

# **RFSK MODEM**

USERS MANUAL  
PRELIMINARY

October, 1990

COPYRIGHT © 1990

MILLE APPLIED RESEARCH CO., INC.  
HOUSTON, TEXAS  
713/472-6272

**PROPRIETARY NOTICE**

Proprietary rights of **MILLE APPLIED RESEARCH CO., INC. (MARC)** are involved in this subject matter and all manufacturing, reproduction, use and sales rights pertaining to such subject matter are expressly reserved. It is submitted in confidence for a specified purpose and the recipient, by accepting this material, agrees that this material will not be used, copied or reproduced in whole or in part, nor its contents revealed in any manner or to any person except to meet the purpose for which it was delivered.

**TABLE OF CONTENTS**

1 GENERAL INFORMATION ..... 1  
    1.1 INTRODUCTION ..... 1  
2 SPECIFICATIONS ..... 2  
3 INTERFACE CONNECTIONS ..... 3  
    3.1 RS-232 CONNECTOR ..... 3  
        3.1.1 Pin 1 Ground Reference ..... 3  
        3.1.2 Pin 2 Transmit Data ..... 3  
        3.1.3 Pin 3 Receive Data ..... 4  
        3.1.4 Pin 4 Request To Send ..... 4  
        3.1.5 Pin 5 Clear To Send ..... 4  
        3.1.6 Pin 6 Data Set Ready ..... 5  
        3.1.7 Pin 7 Ground Reference ..... 5  
        3.1.8 Pin 8 Data Carrier Detect ..... 5  
        3.1.9 Pin 11 Data Terminal Ready ..... 5  
    3.2 ANALOG SIGNAL CONNECTIONS ..... 5  
    3.3 TEST INPUT CONNECTION ..... 6  
    3.4 PUSH-TO-TALK CONNECTION ..... 6  
4 MODEM OPERATING MODE SELECTION ..... 7  
    4.1 OPERATING MODE SELECTION SWITCH ..... 7  
        4.1.1 Frequency Parameters ..... 7  
    4.2 TIMING PARAMETERS ..... 9  
        4.2.1 RTS1 Delay ..... 10  
        4.2.2 HOLD Delay ..... 10  
        4.2.3 RTS2 Delay ..... 10  
    4.3 TRANSMIT LEVEL SELECTION ..... 10

**LIST OF FIGURES**

Figure 1 Interface Signals ..... 3  
Figure 2 RS232 Connector Pin Assignments ..... 4  
Figure 3 Test Signal Connections ..... 6  
Figure 4 Option Switch Settings ..... 7  
Figure 5 Modem Frequency Parameters ..... 8  
Figure 6 Timing Adjustments ..... 9  
Figure 7 Modem Timing Parameters ..... 11

---

## GENERAL DESCRIPTION

### 1.1 INTRODUCTION

This Manual details the information necessary for set-up and operation of the MARC™ Modem board for the Allen-Bradley Programmable Logic Controller (PLC). The modem board is MARC Part Number 137-002.

The 137-002 Modem is an asynchronous Frequency Shift Keying (FSK) voiceband modem intended for use in leased line applications. The Modem can be used in either 2-Wire or 4-Wire configurations. It is switch selectable for operating mode and baud rates of 300, 600 or 1200 bits per second (bps). The Modem is compatible with the applicable Bell and CCITT recommended standards for 103/13/108, 202, V.21 and V.23 type modems. In addition, the 137-002 Modem provides the controls necessary when interfacing to many common radio transmitters/receivers. Specifically, the modem provides a contact output which can be used to turn on the radio transmitter. This "push-to-talk" output is controlled by the RS232 Request to Send input and by delay timers in the modem. A test switch is available on the front of the modem module which will force continuous high and low frequency tones onto the modem output for use in testing receiver signal strengths. The test switch function can also be implemented by driving the modem test inputs from other sources such as standard DC outputs from a PLC.

The transmit signal level from the Modem is switch selectable by the user from + 2 to -12 dbm in 2 dbm increments for added versatility.

The interface signal levels to the Modem conform to the RS232-C standard. Connection to the RS232 interface is via a 15-pin "D" connector on the front of the modem. A standard 1771-WC swing arm connector is used for connection to the communication line, the push-to-talk output and the modem test inputs.

The Modem card obtains + 5VDC power from the PLC backplane connector. No other connections to the backplane are made.

---

## SPECIFICATIONS

### Physical:

- Requires one module slot in an Allen-Bradley 1771 I/O chassis
- 1.1" W X 10" H X 5.75" D (Standard Allen-Bradley Module Size)
- 1 pound, 14 ounces

### I/O Connections:

- 15-Pin "D" Connector (DE15S) for RS-232 Interface
- 1771-WC Swing-arm for Communication Line, Push-to-talk and Test inputs
- Test Inputs 12 to 36 Volts DC

### Compatibility:

- Bell 103/113/108
- Bell 202
- CCITT V.21
- CCITT V.23

### User Selectable Options:

- Optional Soft Carrier Turn Off on V.23 Modes
- Full or Half Duplex Operation
- Switch Selectable Operating Mode
- Switch Selectable Transmit Level
- Dual RTS/CTS Delay Time Adjustments
- Adjustable Transmitter Hold Time

### Backplane Power Supply Load:

- 750 ma from 5 VDC

### Operating Environment:

- 0 to 60 Degrees C
- Relative Humidity 10 to 90% (non-Condensing)

## INTERFACE CONNECTIONS

### 3.1 RS-232C CONNECTOR

Connections to the Comm-Troller or other devices with RS-232C compatible communication ports is made via connector P1 which is a 15-pin "D" connector located near the top of the Modem module. Figure 1 below details the interface connector pin assignments.

#### 3.1.1 Pin 1 Ground Reference

Pin 1 is a ground reference for the RS-232 voltage levels.

#### 3.1.2 Pin 2 Transmit Data

Data to be transmitted onto the phone lines is presented on pin 2. The input signal levels are standard RS-232 voltage levels. A low input on this line (negative

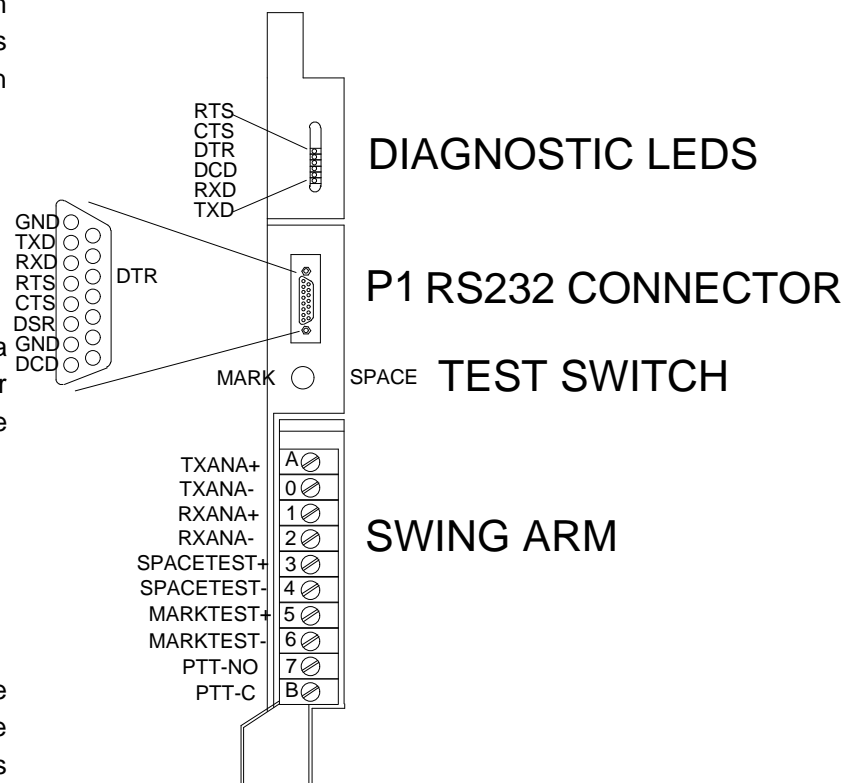


Figure 1 Interface Signals

# RFSK MODEM INTERFACE CONNECTIONS

voltage) will result in a "MARK" tone on the line. A high input on this line (positive voltage) will result in a "SPACE" tone on the line.

### 3.1.3 Pin 3 Receive Data

Data received from the phone line and decoded by the modem is present on pin 3. The signals on this line are equivalent to those on pin 2. That is, a "MARK" tone on the line will be indicated by a negative output and a "SPACE" tone by a positive output.

### 3.1.4 Pin 4 Request To Send

A high level on this input instructs the modem to enter the Transmit Mode. This input must remain high for the duration of data transmission. A low level on this input disables the transmitter. The state of this input has no effect if Data Terminal Ready input is low.

PIN	FUNCTION
1	Ground Reference
2	Transmit Data (TXD) input
3	Receive Data (RXD) output
4	Request To Send (RTS) input
5	Clear To Send (CTS) output
6	Data Set Ready (DSR) output
7	Ground Reference
8	Data Carrier Detect (DCD) input
11	Data Terminal Ready (DTR) input

### 3.1.5 Pin 5 Clear To Send

The Clear To Send (CTS) output goes high at the end of a delay initiated when Request To Send (RTS) goes high. Actual data to be transmitted should not be presented to the transmitted data input until a high is indicated on the Clear To Send output. Normally the user should force the transmitted data input low whenever Clear To Send is off (low). This signal never goes high as long as Data Terminal Ready is low (disabled). Clear To Send goes low at the end of a delay initiated when Request To Send goes low. Values for  $t_{RTS1}$ ,  $t_{RTS2}$  and  $t_{HOLD}$  are user adjustable within the ranges specified in Figure 7.

**Figure 2 RS232 Connector Pin Assignments**

## 3.1.6 Pin 6 Data Set Ready

The Data Set Ready output follows the Data Terminal Ready input. That is, if DTR is high then DSR will be high; if DTR is low then DSR will be low.

## 3.1.7 Pin 7 Ground Reference

Pin 7 is a ground reference for the RS-232 voltage levels.

## 3.1.8 Pin 8 Data Carrier Detect

A high level ( $> 3V$ ) on the data carrier detect output indicates that a valid carrier signal is present at the receiver and has been present for at least a time  $t_{CDON}$ , where  $t_{CDON}$  depends upon the selected modem configuration. A low on this output ( $< -3V$ ) signifies that no valid carrier is being received and has not been received for a time,  $t_{CDOFF}$ . Data Carrier Detect remains low when Data Terminal Ready is low. Values for  $t_{RCON}$  and  $t_{RCOFF}$  are configuration dependent and are listed in Figure 7.

## 3.1.9 Pin 11 Data Terminal Ready

A high level on this input indicates that the data terminal desires to send and/or receive data via the modem. This signal is gated with all other inputs and outputs so that a high level enables all these signals as well as the internal control logic. A low level disables all TTL I/O pins and the internal modem logic.

## 3.2 Analog Signal Connection

The telephone line connection is made at the swing arm connection. Two line coupling transformers are provided on the modem board for direct connection to the transmit and receive wire pairs in leased line applications. The line coupling transformers each provide an isolated 600 Ohm line connection. Transformers T1 and T2 are designed to meet FCC Part 68 requirements for telephone line connections. The transmit pair (output from the Modem) is on pins A and 0 of the swing arm connector. The receive pair (input to the Modem) is on pins 1 and 2 of the swing arm connector.

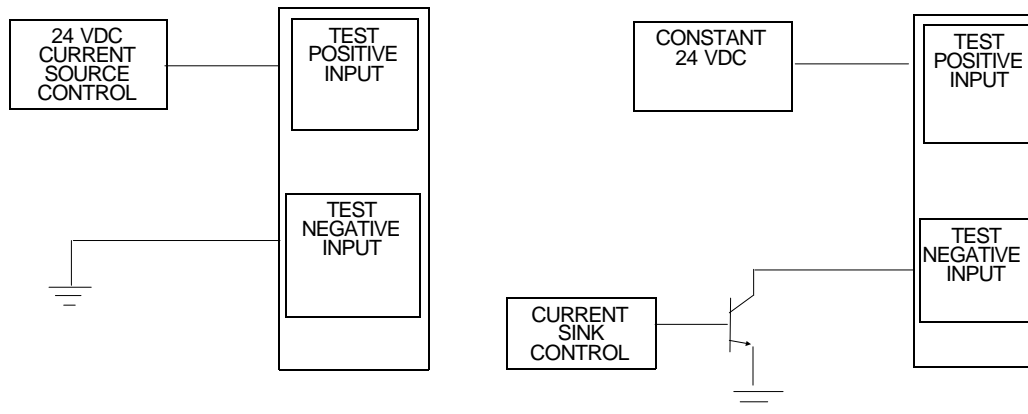


Figure 3 Test Signal Connections

### 3.3 Test Input Connection

The test mode of operation of the modem can be entered either by manually operating the Test Switch or by driving the Test Inputs from a remote source such as a PLC output. The test mode inputs override the normal modem inputs. The Test Inputs are optically isolated and can be driven by either a current sourcing circuit or a current sinking circuit, whichever is available. The Marktest Input is on the swing arm pins 3 and 4. To use the Marktest input with a current sourcing circuit the Marktest + input (pin 3)s should be connected to the driving source and the Marktest - input connected to ground. If a current sinking circuit is used to drive the Marktest input then the Marktest + input should be connected to a positive DC source with a voltage between 12 and 36 volts. The Marktest - input is connected to the current sinking circuit. The Spacetest inputs function exactly the same as the Marktest inputs except that the connections for the Spacetest input are to the swing arm pins 5 and 6.

### 3.4 Push-to-Talk Connection

The Push-to-Talk output is connected to the swing arm on pins 7 and B. The Push-to-Talk output is a hard relay contact which is driven by the circuitry of the modem. Typically one side of the output will be connected to the radio ground reference and the other side of the relay to the "PTT" input of the radio.

# MODEM OPERATING MODE SELECTION

---

## MODEM OPERATING MODE SELECTION

### 4.1 OPERATING MODE SELECTION

The desired mode of operation is selected by setting the switches on switch SW1 as defined in the following Figure.

1	2	3	4	5	6	7	8	OPERATING MODE
1	1	1	1	1	X	X	X	Bell 103 Originate 300bps full duplex
1	1	1	1	0	X	X	X	Bell 103 Answer 300bps full duplex
1	1	1	0	1	X	X	X	Bell 202 1200bps half duplex
1	1	1	0	0	X	X	X	Bell 202 1200bps half duplex w/equalizer
1	1	0	1	1	X	X	X	CCITT V.21 Originate 300bps full duplex
1	1	0	1	0	X	X	X	CCITT V.21 Answer 300bps full duplex
1	1	0	0	1	X	X	X	CCITT V.23 Mode 2 1200bps half duplex
1	1	0	0	0	X	X	X	CCITT V.23 Mode 2 1200bps half duplex w/equalizer
1	0	1	1	1	X	X	X	CCITT V.23 Mode 1 600bps half duplex
1	0	0	1	1	X	X	X	CCITT V.23 Mode 1 600bps w/soft turn off
1	0	0	0	1	X	X	X	CCITT V.23 Mode 2 1200bps w/soft turn off
1	0	0	0	0	X	X	X	CCITT V.23 Mode 2 1200bps w/equalizer and soft turn off
0	1	1	0	1	X	X	X	Bell 202 1200bps full duplex
0	1	1	0	0	X	X	X	Bell 202 1200bps full duplex w/equalizer
0	1	0	0	1	X	X	X	CCITT V.23 Mode 2 1200bps full duplex
0	1	0	0	0	X	X	X	CCITT V.23 Mode 2 1200 bps full duplex w/equalizer
0	0	1	1	1	X	X	X	CCITT V.23 Mode 1 600bps full duplex

X = Not Used, 0 = Switch OFF, 1 = Switch ON

Figure 4 Option Switch Settings

#### 4.1.1 Frequency Parameters

Selection of the operating mode automatically determines the frequency parameters which will be used in communication. Figure 5 details the frequency parameters for each mode.

## MODEM OPERATING MODE SELECTION

MODE	TRANSMIT FREQUENCY		RECEIVE FREQUENCY		SOFT TURN OFF TONE
	SPACE	MARK	SPACE	MARK	
Bell 103 Orig	1070	1270	2025	2225	
Bell 103 Ans	2025	2225	1070	1270	
CCITT V.21 Orig	1180	980	1850	1650	
CCITT V.21 Ans	1850	1650	1180	980	
CCITT V.23 Mode 1	1700	1300	1700	1300	900
CCITT V.23 Mode 2	2100	1300	2100	1300	900
Bell 202	2200	1200	2200	1200	900

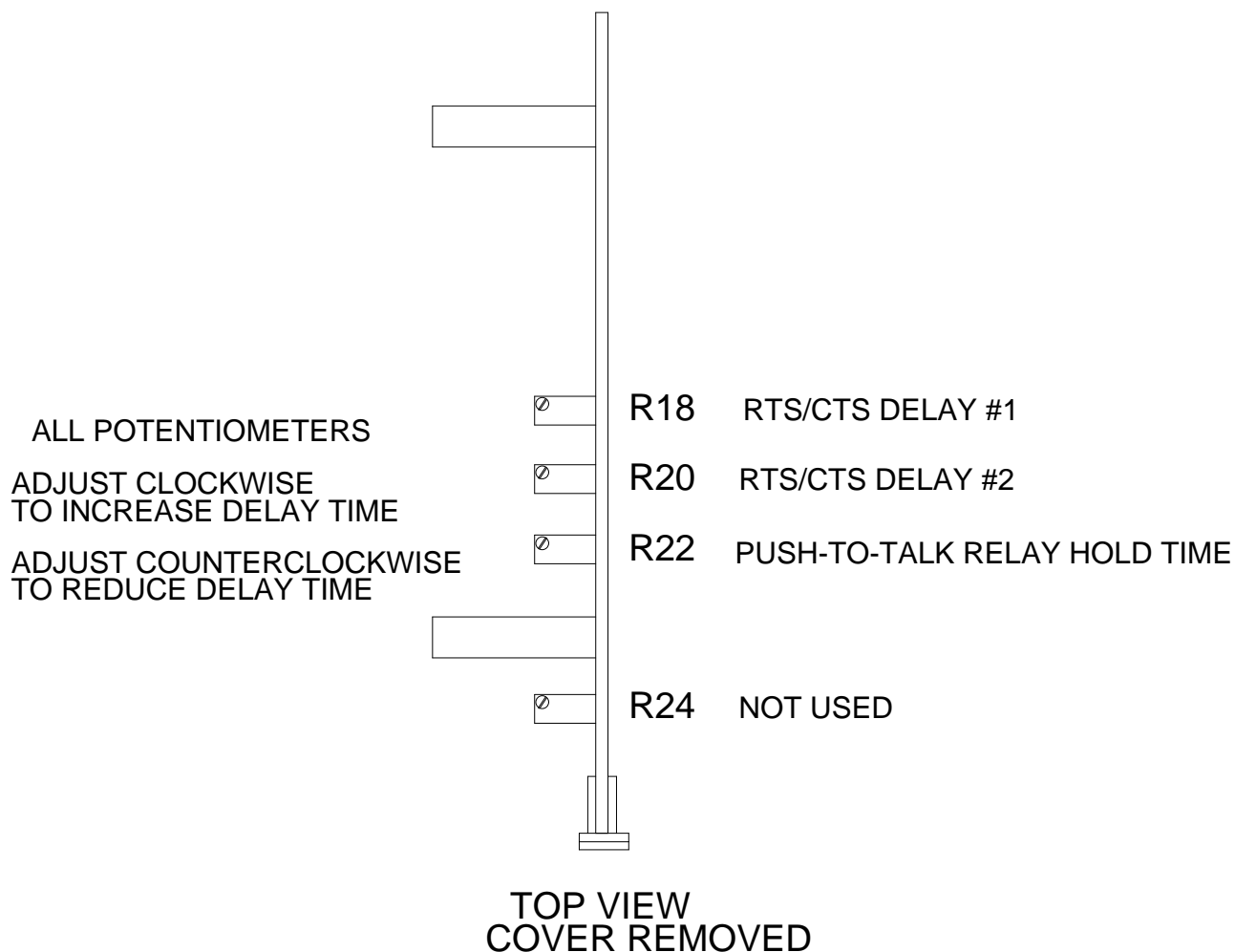
Figure 5 Modem Frequency Parameters

# RFSK MODEM

## MODEM OPERATING MODE SELECTION

### 4.2 TIMING PARAMETERS

The delay times associated with RTS1, RTS2 and HOLD are user adjustable using trimpots located along the upper edge of the circuit card. The range of adjustment for each delay is specified in Figure 6. RTS1, RTS2 and HOLD are delay timers which are controlled by either the rising edge or the falling edge of the RS232 input signal RTS (P1 pin 4).



**Figure 6 Timing Adjustments**

### 4.2.1 RTS1 Delay

The RTS1 Delay is started when the RTS input goes high. The delay is adjustable using potentiometer R18 located along the top edge of the modem card. The Push-to-Talk output is energized whenever the RTS signal goes high. The RTS1 delay is used to inhibit or "hold off" the Clear To Send (CTS) signal until the transmitter has had time to build up to full power. When the CTS output is activated the transmitting device is allowed to place its data onto the transmit data lines.

### 4.2.2 HOLD Delay

The HOLD Delay is exactly the opposite of the RTS1 Delay. The HOLD Delay is started when the RTS input goes low instead of high. The Push-to-Talk output is held on for the duration of the HOLD time after the RTS signal goes low. This provides a "quiet interval" at the end of each transmission. The HOLD time is adjustable using potentiometer R22 located along the top edge of the modem card. The HOLD time is user adjustable from approximately 2 to over 350 msec.

### 4.2.3 RTS2 Delay

The RTS2 Delay is a special feature of the MARC 137-002 modem. It is used to significantly speed up the total message transaction time in some applications. It does this by reducing the RTS/CTS delay time (set by RTS1 Delay) if the transmitting device has a second message ready to send **before** the HOLD time has expired from the previous message. The net result is that the transmitter remains on until all message transactions have been completed for a specific site. If the transmitter is already on then there is no need to delay for it to build to full power before transmitting. The RTS2 delay sets the amount of delay between RTS and CTS if the transmitter is already on (within the HOLD time). The delay time is user adjustable from a minimum time of 8.3 msec to a maximum of approximately 100 msec.

## 4.3 TRANSMIT LEVEL SELECTION

The transmit level is determined by setting the desired switch position on SW2 to the ON position. The Transmit levels are clearly marked near switch SW2. Only one switch position should be in the on position. Transmit levels can be set in 2 db increments from -12 to + 2 db.

MODEM OPERATING MODE SELECTION

	$t_{RCON}$ MIN ms	$t_{RCOFF}$ ms	$t_{CDON}$ ms	$t_{CDOFF}$ ms	$t_{SQ}$ ms	$t_{STO}$ ms	$t_{RTS1}$ ms	$t_{RTS2}$ ms	$t_{PTTOFF}$ ms
Bell 103 Orig	25.0	0.52	9-20	4-23	-	-	10-350	10-50	10-350
Bell 103 Ans	25.0	0.52	9-20	4-23	-	-	10-350	10-50	10-350
CCITT V.21 Orig	25.0	0.52	10-20	10-20	-	-	10-350	10-50	10-350
CCITT V.21 Ans	25.0	0.52	10-20	10-20	-	-	10-350	10-50	10-350
CCITT V.23 Mode 1	8.0	0.52	3-7	3.4-11.3	9.0	8.0	10-350	10-50	10-350
CCITT V.23 Mode 2	8.0	0.52	3-7	3.4-11.3	9.0	8.0	10-350	10-50	10-350
BELL 202	8.0	0.52	3-7	3.4-11.3	9.0	8.0	10-350	10-50	10-350

Figure 7 Modem Timing Parameters