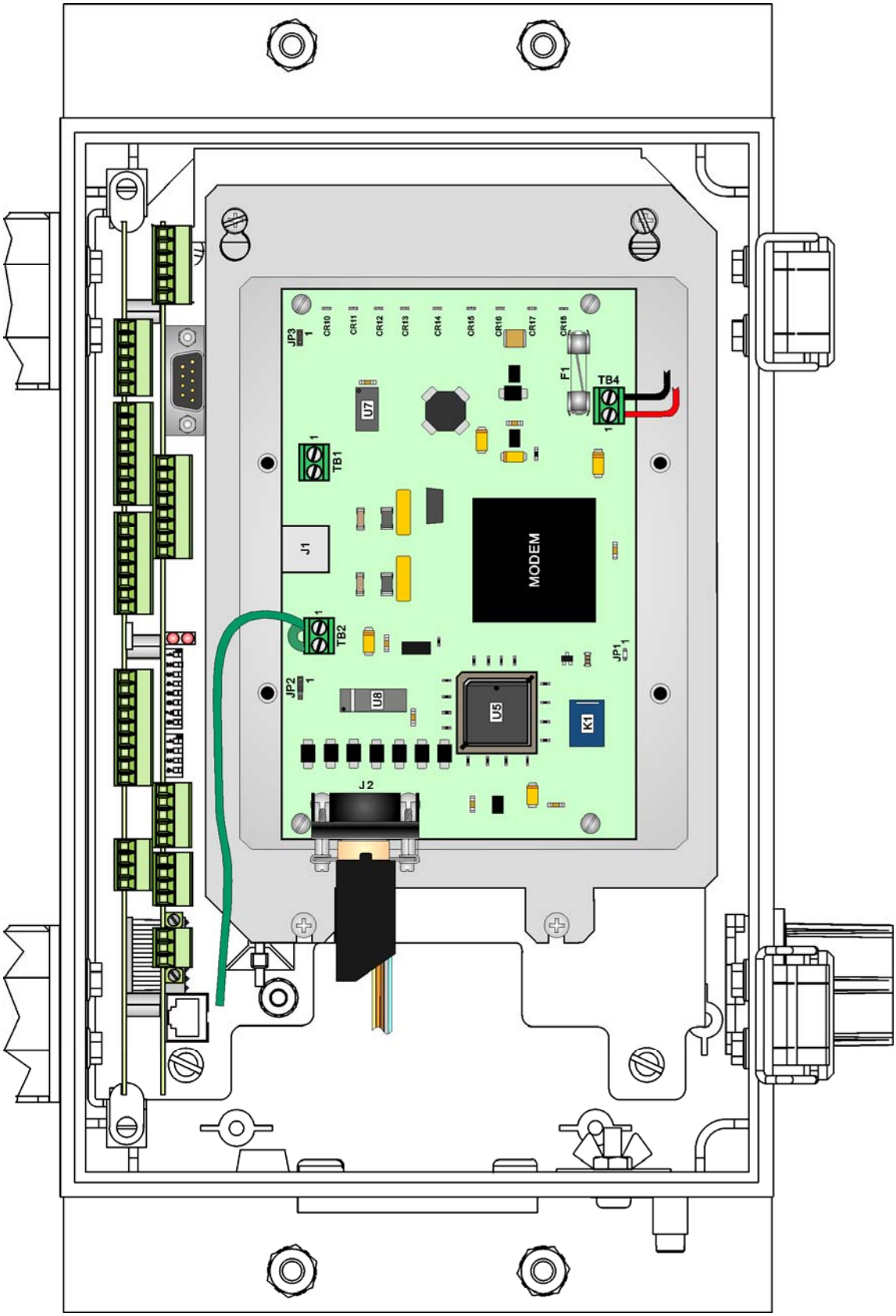


Figure 3-5. 9600 PSTN Modem Installed in ControlWave EPAC (Front View)

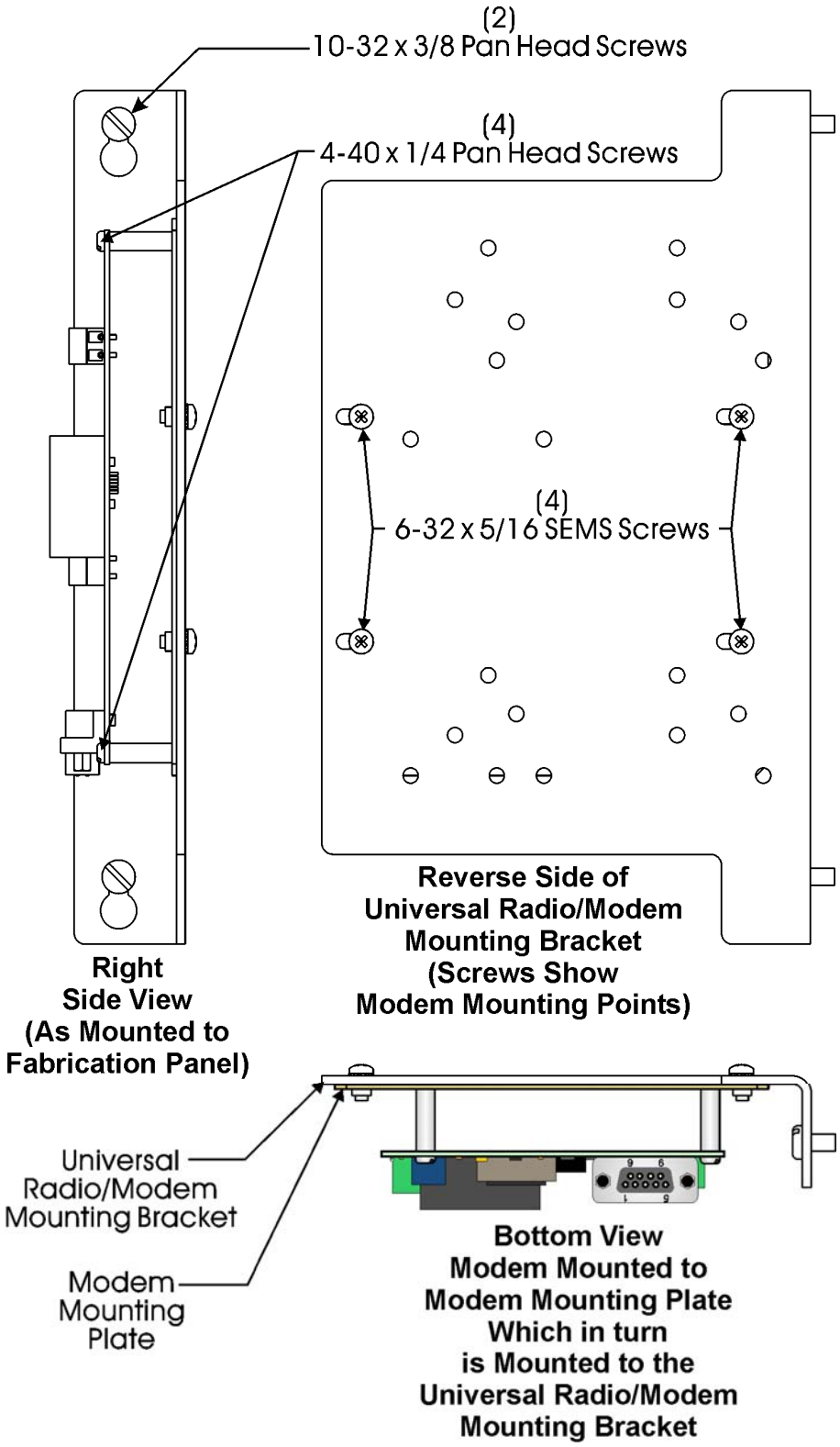


Figure 3-6. Modem Installation Diagram (GFC Plus) - Modem mounted to Modem Mounting Plate, Modem Mounting Plate mounted to Universal Radio/Modem Mounting Bracket which in turn is mounted to the Fabrication Panel

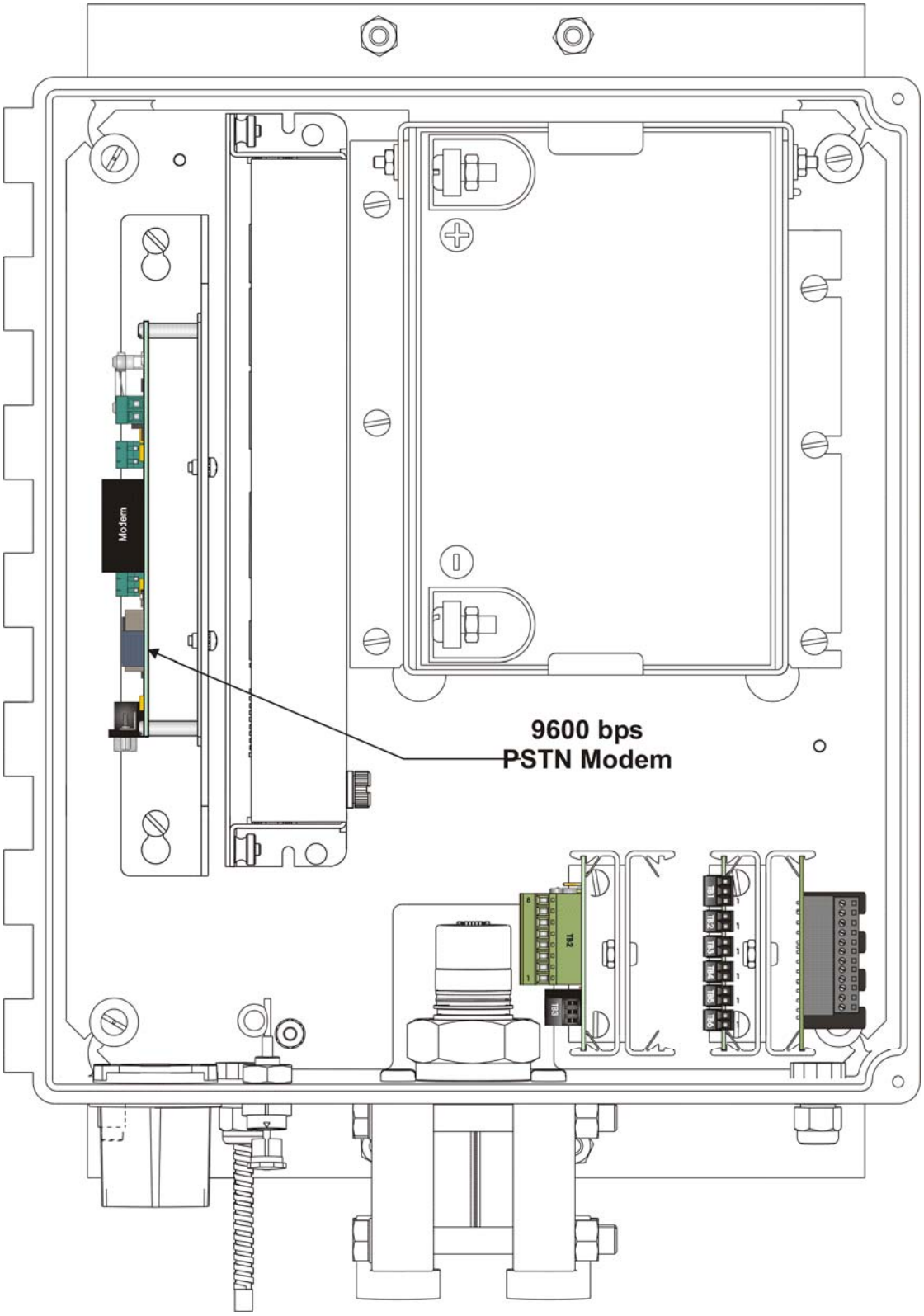


Figure 3-7. 9600 bps - PSTN Modem Installed in ControlWave GFC Plus (Front View)

Table 3-2. Wiring Listing

CW CPU Board Connector & Signal	Signal Direction	Modem Connector & Signal	Port Usage	Wire Color
TB3-3 (TXD)	To Modem	J2-3 (TXD)	RS-232	Brown
TB3-2 (RXD)	From Modem	J2-2 (RXD)	RS-232	Blue
TB3-4 (DTR)	To Modem	J2-4 (DTR)	RS-232	Yellow
TB3-7 (RTS)	To Modem	J2-7 (RTS)	RS-232	Orange
TB3-8 (CTS)			RS-232	*
TB3-1 (DCD)	From Modem	J2-1 (CD)	RS-232	Gray
TB3-5 (GND)		J2-5 (GND)	Ground	Green
TB1-5 (AUXPWROUT)	To Modem	TB4-1 (EXTVDC)	Power	Red
TB1-6 (PWRGND)		TB4-2 (GND)	Pwr Gnd	Black

*** Note: Install a jumper wire between RTS and CTS on the CPU/system controller board.**

3.2 PSTN Hookup

A PSTN using a master and three (3) remote ControlWave flow computers (each equipped with a 9600 bps - PSTN modem) is shown in *Figure 1-1*. You typically make the connection to the PSTN using a cable that has standard telephone connectors at both ends. Plug one end of the cable into connector J1 of the modem and plug the other end into a telephone wall receptacle. In some cases wires associated with a phone cable (un-terminated at one end - see *Figure 3-8*) may be plugged into modem connector TB1 (TB1-1 = PSTN-tip & TB1-2 = PSTN-ring). The telephone company provides the necessary subscriber loops at its central system along with the phone numbers for each destination.

Caution **Only connect one modem to each drop. If you attempt to make connect two or more modems in parallel across a single drop, the impedance mismatch will adversely affect the signal quality. Modems will not provide reliable communications under these conditions.**

An application consisting of a single master and a single remote requires only one of the remote connections shown in *Figure 1-1*.

The 9600 bps - PSTN modem is FCC-approved for use with public telephone lines. Before placing a modem in operation, check the following items to ensure that all FCC requirements are met:

- Connections to party line service is subject to state tariffs.
- Connection to telephone company provided coin service (central office implemented systems) is prohibited.
- The equipment compliance information is summarized as follows:

  Complies with Part 68 FCC Rules.

Contains device with FCC Registration Number: B46USA-30667-F-A-E

Ringer Equivalence Number (REN): 6B

Note: The sum of all the RENs on your telephone lines should be less than five in order to assure proper service from the telephone company. In some cases, a sum of five may not be usable on a given line.

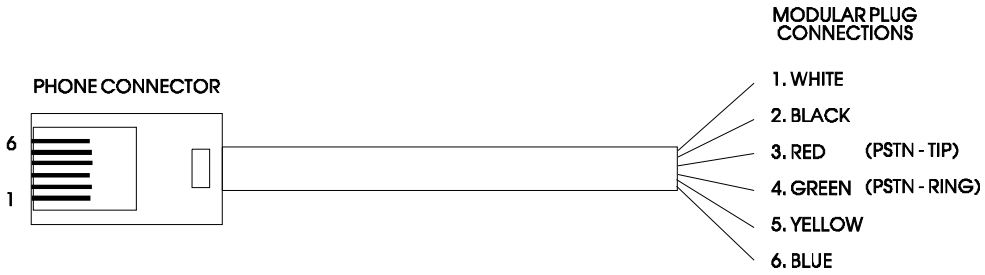


Figure 3-8. Wiring for Phone Connector

- Any direct connections to PSTN lines must be made through standard plugs and jacks as specified in the FCC rules. The PSTN line is connected to the modem via either a cable equipped with an appropriate phone plug (into modem connector J1) or an open-ended cable that is hardwired to modem connector TB1. Notify your telephone company that the jack required for your device is one of the following:

  USOC:FJ45S

  USOC:RJ11C

Note: The Jack provided on the Modem (J1) is a 6-Pin TelCo RJ-11. Connections to the modem are Pin 3 PSTN-tip, and Pin 4 PSTN-ring. Two position terminal block (TB1) is also provided; connections to the modem are TB1-1 = PSTN-tip & TB1-2 = PSTN-ring.

- After the telephone company installs the above jack, connect the modem to your equipment by inserting the appropriate equipment interface cable (plugs) into the modem jack (or terminal block) and the wall jack.

3.2.1 If Telephone Equipment Problems Arise

If any of your telephone equipment is not operating properly, you should immediately remove it from your telephone line, as it may cause harm to the telephone network. If the telephone company notes a problem, they may temporarily disconnect service. When practical, they will notify you in advance of this disconnection. If advance notice is not feasible, you will be notified as soon as possible. When you are notified,

you will be given the opportunity to correct the problem and informed of your right to file a complaint with the FCC. Contact your telephone company if you have any questions about your phone line. In the event that repairs are ever needed on the 9600 bps - PSTN modem, contact Emerson Remote Automation Solutions for a return authorization (RA) number.

Chapter 4 – Modem Diagnostics

⚠ **Caution**	**Printed circuit board (PCB) components can be damaged by electrostatic discharge (ESD) during handling (disassembly, reassembly, test) Use grounded wrist straps and surface pads when workingnear or handling any PCB. Refer to supplement document S14006 for proper ESD grounding and handling techniques.**

4.1 Escape Code Sequence

When the modem establishes a connection and enters on-line data mode, it is possible to break into the data transmission in order to issue further commands to the modem in an on-line command mode. This is achieved by the DTE sending the modem a sequence of three (3) ASCII characters specified in register S2. The default character is '+'. The maximum time allowed between receipt of the last character of the three escape character sequence from the DTE and sending of the OK result code to the DTE is controlled by register S12.

4.2 Loopback and Line Signal Tests

AT&Tn commands form part of the CCITT V.54 protocol and can be used for diagnostic testing**.**

Note: &Tn commands can only be used when the modem is configured for &Q0 <CR> (unbuffered/direct asynchronous mode).

There are four loopback configurations that can be used to aid in troubleshooting modem/line problems:

- Local Analog Loopback (see *Figure 4-2*)
- Local Digital Loopback (see *Figure 4-3*)
- Remote Digital Loopback with Local Self Test (see *Figure 4- 4*)
- Local Analog Loopback with Self Test (see *Figure 4-5*)

The following tests can be done but communication between the master and slave units has to be stopped as follows:

1. Connect to the modem using terminal emulation software (such as HyperTerminal or PROCOMM, or an ASCII terminal at 9600 bps:
2. Type ATDT and the number that you want to dial.
3. Wait for a connect at 9600 bps (or less) then type +++ to put the modem into the Command Mode.
4. Wait for O.K., then type AT%L%Q.

4.2.1 Line Signal Level Command (%L)

The AT%L provide a means of determining the received signal level.

The **%L** command causes the modem to return a value which indicates the received signal level at the modem data pump interface. The value is determined by the loss/gain of the modem Telco interface circuit (□bB) at the tip/ring input to the modem (**not** at the telephone line connector). For example, 009 = -9 dBm, 043 = -43 dBm, and so on. Typical values should be -25dBm to -35dBm for most Telco connections.

Results Code: OK

4.2.2 Line Signal Quality Command (%Q)

The AT%Q command causes the modem to report information about the line signal quality.

The **%Q** command causes the modem to report the line signal quality (DAA Telco Interface dependent) at the modem data pump interface. The modem returns the higher order byte of the Eye Quality Monitor (EQM) value. Typical value should be below 10. The lower the number, the better the performance of the modem. Based on the EQM value, retrain or fallback/fall forward may be initiated if enabled by %E1 or %E2.

Example:

```
AT%Q

015
```

Results Codes:

OK	If connected.
ERROR	If not connected, or connected in 300 bps, V.23, or fax modes (N/A).

4.2.3 Connection Failure Reason Code Register (S86)

S-Register S86 can help you to determine the cause of a connection failure. When the modem issues a NO CARRIER result code, a value is written to this register. To read this register, following the connection failure, issue ATS86?<CR>. The modem will report a Call Failure Reason Code. The following cause codes are associated with register S86:

0	Normal disconnect, no error occurred.
4	Loss of carrier.
5	V.42 negotiation failed to detect an error-correction modem at the other

	end.
6	Other error-control modem did not respond to feature negotiation message sent by this modem.
7	Other modem is synchronous-only; this modem is asynchronous-only.
8	Modems could not find a common framing technique.
9	The modems could not find a common protocol.
10	Feature negotiation message sent by other modem is incorrect.
11	Synchronous information (data of flags) not received from other modem.
12	Normal disconnect initiated by the remote modem.
13	Remote modem doesn't respond with 10 re-transmissions of the same message.
14	Protocol violation occurred.
15	Compression failure.

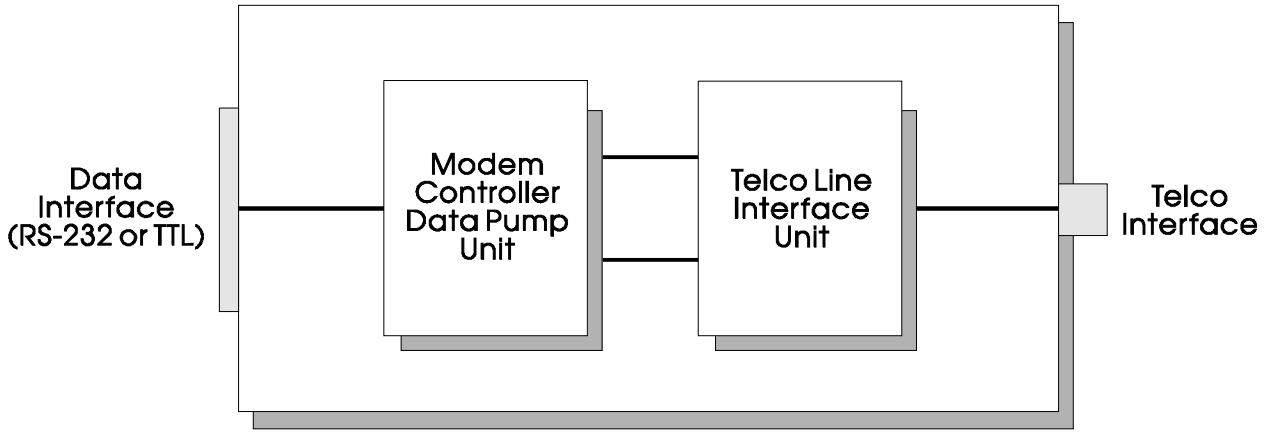


Figure 4-1. Typical Modem Configuration

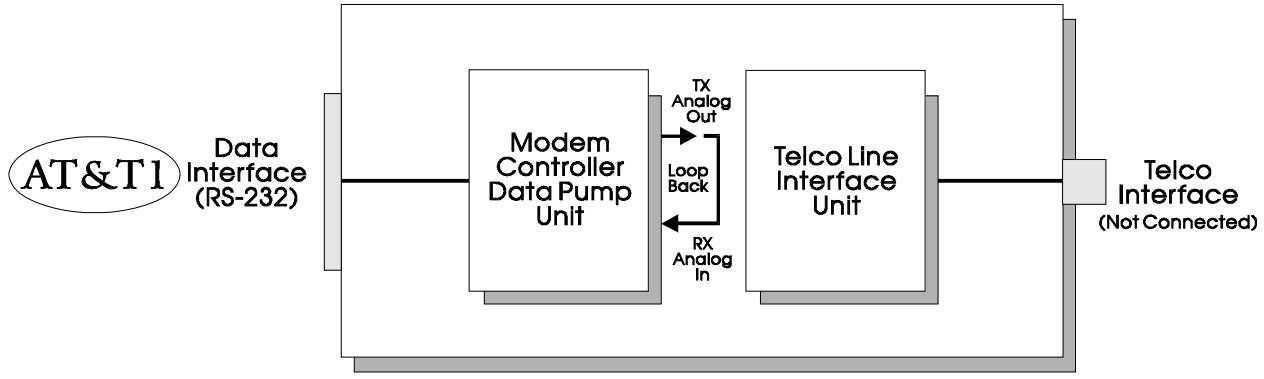


Figure 4-2. Initiate Local Analog Loopback Diagram

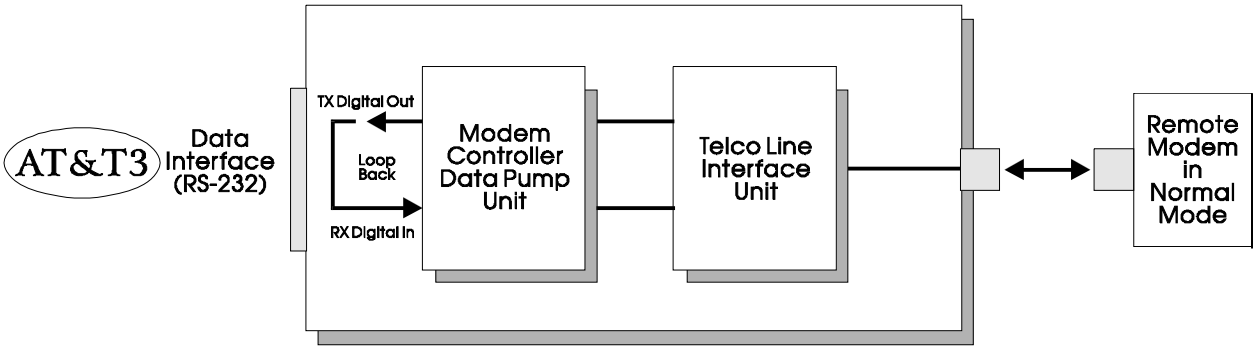


Figure 4-3. Perform Local Digital Loopback Diagram

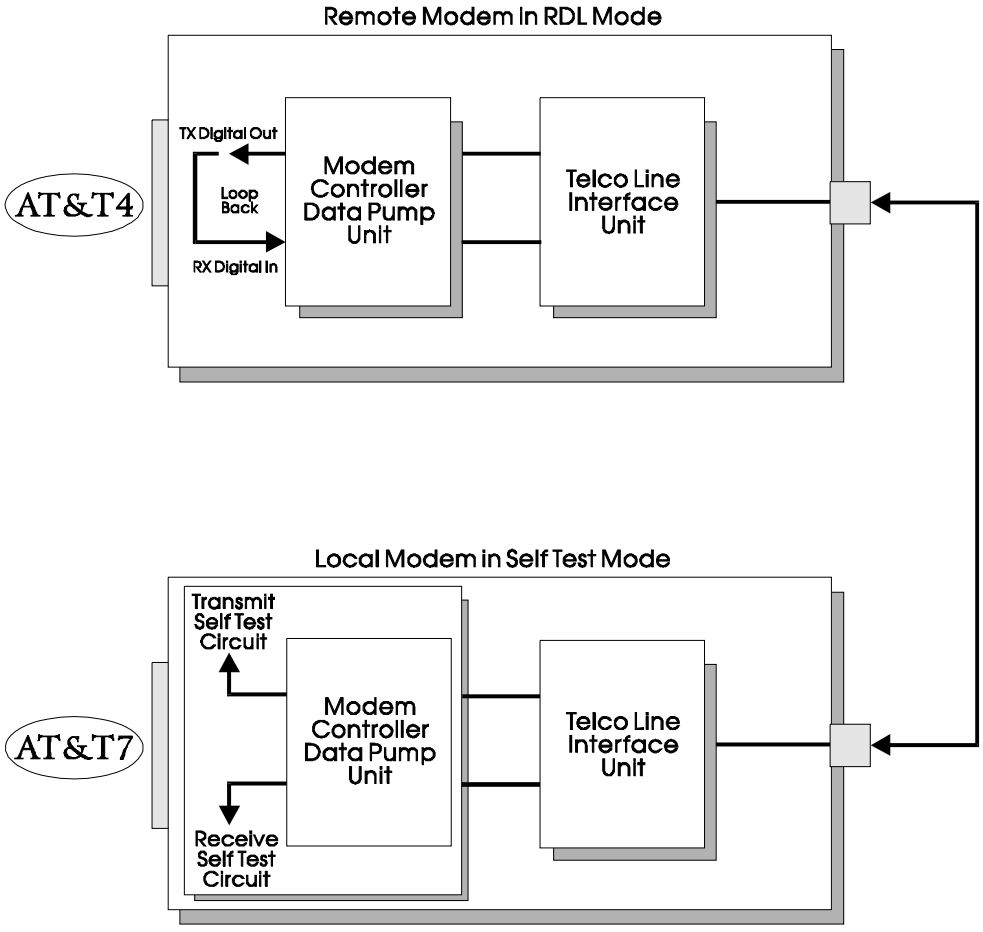


Figure 4- 4. Remote Digital Loopback with Local Self Test

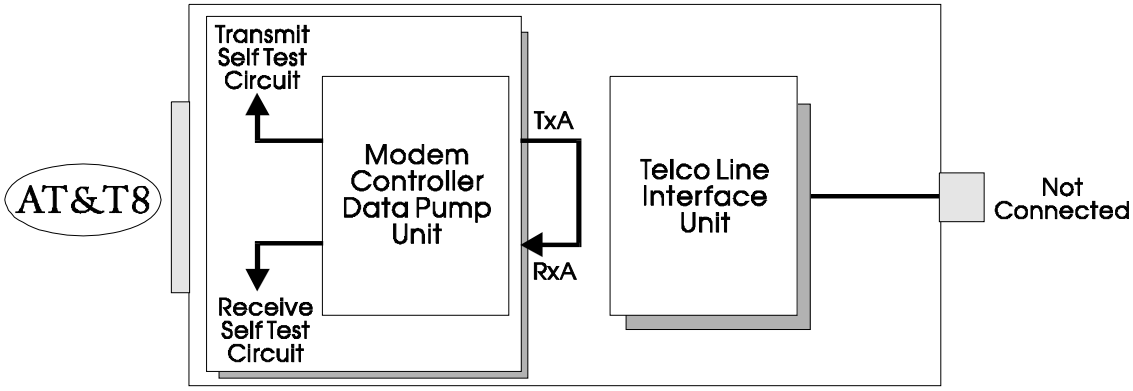


Figure 4-5. Local Analog Loopback with Self Test

4.2.4 Test and Diagnostic Command (&Tn)

The modem performs selected test and diagnostic functions according to the parameter supplied. A test can be run only when in an asynchronous operation in non-error correction mode (normal or direct mode). To terminate a test in progress, enter the escape sequence first, except for parameters 7 and 8 (see Escape Code Sequence *Section 4.1*). If S18 is non-zero, a test terminates automatically after the time specified by S18 and displays the OK message. **&Tn** commands are formatted and function as follows:

AT&T0	Terminate Test in Progress	Terminate test In progress and clear register S16. If a V.54 loopback test is in process (as a result of executing an &Tn command), the &T0 command will cause the test to be terminated provided that the modem is in command state, or a V.54 state that accepts commands from the DTE.
AT&T1	Initiate Local Analog Loopback	Initiate local analog loopback, V.54 Loop 3. Sets S16 bit 0. If a connection exists when this command is issued, the modem hangs up. The CONNECT XXXX message is displayed upon the start of the test. When the AT&T1 command is entered, the modem goes on hook and configures itself for analog loopback. DSR is turned OFF (if &S1 is in effect), the analog loopback state is entered, and the test timer is set to the value in S18 (10 seconds). A connect result code is sent to the DTE, and the test timer then begins its count down. The test is terminated when the test timer expires. **Results Code Description** CONNECT — When local analog loopback state is entered. ERROR — If any other &Tn test is active (except &T0) or if in the on-line command state. OK — After test is stopped by the test timer, the HO command, or the &T0 command.
AT&T2		No Function.

AT&T3	Perform Local Digital Loopback	Perform local digital loopback, V.54 Loop 2. Sets S16 bit 2. If no connection exists when this command is issued, ERROR is returned. Sets register S16 bit 4 when the test is in progress. The modem must be in the command state (after connection is established) when this command is issued, otherwise an ERROR result code will occur. The AT&T3 command establishes a loopback of received data, after demodulation, and sends it back to the distant end. The modem is configured for local digital loopback, DSR is turned OFF (if &S1 is in effect), the test timer is started with the value in S18 (10 seconds), and an OK result code is sent to the DTE. **Results Code** — **Description** CONNECT — After 2 second delay. ERROR — If any other self test is active (&T1, &T6, &T7 or &T8) or if in idle state. OK — When test is terminated.
AT&T4	Grant Remote Digital Loopback (RDL) Requests	Grant remote digital loopback (RDL) requests - Enables digital loop-back acknowledgment for remote request, i.e., an RDL request from a remote modem is allowed. Sets register S23 bit 0 (Factory Default). When in the on-line state, the modem will honor a remote digital loopback request from a distant modem if it occurs. This will result in an ERROR if the command is given while any V.54 test is active (&T1, &T3, &T6, &T7 or &T8). N*OTE: There are data patterns that may cause a Remote Digital Loopback condition. Care should be given to the type of data being received so that no RDL modes will be initiated.*
AT&T5	Deny RDL Request	Deny RDL request - Clears register S23 bit 0 (Profile Default). the modem will not respond to a remote digital loopback request from a distant modem. This will result in an error if the command is given while any V.54 test is active (&T1, &T3, &T6, &T7 or &T8).
AT&T7	Initiate a Remote Digital Loopback (RDL) With Local Self Test	Initiate a remote digital loopback (RDL) with local self test - V.54 loop 2, with self test. (In self test, a test pattern is looped back and checked by the modem.) If no connection exists, ERROR is returned. The test is terminated after the expiration of S18 (10 seconds) and the number of detected errors is reported to the DTE. Register S16 bit 5 will be set when the test is in progress. This is a system test, end to end. The command is valid if the modems are in the command state with a connection established. Configure the remote modem with an AT&T4 command so that it will honor an RDL request. Enter AT&T7 at the local modem and it will send a digital loopback request to the remote modem. After the RDL acknowledgment signal has been received from the remote modem, DSR is turned OFF (if &S1 is in effect), the on-line state is entered, an OK result code is sent to the DTE, and the test timer is set to the value in S18 (10 seconds). While the test is active, the local modem sends a test message to the remote modem and counts the errors in the received (looped back) signal. The modems stay in the command state during the test. When the test is terminated (except by a loss of carrier), the local modem sends the release signal to the remote modem, as in &T6, and reports the three-digit error count to the DTE. The information text is followed by an OK result code. The test is terminated by the S18 timer running out. **Results Code** — **Description** OK — When command executed is started.

		OK	After error count is sent to DTE (&T1, &T3, &T6, &T7 or &T8).
		ERROR	If not in the on-line command state.
		ERROR	If the RDL signal is not acknowledged.
AT&T8	Local Loopback With Self Test	Local loopback with self test - Initiates local analog loopback, V.54 Loop 3, with self test. (In self test, a test pattern is looped back and checked by the modem). If a connection exists, the modem hangs up before the test is initiated. When the test is terminated either via expiration of S18, or via the &T0 or H command, the number of detected errors is reported to the DTE. Sets register S16 bit 6 when the test is in progress. This command may not be available in some countries due to PTT restrictions. The modem should be on hook. Enter AT&T8 to configure the modem for analog loopback and self test. The test timer is started at the time indicated by S18 (10 seconds), DSR is turned OFF (if &S1 is in effect). A self test condition is entered, and an OK result code is sent to the DTE. During the test, the modem sends a test message and counts the errors in the looped back signal. The test is terminated when the timer (S18) times out. When the test is terminated, the three digit error count is sent to the DTE. An OK result code follows the error count.	
		Results Code	**Description**
		OK	If a test state is entered.
		OK	After error count is sent to DTE.
		ERROR	If any other V.54 test is active (&T1, &T3, &T6, &T7) or if on-line.

4.3 Modem LEDs

The 9600 bps - PSTN modem contains nine (9) LEDs. When Jumper JP3 has been removed, these LEDs are disabled. These LEDs function as follows:

Table 4-1. Modem LEDs

Board ID	Label	Function	Description
CR10	TXD	Transmit Data	When lit this LED indicates transmitting activity. Both MARK and SPACE data (TXD) from the host device (DTE) are sent to the local modem (DCE) at J2-3.
CR11	RXD	Receive Data	When lit this LED indicates receiving activity. Both MARK and SPACE data (RXD) are being sent from the local modem to the host at J2-2.
CR12	RTS	Request to Send	When lit this LED indicates that the host is ready to send data to the local modem.
CR13	CTS	Clear to Send	When lit this LED indicates that the local modem has signaled the host that it is clear to receive data. CTS is

			issued in response to an RTS.
CR14	DTR	Data Terminal Ready	When lit this LED indicates that the host has activated the local modem.
CR15	DCD	Data Carrier Detect	When lit this LED indicates that the local modem detects the presence of a carrier from a remote modem.
CR16	DSR	Data Set Ready	When lit this LED indicates that the local modem is ready to send or receive data to/from the remote modem.
CR17	RI	Ring Indicator	When lit this LED indicates that the modem detects a ring on the phone line.
CR18	PWR	Power	When lit this LED indicates the modem has power.

Chapter 5 – Specifications

5.1 Operating Specifications

Function:	Provides PSTN (Public Switched Telephone Network) communications.
Operating Modes:	Sync. or Async. 2-wire switched network - Half or Full Duplex.
Line Type:	Two-wire loop start lines.
Modem Configuration:	"AT" based commands.
Data Rate:	V.32 bis - 9600 bps, V.32 - 9600 bps, V.22 bis - 2400 bps, V.22 - 1200 bps or 600 bps, V.21 - 300 bps. Bell 103J - 300 bps, Bell 212A - 1200 bps.
Telephone Functions:	Dialing and answering by AT commands. Automatic answering is also programmable.
Approvals:	Telephone - FCC Part 68. (also suitable for approval within Canada).
Trans. Output Levels:	-10 dBm fixed (USA) - (0-15 dBm adjustable - firmware dependent).
PSTN Arrangements:	Loop Start arrangement (transmission output does not exceed -10 dBm). Allows connection to any voice telephone jack.
Isolation:	Data Access Arrangement (DAA) with 1000 Vac (Modem to PSTN).
Sleep Mode Current:	0.5mA (max) @ 12V (Input Voltage) 1.0 mA (Max) @ 6V (Input Voltage)
Surge Capability:	Withstand surge of 100A with 10 x 160μS waveform.

5.2 Environmental Specifications

Temperature:	Operating Range: -40° to +60°C (-40° to 140°F) Storage Range: -40°to +85°C (-40°to 185°F)
Relative Humidity:	15% to 90% (Non-condensing)
Vibration:	1g for 10-500 Hz on any axis per SAMA PMC-31-1 without damage or impairment.
RFI Susceptibility:	Meets susceptibility requirements of IEC 1000-4-6 level 2 (3V/M) from 150kHz to 80MHz.
EMI Radiated:	Field connected circuits have been designed to meet the requirements of IEC 1000-4-3 for radiated emissions.

ESD Susceptibility:	Field connected circuits have been designed to meet the requirements of IEC 1000-4-2 for ESD withstand capability up to 15KV.
Surge Susceptibility:	Field connected circuits have been designed to meet the requirements of ANSI/IEEE C37.90.1-1989 (Formally IEEE 472) for surge withstand capability.

5.3 FCC & UL Approvals

Telephone Interface:	FCC Part 68.
Environment:	UL listed (pending) for use in Class I, Division 2, Groups A, B, C and D hazardous locations.

5.4 Modem Connectors

5.4.1 Connector J1

PSTN RJ11 modem connector (J1) provides the interface to the PSTN network via a modular phone cord and the Telephone Co. RJ11 jack.

Table 5-1. Primary Telephone RJ11 Connector - J1

J1 Pin #	Signal Name	Description	Input/Output
1	N/A	Not Used	---
2	N/A	Not Used	---
3	T/R_1 (PSTN-tip)	Transmit/Receive	I/O
4	T/R_2 (PSTN-ring)	Transmit/Receive	I/O
5	N/A	Not Used	---
6	N/A	Not Used	---

5.4.2 Connector TB1

PSTN modem connector (TB1) provides tip/ring interface to the PSTN via screw mount terminals (in lieu of connector J1).

Table 5-2. PSTN Connector - TB1

TB1 Pin #	Signal Name	Description	Input/Output
3	PSTN-Tip	Transmit/Receive	I/O
4	PSTN-Ring	Transmit/Receive	I/O

5.4.3 Connector J2

A 9-pin D-Type connector for modem configuration and/or DTE/Modem interfacing. These connectors are used for configuring the modem with an ASCII terminal or a terminal emulation program (such as PROCOMM Plus or SMARTCOM) and as the RS-232 data port

Table 5-3. RS-232 Data/Configuration Port D-Type Connector J2

J2 Pin #	Signal Name	Description	Input/Output
1	DCD	Data Carrier Detect	O
2	RXD	Receive Data	O
3	TXD	Transmit Data	I
4	DTR	Data Terminal Ready	I
5	GND	Ground	---
6	DSR	Data Set Ready	O
7	RTS	Request To Send	I
8	CTS	Clear To Send	O

Note: Pin 9 is not used.

5.4.4 Connector TB2

Terminal Block (TB2) is provided for ground (GND) connections.

Table 5-4. Ground Connector TB2

TB1 Pin #	Signal Name	Description	Connection
1	Chassis Ground	Ground	Connect to DTE Ground Lug.
2	Surge Ground	Ground	Connect to DTE Ground Lug.

5.4.5 Connector TB4

Power Terminal (TB4) provides screw mount terminals for unregulated power (+5.4 to +16Vdc and ground).

Table 5-5. - Unregulated Power Connector -TB4

TB1 Pin #	Signal Name	Description	Input/Output
1	EXTVDC	Unregulated Power Input (+5.4 to +16 VDC)	I
2	GND	Ground	---

Glossary

CTS	Clear to Send - the local modem signals the host that it is ready to receive data. This is issued in response to an RTS signal from the host.
DCD	Data Carrier Detect – the local modem signals that it detects the presence of a carrier from the remote modem.
DCE	Data Communications Equipment
DPSK	Differential Phase Shift Keying
DSR	Data Set Ready – the local modem signals it is ready to send/receive data from the remote modem.
DTE	Data Terminal Equipment
DTR	Data Terminal Ready – The host has activated the local modem.
FSK	Frequency Shift Keying
PSTN	Public Switched Telephone Network
QAM	Quadrature Amplitude Modulation
RI	Ring Indicator – the modem detects a ring on the phone line
RTS	Request To Send – a signal from the host to the modem that the host is ready to send data to the modem.
RXD	Receive Data – receive activity in progress.
TCM	Trellis-Coded Modulation
T/R	Transmit / Receive
TXD	Transmit Data – transmit activity in progress.

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