2070-9D
2070-9A
2070-9B
2070-9E
USER'S MANUAL

33.6K SMART MODEM

June 11, 2009

PRELIMINARY

Proprietary Data

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PRELIMINARY

TABLE of CONTENTS

GLOSSARY

Anti-Streaming – A function on GDI modems that prevents a Host from transmitting continuously.

DCD – Data Carrier Detect. An EIA RS-232D control signal that can be used to gate RXD to a DTE.

DCE – Data Communications Equipment. A device that converts data from a DTE to a transport stream. For example. The GDI model 400 modem is a DCE that converts RS232 data from a controller to a FSK Telco system.

DTE – Data Terminal Equipment. A device that initiates communication over RS232 lines.

CTS – Clear To Send. A EIA RS-232D control signal that can be used to gate TXD data from a DTE.

Full duplex – A communication system where data can be transmitted in both directions at the same time.

Half duplex - A communication system where data can be transmitted in only one direction at a time.

FSK – Frequency Shift Keying. Communication protocol where data is encoded into binary format and represented by different frequencies.

Host – Any DTE device.

MARK – Signal state of a FSK system that represents a logical "1" value.

Private wire – Telco communication hardware that is leased for private use.

SPACE – Signal state of a FSK system that represents a logical "0" value

0 dBm – Represents the signal level required to produce 1mw in a 600Ω load.
Soft carrier

Surface mount parts – Electronic parts that are designed to be soldered to pads instead of vias.

RXD – Receive Data. An EIA RS-232D data signal that transfers information in form of binary data to a DTE.

RTS – Request To send. An EIA RS-232D control signal that can be used to gate TXD to a DTE. The DTE asserts RTS and then waits for the DCE to respond with CTS.

TXD Transmit Data. n EIA RS-232D data signal that transfers information in form of binary data from a DTE.

GERNERAL DESCRIPTION

The 2070-9xx is a 33.6Kbps dial-up modem in a form factor designed for use in a Model 2070 Controller.

It is compatible with other V.34 modems and is designed for traffic control environments.

Located on the front panel of the 2070-9xx is a RS-232 port that can connect the dialup modem to a computer through a female DB9 connector. This port can also be connected to the 2070's I/O bus.

The phone line connects to the 2070-9xx through a standard RJ-11 connector located on the front panel. A second RJ-11 connector is provided for connection to a telephone.

The 2070-9xx can automatically negotiate line rates from 300bps to 33600 bps.

All operating parameters such as speed, etc., can be configured using industry standard AT commands.

The serial port has a maximum speed of 115.2 Kbps and is RS-232 and V.24 compatible.

The 2070-9xx cannot be used with leased lines.

The SM336 also features Auto Answer, Auto Dial, and tone or pulse dialing.

The 2070-9xx can be factory fitted with a FSK Expansion Card. which is a FSK Private wire Modem.. FSK stands for Frequency Shift Keying which is a modulation scheme that Shifts (changes) the frequency to represent a digital "1" (SPACE) or an "O" (Mark).

The FSK option can be configured for the following baud rates:

2070-9A: 1200bps serial, 1200Hz/2200Hz Mark/Space Frequencies, and 900Hz Soft Carrier frequency

2070-9B: 9600bps serial, 11200Hz/17600Hz Mark/Space Frequencies and 7800Hz Soft Carrier frequency.

2070-9E: 19200bps serial, 19200Hz/38400Hz Mark/Space Frequencies and 13800 Soft Carrier Frequency.

GENERAL CHARACTERISTICS

FORM FACTOR

Standard 2070 plug in board size: 8.375" x 5.69" x 1.592"

Temp……..-37 to +74 degrees C.
Humidity…….5 to 95 % non-condensing.
Power ……5 V @ 500ma
+12V @ 100 ma
-12V @ 100ma

DIALUP:

Modulation……..Quadrature Amp. Mod.

Modem…ITU V.34 and Rockwell V.FC

Interface…ITU V.24/V.28, EIA-232

Data Throughput…..115.2 Kbps

Data Rates:
33.6Kbps, 31.3Kbps, 28.8Kbps, 26.4Kbps, 24.0Kbps, 21.6Kbps, 19.2Kbps, 16.8Kbps, 14.4Kbps, 12.0Kbps, 9.6Kbps, 7.2Kbps, 4.8Kbps, 2.4Kbps, 1.2K baud, 300 baud.
The modem will automatically select the best operating speed. Speeds are ±0.01%.

Specifications: V.34, V.32 bis, V.32, V.22 bis, V.22A/B, V.23, V.21, Bell 212, Bell 103, V.33, V.17, V.29, V.27, V.21 Channel 2

Error Correction….V.42 LAPM, MNP2-4, MNP 10

Data Compression…V.42 bis, MNP 5

Loop Tests….. ITU V.54 loop2 (RDL) and Loop 3 (LAL)

Data Carrier…….1800 ± 0.5 Hz
Calling Tone……1300 ± 10 Hz
Answering Tone…2100 ± 15 Hz
Receiver Freq. Tolerance…….±14 Hz
S/N Ratio……..-26 dB
Dynamic Range……-12 dBm to –42 dBm
Transmit Level: Fixed at –11 ±2 dB
Ring detect Sensitivity…. 38 VRMS
Ring Equiv. Number…….1 Bel
Termination……600 Ohm
Return Loss… Better than 14 dB between 200 and 4000 Hz

FSK:

Serial Data Rate……..0-19,200 baud.
Meets EIA RS-232D and CCITT V.24 electrically
CTS Delay .....12 ±2 ms
Soft Carrier Turnoff Time 10 ±2ms
Receive Squelch .....6.5 ±1ms
Carrier Detect Time.....8 ±2ms
Data Format…Asynchronous, serial by bit

Line interface…..Private Metallic wire 600 Ohm
Modulation…….Phase Coherent FSK.

Modulation Frequencies:
Mark and Space Frequencies have a ±1% tolerance.

Frequency	2070-9A	2070-9B	2070-9E
Mark	1200Hz	11200 Hz	19200 Hz
Space	2200 Hz	17600 Hz	38400 Hz
Soft Carrier	900 Hz	7800 Hz	13800 Hz

4 wire Full Duplex and 2 wire Half Duplex
Receive Sensitivity….0 to -40 dB.
Output Level……Continuously adjustable from -8dBm to 0 dBm. (set to 0dBm)

Anti-streaming
RTS Trigger mode time-out 7s.
Loss of Data mode time out 7s.

INDICATORS, CONNECTORS, AND SWITCHES

Dialup Indicators:
Transmit Data TX
Receive Data RX
Data Terminal Ready DTR
Data Carrier Detect DCD
Data Set Ready DSR
Ring Indicator RI

Dialup Connectors:
Phone Connector RJ11
Line Connector RJ11

RJ45 Termination Table

Pin	Signal
1	NC
2	TIP
3	RING
4	NC

Configuration Port DB9

DB9 Termination Table

Pin	Signal
7	RTS
4	DTR
8	CTS
6	DSR
3	TXD
1	DCD
9	RI
2	RXD

FSK:
Receive Data……..…RXD
Data Carrier Detect…...DCD
Transmit Data……TXD
FSK on board Indicators
Request to Send…….RTS
Clear to Send…….CTS

FSK Enable/Disable switch
FSK Full Duplex/Half Duplex switch.
FSK / EIA 232C Connector (C20)

C20 Termination Table

C20			
Pin	Function	Pin	Function
A	Audio In	J	RTS
B	Audio In	K	Data In (TXD)
C	Audio Out	L	Data Out (RXD)
D	+5 VDC	M	CTS
E	Audio Out	N	DC Gnd #1
F	NA	P	NA
H	CD	R	NA

Board Power On/Off switch.

96 pin edge connector

Pin	A	B	C
1	SP1-TXD+		
2	SP1-TXD-		
3	SP1-RXD+		
4	SP1-RXD-		
5	SP1-RTS+		
6	SP1-RTS-		
7	SP1-CTS+		
8	SP1-CTS-		
9	SP1-DCD+		
10	SP1-DCD-		
11	SP2-TXD+		
12	SP2-TXD-		
13	SP2-RXD+		
14	SP2-RXD-		
15	SP2-RTS+		
16	SP2-RTS-		
17	SP2-CTS+		
18	SP2-CTS-		
19	SP2-DCD+		
20	SP2-DCD-		
21	DC Gnd	C50 EN	
22			
23		DC Gnd	
24			
25			
26			
27	DC Gnd #1	DC Gnd	DC Gnd
28	+12 Serial		
29	+5VSerial	+5VSerial	
30	DC Gnd #1	DC Gnd	DC Gnd
31			
32			

INSTALLATION

Installation of the 2070-9 is relatively simple. It can be installed with the power on provided that the power switch on the front panel is in the "OFF' position.

The 2070-9xx receives power from the Model 2070 Controller, and the Controller

The incoming phone line is to be connected to the RJ-11 "LINE" connector . An external phone can be connected to the RJ-11 labeled "PHONE."

Note: As the RJ11 connectors are connected in parallel, remember not to use the phone while the modem is in operation.

Configuring the 2070-9xx is achieved through a series of switches on the front panel and on the board itself.

The configuration switches for the dialup modem are located on the top of the main board closer to the front panel. Refer to the following table when configuring the modem:

Dialup Configuration Switches

Switch	Closed	Open
1-DB9	SP2	Dial Up
2-DM9 mode	DCE	DTE
3-RTS mode	High	Normal
4-RS-485	Normal	Inverted
5-Future Expansion		

Switch 1: Default = Open.
Open - When switch 1 is open the dialup modem can be configured via the front panel DB9 connector.

Closed When switch 1 is closed, the DB9 is connected to the controllers SP1 port.

Switch 2: Default = Closed.

Open-When switch 2 is open, the directionality of the port is DTE.

Closed-When switch 2 is closed, the directionality of the port is DCE.

Switch 3: Default = Open.
Open-RTS/CTS handshaking is active.
Closed-RTS/CTS handshaking is not active and RTS is asserted constantly.

Switch 4: Default = Open
Open-The RS-485 signals are inverted.
Closed-The RS-458 signals are not inverted.

FSK Configuration Switches

Switch Pos.	FUNCTION
1	Full Duplex (ON) Off for Half
2	Half Duplex (ON) Off for Full
3	RTS timing ON = short timing
4	Soft Carrier Timing ON=Short timing
5	Rec Squelch--ON for Half duplex
6	Rec Squelch Timing ON for short timing
7	Carrier Detect timing ON for short timing
8	Anti-Streaming ON=enabled

For normal 4 wire Full Duplex operation, switch 1 should be ON and everything else should be OFF. This will select standard timing and full duplex operation. If Anti-Streaming is required, turn switch 8 ON.

For Normal 2 wire Half Duplex operation, switches 2 and 5 should be ON and everything else is OFF. Turn switch 8 ON if Anti-Streaming is required. Only the Audio Out transformer is used for 2 wire operation. Switch 2 connects the input amplifier of the receiver to the board side of the Output transformer so that signals coming into the transformer are available to the receiver. Switch 5 enables the Receiver Squelch, which turns RXD OFF when the Modem is transmitting.

In the 4-wire full duplex mode of operation, there is no connection between the Transmitter circuit and the Receiver circuit. In the 2-wire mode, the transmitter output is connected to the Receiver input.

For further adaptation, all of the timing signals can be configured to be half their normal time. Switch position 3 reduces the CTS delay to 6ms. Position 4 reduces the Soft Carrier time to 5ms. Position 6 reduces the Receiver Squelch time to 3.2ms. (This is the time, in a 2 wire half duplex system, that the Receiver is held OFF after a transmission). Switch position 7 reduces the Carrier Detect time to 4ms.

These faster timing can be used in a system where you are running out of time in polling a large number of intersections. While the faster timing will allow for more modems in the same network, it also allows for more system errors. All modems have to be set for the faster timing.

Switch position 8 on the dipswitch turns the Anti-Streaming circuit on and off. The Anti-Streaming circuit will turn off the Transmitter after it has been transmitting for 7 seconds continuously. This will prevent a single malfunctioning Controller from interfering with other remote modems on the same line. This feature is typically used on remote/slave modems where the transmitted data packets are short. The anti-streaming circuit will be active until RTS is de-asserted. When RTS goes low, the anti-streaming circuit will reset automatically and the Controller can then transmit again.

The Anti-Streaming feature is not normally activated on a Local/Master modem since they are transmitting continuously to all of the remotes/slaves. If there is a possibility that a message may go over 5 seconds, do not use the Anti-Streaming Feature.

The Input impedance can be changed with switch 8. Normally, the 600 Ohms position is used but where reduced loading is required, the high impedance position can be used for units not at the end of a line.

SHORT TIMING

In a system with many Modems on a line, you may find that you can't get to every Controller in the allotted time period. By switching over to the Short timing positions on the dipswitch you can save 12 ms per poll and response. To use short timing switches 3, 4, 6, and 7 should be turned ON for all of the units on a particular line.

As mentioned previously, there is the possibility of more communication errors with short timing. You will have more errors because there is a greater possibility of noise activating one of the Carrier Detect circuits. Once the receiver is turned on, the error rate is the same. On systems with good quality wire, you may not notice any change in system errors.

DISTANCE OR MAXIMUM UNITS PER LINE

The signal level on a line is determined by:

1. **The length of the line**
2. **The quality of the line**
3. **The number of units on the line.**
4. **The transmitted signal level**

We can do anything about the length and quality of the line but we can adjust the transmitted signal level and the input impedance of the 496 Modem.

The output level of the 496 is set at the factory to 0 dBm. A 0 dBm signal is normally good enough to give you a range of 5-6 miles on 22 AWG wire. 19 AWG wire will give you another 20% more distance. The output signal level can be increased to +10 dBm by adjusting the potentiometer VR2, which is labeled "AMP". This can give you as much as 25% more distance.

The signal levels are measured across a 600-Ohm resistor. If you are going to measure the output level, load the output with one other modem or use a 600 resistor, which is more accurate. The potentiometer VR2 (AMP) will provide an adjustment range of –8 to +10 dBm. Increasing the output level may increase the cross talk in some systems.

Another way to get more distance or more units on a run is to raise the impedance of the modems in the middle of a line. The two end units are left at 600 Ohms input impedance but the units between them are changed to 4.75K. This is done by moving the jumper on JP1 to the 4.75K position from the 600 position. This will reduce the loading effects caused by the input impedance of the modem.

SYSTEMS WITH NO RTS SIGNAL

Some computers or camera systems may not have the standard

handshaking signals RTS and CTS. The 496 needs to have the RTS signal before it will transmit. In a 4-wire system where the modem can transmit continuously (at a master or a point to point system), the JP2 jumper can be installed which will force a RTS signal into the modem. This will cause the modem to transmit continuously. This will not cause a problem at a Master Modem or in a point-to-point system. This will not work for modems that are connected to local controllers that share a line going back to a Master. The RTS pin on the edge connector is pulled up with a 1.0K resistor to +12V so make that nothing is connected to the RTS pin (L).

If you are in a situation where you don't have control of RTS but you have more than one modem on the line, you will have to use a Key On Data device to control the Modem. GDI can supply these devices. Please contact the factory for more information.

A common problem in 4-wire systems is not connecting them correctly. The pair of wires from the Audio Out from the Master Modem is connected to the Audio In of all of the remote Modems. All of the Audio Out signals from all of the Remote Modems are connected together and connected to the Audio In of the Master. The Audio signals are transformer coupled and are not polarity sensitive.

ADJUSTMENTS

The only adjustment that should be made to the FSK Expansion modem is the output level. VR2 potentiometer (labeled AMP) is used to make that adjustment. The Audio output must be loaded with 600 Ohms and the output level measured across the 600-Ohm resistor. You have an adjustment range from –8 to 0 dBm.

The two other potentiometers on the board should not need adjustment for the life of the modem and require special equipment to set correctly. Contact the factory if you feel these need adjustment.

THEORY OF OPERATION

Dialup Modem:

The 2070-9xx provides a Hayes compatible dialup smart modem interface to the 2070 controller.

Power to the board can be switched on and off from a front panel SPST switch. This switch, when on, provides a current path for the quad SPST relay that connects/disconnects the controller power supply to the 2070-9.

Isolation from the controller's power supply is provided by a encapsulated transformer coupled DC to DC converter which provides the necessary power for both the smart modem and the FSK Expansion Board.

Isolation from the 2070 controllers I/O bus is provided by the use of opto-isolaters that link the signals from the controller to the smart modem while isolating power and ground.

The RS-485 signals are first converted to TTL using single supply line drivers. The signals are then fed to the opto-isolators.

The ouputs of the opto-isolaters are fed to a PLD.

The functionality of the "Programable Logic Device" is "created" by the GDI engineering staff not by the manufacturer of the part. This makes it possible to make the modem configurable for different modes of operation without the need for dozens of costly descrete components, switches, and jumpers. It also provides a means for making rapid changes to the functionality without increasing the cost to the user.

There are four switches connected to the PLD which configures all modes for the board. This includes RTS/CTS handshaking modes, RS-485 inversion, and DB9 configuration.

The PLD then routes the signals to the correct outputs. The signals from SP1 are always routed to the smart modem module. The signals from SP2 can be routed to the front panel DB9. But, normally, the DB9 is connected to the smart modem which provides a means to manually configure it using the AT command set.

However, the smart modem is typically configured "on the fly" by the controller via SP1 using an AT command string.

The signals are then modulated/De-Modulated by the smart modem and transmitted/Received out/in the RJ11 connecter after first passing through the line filters. The line filters filter out and noise from the telephone system that might create signal degradation and cause errors.

The logic state of the signals are displayed on the front panel useing LEDs. When the LED is lit, the signal is active. Each status signal is buffered by an N-Channel MOSFET transistior which provides the necessary current for the LED.

The speaker is driven by a monolithic 700-mW low-voltage power amplifier which is connected directly to the smart modem.

The ouput signals from SP2 are directly connected to a 50 pin socket which the FSK Expansion Board plugs in to. The Expansion Board provides all signal isolation to both the controller and the line.

FSK Option

The Space Frequency is used to transmit a digital "1" and the Mark frequency is used to transmit a digital "0." At the end of the data transmission, the Soft Carrier frequency is transmitted for 10 ms. The Soft Carrier is to causes the receiving modems receiver section to shut down. This prevents noise from getting though the Receiver.

The Receiver section of the modem amplifies the signal it receives through the coupling transformer and filters it so that only frequencies in the correct band will get passed on to the demodulator. Signals as low as 6 milliVolts will produce RS-232 level signals (±12V) at the receiver output.

Further noise prevention is accomplished through the use of special filter circuits which are used to enable the Carrier Detect Signal. There must be 8ms of the Mark frequency present on the input for Carrier Detect to activate.. When the Carrier Detect signal goes active, the Receiver will be enabled. That Mark signal will also have to be above a certain threshold before the Mark detect circuit will be activated.

The CTS delay circuitry will cause the Mark frequency to be present on the receivers input for 12ms. When RTS (Request to Send) is asserted, the modem starts transmitting the Mark frequency. The Host Computer or Controller will not send data until CTS is asserted.

Data Carrier Detect (DCD) controls the output of the Receiver and can be used to key the Controller or Host Computer. The no-signal state of the RXD signal is -12vdc or "Mark."

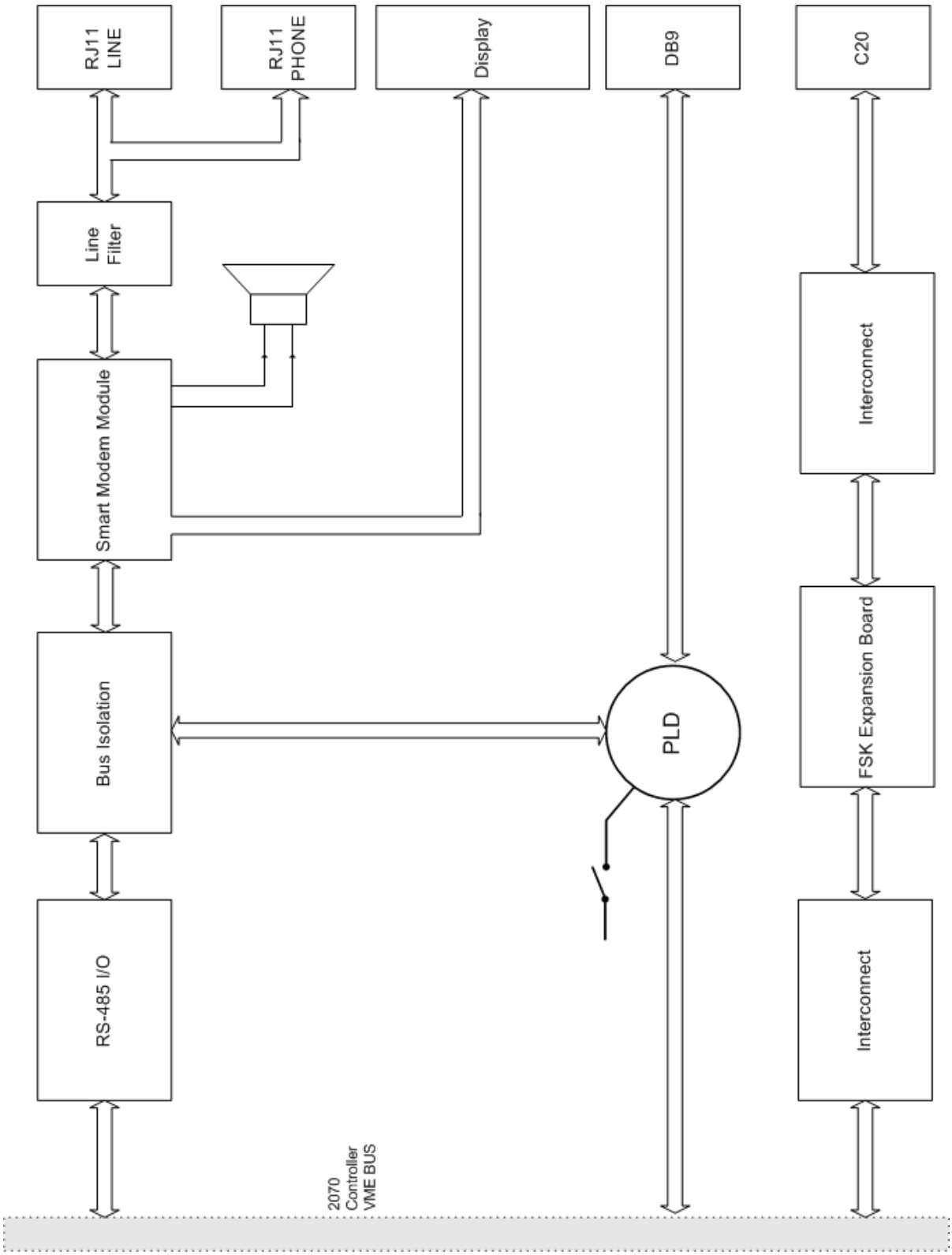
At the end of a data transmission the Controller or Host Computer de-asserts RTS which causes the modem to transmit the Soft Carrier frequency for 10ms.

At the receiving end, the "in-band", "out-of-band", and "soft carrier" filters all cause the receiver to shut down. Without these special filters, the receiver could respond to the transition from soft carrier to no signal and could create a false start bit.

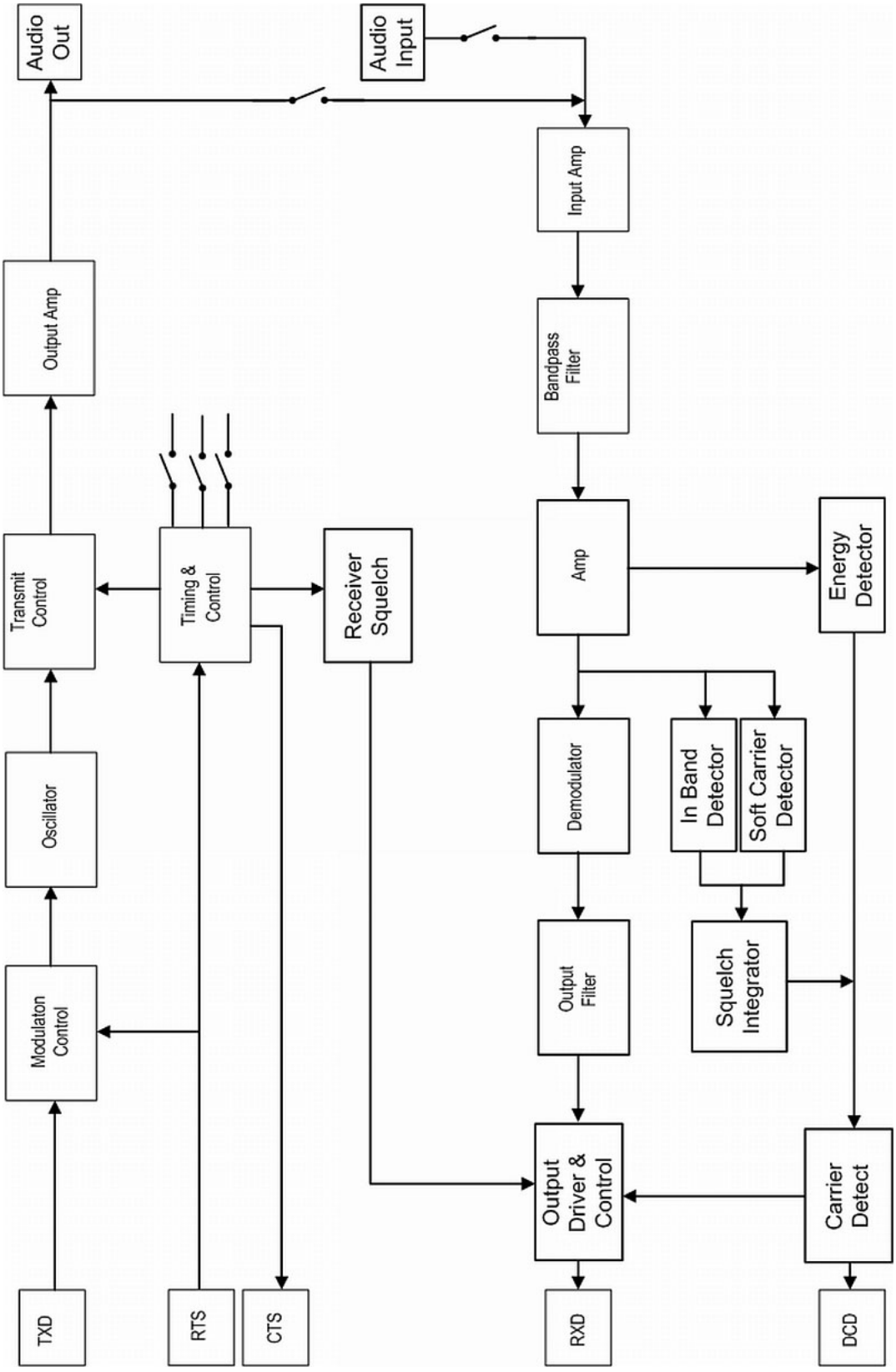
The Block diagram of the FSK modem shows how the different sections of the modem are interconnected.

Block diagrams

Dialup Block Diagram



FSK Expansion Block Diagram



MAINTENANCE

Preventative Maintenance

There is no preventative maintenance required or anything that needs to be adjusted for the life of the product.

Trouble analysis

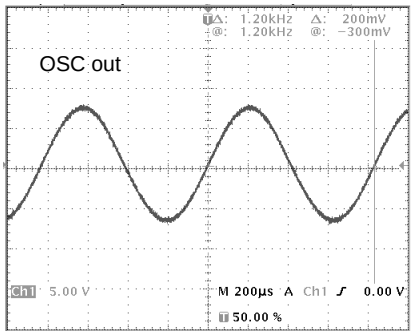
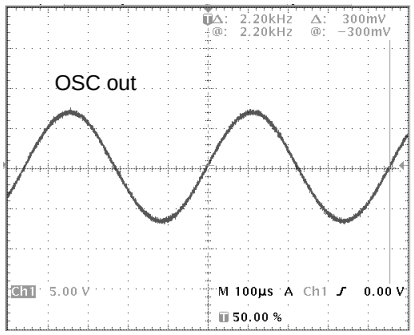
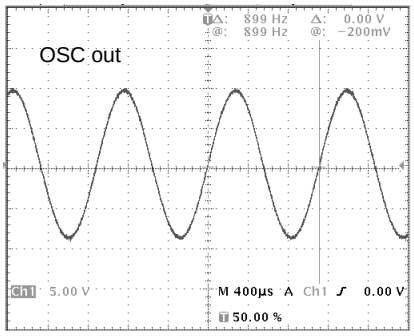
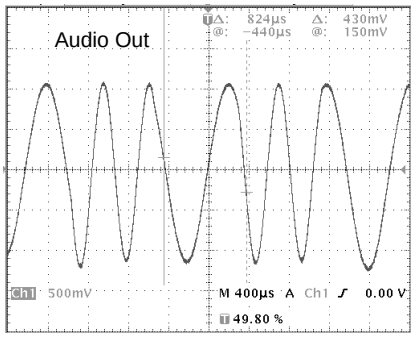
The model 2070-9xx is a fairly complex Modem with hundreds of parts. This makes this Modem hard to trouble shoot for the average technician with limited experience. It also requires special soldering tools to work with the surface mount parts. On the other hand this modem is constructed with top quality parts and so you will not experience many failures.

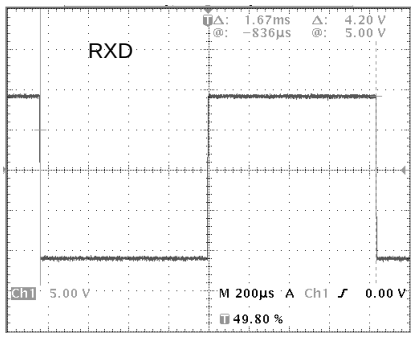
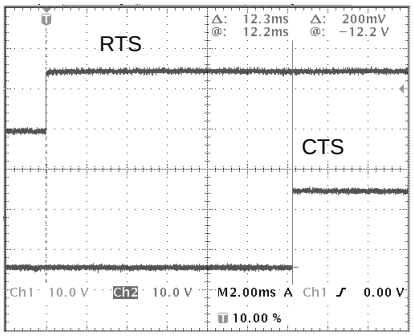
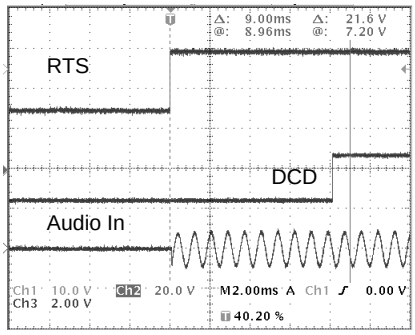
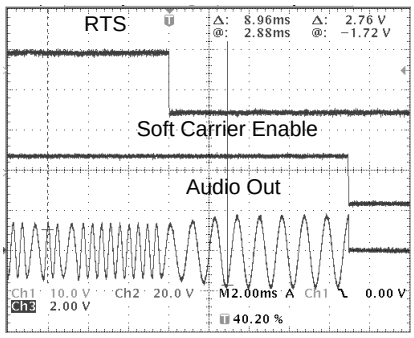
The chart on the next page will help find the problem if you decide to fix the model 400 yourself.

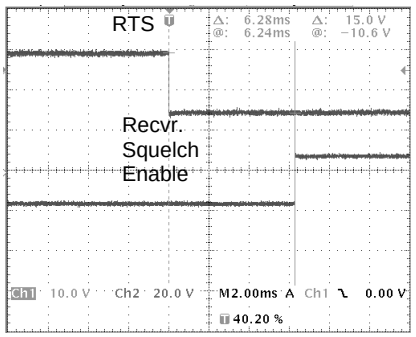
Trouble shooting Sequence chart

PROBLEM	CAUSE
The board is non-functioning	**Power coming into the board or could have a problem. Check connectors**
Modem is not generating Mark and Space Freq.	**No RTS or TXD coming from Host. Check edge connector, Q8, Q7 and U8.**
Transmitter turns Off after 6 seconds	**Anti-streaming is turned on and transmissions of more that 6 seconds are being used.**
No Receive Data RXD and CD LEDS off	**Check edge connector, U1, U2, and U3..**
No Receive Data no LEDs	**Check output of input filter U1 pin8, you should have a strong signal at this point.**
No Receive Data CD LED on	**Check Demodulator section. UU6.8, U6.14, and U5.14 should be close to +12v.**

Waveforms

Signal	Characteristic	Waveform
Mark Frequency	**1200Hz**	
Space Frequency	**2200Hz**	
Soft Carrier Frequency	**900Hz**	
Alternating Bit Pattern	**1720Hz**	

Symmetry	**50%**	
CTS Delay	**12ms**	
DCD	**8ms**	
Soft Carrier time	**10ms**	

Receiver Squelch Time	**6.5ms**	

Voltage Measurements

For DC Isolated Models

TP	Measurement	tolerance
TP13	5vdc	±.2vdc
TP11	-5vdc	±.2vdc
TP10	+5vdc	±.2vdc

For non-Isolated Models

TP	Measurement	tolerance
TP13	12vdc	±.6vdc
TP11	-12vdc	±.6vdc
TP10	+5vdc	±.2vdc

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