

Substation Automation and Protection Division

Modem Communications To ABB Relays

ABSTRACT: Advances in telephony switching systems and semiconductor technologies have made digital communication via analog public telephone systems an affordable reality. Advances from the initial Bell 202 modems operating at speeds of 300 baud to modern day V.90 modems which can theoretically operate at 56K have made fast data transfer within a substation a reality. This paper explains the theory of modern day modems and their use with ABB protective relays and configuration software. Although many manufacturer's of modem equipment are available, this application note covers the theory and application of 10 bit dial-up telephone modems. ABB does not specify specific modem vendors equipment, this application note is to be a guide to configuration of general vendor's telephony equipment with various ABB products. This application note is intended to present four examples of modem connectivity between ABB products and a personal computer.

Modem Theory

Early Modems

In the beginning, telephony operated using analog signals. The legacy public telephone network required that the standard Bell Telephone. Signals placed upon the telephone network consisted of voice communication. The channels were limited (which led to the creation of the party- line) and communication consisted of much dead time in which no activity was occurring on the expensive phone connection.

When digital computers were evolving, there came a need to interconnect the various sites for a limited period of time. Expensive digital data exchange networks were available for device interconnection. Installation of these systems for limited use was impractical due to installation costs but also for their operational costs. Some systems (such as ARPA net [precursor to the internet]) were available but only to the military and select universities. Another method had to be developed to allow general industries to communicate via a public medium.

It was widely known that Analog signals have three distinct characteristics.

- a. Frequency (which may be varied and measured in communication systems).
- b. Amplitude (which may be increased decreased).
- c. Phase (which may be shifted with respect to a particular reference at any time).

Engineers at Western Electric (the R&D arm of Bell Telephone) took advantage of these characteristics of an analog signal and created a device called a modem. MO – MODULATOR : DEM – DEMODULATOR. The public telephone network communication channel was able to carry signals from 300 Hz to 4,000 Hz. The modem translated the signal from a digital waveform to an analog waveform (modulator) and transferred it to a telephone line analog grade signal. Figure 1 illustrates this transformation. The receiving modem translated the analog signal to a digital signal (demodulator) Thus the initial methods of communicating were developed to use the operating analog bandwidth of the telephone systems. The physical interface employed for the digital interface was a recently specified RS 232 interface. For a more in depth explanation of RS 232, please reference other application notes available from ABB's FAXBACK service or WEB Site.

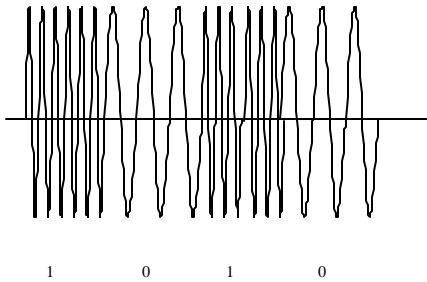


Figure 1 - Frequency Shift Keying Modulation

The first Bell 202 modems used data transmission rates from 300 Baud to 1200 baud using Frequency Shift Keying. FSK modems used one of two methods of implementation. Half Duplex FSK and Full Duplex FSK.

Half duplex FSK: One frequency band pair is used to transmit/receive data. The one modem transmitting data uses one frequency to denote a binary "1" and another to denote a binary "0". The other modem decodes the 1's and 0's for corresponding to the specific frequency. The signal is then translated from the analog encoding to the digital encoding. Turn around time is an issue when the modems switch from transmitting data to receiving data. Less of the telephone bandwidth range is used for communications, but communications are slower in that each modem must signify whether it is to transmit or receive data. One cannot transmit or receive data at the same time.

Full duplex FSK: Two frequency bands are employed. One set of frequencies represent the transmit channel (frequencies allocated to the transmitted "1"s or "0"s). The other set of frequencies are allocated to the receive channel (frequencies allocated to the receivers "1"s or "0"s). This type of encoding has advantages in that no delay results for channel turnaround delay results and that full duplex communications is possible. The first Bell 202 modems were developed using FSK.

With these limitations, FSK technologies are not used in modern modems.

Next Developments

However innovative these FSK methods were, there was still a limitation on the bandwidth of the telephone network. FSK used an entire phase in the frequency. The next innovation was to use analog to digital converters to send/receive more information at faster data rates than the maximum frequency of 4,000 Hz that a telephone system may allow. New A/D or D/A converters were able to convert signals dependent upon the phase shift of the signal. Using fast analog to digital (A/D) and digital to analog (D/A) converters made data transfer rates in excess of 4000 baud possible. Intermediate developments using the combination of phase and multiple bits could be encoded into a symbol. Four symbols could be represented by two bits. The transmission of the bits could be referenced with relation to the frequency and phase shift. For a brief time, a method using the analog signal phase shift, frequency allowed data to be transmitted/received in excess of 4000 Hz. The method was referred to as Quad Phase Shift Keying or Differential Phase Shift Keying. However, this method was short lived due to the fact that more efficient methods of data encoding were developed.

The next development which elevated modem data transfer rates to those from 9600 to 33,600 baud. The method is referred to as Quadrature Amplitude Modulation (QAM). Modern modems (such as those sold in electronics stores) use this technique in that the amplitude, phase, and frequency encode the digital bits into a symbol. A simplified explanation is provided.

Figure 2 illustrates the possible combinations of data, which may be represented by two bits. Four possible symbols may be transmitted/received using this method (as was the case with QPSK methods). If, for example a sine wave is split into four quadrants each part of the phase could represent each of the two bit combinations in an analog fashion. Thus the phase from 0 – 90 degrees could represent the value 00, 90-180 degrees could represent the value 01, 180-270 degrees could represent the value 10, and logically 270 – 360 could represent the value 11. A rapid A/D and D/A converter could determine the phase of the conversion area and determine the value depending upon the amplitude of the signal being converted. Thus, four symbols could be transferred in a single phase.

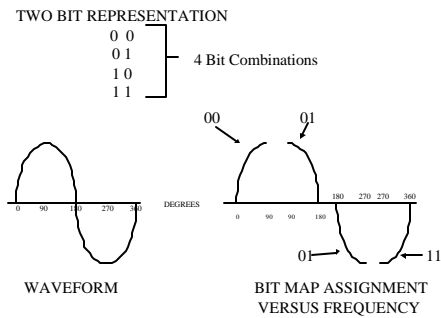


Figure 2 - QAM Analysis 4 Bit Analysis

Expanding this concept, Figure 3 illustrates what could occur if a 16 symbols could be transferred using an extended sine wave interpretation. The proper designation for this encoding is 16-QAM. Thus 16 is the number of symbols which may be expressed in one waveform. Each 1/4 cycle could represent a quadrature 00 – 01- 10- 11. Each 1/4 cycle could then be designated to two bit values depending upon the phase angle location upon the cycle. QAM modem manufacturers have a quadrature plot illustrating the phase/bit encoding which occurs in their design. This technology allows modems to transfer data at rates of 33,600 bits per second over telephone lines designed to carry voice at 4000 hz. This is pretty impressive in that the average cost of a 10 bit synchronous modem capable of operating at 56K bits per second (theoretically) is \$100.

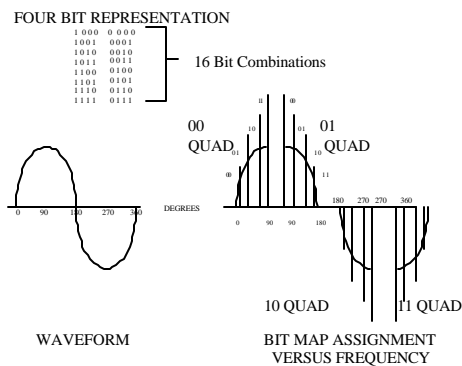


Figure 3 - QAM – 16 Bit Encoding

Another new technology used in modems is one called, Trellis Encoding Technology. One of the modems presented in this paper uses this technology which evaluates speed optimization and fast forward error detection/correction technology. Within the present V. standards, error detection/correction

and line speed balancing improves with each technology. One modem shall be used in this paper which uses Trellis Encoding Technology .

The Tricky Thing About Baud Rates

Baud rate is defined as the amount of changes a signal can undergo in 1 second. With FSK modems in the initial days of the Bell 202 modem, 1 baud = 1 bit. Today, with the complexity of modem technology, one bit does not equal one baud. As illustrated in the descriptions of DPSK and QAM, one transition of signal may not equal one baud in that two bits may represent 4 combinations, 3 bits may represent 8 combinations, 4 bits may represent 16 combinations, 8 bits may represent 256 combinations, and 12 bits may represent 4,096 combinations. Thus operation over a standard frequency 300, 600, or 2400 hertz (audio) may yield (when signals are decoded into digital signals) baud rates of up to 33, 600 bits per second.

Standards

Early modems were defined as per their operating baud rate. An international committee the ITU-T (International Telecommunications Union) developed standards defining the operation of modems. Today, the V. (VEE DOT) standard is recognized as the modem definition standard to which modems are designed. Some standards are listed below:

V.29 BIS - 2,400 Baud : 9,600 Bits per second: 2 Wire Full Duplex, 4-DSPK, 16 QAM

V.32 BIS - 2,400 Baud: 14,400 Bits per second: 2 Wire Full Duplex 64- QAM,

V.34 + - 2,400 Baud: 33,600 Bits per second: 2 Wire Full Duplex 4,096 QAM.

With the increasing complexity of modem technology, another innovation came about increasing the acceptance of telephone modem technology in circuits, Hayes AT command set. Hayes was one of the pre-eminent manufacturers of modem technology in the early 70's. They developed a command set which allowed a modem to be placed in several operational modes. Modems could be configured "on the fly" to auto-answer, change transmission/reception speeds, enable data encoding modes, dial out phone numbers as well as other capabilities.

With the introduction of the Hayes AT command set, integration of modems into more common acceptance within a variety of applications. Configuration could occur using a commonly supplied "WINDOWS" Terminal Emulator program. When the terminal connected with the modem the "AT" command could be sent to the modem with the appropriate command. Unfortunately over time there has been a deviation in the HAYES command set in that there is no such thing as a "STANDARD HAYES AT COMMAND" set.

10 Bit Versus 11 Bit Modems

Commercially available dial-up modems, such as those generally sold through chain electronic stores may be used with many of the protocols offered in the ABB Protective relays. Modems such as those allowing telephone connectivity using 10 bit protocols are generally those available inexpensively. A 10 bit telephone modem is in the cost area of \$100 (120 VAC operation) whereas 11 bit modems are in the area of cost of \$1500 (120 VAC operation) [COSTS QUOTED ARE FOR YEAR 2000]. Modems using 125 VDC power sources are much more expensive than those quoted for 120 VAC operation.

10 BIT PROTOCOL

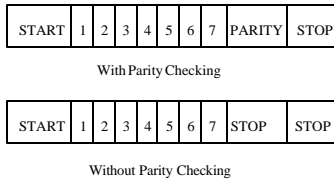


Figure 4 - 10 Bit Protocol Packet

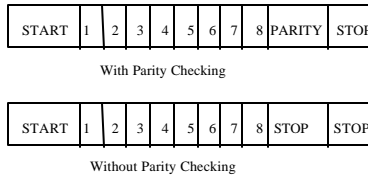


Figure 5 - 11 Bit Protocol Packet

The difference in packet size is illustrated in Figures 4 and 5. An 10 bit protocol is comprised of 1 Stop Bit, 1 Parity Bit, and 7 Data Bits or in the case of no parity, a stop bit is inserted to complete the 10 bit packet. Thus the total of bits transferred is 10 bits. 10 bit protocols usually are those encoded in ASCII. The ASCII encoding is defined to be a code from 00 to 7E (7 bits of data per character). A modem must be able to anticipate the data packet size in order to transfer the protocol bytes. A 10 bit modem is only able to reliably transmit/receive such 10 bit data packets.

An 11 Bit protocol is one in which a byte's worth of data may be transferred. An 11 bit protocol is comprised of 1 Stop Bit, 1 Parity Bit, 1 Start Bit, and 8 Data Bits or in the case of no parity an additional stop bit is substituted.. Thus byte data may be transferred using an 11 bit modem without any data encoding. This is why 11 bit data may not be transferred/received via a 10 bit modem. It is important to match the modem with the protocol being used.

Modem Cabling Options

Cabling is dependent upon the devices attached and modem control options enabled. Through the "AT" modem command set such capabilities as RTS/CTS control, CD, DTR enable is possible. However, if one requires that a standard modem setting shall not be changed from location to location, signal jumpering through the cable may be preferable. What follows are a few diagrams illustrating cable connection between some devices. If one is unsure as to the function or emulation of RS 232 please reference one of the many fine ABB application notes on the subject.

The Modem is generally a DCE RS232 device. It is configured via a personal computer using a terminal emulator program such as:

DOS OPERATING SYSTEM – PROCOMM

WINDOWS 3.1 - TERMINAL or a similar 16 bit application program commonly available.

WINDOWS 95,98, or NT – Hyperterminal or similar 32 bit application programs commonly available.

Such programs are available to be configured for handshake control, no handshake, XON/XOFF control. A variety of cables are illustrated for connection of a device to the modem for AT terminal command configuration, or device operation connectivity.

Knowledge of the RS 232 port design is important when interconnecting a modem and an IED. Also if configuration software is required to communicate and configure the device through the com port, knowledge of the software's requirement to control the RTS/CTS, CD, DSR, or DTR RS 232 lines must be known. Table 1 lists the variety of ABB products and the emulation of each of the ports and applicability of cable design.

Table 1 - Product Cable Guidelines For Connection To A Modem

PRODUCT	RS 232 Port	RS232 Emulation	CTS/RTS – DSR/DTR*	NOTES FOR MODEM CONNECTION
DPU 2000 (Front and Back Ports)	9 Pin Female	DTE	NO NO*	USE FIGURE 6 CABLE
DPU 2000R (Front and Back Ports)	9 Pin Female	DTE	NO NO*	USE FIGURE 6 CABLE
TPU 2000 (Front and Back Ports)	9 Pin Female	DTE	NO NO*	USE FIGURE 6 CABLE
TPU 2000R (Front and Back Ports)	9 Pin Female	DTE	NO NO*	USE FIGURE 6 CABLE
GPU 2000R (Front and Back Ports)	9 Pin Female	DTE	NO NO*	USE FIGURE 6 CABLE
PONI R	9 Pin Male	DTE	YES NO*	USE FIGURE 7 or 8 Cable dependent on handshake options.
REL 512 Front Port	9 Pin Female	DCE	NO NO*	USE FIGURE 9 CABLE
REL 512 Rear Port (Serial Port 1)	9 Pin Male	DTE	NO NO	USE FIGURE 12 CABLE (Modem Handshake options disabled).
REL 512 Network Port (DNP 3.0 Card)	9 Pin Female	DTE	YES** NO*	USE FIGURE 10 or 11 Cable dependent on handshake options.
RCP SOFTWARE	IBM "XT" 25 Pin Female IBM COMPAT. 9 Pin Male	USUALLY DTE Hardware Dependent	NO NO*	Sample cables are illustrated in FIGURES 12 and 13.
ECP SOFTWARE OR WIN ECP SOFTWARE	IBM "XT" 25 Pin Female IBM COMPAT. 9 Pin Male	USUALLY DTE Hardware Dependent	NO NO*	Sample cables are illustrated in FIGURES 12 and 13.
PONI M COMSET SOFTWARE	IBM "XT" 25 Pin Female IBM COMPAT. 9 Pin Male	USUALLY DTE Hardware Dependent	YES NO*	Sample cables are illustrated in FIGURES 12 and 13.

** PONI – R Card does not support DTR/DSR HANDSHAKE LINES

Additionally, Figures 14 and 15 illustrate a communication cable configuration when a Modicon PLC is connected to a Modem (as is the case when it is using a Ladder Logic XMIT block allowing the port to operate as a host device).

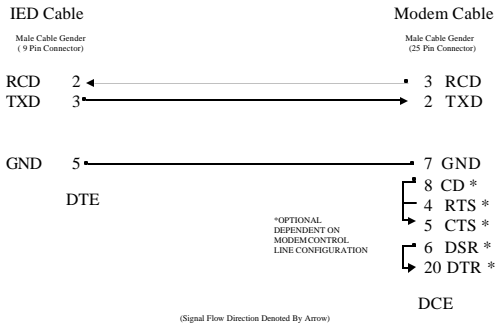


Figure 6 - Example Cable 1: GPU 2000R, TPU 2000, TPU 2000R, DPU 2000, DPU 2000R, MSOC, or DPU 1500R. It is recommended that DSR, CD, and CTS control be disabled via modem. If control is disabled, jumpers are optional as shown.

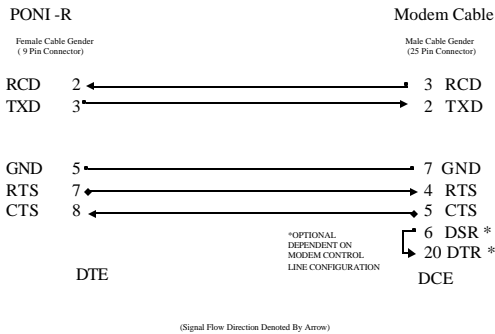


Figure 7 - Example Cable 2: ABB PONI R (installed in a REL 301, 302, 350, 352, 356 or MDAR), using hardware handshaking configured in the modem. Install optional jumper if modem configured for supplying DSR signal.

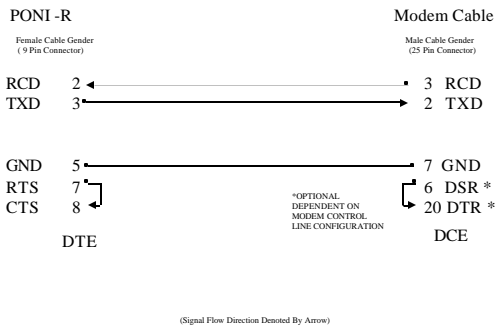


Figure 8 - Example Cable 3: ABB PONI R (installed in a REL 301, 302, 350, 352, 356 or MDAR), NOT using hardware handshaking configured in the modem. Install optional jumper if modem configured for supplying DSR signal.

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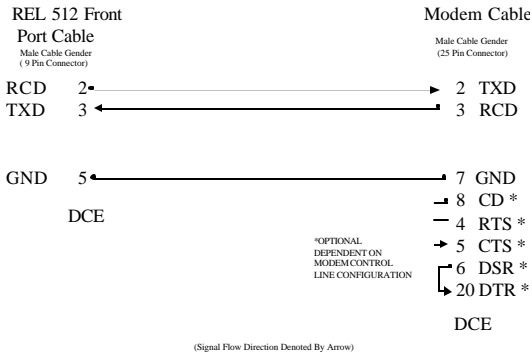


Figure 9 - Example Cable 4: ABB REL 512 Connected To A Modem Through The RS 232 Front Port. It is recommended that RTS/CTS and DSR/DTR handshaking be disabled so optional jumpers need not be installed within the cable.

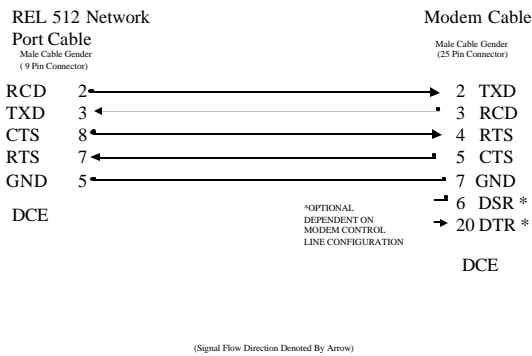


Figure 10 -Example Cable 5: REL 512 Network Port Cable Connection To a MODEM. It is advisable that the DSR/DTR control be disabled in the modem so that the optional DSR/DTR jumpers not be inserted in the cable.

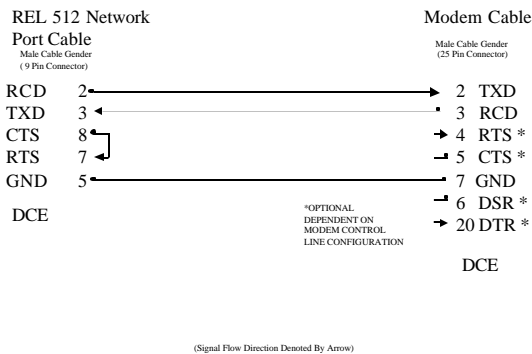


Figure 11 - Example Cable 5: ABB REL 512 Connected To A Modem Through The RS 232 Network Port With Handshaking From The REL 512 Disabled. It is recommended that RTS/CTS and DSR/DTR handshaking be disabled in the MODEM so optional jumpers need not be installed within the cable.

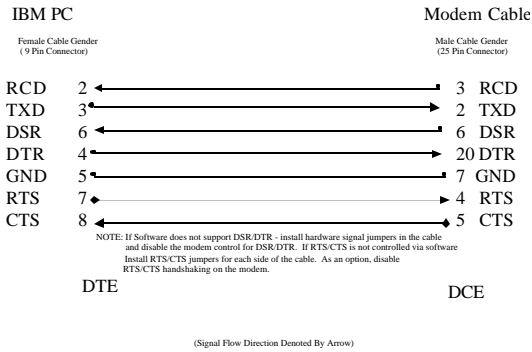


Figure 12 - Cable 6: IBM PC 9 Pin Port Cable Connecting to a Modem With Handshaking Enabled. Please refer to the NOTE for optional jumpers and modem configuration options.

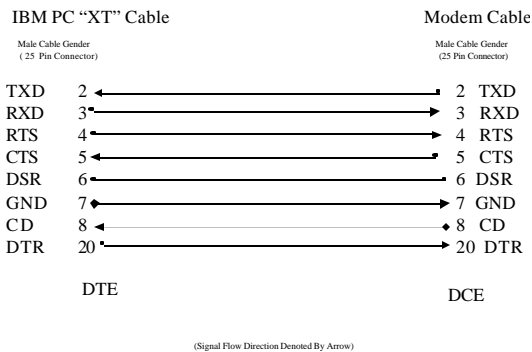


Figure 13 - Cable 7: IBM PC 25 Pin Port Cable Connecting to a Modem With Handshaking Enabled. Please refer to the NOTE for optional jumpers and modem configuration options. NOTE CHECK SOFTWARE WITH RESPECT FOR SUPPORTED RS 232 PIN HANDSHAKING OPTIONS.

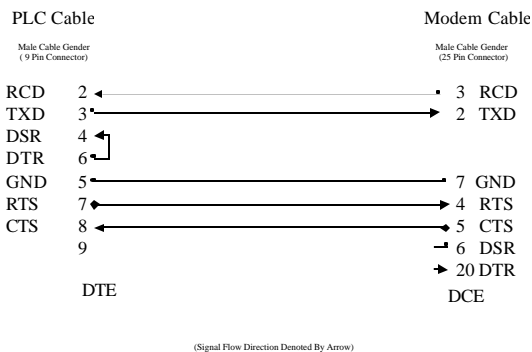


Figure 14 - Cable 8: PLC Cable Connectivity To a Modicon PLC with Handshaking Enabled On The PLC And Modem Side.

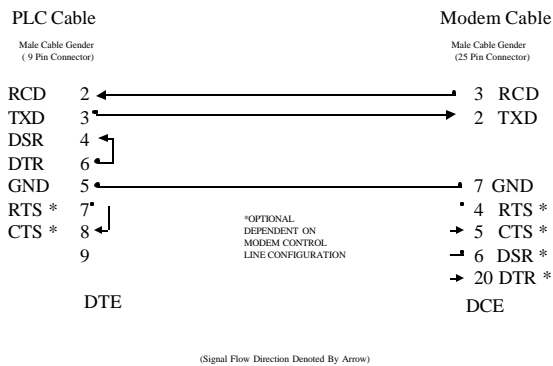


Figure 15 - Cable 8: PLC Cable Connectivity To a Modicon PLC with Handshaking Disabled On The PLC And Modem Side.

At Command Set

Within these examples, a Hayes Compatible external telephone modem from 3Com and ZOOM is used. The command sets and S Registers differ slightly based upon the chip set used. For example, the ZOOM modem uses a chipset from LUCENT TECHNOLOGIES. The description of the command set is available from the internet web-site www.lucent.com. The 3Com modem has their command set available on the Internet web-site www.3com.com : The AT "&" commands are usually the same for both manufacturers, However, the definition of the AT "X" (Where X may be a letter or a "\ " or && and a letter) commands vary widely between the manufacturers. Also the AT"S" (S register commands) register definitions vary widely between the two manufacturers.

US Robotics (3COM) 56 K (V.90 or X2) Sportster Faxmodem

The Sportster FAXMODEM is an external modem. This modem allows visualization of a variety of parameters allowing for visual troubleshooting in the event of trouble. The Sportster also has a set of dipswitches allowing for quick configuration without connection of a "Terminal Emulator" to configure the unit through "AT commands. Please refer to the web-site documents for a more complete explanation of configuration strings.

Prior to configuring the modem, attach the proper cable between the terminal emulator and the modem. One Should Type "AT" (without the quotation marks) and depress the enter key. The modem shall echo back an "OK" to acknowledge the communication. It is recommended that the dipswitches for this unit be set as follows:

- 1: Down – Data Terminal Ready Overriden (EXCEPT IF USING THE BIRT)
- 2: Down – Numeric Results Code Displayed
- 3: Down – Display Results Code
- 4: UP – Echo OFFLINE Commands
- 5: Dependent upon application – AUTO ANSWER
- 6 Down- Carrier Detect Override (EXCEPT IF USING THE BIRT)
- 7: UP – Load NVRAM DEFAULTS
- 8: Down – Smart Mode Operation

If the modem does not answer, please check the terminal emulator settings to be the following:
9600 Baud

7 Data Bits

1 Stop

Even Parity

Hardware or No Flow Control depending upon the cable selected and configuration of modem.

VT 100 Terminal Emulation

Inbound Communications : Carriage Return = Carriage Return and Line Feed

If the modem does connect, then the following command may be sent to initialize the modem to parameterize the RS 232 com ports to the proper mode as explained below.

AT=&F1

&F1 = Initialize the modem to Hardware Control Factory Defaults.

AT = &A3 &B1 &C1 &D0 &G0 &H1 &I0 &K1 &M4 &N0 &P0 &R2 &S0 &T5 &U0 &Y1

&A = Protocol Indicators Added (error control and data compression) (3 = Yes)

&B = Serial Port Rate (0= Follows Connection Rate)

&C = Carrier Detect Override (1 = Overridden)

&D = Data Terminal Ready Control (0= Overridden)

&G= Guard Tone (0 = USA & Canada)

&H = Hardware Flow Control (1 = CTS Enabled, 0 = Disabled)

& I = Software Flow Control (0 = Disabled)

& K = Data Control Compression (Auto Enable Disabled =0)

& M = Error Control (4 = Normal)

& N = Sets Connect Speed (0 = Determined by remote modem).

& P = Rotary Dial Ratio Pulse (0 = USA & Canada)

& R = RD Hardware Flow Control (RTS) (2 = Received Data To Computer)

& S = Data Set Ready Operation (0 = DSR Overridden – Always ON)

& T = Test Loop Enable (5 = Inhibits Test Mode)

& U = Floor Connect Speed (Determined by &N Codes 0 = Best Possible Speed)

& Y = Break Handling (1 = Expedited, Destructive)

For this modem, Register S0 controls the Auto-answer feature. Autoanswer is controlled via the dip-switch position 5 and a combination of the value in register S0. To change the value of auto answer pickup (number of rings) send the command:

ATS0= X, where X is the number of rings which the device shall sense for phone pickup. Note if the host is to dial out the number at all times, this parameter may be set to a "0" thereby disabling the auto answer feature.

Once the commands are written to the modem, one must write them into the modem's non-volatile memory. The command should be sent as follows to the modem:

AT=&W0

Or

AT=&W1

The US ROBOTICS Sportster Modem offers two NVRAM profiles. W0 places the parameters in to Profile 1, whereas W1 places the parameters in Profile 2.

Zoom 56Kx Dual Mode Faxmodem Configuration

The ZOOM modem offers more LED's on their external modem than the US Robotics device. However, the ZOOM modem must be configured for each parameter via a "TERMINAL EMULATOR" program. The ZOOM modem does not offer a dipswitch for configuration of the different operation modes. AT "\ commands and AT "X" (where X is a letter) performs the setup of the device.

Prior to configuring the modem, attach the proper cable between the terminal emulator and the modem. One Should Type "AT" (without the quotation marks) and depress the enter key.

If the modem does not answer, please check the terminal emulator settings to be the following:

9600 Baud
7 Data Bits
1 Stop
Even Parity
Hardware or No Flow Control depending upon the cable selected and configuration of modem.
VT 100 Terminal Emulation
Inbound Communications : Carriage Return = Carriage Return and Line Feed

If the modem does connect, then the following command may be sent to initialize the modem to parameterize the RS 232 com ports to the proper mode as explained below.

AT=&F0

&F0 = Initialize the modem to Hardware Control Factory Defaults.

AT = &C1 &D0 &G0 &K3 &Q0 &S0

&C = Carrier Detect Override (1 = Overridden)
&D = Data Terminal Ready Control (0= Overridden)
&G= Guard Tone (0 = USA & Canada)
& K = Local Flow Control (0 = Disabled, 3 = Hardware RTS/CTS, 4 = XON/XOFF)
&Q = Asynchronous Communication Mode (0 = Asynchronous Mode Buffered)
& S = Data Set Ready Operation (0 = DSR Overridden – Always ON)

For this modem, Register S0 controls the Auto-answer feature. Autoanswer is controlled via the dip-switch position 5 and a combination of the value in register S0. To change the value of auto answer pickup (number of rings) send the command:

ATS0= X, where X is the number of rings which the device shall sense for phone pickup. Note if the host is to dial out the number at all times, this parameter may be set to a "0" thereby disabling the auto answer feature.

To view the configuration, one may issue the following command:

AT=&V

&V = View Active Configuration and Stored Profile

This can view the programmed profiles.

To store this configuration, the command AT=&W0.

Refer to the document at www.lucent.com for an explanation of the AT “L” commands where L is the defined commands for dial-up, speaker control, and other modem functions.

Connectivity Example 1- TPU 2000R To WINECP Configuration Software Connectivity Example

If one was to connect a TPU 2000R to a configuration program such as WIN ECP over a long distance, a method to accomplish this is via a telephone dialup modem. As illustrated in Figure 16, a personal computer with WIN ECP is at the headquarters attached to a Public Telephone Switched Network. A standard 10 bit telephone modem is providing connection of the digital signals to the analog telephone line.

At a remote location is a TPU 2000R attached to a modem providing connectivity.

At both ends, the modem must be configured for appropriate auto- answer capabilities and RS 232 port capabilities. The protocol used to connect is ABB’s Standard 10 Byte protocol. This is a 10 bit protocol which may be transmitted asynchronously via a telephone dialup modem as those discussed via this application note. The Standard 10 byte protocol is a Master-Slave protocol. The device at the PC terminal end (WIN ECP End) sends the command dial up string whereas the DPU 2000R modem end must be configured to AUTOANSWER capabilities. If a ZOOM Modem is placed at the Host end and a US Robotics modem is placed at the IED end, the following configuration must be configured for each.

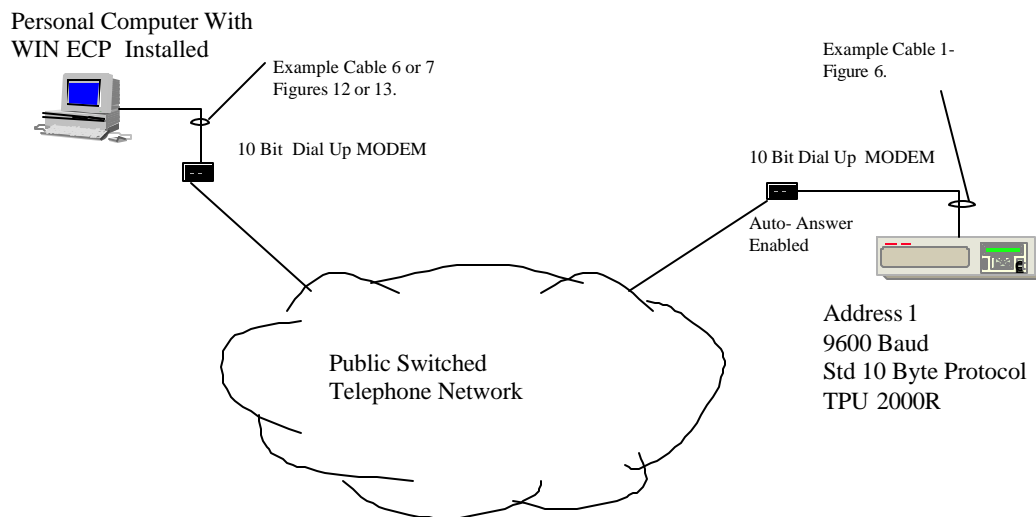


Figure 16 – Application Topology Diagram PC TO TPU 2000R Point To Point.

Figures 17 and 18 illustrate the WIN ECP screens required for connectivity to the device upon dial up. Upon execution of the ABB WIN ECP program, the initial screen shown in Figure 17 appears. One should select Remote Access which allows attachment to the remote modem if the proper AT command strings and numeric dial out instructions are given.

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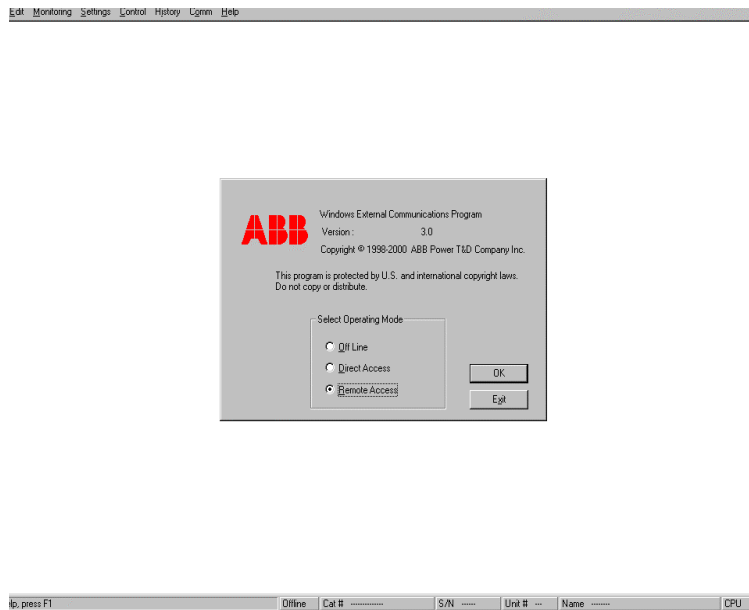


Figure 17- Initial ABB WIN ECP Access Screen

If one depresses the OK button after selecting the WINDOWS RADIO button Selection for Remote Access, the screen as illustrated in Figure 18 appears.

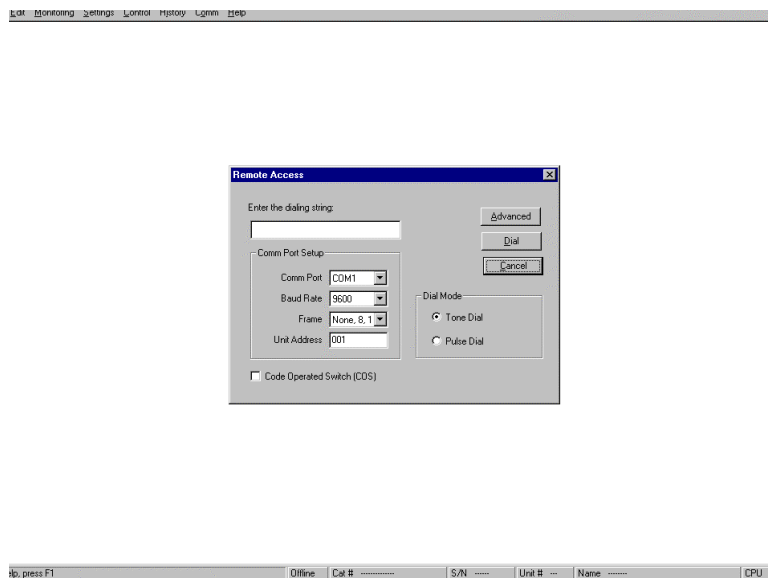


Figure 18 - Parameter Selection Screen For Remote Dial – Up Access

The COM PORT is that of the PC's modem port for attachment to the phone line.
The Baud Rate is that for the remote modem and must match that of the Standard 10 Byte port which the modem is attached to the TPU 2000R.
The Frame is that selected for the Remote TPU 2000R.
The Unit Address is the unit address of the Remote TPU 2000R node.

If Pulse Dial is selected, then the the Modem Command for sending the Pulse command is sent when dialing the number, otherwise, if Tone Dial is selected the command ATDT is sent to prefix the modem dial out string. In this case, the Tone Dial selection is activated.

The dialup string is:

ATDT ,,,18005551212 (the substation number of the remote device)

To hang up the device the WIN ECP program must be able to send the command:

ATH0

Additionally, one must be sure that the appropriate modem configuration strings have been accepted by the modem for correct handshake control and remote auto answer configuration.

Connectivity Example 2– REL 3XX TO RCP Configuration Software

If one wished to connect an ABB transmission relay such as a REL 300 (MDAR), REL 301, REL 302, REL 350, REL 352 or REL 356 to its configuration software (RCP – Remote Communication Program), using a dial up configuration as illustrated in Figure 19 is quite possible. The REL transmission relay uses a PONI R card for direct point to point communication via a cable or a modem. Please reference Instruction Leaflet 40-603 titled RCP Communication Program Users GUIDE and Instruction Leaflet 40-610 titled RS-PONI RS 232 Product Operated Network Interface User’s Guide.

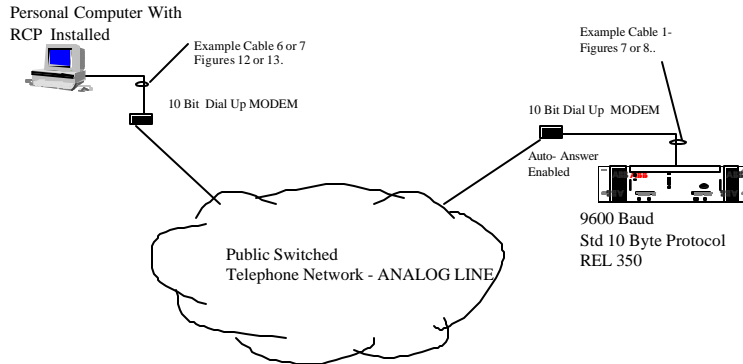


Figure 19 - RCP TO REL 350 Communicatation Topology Example

In this example, a REL 350 shall be connected together with two US ROBOTIC Model 005686 Sportster Modems as described previously in this application note. RCP software shall be configured to communicate to the REL 350 via the aforementioned modems. Several steps are to be completed in this example.

1. Configure the PONI R dipswitches to correspond to the appropriate baud rates of the modem and RCP software.
2. Attach the correct cables as to the relay devices as indicated in Figure 19. In this example however, we shall disable handshaking (RTS/CTS) in the modem, so a straight through DTE to DCE cable is necessary.
3. Configure the US ROBOTIC modems to enable/disable the appropriate features.
4. Configure the RCP software to connect to the modem and enable communications.

5. Execute the communication command sequence and establish communications.

STEP 1

In this example, the communication baud rate selection shall be set for 9600 baud. The baud rate of the PONI R card is configured via dipswitches located at the rear of the card, consult the PONI R manual referenced in this document. Also configure the PONI R card for NO COMMAND ISSUED mode. If one is to view the dipswitches of the PONI R (installed in the REL 350) card, the four dipswitch positions (left to right) are upward, and the rightmost dipswitch is downward. This corresponds to dipswitch positions 1 through 5 being 1 0 0 0 0 or ON, OFF, OFF, OFF, OFF. The PONI R CARD is now configured.

STEP 2

As per Figure 19, connect the cables as indicated for the personal computer to modem and the REL 350 PONI R to modem connection. In this example, the handshaking shall be disabled on the PONI R card modem. Thus even using standard off the shelf cables (9 to 25 pin cables with each pin run straight through) shall operate in this example.

STEP 3

Now the modems shall be configured. Using the HYPERTERMINAL program supplied with Windows 95, 98, NT or 2000 can be used to configure the modems. Using hyperterminal as illustrated in Figure 20, one can issue the AT commands to configure the modem.

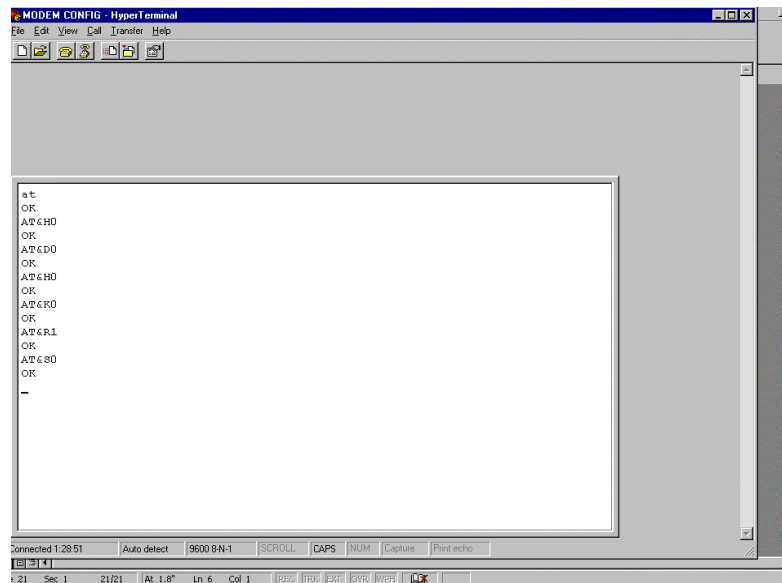


Figure 20 - Hyperterminal At Command Set Example

Each modem must be configured in this method. The modem parameters and dipswitch settings shall be covered for each modem location.

Dipswitch Settings For The Modem Local To RCP:

- Modem Dipswitch Position
- Position 1 UP – Data Terminal
- Position 2 UP – Verbal Results Codes
- Position 3 DOWN – Display Results Codes

Position 4 UP-Echo Offline Commands
Position 5 DOWN – Disable auto answer
Position 6 DOWN – Carrier Detect Override
Position 7 UP – Load NVRAM defaults
Position 8 DOWN – Smart Mode

Dipswitch Settings For The Modem Local To The REL 350/ PONI R card:

Modem Dipswitch Position
Position 1 UP – Data Terminal
Position 2 UP – Verbal Results Codes
Position 3 DOWN – Display Results Codes
Position 4 UP-Echo Offline Commands
Position 5 UP – Auto Answer on the first ring, or higher if specified in NVRAM
Position 6 DOWN – Carrier Detect Override
Position 7 UP – Load NVRAM defaults
Position 8 DOWN – Smart Mode

In setting the modems via the AT command set, it was determined that the modem closest to the computer executing the RCP program shall use the factory defaults of the modem right out of the box. If one was to view the USROBOTICS troubleshooting guide (available on the www.3com.com website) the factory defaults are listed in the downloadable files.

For the modem attached to the RCP program, one must change a few parameters within the modem to ensure connectivity. Starting with the factory default settings with the modem right out of the box, one should issue the AT commands:

```
AT&H0&D0&K0&R1&S0
```

Which corresponds to the following definitions as designated in the USROBOTICS literature:

```
&H0 = Flow Control Disabled  
&D0 = DTR Override (Default)  
&K0 = DATA COMPRESSION DISABLED  
&R1=MODEM IGNORES RTS  
&S0 = DSR OVERRIDE ALWAYS ON
```

As stated previously, other commands could be issued to the modem to allow it to peacefully co-exist and operate with the PONI R card. It is highly recommended to write the settings to the EEPROM in the modem by issuing the AT&W 1 or AT&W2 command

STEP 4

The RCP program must now be configured to operate with the modem and issue the commands. The steps to use this are as follows:

One must start RCP and enter the standard start screen as illustrated in Figure 21.



Figure 21 – RCP Standard Setup Screen

One must configure a substation file for the REL 350 connection. Depress the Alternate key and S simultaneously to enter the Substation menu and depress the down arrow ↓” once to select “ New Substation File” menu selection as illustrated in Figure 22.

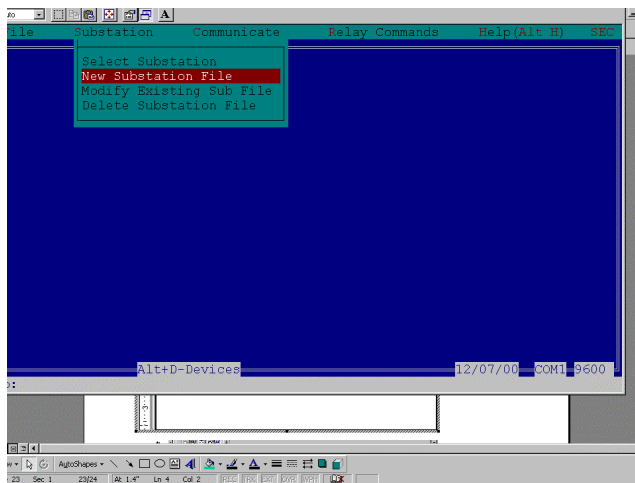


Figure 22 –New Substation Setup Screen

A file must be configured for the REL 350 connection. Since a PONI R card is not addressable, it is considered a point to point device. As illustrated in Figure 23, one must pick an option for the configuration . In our example (as shown in the topology of Figure 19), although the REL 350 is networked through a modem, the connection is still point to point, one must select the selection “1” to allow correct connectivity. Figure 23 illustrates the screen queries and answers for this specific example.

As illustrated in Figure 24, the operator must supply additional configuration data. Figure 24 lists the configuration responses for this example. Configuration data to be supplied is as such:

RELAY TYPE – in this case selection 5 (REL 350) is selected.

DEVICE DESCRIPTION – This field is used only for documentation purposes.

LOGON SEQUENCE – In this example, the ATDT command is used for a pulse tone telephone system. Also in this example, an analog system is used and an additional prefix of “9” must be dialed to access the external public telephone system, the comma “,” is used to insert a delay before dialing the telephone number of the remote location (where the REL 350 resides). In this instance, the substation is located in a telephone overlay area where the area code must be dialed with the main number. Additionally, since the remote modem is resident at an analog extension, several commas “,” are added to create a delay for the phone line to transfer to that extension and then synchronize with the remote modem. A query is generated to accept the configuration and a request for the file name to store the information is then requested (without the operating system file extension).

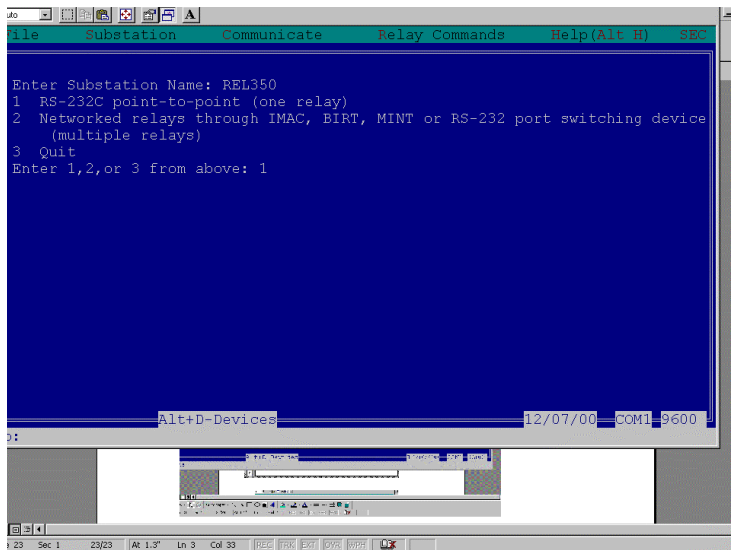


Figure 23 – Initial Substation Configuration Screen

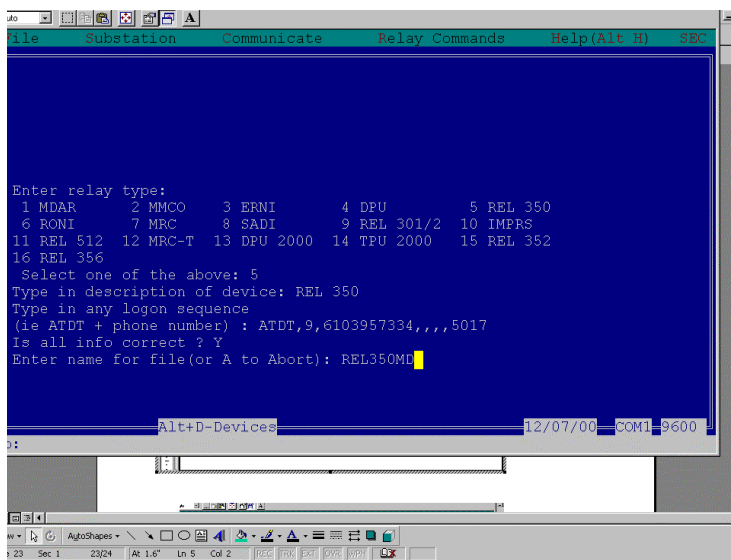


Figure 24 – Final Substation Configuration Screen Query

One must then configure the RCP program to execute the dial up sequence and configure the personal computer communication port selected. One must depress the Alternate key and “C” key simultaneously to access the “COMMUNICATE” menu shown in Figure 25.

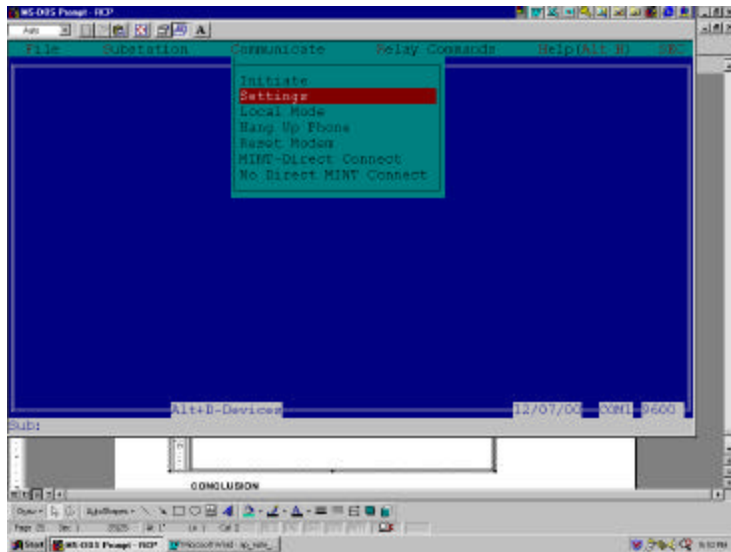


Figure 25 – Communicate Menu Selections

One should depress the down arrow key “↓” once to select the settings menu to configure the port type, baud rate, and communication port selection as illustrated in Figure 26.

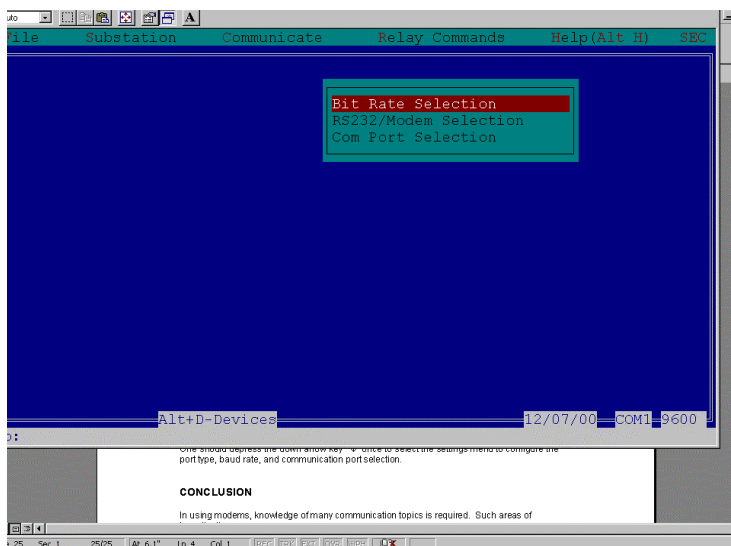


Figure 26 – RCP Settings Selection Screen

For this example, one must configure the RCP program for the same parameters as the PONI R card, in other words, 9600 Baud. (Selection 9 in the Bit Rate Selection Submenu) shown in Figure 27 .

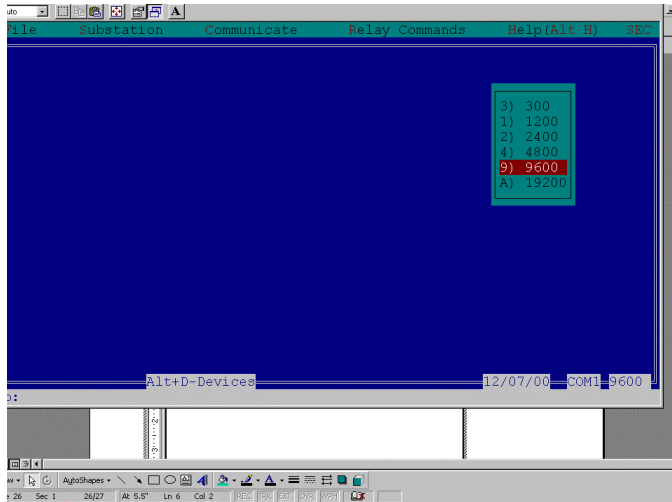


Figure 27 – Communication Baud Rate Setting Screen

Execute the same procedure to access the RS232/MODEM Selection submenu. The selection for modem must be selected. By using this selection, the query for ATDT dial out command screen will be issued when issuing the connect command prompt.

Figure 28 illustrates the screen presented for the RS 232/ MODEM prompt.

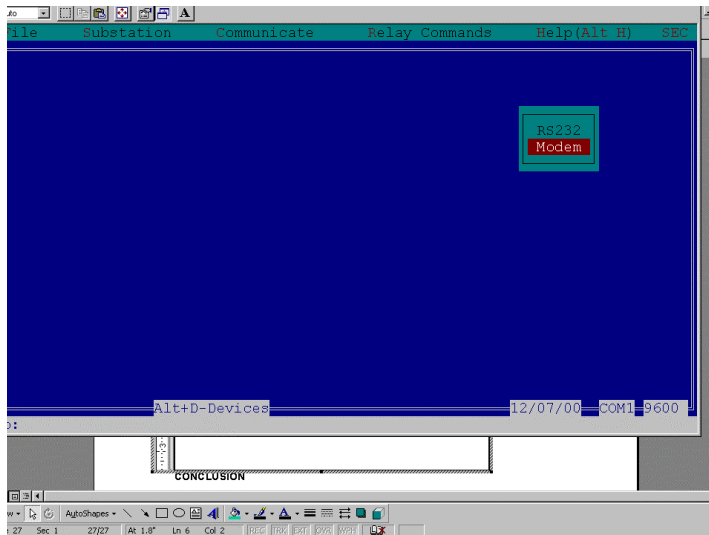


Figure 28 – MODEM/RS 232 Screen Prompt Selection Submenu

The COM PORT Selection menu must be used to select the PC computer port through which RCP will issue commands. In the sample case, the PC used has only one com port port “1” . The selections for the communication port parameters are shown on the bottom right hand side of the communication screen.

One must now select the previously configured file for operation. Simultaneously depress the “ALT” and “S” keys on the keypad to select the Substation Screen as illustrated in Figure 22. Highlight the “SELECT

SUBSTATION” selection. The screen as shown in Figure 29 will be presented. As illustrated, the file REL350md .sub is available for selection. Depress the right arrow key “→” twice to select the file (highlighted as shown) and depress the enter key. Depress the enter key again to select the REL 350 description of the intended IED to be attached.

Finally, one must initiate communications with the relay. Depress the alternate “C” keys simultaneously to view the menu as illustrated in Figure 25. Highlight the “INITIATE “ selection and depress the enter key to display the dial out query shown in Figure 30.

Notice that the dial out telephone number is visible. Depress the “Y” key on the keyboard to initiate communications. One should notice a black screen as illustrated in Figure 31 which follows. Once the modem connects end to end, one will be prompted to depress the enter key to return to the main screen as shown in Figure 21. One may then proceed to the “RELAY COMMANDS” menu to query the relay for information. The modem is configured to operate the speaker (there is a volume control on the left hand side of the modem as one faces the front of the modem) until connection occurs.

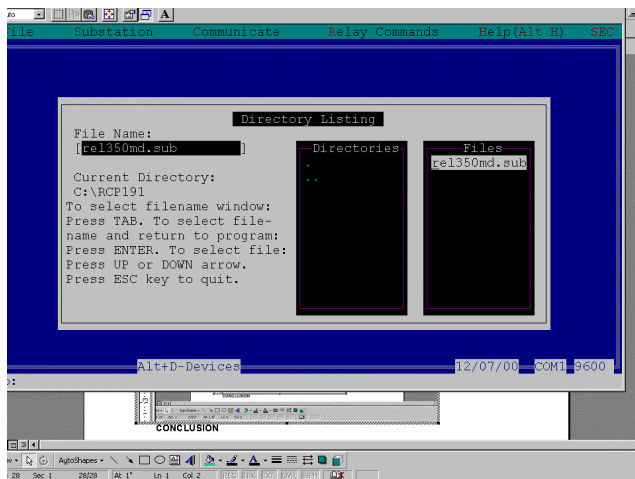


Figure 29 – Substation File Selection Screen

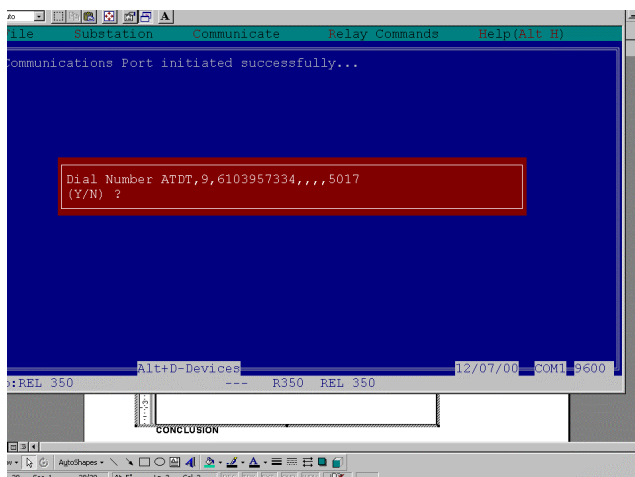


Figure 30 – Dial Out Initiation

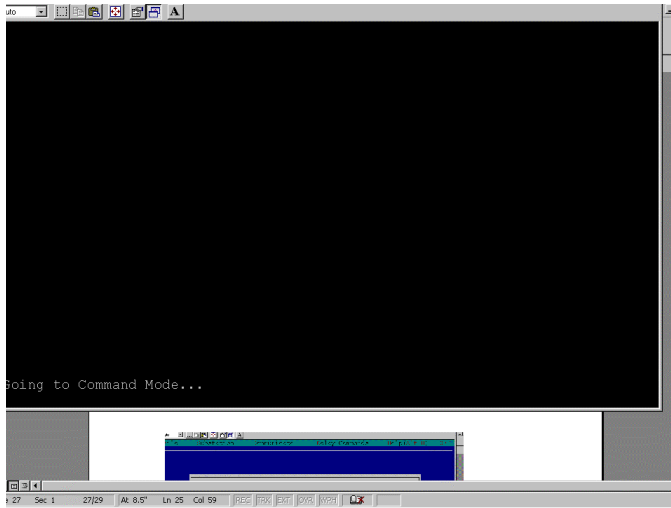


Figure 31 – Modem Command Mode Screen Upon Device Connection

At the conclusion of the communication session, one must remember to “hang up” the modem and disconnect the device. Depressing the Alternate key and the “C” key simultaneously will display the screen as illustrated in Figure 25. Use the down arrow “↓” to select the “HANG UP” selection. The program will issue the AT&H0 command.

Example 3 – Connection Of A REL 512 ASCII Front Port To Hyperterminal Software

PREFACE - The REL 512 differs from the other two relays presented in EXAMPLE 2 and EXAMPLE 1 above. The communication port is a master/slave port design. The configuration port uses ASCII strings in that a dumb terminal interface is able to attach and display the device settings/metering parameters The REL 512 sends out (via its RD line) a time/date ASCII string every minute for display on the attached device. This fact is very critical in that the modem or device attached must be able to tolerate this string. Additionally, the REL 3XX products or the TPU/DPU 2000R , GPU 2000R or DPU 1500R communication ports are slave only in their protocol design. The port only responds to requests. The REL 512 differs in that it sends out at time string without any prompting to the attached device.

The REL 512 also uses a numeric character or alphabet character to move through its menus. The other devices discussed in the other examples use protocols and do not respond to the attached device strings. The REL 512 will respond to each character. As shown in this example, the attached device (in this case the modem) must be able to tolerate this operational characteristic.

The REL 512 has settings capabilities configurable and viewable via its front com port (which is a DCE RS232 port) or its front panel interface. Any dumb terminal emulator is able to connect to the front port and synchronize with the unit to allow visualization of the REL 512 parameters. Within this example, two USROBOTIC model 002806 (V.EVERYTHING modem using trellis technology encoding [which differs from the QAM encoding]). As illustrated in Figure 32, the modems are configured via a point to point connection. The REL 512 ASCII protocol is not addressable and therefore cannot be multi-dropped unless port switch devices are added to the system. The steps to establish communications are:

1. Connect the correct cable between the REL 512 front and the modem.

2. Connect the correct cable between the PC executing the HYPERTERMINAL program (in this case the operating system used is WINDOWS 95).
3. Parameterization of the REL 512 front port communication parameters.
4. Parameterization of the HYPERTERMINAL settings.
5. Parameterization of the USROBOTICS modems using its particular AT command set.
6. Execution of the connectivity procedure to establish communications.

As illustrated in Figure 32, the topology of the REL 512 interconnection with the HYPERTERMINAL software is illustrated. Please note on the diagram, the appropriate cables used to connect the device. In this example, the communication handshaking cannot be used since RTS/CTS, DCD, DSR, DTR signals are not supported on the REL 512 front communication RS 232 port.

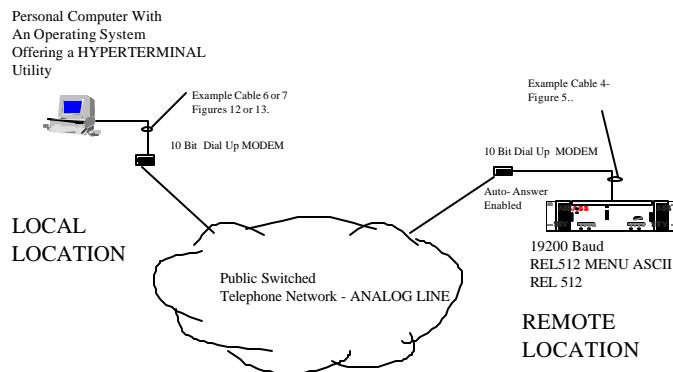


Figure 32 – Modem Connection Between A REL 512 Front Port And Hyperterminal Configuration Software

Step 1 And Step 2: Attach the Correct Cables to the Devices

Connect the cables as illustrated in Figure 32 above.

Step 3: Configure the REL512 Communication Port

Configure the front port interface of the REL 512 with the correct parameters. The standard configuration for the REL 512 is:

8 Data Bits
No Parity
2Stop Bits
9600 Baud.

Configure the front port with these parameters:

8 Data Bits
No Parity
1Stop Bit
19200 Baud.

The procedure to configure the front port interface is as follows:

When connecting a device to the front port of the relay, the communication parameters for the port must be changed to reflect those of the device to which it is connecting. To change the parameters via the REL 512 front panel interface one could follow the procedure as follows:

1. From the screen of the Front Panel Interface viewing the meter readings, Depress the "E" key to get the menu :
 - E Fault Records
 - Device Info
 - ← Edit Settings
 - C Metering
2. Depress the Left Arrow Key "←" to Display the Menu
 - E Edit Settings
 - Fault Records
 - ← View Settings
 - C Metering
3. Depress the "E" Key to display the menu
 - E Password
 - *****
 - C Edit Settings

One must enter the CORRECT password to change the relay settings for this procedure. The default password for the REL 512 is "ABB" (without the quotation marks). If the password has been changed, please enter the correct password as follows:

- Depress the up arrow "↑" or down arrow "↓" to page through the numeric and alphabet selections for the password.
- Depress the left arrow "←" or the right arrow "→" to move through the different positions of the password.

4. Depress the " E" key to accept the password selection you have entered. If the password is accepted the following screen shall be visible.

```

E      Password

←      Accepted
C      Edit Settings
    
```

5. Depress the left arrow "←" key to accept the settings and proceed to the next menu which is shown

```

E      Sys Settings
→      Act Settings

C      Edit Settings
    
```

6. Depress "E" so that the System Settings may be changed. The following menu item shall be displayed:

```

E      CHG ACTIVE GRP
→      IDENTIFICATION

C      System Settings
    
```

7. Depress the right arrow key "→" to display the following screen:

```

E      IDENTIFICATION
→      SYSTEM PARAM
←      DATE & TIME
C      Sys Settings
    
```

8. Depress the right arrow key “→” to display the following screen:

E SYSTEM PARAM
→ COMM PORTS
← IDENTIFICATION
C Sys Settings

9. Depress the right arrow key “→” to display the following screen:

E COMM PORTS
→ DATA RECORDING
← SYSTEM PARAMS
C Sys Settings

10. Depress the “E” key to display the following screen:

E FRONT PORT
→ REAR PORT
← MODBUS ID
C COM PORTS

Since this example is a guide to configuring the communication settings for the FRONT COM ASCII port, please refer to step 11 for FRONT PORT CONFIGURATION INSTRUCTIONS.

11. Depress the “E” key to display the following screen:

E FRNT BIT RATE
→ FRNT DATA LGTH
← FRNT STOP BITS
C FRONT PORT

12. Depress the “E” key to display the following screen:

E ENTER
System Group
← 115200
C FRNT BIT RATE

By depressing the “←” left arrow key, one can view the baud rate selections for the REL 512 front port interface. The available selections are:

115200
2400
9600
19200

Select the desired baud rate by depressing the “E” key.

13. Depress the “C” key to display the following screen

E FRNT BIT RATE
→ FRNT DATA LGTH
← FRNT STOP BITS
C FRONT PORT

14. One must then select the Front panel data length depress the “→” to reveal the following screen.

E FRNT DATA LNGTH
→ FRNT PARITY
← FRNT BIT RATE
C FRONT PORT

15. One must select the Front Port Data Length. Depressing the “E” key allows visualization of the following menu.

```
E    ENTER
      System Group
←    8
C    FRNT DATA LNGTH
```

Depressing the left arrow key “←” allows the operator to select from the following data lengths:

```
8
7
```

16 Depress “E” to accept the parameters and then depress the “C” to return to the menu:

```
E    FRNT DATA LNGTH
→    FRNT PARITY
←    FRNT BIT RATE
C    FRONT PORT
```

17. One must set the parity by depressing the left arrow key “←” to display the following screen.

```
E    EDIT PARITY
→    FRNT STOP BITS
←    FRNT DATA LNGTH
C    FRONT PORT
```

18. Depress “E” to display the following screen

```
E    ENTER
      System Group
←    NONE
C    FRNT PARITY
```

By depressing the left arrow key “←” the choices for parity are displayed. The choices for selection are:

```
NONE
ODD
EVEN
```

19. Depress the “C” key to display the following screen

```
E    FRNT BIT RATE
→    FRNT DATA LGTH
←    FRNT STOP BITS
C    FRONT PORT
```

20. Depress the left arrow key “←” to select the Front Panel Stop Bit selections. The following Screen should be visible.

```
E    ENTER
      System Group
←    1
C    FRNT STOP BITS
```

The selections for Stop Bits are 1 or 2.

21. Depress the “E” key to accept the selections.

22. Depress the “C” key to back out of the relay and accept the settings when prompted by the front panel Interface.

Step 4: Configure Hyperterminal

Configuration of HYPERTERMINAL requires a few easy steps. The same configuration of hyperterminal may be used for two tasks:

- Configuration of the MODEMS with the AT command sets.

- Dial out and query of the REL 512 MENU ASCII SCREENS for device configuration and file retrieval.

The REL 512 FRONT port as illustrated in TABLE 1 does not offer handshaking. Therefore, setup requires that no handshaking be used for HYPERTERMINAL. HYPERTERMINAL MUST BE SET UP WITH COMMUNICATION PARAMETERS WHICH MATCH THAT OF STEP 3 ABOVE, namely:

- 8 Data Bits
- 1 Stop Bit
- No Parity
- 19200 Baud

The steps to accomplish this are as follows:

1. Select HYPERTERMINAL from the WINDOWS menu to reveal the following screen illustrated in Figure 33.
2. Select the icon labeled Hyperterminal.exe The screen illustrated in Figure 34 should be visible. The operator will be prompted for a name as illustrated.

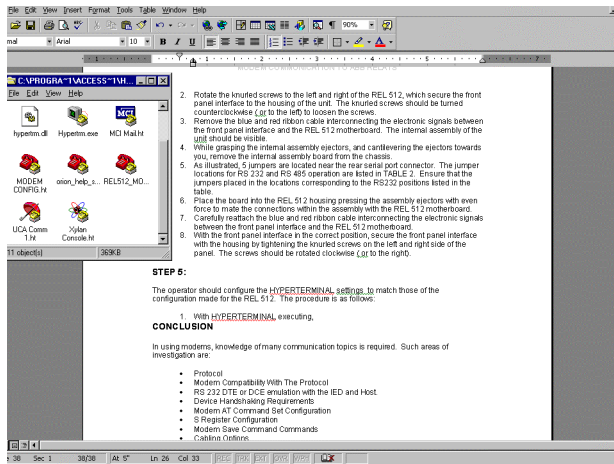


Figure 33 – Hyperterminal Selection Screen

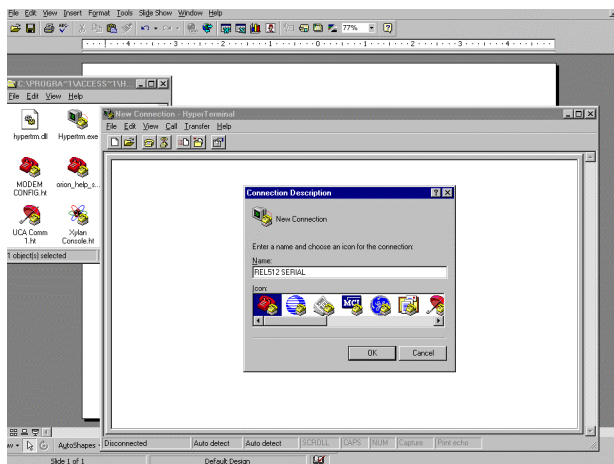


Figure 34 – Hyperterminal Setup Screen

3. Once the OK icon has been depressed, the screen for port setup will be displayed. Note that the port setup menu is illustrated for display and COM 1 selection is highlighted for this example and selection. Notice that with the MODEM selection (for the built in computer internal modem) deselected, the some of the fields are "greyed out".
4. The COM properties for the modem must be selected for this example to those selected for the REL 512. In this case the same settings configured for the REL 512 in STEP 3 are selected for the interface. Notice that the settings are selected in Figure 35 for those configured in STEP 3. Notice for this example, hardware handshaking is enabled for RTS/CTS configuration (since HYPERTERMINAL TO MODEM CONFIGURATION IS OCCURRING NOTE: REL 512 DOES NOT HAVE HANDSHAKING AND THE MODEM WILL BE CONFIGURED AS SUCH).
5. Once the OK pushbutton is depressed, the screen depicted in Figure 37 is presented to the operator. AT commands can now be typed to configure the modem with the appropriate parameters for operation in this system.

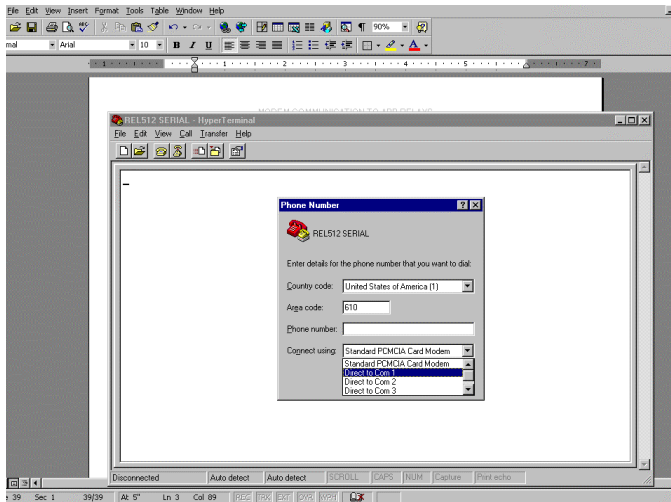


Figure 35 – Com Port Configuration For Attachment Of Hyperterminal Session

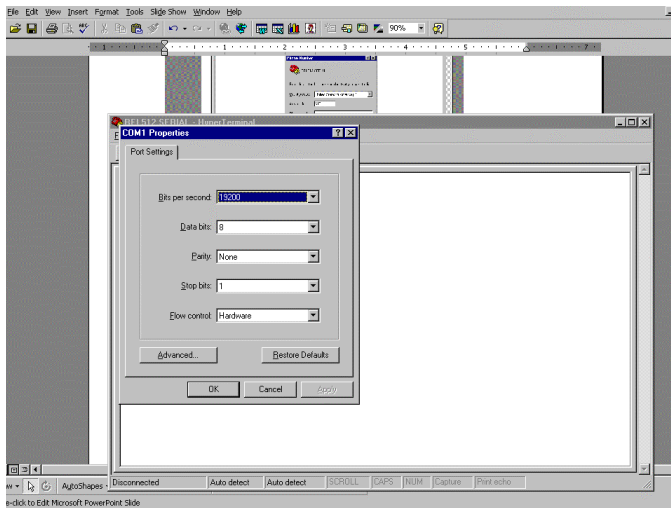


Figure 36 – Com Port Settings Configuration Screen

The configuration process for this step is now complete.

Step 5 – Configuration Of The Modem Parameters For The Local And Remote Sites

THE USROBOTICS modems used (Model 002806- V.Everything) have commands similar to those of the previous USROBOTIC modems. Several differences are apparent with respect to their “S” register configurations and auto configurability. Additional sessions may be set up to allow remote configuration. However, it is strongly advised that remote configuration and automation dial up capabilities not be used with the REL 512 since difficulties may result since handshaking is not available.

Another word of caution should be issued in that the V.Everything modem may experience difficulties connecting with the REL 512 master/slave emulation of the port during dial-up sessions. IF the MODEM is undergoing the attachment process and the REL 512 happens to send out its time ASCII string to the MODEM simultaneously, the modem will disconnect and display the prompt “NO CARRIER” at the host site. This process will take a few minutes to occur and until this occurs, no communications will occur. If a command string is sensed via the SD line (remote modem LED will illuminate) during the dialing process, the remote modem will hang up (the remote modem OH [On Hook] LED will extinguish. There is no way to overcome this limitation in operation with this model of modem.

Some important words covering the configuration of the MODEM when used with the REL 512:

- DISABLE DTR (&D0)
- USE THE DEFAULT DISABLE OF SOFTWARE FLOW CONTROL (&I0)
- DSR ALWAYS ON (&S0)
- DISABLE CARRIER DETECT (&C0)

Thus the command string should look like this:

```
AT&D0&S0&I0&C0&W
```

Note the &W writes the current setting to the Non-Volatile RAM.

Additional tips are covered in the following tips for LOCAL modem configuration (that modem attached to the HYPERTERMINAL Personal Computer) and the REMOTE modem (that modem attached to the REL 512). Attach the cable from the PC to the modem undergoing the configuration process. It is advisable to label each modem location since the LOCAL modem will be configured slightly differently from the remote modem.

Local Modem

Local Modem parameters are illustrated in Figure 37. To display the current list of parameters, the command string AT&I4 should be typed in the HYPERTERMINAL environment . A list of the parameters used is shown. The LOCAL modem also may be configured via the dipswitches located underneath the relay.

Dipswitch Positions are:

POSITION 1 –UP = DTR Always ON
POSITION 2 –UP =VERBAL RESULTS CODE
POSITION 3 –DOWN = DISPLAY RESULTS CODE
POSITION 4 –UP =ECHO OFFLINE COMMANDS
POSITION 5 –DOWN =SUPPRESS AUTO ANSWER

POSITION 6 –DOWN = CARRIER DETECT OVERRIDE
 POSITION 7 –UP =DISPLAY NORMAL RESULTS CODE
 POSITION 8 –DOWN =ENABLE AT COMMAND SET
 POSITION 9 –UP =NO DISCONNECT WITH +++
 POSITION 10 –UP =LOAD NVRAM DEFAULTS

NOTE this local modem is only configured for DIAL OUT capability – no auto answer. Additionally, all commands are echo'd back to the terminal for easy access and troubleshooting. Upon Power UP the NVRAM defaults are loaded into memory. It is also illustrates in Figure 33 that handshaking is enabled. No other parameters have been changed from the default settings.

```

ATZ
VZRobotics Courier V.Everything Settings...

B0 C1 E1 F1 M1 Q0 V1 X7
BAUD=19200 PARITY=N WORDLEN=8
DIAL=HUNT ON HOOK TIMER

&A3 &B1 &C0 &D2 &E0 &H1 &I0 &K1 &L0 &M4 &N0
&P0 &R2 &S0 &T5 &U0 &X0 &Y1 &Z6 #CID=0

S00=001 S01=000 S02=043 S03=013 S04=010 S05=008 S06=002 S07=0 60
S08=002 S09=006 S10=014 S11=070 S12=050 S13=000 S14=001 S15=000
S16=000 S17=000 S18=000 S19=000 S20=000 S21=010 S22=017 S23=019
S24=150 S25=005 S26=001 S27=000 S28=008 S29=020 S30=000 S31=000
S32=009 S33=000 S34=000 S35=000 S36=000 S37=000 S38=000 S39=000
S40=000 S41=000 S42=126 S43=200 S44=015 S45=000 S46=000 S47=000
S48=000 S49=000 S50=000 S51=000 S52=000 S53=000 S54=064 S55=000
S56=000 S57=000 S58=000 S59=000 S60=000 S61=000 S62=000 S63=000
S64=000 S65=000 S66=000 S67=000 S68=000 S69=000 S70=000

LAST DIALED #: T9,6103957334,,,,5017

OK
  
```

Figure 37 – Local Modem Configuration Parameters

Remote Modem

The configuration requirements for the remote modem vary slightly from the local modem. The configured commands in the REMOTE modem are illustrated in Figure 38. The parameters configured in your remote modem may be accessible using the command AT&I4. It is important to connect the HYPERTERMINAL program to the modem being configured as REMOTE to accomplish this. It is also advisable to label the modem as being a REMOTE device for identification purposes only.

The remote modem should have all its handshaking requirements turned off. Additionally, the COMMAND MODE ECHO and the ONLINE MODE ECHO must be disabled. Failure to disable these parameters will lockup the buffer of the modem and the REL 512 since the connect strings, REL 512 time ASCII strings (on a 1 minute basis) will be returned to the REL 512 for response.

The important command strings to configure are:

- DISABLE DTR (&D0)
- USE THE DEFAULT DISABLE OF SOFTWARE FLOW CONTROL (&I0)
- DSR ALWAYS ON (&S0)
- ONLINE ECHO OFF (E0)
- ONLINE LOCAL ECHO OFF (F1)
- DISABLE CARRIER DETECT (&C0)

- DISABLE TRANSMIT FLOW CONTROL (&H0)
- DISABLE RECEIVED DATA RTS CONTROL (&R1)

The AT command set string should look like this:

AT&D0&I0&S0E0F1&C0&H0&R1&W

As with the previous example, the &W writes the command string to NVRAM.

Since this modem is configured for AUTO ANSWER, certain “S” registers should be configured for optimal performance. In this example, sample “S” register values are given as an example. The user should engineer appropriate values for their application:

- ATS0=3 (3 Rings before Auto Answer)
- ATS41=10 (10 Attempts before disconnect of Auto Answer)
- ATS19 = 1 (1 Minute Inactivity causes hang up).

The “S” register definitions are particular to this particular brand of modem. Refer to the website or CD ROM included with the modem to verify correctness. As explained previously, the command AT&W should be sent to the device to write the parameters into NVRAM.

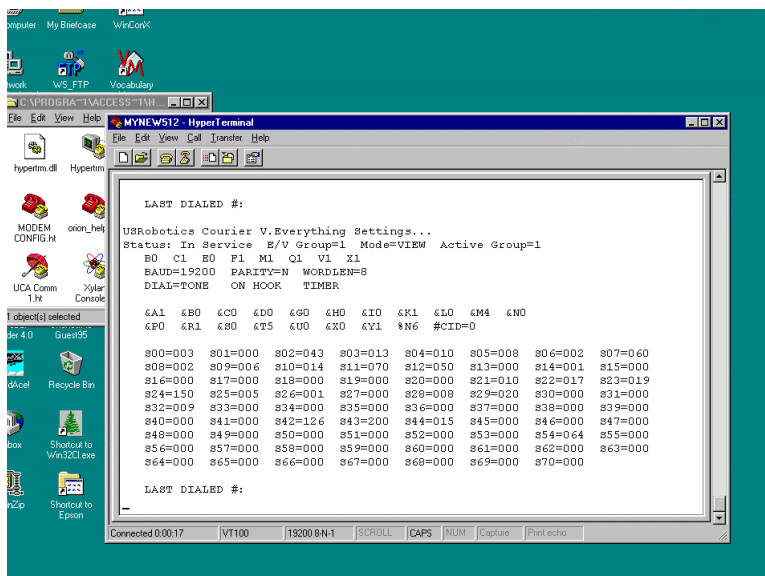


Figure 38 – Remote Modem Settings

As described in for the local modem, the following dipswitches could be configured for power-up auto-configuration:

Dipswitch Positions are:

POSITION 1 –UP = DTR Always ON

POSITION 2 –UP =VERBAL RESULTS CODE

POSITION 3 –UP = SUPPRESS RESULTS CODE

POSITION 4 –DOWN =NO ECHO OFFLINE COMMANDS

POSITION 5 –UP = AUTO ANSWER ON RING

POSITION 6 –DOWN = CARRIER DETECT OVERRIDE

POSITION 7 –DOWN =INHIBIT DISPLAY NORMAL RESULTS CODE

POSITION 8 –DOWN =ENABLE AT COMMAND SET *** (see note that follows)

POSITION 9 –UP =NO DISCONNECT WITH +++

POSITION 10 –UP =LOAD NVRAM DEFAULTS

***NOTE – Once configuration is complete it may be advisable to place dipswitch 8 in the UP position to disable AT commands. In this way if an “AT” command string is contained within the modem upload or download file strings or ASCII command strings, the modem will not respond unpredictable or disrupt communications.

Step 6: Connection And Execution Of Attachment Procedure

Attach the modem to analog lines (local and remote). Use the ATDT command string to access the modem as illustrated in Figure 39 using HYPERTERMINAL. Since the command echo is not suppressed for the local modem, the example screen in Figure 39 shows the RING and CONNECT prompts returned upon successful communication.

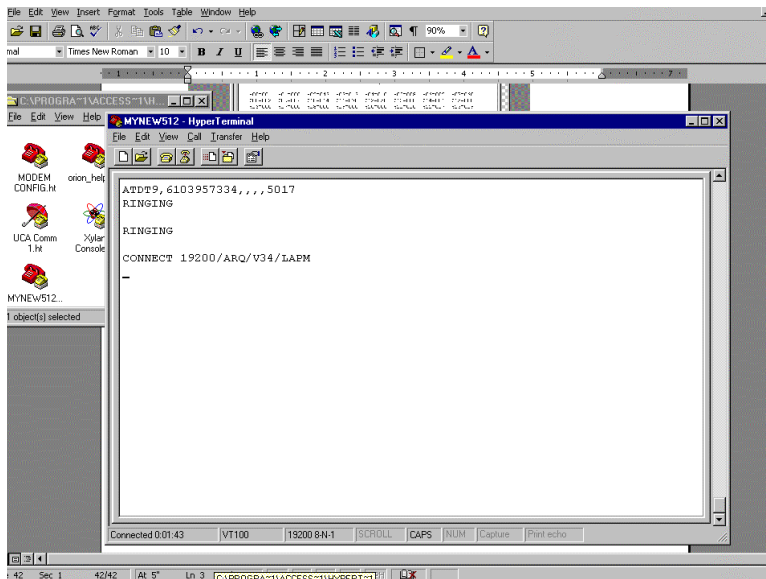


Figure 39 – ATDT Sample String And Successful Connection Banner

If the modem does not connect, then the REL 512 may have been sending its time string during the dial up procedure. If this is the case, redial or modify the reconnect tries in the S19 register.

If the modem does connect, then depress the “/” key or Backspace key on the keyboard to reveal the REL 512 startup screen illustrated in Figure 40.

To exit the session, depress the hang up icon located on the HYPERTERMINAL screen or the HANG UP submenu located on the TERMINAL screen. Also one may send the AT&H0 string for hang up.

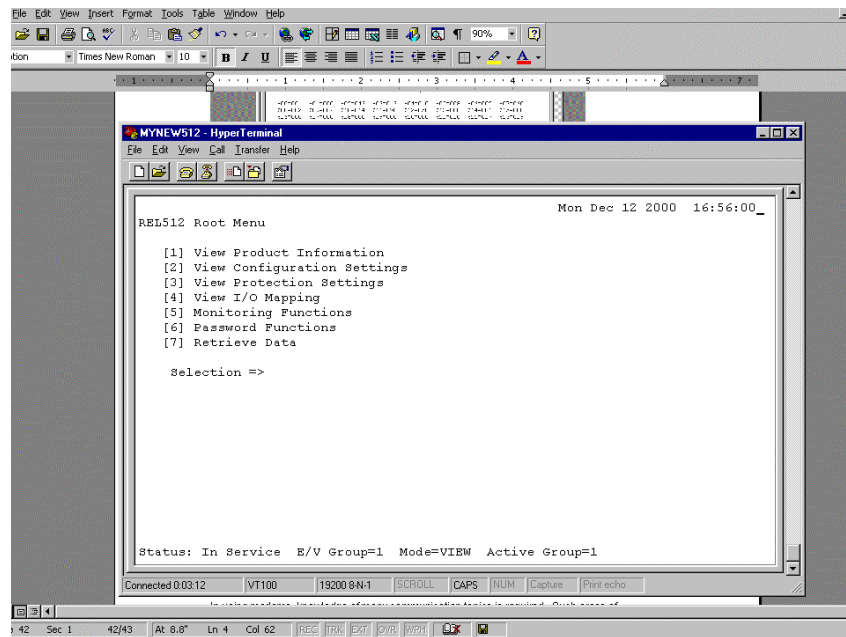


Figure 40 - REL 512 Configuration Menu Screen

Example 4 – Connection Of A REL512 ASCII Serial Port 2 (Rear Port) To Hyperterminal Software

The REL 512 has settings capabilities configurable and viewable via its rear com port (which is a DTE RS232 port). Any dumb terminal emulator is able to connect to the rear port and synchronize with the unit to allow visualization of the REL 512 parameters. Within this example, two USROBOTIC model 002806 (V.EVERYTHING modem using trellis technology encoding [which differs from the QAM encoding]). As illustrated in Figure 41, the modems are configured via a point to point connection. The REL 512 ASCII protocol is not addressable and therefore cannot be multi-dropped unless port switch devices are added to the system. The steps to establish communications are:

1. Connect the correct cable between the REL 512 SERIAL 2 port and the modem.
2. Connect the correct cable between the PC executing the HYPERTERMINAL program (in this case the operating system used is WINDOWS 95).
3. Parameterize the REL 512 rear port communication parameters.
4. Set the jumpers internal to the relay for correct RS 232 port configuration
5. Configure and set HYPERTERMINAL settings.
6. Parameterize each USROBOTICS modem using its particular AT command set.
7. Execute the connectivity procedure to establish communications.

As illustrated in Figure 41, the topology of the REL 512 interconnection with the HYPERTERMINAL software is illustrated. Please note on the diagram, the appropriate cables used to connect the device. In this example, handshaking will be used to provide coordination between the modems. The USROBOTIC modems allow Carrier Loss Redial capability along with dial back security capability. Although these features will not be configured and examined in this rudimentary application note, the RS 232 handshaking features will be set up to its fullest capability to allow addition (and reliability in operation) of these capabilities at a later date.

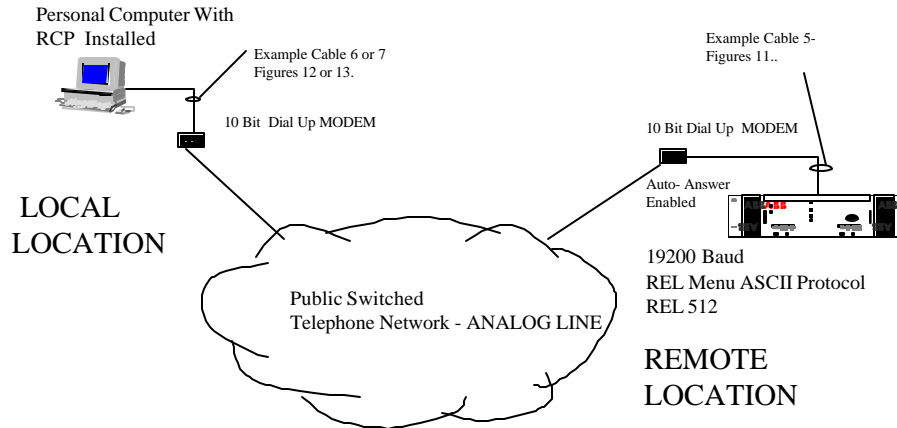


Figure 41 – Modem Connection Between A REL 512 Serial Port 2 (Located At The Back Of The Relay) And Hyperterminal Configuration Software

Step 1:

Construct and attach the cable as illustrated in Figure 41 above for the REL 512 / modem connection. (REMOTE LOCATION).

Step 2:

Construct and attach the cable as illustrated in Figure 41 above for the personal computer to modem connection. (LOCAL LOCATION)

Step 3:

Configure the rear port interface of the REL 512 with the correct parameters. The default parameters for all ports are 9600 baud, 8 data bits, No parity, 2 Stop bits. However, with the standard configuration, the port cannot be used with a 10 bit modem as previously explained. The Serial port 2 (located at the back side of the REL 512) must be configured following the attached procedure. Configure the front port with these parameters which are compatible for operation with a 10 bit modem:

- 19200 Baud
- 8 Data Bits
- No Parity
- 1 Stop Bit

The procedure to configure the REAR port interface is as follows:

When connecting a device to the front port of the relay, the communication parameters for the port must be changed to reflect those of the device to which it is connecting. To change the parameters via the REL 512 front panel interface one could follow the procedure as follows:

1. From the screen of the Front Panel Interface viewing the meter readings, Depress the “E” key to get the menu :
 - E Fault Records
 - Device Info
 - ← Edit Settings

- C Metering
- 2. Depress the Left Arrow Key “←” to Display the Menu
 - E Edit Settings
 - Fault Records
 - ← View Settings
 - C Metering
- 3. Depress the “E” Key to display the menu
 - E Password

- C Edit Settings

One must enter the CORRECT password to change the relay settings for this procedure. The default password for the REL 512 is “ABB” (without the quotation marks). If the password has been changed, please enter the correct password as follows:

- Depress the up arrow “↑” or down arrow “↓” to page through the numeric and alphabet selections for the password.
 - Depress the left arrow “←” or the right arrow “→” to move through the different positions of the password.
- 4. Depress the “E” key to accept the password selection you have entered. If the password is accepted the following screen shall be visible.
 - E Password

 - ← Accepted
 - C Edit Settings
 - 5. Depress the left arrow “←” key to accept the settings and proceed to the next menu which is shown
 - E Sys Settings
 - Act Settings

 - C Edit Settings
 - 6. Depress “E” so that the System Settings may be changed. The following menu item shall be displayed:
 - E CHG ACTIVE GRP
 - IDENTIFICATION

 - C System Settings
 - 7. Depress the right arrow key “→” to display the following screen:
 - E IDENTIFICATION
 - SYSTEM PARAM
 - ← DATE & TIME
 - C Sys Settings
 - 8. Depress the right arrow key “→” to display the following screen:
 - E SYSTEM PARAM
 - COMM PORTS
 - ← IDENTIFICATION
 - C Sys Settings
 - 9. Depress the right arrow key “→” to display the following screen:
 - E COMM PORTS
 - DATA RECORDING

- ← SYSTEM PARAMS
 - C Sys Settings
10. Depress the "E" key to display the following screen:
- E FRONT PORT
 - REAR PORT
 - ← MODBUS ID
 - C COM PORTS

Since this example is a guide to configuring the communication settings for the FRONT COM ASCII port, please refer to step 11 for FRONT PORT CONFIGURATION INSTRUCTIONS.

11. Depress the "→" key to display the following screen:

- E REAR BIT RATE
- REAR DATA LGTH
- ← REAR STOP BITS
- C REAR PORT

12. Depress the "E" key to display the following screen:

- E ENTER
- System Group
- ← 115200
- C REAR BIT RATE

By depressing the "←" left arrow key, one can view the baud rate selections for the REL 512 REAR port interface. The available selections are:

- 115200
- 2400
- 9600
- 19200

Select the desired baud rate by depressing the "E" key.

13. Depress the "C" key to display the following screen

- E REAR BIT RATE
- REAR DATA LGTH
- ← REAR STOP BITS
- C REAR PORT

14. One must then select the Front panel data length depress the "→" to reveal the following screen.

- E REAR DATA LNGTH
- REAR PARITY
- ← REAR BIT RATE
- C REAR PORT

15. One must select the Front Port Data Length. Depressing the "E" key allows visualization of the following menu.

- E ENTER
- System Group
- ← 8
- C REAR DATA LNGTH

Depressing the left arrow key "←" allows the operator to select from the following data lengths:

- 8
- 7

16. Depress "E" to accept the parameters and then depress the "C" to return to the menu:

```
E    REAR DATA LNGTH
→   REAR PARITY
←   REAR BIT RATE
C    REAR PORT
```

17. One must set the parity by depressing the left arrow key "←" to display the following screen.

```
E    EDIT PARITY
→   REAR STOP BITS
←   REAR DATA LNGTH
C    REAR PORT
```

18. Depress "E" to display the following screen

```
E    ENTER
      System Group
←   NONE
C    REAR PARITY
```

By depressing the left arrow key "←" the choices for parity are displayed. The choices for selection are:

```
NONE
      ODD
      EVEN
```

19. Depress the "C" key to display the following screen

```
E    REAR BIT RATE
→   REAR DATA LGTH
←   REAR STOP BITS
C    REAR PORT
```

20. Depress the left arrow key "←" to select the REAR Panel Stop Bit selections. The following Screen should be visible.

```
E    ENTER
      System Group
←   1
C    REAR STOP BITS
```

The selections for Stop Bits are 1 or 2.

21. Depress the "E" key to accept the selections.

22. Depress the "C" key to back out of the relay and accept the settings when prompted by the REAR panel interface.

Step 4:

The REL 512 Serial Port 2 is able to be configured for RS232 or RS 485 connectivity. The configuration procedure is achieved via jumpers located near the Serial Port 2 interface on the relay. The default configuration for the relay is RS232. However one should verify jumper settings via the following procedure:

1. The technician performing this operation should be wearing anti-static wrist straps and work on an anti-static environment to ensure that static electricity is not conducted between the operator and REL 512 internal components.

2. Rotate the knurled screws to the left and right of the REL 512, which secure the front panel interface to the housing of the unit. The knurled screws should be turned counterclockwise (or to the left) to loosen the screws.
3. Remove the blue and red ribbon cable interconnecting the electronic signals between the front panel interface and the REL 512 motherboard. The internal assembly of the unit should be visible.
4. While grasping the internal assembly ejectors, and cantilevering the ejectors towards you, remove the internal assembly board from the chassis.
5. As illustrated, 5 jumpers are located near the rear serial port connector. The jumper locations for RS 232 and RS 485 operation are listed in TABLE 2. Ensure that the jumpers placed in the locations corresponding to the RS232 positions listed in the table.
6. Place the board into the REL 512 housing pressing the assembly ejectors with even force to mate the connections within the assembly with the REL 512 motherboard.
7. Carefully reattach the blue and red ribbon cable interconnecting the electronic signals between the front panel interface and the REL 512 motherboard.
8. With the front panel interface in the correct position, secure the front panel interface with the housing by tightening the knurled screws on the left and right side of the panel. The screws should be rotated clockwise (or to the right).

Table 2 - Card Jumper Settings.

Jumper Pins	1,2	2,3
Mode Selection:		
JP1-4	RS-232	RS-485
RS-485 Configuration		
JP5	Half duplex	Full duplex
JP6	2 wire	4 wire
JP7	2 wire	4 wire
RS-485 Termination/Bias Resistors:		
Jp8	121 Ohms	Open
JP9	523 Ohms	Open
JP10	523 Ohms	Open

Step 5:

The operator should configure the HYPERTERMINAL settings to match those of the configuration made for the REL 512. The procedure is as follows:

1. Select HYPERTERMINAL from the WINDOWS menu to reveal the following screen illustrated in Figure 42.
2. Select the icon labeled Hyperterminal.exe The screen illustrated in Figure 43 should be visible. The operator will be prompted for a name as illustrated.

Modem Communications To ABB Relays AN-63A-00

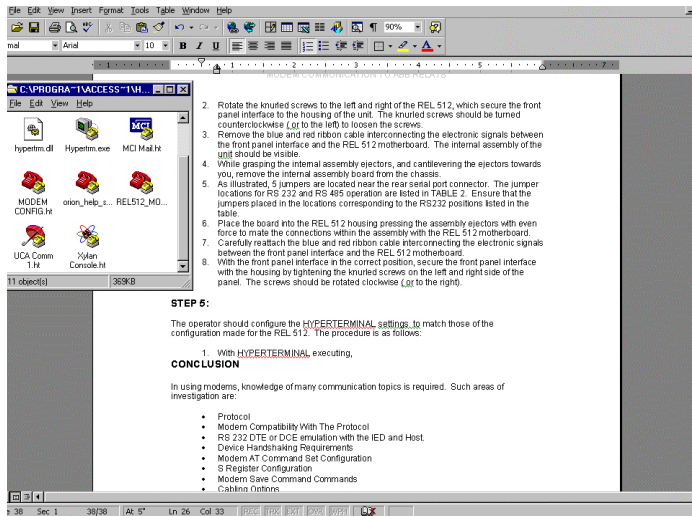


Figure 42 – Hyperterminal Selection Screen

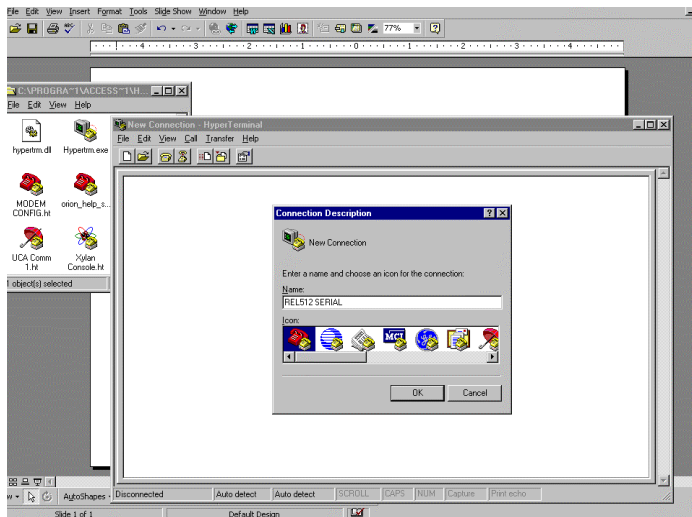


Figure 43 – Hyperterminal Setup Screen

3. Once the OK icon has been depressed, the screen for port setup will be displayed. Note that the port setup menu is illustrated for display and COM 1 selection is highlighted for this example and selection. Notice that with the MODEM selection (for the built in computer internal modem) deselected, the some of the fields are "greyed out".
4. The COM properties for the modem must be selected for this example to those selected for the REL 512. In this case the same settings configured for the REL 512 in STEP 3 are selected for the interface. Notice that the settings are selected in Figure 44 for those configured in STEP 3. Notice for this example, hardware handshaking is enabled for RTS/CTS configuration.
6. Once the OK pushbutton is depressed, the screen depicted in Figure 45 is presented to the operator. AT commands can now be typed to configure the modem with the appropriate parameters for operation in this system.

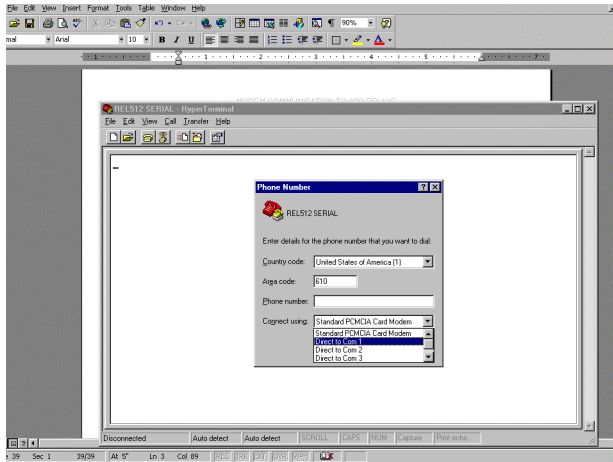


Figure 44 – Com Port Configuration For Attachment Of Hyperterminal Session

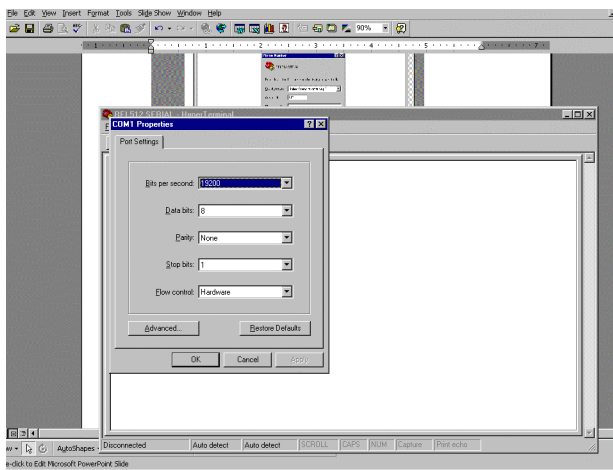


Figure 45 – Com Port Settings Configuration Screen

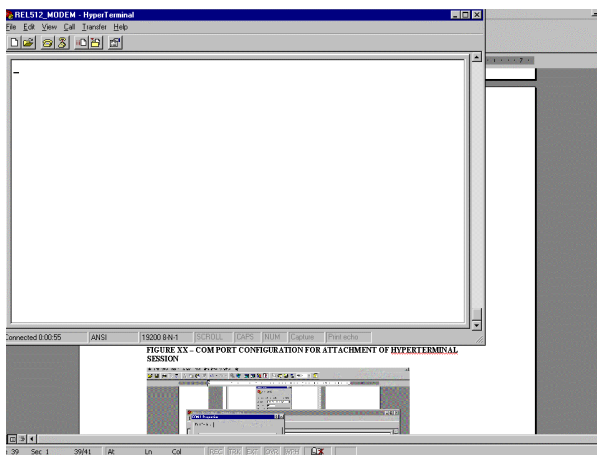


Figure 46 – Hyperterminal Screen For Data Communication Entry.

Steps 6 And 7 – Configuration Of The Modem Parameters For The Local And Remote Sites

THE USROBOTICS modems used (Model 002806- V.Everything) have commands similar to those of the previous USROBOTIC modems. Several differences are apparent with respect to their “S” register configurations and auto configurability. Additional sessions may be set up to allow remote configuration. However, it is strongly advised that remote configuration and automation dial up capabilities not be used with the REL 512 since difficulties may result since handshaking is not available.

Another word of caution should be issued in that the V.Everything modem may experience difficulties connecting with the REL 512 master/slave emulation of the port during dial-up sessions. IF the MODEM is undergoing the attachment process and the REL 512 happens to send out its time ASCII string to the MODEM simultaneously, the modem will disconnect and display the prompt “NO CARRIER” at the host site. This process will take a few minutes to occur and until this occurs, no communications will occur. If a command string is sensed via the SD line (remote modem LED will illuminate) during the dialing process, the remote modem will hang up (the remote modem OH [On Hook] LED will extinguish). There is no way to overcome this limitation in operation with this model of modem.

Some important words covering the configuration of the MODEM when used with the REL 512:

- DISABLE DTR (&D0)
- USE THE DEFAULT DISABLE OF SOFTWARE FLOW CONTROL (&I0)
- DSR ALWAYS ON (&S0)
- DISABLE CARRIER DETECT (&C0)

Thus the command string should look like this:

```
AT&D0&S0&I0&C0&W
```

Note the &W writes the current setting to the Non-Volatile RAM.

Additional tips are covered in the following tips for LOCAL modem configuration (that modem attached to the HYPERTERMINAL Personal Computer) and the REMOTE modem (that modem attached to the REL 512). Attach the cable from the PC to the modem undergoing the configuration process. It is advisable to label each modem location since the LOCAL modem will be configured slightly differently from the remote modem.

Local Modem

Local Modem parameters are illustrated in Figure 47. To display the current list of parameters, the command string AT&I4 should be typed in the HYPERTERMINAL environment. A list of the parameters used is shown. The LOCAL modem also may be configured via the dipswitches located underneath the relay.

Dipswitch Positions are:

POSITION 1 –UP = DTR Always ON
POSITION 2 –UP =VERBAL RESULTS CODE
POSITION 3 –DOWN = DISPLAY RESULTS CODE
POSITION 4 –UP =ECHO OFFLINE COMMANDS
POSITION 5 –DOWN =SUPPRESS AUTO ANSWER
POSITION 6 –DOWN = CARRIER DETECT OVERRIDE

POSITION 7 –UP =DISPLAY NORMAL RESULTS CODE
 POSITION 8 –DOWN =ENABLE AT COMMAND SET
 POSITION 9 –UP =NO DISCONNECT WITH +++
 POSITION 10 –UP =LOAD NVRAM DEFAULTS

NOTE this local modem is only configured for DIAL OUT capability – no auto answer. Additionally, all commands are echo'd back to the terminal for easy access and troubleshooting. Upon Power UP the NVRAM defaults are loaded into memory. It is also illustrates in Figure 33 that handshaking is enabled. No other parameters have been changed from the default settings.

```

AT+I4
USBRobotics Courier V.Everything Settings...
B0 C1 B1 P1 M1 Q0 V1 X7
BAUD=19200 PARITY=N WORDLEN=8
DIAL=HUNT CN HOOK TIMER

8A3 8B1 8C0 8D2 8E0 8H1 8I0 8K1 8L0 8M4 8N0
8P0 8R2 8S0 8T5 8U0 8X0 8Y1 8N6 #CID=0

800=001 801=000 802=043 803=013 804=010 805=008 806=002 807=060
808=002 809=006 810=014 811=070 812=050 813=000 814=001 815=000
816=000 817=000 818=000 819=000 820=000 821=010 822=017 823=019
824=150 825=005 826=001 827=000 828=008 829=020 830=000 831=000
832=009 833=000 834=000 835=000 836=000 837=000 838=000 839=000
840=000 841=000 842=126 843=200 844=015 845=000 846=000 847=000
848=000 849=000 850=000 851=000 852=000 853=000 854=064 855=000
856=000 857=000 858=000 859=000 860=000 861=000 862=000 863=000
864=000 865=000 866=000 867=000 868=000 869=000 870=000

LAST DIALLED #: *9,6103957334,...,5017

OK
  
```

Figure 47 – Local Modem Configuration Parameters

Remote Modem

The configuration requirements for the remote modem vary slightly from the local modem. The configured commands in the REMOTE modem are illustrated in Figure 48. The parameters configured in your remote modem may be accessible using the command AT&I4. It is important to connect the HYPERTERMINAL program to the modem being configured as REMOTE to accomplish this. It is also advisable to label the modem as being a REMOTE device for identification purposes only.

The remote modem should have all its handshaking requirements turned off. Additionally, the COMMAND MODE ECHO and the ONLINE MODE ECHO must be disabled. Failure to disable these parameters will lockup the buffer of the modem and the REL 512 since the connect strings, REL 512 time ASCII strings (on a 1 minute basis) will be returned to the REL 512 for response.

The important command strings to configure are:

- DISABLE DTR (&D0)
- USE THE DEFAULT DISABLE OF SOFTWARE FLOW CONTROL (&I0)
- DSR ALWAYS ON (&S0)
- ONLINE ECHO OFF (E0)
- ONLINE LOCAL ECHO OFF (F1)
- DISABLE CARRIER DETECT (&C0)

- DISABLE TRANSMIT FLOW CONTROL (&H0)
- DISABLE RECEIVED DATA RTS CONTROL (&R1)

The AT command set string should look like this:

AT&D0&I0&S0E0F1&C0&H0&R1&W

As with the previous example, the &W writes the command string to NVRAM.

Since this modem is configured for AUTO ANSWER, certain “S” registers should be configured for optimal performance. In this example, sample “S” register values are given as an example. The user should engineer appropriate values for their application:

- ATS0=3 (3 Rings before Auto Answer)
- ATS41=10 (10 Attempts before disconnect of Auto Answer)
- ATS19 = 1 (1 Minute Inactivity causes hang up).

The “S” register definitions are particular to this particular brand of modem. Refer to the website or CD ROM included with the modem to verify correctness. As explained previously, the command AT&W should be sent to the device to write the parameters into NVRAM.

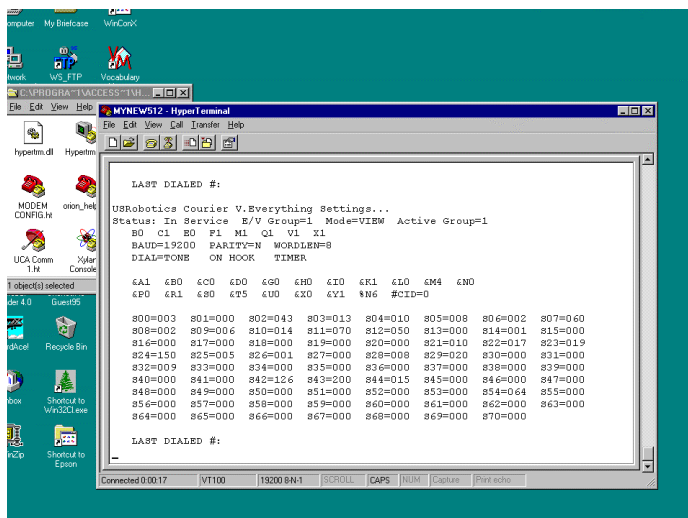


Figure 48 – Remote Modem Settings

As described in for the local modem, the following dipswitches could be configured for power-up auto-configuration:

Dipswitch Positions are:

- POSITION 1 –UP = DTR Always ON
- POSITION 2 –UP =VERBAL RESULTS CODE
- POSITION 3 –UP = SUPPRESS RESULTS CODE
- POSITION 4 –DOWN =NO ECHO OFFLINE COMMANDS
- POSITION 5 –UP = AUTO ANSWER ON RING
- POSITION 6 –DOWN = CARRIER DETECT OVERRIDE
- POSITION 7 –DOWN =INHIBIT DISPLAY NORMAL RESULTS CODE
- POSITION 8 –DOWN =ENABLE AT COMMAND SET *** (see note that follows)

POSITION 9 –UP =NO DISCONNECT WITH +++
 POSITION 10 –UP =LOAD NVRAM DEFAULTS

***NOTE – Once configuration is complete it may be advisable to place dipswitch 8 in the UP position to disable AT commands. In this way if an “AT” command string is contained within the modem upload or download file strings or ASCII command strings, the modem will not respond unpredictable or disrupt communications.

Step 8: Connection And Execution Of Attachment Procedure

Attach the modem to analog lines (local and remote). Use the ATDT command string to access the modem as illustrated in Figure 49 using HYPERTERMINAL. Since the command echo is not suppressed for the local modem, the example screen in Figure 49 shows the RING and CONNECT prompts returned upon successful communication.

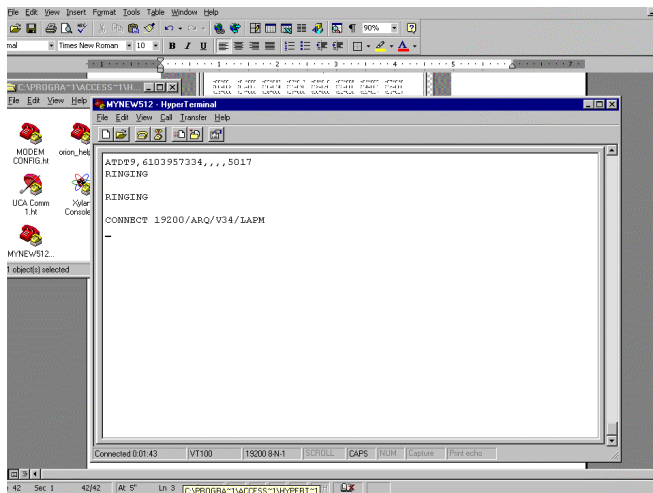


Figure 49 – ATDT Sample String And Successful Connection Banner

If the modem does not connect, then the REL 512 may have been sending its time string during the dial up procedure. If this is the case, redial or modify the reconnect tries in the S19 register.

If the modem does connect, then depress the “/” key or Backspace key on the keyboard to reveal the REL 512 startup screen illustrated in Figure 50.

To exit the session, depress the hang up icon located on the HYPERTERMINAL screen or the HANG UP submenu located on the TERMINAL screen. Also one may send the AT&H0 string for hang up.

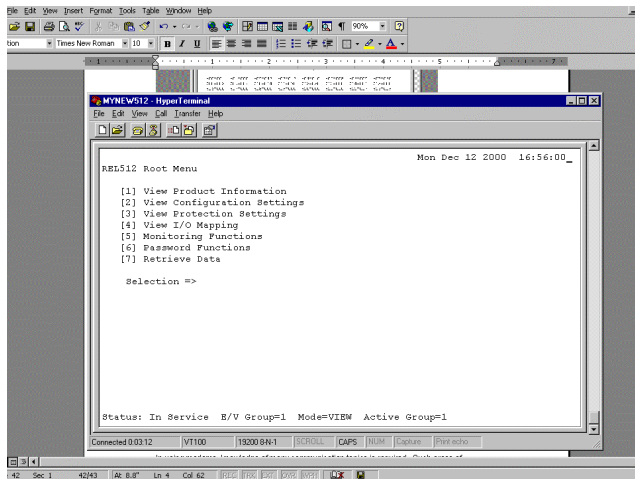


Figure 50 - REL 512 Configuration Menu Screen

Conclusion

In using modems, knowledge of many communication topics is required. This brief and rudimentary application note covers only a miniscule amount of information needed to successfully attach a 10 Bit Telephone Modem to an Analog Public Switch Telephone Network. Proper engineering of a communication network requires areas of investigation as:

- Protocol
- Modem Compatibility With The Protocol
- RS 232 DTE or DCE emulation with the IED and Host.
- Device Handshaking Requirements
- Modem AT Command Set Configuration
- S Register Configuration
- Modem Save Command Commands
- Cabling Options

ABB relays have been proven to operate reliably with many manufacturer's modems. Careful system configuration is the key to a successful project installation. It is hoped that this rudimentary application note assists the user in the task of easily and flawlessly attaching a modem to ABB products.

Contributed by:
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Revision 1.0, 12/7/00

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