Elite 2864I

User's Manual

Version 2.0

ZyXEL

ACCESSING INTERNET & INTRANET

65-020-286403

ZyXEL Limited Warranty

ZyXEL warrants to the original end user (purchaser) that this product is free from any defects in materials or workmanship for a period of up to two (2) years from the date of purchase. During the warranty period, and upon proof of purchase, should the product have indications of failure due to faulty workmanship and/or materials, ZyXEL will, at its discretion, repair or replace the defective products or components without charge for either parts or labor, and to whatever extent it shall deem necessary to restore the product or components to proper operating condition. Any replacement will consist of a new or re-manufactured functionally equivalent product of equal value, and will be solely at the discretion of ZyXEL. This warranty shall not apply if the product is modified, misused, tampered with, damaged by an act of God, or subjected to abnormal working conditions.

Note: Repair or replacement, as provided under this warranty, is the exclusive remedy of the purchaser. This warranty is in lieu of all other warranties, express or implied, including any implied warranty of merchantability or fitness for a particular use or purpose. ZyXEL shall in no event be held liable for indirect or consequential damages of any kind or character to the purchaser.

To obtain the services of this warranty, please contact ZyXEL's Service Center, refer to the separate Warranty Card for your Return Material Authorization number (RMA). Products must be returned Postage Prepaid. It is recommended that the unit be insured when shipped. Any returned products without proof of purchase or those with an out-dated warranty will be repaired or replaced (at the discretion of ZyXEL) and the customer will be billed for parts and labor. All repaired or replaced products will be shipped by ZyXEL to the corresponding return address, Postage Paid (USA and territories only). If the customer desires some other return destination beyond the U.S. borders, the customer shall bear the cost of the return shipment. This warranty gives you specific

legal rights, and you may also have other rights which vary from state to state.

Note: ZyXEL does not assume any liability arising out of the application or use of any products, or software described herein. Neither does it convey any license under its patent rights nor the patents rights of others. ZyXEL further reserves the right to make changes in any products described herein without notice. This document is subject to change without notice.

Acknowledgments

Trademarks mentioned in this manual are used for informational purposes only.

Trademarks are properties of their respective owners.

FCC Part 15 Information

This device complies with Part 15 of FCC rules. Operation is subject to the following two conditions:

1. This device may not cause harmful interference.
2. This device must accept any interference received, including interference that may cause undesired operations.

This equipment has been tested and found to comply with the limits for a CLASS B digital device pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy, and if not

installed and used in accordance with the instructions, may cause harmful interference to radio communications.

If this equipment does cause harmful interference to radio/television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and the receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment. Shielded RS-232 cables are required to be used to ensure compliance with FCC Part 15, and it is the responsibility of the user to provide and use shielded RS-232 cables.

Information for Canadian Users

The Industry Canada label identifies certified equipment. This certification means that the equipment meets certain telecommunications network protective, operation, and safety requirements. The Industry Canada does not guarantee that the equipment will operate to a user's satisfaction.

Before installing this equipment, users should ensure that it is permissible to be connected to the facilities of the local telecommunications company. The equipment must also be installed using an acceptable method of connection. In some cases, the company's inside wiring associated with a single line individual

service may be extended by means of a certified connector assembly. The customer should be aware that the compliance with the above conditions may not prevent degradation of service in some situations.

Repairs to certified equipment should be made by an authorized Canadian maintenance facility designated by the supplier. Any repairs or alterations made by the user to this equipment, or equipment malfunctions, may give the telecommunications company cause to request the user to disconnect the equipment.

For their own protection, users should ensure that the electrical ground connections of the power utility, telephone lines, and internal metallic water pipe system, if present, are connected together. This precaution may be particularly important in rural areas.

Caution: Users should not attempt to make such connections themselves, but should contact the appropriate electrical inspection authority, or electrician, as appropriate.

This digital apparatus does not exceed the class A limits for radio noise emissions from digital apparatus set out in the radio interference regulations of Industry Canada.

The declarations of CE marking:

This product has been approved for connection to the Public Switched Telecommunication Network using interfaces compatible with ITU-TSS recommendation. This product complies with the following directives:

1. The Council Directive 89/336/EEC of 3 May 1992 on the approximation of the laws of the member states relation to Electro Magnetic Compatibility. (EMC Directive)
2. Council Directive 91/263/EEC of 29 April 1991 on the approximation of the laws of the Member States concerning telecommunication terminal equipment. (The Telecom Terminal Equipment Directive)
3. 93/68/EEC of 22 July 1993 amending the Directives 89/336/EEC, 91/263 /EEC and 92/31/EEC.(Marking Directive)

   The Council Directive 92/31/EEC of 28 April 1992 amending directive on the approximation of the laws of the member states relating to Eletro Magnetic Compatibility.

Contacting ZyXEL

If you have questions about your ZyXEL product or desire assistance, contact ZyXEL Communications Corporation in one of the following ways:

- **Phone**: In North America call between 8:00 AM and 5:00 PM PST at (714) 693-0808

  Outside North America, you can dial +886-3-5783942 EXT 252 between 8:00AM and 5:00PM Taiwan time (GMT +8:00).

- **Fax**: ZyXEL in North America: (714) 693-8811 or Taiwan: +886-3-5782439

- **E-mail**:

  - **Sales inquiries**: sales@zyxel.com in North America. sales@zyxel.hinet.net outside North America.
  - **Technical support**: support@zyxel.com in North America. support@zyxel.hinet.net outside North America.

- **Product information**: Visit our site on the World Wide Web: http://www.zyxel.com.

- **FTP**: Information , such as ZyXEL software and ROM updates for North America can be found at this FTP address: ftp.zyxel.com

  For European versions and related files, use the address: ftp.zyxel.co.at

- **Postal Service**: You can send written communications at the following address:

  ZyXEL Communications Corporation

  6, Innovation Road II, Science-Based Industrial Park

  Hsinchu, Taiwan 300, R.O.C.

  or

  ZyXEL Communications Inc.

  4920 E. La Palma Avenue

  Anaheim, CA92807, U.S.A.

Contents

1 Introduction

Congratulations on your purchase of an ZyXEL Elite 2864I ISDN modem, one of ZyXEL's premier high performance products.

The ZyXEL Elite 2864I ISDN modem sets new standards in performance and usability for the explosively growing ISDN Internet and telecommuting markets. This universal communication platform supports highly integrated services over ISDN lines without sacrificing connectivity to today's more prevailing analog world.

For the US, Korea, and some Nordic countries, ZyXEL provides an optional 2B1Q U-interface which allows direct connection to the network without the use of an external NT-1 device.

Unpacking Your Elite 2864I

Before you proceed further, please check all items you received with your modem against this list to make sure nothing is missing. The complete package should include:

- One 2864I ISDN modem
- One power adapter pack
- One RJ-11 telephone cable
- One RJ-45 ISDN telephone cable
- One shielded RS-232 cable
- One 2864 series modem user's manual
- One 2864I ISDN modem user's manual (This manual)
- One 3.5" support disk

- One warranty/registration card
- One Quick Reference guide

Contact your dealer or the store where you bought the modem if anything is missing. Check the modem for shipping damages. If you find any damage, contact the shipping agency immediately.

Retain shipping and packaging materials for future storage or shipping needs.

Becoming a Registered Owner

Complete the pre-addressed Warranty Registration Card and place it in the mail. Registered owners will receive future product information and update announcements. Warranty registration is not necessary for product repair/or replacement - please also save your **dated invoice** as proof of purchase.

2 Installation

This chapter describes the installation procedure for the Elite 2864I ISDN modem. Make sure your installation site is clean and well ventilated. The ventilation slots of your ISDN modem should not be covered and should be allowed free movement of air.

Connecting Your Elite 2864I to the Power Supply

You will find the following switch and connectors on the back panel of the Elite 2864I:

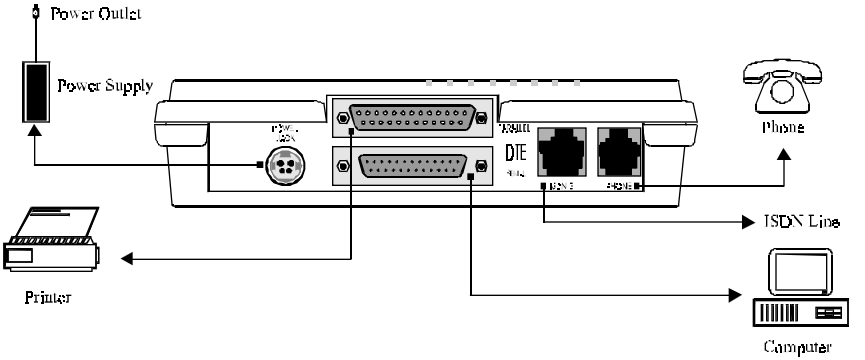


Figure 2-1 Back Panel

POWER JACK - Input terminal for power adapter. There is no power switch on the Elite 2864I, the power switch on the power adapter will turn off the power adapter and shut off the power to the modem. Always turn off the power adapter before connecting or disconnecting the power jack.

PARALLEL - Parallel port DB25 male connector for connection to a printer.

SERIAL - Serial port DB25 female connector for connection to a DTE serial port (computer/terminal).

LINE - ISDN RJ-45 terminal jack. For the Elite 2864I, this is for connection to an S0 (S/T) interface; while for the Elite 2864IU, U interface.

PHONE - A/B adapter RJ-11 terminal jack, for connection to an analog telephone.

Plug the power cord into the **POWER JACK**. Connect the power adapter to an electrical outlet.

NOTE: DO NOT USE ANY POWER ADAPTER OTHER THAN THE ONE SUPPLIED WITH THIS MODEM. USING ANY OTHER POWER ADAPTER MAY CAUSE SERIOUS DAMAGE TO THE MODEM AND VOID THE WARRANTY. ALWAYS TURN OFF THE POWER SWITCH ON THE POWER ADAPTER BEFORE MAKING POWER CONNECTION. NEVER PLUG OR UNPLUG MODEM'S POWER JACK WITH POWER ADAPTER TURNED ON, IT MAY DAMAGE YOUR ISDN MODEM.

Connecting the Elite 2864I to Your Computer

The modem has both a parallel port and a serial port connector. You can connect the serial port connector to your computer's serial port and connect the parallel port connector to a laser printer. If you have the modem set up for auto fax receive and print, you only need a parallel port connection to a printer.

A 25-pin male to female shielded RS-232 cable is used to connect the modem's serial port to a computer's regular RS-232 serial port connector. If you have an AT type 9-pin serial port connector on your PC, a 9-pin female to 25-pin male cable adapter is needed. If you have other type of serial port connector, like Apple Macintosh's, you need a special cable adapter for it.

The normal PC printer cable will connect the male parallel port connector to a printer's D-shell connector.

Connecting the Elite 2864I to Your ISDN Line

The Elite 2864I comes with a choice of two types of ISDN line interfaces.

S/T Interface Model

If you have purchased the Elite 2864I, you will need an NT-1 device to connect to the network. In Europe, the NT-1 or NT-A/B are provided and installed by the telephone company.

Although there are a lot of NT-1s on the market, most of them have two sets of RJ-11 or RJ-45 jacks:

- One set will be marked “Line,” “ISDN,” “Wall,” or “U.” It should be a single RJ-11 or RJ-45 jack.
- The other set will be marked “Terminal” or “S/T.” It can be either a single or multiple RJ-45 jack(s).

Before making the connection, make sure that the termination is set up properly. The termination set-up depends on the number of devices connected to the NT-1 and how the devices are connected. It also depends on the distance from the device(s) to the NT-1. Refer to your NT-1 manual for more information.

When the telephone company installs your ISDN line, you can specify the type of jack you want installed. You should order the jack that is recommended by the NT-1 device. In most cases, RJ-11 jacks will be installed unless you specified otherwise (In Canada, an RJ-45 jack will be installed). The NT-1 device should come with the proper cable for connection from the wall jack and the NT-1’s line jack.

Regardless of the type of wall jack you have installed, only the center two pins are connected.

The cable connecting the NT-1 device to the Elite 2864I is provided for you. It is an RJ-45 to RJ-45 cable with four conductors running through it.

Once everything is set up, connect the Elite 2864I to your ISDN line:

1. Use the phone cable (RJ-45) that is included, connect the Elite 2864I's "ISDN" jack to your NT-1 "Terminal" or "S/T" jack.
2. Using the proper cable, connect your NT-1 "line" or "U" jack to the wall jack installed by your phone company.
3. Make sure all the connectors are properly inserted.

NOTE: FOR S/T INTERFACE, AN IMPROPER TERMINATING RESISTOR SETTING MAY CAUSE YOUR ISDN MODEM TO MALFUNCTION. A RULE OF THUMB IS TO INSTALL TERMINATING RESISTORS ON BOTH THE NT (NETWORK TERMINATOR) AND THE TE (TERMINAL EQUIPMENT) THAT HAVE THE LONGEST CABLE CONNECTIONS. THE FACTORY DEFAULT SETTING OF THE TERMINATING RESISTORS OF THE 2864I IS DISCONNECTED, WHICH MOST LIKELY FITS YOUR ISDN TELEPHONE LINE. IN SOME CASES, HOWEVER, THERE IS A NEED FOR THE TERMIANTING RESISTORS TO BE CONNECTED IN THE 2864I. THIS CAN BE INDICATED, BUT NOT EXCLUSIVELY, BY THE FAIL OF TEST SEQUENCE NUMBER 2 OF THE ISDN DAUGHTER BOARD'S POWER-ON SELF TEST. TO CONNECT THE TERMINATING RESISTORS INSIDE THE 2864I, OPEN THE TOP COVER OF THE CASE AND UNPLUG THE ISDN DAUGHTER BOARD. IN THE NEIGHBORHOOD OF THE RJ-45 SOCKET, THERE ARE TWO JUMPERS LABELED JMP1 AND JMP2. BOTH OF THE JUMPERS SHOULD BE CONNECTED IN ORDER TO MAKE A PROPER IMPEDANCE TERMINATION.

U Interface Model

If you have purchased the Elite 2864IU, you can connect the U-Interface directly to the wall jack.

In most cases, the ISDN jack installed by the phone company is a RJ-11 jack (except in Canada, where RJ-45 jack will be installed), and the U-Interface jack on the back of the Elite 2864IU is a RJ-45

jack. A RJ-45 to RJ-45 (or RJ-11 to RJ-45, depends on your regional distributor's request) phone cable is included with your Elite 2864IU.

To connect the Elite 2864IU to your ISDN line:

1. Connect the RJ-45 connector to the "ISDN" jack on the back of the Elite 2864IU.
2. Connect the other end of the RJ-45 cable (or RJ-11) to your wall jack.

Power On and Self Diagnostics

Once you have completed all of the installation steps above, turn on the power switch on the power adapter to power up your Elite 2864I. A series of diagnostic tests will be performed while the B1, B2, and AA LEDs are blinking.
If all self tests are OK, the B1, B2, and AA LEDs will be in normal state and your ISDN modem is ready for use. If you have a communication program loaded and active (connected to the same serial port that the Elite 2864I is connected to), you should see the DTR LED light up after the self test.

If the test routine fails, the LED flashes. Refer to Chapter 14 for more information on self-tests and error codes.

Elite 2864I Front Panel

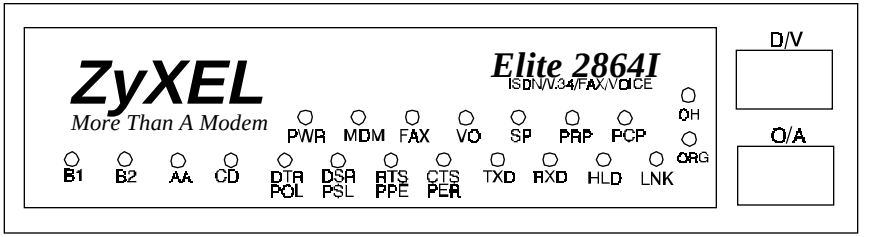


Figure 2-2 Front Panel

LED Indicators:

PWR - **P**o**w**e**r** on indicator; lights up when the Elite 2864I's power is turned ON.

MDM - **M**o**dem** mode indicator; lights up when the Elite 2864I operates in modem mode.

FAX - **Fax** mode indicator; lights up when the Elite 2864I is in fax transmission or receiving mode.

VO - **Vo**ice mode indicator; lights up when the Elite 2864I operates in voice mode.

SP - **S**erial **p**ort active indicator; lights up when the Elite 2864I is using the serial port for DTE communication.

PRP - **Pr**inter **p**arallel port active indicator; lights up when the Elite 2864I is using the parallel port to drive a printer for fax printing.

PCP - Reserved

B1 - **B1** channel connection indicator; lights up when B1 channel is established. Single blink indicates data transmission is protected by Data Encryption Standard (**DES**). Triple blink indicates data is protected by **triple DES**.

B2 - **B2** channel connection indicator; lights up when B2 channel is established. Single blink indicates data transmission is protected by

Data Encryption Standard (**DES**). Triple blink indicates data is protected by **triple DES**.

AA - **A**uto-**a**nswer indicator; lights up when the Elite 2864I is in the Auto Answer mode; flashes when it rings.

CD - **C**arrier **d**etect indicator; lights up when a valid carrier is detected on the line for fax/modem operation. For ISDN data calls, the LED lights up when a B-channel protocol has been established and is ready for data transmission.

DTR/POL

DTE mode:

Data **t**erminal **r**eady indicator, lights up when the DTE or Computer indicates that it is ready for communication by raising the corresponding RS-232 signal.

Printer mode:

Printer **o**n **l**ine indicator; indicates the signal status of Select from printer. It lights up when the printer is selected and is available for data transfer.

DSR/PSL

DTE mode:

Data **s**et **r**eady indicator; lights up when the Elite 2864I is ready for communication.

Printer mode:

Printer **se**l**e**ct signal; indicates the signal status of "-Select-In" from the Elite 2864I to printer. It lights up when printer is enabled to input data.

RTS/PPE

DTE mode:

Request **t**o **s**end indicator; indicates the signal status of RS-232 signal RTS from DTE. RTS is used for hardware flow control in the case of asynchronous data transmission.

Printer mode:

Printer **p**aper **e**nd indicator, lights up when printer runs out of paper. It indicates the signal status of PE from printer.

CTS/PER

DTE mode:

Clear **t**o **s**end indicator; lights up when the Elite 2864I can accept data for transmission.

Printer mode:

Printer **e**rror **i**ndicator; lights up when an error condition exists in the printer, e.g., paper empty or not on-line. It indicates the signal status of Error from printer.

TXD - Transmit **d**ata indicator; flashes when the DTE/Computer is transmitting data to the Elite 2864I.

RXD - Receive **d**ata indicator, lights up when the DTE/Computer is receiving data from the Elite 2864I.

HLD - Call **h**e**ld** indicator; lights up when the telephone connected to the A/B adapter is in Hold condition.

LNK - The Link LED lights up when the link with the local switch is active and flashes when attempting to make a connection.

LNK is also used as a self-test indicator for the internal fax/modem initialization.

OH - Hook status of the A/B adapter, lights up when the telephone handset is picked up (off-hook); flashes when the analog telephone set connected to the A/B adapter is used for local voice mode operation (play back or record).

ORG - Modem Originate mode indicator, lights up when the modem is in originate mode otherwise it is in answer mode.

Front Panel Switches

D/V - A switch that supports three functions: Quick Answer, Quick Disconnection, and Quick Dial.

1. Quick Answer: While the modem is ringing and the Auto-answer function is disabled (S0 = 0), press D/V key will answer the incoming call.
2. Quick Disconnection: While in the connection state of a data call, press the D/V key to disconnect the call.
3. Quick Dial: If S35.4=1, AT*Dn, and AT&Zn=xxxxx are all set, press the D/V key to place a call using the default number in the phone table.

O/A - Reserved.

Understanding AT Commands

Your Elite 2864I, by default, communicates asynchronously with computers using AT commands. AT commands are also used to configure and control your Elite 2864I. A command statement is usually sent to the modem by being typed from the computer keyboard.

Command statements must be written in a specific form in order for your Elite 2864I to recognize them. A command statement begins with the letters “AT” or “at” followed by one or more commands and then by <Enter>.

AT commands can only be issued when your Elite 2864I is in “command” or “off-line” mode.

Once your Elite 2864I has established a connection with the remote device, it goes into “on-line” mode, and the characters sent from your computer are transmitted to the remote device.

In order to issue an AT command statement, you first need to run your communications software and configure it to the port connected to your Elite 2864I. Refer to your communications software manual if this is not the case.

Once the communication terminal program is running and your Elite 2864I is connected:

Type:

```
AT<Enter>
```

Elite 2864I responds:

```
OK
```

This confirms that the modem and your computer are communicating correctly.

Supported AT Command Types

Type of AT Command	Example
Basic AT (Hayes compatible)	ATB00
Basic AT$ (on line help)	AT$
Extended AT&	AT&N0
Extended AT* command	AT*I1
S-Register command	ATS0=1
S-Register bit-mapped command (set S-Register bit 1 equal to 1)	ATS13.1=1
S-Register inquiry command	ATS0? Or ATS13.1?

You may also browse the list by using the on-line help command: AT$.

Quick Tips When Issuing AT Commands

The ENTER or RETURN key must be pressed to execute a command.

Multiple AT commands can be combined into one line. For example, AT&O2 and ATB02 can be combined into one line AT&O2B02.

The Elite 2864I processes commands from left to right. The AT command that appears to the right might over-write the command to the left. For example, ATB1B0 will result in ATB0 since both B1 and B0 can not co-exist.

If you see duplicate characters for each one you type, your Elite 2864I and software both have their echo feature turned on (default). To eliminate the double characters, turn off the software command echo.

Use “A/” to repeat the last command. No ‘AT’ prefix is needed for this command.

The Elite 2864I supports either verbose result code (i.e. “OK”) or numerical result code (i.e. “0"). You can use **ATV*n*** command to set it one way or the other:

Command	**Description**
ATV0	Select numerical result code
ATV1	Select verbose result code

3 Configuring Your ISDN Line and Network

You are now ready to set-up your ISDN network. There is a simple utility for Windows 3.x , Windows 95, or Windows NT provided by ZyXEL to help you set-up the network. This set-up procedure needs to be done only once. The network information will be stored in the non-volatile memory of the Elite 2864I. Turning the power off will not erase the information. The only time you will need to reconfigure your line is when you perform a hardware reset on your modem or when you change options on your ISDN line.

Figure 3-1 Internet Configuration Manager

ZyXEL Internet Configuration Software

Along with your Elite 2864I, you will find a disk labeled “ZyXEL Internet Configuration Manager”. The Configuration utility is an easy way to set up and configure your Elite 2864I without the use of a terminal program. To install this software simply run the setup file from the Run line. The main menu of the Internet Configuration Manager is shown in Figure 3-1. Press the *Help* button for instructions on using the utility.

More often than not, a driver (INF file) is used to configure the modem under Windows. Refer to Chapter 4 “Windows 95 and NT Setup” for more detailed information.

If your Elite 2864I is not going to be set-up by a computer running Windows, you will need some type of terminal program that allows you to send AT commands to the modem and receive responses from the modem.

Configuring Your Modem Using a Terminal Program

If you are not using the Internet Configuration Manager that is packaged with the Elite 2864I, you will need a terminal program to configure the unit. The Elite should work with any asynchronous terminal program that can communicate directly with one of the communication ports on your system. If you do not know how to use a terminal program, refer to the instructions that came with the terminal program.

Make sure the program is set up to communicate with the COM port that the Elite 2864I is connected to. You can check to see if the DTR LED is on when the terminal program is active. In most cases, if the terminal program is active and ready to communicate with the port that the Elite 2864I is connected to, it will activate the DTR signal. This will cause the DTR LED to light up. If DTR is not ON, you will need to check the program’s settings.

The communication speed can be set to anywhere between 1,200bps and 460,800bps, but 115,200bps is a good default value. The Elite 2864I will automatically adjust its speed to match your communication speed.

Once the terminal communication program is ready, you can type a simple command to see if the Elite 2864I responds.

Type:

```
AT<Enter>
```

Elite 2864I should respond:

```
OK
```

Type:

```
ATI<Enter>
```

Elite 2864I should respond:

```
28642
```

Type:

```
ATI1<Enter>
```

Elite 2864I should respond:

`Elite 2864I DSS1: V 2.06` *(ISDN Firmware version number)*

`Internal fax/modem:  V 1.14` *(Fax/modem Firmware version number)*

`FC2C` *(Firmware checksum will change based on your firmware version)*

`OK`

Once the Elite 2864I accepts the commands that you typed, it is ready to be programmed and ready to operate with your ISDN network. If you do not see any response from the device, go over your installation procedures again or contact the ZyXEL Technical Support.

Testing Your Connection

You are recommended to check the readiness of your ISDN and Elite 2864I before you start using them. There is an AT command designed for this purpose which uses one B-channel (B1) to place a call to itself and uses the other B-channel (B2) to receive the call. So this is a modem - B1 - CO(ISDN Switch) - B2 - modem loop back test.

Follow these instructions to make your test call:

Type:

```
AT&ZOI=your_isdn_number<Enter>
```

Elite 2864I responds:

```
OK
```

Type:

```
AT&T11<Enter>
```

Elite 2864I responds:

```
OK

Dial your_isdn_number

Loop from B1 to B2 through the switch
established!

Sending and receiving data.......

B1/B2 loopback test successed.

Disconnecting.....

NO CARRIER
```

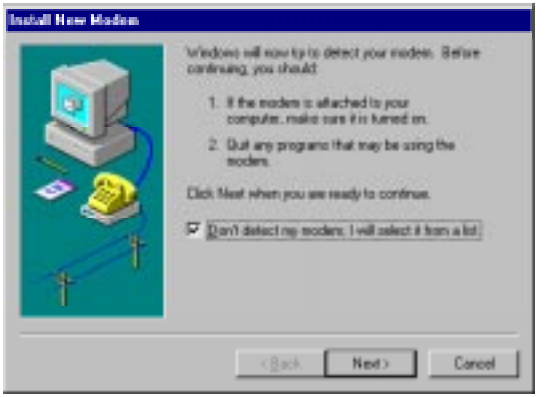
4 Windows 95 and NT Setup

This chapter contains step by step procedures for installing the Windows 95 and NT drivers, configuring a Dial-up Network, and installing CAPI for the Elite 2864I.

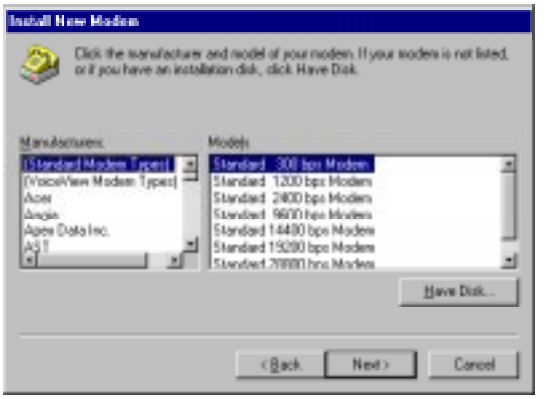
Installing the Windows 95 Driver (INF file)

Step 1 - Open the Control Panel by double clicking the “Control Panel” icon in your “My Computer” folder.

Step 2 - Double click “Modems,” then click the “Add” button. The following dialog box will appear.

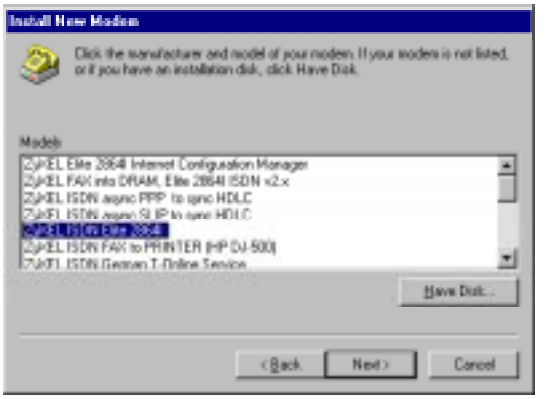


Step 3 - Select “Don't detect my modem; I will select from a list.” Then click “Next.”



Step 4 - Click the “Have Disk” button.

Step 5 - Insert the ZyXEL Windows 95 driver disk into your floppy drive and click OK. If you have downloaded an updated INF file from ZyXEL’s FTP, Website, or BBS, use “Browse” to find the location of the updated .INF file, click “Open,” then click “OK.”



Step 6 - Select the Elite 2864I driver with the protocol that your host is using. Generally, the samples listed below will work. However, we recommend that you check with your Internet Service Provider to verify which protocol they use.

If you are connecting to an Internet Service Provider (ISP), select:

ZyXEL ISDN async PPP to sync HDLC

If the ISP has not upgraded to an ASCEND compatible server, select:

ZyXEL ISDN X.75 64K0

If you are calling another location such as a BBS system, select:

ZyXEL ISDN X.75 64K0

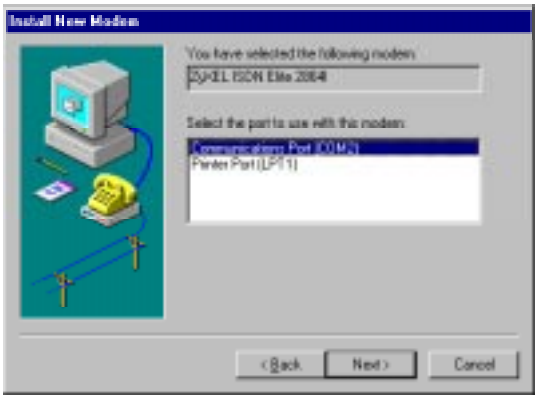
If you dial up to CompuServe, select:

ZyXEL ISDN V.120 64K0

If you are calling MicroSoft Network's (MSN) ISDN line, select:

ZyXEL ISDN async PPP to sync HDLC

After you have completed the selections above, click “Next.”



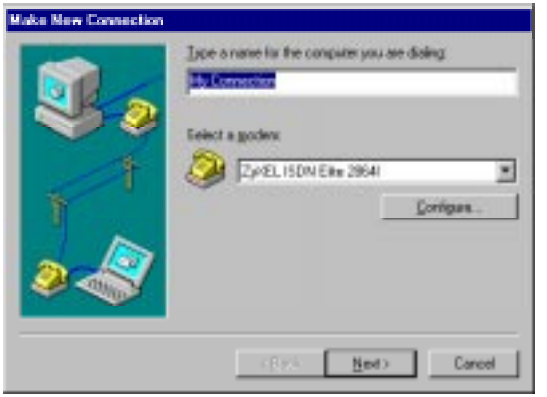
Step 7 - Select the COM port your modem is connected to and click “Next.” A final dialog will appear, Click “Finish.” You should now see a window similar to the one below:

Step 8 - Clicking “Close” completes the installation of your Elite 2864I modem driver. You may now use programs such as “Dial-Up Networking” with your Elite 2864I.

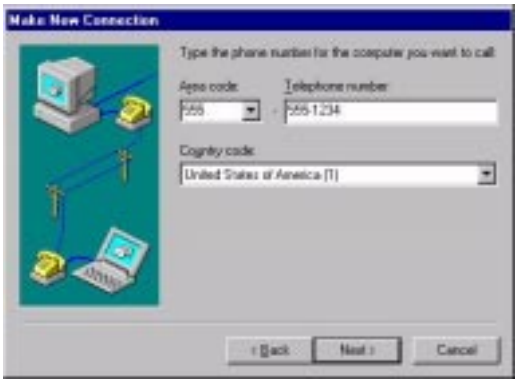
Configuring Windows 95 Dial-Up Networking

This section assumes you have already fully installed Windows 95. If you have not installed the Dial-Up Networking feature in Windows 95, please install it before you continue.

Step 1 - Double click on the “My Computer” icon and then double click on the “Dial-up Networking” icon. From within the Dial-up Networking folder, double click on the “Make New Connection” icon.



Step 2 - Choose a name for your connection and select your modem type from the drop down window. Then click on the “Next” button.



Step 3 - Type the phone number of your ISP or whatever host you will be calling. Click on the “Next” button.

Click on the Finish button. A new icon is created in the Dial-up Networking folder.

Step 4 - Right click on this icon, then select “Properties” from the menu.

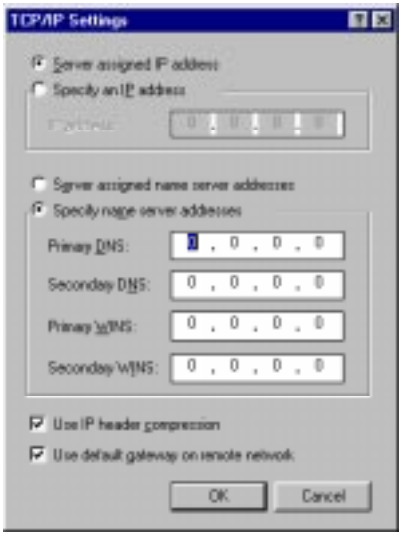
Step 5 - Make sure your Elite 2864I appears in the "Connect Using" box. Then click on the "Server Type" button.

These options are mostly host or server specific.

- If you are using PPP, use the default settings shown above.
- If you are connecting to a LAN, then select "Login to Network."

- If you are logging on to a Microsoft Windows network, select “NetBEUI.”
- If you are logging on to a Novell network, then select “IPX/SPX Compatible.”
- If you are logging on to an Internet connection, then select “TCP/IP.”

Step 6 - Click on “TCP/IP Settings.”

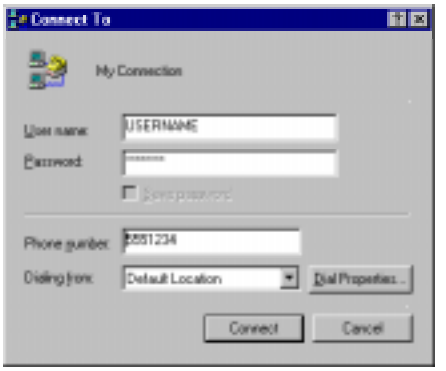


If your host requires you to specify an IP address (Static IP), then click on the "Specify an IP address" radio button and enter your IP address. If your host assigns an IP when you log in (Dynamic IP), then leave the "Server assigned IP address" checked. Most servers assign an IP to you when you log in.

Click the “Specify name server address” radio button and enter your primary and secondary DNS (Domain Name Server) IP.

In most cases, you should leave "Use IP header compression" and "Use default gateway on remote network" checked. When all of the selections have been made, click “OK.”

Step 7 - This completes the remote connection definition. Locate the new connection icon in your “Dial-up Networking” folder, and double click on it.



Step 8 - If the **User name** and **Password** are incorrect or are not there, type them in. Click on the Connect button and your Elite 2864I will dial the number and establish a connection.

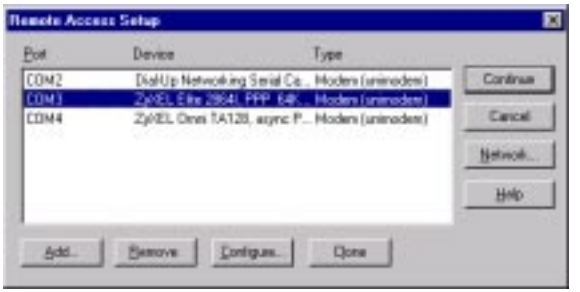
Configuring Windows NT 4.0 Dial-Up Networking

This section assumes you have already fully installed Windows NT. If you have not installed the Dial-Up Networking feature in Windows NT, please install it before you continue.

Step 1 - From the Windows NT **Start** button choose **Settings**, **Control Panel**, **Network**.

Step 2 - From the Network dialogue box select **Remote Access Service** and click **Add** then **OK**. Then click the Properties button.

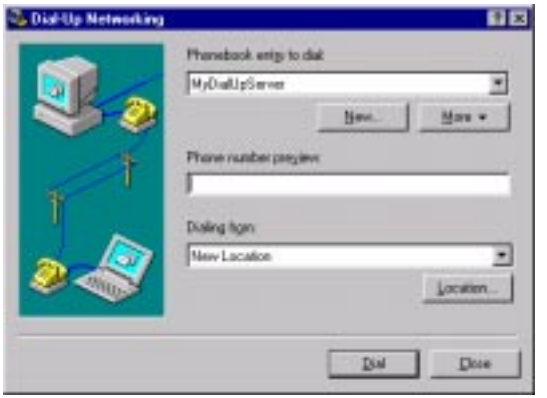
Step 3 - From the Remote Access Setup dialogue box select the appropriate COM port and click the **Configure** button.



Step 4 - From the Configure Port Usage dialogue box choose the desired call option and click **OK**.

Step 5 - From the Windows NT **Start** button choose **Programs**, **Accessories**, **Dial-Up Networking**.

Step 6 - From the Dial-Up Networking dialogue box click the **New** button.



Step 7 - From the New Phonebook Entry Wizard dialogue box type a phonebook entry name, and click the **Next** button.

Step 8 - From the Server dialogue box click all options that apply and click **Next**.

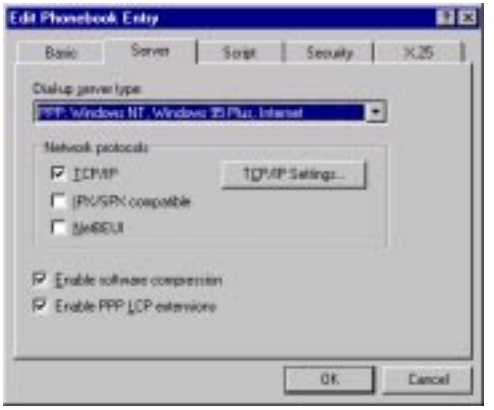
Step 9 - From the Phone Number dialogue box type in the phone number of the dial-up server you want to call and click **Next**.

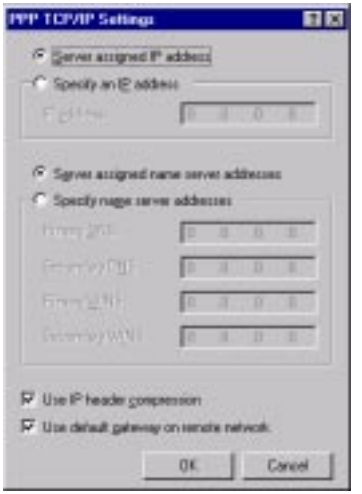
Step 10 - From the New Phonebook Entry Wizard dialogue box click **Finish**.to save your phonebook entry.

Step 11 - From the Dial-Up Networking dialogue box click the **More** button and scroll down to Edit entry and modem properties.

Step 12 - From the Basic tab, enter the entry name, phone number and choose the RAS port which you want to use. If you select the "Use Telephony dialing properties" checkbox, the RAS will use the built-in telephony settings to control how it dials the phone.

Step 13 - From the Server tab, leave the default setting PPP: Windows NT, Windows 95 Plus, Internet as the Dial-up server type. Enable the proper protocols. Select the **TCP/IP Settings** button to set the IP address and name server information.





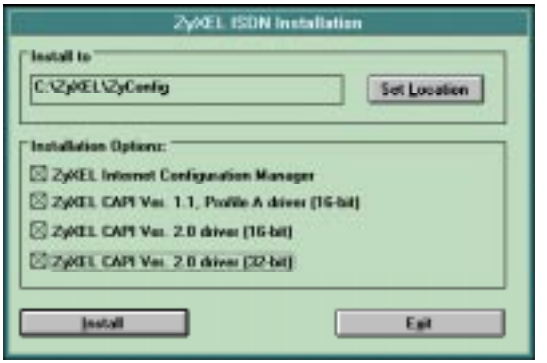
Step 14 - From the Script tab, select the proper login procedure and click **OK**.

Step 15 - The RAS is ready to dial. From the drop down list select the phonebook entry to dial, phone number, and the location dialing from. You can modify several options in More. When you are finished click **Dial**.

CAPI Installation

Follow the steps below to install the ZyXEL Internet Configuration Manager and ZyXEL CAPI drivers:

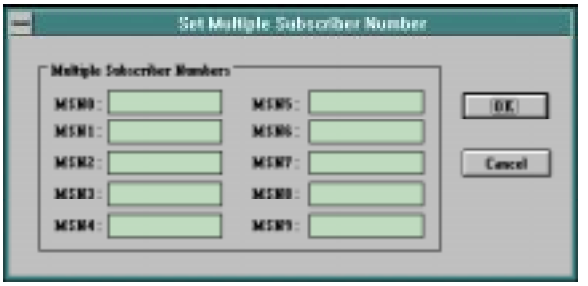
1. From the Win95 **Start** button choose **Run**.
2. From the Run dialogue box type: **A:\Setup.exe** and click **OK**.
3. From the ZyXEL ISDN Installation dialog box choose the appropriate CAPI driver and click the **Install** button.



4. From the Question dialogue box click **No** if you do not wish to setup Multiple Subscriber Numbers. This completes CAPI installation. If you click **Yes** continue with the steps below:

   Only CAPI 1.1a requires setup of Multiple Subscriber Numbers.

5. From the Set Multiple Subscriber Numbers dialog box type in the desired numbers and click OK.



5 ISDN Communication Basics

In this chapter, we will cover how to initiate and receive calls over digital lines using your Elite 2864I.

Outgoing Calls

The Elite 2864I has 3 modes in which to send communication over an ISDN network.

- ISDN data
- Analog port
- Internal fax/modem

These modes are auto-switching based on the commands you issue. Let's take a look at how the communication mode is automatically switched.

Dialing Out Using ISDN Mode

The command "ATDI" tells your Elite 2864I that you want to make an ISDN data call and to therefore use the ISDN mode to call out.

Type:

`ATDI17142630398<enter>` *(Make an ISDN call)*

Dialing Out for Analog Adapter Port

Using the "B" command following the "ATD" will tell your Elite 2864I to automatically switch calls to the analog adapter once dialing is complete.

Type:

```
ATDB17146930762<enter>
```

Dialing out for Internal Fax/modem

Using the "M" command following the "ATD" will tell your Elite 2864I to automatically switch calls to the internal fax/modem once dialing is complete.

Type:

```
ATDM17146930762<enter>
```

Manually Switching Communication Modes

The manual switching functions will only be necessary if your communication software does not allow you to change your dial-up string.

Conventional dialing commands: ATD, ATDT and ATDP, used by most existing communication software, can be mapped onto one of the new dialing commands according to the AT&O setting as follows:

AT Command	Dial string it will map to
AT&O0	ATD, ATDT and ATDP are the same as ATDM
AT&O1	ATD, ATDT and ATDP will place a call, for either ISDN data or internal fax/modem, automatically according to the solicited response of the called party.
AT&O2	ATD, ATDT and ATDP are the same as ATDI
AT&O3	ATD, ATDT and ATDP are the same as ATDB

The factory default is **AT&O2**. This means the modem will select ISDN data mode when you do not specify which communication mode to use in your dial command (i.e. ATD or ATDT).

Placing the Call

To initiate a call, choose the proper communication mode and configure the mode according to the bearer service (or protocol) you want to use. Here are some simple commands that will be useful when placing a call:

Command	Description
ATB*n*	Changes ISDN B channel protocol setting
ATDL	Re-dials the last dialed telephone number

Incoming Calls

When a call comes in, it will be carried by one of the following protocols:

- V.120
- HDLC PPP, MPPP or SLIP
- V.110
- X.75

or the call may be initiated by an analog device.

This section will provide some general guidelines for setting up the device for call answer handling. Be aware that the Elite 2864I will not automatically answer a call unless S-register **S0** is set to a value greater than 0 (zero). If S-register S0=0, the Elite 2864I will only report "RING" to your terminal program. It can also respond with an audible tone that will allow you to decide whether or not you should to take any action.

When an ISDN data call comes in, the Elite 2864I will try to negotiate a connection using the proper ISDN protocol. When an analog call comes in, the Elite 2864I will send the call to the analog port or the internal fax/modem.

Digital Data

The Elite 2864I currently supports Circuit Switched Data (CSD) for ISDN data applications. The CSD protocols supported by the Elite 2864I include: PPP, MPPP, V.120, X.75, and V.110. PPP is the most popular protocol used in North America; it is used by most of Internet service providers. Once the Elite 2864I answers a call, it will examine the incoming data to determine which protocol to use, and automatically switch to this mode. This operates transparently to the user. In addition to the internal fax/modem, the Elite 2864I is able to auto-switch for PPP, MPPP, V.120, X.75, V.110, and above protocols over speech channel. In most cases, you can rely on the auto-switching feature for your applications. If you need more specific settings for answering calls, refer to the section entitled "Answering a Call Using MSN" found later in this chapter.

Determining the Packet Length

User information is sent on a frame-by-frame basis for most ISDN data calls. Sometimes we call it "packetized." The maximum frame length on the sending side should not exceed the maximum frame length that the receiving side allows. Sometimes this information will be exchanged during handshaking. However, few manufacturers, if any, have implemented this mechanism.

If the sending side sends packets greater than what the receiving side allows, the receiving side will discard the frame and reply with a Frame Reject Frame (FRMR). The FRMR indicates that the information received is too long. Both sides will then reset their link layer negotiation and re-send the frame again. Usually this will happen repeatedly until the call gets disconnected.

The Elite 2864I has a fixed maximum receiving frame size of 2048 bytes which is larger than most devices can support. The default maximum sending frame size is 252 bytes for V.120 and 2048 for

X.75. If you need to change the maximum sending frame size, the ATCL command should be used.

Type:

```
ATCL252<Enter>
```
(Set the frame size to 252 octets, user value between 1-2048)

Elite 2864I responds:

```
OK
```

Type:

```
ATCL?<Enter>
```
(To inquire about the current setting of the packet length)

Elite 2864I responds:

```
Maximum user data length in a packet (byte)
: 252
```

Answering a Call Using MSN

When answering an incoming call, the call will first be identified if the caller number matches the MSN settings.

The Multiple Subscriber Number (MSN) supplementary service enables multiple ISDN numbers to be assigned to a single ISDN BRI line. It allows the caller to select, via the public network, one or more distinct terminals from a variety of terminal choices. Since the Elite supports many different communication protocols and a analog adapter, each of them can be assigned to an ISDN number using the following command:

AT&ZIn=s (where 's' is the MSN)	
&ZI0=s	assigns MSN 's', phone number for X.75
&ZI1=s	assigns MSN 's', phone number for V.110
&ZI2=s	assigns MSN 's', phone number for V.120
&ZI3=s	assigns MSN 's', phone number for PPP, MPPP
&ZI4=s	assigns MSN 's' for ISDN data and fax/modem, protocol auto-detection
&ZI5=s	assigns MSN 's', phone number for PPP, MPPP
&ZI6=s	assigns MSN 's', phone number for fax/modem

AT&ZIn=s (where ‘s’ is the MSN)	
&ZI7=s	assigns MSN ’s’, phone number for a/b adapter

AT&ZI? can be used to display the MSN numbers. The factory default for these numbers are UNASSIGNED.

If an incoming SETUP message is offered with addressing information (i.e. the appropriate part of the called_party_number), this address will be compared with the MSN numbers assigned by the AT&ZIn=s commands. The call will be accepted using the specific protocol, if the assigned number of this protocol matches the received called party number.

NOTE: YOU ARE NOT REQUIRED TO ENTER THE COMPLETE NUMBER STRING FOR THE AT&ZIN COMMAND. THE LAST FEW DISTINGUISHABLE DIGITS WILL BE ENOUGH FOR THE ELITE 2864I TO MAKE THE DECISION. TWO PHONE NUMBER STRINGS ARE SAID TO BE MATCHED IF THEIR LEAST SIGNIFICANT “N” DIGIT(S) ARE IDENTICAL, WHERE “N” IS THE NUMBER OF DIGITS IN THE SHORTER STRING.

Normally, Called_Party_Subaddress information within the incoming SETUP message is not used by the Elite 2864I to select the protocols or services. It just indicates the subaddress (if any) to the DTE.

Best-effort call answering

If some numbers have been set using &ZIn command (as can be seen by the AT&ZI? command) and they are not matched with the address of the incoming call, the Elite 2864I will, by default, ignore the call as it may be intended for other devices that share the same S/T interface (S0 bus) with the 2864I.

If you want the Elite 2864I to answer inbound calls using all possible protocols, you can set the best-effort call answering bit as follows:

Command	Function
ATS119.3=0	Answer call only when number matched (by default)
ATS119.3=1	Best effort call answering

Ambiguity resolution switch for voice calls

For a Speech or voice-band-data call, if the &ZI number assignment can tell whether the fax/modem or the analog adapter is being addressed, then the call will be delivered to the proper destination. But sometimes, ambiguity of address matching may exist. This may happen if the &ZIn numbers of the various protocols are either unassigned or not matched or the address information is absent in the incoming SETUP message. In this case, users may wish to set the answering priority for answering a call using the internal fax/modem or the a/b adapter (for external devices). The AT&Ln command sets the address ambiguity resolution flag:

AT&L0 - The a/b adapter has the higher priority to answer a voice or voice-band-data call; if the a/b adapter is busy, the call will be forwarded to the internal fax/modem.

AT&L1 - The internal fax/modem has the higher priority to answer a voice-band call; if the internal fax/modem is busy, the call will be forwarded to the a/b adapter.

Multi auto-answering of data calls

When an ISDN data call comes in, the Elite 2864I can determine the protocol to be used in one of two exclusive ways.

1. By way of the information conveyed by the SETUP message (for DSS1, these include the Bearer-Capability, Low-Layer-Compatibility, or High-Layer-Compatibility information elements; for 1TR6, these include the Service Indicator as well as an Additional Octet of the Service Indicator)

2. Using the Multi Auto-answering process. The Elite 2864I determines the protocol by monitoring the B channel signal sent by the calling site.

With either method, the data call can be identified by the Elite 2864I to be fax/modem, X.75, V.110, V.120, or PPP, MPPP Async-to-Sync conversion.

If the address-matching process is unable to tell which protocol to use, the Elite 2864I will go into its “Multi Auto-answering Routine,” by examining the B channel data pattern and hence determine the protocol to use.

When alerted, the Elite 2864I will send a RING message to the DTE in the following format:

```
RING
FM:17145522863     TO:17142630398
```

6 Async to Sync PPP and SLIP

More and more Internet Service Providers (ISP) are offering their services through dial-up ISDN lines for higher data bandwidth. The equipment used at the service provider's location are frequently ISDN LAN routers which, unlike terminal adapters, do not have asynchronous capability. For this reason, terminal adapters that support only X.75 or other asynchronous protocols will not work with this type of equipment.

The Elite 2864I is able to convert the asynchronous data it receives from your computer to synchronous format in order to communicate with ISDN LAN routers. We call this process asynchronous to synchronous HDLC conversion. To simplify it, we call it Async to Sync PPP (Point-to-Point Protocol) or Async to Sync SLIP (Serial Line Internet Protocol) protocol.

Making Async to Sync PPP and SLIP Calls

In order to communicate with an ISDN LAN router (from vendors such as Ascend and Cisco), you'll need to set the Elite 2864I B channel protocol to one of the following:

`ATB40<Enter>` *(HDLC PPP)*

or

`ATB41<Enter>`(*HDLC SLIP)*

You should also set the DTE speed based on the bandwidth that the switches support.

Most of the time, you will only use this protocol for making calls to remote sites with ISDN LAN Routers. If the remote access site you are calling uses a Terminal Adapter such as the Elite 2864I, you can use X.75 or V.120, as it provides V.42bis data compression.

Before making the call, check which protocol is set for the ISDN mode using the &V command to view the settings.

Type:

```
AT&V<Enter>
```

The Elite 2864I responds:

```
Current Settings...

Switch Type: DSS1

ISDN Outgoing Service: PPP Async-to-Sync
Conv 64K
```

If the settings displayed matches your current setup, you are ready to place the call.

Type:

```
ATDI<remote_access_number><Enter>
```

Elite 2864I will respond:

```
Connect 115000/64000 PPP/None
```

Keeping a Line Connected During Idle Time

If you are using PPP to access a Server, more often than not, the Server will have a watchdog timer to monitor the line activity. If the idle time exceeds some time interval (usually 1 minute), the Server will release the connection for other clients to dial in. As a user, you could be very annoyed in some circumstances since, once disconnected, you have to dial to the server again and repeat the login procedure. The value in register S124 (in seconds) is used as the idle time gauge. If the idle time exceeds this guarding period,

the Elite 2864I will send out a dummy PPP packet to the Server to keep it from disconnecting the line.

Example: If the server you are calling disconnects after 1 minute of inactivity, issue the following command before connecting:

`ATS124=59<Enter>` (send dummy PPP packet after 59 sec of inactivity)

Setting S124=0 will disable this function.

Answering Async to Sync PPP calls

There is no need to configure the ISDN mode to the protocol of an incoming call. If it is set to auto-answer or an answering command is issued, the Elite 2864I will be able to determine the correct protocol to use by examining the data coming in from the remote site. You can also set up an MSN entry for the phone number for the protocol, so calls to this number will be answered properly. To do this, use **AT&ZI3=*xxx***; where *'xxx'* is the number that the call is expected to dial in.

To allow the Elite 2864I to automatically answer the incoming call, you need to set S0 to a value greater than 0 (i.e. ATS0=1). Elite 2864I will answer the call and use asynchronous to synchronous conversions to and from the DTE. If S0 is not set (S0=0), the DCE will report "RING" and will also make an audible ring notification.

Multilink PPP

Multilink PPP (MPPP) is a protocol that allows virtual bundling of the two B channels, for connection speeds of 128Kbps. MPPP support is a standard feature of Elite 2864I models.

Making a Call Using Multilink PPP

A Multilink PPP connection is initiated at the calling site when **ATB40** (B channel protocol HDLC PPP) has been selected and the Multilink PPP mode has been enabled by an **AT&J***n* command:

AT&J0	Disables Multilink PPP
AT&J1	Enables Multilink PPP in answer mode only
AT&J2	Enables Multilink PPP in call mode only
AT&J3	Enables Multilink PPP in both call and answer modes

By default, the Elite 2864I dials the same number for both Multilink PPP connections. If the destination you are dialing requires two different telephone numbers to establish a two channel Multilink PPP connection, then the following command can be used:

```
ATDIphone_number_1+phone_number_2
```

where phone_number_1 and phone_number_2 are the phone numbers of the destination.

If the destination refuses the Multilink PPP during the LCP negotiation, a single B channel PPP connection will be established. Whether or not the Multilink PPP connections have been established, the connection message will be the same.

Dialing Pre-stored Phone Numbers

Use ATDSn, n=0,1,..,39, to dial the (n+1)th phone number twice for both the Multilink PPP connections. Use ATDSn+Sm, (n and n=0,1,...,39) to dial the (n+1)th phone number for the first connection and the (m+1)th phone number for the second connection.

For example, ATDIS0+S1<Enter> will dial the number stored in location ‘0’ , and the number stored in location ‘1’ for the MPPP connection.

Bandwidth Allocation Protocol (BACP/BAP)

The Bandwidth Allocation Control Protocol and Bandwidth Allocation Protocol (BACP/BAP) provides a means for the server site to assign the phone number for the second B-channel to the client side TA automatically. It can be enabled as follows:

ATBP0	Disable BACP/BAP function
ATBP1	Enable BACP/BAP function (by default)

Endpoint Discriminator

The Endpoint Discriminator option represents identification of the system transmitting the packet. This option advises a system that the peer on this link could be the same as the peer on another existing link. Some Multilink PPP implementations require the use of the Endpoint Discriminator option.

The Endpoint Discriminator consists of two components: Class and Address.

The Class field is one octet as stored in S-register S85 and indicates the identifier address space. Valid values of S85 are assigned as follows:

0	Null Class (by default)
1	Locally Assigned Address
2	Internet Protocol (IP) Address
3	IEEE 802.3 Globally Assigned MAC Address
4	PPP Magic-Number Block
5	Public Switched Network Directory Number

The Endpoint Discriminator Address field is of variable length from 0 to 20 octets and can be assigned by the ATEPD command:

```
ATEPD =
<Octet_1,Octet_2,Octet_3,..,Octet_n>
```

Each Octet_i is in the range from 0 to 255. The angle brackets '<' and '>' are part of the this command. The command ATEPD? can be used to view current setting of the Endpoint Discriminator Address.

NOTE: THE ENDPOINT DISCRIMINATOR OPTION IS NOT REQUIRED IN MOST CASES, THUS USERS DON'T HAVE TO CHANGE THE DEFAULT SETTINGS. THE SYSTEM ADMINISTRATOR OF YOUR CORPORATE OR THE INTERNET SERVICE PROVIDER WILL PROVIDE THESE VALUES IF THE ENDPOINT DISCRIMINATOR OPTION IS REQUIRED.

Call Bumping

When call bumping is enabled (by default), you can place or answer a voice call (and only one) from a device that is attached to the a/b adapter while a Multilink PPP call is active. The Elite 2864I automatically removes one of the Multilink PPP connections and uses it for the voice call. Once the voice call ends, the Elite 2864I automatically reestablishes that channel for Multilink PPP operation. The call bumping function can only be effective when the Elite 2864I is in the calling site (the client site). The following command can be used to select the DCA function:

ATCE0	Disable the call bumping function
ATCE1	Enable the call bumping function (default)

STAC LZS Compression

The Hi/fn (previously known as STAC) LZS compression, negotiated by the Compression Control Protocol (CCP), is widely supported by ISP‘s equipment. The Elite 2864I also supports this data compression protocol. The following command can be used to select the CCP/STAC function:

AT&K44	Enable the CCP/STAC compression function (default)
AT&K00	Disable the CCP/STAC compression function

NOTE: SOMETIMES THE DTE MAY ALSO COMPRESS DATA BY EITHER SOFTWARE OR HARDWARE MEANS. THE ELITE 2864I WILL MONITOR THE DTE'S ACTIVITIES FOR CCP NEGOTIATION AND WILL DISABLE THE MODEM'S COMPRESSION FUNCTION WHENEVER THE DTE HAS A SUCCESSFUL CCP NEGOTIATION.

7 V.120 ISDN Communications

This chapter describes how to set-up and configure your Elite 2864I for V.120 ISDN protocol.

Placing Outgoing Calls

Some switches transmit all network signals through the D channel, allowing both B channels to be used exclusively for your communication purposes. This allows for throughput of 64Kbps per channel. This is the case for most European countries. However, not all switches support out-of-band signaling at this time. For switches that do not support out-of-band signaling, network signals are transmitted through the B channels. This reduces the bandwidth to 56Kbps.

When you are making a V.120 call, make sure that the communication supports out-of-band signaling. If it does not, you'll need to set your Elite 2864I to 56K mode using the AT&E1 command (AT&E0 to set it back to 64k mode.) If your Elite 2864I is on the receiving end, you can keep the setting at AT&E0, 64k data mode. The Elite 2864I will automatically switch between the two speeds in answer mode.

Configuring V.120 Mode

To configure for a V.120 call, type:

`ATB20<Enter>` *(Select V.120 for communication)*

Elite 2864I responds:

`OK`

Now you are ready to dial the phone number. If you need to save the setting into non-volatile RAM, follow the steps below:

Type:

AT&W0<Enter> *(Save the settings to profile 0) [Profiles available: 0-3]*

Elite 2864I responds:

OK

Type:

ATZ0<Enter> *(Save stored settings as the power on settings to profile 0) [Profiles available: 0-3]*

Elite 2864I responds:

OK

All the above commands can be simplified by combining all of the commands onto one line as follows:

ATB20&WZ0<Enter>

Dialing in V.120 mode

Finally, use the **ATD*n*** command to make the call (*n* is the phone number you wish to dial). Once the connection is made, you should see the following connect message.

CONNECT 115200/V120 64000/LAPD

This indicates that the connection is made with the following parameters:

DTE speed	115,200bps
Protocol	V.120
Data Speed	64,000bps
Error	Control LAPD

Answering Incoming Calls

In most cases, there is no need to configure the Elite 2864I to properly answer calls. The Elite 2864I is able to decide which protocol to use by detecting the type of data that is coming in. All you need to do is set S0 to greater than or equal to 1, so the Elite 2864I will automatically answer an incoming call. If S0=0, the DCE will simply report "RING" to your terminal and sound a ring notification.

Speeds of 128Kbps

BRI ISDN consists of three (2B+D) logical channels. Each B channel can be used independently for a dial-up connection running at 56Kbps or 64Kbps (bits per second).

The two B channels can be used together for a single data connection to provide 112K (with In-Band Signaling) or 128K (when Out-of-Band Signaling is used). This is a a "Bundled Connection" (different from BONDING).

Identifying Your Line Provisioning

For bundled connections, the two B channels of your ISDN line must be able to handle data circuit switch connections with unrestricted 64K or 56Kbps line speeds. Two separate data calls will be established consecutively.

Making a Bundled Call with V.120

A bundled V.120 connection is initiated at the calling site when **ATB20** (B channel protocol V.120) has been selected and the channel bundling mode has been enabled by an **AT&J3** command. The channel bundling command (AT&J3) must be set on both the calling and receiving sides, otherwise a single channel connection will be made.

Type:

`ATB20<Enter>` *(Set B channel protocol to V.120)*

`AT&J3<Enter>` *(Set the Elite 2864I to make a bundled call)*

Type:

`AT&WZ<Enter>` *(If you want to save the setting)*

Once this is done, the ATD command will generate two consecutive SETUP messages to invoke bundle initiation.

For the Northern Telecom switch, each BRI phone number can only be called once at any given time. So if you dial this number, it will report "busy" to any other incoming calls. In order to use two B channels for aggregation, we must place two calls with different phone numbers. To do this, separate the two numbers with a "+" sign after the "ATD" command:

`ATDI[phone_number_1]+[phone_number_2]<Enter>`

The answering Elite 2864I determines that the call is a bundle request: when AT&J3 is set, and two consecutive SETUP messages are received. The two data calls are established as one message. The phone company's ISDN line splits it off into two messages. That is, the ISDN network treats them as two independent calls. Finally, the receiving side receives one bundled message into the computer's serial port.

The success of a bundle connection initiation is indicated by the connect message reported to the DTE:

`CONNECT 460800/V120M 128K/LAPD`

or

`CONNECT 460800/V120M 128K/LAPD/V42b` *(with data compression)*

If you are not using American ISDN, you have a choice between Multiple Link Protocol (MLP) or "cFos" channel bundling (CCB). These can be set using the following commands:

ATS100=0	MLP channel bundling
ATS100=1	CCB channel bundling

Dialing pre-stored phone numbers

Use ATDSn, n=0,1,..,39, to dial the (n+1)th phone number twice for both the bundle connections. Use ATDSn+Sm, (n and n=0,1,...,39) to dial the (n+1)th phone number for the first connection and the (m+1)th phone number for the second connection.

For example, ATDIS0+S1<Enter> will dial the number stored in location '0', and the number stored in location '1' for the bundle connection.

The availability of various bundle protocols is outlined below:

	Multiple Link Protocol (MLP)	**'cFos' Channel Bundling (CCB)**	**Multilink PPP**
Enable Channel-Bundling	*AT&J3*	*AT&J3*	*AT&J3*
Applicable Data Protocols	*X.75 (ATB0n), V.120 (ATB20)*	*X.75 (ATB0n), V.120 (ATB20)*	*PPP (ATB40)*
Call bumping	*No*	*No*	*Yes (ATCE1)*
Bundle Type Selection	*S100=0*	*S100=1*	*S100=1*
STAC Compression	*No*	*No*	*Yes (AT&K44)*
V.42bis	*Yes (AT&K44)*	*Yes (AT&K44)*	*No*
In-band Bundle Negotiation	*No*	*No*	*Yes*
End Point Discrimination	*N/A*	*N/A*	*Optional*

Error Correction and Data Compression with V.120

With V.120, the default setting is for LAPD error correction only. No data compression will be negotiated. The following AT commands are used to switch the V.42bis data compression on or off for ISDN data calls when using V.120 protocol.

AT&K44	enables V.42bis on ISDN calls

AT&K00	disables V.42bis on ISDN calls

With the &K44 setting, the Elite 2864I will try to connect using V.42bis data compression. If the remote device doesn’t support V.42bis, then LAPD error correction will be used.

When a connection is made using V.42bis compression, the following connect message will be displayed.

```
CONNECT 115200/V120 64000/LAPD/V42b.
```

It takes extra time for the calling ISDN TA to negotiate V.42bis. If you know in advance that the called site has no V.42bis capability, it would be better to issue the AT&K00 command beforehand in order to get a quick connection.

V.42bis is an international data compression standard commonly used in modem communications. This standard provides real time data compression. ZyXEL's expertise in data compression has been brought into ISDN applications, which are much faster in speed than modem communications.

Bundle Connection with V.42bis Data Compression

If both sites have set **AT&K44** to enable V.42bis negotiation then XID frames will be exchanged through the main B channel which corresponds to the call established by the first SETUP message.

Only one data compression channel will be used in bundle connection. That means the compression is done before packet disassembly and the decompression is done after packet assembly. The compression ratio of V.42bis is commonly recognized as up to 4:1 for text files. If the line speed is 128K bps, then the DTE speed may reach 512K bps. This makes the DTE's normal RS-232 serial port unsuitable for bundle applications. A special I/O card on the computer side is required in this situation.

Selecting V.120 for European ISDN (DSS1)

With European ISDN, V.120 is an option in the Bearer Capability (BC) information element, which is a mandatory information element in the SETUP message. Some CompuServe Providers need to use the Low-Layer-Compatibility (LLC) information element to identify the V.120 call. The Low-Layer-Compatibility can be controlled by issuing the following commands:

S80.6 = 1	Sending LLC for ISDN data call
S80.6 = 0	Not sending LLC for ISDN data call (default)

8 X.75 ISDN Communications

This chapter will describe how to set-up and configure your Elite 2864I with X.75 protocols. It will also describe Data Encryption Standard (DES) and its application within a growing market of companies and individuals who are concerned with sending and receiving secured messages.

X.75 was originally designed for packet-switched signaling systems in public networks to provide data transmission services. But it is now also used as the link layer for telematic services in ISDN. These services include both ISDN circuit-switched mode (DTE-DTE communication) and ISDN packet-switched mode (DTE-DCE communication). The table below shows the specifications of different ISDN protocols.

	V.110	**V.120**	**X.75**
Layer 1	80 Bits Framing	HDLC	HDLC
Layer 2	None	LAPD	LAPB Transparent
Layer 3	None	V.120	ISO8208 T.70 NL
Error Control	No	Yes	Yes
V.42bis	No	Yes	Yes
Async or Sync if used with V-Series DTE	Async and Sync	Async Only	Async Only
Bundle	No	Yes	Yes
Max. Line Speed	Async: 38.4 Kbps Sync: 64 Kbps	64Kbps 128Kbps	64Kbps 128Kbps
AT-Command Configuration	ATB10	ATB20	ATB00: Transparent ATB01: T.70 NL

Answering an X.75 Call

There is no need to configure the ISDN mode to the protocol of an incoming call. The Elite 2864I will be able to determine the correct protocol to use by examining the data coming in from the remote site if the device is set to auto-answer or once an answering command is issued.

To allow the Elite 2864I to answer the incoming call, you need to set S0 to a value greater than 0 (i.e. ATS0=1). The Elite 2864I will answer the call and use asynchronous to synchronous conversions to and from the DTE. If S0 is not set (S0=0), the DCE will report "RING" and will also make an audible ring notification.

Making an X.75 Call

CAPI 1.1a specifies X.75 with T.70 NL as its default.

CAPI 2.0 specifies X.75 with transparent layer 3 as its default.

The default data protocol of the Elite 2864I is ATB00. X.75 protocols can be chosen using the following AT commands:

ATB00	X.75 with transparent layer 3
ATB01	X.75 with T.70 NL

The ATB0x commands not only specify the outgoing protocol, but also set the default layer 3 for an incoming X.75 call without layer 3 information. It is important for both ends of an X.75 connection to execute the same pre-assigned layer 3 protocol, as it reduces the chance that the Elite 2864I will make the wrong protocol selection.

For European ISDN (DSS1), the Low-Layer-Compatibility (LLC) information element in the SETUP message can be used to specify the layer 3 protocol. Since this is an option for ISDN switches, some of the switches might not deliver the LLC information

element to the remote end. There is no provision for the 1TR6 switch to specify the layer 3 protocol for X.75 type of calls.

Making a Bundled Call with X.75

A bundle connection is initiated at the calling site by sending two consecutive SETUP messages to the network. The two SETUP messages are all the same except for the Call Reference values.

AT&J*n* can be used for bundle configuration as follows:

AT&J0	Disables B channel bundling
AT&J1	Enables B channel bundling in answer mode only
AT&J2	Enables B channel bundling in call mode only
AT&J3	Enables B channel bundling in both call and answer modes

The bundle protocol can be selected as follows:

ATS100=0	MLP channel bundling
ATS100=1	CCB channel bundling

If channel bundling is enabled, the **ATDIs** command will generate two consecutive SETUP messages to invoke bundle initiation.

For Northern Telecom ISDN, each BRI destination phone number can only be called once at any time. In order to use two B channels for aggregation, we must place two calls with different phone numbers. The following command can be used for this purpose.

```
ATDIphone_number_1+phone_number_2
```

If the called site receives two consecutive SETUP messages with the same Calling Party Number and Bearer Capability *(or Origination Address for and Service Indicator for 1TR6)* then it is deemed as a bundle request. The two data calls are established following normal call control procedures. That is, the network treats them as two independent calls.

The TA's in the two sites then use **X.75 Multiple Link Protocol** or **'cFos' channel bundling protocol** to coordinate the two B channels. The former would need an overhead of two octets for each packet. The success of bundle connection initiation is indicated by the connect message reported to DTE as follows:

```
CONNECT 460800 / X.75M 128K / V42b
```

If a B channel is unavailable in any site then the bundle initiation will fall back to single channel connection. In this case the connect message will be as follows:

```
CONNECT 460800 / X.75 64000 / V42b
```

Dialing Pre-stored Phone Numbers

The 40 phone numbers stored in the NVRAM can also be used to place a bundle call.

- Use **ATDS*n*,** (*n*=0-39), to dial the (n+1)th phone number twice for bundle connections.
- Use **ATDS*n*+,** (*n*=0-38), to dial the (n+1)th phone number for the first connection and to dial the (n+2)th phone number for the second connection.
- Use **ATDS*n*+S*m***, (*n*=0-39; *m*=0-39), to dial the (n+1)th phone number for the first connection and the (m+1)th phone number for the second connection.

The availability of various bundle protocols is outlined below:

	Multiple Link Protocol (MLP)	**'cFos' Channel Bundling (CCB)**	**Multilink PPP**
Enable Channel-Bundling	*AT&J3*	*AT&J3*	*AT&J3*
Applicable Data Protocols	*X.75 (ATB0n), V.120 (ATB20)*	*X.75 (ATB0n), V.120 (ATB20)*	*PPP (ATB40)*
Call bumping	*No*	*No*	*Yes (ATCE1)*

	Multiple Link Protocol (MLP)	'cFos' Channel Bundling (CCB)	Multilink PPP
Bundle Type Selection	*S100=0*	*S100=1*	*S100=1*
STAC Compression	*No*	*No*	*Yes (AT&K44)*
V.42bis	*Yes (AT&K44)*	*Yes (AT&K44)*	*No*
In-band Bundle Negotiation	*No*	*No*	*Yes*
End Point Discrimination	*N/A*	*N/A*	*Optional*

Invoking V.42bis Data Compression

The following AT commands are used to switch the V.42bis data compression on or off for ISDN data calls when using X.75 or V.120 protocols:

AT&K44	(enable V.42bis on ISDN call)
AT&K00	(disable V.42bis on ISDN call)

For X.75, to negotiate compression parameters with the remote ISDN terminal, we exchange XID frames before the Link Layer is established. The calling site will send an XID frame with V.42bis request to the called site. If the called site understands this XID's meaning, it will either reply to an XID frame with V.42bis request. If it is able to execute V.42bis; it will ignore the XID or reply with an XID frame with V.42bis reject or empty information field.

The calling site will assume that the remote site is unable to execute V.42bis if it gets no reply for a period of time after sending the request XID. In this situation, normal connection without data compression will be established.

It takes about 2 seconds for the calling ISDN TA to send XID and wait until time out. If you know in advance that the called site has no V.42bis capability, it would be better to issue the AT&K00 command beforehand in order to get a quick connection.

If you are interested in the V.42bis negotiation procedure, you can use the embedded protocol analyzer to capture and analyze the exchanged XID frames.

Bundle Connection with V.42bis Data Compression

If both sites have set **AT&K44** to enable V.42bis negotiation then XID frames will be exchanged through the main B channel which corresponds to the call established by the first SETUP message.

Only one data compression channel will be used in a bundle connection. That means the compression is done before packet disassembly and the decompression is done after packet assembly. The compression ratio of V.42bis is commonly recognized as up to 4:1 for text files. If the line speed is 128K bps, then the DTE speed may reach 512K bps. This makes the DTE's normal RS-232 serial port unsuitable for bundle applications. A special I/O card on the computer side is required in this situation.

Data Encryption

PLEASE NOTE:
In response to customer needs and requirements, ZyXEL has taken the initiative to implement Data Encryption into the Elite 2864I. Implementation of this public DES algorithm has been arranged exclusively by ZyXEL, without violation of any patents. Its use with the Elite 2864I is free for all. ZyXEL however, will not be responsible for any contrary rules that apply in the countries where the Data Encryption feature is being used. It is the sole responsibility of the user to be aware of established rules and regulations in their respective countries regarding the use of Data Encryption. Users intending to export the Elite 2864I should investigate and adhere to local export laws.

For many years, the cryptographic protection of data communication has been a matter of importance only to military or government security agencies. But during the last two decades, with the advance of microelectronics and computer-communication technology, the following trends may change its significance and application:

1. Companies and individual users rely more on data communication to exchange sensitive information. Specifically, more and more people are using ISDN for LAN-to-LAN interconnection and Internet services.
2. Inexpensive but powerful equipment makes the interception job of wire-tapers or hackers easier than before.
3. It is possible now for civilians to employ security practices that can protect against powerful adversaries.

NOTE: ZYXEL DOES NOT ASSUME ANY LIABILITY ARISING OUT OF THE APPLICATION OR USE OF ANY OF THE SECURITY FUNCTIONS DESCRIBED IN THIS CHAPTER. NEITHER DOES IT CONVEY ANY LICENSE UNDER ITS PATENT RIGHTS NOR THE RIGHTS OF OTHERS.

Data Encryption Standard (DES)

DES is a Federal Information Processing Standard in the United States. DES is a block cipher - that means it encrypts data in 64-bit blocks. A 64-bit block of plain text goes in one end of the algorithm, and a 64-bit block comes out of the other end. Both encryption and decryption use the same algorithm. The key length is 56 bits. Some of the 56-bit numbers are considered to be weak keys. But the weak keys will be automatically avoided by Elite 2864I. One major criticism of the DES standard is that its key is too short to survive the brute force (exhaustive search) attack of today's technology.

Triple DES, which uses two DES keys, has been adopted to improve the DES algorithm in the ISO 8732 standard. This way, the

equivalent key length is 112 bits, and the resultant cipher text is much harder to break using an exhaustive search : 2^{112} attempts instead of 2^{56} attempts.

The table below is an estimation of security, depending on key length using the 1990s' technology: (Please refer to Dr. Dobb's Journal, April 1994 for more detailed information):

Key Length	Time Required for a $1M Machine to Break	Time for a $1B Machine to Break
56Bits	3.5 hours	13 seconds
100Bits	7 billion years	7 million years
128Bits	10^{18} years	10^{15} years

Manual DES Key Generation

The Elite 2864I currently supports encryption with X.75 protocol. The key used by DES can be manually entered via an AT command before each connection is made (the Elite 2864I will not remember the Key you used).

Type:

```
ATCK<DES_Key><Enter>
```

Example: ATCK<678901234567890><Enter>

NOTE: THE "<" AND ">" ARE REQUIRED CHARACTERS FOR THE DES_KEY PARAMETER

Use the above example to preset the DES key. The DES_Key is a string of printable characters. The number of characters in the string should be larger than 15 and less than 65. The AT command interpreter will convert the string DES_Key to a real DES key. The Elite 2864I will check to see if the converted key is a weak key for DES, if so, it modifies the key according to a predetermined algorithm to get a non-weak key.

Both ends of an ISDN link should key in the same DES_Key before a DES ISDN call can be established. Failure to do so will

cause either an immediate disconnection or an unintelligible connection.

You can combine the DES_Key with your dialing string when you are making a call or combining it with your answering string when you are answering a call. For example:

When dialing type:

```
ATCK<678901234567890>D6931111<Enter>
```

When answering type:

```
ATCK<678901234567890>A<Enter>
```

This way, the encryption key is given to Elite 2864I just before it is needed.

Automatic DES Key Generation

The Elite 2864I can also generate the DES key automatically which is selected by the following AT command:

ATS89.2 = 0	Use an automatically generated key
ATS89.2 = 1	Use a manually generated key

Control of Data Encryption

The AT commands to control the data encryption are as follows :

S Register setting	Description
ATS89.0 = 1	DES is desired
ATS89.0 = 0	DES is disabled (Default)
ATS89.1 = 1	Triple DES is preferred
ATS89.1 = 0	Single DES is preferred (Default)
ATS89.2 = 0	Use an automatically generated key
ATS89.2 = 1	Use a manually generated key

The DES request as well as any key distribution parameters, are exchanged via XID frames in the same way as V.42bis negotiation. Interested users can use the embedded protocol analyzer to examine the structure of XID frames. Both V.42bis and the data encryption functions can be invoked simultaneously for an ISDN

data call. But the DES can not be used for bundle connections, due to the limitation of computing resources.

LED Indicators For Data Encryption

The B channel LED indicator (B1 or B2) lights up when the B channel is connected. A single blinking LED indicates that data transmission is protected by Data Encryption Standard (DES). A triple blinking LED indicates that data is protected by triple DES.

9 V.110 and Synchronous Mode Communications

V.110 is most popular in Japan. The table below shows the specifications of different ISDN protocols:

	Synchronous	**V.110**	**X.75/V.120**
Layer 1	Transparent	80 Bits Framing	HDLC
Layer 2	None	None	LAPB/LAPD
Layer 3	None	None	ISO8208 T.70 NL/ V.120
Error Control	No	No	Yes
V.42bis	No	No	Yes
Async or Sync	Sync	Async	Async
Bundle	Yes (Note)	No	Yes
Max. Line Speed	64Kbps 128Kbps (Note)	38.4 Kbps	64Kbps 128Kbps
AT-Command Configuration	ATB11&M1 (Sync Data) ATB11&M3*I1 (V.25bis Sync HDLC)	ATB10	ATB0: Transparent ATB01: T.70 NL/ ATB20
Note : BONDING protocol for synchronous mode will be F/W upgradeable at ZyXEL‘s option.			

Answering a V.110 call

Once you set the proper V.110 communication mode, either asynchronous or synchronous, there is no need to configure the ISDN mode to the protocol of an incoming call. The Elite 2864I will be able to determine the correct protocol to use by examining the data coming in from the remote site if the device is set to auto-answer or once an answering command is issued.

To allow the Elite 2864I to answer the incoming call, you need to set S0 to a value greater than 0 (i.e. ATS0=1). If S0 is not set (S0=0), the DCE will report “RING” and will also make an audible ring notification.

Making V.110 Calls

Before the **ATDIxxx** command is given to place the call, you need to make sure that the Elite 2864I is in the asynchronous mode (AT&M0). Then use the following commands to configure V.110:

AT Command	Description
ATB10	User rate follows DTE speed (see note below)
ATB13	User rate = 2400bps
ATB14	User rate = 4800bps
ATB15	User rate = 9600bps
ATB16	User rate = 14400bps
ATB17	User rate = 19200bps
ATB18	User rate = 38400bps
ATB19	User rate = 57600bps (Japanese version only)

The highest Async V.110 user rate depends on bit 4 of S119 as follows:

S119.4=0	19200 bps
S119.4=1	38400 bps for areas other than Japan (default)
S119.4=1	57600 bps for Japanese version

If the DTE speed is higher than what has been set, the user rate on above table will be used.

Synchronous Connections

Use the following commands to choose the data rate for synchronous operation :

ATB11	64000bps
ATB19	56000bps

There are two modes of synchronous operation :

1. **Asynchronous commands, synchronous data (AT&M1):** The Elite 2864I accepts AT commands in asynchronous mode. Once the call is connected, it enters synchronous mode for data transmission.
2. **Synchronous mode (AT&M3*I1):** The Elite 2864I accepts synchronous commands from V.25 bis or a PC with an add-on synchronous card, and exchanges data synchronously with a remote TA.

NOTE: THE ELITE 2864I DOES NOT SUPPORT NETWORK INDEPENDENT CLOCK COMPENSATION. THE SYNCHRONOUS TIMING SOURCE MUST BE SUPPLIED BY THE ELITE 2864I, WHICH IS PHASE LOCKED TO THE NETWORK SYNCHRONOUS CLOCK.

10 Handling Analog Calls

The analog adapter enables you to connect analog devices (e.g. telephone, fax, PBX, or modem) to an ISDN Basic Rate line. Any conventional analog telephony equipment which supports DTMF tone/pulse dialing can be plugged into the RJ-11 socket of the Elite 2864I.

This chapter will outline the steps you need to take to place and answer analog calls via your ISDN line.

NOTE: GERMAN ZYXEL CUSTOMERS: THE INNER TWO PINS OF THE RJ-11 ARE USED FOR THE TIP AND RING (OR A AND B SIGNALS IN GERMANY, THE TWO SIGNALS THAT CONNECT TO A TELEPHONE SET). THIS IS THE STANDARD PIN ASSIGNMENT, BUT SOME BZT-APPROVED TELEPHONES USE THE OUTER TWO PINS FOR A AND B. IF THIS IS THE CASE, USE THE ATTACHED TAE ADAPTER WHICH HAS A UNIQUE INTERFACE DEFINITION OR USE AN RJ-11 CABLE THAT CONNECTS THE INNER PINS ON ONE END AND THE OUTER PINS ON THE OTHER END.

The following table shows some of the most frequently used AT commands for your reference:

AT Command	Description
ATDBs	Dials out for device connects to a/b adapter (via DTE), "s" represents the number string to dial
ATDMs	Dials out for internal fax/modem
AT&V6	View current setting of the analog port
AT&L0 or ATS84.5=0	Assign inbound analog calls to the analog port first
AT&L1 or ATS84.5=1	Assign inbound analog calls to internal fax/modem first
AT&ZI6=s	Assign the Called phone number for internal fax/modem
AT&ZI7=s	Assign the Called phone number for analog adapter
ATS56=n	Flash timer, in 100 ms unit, to set maximum duration of ON-OFF hook transition to be recognized as "Flash"

AT Command	Description
ATS118.7=0	Enable analog incoming calls (Default)
ATS118.7=1	Reject analog incoming calls (for pure ISDN data)
ATS118.6=0	Enable analog port to receive global call (i.e. MSN unmatched or destination address unspecified) (Default)
ATS118.6=1	Disable analog port to receive global call
ATS89.6=0	To disable the metering pulse for analog port
ATS89.6=1	To enable the metering pulse for analog port

Placing a Call from the Analog Port

Making a call from the analog adapter is as easy as picking up the telephone connected to the analog port and dialing. With a terminal program's assistance you can also use the Elite 2864I to dial the number for you.

Type:

`ATDB714-693-0808<Enter>` *(Dial the number)*

Elite 2864I returns:

`CONNECT` *(Dialing is complete)*

Now, just pick up the phone handset and wait for the remote device to answer.

A busy tone will be heard on the handset if:

1. The B channel is unavailable
2. The dialed number is undeliverable
3. The called party is busy

This indicates the failure of the attempt to connect. To place another call, hang up the phone, then pick it up again. If the called party is being alerted, a ring-back tone will be heard.

Accepting an Incoming Call

Incoming ISDN calls are directed to the analog adapter if:

1. Voice calls will be sent to the internal fax/modem or analog adapter automatically when received. As the manufacture default, the call will be sent to the analog adapter, then the internal fax/modem if the analog adapter is busy.
2. The MSN is set to AT&ZIn=s where you specify the phone number, “s”, the remote user dialed to be sent to a specific analog adapter, “n”.
3. The MSN setting for the phone number in the incoming SETUP message is acceptable to both the internal fax/modem and analog adapter, the ambiguity resolution bit (Bit 5 of S84, or &Ln) is set to 0 (analog adapter has the higher priority) or 1 (internal fax/modem has the higher priority).

Internal fax/modem Operations

For the internal fax/modem‘s operations, refer to the 2864 series modem user's manual.

Feature Phone

ISDN has been designed to support many luxury telephone features. Using the ISDN modem's a/b adapter, even with simple analog telephones, the user can enjoy the ISDN features such as call back and broker.

Call Back

You may place your current call on hold and then make another call to a third party. Afterwards, when the second call is over, you may return to the original call. To use Call Back follow the instructions given below:

1. Press the flash key (touch tone only)
2. Dial "0" to get a dial tone.

3. Dial the desired number and talk with the third party.

To return from call back :

1. Hang up the handset. The phone will ring.
2. Pick up the handset and continue your original call.

Broker

You can place your current call on hold while making another call to third party. Once the connection is established, you can switch back and forth between the two calls:

1. Press the flash key (touch tone only)
2. Dial "0" to get a dial tone.
3. Dial the desired number and wait until the call is answered

The connection to the first call will be kept.

To switch back and forth between the two calls:

1. Press the flash key (touch tone only)
2. Dial "0"

You will be switched to the other party.

To return from brokering:

1. Hang up the handset to terminate the current call.
2. The phone will ring.
3. Pick up the handset and continue the rest of the call.

11 Advanced ISDN Call Control

Call Control for DSS1 (Digital Subscriber Signaling #1)

In order to initiate a DSS1 ISDN call, two information elements are necessary:

1. The **Bearer Capability** element indicates what kind of bearer service is desired. It is also used for compatibility checking in the addressed entity.
2. The **Called Party Number** element provides necessary information for the telephone company Central Office (CO) to direct the call to the destination.

Other optional information elements which are pertinent to call control include:

- High-Layer-Compatibility
- Low-Layer-Compatibility
- Calling-Party-Number
- Called-Party-Number
- Calling-Party-SubAddress
- Called-Party-SubAddress

Control of Outgoing Service Indicator

The **High-Layer-Compatibility** and **Low-Layer-Compatibility** information provides a means for compatibility checking by the

called party. They are transferred transparently by the ISDN network between the call originating entity (e.g. the calling user) and the addressed entity.

The outgoing **High-Layer-Compatibility** can be controlled by setting the value of S-register S(108+n) as follows:

n=0 (**S108**)	Setting for internal fax/modem
n=2 (**S110**)	Setting for ISDN data calls
n=3 (**S111**)	Setting for analog adapter

S(108+n=)	**Function**
0	No High-Layer-Compatibility info element will be sent (default)
1	Telephony
4	Facsimile Group 2/3
40	Teletex service (Rec. F.220)
49	Teletex service (Rec. F.200)
50	International interworking for video services (Rec. F.300 and T.110)
53	Telex service (Rec. F.60)
56	Message Handling Systems (MHS) (Rec. X.400 series)
65	OSI application (Rec. X.200 series)

Example: AT**S111=4** sets Fax compatibility message for Analog Port 1.

Bearer-Capability and **Low-Layer-Compatibility** information elements will be determined when you configure the B channel protocols using the command **ATBnn**. The outgoing Low-Layer-Compatibility information element can be turned on or off by setting **S80 bit '*n*'** as follows:

n = 4	for internal fax/modem
n = 6	for ISDN data calls
n = 7	for the analog adapter

S80.*n*=0	Disable outgoing Low-Layer-Compatibility (default)

S80.*n*=1	Enable outgoing Low-Layer-Compatibility

Example: **ATS80.7=0** disables Low-Layer-Compatibility messages for the Analog Port.

Control of ISDN Phone Number and Sub-address

The **Calling-Party-Number** information element identifies the *origin* of a call, and the **Called-Party-Number** information element identifies the *destination* of a call.

The **Calling-Party-Subaddress** information element identifies the Subaddress associated with the *origin* of a call. The **Called-Party-Subaddress** information identifies the Subaddress of the *destination* of a call.

Each type of outgoing call can be assigned with one Number/Subaddress pair by using the command **AT&ZO*x*=*s***. Possible values for ***x*** are as follows:

x = **I**	for ISDN data calls
x = **M**	for internal fax/modem
x = **B**	for the analog adapter

The number-Subaddress-string '***s***' is defined as:

***s* = [[Y*n*][N*n*]own-number][/[[Z*n*]own-Subaddress]/]**

where **Y*n*** specifies the type of number:

Y0	unknown (default if Y*n* is omitted)
Y1	international number
Y2	national number
Y3	network specific number
Y4	subscriber number

N*n* is the identifier of numbering plan:

N0	unknown (default if N*n* is omitted)
N1	ISDN numbering plan (Rec. E.164)
N3	data numbering plan (Rec. X.121)
N4	telex numbering plan (Rec. F.69)
N8	national standard numbering plan
N9	private numbering plan

Zn specifies the Subaddress type:

Z0	NSAP (Rec. X.213) with AFI=0x50, IA5 characters (default if Z*n* is omitted)
Z2	user specified, IA5 characters

The command **AT&ZO*x*=//** will remove the Number/Subaddress assignment.

The number and Subaddress assigned by **AT&ZO*x*=*s***, if any, will be used for Calling-Party-Number and Calling-Party-Subaddress information elements respectively while dialing.

The default settings of the Phone Number and Subaddress of all the types of calls are **UNASSIGNED -** meaning the SETUP message sent by the Elite 2864I contains neither Calling-Party-Number nor Calling-Party-Subaddress information elements.

The command **AT&ZO?** can be used to browse the current settings of the own numbers and subaddresses.

Call Control for 1TR6 (Old German ISDN)

In order to initiate an 1TR6 ISDN call, two information elements are necessary:

- Service Indicator
- Destination Address

The **Service Indicator** determines what kind of bearer services are desired. The **Destination Address** provides necessary information for the telephone company Central Office (CO) to direct the call to the remote party.

Control of Outgoing Service Indicator

The **Outgoing Service Indicator** will be assigned when you configure the B channel protocols using the command **ATBnn**.

Since there are a number of combinations of voice or voice-band-data services on the analog adapters, users may want to control the outgoing Service Indicator themselves for some specific applications.

The following table is recommended to configure **S104/S107** (Service Indicator) and **S108/S111** (Additional Information Octet) according to the terminal types :

	Service Indicator **S107: analog adapter** **S104: internal fax/modem**	**Addi. S. I.** **S111: analog adapter** **S108: internal fax/modem**
Telephone	1 (*Fernsprechen*)	1 (*3.1 KHz*)
Modem	2 (*analog - dienste*)	3 (*Daten Über Modem*) or 4 (*Btx Über Modem*)
G3 Fax	3 (*analog - dienste*)	2 (*Fax Gruppe 3*)

Control of ENDGERÄTEAUSWAHLZIFFER (EAZ)

EAZ (or Terminal Selection Code) is the last digit of an ISDN phone number in 1TR6. Usually EAZ=0 indicates that a global call (any terminal on the S0 interface) which is service-compatible with the incoming call, can answer the call.

Other values of EAZ (1,2,....,9) provides the possibility for assigning multiple ISDN numbers to a single ISDN BRI line. A calling user can select, via the public network, one or more distinct terminals on a single BRI line.

With its highly integrated, multi-function features, the Elite 2864I can be imagined as a “black box” containing multiple distinct terminals. Each of these "internal terminals" can be assigned one EAZ using the command **AT&ZI*n*=*m*,** where *n*=0-7 and *m*= 0-9.

Command	**Function**
&ZI0=*m*	assigns EAZ for X.75
&ZI1=*m*	assigns EAZ for V.110
&ZI2=*m*	assigns EAZ for V.120
&ZI3=*m*	assigns EAZ for PPP, MPPP
&ZI4=*m*	assigns EAZ for ISDN data, protocol auto-detection
&ZI5=*m*	assigns EAZ for PPP, MPPP
&ZI6=*m*	assigns EAZ for internal fax/modem
&ZI7=*m*	assigns EAZ for analog adapter

The default EAZ of each protocol is as follows:

&ZI**0=1**	for **Data;**
&ZI**4=2**	for **Data;**
&ZI**6=3**	for **internal fax/modem;**
&ZI**7=4**	for the **analog adapter.**

AT&ZI? can be used to display the EAZ numbers assigned by the AT&ZI*n*=*m* commands.

The EAZ (last digit) of the destination address in an incoming SETUP message will be checked with each protocol's EAZ. If there is a match and the service indicated is compatible with this protocol, the call will be accepted using the protocol.

NOTE: THE EAZS MUST BE ASSIGNED PRECISELY IN ORDER TO ACCEPT CALLS ACCORDINGLY.

The suffix digit to an ISDN phone number in a dial out command will be used as the destination EAZ (in the Destination Address W-

element) in the SETUP message sent to the destination. If this suffix digit is omitted, the switch will assume the EAZ is 0.

Each type of outgoing call of the Elite 2864I can be assigned with one origination EAZ by using the command **AT&ZO*x*=Origination_EAZ**, (where *x* = **I** for ISDN data calls, **M** for internal fax/modem, and **B** for the analog adapter).

The command **AT&ZOx=//** removes the assignment of the origination EAZ.

The number assigned by **AT&ZOx=Origination_EAZ**, if any, will be used for the Origination Address W-element while dialing. The default settings of origination EAZ of all the types of calls are **UNASSIGNED,** meaning the SETUP message sent by the Elite 2864I contains no Origination Address W-element.

The command **AT&ZO?** can be used to list the current settings of the origination EAZs.

Answering a Call

The incoming call will first be identified as either an ISDN data call or a voice call (including the voice-band-data). ISDN data calls will be routed to the digital communications portion of the Elite 2864I. Voice calls or voice-band-data calls will be assigned to the analog adapter or internal fax/modem.

Answering a Call for DSS1

The Multiple Subscriber Number (MSN) supplementary service provides the possibility for assigning multiple ISDN numbers to a single ISDN BRI line. Calling users can select, via the public network, one or more distinct terminals on a BRI line.

In some areas however, it is very expensive to get additional subscriber numbers. The Subaddress, which is transferred transparently by the ISDN network between the call originating

entity (e.g. the calling user) and the addressed entity, can be used for the same purpose as the MSN. Since the Elite 2864I is highly integrated and multi-functional, it can be imagined as a “black box” that contains multiple distinct terminals. Each of these "internal terminals" can be assigned one ISDN number using the **AT&ZIn=xxxx**... command.

The number assigned by AT&ZIn=xxxx... can be interpreted as either the MSN or the Subaddress. This is determined by the bit 5 of S119 as follows.

S119.5=0	number is treated as the MSN (default)
S119.5=1	number is treated as the Subaddress

The factory default for these numbers are unassigned. If an incoming **SETUP** message is offered with addressing information (i.e. the appropriate part of the called party number or the called party Subaddress), this address will be compared with the MSN/Subaddress numbers assigned by the AT&ZIn=xxxx... commands. The call will be accepted using the specific protocol if the assigned number of this protocol matches with the received called party number or called party Subaddress.

NOTE: TWO PHONE NUMBER STRINGS ARE SAID TO BE MATCHED IF THEIR LEAST SIGNIFICANT "N" DIGIT(S) ARE IDENTICAL, WHERE "N" IS THE NUMBER OF DIGITS OF THE SHORTER STRING. USUALLY ONE DIGIT IS ENOUGH TO DISTINGUISH THE VARIOUS PROTOCOLS.

Answering a Call for 1TR6

If an incoming **SETUP** message is offered with addressing information (i.e. the destination address W-element). This address will be compared with the EAZ numbers assigned by the AT&ZI*n*=*m* commands. The call will be accepted using the specific protocol if the assigned number of this protocol matches with the received address.

Best-effort Call Answering

If some numbers have been set using &ZI command (as can be seen by the AT&ZI? command) and they are not matched with the address of the incoming call, the Elite 2864I will, by default, ignore the call as it may be intended for other devices that share the same S/T interface (S0 bus) with the Elite 2864I.

If you want the Elite 2864I to answer inbound calls as often as possible, you can set the best-effort call answering bit as follows:

S119.3=0	Answer call only when number matched (by default)
S119.3=1	Best effort call answering

Ambiguity Resolution Switch for Voice Calls

For a voice or voice-band-data call, if the &ZI number assignment can tell whether the analog adapter or internal fax/modem is being addressed, then the call will be delivered to the proper destination. But sometimes, ambiguity of address matching may exist. This may happen if the &ZI numbers of the various protocols are either unassigned or not matched or the address information is absent in the incoming SETUP message. In this case, users may wish to set the priority of answering a call as either the analog adapter or internal fax/modem. The AT&Ln command sets the address ambiguity resolution flag:

AT&L0	The analog adapter has the higher priority to answer a voice or voice-band-data call; if it is busy, the call will be routed to internal fax/modem.
AT&L1	The internal fax/modem has the higher priority to answer a voice or voice-band-data call; if it is busy, the call will be routed to the analog adapter.

Multi-Auto-Answering of Data Calls

For an ISDN data call, if the Elite 2864I can exclusively determine the protocol to be used by means of the information conveyed by the SETUP message (for DSS1, these include the Bearer-

Capability, Low-Layer-Compatibility, or High-Layer-Compatibility information elements; for 1TR6, these include the Service Indicator as well as the Additional Octet of Service Indicator), then the indicated protocol will be used. Otherwise, the Multi-Auto answering process will be invoked. The Elite 2864I can monitor the B channel signal sent by the calling site.

The data call can be identified by the Elite 2864I to be internal fax/modem, X.75, V.110, V.120, or PPP Async-to-Sync, conversion and MPPP.

Data Call Indication

When ringing, the Elite 2864I will send the first RING message to the DTE with a format as follows:

```
RING <CR><LF>

[FM:[[Prefix]Calling-Party-
Number][/Subaddress/]]

[TO:[Called-Party-Number][/Subaddress/]]
<CR><LF>

RING <CR><LF>

RING <CR><LF>

......
```

The display of address information between the first RING and the second RING can be disabled by setting **ATS84.4=1**. The term [Prefix] is a predefined number string to be added in front of the Calling-party-number before indicating it to the DTE. This is useful for some automatic dial-back-up systems. The number string can be assigned as follows:

ATCI<Prefix>	When and only when the type-of-number denotes an international number will this "Prefix" be added to the Calling-party-number before indicating it to the DTE.

ATCI<>	Disables the international number prefix-adding function. (Default)
ATCN<Prefix>	When and only when the type-of-number denotes a national number will this "Prefix" be added to the Calling-party-number before indicating it to the DTE.
ATCN<>	Disable the national number prefix-adding function. (Default)

NOTE: THE ANGLE BRACKETS '<' AND '>' ARE PART OF THIS COMMAND.

Disable inbound call connection

In some cases, the user may require the Elite 2864I **not** to answer any incoming calls. This can be done by setting the bit 0 of S-register S118:

S118.0=0	Enable the Elite 2864I to answer a call (default)
S118.0=1	Disable the Elite 2864I to answer any call (default North America model only)

Point-to-Point Configuration

In some areas, since the Direct-Dial-In (DDI) number is less expensive than the MSN, users may want to subscribe to point-to-point ISDN to employ the DDI function. In this case, only one TA can be connected to the ISDN line and the TEI (Terminal Equipment Identifier) is always ZERO. This can be done by setting the bit 1 of S-register S119:

S119.1 = 0	Disable point-to-point DDI function (default)
S119.1 = 1	Enable point-to-point DDI function

Placing a Call

To make a call, configure the Elite 2864I according to the Bearer Service (or protocol) you want to use.

ATBnn	for ISDN data call

Placing a call for DSS1

The **ATD*x*** command is used for dialing as follows.

ATD*x*[Y*n*][N*n*]called_party_number[/[Z*n*]called-party-subaddress/]

x = **I** (for ISDN data calls), **M** (for internal fax/modem), or **B** (for the analog adapter).

Y*n* specifies the type of number:

Y0	unknown (default if Yn is omitted)
Y1	international number
Y2	national number
Y3	network specific number
Y4	subscriber number

N*n* is the identifier of numbering plan:

N0	unknown (default if Nn is omitted)
N1	ISDN numbering plan (Rec. E.164)
N3	data numbering plan (Rec. X.121)
N4	telex numbering plan (Rec. F.69)
N8	national standard numbering plan
N9	private numbering plan

Z*n* specifies the type of the Subaddress:

Z0	NSAP (Rec. X.213) with AFI=0x50, IA5 characters (default if Zn is omitted)

Z2	user specified, IA5 characters

The **called_party_number** or an appropriate part of it, will be sent to the addressed entity. The **called_party_subaddress** will be transferred transparently by the ISDN network to the destination.

Use **ATDL** to redial the last dialed telephone number (and/or Subaddress).

Placing a call for 1TR6

The **ATD*x*[Y*n*][N*n*]destination_address** command is used for dialing as follows:

x = **I** (ISDN data), **M** (internal fax/modem), or **B** (the analog adapter)

Yn specifies the type of address:

Y0	unknown (default if Yn is omitted)
Y1	international number
Y2	national number

Nn is the identifier of numbering/addressing plan:

N0	unknown (default if Nn is omitted)
N1	ISDN numbering plan (Rec. E.164)

The **destination_address** is the ISDN phone number of the called party. The last digit of this number is the EAZ. Use **ATDL** to redial the last dialed ISDN phone number.

Leased Line ISDN

The B-channel protocols supported for the leased line are V.110, V.120, X.75, PPP and MP which is selected using ATBxx

commands as in the dial-up mode. The following AT commands are used to select the Leased Line function:

AT&In	normal/leased line options S14b2-3
AT&I0	normal dial-up phone line.
AT&I1	leased line function in B1 channel only, dial-up function in B2 channel
AT&I2	leased line function in B2 channel only, dial-up function in B1 channel
AT&I3	leased line function in both B1 and B2 channels.

If the leased line mode configuration has been saved as the power-on user's profile and upon power-on, the Elite 2864I will ALWAYS try to make a connection with the remote site using the pre-selected protocol, B-channel (B1 or B2), and originate/answer mode. To change the Elite 2864I from the leased line mode back to the dial-up mode in this case, one has to reset the modem to factory default settings.

For some protocols that are originate/answer mode sensitive, use the following command to configure the originate/answer mode:

AT*Mn	leased line auto-handshake mode selection S14b0
AT*M0	leased line auto-handshake for Originate mode
AT*M1	leased line auto-handshake for Answer mode

If the leased line mode is just selected after power-on, the following commands can be used to make a leased line connection:

ATDB1	use B1 channel in Originate mode
ATDB2	use B2 channel in Originate mode
ATDB3	use both B1 and B2 channels in Originate mode
ATAB1	use B1 channel in Answer mode
ATAB2	use B2 channel in Answer mode
ATAB3	use both B1 and B2 channels in Answer mode

12 Security Functions

Security Types and Levels

The Elite 2864I provides security functions that may be enabled to prevent unauthorized connections. Two types of security functions are provided.

- **Type 1** security is to be used when the remote TA is a ZyXEL ISDN TA
- **Type 2** security is to be used when the remote TA is non-ZyXEL.

With a **Type 1** connection, the dial-in (remote) TA will send in its supervisor password for matching with local Elite 2864I's pre-stored password list. With a **Type 2** connection, the remote terminal will be prompted to enter the password at the initial connection and the local Elite 2864I will match the entered password with the pre-stored password list.

The two types of security are summarized in the table below:

	Type 1 Security	**Type 2 Security**
Remote (Calling) Site	ZyXEL ISDN device only	Can be TA of any brand
Password Check	Automatic	Interactive
Protocols Supported	X.75, V.120	Any data protocol
AT Commands	*G1 for Level 1 security *G2 for Level 2 security	*G3 for Level 1 security *G4 for Level 2 security *G5 for Level 3 security

Level 1 security

Will only perform password checking. With Level 1 security, the local modem will maintain the connection if the password is matched, the line will be disconnected otherwise.

Level 2 security

Provides extra Calling Party Number checking and call-back, the call-back number is pre-stored in the password table. If the password has been matched *(in a maximum of 3 tries over a 40 second time period)* with its pre-stored password list, the local modem will check the Calling Party Number (CPN) (or Origination Address for 1TR6) against the pre-stored number corresponding to the password. If they are matched, the local modem will choose either to keep the connection or to disconnect and then call back according to the setting of bit 6 of S119:

S119.6=0	Disconnect and then call back
S119.6=1	Keep the connection

If the CPN does not match with what is stored in the table, the local modem will disconnect the call. If CPN is unavailable in the SETUP message, the local modem will disconnect the call and then call back using the pre-stored number corresponding to the dial-in password.

Level 3 security

Once the password is matched the local modem will prompt the remote user to enter a call back number.

The three levels of security are summarized in the table below:

	Level 1	**Level 2**	**Level 3**

	Level 1	Level 2	Level 3
Password Check	*Yes*	*Yes*	*Yes*
CPN Check OK and S119.6=0	*N/A*	*Call back*	*Prompts the remote user to enter call back number for calling back.*
CPN Check OK and S119.6=1	*N/A*	*Keep the connection*	
CPN unmatched	*N/A*	*Disconnect*	
CPN not Available	*N/A*	*Call back using the corresponding pre-stored number*	
AT Commands	**G1 for Type 1* **G3 for Type 2*	**G2 for Type 1* **G4 for Type 2*	**G5 for Type 2*

Setting and Modifying Passwords

40 user passwords may be defined by **AT*H*n*** command, where "*n*" represents the index to the entry, numbers between 0-39 are accepted.

The corresponding 40 call-back numbers are defined by **AT&Z*n*=*xxx*** command, where "*n*" represents the index to the entry, and "*xxx*" represents the assigned call-back phone number. Any character (ASCII 0-127) can be used in the password table, the maximum password length is 8 characters for each entry.

The security functions are only accessible through AT commands in terminal mode. Supervisory password is required for adding or to modify the entries. The default supervisor password is **ZyXEL** when Elite 2864I is shipped from the factory. This supervisory password is sent to the remote if Type 1 security is set at the remote end.

To modify the supervisor password, use **AT*HS**.

You will be asked for the original password and a new password and then to re-enter the new password for verification. For example:

```
Password:
********      (Enter current supervisory password)
Password:
********      (Enter new supervisory password)
Verify:
********      (Enter the new supervisory password again)
OK
```

Use command **AT*H*n*** to modify the "*n*"th user password. You will be prompted to enter the supervisory password first and then the user's password for this entry will be requested and verified. The command **AT*V** will list the 40 user passwords and the supervisor password on the screen for viewing.

Non-password Auto Call Back Function

In addition to the standard modem-like security functions described in the previous section, the Elite 2864I provides another simpler call back function. The Calling Party Number (origination address) will be checked against the 5 pre-stored call-back numbers before the B channel is connected. If the CPN is matched with any one of the numbers, the incoming call will be rejected (without connection, hence without any charge) and the Elite 2864I will automatically call back using the matched phone number.

This function can be controlled by using the following command:

AT*GC0	disable the auto call back function (default)
AT*GC1	enable the auto call back function

The pre-stored numbers can be set using the following command:

AT*HCn=xxxx, n=0,1,..,4

Password: (Enter supervisory password)

*****

Call Back Number:

*****

OK

You will be prompted to enter the supervisory password first.

The AT*VC command can be used to list all the pre-stored numbers.

13 Upgrading Your Elite 2864I

This chapter describes how to upgrade flash EPROM firmware when it is available.

Upgrading with Flash EPROM

Your Elite 2864I modem employs a flash EEPROM that lets you conveniently download updated firmware and program the modem with new features and enhanced functions. If you use Windows, you can use the ZyXEL Internet Configuration Manger to upgrade new firmware. Otherwise you have to use a terminal program that supports the X-modem protocol.

Obtain the new firmware from ZyXEL's BBS, WWW, or FTP site. The firmware is distributed in file "**E2864Id.vvv**", where the extension **vvv** denotes the version of this firmware. The modifier ***d*** in the filename has the following definitions:

G	German national ISDN (1TR6)
E	European ISDN (DSS1), also used in most other countries including Asian countries.
A	American ISDN (AT&T 5ESS, Northern Telecom DMS-100, or National ISDN-1, the active D channel protocol can be chosen by an AT command)

NOTE: THE AMERICAN FIRMWARE VERSION SUPPORTS BOTH THE S/T INTERFACE AND U INTERFACE MODELS. DURING THE POWER-ON TEST, IT CHECKS THE HARDWARE CONFIGURATION AND FOLLOWS THE INITIALIZATION PROCEDURES OF THE SPECIFIC INTERFACE.

1. Make sure your Elite 2864I is turned ON.

3. Start any communications program that supports the Xmodem protocol, and type:

```
ATUPX<Enter>
```

Elite 2864I responds:

```
You have chosen Xmodem (128 bytes of data
with checksum) protocol to update your
modem. Data in Flash ROM will be erased
!!!

Are you sure (Y/N) ?
```

4. Press Y. The following message then appears:

```
Start programming, please upload
```

5. Use the Xmodem protocol to upload the file E2864Id.vvv to your modem. This step updates the modem's flash EEPROM with the new firmware. When installation is complete, the modem will restart automatically.

In the unlikely event that your modem fails to respond to AT commands after upgrading the EEPROM follow the procedure below:

1. Power cycle the Elite 2864I. The cold reset will prompt the modem to check the integrity of the codes in the flash EEPROM.
2. If proper valid firmware can not be verified, the Elite 2864I will initiate Kernel Mode. Once it is in Kernel mode, you can issue limited "AT" commands. At this point you should return to step 3 of the upgrading procedure.

14 Diagnostics and Protocol Analyzer

This chapter provides quick easy-reference diagnostic tables for the Elite 2864I. The Elite 2864I can perform its own diagnostic tests, which can provide invaluable information about each of its functions.

Diagnostics

The Elite 2864I ISDN modem provides a full range of diagnostic capabilities. For the description of those diagnostic functions that are exclusively for the internal fax/modem, refer to the **2864 Series Modem User's Manual**.

Power-on Self-test

At each power-up or upon a reset command from the panel, the modem will test the main-board's ROM code checksum, system RAM memory, DSP code checksum, DSP RAM memory, EEPROM, digital circuits and analog circuit calibrations. The 2864I will also test the ISDN daughter board to make sure that the interface circuits are ready to serve.

Main-board's Self-test

The **HLD** LED will be ON during power-on main-board self-test, and OFF after the test if it is OK. The **LNK** LED flashes if the test fails. The number of blinks indicates the kind of error as seen in the following table:

1	ROM code checksum error.
2	System RAM fail.
3	EEPROM checksum error. The factory default settings will be downloaded to the EEPROM and the self-test will be re-initiated. This is not a real error.
4	The testing of DSP RAM fails - Condition A.
5	The testing of DSP RAM fails - Condition B.
6	Analog circuit calibration error. (VO calibration fail)
7	Analog circuit calibration error. (VR calibration fail)
8	Analog circuit calibration error. (FR calibration fail)
9	Communications between controller and DSP fail - Condition A.
10	Communications between controller and DSP fail - Condition B.

ISDN Daughter Board's Self-test

Once the main-board's self-tests have been passed, the 2864I starts to test the ISDN daughter board and its interface with the main-board. There are six test items for this test, each test takes about half a second. The following table is a summary of the ISDN daughter-board self-tests:

Test Seq.	LED **B1**	LED **B2**	LED **AA**	**Test Description**
1	on*	off	off	Siemens 2086 chip's address/data bus test
2	off	on*	off	Siemens 2086 chip's functional test
3	off	off	on*	Siemens 2160 chip's functional test
4	on*	off	off	Interface test 1 with Siemens 2086 chip
5	off	on*	off	Interface test 2 with Siemens 2086 chip

6	off	off	on*	Interface test 3 with Siemens 2086 chip

NOTE: THE LED LIGHTS UP WHILE TEST IS RUNNING AND BLINKS IF THE TEST FAILS.

The LNK LED will light up for half a second to indicate the success of the Elite 2864I's power- on self-test. After this, the LNK LED will become the normal physical layer (layer 1) active indicator.

ISDN Loopback test (AT&T9)

The AT&T9 command will invoke an ISDN loopback test connection. The loopback point is in the S/T interface chip (Siemens 2086 chip) or the U interface chip (Siemens 2091 chip) just behind the line transformers, thus it checks almost every part of the ISDN modem and RS-232 cable except the passive front-end of the ISDN S/T or U interface.

During this test, data from the terminal or computer is sent through the DTE interface to the Elite 2864I's transmitter and is packetized to the proper frame format according to the B channel protocol selected and then loop-backed to the receiver, de-packetized, and sent through the DTE interface back to the terminal or computer's screen. Any errors will be displayed on the screen. The screen will also show the data you have sent to the modem.

Loopback with Self-test (AT&T10)

The AT&T10 command will invoke an ISDN loopback connection with self-test. The data is generated by the Elite 2864I and will go through the same path as the above Loopback Test does. The data pattern is printable ASCII characters. You can see the result on the screen. The loop backed data is compared with the transmitted data. Should an error happen, the LNK LED will start to flash.

Send any character through the DTE interface to the modem will discontinue the test.

B1/B2 Loopback with Self-test (AT&T11)

There is an AT command designed for testing the readiness of your ISDN line which uses one B-channel (B1) to place a call to itself and uses the other B-channel (B2) to receive the call. So this is a modem - B1 - CO(ISDN Switch) - B2 - modem loop back test.

Follow these instructions to make your test call:

Type:

```
AT&ZOI=your_isdn_number<Enter>
```

Elite 2864I responds:

```
OK
```

Type:

```
AT&T11<Enter>
```

Elite 2864I responds:

```
OK
Dial your_isdn_number
Loop from B1 to B2 through the switch
established!
Sending and receiving data.....
B1/B2 loopback test successed.
Disconnecting.....
NO CARRIER
```

The Diagnostic Command (ATCG)

The ATCG command can be used to test and isolate any hardware problems. Some of the tests are interactive operations, just follow the indications prompted on the screen to carry out the tests. If the Elite 2864I is operating correctly, the test results will be as follows:

```
atcg
```

```
2086 Communication Test ( Address & Data Bus ) ..... OK
2086 CI Code Test ( Layer 1 Function ) ..... OK
2086 HDLC FIFO Test ( Layer 2 Function ) ..... OK
Asic 1 Communication Test ( DSP Communication ) ..... OK
Asic 2 Communication Test ( HDLC Communication ) ..... OK
PCM CODEC Test ( Backward Compatibility ) ..... OK
ISDN Layer 1 Activation Test ..... OK

Now, Ringer is active, please listen and then OffHook in 5
secends !!
OffHook is detected, ..... OK

Now, Dial Tone is active, Please Listen and dial 123456789*0# in
sequence.
123456789*0#
Dial Digit Completed ..... OK

Please Hangup Phone !!
OnHook is detected, ..... OK

Country code and Codec compatibility test ..... OK
```

Resetting The Elite 2864I

The Elite 2864I can be returned to the factory default state in the following way:

Hold the DATA/VOICE key down while turn the unit ON, keep holding down the switch for 3 seconds after the power switch is turned ON then release the switch. The Elite 2864I will reset to the factory setting and run a continuous analog loop-back self-test. Printable characters will show on the terminal screen if one is connected.

Using The Embedded Protocol Analyzer

The embedded protocol analyzer (hereafter abbreviated as EPA) records and analyzes various protocols on the B channel, D channel and DTE-DCE interface. The results are displayed with ANSI color. This professional tool is designed for hobbyists as well as users with technical backgrounds. The EPA enables you to examine messages exchanged between your Elite 2864I and the Central Exchange office when making an ISDN call. You can review the packets sent or received through the B channel (for X.75 or V.120) to or from the remote site. You can also check the

AT commands issued from an application software program. This will help you understand their causal relationship with other events.

In addition to its tutorial purpose, the EPA is very useful for diagnostics. If you have compatibility problems with your Central Exchange or with the TA at the remote site, the EPA will be your first aid resource. According to the EPA's analysis, you may decide to fix the problem yourself (e.g. modify the configuration and try again) or log the analyzed results as a file (a very comprehensive bug report), and then send it to ZyXEL's Tech Support department.

Capturing the Protocol Data

The data captured by the EPA can be classified into three categories:

- B channel user data protocols
- D channel signaling protocols
- DTE-DCE protocols

The D channel signaling protocols include layer 2 and layer 3 call control protocols. Frames and messages exchanged via the D channel are all recorded for further analysis. These data messages are essential to understanding interactive operations between an ISDN TA and the ISDN network. They contain the compatibility information for the Elite 2864I and your Central Exchange.

The B channel user data protocols include X.75 and V.120. Only the layer 2 header (addresses and control bytes) and layer 3 header are captured. Since X.75 may be used with various layer 3 protocols (e.g. T.70, T.90, and ISO8208), only the first 8 octets of the information field are recorded as the layer 3 header, and are displayed in raw data form. The analysis of the protocol data will be carried out by ZyXEL's Technical Support department.

The DTE-DCE protocols (at the R reference point according to the ISDN nomenclature) include the AT commands/responses as well as the CAPI internal interface. The CAPI internal interface is used with ZyXEL's CAPI driver. The ZyXEL CAPI driver communicates with the Elite 2864I through this internal interface. It is not recommended that users get involved in this internal interface. The AT commands/responses, on the other hand, are in a standard user interface. An analysis of these commands and responses might prove very informative. All messages captured by the EPA are tagged with a time stamp according to a free running timer that starts at the beginning of data capture. The resolution of this timing information is 0.01 second.

The following commands determine the kind of protocol data to be captured by the EPA:

AT Command		**Description**
ATCD*n*		
	n=0	Disable the capture of D channel protocols
	n=1	Enable the capture of D channel protocols (default)
ATCB*n*		
	n=0	Disable the capture of B channel protocols (default)
	n=1	Enable the capture of B channel protocols
ATCC*n*		
	n=0	Disable the capture of DTE-DCE interface protocols (default)
	n=1	Enable the capture of DTE-DCE interface protocols

The EPA starts to capture data when the command ATCT is issued. This capturing process will continue until the command ATC$ is issued. The EPA maintains 8 Kbytes RAM as a ring buffer. In case the buffer is full, the earliest data captured will be overwritten by the latest data.

Analyzing the Captured Data

To view the analyzed result, use the command ATC$. For your convenience, the relevant AT commands are summarized as follows:

AT Command	Description
ATCT	Clears buffer and starts the embedded protocol analyzer. Captures data immediately and starts the timer.
ATC$	Invokes the interpretation function of the embedded protocol analyzer and displays the results on the DTE screen.

The analyzed results can be viewed as if it were in a full screen editor. Several number keys are used to control the display. For PC users, it is convenient to use the keys on the numeric keypad (make sure that Num-Lock is on.).

The functions of the control keys are as follows:

Key	Function	Description
1	End	Display to the end of buffer
2	Cursor down	Scroll one line up
3	Page down	Display the next page
7	Home	Display the first page
8	Cursor up	Scroll one line down
9	Page up	Display the previous page
Q, q	Quit	Quit embedded protocol analyzer

Any other key will display the control menu.

15 AT Command Set Reference

DTE Interface Operation Modes

There are two operation modes for the DTE interface :

- **Simplex mode** is used for conventional AT Command operation.
- **Multiplex mode** is used as an internal interface for ZyXEL CAPI drivers.

Simplex mode

In simplex mode, the Elite 2864I is used just like an ordinary modem. The DTE interface will be either in the command state or in the data state. Only one data connection session is possible at any time.

To invoke various functions of the Elite 2864I, a number of different AT Commands can be used. The simplex mode is designed for the AT Command users. The guides and descriptions throughout the rest of this manual, if not otherwise specified, are applicable to this mode. The power-on default of the DTE interface is in simplex mode as well.

Multiplex mode

The multiplex mode is designed for ZyXEL CAPI drivers. It can also be used by third parties to develop various drivers on different platforms for public domain or for commercial purposes.

The commands or data are **packetized.** Each packet has its own destination address. All the DTE channels can be accessed individually by way of multiplexing.

Since it is not intended for all users, the specifications and manual for the multiplex mode will be available in a separate text file, and will only be available in the electronic format upon request.

AT Command Descriptions

An AT Command is a command in asynchronous data format issued by the computer to the modem through the asynchronous computer-modem interface. AT Commands control the modem's behavior and actions. To send an AT Command from a computer to the modem, you must be running a communication software and the modem must be in the command state.

Exceptions to this are A/, A>, and +++. These commands are not preceded by AT, or followed by any more characters.

A/	re-executes the last command once
A>	re-executes the last command once or repeats the last call up to 9 times until aborted by pressing down on any key on the keyboard or front panel **or** until a successful connection with a remote modem has been made.
+++	is the escape sequence code that is entered in data state to return the modem to command state. The modem will accept AT commands only while it is in command state.

The AT command prefix may be typed in either upper ‘AT’ or lower case ‘at’. Do not use a combination of upper and lower cases in the prefix.

The following tables list all of the AT commands supported by the Elite 2864I. An asterisk * following a command option or value indicates that it is a default setting when the modem is shipped.

Basic "AT" Command Set

Command	Options	Function & Description	Ref.
A/		Re-execute the last command once	
A>		Re-execute the last command once or repeat the last call up to 9 times. (See also S8)	
<any key>		Terminate current connection attempt when enter in handshaking state.	
+++		Escape sequence code, entered in data state, wait for modem to return to command state.	
All the Following Commands Require an AT Prefix.			
A		Go on-line in answer mode. (See also S39.2, S43.6)	
AB*n*	B1	Excite a leased line connection using B1 channel on answer mode.	
	B2	Excite a leased line connection using B2 channel on answer mode.	
	B3	Excite leased line connection using B1 and B2 channel on answer mode.	
B*n*		For internal modem: Handshake option.	S28.7
	B0 *	Select CCITT V.22 for 1200 bps communication.	
	B1	Select Bell 212A standard for 1200 bps.	
B*nn*		Select ISDN Teleservice. 'B' must be followed by two digits.	S82 S102
	B00	X.75 Transparent.	
	B01	X.75 T.70.	
	B10	V.110 user rate follows DTE speed (async.) or V.110 user rate determined by in-band negotiation (sync.)	
	B11	V.110 user rate = 64000 bps (sync mode.)	S117
	B13	V.110 user rate = 2400 bps.	
	B14	V.110 user rate = 4800 bps.	
	B15	V.110 user rate = 9600 bps.	
	B16	V.110 user rate = 14400 bps.	
	B17	V.110 user rate = 19200 bps.	
	B18	V.110 user rate = 38400 bps (async only).	
	B20	V.120.	
	B40	PPP async to sync conversion.	
	B41	SLIP to sync HDLC conversion.	
BP*n*		Configuration PPP BACP/BAP negotiation.	
	BP0	Disable PPP BACP/BAP.	

	BP1 *	Enable PPP BACP/BAP.	
CB*n*		Configuration of embedded protocol analyzer.	S84.1
	CB0	Disable the capture of B channel protocols.	
	CB1	Enable the capture of B channel protocols.	
CC*n*		Configuration of embedded protocol analyzer.	S84.0
	CC0	Disable the capture of DTE-DCE interface protocols.	
	CC1	Enable the capture of DTE-DCE interface protocols.	
CD*n*		Configuration of embedded protocol analyzer.	S84.2
	CD0	Disable the capture of D channel protocols.	
	CD1	Enable the capture of D channel protocols.	
CEn		Call bumping control for PPP/MP and CCB.	S58.0
	CE1	Disable the call bumping function.	
	CE2*	Enable the call bumping function.	
CG		Diagnostics and Hardware test.	
CH?		Display the accumulated charging unit of the last call.	
CI<prefix>		Prefix number string to be added to the Calling-party-number before indicating to the DTE when the type of number denotes international.	
CK<DES_key>		Set the key for DES (Data Encryption Standard)	
CL*n*	n=0-2048	Maximum size of user data in a packet (number of bytes).	
CL?		Inquire current setting of ATCLn.	
CN<prefix>		Prefix number string to be added to the Calling-party-number before indicating to the DTE when the type of number denotes national.	
CP*n*		Loopback 4 control.	S83.0
	CP0	Disable Loopback 4.	
	CP1	Enable Loopback 4.	
CR*n*	n=0-30 *	Resumes a previously suspended call, n is the call identifier (Europe).	
CS*n*	n=0-30 *	Suspend a call, n is the call identifier (Europe).	
CT		Clear buffer and start the embedded protocol analyzer. Capture data immediately and start timer.	
C$		Invoke the interpretation function of the embedded protocol analyzer and display the results on DTE.	

D*s*		Dial s (numbers and options) that follow (see also S38.0, S35.4). The options of s are listed as follows:	
	,	Pause for a time specified in S6. Remaining digits will be dialed as in-band DTMF.	
	W	Wait for second dial tone. Remaining digits will be dialed as in-band DTMF.	
		ISDN numbering options:	
	Y0 *	Unknown type of number.	
	Y1	International number.	
	Y2	National number.	
	Y3	Network specific number.	
	Y4	Subscriber number.	
	Y6	Abbreviated number.	
	Z0 *	Type of sub-address, NSAP with AFI=$50, IA5 characters.	
	Z2	Type of sub-address, user specified, IA5 characters.	
	N0 *	Unknown numbering plan.	
	N1	ISDN/Telephony numbering plan (CCITT E.164/E.163).	
	N3	Data numbering plan (CCITT X.121).	
	N8	National standard numbering plan.	
	N9	Private numbering plan.	
	/	Called party sub-address delimiters.	
	A	Don’t care (no Called Party Number information element in the output SETUP message / coming call with any Called Party Number will be granted).	
	The format of ”	[[Yn][Nn]called_party_number][[W][,]]inband_dtmf_number or [[Yn][Nn]called_party_Number][/[Zn]called_party_subaddress/] or [A][/[Zn]called_party_subaddress/].	
DB*s*		Dial s (number and options) that follows for the Analog adapter.	
DB*n*		Connection option if the leased line mode is just selected after power-on.	
	DB1	Use B1 channel in originate mode.	
	DB2	Use B2 channel in originate mode.	
	DB3	Use both of B1 and B2 channel in originate mode.	

DI*s*		Dial s (number and options) that follows for ISDN data call.	
DL		Repeat last ATD command.	
DM*s*		Dial s (number and options) that follows for the internal fax/modem.	
DN*r*=*nnn*		User enters Directory Number nnn … (USA only).	
	DN0	First DN Number.	
	DN1	Second DN Number, if any.	
DS*n*	n=0-39	Dial number stored in non-volatile RAM at location 'n'.	S44.3
DS*n*+S*m*		For placing a bundle call with two separate stored phone number 'n' and 'm'.	
D*nnn*+*mmm*		For placing a bundle call with two separate phone number nnn and mmm.	
E*n*		Command mode local echo of keyboard commands.	S23.0
	E0	Echo off.	
	E1 *	Echo on.	
H*n*		On/off hook control.	
	H0 *	Hang up (on-hook) the modem or ISDN, same as 'ATH'.	
	H3	Hang up the analog adapter.	
I*n*		Display inquired information.	
	I0	Display product code, same as 'ATI' Results: 28641 (USA) 28642 (DSS1) 28643 (1TR6)	
	I1	Display product information and ROM checksum Results: Elite 2864I <switch>: V x.xx Internal fax/modem: V x.xx <checksum> where <switch>= USA, DSS1, or 1TR6	
	I2	Display link status report of internal fax/modem.	
	I3	Display link status report of ISDN call.	
JAn	n=0-255 48 *	Add-threshold for PPP/MP Bandwidth-On-Demand in Kbps unit.	S126
JSn	n=0-255 32 *	Sub-threshold for PPP/MP Bandwidth-On-Demand in Kbps unit.	S127

JKAxn	n=0-630 *	Add-persist time interval for BOD, BOD disable if n=0 x = M(in Minute unit) or S(in Second unit)	S85.1-7
JKSxn	n=0-630 *	Sub-persist time interval for BOD, BOD disable if n=0 x = M(in Minute unit) or S(in Second unit)	S125.1-7
L*n*	n=0-74 *	Speaker volume control. The higher the value, the higher the volume.	S24.4-6
M*n*		Speaker control.	S21.1-2
	M0	Speaker always OFF.	
	M1 *	Speaker ON until carrier is detected.	
	M2	Speaker always ON.	
	M3	Speaker ON after the last digit is dialed out and OFF when carrier is detected.	
N*n*	n=0-75 *	Ring volume control. 'N0' will disable the audio ring function.	S24.0-2
O		Return to on-line state.	
P*n*		D channel protocol selection (USA) for American Version.	
	P0 *	Northern Telecom proprietary ISDN.	
	P1	National ISDN 1 (1 SPID).	
	P2	National ISDN 1 (2 SPID).	
	P3	Reserved.	
	P4	AT&T custom point-to-point.	
	P5	AT&T custom point-to-multipoint (1 SPID).	
	P6	AT&T custom point-to-multipoint (2 SPID).	
Q*n*		Result code displayed.	S23.7
	Q0 *	Modem returns result code.	
	Q1	Modem does not return result code.	
	Q2	Modem returns result code but quiet after answering on a RING (will not show in AT&Vn).	S40.1
Sr.b=*n*		Set bit 'b' of S-register 'r' to value 'n'. 'n' is a binary digit '0' or '1'.	
Sr.b?		Display value of bit 'b' of S-register 'r'.	
Sr=*n*		Set S-register 'r' to value 'n'. 'n' must be a decimal number between 0 and 255.	
Sr?		Display value stored in S-register 'r'.	
SPIDn=m		User enters Service Profile ID" (SPID), for USA switches.	
	SPID0	First SPID number.	
	SPID1	Second SPID Number, if any.	

SPID?		Display the SPID setting(s) (USA only).	
T		Repeat last user-to-user information (Europe).	
Tn<string>		The <string> will be sent to the called party via an User-user information element in the next message. Characters other than the alpha-numerical values can be represented by <nnn> in the string, where nnn is the unsigned value of the character. The maximum number of characters in the string is 31 for ETSI.	
	T0	User-specific protocol	
	T1	OSI high layer protocol	
	T2	X.244	
	T3	Reserved for system management convergence function.	
	T4 *	IA5 character	
	T7	ITU-TS Recommendation V.120 rate adaption	
	T8	Q.931 user-network call control message.	
UPX		Upload firmware to the Flash EPROM using Xmodem protocol.	
V*n*		Sets display type for Result Codes.	S23.6
	V0	Display result code in numeric form. (See also S35.7 and the result code table of 'ATXn').	
	V1 *	Display result code in verbose form.	
X*n*	n=0-7 5 *	Result code options, see the Options Table.	S23.3-5
Z*n*	n=0-4	Reset modem and set power-on profile.	S15.5-7
	Zn	Reset modem and load user profile n (0-3).	
	Z4	Reset modem and load factory settings.	
$		Basic command summary help	

Description of ATI3 Output:

The Link Status Report output appears as follows:

```
ZyXEL ISDN MODEM LINK STATUS REPORT

Connect DTE Speed         :
Error Control Level       :
Protocol Link Speed       :
Bytes Received            : 0
Bytes Sent                : 0
Cause                     :
Cause Value                       : 0
HDLC FCS Error            : 0
HDLC Receive Over-run     : 0
HDLC Transmit Under-run   : 0
```

Output Parameter	Output Value Description
Connect DTE Speed	Current on-line DTE speed
Error Control Level	Error control protocol used for current session
Protocol Link Speed	Current on-line DCE speed, line speed
Bytes Received	Number of data bytes received from remote
Bytes Sent	Number of data bytes sent to remote
Cause	Verbose disconnection reason for the last session
Cause Value	Numerical disconnection reason for the last session
HDLC FCS Error	Errors in frame (block) checksum (If there were many FCS Errors, you may have experienced problems on the line)
HDLC Transmit Under-run	For modem's processor power measurement.
HDLC Receive Over-run	For modem's processor power measurement.

Extended "AT&" Command Set

Command	Options	Function & Description	Ref.
&B*n*		Data rate, terminal-to-modem (DTE/DCE)	S28.6
	&B0	DTE rate follows connection rate. (See also S44.6)	
	&B1 *	DTE/DCE rate fixed at DTE setting. (See also S18, S20 and S44.6)	
&C*n*		Carrier Detect (CD) options	S21.4
	&C0	CD always ON. (See also S42.7)	
	&C1 *	CD tracks presence of carrier. (See also S38.3, S42.7)	
&D*n*		Data Terminal Ready (DTR) options	S21.6-7
	&D0	Ignore DTR signal, assume DTR is always ON.	
	&D1	108.1, DTR OFF-ON transition causes dial of the default number. (See also 'AT*Dn' and S48.4)	
	&D2 *	108.2, Data Terminal Ready, DTR OFF causes the modem to hang up.	
	&D3	Same as &D2 but DTR OFF causes the modem to hang up and reset from profile 0.	
&E*n*		B channel line speed for ISDN data call	
	&E0 *	64Kbps	
	&E1	56Kbps (Default for American ISDN)	

&F		Load factory settings to RAM as active configuration.	
&H*n*		Data flow control, DTE/DCE.	S27.3-5
	&H0	Flow control disabled.	
	&H3 *	Hardware (CTS/RTS) flow control	
	&H4	Software (XON/XOFF) flow control.	
&I*n*		Dial-up/leased line options	
	&I0 *	Dial-up line mode	
	&I1	Leased line mode in B1 channel	
	&I2	Leased line mode in B2 channel	
	&I3	Leased line mode in both B1 and B3 channel	
&J*n*		Bundle selection (See also S100)	S87.5-6
	&J0 *	Bundle connection is disabled	
	&J1	Bundle connection is enabled in answer mode only	
	&J2	Bundle connection is enabled in call mode only	
	&J3	Bundle connection is enabled in both directions	
&K*n*		Modem error control and data compression	S27.0-2
	&K0	No error control. (Same as AT&K)	
	&K1	MNP4 (See also S41.0)	
	&K2	MNP4+MNP5 (See also D38.5, S41.0)	
	&K3	V.42+MNP4	
	&K4 *	V.42+V.42bis, compatible with &K2 (See also S38.5)	
&K*nn*		ISDN data compression control. &K must be followed by two digits.	S83.2
	&K00	Disable V.42bis (or disable reliable PPP).	
	&K44	Enable V.42bis (V.120, X.75, PPP), STAC (PPP)	
&L*n*		Modem and a/b adapter address ambiguity resolution	S84.5
	&L0	A/B adapter first	
	&L1	Fax/Modem first	
&M*n*		Synchronous/asynchronous mode options	S14.6-7
	&M0 *	Asynchronous mode with data buffering	
	&M1	Asynchronous command, synchronous data	
	&M2	Direct asynchronous mode, no data buffering	
	&M3	Synchronous mode	
&N*n*		Modem link mode options (DTE/DCE). (See also S43.7, S48.1)	S19

&N0 *	Multi-Auto, auto negotiate highest possible link rate: V.34, ZyX 19200, ZyX 16800, V.32bis, V.32, V.22bis, V.22 and Bell 212A, G3 Fax V.17/V.29/V.27ter and cellular modes. (See also S38.4, S43.0, S43.1, S43.3 and S48.5)	
&N1	V.33 14400/12000 (models with 4-wire leased line only)	
&N2	V.33 12000 (models with 4-wire leased line only)	
&N3	V.32 9600T/9600/7200T/4800	
&N4	V.32 9600/7200/4800	
&N5	V.32 4800	
&N6	V.29 9600 (models with 4-wire leased line only)	
&N7	V.29 4800 (models with 4-wire leased line only)	
&N8	V.29 4800 (models with 4-wire leased line only)	
&N9	V.27bis 4800 (models with 4-wire leased line only)	
&N10	V.27bis 2400 (models with 4-wire leased line only)	
&N11	V.26bis 2400 (4-wire leased line or 2-wire half-duplex).(See also S35.2, S39.5)	
&N12	V.23 1200/75 (See also S48.3, S52.7)	
&N13	V.23 600/75 (See also S52.7)	
&N14	V.22bis 2400/1200	
&N15	V.22 1200	
&N16	V.21 300	
&N17	V.32bis 14400/12000/9600/7200/4800	
&N18	V.32bis 12000/9600/7200/4800	
&N19	V.32bis 7200/4800	
&N24	BELL 212A 1200	
&N25	BELL 103 300	
&N32	G3 Fax V.17/V.29/V.27ter 14400/12000/9600/7200/4800/2400 (See also S42.4).	
&N34	ZyXEL 19200	
&N35	ZyXEL 16800	
&N36	ZyXEL 14400	
&N37	ZyXEL 12000	

	&N38	ZyXEL 9600	
	&N39	ZyXEL 7200	
	&N42	CELL 14400	
	&N43	CELL 12000	
	&N44	CELL 9600	
	&N45	CELL 7200	
	&N46	CELL 4800T	
	&N62	V.34 28800	
	&N63	V.34 26400	
	&N64	V.34 24000	
	&N65	V.34 21600	
	&N66	V.34 19200	
	&N67	V.34 16800	
	&N68	V.34 14400	
	&N69	V.34 12000	
	&N70	V.34 9600	
	&N71	V.34 7200	
	&N72	V.34 4800	
	&N73	V.34 2400	
&O*n*		Set default call type for conventional dialing commands.	S83.4-5
	&O0	ATDs, ATDPs, and ATDTs default to make fax/modem calls	
	&O2	ATDs, ATDPs, and ATDTs default to make ISDN data calls	
	&O3	ATDs, ATDPs, and ATDTs default to make calls for the analog adapter	
&O1		Autoselection of 64 Kbps and 3.1 kHz on outgoing calls	
&S*n*		Data Set Ready (DSR) function selection.	S21.3
	&S0 *	DSR overridden, DSR always ON.	
	&S1	DSR according to CCITT (ITU-TSS). (See also S41.5, S44.4)	
&T*n*		Modem testing.	
	&T0	Terminate test in process	
	&T1	Initiate Analog Loopback (ALB) test	
	&T8	Initiate Analog Loopback with self test (ALB+ST)	
	&T9	Initiate ISDN Loopback test	
	&T10	Initiate ISDN Loopback with self test	
&V*n*		View profile settings.	

	&V0	View current active settings.	
	&V1-4	View the (n-1)th user profile settings	
	&V5	View factory default settings	
	&V6	View a/b adapter setting	
	&V8	System resources status	
&W*n*	n=0-3	Write current settings to user profile n in non-volatile RAM. (See also S35.6)	
&Y*n*	n=0-2	Break handling. (Destructive Break clears the buffer. Expedited Break is sent immediately to the remote system.). For internal modem only	S28.2-3
	&Y0	Destructive, expedited	
	&Y1 *	Nondestructive, expedited	
	&Y2	Nondestructive, unexpedited	
&Z*n=s*	n=0-39	Write phone number/s to NVRAM at location n (n=0-39) use AT*Dn or ATS29=n to set the default dial pointer.	
&ZI*n=s*	n=0-7 s=phone number	Assign the phone number (including subaddress, if any) for various B-channel protocols. In answer mode, these numbers will be compared with the received called party number and called party subaddress information. The call will be accepted using the specific protocol if the assigned number of this protocol matches with the called party number.	
	n=0	assigns the phone number for X.75	
	n=1	assigns the phone number for V.110	
	n=2	assigns the phone number for V.120	
	n=3	assigns the phone number for PPP async to sync HDLC	
	n=4	assigns the phone number for ISDN data (Multi-Auto answering , auto-detect the protocols)	
	n=5	Assign the phone number for PPP async to sync HDLC	
	n=6	Assign the phone number for internal fax/modem	
	n=7	Assign the phone number for the a/b adapter	
&ZI?		Display the phone number (including subaddress , if any) for various B channel protocols	

&Z0*x*=*s*		Write own phone number (including subaddress, if any. The number specified by &ZOx will be used as the calling party number while dialing x = M(fax/modem), I(ISDN), or B(a/b adapter)	
&ZO?		Display the own phone numbers assigned via the AT&ZOx=s command	
&Z?		Display all the phone numbers stored in NVRAM	

Extended "AT*" Command Set

Command		Function & Description	Ref.
*C*n*		Character length, including start, stop and parity bit.	S15.3-4
	*C0 *	10-bit character length.	
	*C1	11-bit character length.	
	*C2	9-bit character length.	
	*C3	8-bit character length.	
*D*n*	n=0-39	Set default dial pointer at telephone directory location n.	S29
	*D0 *	(See also S35.4 and S38.0)	
*E*n*		Internal modem error control negotiation	S21.0
	*E0 *	If error control negotiation fails, keep the non-error control connection.	
	*E1	If error control negotiation fails, disconnect the call (hang-up).	
*G*n*		Security function selection	S36.5-7
	*G0 *	Disable security function	
	*G1	Enable type 1 security, with password check (ZyXEL to ZyXEL only).	
	*G2	Enable type 1 security, with password check and call back (ZyXEL to ZyXEL only)	
	*G3	Enable type 2 security, with password check	
	*G4	Enable type 2 security, with password check and call back	
	*G5	Enable type 2 security, with password check and call back, remote site enters the call back number	
*GC*n*	n=0-1	Call-back function selection	S119.0
	*GC0	Disable call-back function	
	*GC1	Enable call-back function	
*HC*n=s*	n=0-4	Modify call back phone number	
*H*n*	n=0-39	Modify user password table at location n.	
*HS		Modify supervisory password (Default: yXEL")	
*I*n*		Command set selection	S17.6-7
	*I0 *	AT command set	
	*I1	V.25bis command set	
*M*n*		Leased line auto-handshake mode selection	
	*M0 *	Leased line auto-handshake on Originate mode	

	*M1	Leased line auto-handshake on Answer mode	
*Q*n*		Action taken when line quality changes	S27.6-7
	*Q0	No action to poor signal quality	
	*Q1	Retrain action taken if signal quality is poor. (See also S41.2)	
	*Q2 *	Adaptive rate, automatic fall-back or forward	
	*Q3	Disconnect if signal quality is poor	
*T		Recall the last CND (Caller ID) information.	
*V		View the Password table	
*VC		View the Call-back Number table	

16 Status Registers and Result Codes

S-registers (Status Registers) contain values that determine and reflect how your Terminal Adapter (TA) operates and executes commands. You can read the values and change them, either using terminal commands or the modem's panel controls with the same results.

Every user profile corresponds to a separate set of S-register values, but when we mention S-registers, we are referring to the ones that correspond to the active profile. If you want to read or change the values in a profile that is currently inactive, you will first have to recall that profile to make it active.

At the time this manual was written, the Elite 2864I was equipped with 127 S-registers, from S0 to S127. S0 to S11 are standard AT S-registers, and S12 to S127 are mostly bit-map configured. Changes in the bit-map configuration can have the same effect as issuing AT Commands. However, using the equivalent AT Command is recommended.

Viewing and Setting S-Registers

There are several AT Commands that are used to view the values stored in the S-registers.

Viewing S-registers

To display the value stored in S-register ‘r’ with AT Commands, use:

```
ATSr?
```

To view all of the S-resister settings use the &Vn command:

```
AT&Vn
```

n=0	View S-register settings for current active profile
n=1-4	View settings for user profile number (n-1)
n=5	View the factory default settings
n=6	View the a/b adapter's setting
n=7	System Resources Status

The S-register values may be displayed in either Decimal or Hexadecimal format when using the preceding commands. Bit 3 of S-register 84 sets which numbering system is used for display.

```
ATS84.3=0    (for decimal format)
ATS84.3=0    (for Hex format)
```

To display the value of bit b of S-register r, type:

```
ATSr.b?
```

Setting S-registers

In order to change the value in S-register 'r' to value 'n' use:

```
ATSr=n (range 0-255)
```

In order to change the value in a specific bit (b) of S-register r, use:

```
ATSr.b=n (range 0-1)
```

In both commands, n is a decimal number in the given range. While the first command modifies all bits in the S-register simultaneously, the second command lets you change bit b without affecting other bits in this S-register. When using **ATSr=n**, you need to do a conversion to or from the binary number to find out which bits you manipulate.

For example, if you want to set S38 bit 3 to 1 for a specific application, you may either use **ATS38.3=1** (simple) or use the following (difficult):

NOTE: THE VALUES USED IN THE EXAMPLE BELOW DIFFER FROM THE ACTUAL VALUES IN THE S-REGISTER AND ARE USED FOR DEMONSTRATION PURPOSES ONLY.

Read the value from S38 using ATS38?

Convert it to binary, using the following weight table:

Bit	Binary value	Decimal value	Hexadecimal value
0	00000001	1	$01
1	00000010	2	$02
2	00000100	4	$04
3	00001000	8	$08
4	00010000	16	$10
5	00100000	32	$20
6	01000000	64	$40
7	10000000	128	$80

To set bit 3 to 1 (binary), do a logic OR operation with the value.

Operation	Example-1			Example-2		
	Binary	Dec.	Hex.	Binary	Dec.	Hex.
OR	10001000	136	$88	01000000	64	$40
	00001000	8	$08	00001000	8	$08
	10001000	136	$88	01001000	72	$48

To set bit 3 to 0 (binary), you must invert the value using a logic NOT operation and then do an logic AND operation.

NOT	00001000	8	$08	00001000	8	$08
	11110111	247	$F7	11110111	247	$F7
AND	10001000	136	$88	01000000	64	$40
	10000000	128	$80	01000000	64	$40

Finally, using the ***result*** decimal value, issue an **ATS38=n** to set the register.

S-Register Descriptions

In most bit-mapped S-registers, the default bit value is 0 and only non-default situations are described. Some reserved bits are for factory use and the user should not change them.

Values followed by an asterisk * are the factory default settings.

Basic S-Registers "ATSn=x"

Command	Function & Description	Ref.
S0=	Set the number of rings on which the modem will answer. 0 value disable auto-answer	+000
S1=	Counts and stores number of rings from an incoming call	+000
S2=	Define escape code character, default <+> (43 dec.)	+043
S3=	Define ASCII Carriage Return	+013
S4=	Define ASCII Line Feed	+010
S5=	Define ASCII Backspace	+008
S7=	Set duration, in number of seconds, modem waits for a carrier	+060
S8=	Set duration, in seconds, for pause (,) option in Dial command and pause between command re-executions for Repeat (>)command	+002
S9=	Set duration, in tenths of a second, of remote carrier signal before recognition (Ignored if in non-FSK or half-duplex operation)	+006
S10=	Set duration, in tenths of a second, modem waits after loss of carrier before hanging up	+007
S11=	Set duration and spacing, in milliseconds, of dialed Touch-Tones	+070
S12=	Reserved	

Extended S-Registers "ATSn=x"

Command	bit	dec	hex	Function and description	Ref.
S13=	bit	dec	hex	Bit-mapped register (For internal fax/modem only)	+000

	1	2	2	Capture modem manufacturer information during V.42 handshake, can be displayed at ATI2 <Last Speed/ Protocol> line if available (Flash or ZyXEL stands for ZyXEL connection).	
S14=	bit	dec	hex	Bit-mapped register	+002
	0	0	0	Modem auto-handshake on Originate mode	
		1	1	Modem auto-handshake on Answer mode	
S15=	bit	dec	hex	Bit-mapped register	+130
	0,1	0	0	Even parity	
		1	1	Odd parity	
		2	2 *	No parity	
	2	0	0 *	1 stop bit	
		4	4	2 stop bits	
	4,3	0	0 *	10 bit character length	*C0
		8	8	11 bit	*C1
		16	10	9 bit	*C2
		24	18	8 bit	*C3
	7-5	0	0	Profile 0 as active settings after power ON	Z0
		32	20	Profile 1 as active settings after power ON	Z1
		64	40	Profile 2 as active settings after power ON	Z2
		96	60	Profile 3 as active settings after power on	Z3
		128	80 *	Factory default as active settings after power ON	Z4
S16=		dec	hex	Test status register	+000
		0	0	No test in progress	&T0
				For internal fax/modem only:	
		1	1	Loopback test in progress	&T1
		8	8	Loopback with self test in progress &T8	
				For ISDN data call only:	
		9	9	Loopback test in progress	&T9
		10	A	Loopback with self test in progress	&T10
S18=		dec		Force modem or TA to fix baud rate when idle	+000
		0 *		Disable fixed baud function	

		n+1		Enable baud rate fixing at idle, n=0-15 baud rate value settings (n) the same as S20 value	
S19=		dec	hex	Modem connection mode	
		0-73	0-49	Same setting value as 'AT&Nn' command	+000
S20=		dec	hex	DTE speed (bps). Auto detected from AT Command	+003
		0	0	230400 bps	
		1	1	115200 bps	
		2	2	76800 bps	
		3	3	57600 bps	
		4	4	38400 bps	
		5	5	19200 bps	
		6	6	16800 bps	
		7	7	14400 bps	
		8	8	12000 bps	
		9	9	9600 bps	
		10	A	7200 bps	
		11	B	4800 bps	
		12	C	2400 bps	
		13	D	1200 bps	
		14	E	460800 bps	
		15	F	300 bps	
S21=	bit	dec	hex	Bit mapped register	+178
	0	0	0	Maintain non-error control connection when modem error control handshake fails	*E0
		1	1	Drop connection when modem error control handshake fails	*E1
	1-2	0	0	Speaker always Off	M0
		2	2	Speaker On until carrier is detected	M1
		4	4	Speaker always On	M2
		6	6	Speaker On after last digit is dialed out until carrier detected	M3
	3	0	0	DSR always On	&S0
		8	8	According to CCITT (see also S44.4, S41.5)	&S1
	4	0	0	CD always On	&C0
		16	10	CD tracks presence of data carrier (see also S38.3)	&C1
	6-7	0	0	Assume DTR always On	&D0

		64	40	108.1, DTR Off-On transition causes dial of the default number	&D1
		128	80	108.2 Data Terminal Ready, DTR Off causes the modem to hang up and return to command state	&D2
		192	C0	108.2, DTR off causes the modem to hang up and reset the modem to profile #0 after DTR dropped	&D3
S23=	bit	dec	hex	Bit mapped register	+105
	0	0	0	Command echo disabled	E0
		1	1	Command echo enabled	E1
	2	0	0	Insertion is not allowed during a phone call	
		4	4	Insertion is allowed during a phone call	
	3-5	0	0	ATX0 (See result code table)	
		8	8	ATX1 dec hex AT	
		16	10	ATX2 40 28 X5	
		24	18	ATX3 48 30 X6	
		32	20	ATX4 56 38 X7	
	6	0	0	Display result code in numeric format (see S35.7)	V0
		64	40	Display result code in verbose format	V1
	7	0	0	Modem returns result code	Q0
		128	80	Modem does not return result code (See also S40.1)	Q1
S24=	bit	dec	hex	Bit mapped register	+138
	0-2	0-7	0-7	Ring volume control, increments of 1 in decimal	N0-7
	4-6	16-112	10-700	x10- 0x70 Speaker volume control, increments of 16 in decimal value	L0-7
S27=	bit	dec	hex	Bit mapped register	+156
	0-2			For internal fax/modem:	
		0	0	No error control	&K0
		1	1	MNP4 + MNP3 (see also S41.0)	&K1
		2	2	MNP4 + MNP5 (see also S38.5, S41.0)	&K2
		3	3	V.42+MNP4	&K3
		4	4	V.42 + V.42bis (compatible with &K2)	&K4
	3-5	0	0	Flow control disabled	&H0
		24	18	Hardware (RTS/CTS) flow control	&H3
		32	20	Software (XON/XOFF) flow control	&H4
		40	28	Reserved	&H5

	6-7			For internal fax/modem	
		0	0	No response to poor signal quality	*Q0
		64	40	Retrain action taken if signal quality is poor	*Q1
		128	80	Adaptive rate (auto fall-back / forward) when signal quality changes S41b2	*Q2
		192	C0	Disconnect when signal quality is poor.	*Q3
S28=	bit	dec	hex	Bit mapped register	+068
	0			Reserved	
	4-5	0	0	No guard tone	&G0
		16	10	Reserved	&G1
		32	20	1800 Hz guard tone	&G2
	7	0	0 *	Select V.22 for 1200 bps communication	
		128	80	Select Bell 212A for 1200 bps communication	
S29=		0-39	0-39	Set default dial phone number pointer, use AT&Zn=s to store phone numbers	+000 *D
S31=		0-255	0-FF	Holds the ASCII decimal value of the XON	+017
S32=		0-255	0-FF	Holds the ASCII decimal value of the XOFF	+019
S35=	bit	dec	hex	Bit mapped register	
	1	2	2	Disable aborting from connection during modem handshaking	
	4	16	10	When Data/Voice with is pressed, modem will dial the default number.	*Dn S29
	5	32 *	20	SREJ option: Enable Selective Reject in V.42	
	7	128	80	Enable extended numerical result codes from 50-71 when an error corrected connection is made. Use with ATV0. (see result code table)	V0 S23.6
S36=	bit	dec	hex	Bit mapped register	+000
	5-7			Security function control register *G3,*G4,*G5 for both ISDN and Modem call	
		0 *	0	Disable security function	*G0
		32	20	Enable type 1 security, with password check (ZyXEL to ZyXEL only)	*G1

		64	40	Enable type 1 security, with password check and call-back (ZyXEL to ZyXEL only)	*G2
		96	60	Enable type 2 security, with password check	*G3
		128	80	Enable type 2 security, with password check and call-back	*G4
		160	A0	Enable type 2 security, with password check and call-back, remote site enter the call-back number	*G5
S38=	bit	dec	hex	Bit mapped register	+000
	0	1	1	Repeatedly dialing default number	*Dn S29
	3	8	8	DCD on/off sequence follows UNIX standard, DCD high before connect message is sent, DCD off after last DCE response is sent	&C1 S21.4
	4	16	10	Auto-mode fax receiving disabled	&N0
	5	32	20	Disable MNP5	&Kn
S39=	bit	dec	hex	Bit mapped register (For internal fax/modem only)	+000
	2	4	4	Answer in originating mode	ATA
	3	8	8	Class 2 Fax Bitfax compatibility: +FCON at 2400 next phase at 19200	
	4	16	10	Class 2 Fax mode DTE shifting: +FCON at current DTE, shift to 19,200 when entering into the next phase	
S40=	bit	dec	hex	Bit mapped register	+000
	1	2	2	No result code displayed in answer mode	Q2
S41=	bit	dec	hex	Bit mapped register (For internal fax/modem only)	+000
	0	1	1	Special MNP compatibility (see also S27.0, S38.5)	&Kn
	2	4	4	Disable retrain abort, up to 5 min. for special satellite line condition	S27b6 *Qn
	3	8	8	Enable CCITT signals 140 and 141 on EIA-232D interface	
	4	16	10	In X2-X7 setting, modem waits for S6 seconds before dialing and ignores dial tone detection	

	5	32	20	DSR follows DCD and pulses (see also S44.4)	&Sn
	6	64	40	Force S0>=2	S0
	7	128	80	Ignore calling tone, not to be used as fax detection	
S42=	bit	dec	hex	Bit mapped register	+000
	3	8	8	Disable escape sequence code in answer mode	
	4	16	10	Disable V.17, 14,400 Fax in calling mode, no effect to answering mode &N32	
	5	32	20	Disable Data/Voice button	
	6	64	40	Disable <RINGING> result code	Xn
	7	128	80	DCD forced on but pulse off for 0.5 second at carrier loss	&C0
S43=	bit	dec	hex	Bit mapped register	+000
	0	1	1	Disable ZyXEL 16800 in Multi-Auto mode	&N0
	1	2	2	Disable ZyXEL 19200 in Multi-Auto mode	
S44=	bit	dec	hex	Bit mapped register	+000
	3	8	8	ATDSn initiates auto-dial of the stored numbers consecutively until connection is made	DSn &Zn S38.0
	4	16	10	DSR follows DTR (see also S41.5)	&Sn
S48=	bit	dec	hex	Bit-mapped register	+000
	2	4	4	Enable data CNG calling tone transmission	
S50=	bit	dec	hex	Bit-mapped register	+000
	0-255			This timer counts when there is no data flow in or out of the RS 232 serial port; modem will hang up phone, when timed out. units is 10 seconds! 000 disables timer Note: timer is forced disabled in leased line and ISDN Mode	
S56=	bit	dec	hex		+050
		0-255	0-FF	Hook flash detected time for a/b adapter, in units of 10ms	
S57=	bit	dec	hex		
	0-3			Reserved	

	4	16	10	Enables the reporting of Class 1 capability in the response to +FCLASS=?	
	5			Reserved	
	6	64	40	Enables busy detection in dialing period	
	7	128	80	Report 'DATA or FAX' before showing Connect Message	
S66=*n*			0 *	Dial back repeat counter of security function	
S71=	bit	dec	hex	Bit-mapped register	+064
	0-2	0-5	0-5	ZyXEL fax receive mode select	+FZF
		0 *	0	Fax to printer, hang up if data	
		1	1	Fax to printer, data to serial port	
		2	2	Fax to DRAM & printer, hang up if data	
		3	3	Fax to DRAM, hang up if data	
		4	4	Fax to DRAM & printer, data to serial port	
		5	5	Fax to DRAM, data to serial port	
	4	16	10	Delete DRAM fax file after printed	
	5	32	20	Keep DRAM fax even it has been retrieved	
	6	0 *	0	High speed fax retrieval for ZFAX only	
		64	40	Slow retrieve process (for Class 2)	
S72=	bit	dec	hex	Select printer type	+000
		0 *	0	HP LJ-II series or compatible PCL Printer	
		1	1	HP LJ-III series or compatible PCL Printer	
		2	2	POSTSCRIPT Printer	
S73=	bit	dec	hex	Bit-mapped register	+008
	0	*0	0	Parallel Port for fax printing	
		1	1	Serial Port for fax printing	
	1	*0	0	Fast PCL Printing	
	2	*0	0	PCL printing resolution 300dpi	+FZR
		4	4	PCL printing resolution 150dpi	
	3	*8	8	Automatic resize for fax printing	
	4-5	0-32	0-20	ZyXEL fax printing, paper size	+FZS
		0	0	Paper size : LETTER (8.5 inch * 11 inch)	
		16	10	Paper size : LEGAL (8 inch * 14 inch)	
		32	20	Paper size : A4 (210 mm * 287 mm)	
S74=				Reserved, read only	
S75=	bit	dec	hex	Bit-mapped register	+008
	0-2	0-5	0-5	Multiauto answered fax class selection	

		0	0	Auto answer by fax class 2	
		1	1	Auto answer by fax class 2.0	
		2	2	Auto answer by fax class 6 / ZFAX	
		3	3	Auto answer by fax class 1	
		4	4	Auto answer by fax class Z / DRAM	
		5	5	Auto answer by fax class Z / Printer	
S76=	bit	dec	hec	Bit mapped register	+000
	0	1	1	FAX response capture enabled	
	1	2	2	FAX command capture enabled	
	2	4	4	V.21 HDLC Tx/Rx capture enabled. This feature is not available for the FAX direct printing mode. Use 'AT+FZX?' command to show the captured log on	
S79=	bit	dec	hex	Bit-mapped register	+000
	7	0 *	0	Sending RELEASE COMPLETE with cause 'call reject' for ATH1	
		128	80	Sending RELEASE COMPLETE with cause 'user busy' for ATH1	
S80=	bit	dec	hex	Bit-mapped register:	+000
	4	0 *	0	Not sending Low Layer Compatibility information for internal fax/modem	
		16	10	Sending Low Layer Compatibility for internal fax/modem	
	6	0 *	0	Do not send Low Layer Compatibility information for ISDN data call	
		64	40	Send Low Layer Compatibility for ISDN data call	
	7	0 *	0	Do not send Low Layer Compatibility information for a/b adapter	
		128	80	Send Low Layer Compatibility for a/b adapter	
S82=		dec		ISDN B channel protocol	Bn
		60		V.120 64000	
		61		V.120 56000	
		62		X.75 64000 Transparent	
		63		X.75 56000 Transparent	
		64		X.75 64000 T.70	
		65		X.75 56000 T.70	
		72		V.110 64000	
		73		V.110 56000	
		74		PPP async to sync 64K	

		75		PPP async to sync 56K	
		76		SLIP to sync HDLC conversion 64K	
		77		SLIP to sync HDLC conversion 56K	
S83=	bit	dec	hex	Bit-mapped register:	+000
	0	0	0	Disable loopback 4 test	CP0
		1	1	Enable loopback 4 test	CP1
	2	0	0	ISDN without V.42bis	&K00
		4	4	ISDN with V.42bis if applicable	&K44
	4-5	0 *	0	ATDs, ATDPs, and ATDTs is mapped to ATDMs	&O0
		32	20	ATDs, ATDPs, and ATDTs is mapped to ATDIs	&O2
		48	30	ATDs, ATDPs, and ATDTs is mapped to ATDBs	&O3
	6	0	0 *	DOVBS answer using 56Kbps (for USA only)	
		64	40	DOVBS answer using 64Kbps	
	7	0	0 *	ISDN data call using nornal Bearer Service (for USA only)	
		128	80	ISDN data call using voice Bearer Service	
S84=	bit	dec	hex		
	0-2			Embedded protocol analyzer control	CCn
		1	1	Capture DTE-DCE interface protocol information	
		2	2	Capture the B channel (X.75 or V.120) frames	
		4	4	Capture the D channel protocol information	
	3	0	0 *	Display S register value in decimal format	
		8	8	Display S register value in hex format	
	4	0 *	0	Indicate Caller ID after the 1st RING message	
		16	10	Disable Caller ID indication	
	5	0	0	Ambiguity resolution bit, A/B adapter first	&L0
		32	20	Ambiguity resolution bit, Fax/Modem first	&L1
S85=	bit	dec	hex		
	0	0	0	Call bumping function disabled	CE0
		1	1 *	Call bumping function enabled	CE1
	1-6		0 *	Add-persist time interval	KAXn
	7	0	0 *	S85.1-6 is in second unit	KASn

		128	80	S85.1-6 is in minute unit	KAMn
S86=		dec	hex	D channel protocol selection (USA) The following number is valid only for American version:	Pn
		0	0	Northern Telecom proprietary ISDN	
		1	1	National ISDN 1 (1 SPID mode)	
		2	2	National ISDN 1 (2 SPID mode)	
		3	3	Reserved	
		4	4	AT&T proprietary point-to-point	
		5	5	AT&T proprietary point-to-multi-point (1 SPID mode)	
		6	6	AT&T custom point-to-multipoint (2 SPID mode)	
S87=	bit	dec	hex		
	2	0	0	CHAP/PAP for authentication conversion	
		4	4	PAP only for authentication conversion	
	4	0 *	0	result code 46 for X7 is CONNECT 112K/ result code 47 for X7 is CONNECT 128K/.....	
		16	10	Result code 46 for X7 is CONNECT 112000/ Result code 47 for X7 is CONNECT 128000/....	
	5-6	0 *	0	Bundle connection is disabled	&Jn
		32	20	Bundle connection is enabled in answer mode only	
		64	40	Bundle connection is enabled in call mode only	
		96	60	Bundle connection is enabled in both directions	
S89=	bit	dec	hex	Bundle and data encryption control	
	0	0 *	0	DES disabled	
		1	1	DES preferred	
	1	0 *	0	Single DES is alright	
		2	2	Triple DES is preferred	
	2	0 *	0	PKDS on, key automatically generated	
		4	4	no PKDS, keyin the key words	
	3	0 *	0	Keep connection whether there is DES or not	

		8	8	Disconnect the call if DES link cannot be established	
	4	0 *	0	second voice call will be routed to a/b adapter if &L1 is set	
		16	10	second voice call won't be routed to a/b adapter if &L1 is set	
	6	0 *	0	disable the metering pulse	
		64	40	enable the metering pulse	
S100=		dec	hex	B channel bundling protocol selection	
		0 *	0	Multiple Link Protocol (MLP)	
		1	1	cFossil channel bundling, for European Switches only (CCB)	
S102=				Outgoing ISDN data type. Value has the same definition as S82	Bnn
S103=		dec	hex	Set number of RING to the a/b adapter	
		0		The call sent to the a/b adapter will keep ringing until the call is answered or the calling side on-hook.	
		n>0		When the RING count has reached the value set (n), the a/b adapter analog call will be re-routed to internal fax/modem	
S104+n=		dec	hex	Outgoing Service Indicator (for 1TR6 only), n=0, internal fax/modem n=2, ISDN data n=3, a/b adapter	
		1	1	Fernsprechen	
		2	2	a/b - Dienste	
		7	7	Daten bertragung 64 Kbps. The defaults are : 2 - internal fax/modem 7 - ISDN data 1 - a/b adapter)	
S108+n=		dec	hex	Outgoing Service Additional (for 1TR6 only) Information n=0, internal fax/modem n=2, ISDN data n=3, a/b adapter	
	SI=1	1	1 *	ISDN-Fernsprechen 3.1 kHz	
		2	2	Fernsprechen analog	
	SI=2	2	2	Fax Gruppe 3	

		3	3 *	Daten Ober Modem	
		4	4	Btx Ober Modem	
	SI=7	0	0	Daten bertragung 64 Kbps (X.75 SLP)	
		11------		Async. V.110	
		01------		Extensions of async.	
		--0----- *		Number of data bits: 8	
		--1-----		Number of data bits: 7	
		---0---- *		Number of stop bits: 1	
		---1----		Number of stop bits: 2	
		----0--- *		No parity	
		----1---		Even parity	
		11---000		1200 bps	
		11---011		2400 bps	
		11---100		4800 bps	
		11---101		9600 bps	
		11---110		14400 bps	
		11---111 *		19200 bps	
		01---000		38400 bps	
		1010----		Sync. V.110	
		10100000		1200 bps	
		10100011		2400 bps	
		10100100		4800 bps	
		10100101		9600 bps	
		10100110		14400 bps	
		10100111		19200 bps	
		10101000		48000 bps	
		10101001		56000 bps	
		10101010		56000 bps for 56kbit-network	
		10101111		In band negotiation	
S108+n=		dec	hex	High Layer Compatibility (Non-1TR6) n=0, internal fax/modem n=2, ISDN data n=3, a/b adapter	
		0 *	0	No High-Layer-Compatibility information element will be sent	
		1	1	Telephone	
		4	4	Facsimile Group 2/3	
		40	28	Teletex service (Rec.F.220)	

		49	31	Teletex service (Rec.F.200)	
		50	32	Information Interworking for Video Services (Rec.F.300 T.110)	
		53	35	Telex service (Rec.F.60)	
		56	38	Message Handling Systems (MHS) (Rec.X.400 series)	
		65	41	OSI application (Rec.X.200 series)	
S114=				I-field data length (MSB byte)	
S115=				I -field data length (LSB byte)	
S117=				V.110 user rate	B1n
S118=	bit	dec	hex		
	0	0 *	0	Enable dial-in call	
		1	1	Disable dial-in call (dial out only)	
	3	0 *	0	Disable CHAP option for PPP/MLPPP	&E1
		8	8	Enable CHAP option for PPP/MLPPP	
	4	0 *	0	Use 3.1KHz Bearer service whenever possible for internal fax/modem	
		16	10	Use Speech Bearer service whenever possible for internal fax/modem	
	5	0 *	0	Use 3.1KHz Bearer service whenever possible for a/b adapter	
		32	20	Use Speech Bearer service whenever possible for a/b adapter1	
	6	0 *	0	Enable analog adapter to accept global calls	
		64	40	Forbid the analog adapter to accept global calls with MSN unmatched (see AT&ZIn=s)	
	7	0 *	0	Enable analog incoming calls	
		128	80	Reject analog incoming calls (pure ISDN data)	
S119=	bit	dec	hex		
	0	0 *	0	Disable call-back function	*GC
		1	1	Enable call-back function	
	1	0 *	0	Disable point-to-point signaling DDI function	
		2	2	Enable point-to-point signaling DDI function	
	2	0 *	0	Disable point-to-multipoint signaling DDI function	

		4	4	Enable point-to-multipoint signaling DDI function	
	3	0 *	0	when no MSN(EAZ) is matched, the inbound call will be ignored	
		8	8	when no MSN(EAZ) is matched, enter multi-auto mode to detect protocol	
	4	0	0	V.110 user rate = 19200 bps if DTE speed greater than 19200 bps	
		16 *	10	V.110 user rate = 38400 bps if DTE speed greater than 38400 bps	
	5	0 *	0	Enable normal MSN function	&ZIn
		32	20	Treat the number assigned by &ZI=n... as sub-address, and match with the called_party_subaddress for inbound call routing	
S120=	0	0 *	0	Enable POTS port call out	
		1	1	Disable POTS port call out	
S124=		dec	hex	Empty IP packet interval for PPP	+000
		0-255	0-FF	Units of 1 sec.	
S125=	bit	dec	hex		
	1-6		0 *	Sub-persist time interval	KSxn
	7	0	0 *	S125.1-6 is in Second unit	KSSn
		128	80	S125b1-6 is in Minute unit	KSMn
S126=		dec	hex	Add-threshold for BOD	JAn,+48
		0-255	0-FF	in Kbps unit	
S127=		dec	hex	Sub-threshold for BOD	JSn,+32
		0-255	0-FF	in Kbps unit	

Bit S-register bit number, 'b', used in 'ATSr.b=n' and 'ATSr.b=?'
dec Decimal value, 'x', used in 'ATSn=x'
hex Equivalent Hexadecimal value.
+nnn Factory default when listed in 'Reference' column.

"ATXn" Result Code Option Table

The following table shows the different options available when setting the ATXn command. The default value for 'n' is 5 when the Elite 2864I is shipped.

ATV0	ATV1	X0	X1	X2	X3	X4	X5	X6	X7
0	OK	V	V	V	V	V	V	V	V
1	CONNECT	V	V	V	V	V	@	$	#
2	RING	V	V	V	V	V	V	V	V
3	NO CARRIER	V	V	V	V	V	V	V	V
4	ERROR	V	V	V	V	V	V	V	V
5	CONNECT 1200		%	%	%	%	@	$	#
6	NO DIAL TONE			V		V	V	V	V
7	BUSY				V	V	V	V	V
8	NO ANSWER				V	V	V	V	V
9	RINGING*				V	V	V	V	V
10	CONNECT 2400		%	%	%	%	@	$	#
11	CONNECT 4800		%	%	%	%	@	$	#
12	CONNECT 9600		%	%	%	%	@	$	#
14	CONNECT 19200		%	%	%	%	@	$	#
15	CONNECT 7200		%	%	%	%	@	$	#
16	CONNECT 12000		%	%	%	%	@	$	#
17	CONNECT 14400		%	%	%	%	@	$	#
18	CONNECT 16800		%	%	%	%	@	$	#
19	CONNECT 38400		%	%	%	%	@		
20	CONNECT 57600		%	%	%	%	@		
21	CONNECT 76800		%	%	%	%	@		
22	CONNECT 115200		%	%	%	%	@		
23	CONNECT 230400		%	%	%	%	@		
24	CONNECT 460800		%	%	%	%	@		
25	CONNECT 921600		%	%	%	%	@		
26	CONNECT 307200		%	%	%	%	@		
27	CONNECT 153600		%	%	%	%	@		
28	CONNECT 102400		%	%	%	%	@		
29	CONNECT 61440		%	%	%	%	@		
30	CONNECT 51200		%	%	%	%	@		
31	CONNECT 62400		%	%	%	%	@		
32	CONNECT 124800		%	%	%	%	@		
33	CONNECT 62400		%	%	%	%	@		
34	CONNECT 41600		%	%	%	%	@		

ATV0	ATV1	X0	X1	X2	X3	X4	X5	X6	X7
35	CONNECT 31200		%	%	%	%	@	$	#
36	CONNECT 249600		%	%	%	%	@		
37	CONNECT 20800		%	%	%	%	@		
38	CONNECT 33600		%	%	%	%	@	$	#
39	CONNECT 28800		%	%	%	%	@	$	#
40	CONNECT 26400		%	%	%	%	@	$	#
41	CONNECT 24000		%	%	%	%	@	$	#
42	CONNECT 21600		%	%	%	%	@	$	#
43	CONNECT 48000		%	%	%	%	@	$	#
44	CONNECT 56000		%	%	%	%	@	$	#
45	CONNECT 64000		%	%	%	%	@	$	#
46	CONNECT 112000		%	%	%	%	@	$	#
47	CONNECT 128000		%	%	%	%	@	$	#

* Use S42.6 to disable 'RINGING' result code

Result Code Chart Symbol Reference:

V	Supported
%	Reports the DTE Speed as: <cr><lf>CONNECT DTE_Speed<cr><lf>
@	CONNECT DTE_Speed/Protocol DCE_Speed/Error_Control ** Example: `CONNECT 115200/V120 64000/LABD`
$	<cr><lf>CONNECT DCE_Speed[/Error_Code]<cr><lf> Example: `CONNECT 64000/ARQ`
#	CONNECT DCE _Speed/Error_Code/Error_Control Example: `CONNECT 64000/ARQ/V42b`

Result Code Field Descriptions

Field Name	Possible Values
Error_Code	NONE, ARQ
Error_Control	LAPB, LAPD, V42 (This field will not show if no error control is negotiated)
Data_Compression	V42b
DCE_Speed	All possible DCE speeds supported
DTE_Speed	All possible DTE speeds supported
Protocol	Only ISDN protocols are listed here X.75

Field Name	Possible Values
	X.75M (X.75 with MLP Bundle) X.75C (X.75 with cFos Bundle) V110 V120 V120M (V.120 with MLP Bundle) V120C (V.120 with cFos Bundle) SLIP PPP BTX

Connect Strings for Error Corrected Connections

To enable the following numerical (ATV0) and verbose (ATV1) result codes when an error corrected connection is made, set S35 bit 7 to 1.

```
ATS35.7=1<enter>
```

ATV0	ATV1	ATV0	ATV1
50	CONNECT	61	CONNECT 24000
51	CONNECT 1200	62	CONNECT 26400
52	CONNECT 2400	63	CONNECT 28800
53	CONNECT 4800	64	CONNECT 31200
54	CONNECT 7200	65	CONNECT 33600
55	CONNECT 9600	66	CONNECT 38400
56	CONNECT 12000	67	CONNECT 48000
57	CONNECT 14400	68	CONNECT 56000
58	CONNECT 16800	69	CONNECT 64000
59	CONNECT 19200	70	CONNECT 112000
60	CONNECT 21600	71	CONNECT 128000

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