# CHAPTER 14, WHAT MODEMS TO USE.

## 14.A SUMMARY:

The traditional communication networks of the world were based on voice grade circuits, designed to transmit human speech. Telephone companies are now offering special high speed (and high cost) data communication circuits of different kinds but the old voice grade circuit still is the most commonly used for data communications.

Telemetry and SCADA systems can use voice grade circuits and high speed circuits. The voice grade circuits should be able to pass frequencies in a 3 KHz wide band. Telemetry and SCADA signals placed on these circuits, conforming to the Bell-202 modem standard, utilize frequency shift signals between 1,200 and 2,200 Hz.

## 14.B WHAT CIRCUITS ARE AVAILABLE?

Telephone company lines, proprietary cables and data radio voice grade circuits are used for communicating Telemetry and SCADA data.

Some older, direct 'metallic' copper pairs leased from the phone company are able to carry DC signals in addition to speech band signals. These are used to transmit the old DC PDM pulse duration signals used for gas measurements and for other measurements.

**WHAT IF THEY CANCEL YOUR METALLIC CABLE LEASE?**

What to do when the phone company tells you they are going to fiber optics and canceling the metallic cables your company has used for years to transmit vital PDM and 4-20 analog measurements?

Install one ScanData LMR RTU at each end of the new fiber optic channel the phone company will lease to your company. It can transmit one analog channel (and two digital channels both ways) quite inexpensively.

If you need more capacity use LMR-R RTUs or LMX, M-system or other higher capacity RTUs

The telephone companies still have a lot of buried cable with paper isolated copper wire pairs. These lines are subject to disturbances. If you lease pairs like these, you know that sudden rain storms are liable to cause interruptions to your communications.

The telephone companies have a lot of money invested in these old buried cables and are therefore reluctant to simply abandon them. Progress marches on, however, and fiber optic cables are installed all over the land.

It is safe to assume that communications with your remote RTUs and PLCs will be over cables that can transmit a 300 - 3,000 band, at least for the foreseeable future.

All data radios available for these systems are those designed to transmit the speech band, which, in essence, means the same 300 - 3,000 Hz band.

## 14.C WHY DO WE NEED MODEMS?

The only way to carry digital information in this speech band is to use a tone. This tone is modulated in one end with the digital information to be transmitted and de-modulated at the other end to retrieve the digital information. The device that performs this modulation and de-modulation is called a modem.

There are two types of Telemetry and SCADA communications. They are vastly different in operation and require totally different modems.

One type of communications is dialing the remote station, just as you dial anyone in the world over your telephone. The other is to use continuous transmission systems, leased cables, company owned cables or radio links. Dialing modems used to be referred to as 'Hayes compatible modems' and radio and cable modems referred to as 'continuous transmission modems'.

## 14.D DIALING MODEMS

A few years ago, telephone communication modems were mainly the property of the telephone company and you leased them, big, bulky and slow devices that were then hi-tech. The Hayes modem company, other modem manufacturers and the widespread use of PC computers changed all that. Small, very inexpensive and very fast modems are now sold over the counter everywhere in electronic and computer stores. Internet and other information networks are now constantly dialed by millions of computers and modems. Computers all over the world also talk directly to each other over modems.

Dialing remote RTUs and PLCs in Telemetry and SCADA systems is now also an accepted practice. Modern error detecting software has made the transfer of information and commands virtually error free, even when dialing remote stations installed in small rural telephone areas with less than perfect service.

Most RTU dialing systems use the Bell standard Bell-212 1,200 baud transfer system for maximum transfer security. The time it takes for the RTU to deliver its message at 1,200 baud is normally less than a second. This is short, relative to the total time it takes to dial the RTU. Higher baud rates would not gain any real time advantage and would only increase the complexity of the software and the possibility of missed transmissions.

**THE EXCELLENT BELL-212 STANDARD**

The Bell Telephone Company designed their old truly robust Bell-103 300 baud transmission standard to send information to remote printers with no errors. These transmissions had to go over modems with voice rubber cups and over rural telephone systems that sometimes were full of noise.

The new Bell-212 is now the 1,200 baud standard for automatic and un-attended remote RTU dialing communication. These transmissions can take a surprising amount of noise and attenuation.

Higher speed transmission standards are available, but they require compression, complex handshakes, re-transmissions and speed fall back, features which are too time consuming and complex for the short messages commonly used in SCADA RTU communication.

## 14.D.1 HOW THE CENTRAL STATION DIALS THE REMOTE RTU

The calling party program (in a laptop or PC or any computer) initiates the call by telling its modem to go off hook, to listen to dial tone and then to dial the number of the RTU.

When the RTU is dialed, it receives a ring. The built in modem in the RTU recognizes the ring and goes off hook. All ScanData RTUs with Bell-212 capability will do this, the LMX RTU, the SMR RTU and the M-system RTU.

The calling party program sends an originate tone. The RTU program recognizes this tone and sends an answer tone through its modem.

After this modem handshake has taken place, the RTU sends an opening message to the calling party, normally a plain ASCII text message such as **'READY'**, preceded by a line feed and followed by a carriage return and a checksum.

The calling party can now proceed to interrogate the RTU and to send commands, programming instructions , program data queries and other commands. The RTU will answer each string it receives with the proper answer.

The communication is normally terminated by the calling party. The RTU will stay on line as long as it receives queries and commands. It will hang up if a period of quiet elapses without any action from the calling party.

## 14.D.2 HOW THE RTU DIALS THE CENTRAL STATION

Only programmable RTUs such as the VBX-7, the SMR and M-system can be made to dial out. The phone number to dial, the condition under which to dial (certain times or on certain alarm or other conditions) must be programmed into the RTU. You therefore need a programmable RTU.

The procedure is the same as when a computer dials the RTU, except that now the RTU is the calling party. The device the RTU dials must be ready to receive incoming calls. If a computer is to be dialed, it must be on line with an automatic answer program. It should be ready to handle the incoming RTU call.

## 14.E THE MDM-202 CONTINUOUS TRANSMISSION MODEM

The MDM-202 1,200 baud modem is used for data transmissions over radio, cable, leased lines and other continuous communication circuits. It is one of the most reliable continuous transmission modems available today. This high reliability is obtained through crystal frequency control, phase coherent FSK transmissions, group delay equalization, dual filtering, automatic level controls, line isolation and double line surge protection.

**WHAT ARE THE CD, RTS AND CTS SIGNALS ON THE MODEM?**

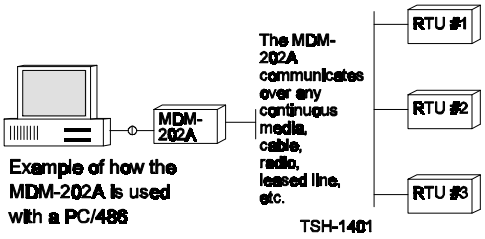
The CD, RTS and CTS RS-232 signals control the modem and tell the computer what the modem is doing.

The CD, Carrier Detect, signal tells your computer that an acceptable carrier with the proper frequency is received from the far end. Else your computer would probably try to read garbage created by noise.

Your computer sends RTS, Ready To Send, to the modem to turn the modem's carrier on and also to turn the radio transmitter on, if you are operating over radio systems.

The CTS, Clear To Send, from the modem to your computer is sent after an adjustable delay to tell your computer that it is OK to go ahead and send a message.

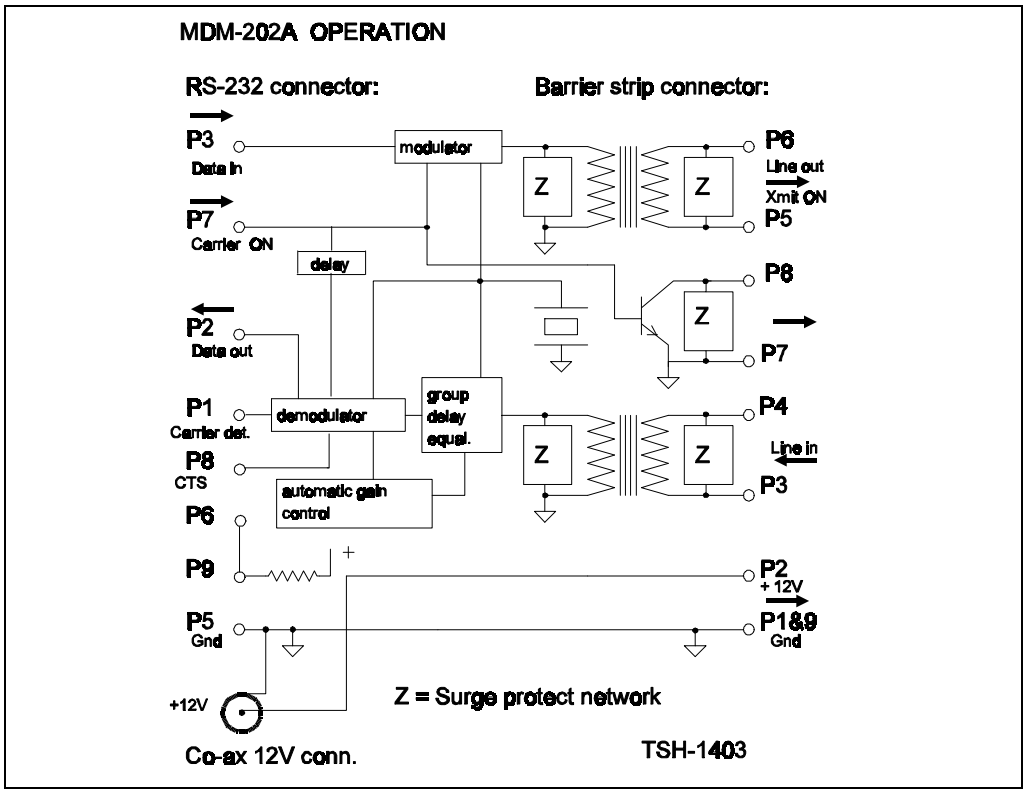
The MDM-202 is completely self contained and can be housed in an optional table top or wall mount steel enclosure. It is designed for continuous operation in industrial environments and is vibration, surge and corrosion protected. It connects between any computer, RTU or PLC serial port and any 4-wire data radio or cable communication circuit, offering reliable continuous communication in any industrial control, data acquisition, Telemetry and SCADA system.




The MDM-202A contains modulator and demodulator circuits which generate and detect Frequency Shift Keying (FSK) carriers conforming to the Bell-202 and CCITT V.23 specifications (which are used by the majority of systems in use today).

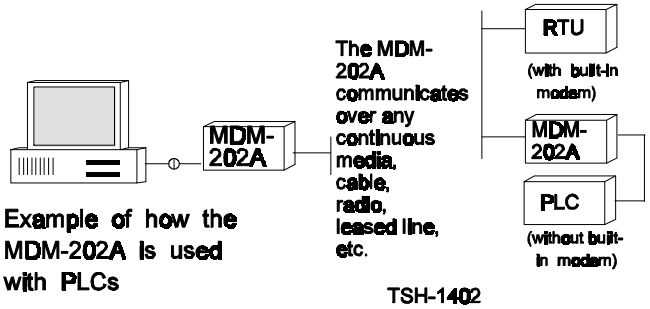
The MDM-202A can communicate with any other Bell-202 and CCITT V.23 compatible modem over virtually any distance. I effect, two modems, one at the near end and the other at the far end, communicate with each other as if there was a straight RS-232 cable running the whole distance.

In operation, the incoming RS-232 signal is converted to TTL levels and then to Bell-202 FSK signals over a crystal controlled frequency synthesizer which generates a phase coherent FSK transmit signal. This signal is passed out over an active filter into a surge protection network, an isolation transformer and a second surge protection network.




The incoming FSK signal passes through two surge protection networks and an isolation transformer into an active filter, a group delay equalizer, an automatic gain control stage and into the FSK demodulator. The resulting TTL signal is converted to RS-232 levels.

The installation and operation of the MDM-202A is simple. Connect the four transmit and receive terminals to the radio or cable. Connect the radio transmitter turn on terminals if a radio is used. Connect the RS-232 serial cable from the computer, RTU or PLC and the modem is ready to run. No adjustment or programming is necessary.



## 14.F THE MDM-202B CONTINUOUS TRANSMISSION MODEM

The MDM-202B is similar to the MDM-202A. 5 LED indicators and 2 jumpered options have been added to the design. The 5 LED indicators are:

- **Receive carrier detect**
- **RTS 'ON' (transmit carrier and radio transmitter 'ON')**
- **Power on**
- **Transmit data**
- **Receive data**

The 2 jumpered options are selected by plug in jumpers on the PC board. They are:

- **4-wire or 2-wire operation**
- **Disable received data**

Note that these jumpers are installed only to make the MDM-202B compatible with other modems that offer these two options. True 4-wire to 2-wire conversion can only be obtained by using the ScanData FSD-202A (see below and also see chapter 11).

When the 2-wire option is selected, all the data transmitted out on the 2-wire from the modulator is also received in the demodulator. This may cause difficulties for computers or PLCs that are disturbed by the received data. ScanData RTUs ignore received data during transmission times.

The 'Disable received data' option available on the board can help systems that are sensitive to received data during transmission. This option disables the receiver (demodulator) when the modem is transmitting (when the RTS made to go high). The demodulator is again enabled and made active the moment RTS goes low.

Making RTS go low creates a garbage character in the demodulator. This is similar to the garbage character generated when a radio transmitter turns off after a message is delivered. The loss of transmitter carrier invariably generates a garbage character in the receiver. Most software packages and all ScanData RTUs are programmed to ignore these garbage character.

If problems with the garbage character persist, use the ScanData FSD-202A four wire to two wire converter. The FSD-202A contains an active hybrid transformer which attenuates the transmitted data from the received data pair at least 20 db (depending on the impedance match). The transmit data from the transmit portion of the 4-wire pair is delivered into the 2-wire pair with no loss and the receive data on the 2-wire pair is also delivered into the receive portion of the 4-wire pair.

## 14.G THE MDM-153 SIEMENS COMPATIBLE MODEM

The Siemens compatible MDM-153 modem is an example of special modem designs available from ScanData.

The MDM-153 contains a modulator and a demodulator and uses FSK transmissions between 1125 Hz and 1688 Hz. Switching from '0' to '1' occurs in the middle of the band. The demodulator works down to -50 dbm. Isolating transformers are used in all branches.

The MDM-153 follows the Siemens functions closely, with bridging options available as follows:

- **2-wire or 4-wire operation**
- **Inserting a 600 ohm receive terminating resistor**
- **Inserting a 600 ohm transmit terminating resistor**
- **Inserting a 600 ohm transmit terminating resistor with carrier 'ON'**

## 14.H CONCLUSION:

The ScanData continuous transmission modems are designed for unattended operation over sometimes questionable lines subject to lightning and voltage surges. These designs are based on many years of experience. They include refinements such as automatic gain adjust, phase delay compensation, zero FSK crossings, completely HardCoat(tm) protective coated boards and other features which have given these modems world wide acceptance.

**Placing Scan-Data RTUs on the WEB.**

The UDS Device Servers allows connecting serial devices such as Scan-Data RTUs, PLCs and SCADA master station PCs to IP based Ethernet networks, quickly and easily. Using a method called serial tunneling, the UDS encapsulates serial data into packets and transports it over Ethernet. Using two UDS units, connected by a network, virtual serial connections can be extended across a facility or around the world.

There is no need to develop special software to take advantage of Ethernet networking. With virtual COM ports, mapped to remote Device Servers o the network, you can replace direct serial connections.

In modem emulation mode, the UDS is used to replace dial-up modems. The unit accepts modem AT commands on the serial port, then establishes a network conection to the end RTU or PLC, leveraging network infrastructure and bandwith to eliminate dedicated modems and phone lines.

The UDS Device Server includes a built-in WEB server, which can be used for configuration or to display operating and troubleshooting information on the attached device. When attached to the Internet, it provides links to online support.

Flash memory provides for maintenance-free non-volatile storage of WEB pages, and allows future system software upgrades.

## WHERE CAN I GET MORE INFORMATION?

Reference literature:

pri-0901.pdf Design Guide and Price List.

app-1238.pdf How the serial port and Bell-202 modems interconnect.

app-1239.pdf How to connect 4-wire modems to 2-wire cables.

mdmc0866.pdf Bell-202 cable and radio modem.

mdm-1046.pdf Bell-202 cable and radio modem with LED indicators.

pmc-1426.pdf Bell-202 plug in modem for the LMX RTU.

foi-1285.pdf Fiber optic modem.

ttsc1033.pdf Radio and cable telemetry test set.

app-1319.pdf How to distribute SCADA data on the WEB.

An easy way to get the latest and most recently updated versions of these descriptions is to go on our WEB site:

**www.scan-data.com**

When you are there, click on the blue button near the bottom of the WEB page that says **Technical Information.** Then click on the description # you need.

A good source of information on the -202 modem is:

**www.bell-202modem.com**