Elite 2864I

User's Manual

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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 option, 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 remanufactured functionally equivalent product of equal value, and will be solely at the option 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 option 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 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.

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 residential installation. 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. However, there is no guarantee that interference will not occur in a particular installation.

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.

Elite 2864I: FCC ID# I88Elite2864I

Information for Canadian Users

The Industry Canada (IC, formerly DOC) label identifies certified equipment. This certification means that the equipment meets certain telecommunications network protective, operational, and safety requirements. IC 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 (telephone extension card). 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.

The Load Number (LN) assigned to each terminal device denotes the percentage of the total load to be connected to the telephone loop used by the device without overloading. The termination on a loop may consist of any combination of devices, subject only to the requirement that the total of the Load Numbers of all the devices not exceed 100.

This digital apparatus does not exceed the class B limits for radio noise emissions from digital apparatus set out in the radio interference regulations of Industry Canada (formerly Canadian DOC).

Table of Contents

Chapter 1 - Introduction

Congratulations on your purchase of the **ZyXEL Elite 2864I** ISDN modem. You have in your hands a truly revolutionary product combining the best of both analog and digital worlds. The Elite 2864I supports highly integrated services over ISDN lines without sacrificing connectivity to today's more popular analog lines.

The Elite 2864I supports V.34 over ISDN and is backwards compatible with all other protocols, standards, and lower speeds. The modem also works with most popular fax software and operates in most popular operating systems.

To take advantage of constant new developments, the Elite 2864I employs the flash EPROMs, which allow for convenient uploading of firmware and for modem programming via your computer.

The ISDN modem has an analog adapter (POTS port) that recognizes standard DTMF tones and generates a standard ring signal to the connected device.

Key Features of the Elite 2864I ISDN Modem

- Full compatibility with both ISDN and remote PSTN via ISDN
- Application interface: ZyXEL ISDN AT Commands
- Signaling protocol compatibility with NI-1, AT&T 5ESS, and Northern Telecom DMS-100 network switches
- Supports V.110, V.120, and Bundle (128Kbps) B-Channel protocols
- Supports SLIP to sync HDLC conversion and PPP async-to-sync HDLC conversion for LAN-to-LAN interconnections and Internet access
- Easy upgrade path using flash EPROM memory
- V.42bis data compression over X.75, and V.120
- High speed serial/parallel DTE interface
- Analog adapter (POTS port)
- Digitized voice capability (2, 3, and 4-bit ADPCM)
- Optional DRAM for on-board fax reception (up to 8Mbytes)
- Cryptographic data protection
- Embedded protocol analyzer with ANSI display
- S/T interface (2864I) or U interface (2864IU) for North America ISDN

U-Interface Option

For the north America ISDN, ZyXEL provides an optional 2B1Q U-interface which is connected directly from the network to the ZyXEL Elite 2864I.

Unpacking Your Elite 2864I

Your Elite 2864I modem should come with the equipment listed below. If any item is missing or damaged, please contact your Dealer or ZyXEL Customer Service Department immediately.

1. One (1) RJ-45 modular telephone cable
2. One (1) AC power adapter, with power cable
3. One (1) serial/parallel cable
4. One (1) Trio Communication Suite software (3 disks)
5. One (1) ZyXEL Drivers disk
6. One (1) Elite ISDN Configuration Manager disk
7. One (1) Gender Changer: (Note it may already be attached to your parallel port.)
8. One (1) Elite 2864I User Manual
9. Warranty/Registration card

How to Become a Registered Owner

Complete the pre-addressed registration card and place it in the mail. Registered owners will receive future product information and update announcement. Please also save your dated invoice as proof of purchase.

What You Need to Have

Operation of your Elite 2864I ISDN modem requires the following:

- Computer or terminal with communication software that communicates with the serial port
- An ISDN Basic Rate Interface service from your telephone company

Chapter 2 - Installing your 2864I

Connecting Your Elite 2864I to the Power Supply

1. Turn off your computer.
2. Make sure the power switch on the supplied power adapter is in the "O" (OFF) position. (see note below)
3. Connect the round end of the power adapter to the POWER JACK on the modem's back panel (see Figure *3*-1).
4. Make sure that you hear a "click," when you plug in the power adapter. If you don't hear or feel the "click," then the power supply has not been inserted properly.
5. Connect the power cable to a wall jack then turn on the power switch (the switch is located on the power adapter).
6. Observe the LED light status on the front panel of your Elite 2864I (without the modem cable and phone line connected to the Elite 2864I).
7. After this cycle is complete, the PWR, SP, CTS & DSR LED's should remain on. If these LEDs are not lit, your modem did not pass the self test. Please refer to Chapter 15 - "**Diagnostics and Protocol Analyzer**" for more information.
8. You can turn the power off now and continue connecting your serial cable and phone line.

Note: *Use only the power adapter supplied with your modem. Never use a power adapter designed for a different product.*

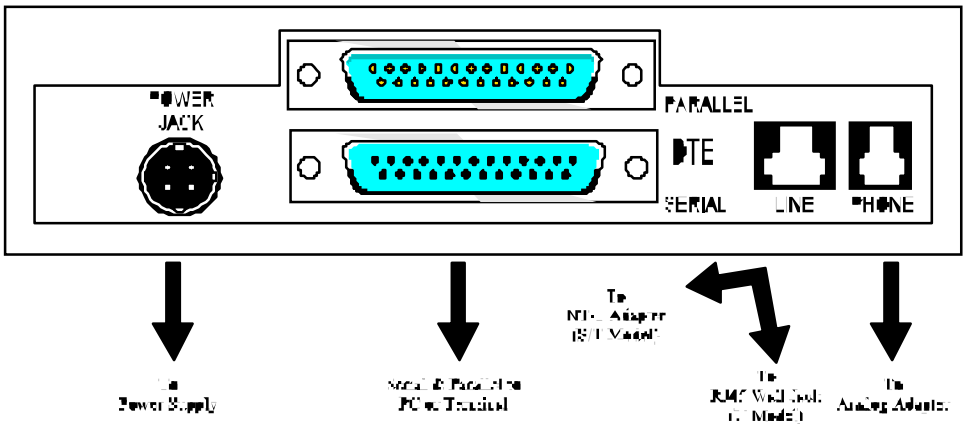


Figure 2-1

Connecting the Elite 2864I to Your Computer

Your Elite 2864I comes with both a **serial port** (RS232C port) and a **parallel port**. The parallel port is a 25 pin male connector and it might be mounted with a 25 pin female to female gender changer. *When you first install the Elite 2864I, we recommend you use the serial port to setup the device.* Then you may try to establish a connection via the

parallel port.

Note: The gender changer (included in the box) is intended for connection of the Elite 2864I parallel port to your HP PCLII, DeskJet or PS compatible laser printer for direct fax printing. You will not need to use this adapter for your data communication needs.

Your Elite 2864I comes with a 25 pin, male to female cable, which can be used as either a serial (RS232C) cable or a parallel cable. Please see diagrams below:

Connecting the Elite 2864I to your Computer Serial Port

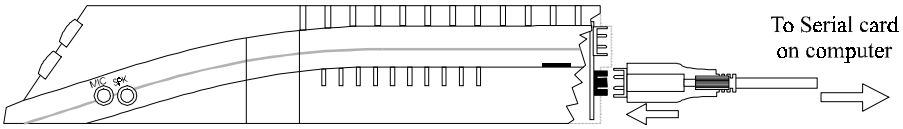


Figure 2-2

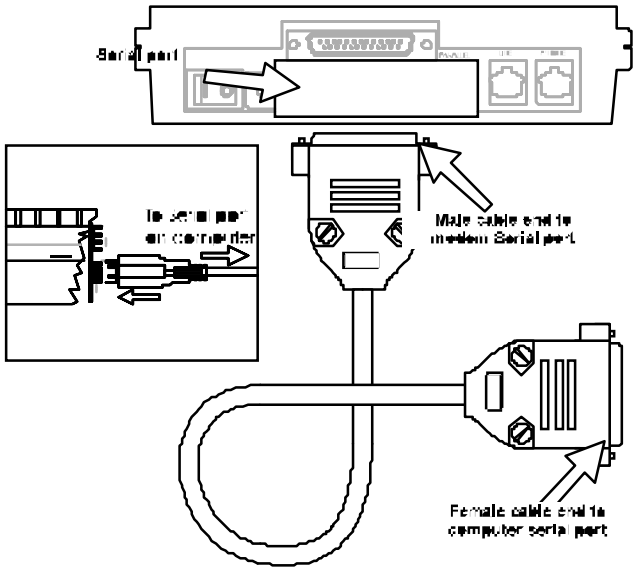


Figure 2-3

Find the male end of your cable.

1. Find the serial port of your Elite 2864I. It is close to the bottom of the device, and is marked, “serial”.
2. Connect the male end of the 25 pin cable to the serial port of the Elite 2864I. Connect the other end of the cable (female end) to your computer’s serial port. In case your computer only supplies a 9 pin serial connector, you will need to obtain a 25 pin to 9 pin converter (a 9 pin female to 25 pin male adapter).

3. Once the connection is made, you can turn the power back on.

Connecting the Elite 2864I to your Computer Parallel Port

Figure 2-4

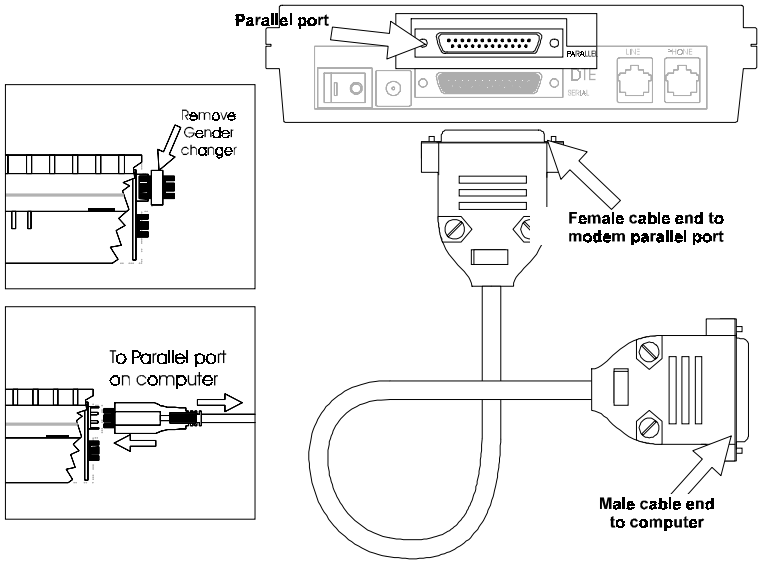


Figure 2-5

1. Connect the female end of the 25 pin cable to your Elite 2864I.
2. Connect the other end of the cable (male in this case) to your computer's parallel port (it is always a 25 pin female).

Connecting the Elite 2864I to your PCL Laser Printer

The Elite 2864I does not come with a printer cable. So for this application, either use your existing cable or get an extra printer cable. A printer cable has one end with a 25 pin male connector. On the other end is a 36 pin Centronics connector which connects to your printer.

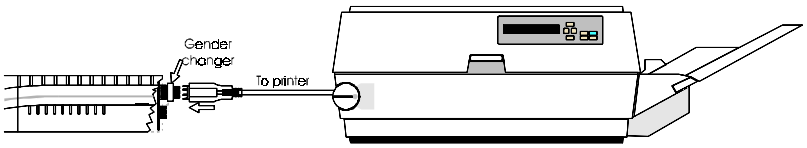


Figure 2-6

1. Find your 25 pin parallel port on your Elite 2864I. When you unpack your Elite 2864I, there should be a female to female gender changer included in the box. If you have removed the gender changer, please replace it so that your parallel port has a 25 pin female connector (to connect to the 25 pin male connector of your printer cable).
2. Find the 25 pin male end of the cable.
3. Connect the male end of the printer cable to the parallel port of your Elite 2864I.
4. Connect the Centronics connector to your HP PCL II, DeskJet or PS compatible laser printer.

This configuration will allow you to receive incoming faxes directly to your printer. You can also connect your Elite 2864I to your PC via the parallel port and perform regular communications. Please refer to Chapter 11 - "**Direct FAX Reception and Printing**", for the settings and commands related to this operation.

In case you want to be able to connect your printer to both your computer and the Elite 2864I, you should get a printer sharing device. This way, the device can do the automatic switching for you.

If you do have a printer sharing device connected, the printer might be busy when a fax is in-coming. In this case, you should upgrade the Elite 2864I by installing DRAM. With DRAM, the received fax will be stored automatically in the Elite 2864I while the printer is busy. Once the printer is free, the Elite 2864I will immediately send the fax to the printer. Additionally, DRAM allows for incoming faxes to be downloaded and stored in your PC.

Connecting the Elite 2864I to Your ISDN Line

The Elite 2864I comes with a choice of two different types of interfaces:

- Elite 2864I and 2864I-S/T come with an S/T interface. This can only connect to your NT-1 (Network Termination) device.
- Elite 2864I-U comes with a U interface. This allows you to connect directly to your wall jack.

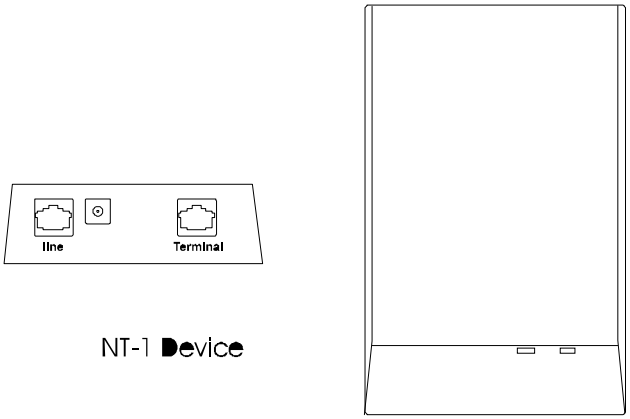


Figure 2-7

S/T Interface

If you have purchased the Elite 2864I or 2864I-S/T model, you will need an NT-1 device to connect to the network.

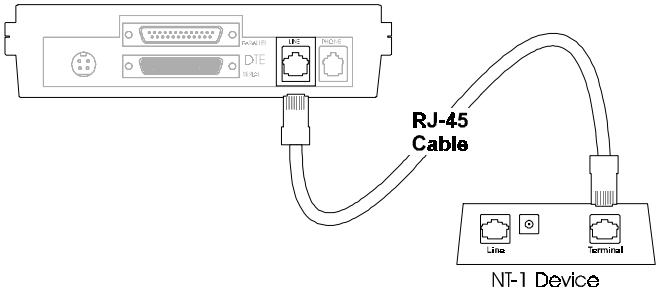


Figure 2-8

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. Please refer to the 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. The NT-1

device should come with the proper cable for connection from the wall jack and the NT-1's line jack.

No matter what kind 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-S/T to your ISDN line:

1. Use the phone cable (RJ-45) that is included, connect the Elite 2864I "ISDN S" 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: If you are using the ISDN line for all your communications, we recommend that you use a UPS (Uninterruptable Power Supply) to provide backup power for the NT-1 and the Elite 2864I. Otherwise, these units as well as any devices attached to the POTS port will not function in the event of a power loss at your location.

U Interface

If you have purchased the Elite 2864I-U, 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, and the U-Interface jack on the back of the Elite 2864I-U is a RJ-45 jack. A RJ-11 to RJ-45 phone cable is included with your Elite 2864I-U.

To connect the Elite 2864I-U to your ISDN line:

1. Connect the RJ-45 connector to the "ISDN U" jack on the back of the Elite 2864I-U.

2. Connect the other end of the RJ-11 cable to your wall jack.

Power On and Self Diagnostics

Once you have completely connected your Elite 2864I to your computer and to the power supply, plug the power cord in to your wall jack and turn on the Elite 2864I modem.

The Elite 2864I modem should cycle through a self test sequence, where you should see a series of LED lights blinking. After this cycle is complete, the PWR, SP, DSR, and CTS lights should stay on.

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 and RTS lights go ON after the self test. If you are using the serial port connection, the SP light will stay on.

If the test routine fails, the LNK LED flashes. Please refer to Chapter 15- "**Diagnostics and Protocol Analyzer**" for more information on the self-test and its error codes.

Note: The Elite 2864I takes longer to initialize than a regular modem because it requires that communication first be established with your local switch when you it is powered on.

Understanding AT Commands

The Elite 2864I communicates asynchronously with computers using AT commands. AT commands are used to configure and control the 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 the Elite 2864I to recognize them. A command statement begins with the letters "AT" or "at". It is then followed by one or more commands and then by a<Enter>.

AT commands can only be issued when the Elite 2864I is in "command" or "off-line" mode.

Once the Elite 2864I has established a connection with the remote device, it goes into "on-line" mode, and the characters sent from your computer (through the Elite 2864I) 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 the Elite 2864I. Please refer to your communications software manual if this is not the case.

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

Type:

```
AT<Enter>
```

Elite 2864I responds

```
OK
```

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

The ZyXEL Elite 2864I supports several groups of AT commands:

Type of AT Command	Example
Basic AT (Hayes compatible)	ATB0
Basic AT$ (on line help)	AT$
Extended AT&	AT&N0
Extended AT* command	AT*I1
AT+	AT+FCLASS=2

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 commands: AT$, AT*$, AT&$, and ATS$.

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&O2and 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 duplicated characters for each one you type, your Elite 2864I and software both have their echo feature turned on (the Elite 2864I defaults to enable command echo). To eliminate the double characters, turn off software command echo.

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

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

Use “A/” to repeat the last command.

Chapter 3 - Configuring Your ISDN Line and Network

You are now ready to set-up your ISDN network. Based on our experience, most problems can be traced back to two factors: either the line was not ordered correctly. Or the line was ordered correctly, but was not programmed correctly.

It would be wise to have your Elite 2864I ready to use before your phone company comes to install your line. That way, you can enter the SPID to your line and confirm that the ISDN network is responding properly before the phone installation people leave.

There is a simple DOS, Windows or Windows 95 utility 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-volitile RAM of the Elite 2864I. Power on-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. We will explain how to set-up up your switch using a Windows/Windows 95 utility which comes with the Elite 2864I.

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

ZyXEL Configuration Manager software

Along with your Elite 2864I, you will find a disk labeled "Elite ISDN Configuration Manager" To install this software simply run the setup file from the Run line. The Setup Wizard will take you through the installation process.

After the software has been installed, double click on the ZyXEL Configuration Manager icon.

Step 1 - You will get the following screen:

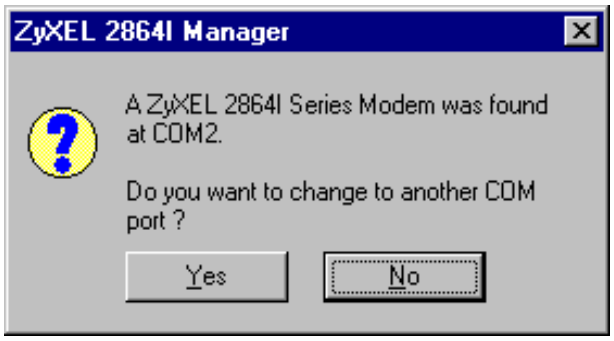


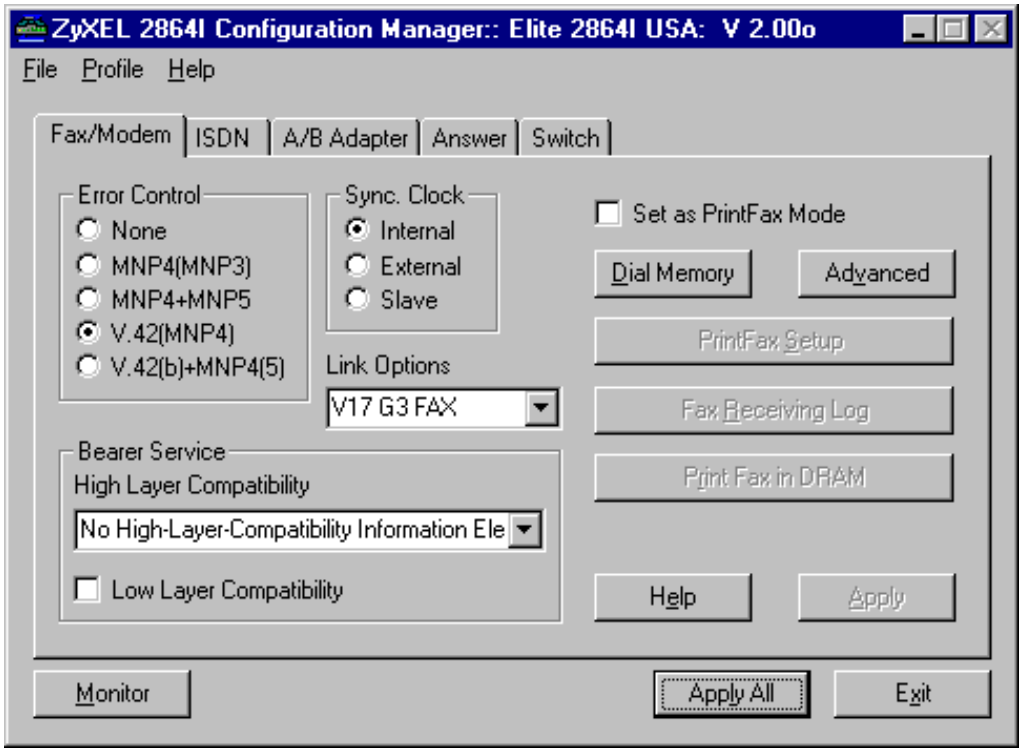
Figure 3-1

Select No, unless you would like to assign another COM port to your Elite 2864I.

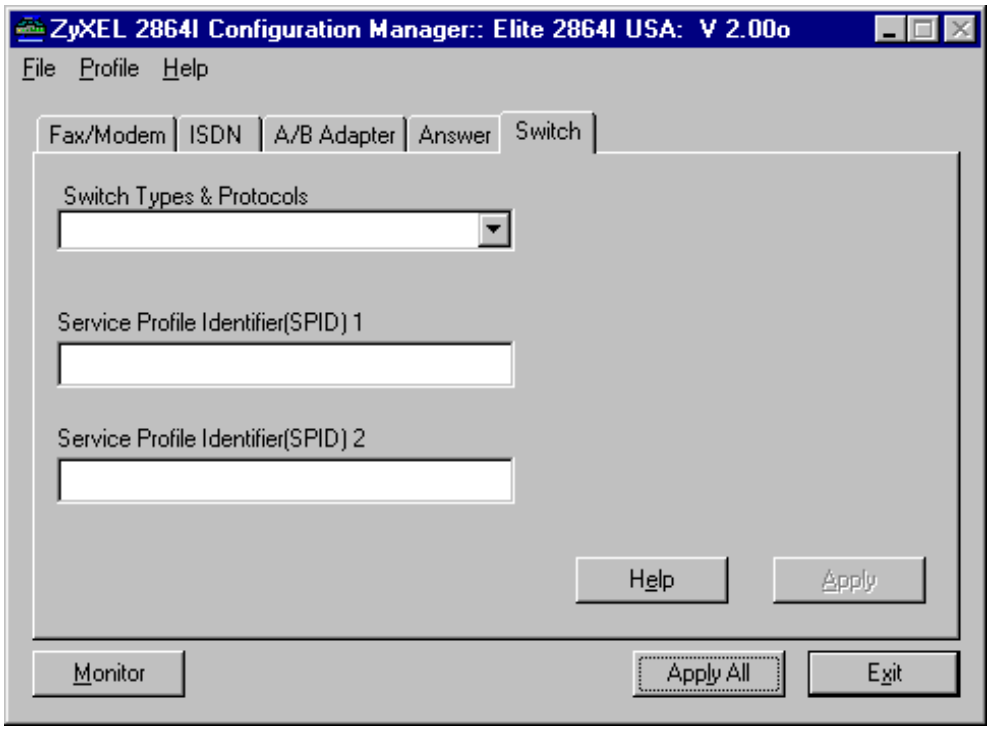
Step 2 - Select No again. We are only going to do a basic SPID setup in this chapter. For more information on setting up MSN please refer to Pages 7-2, 6-3, and 9-4.

Figure 3-2

Step 3 - Select the Switch folder.



Step 4 - Use the information provided by your ISDN service provider in conjunction with the table below to select the proper switch type



If you used the ZyXEL ISDN order forms to order your ISDN service, you should have recorded this information on the order form. Using this table select the appropriate switch:

Switch Type	Protocol	SPIDs	Selection from the Menu
AT&T 5ESS	Point-to-Point	0	AT&T 5ESS Point-to-Point
	Point-to-Multipoint	1	AT&T 5ESS Point-to-Multipoint with 1 SPID
	Point-to-Multipoint	2	AT&T 5ESS Point-to-Multipoint with 2 SPID
	National ISDN-1	1	National ISDN-1 with 1 SPID
	National ISDN-1	2	National ISDN-1 with 2 SPID
Northern Telecom DMS100	Custom	2	Northern Telecom DMS100 Custom with 2 SPID
	National ISDN-1	1	National ISDN-1 with 1 SPID
	National ISDN-1	2	National ISDN-1 with 2 SPID
Siemens EWSD	National ISDN-1	1	National ISDN-1 with 1 SPID
	National ISDN-1	2	National ISDN-1 with 2 SPID

Step 5 - Click Apply and make sure the Elite 2864I accepted all the information. Wait approximately 60 seconds for the 2864I to sync up with the network. If the **LNK** LED comes on, the setting are correct; if not, you will need to double-check your settings.

Configuring your Modem using a Terminal program

Getting a Terminal Program Ready

If you are not using the ISDN configuration utility that is packaged with the Elite 2864I, you will need a terminal program to help you program your Elite 2864I. The Elite 2864I 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, please refer to the instructions that come with the terminal program.

Make sure the program is set up to communicate with the port (serial 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. Then it will force the DTR LED light to ON. If DTR is not ON, you will need to check the program's setting again.

The communication speed should be set to anywhere between 1,200bps and 460,800bps. The Elite 2864I will automatically adjust its speed to match your communication speed. Serial and parallel port drivers are shipped with the Elite 2864I to improve the performance of Windows. To install the driver, please check installation instructions located on the driver diskette.

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

Type:
```
AT<Enter>
```

Elite 2864I should respond:
```
OK
```

Type:
```
ATI<Enter>
```

Elite 2864I should respond:
```
Elite 2864I
```

Type:
```
ATI1<Enter>
```

Elite 2864I should respond:
```
E2864 V 2.00a (Firmware version number)

Internal fax/modem:  V 1.06

B73 (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.

Configuring Your ISDN Line Switch Type and SPID

Switch Type Configuration

In North America there are three popular types of switches, they are:

- AT&T 5ESS
- Northern Telecom DMS100
- Siemens EWSD

These switches are either running software that confirms to the National ISDN-1 standard, or a custom version. Currently, the Elite 2864 supports a total of 6 different combinations, listed in Table 3-1.

You must have the switch type information available when you install your ISDN line. If you used the ZyXEL ISDN order forms to order your ISDN service, you should have recorded this information on the order form.

The ATPn command is used to program the D-channel protocol. This is to allow the Elite 2864I to work with the type of switch your ISDN line is connected to. “n” is a digit that indicates the type of switch. Please use the following table for the “n” value.

The Elite 2864I is shipped with a default value of ATP0, which is Northern Telecom’s DMS-100 switch with Custom protocol.

ISDN Network Switch	Switch Version (protocol)	AT Command	# of Spids
AT&T 5ESS	Point-to-Point	ATP4	0
	Point-to-Multipoint	ATP5	1
	Point-to-Multipoint	ATP6	2
	National ISDN-1	ATP1	1
	National ISDN-1	ATP2	2
NT DMS 100	Custom	ATP0	2
	National ISDN-1	ATP1	1
	National ISDN-1	ATP2	2
Siemens EWSD	National ISDN-1	ATP1	1
	National ISDN-1	ATP2	2
Other	National ISDN-1	ATP1	1
	National ISDN-1	ATP2	2

Table 3-1

Once you have identified the switch you have, enter the proper value.

Example: if your switch type is DMS 100 with Custom protocol:
Type:

```
ATP0<Enter>
```

Elite 2864I should respond:

```
OK

Switch Type: Northern Telecom DMS100
```

At this point you should save the settings in the power-up.

Type:

```
AT&WZ<Enter>
```

The Elite responds:

```
OK
```

SPID Setup

You are ready to enter the SPID (Service Profile Identifier) number. Unless your switch type is AT&T 5ESS with Point-to-Point protocol, SPID(s) will be needed. The ISDN switches use Service Profile Identifier (SPID) to represent the network services to which the Elite 2864I has subscribed. Each SPID corresponds to one Terminal End point Identifier (TEI). Different switches may provide different rules for the SPID number format. You should get the SPID number from your local phone company.

To program your SPID number into the your Elite 2864I:

Type:
`ATSPID0=`*n* (n is the SPID provided by your phone company)

Elite 2864I should respond:

```
OK

SPID Correct!
```

This response indicates the SPID number was accepted.

If a second SPID is required.

Type:

Type:
`ATSPID1=`*n* (n is the second SPID provided by your phone company)

Elite 2864I should respond:

```
OK

SPID Correct!
```

If the Elite 2864I does not respond as in the above, an error condition is present.

If the response is:

```
OK

SPID Error!
```

This indicates an incorrect SPID number was entered.

If the response is:

```
OK
```

This indicates a general failure. The SPID was not verified. This would occur if the ISDN line is not connected to your Elite 2864I, of if your NT-1 is not functioning properly.

Once the SPID(s) are entered and accepted, you will see the **LNK** LED light up. If you are not able to get the SPID(s) to accept correctly, verify the number(s) with your phone company again. You should recheck all your cable connections before calling your phone company. If it still does not work, you will need your phone company's support to make sure the SPID(s) is correct and the line you ordered has been correctly setup.

Note: We recommend that you always make sure the cable connections are correct and securely in place. This will make it easier for you to isolate the problem area when talking to our technical support staff or the phone company.

Correctly entered and accepted SPID numbers will be stored in nonvolatile memory. That way you won't need to enter the SPID again, even if the power is turned off. However, if you perform a hardware reset, you will need to re-enter the SPID number(s) and switch type again. Make sure you write down or store all the relevant information so it can be retrieved at a later date.

Testing your Connection

After the SPID number(s) are entered and accepted, use your terminal program to dial ZyXEL V.120 number (714-263-0398 or 714-263-0498) to see if you can get a "CONNECT" message. Follow these instructions to make your test call:

Type:

```
AT<Enter>
```

Elite 2864I responds:

```
OK
```

Type:

```
AT&F<Enter>
```

Elite 2864I responds:

```
OK
```

Type:

```
ATDI7142630398<Enter>
```

Elite 2864I responds:

```
CONNECT 115200/V.120 56000/LAPD
```

You may only get a “CONNECT” message and no other communication. This is OK. In Chapter 4 - “ISDN Communication Basics” you will learn how to setup your Elite 2864I to connect and then communicate over the line.

Making Your First ISDN Data Connection

Your Elite 2864I should already be connected to you ISDN line properly. If you have the Elite 2864I-U, the phone company’s line should be connected to the jack labeled “U”. If your Elite model is 2864I or 2864I-S/T, the line from your NT-1 device’s “Terminal” jack should be connected to the jack labeled “S/T”.

Also make sure that the **LNK** LED light is on. If the LED is unlit, check that your ISDN switch setup and SPID number(s) are correct. (Refer to the previous section.)

Start your terminal program.

Type:

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

Elite 2864I responds:

```
Switch Type : Northern Telecom DMS

DTE Mode : ISDN    Outgoing Service : V.120 56K

Calling Party Number :()

E1  L1  M1  N5  Q0  V1  X5

B0 &C1 &D2 &G0 &H3 &J0 &K0 &L0 &M0 &N61 &R1 &S0 &X0 &Y1

*B0 *C0 *D0 *E0 *F0 *G0 *I0 *L0 *M0 *P9 *Q2 *S0


S0=0 S1=16 S2=43 S3=13 S4=10 S5=8 S6=3 S7=4 S8=2

S9=6 S10=7 S11=70 S12=0 S13=0 S14=2 S15=98 S16=0 S17=18

S18=1 S19=61 S20=14 S21=178 S22=0 S23=105 S24=21 S25=0 S26=0

S27=152 S28=68 S29=0 S30=0 S31=17 S32=19 S33=0 S34=30 S35=34

S36=0 S37=0 S38=0 S39=0 S40=0 S41=0 S42=0 S43=8 S44=0

S45=100 S46=28 S47=64 S48=0 S49=6 S50=0 S51=0 S52=0 S53=0

S54=0 S55=0 S56=0 S57=0 S58=0 S59=0 S60=0 S61=0 S62=0

S63=0 S64=0 S65=0 S66=0 S67=0 S68=0 S69=0 S70=0 S71=0

S72=0 S73=0 S74=0 S75=0 S76=0 S77=0 S78=0 S79=0 S80=0

S81=0 S82=0 S83=0 S84=0 S85=0 S86=0 S87=0 S88=0 S89=0

S90=0 S91=0 S92=0 S93=0 S94=0 S95=0 S96=0 S97=0 S98=0

S99=0 S100=2 S101=0 S102=0 S103=61 S104=72 S105=0 S106=9 S107=6

S108=7 S109=0 S110=7 S111=0 S112=51 S113=7 S114=0 S115=10 S116=0

S117=0 S118=0 S119=0 S120=0 S121=252 S122=0 S123=0 S124=0 S125=0

S126=0 S127=0
```

Check to make sure that your DTE Mode is set to ISDN. Also check to make sure that you are using V.120 with a 56K channel. The **ATB20** command switches to V.120 mode, and **AT&E1** tells the Elite 2864I to utilize the 56K bandwidth.

Now you are ready for your first call. As a test, you may dial into our ISDN BBS line at **714-263-0398.**

Type:

```
ATDI17142630398<Enter>
```

You should now see the B1 LED go on.

Elite 2864I responds:

```
CONNECT 460800/V120 56000/LAPD

FrontDoor 2.20c.mL/OX000046; MultiLine

Press <<Esc>> twice for ZyXEL BBS
```

From this screen, you can either continue the session or hang up.

We are now ready to try a bundled (2 B Channels) connection.

To make a bundled connection, follow the above instructions, with one change:

You must let the Elite 2864I know that you want to make a bundled connection. Typing *AT&J3* will tell the Elite 2864I to set up a bundled call.

When dialing into an AT&T 5ESS or a Seimens EWSD switch, dial a normal ATD<<number>>. If you are dialing into a DMS switch, then tell the remote Elite 2864I that it needs to make 2 separate connections.

To dial our BBS, type:

```
AT&J3<Enter>

ATDI17142630398+17142630498<Enter>
```

Elite 2864I responds:

```
CONNECT 460800/V120 112000/LAPD

FrontDoor 2.20c.mL/OX000046; MultiLine

Press <Esc> twice for ZyXEL BBS
```

From this screen, you can either continue or hang up.

Chapter 4 - 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 2864I has 3 modes in which to send communication over ISDN network.

- Analog data *(modem/fax/voice)*
- ISDN data
- POTS port communication

These modes are auto-switching based on the commands you issue. Let's take a look at how the communication mode is automatically switched. At your terminal program, proceed with the following instructions:

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 using Analog mode

An "M" command following the "ATD" will tell your Elite 2864I to automatically switch into the modem/fax mode.

Type:

`ATDM17146930762<enter>` *(Make a modem call)*

Dialing out using POTS Port mode

Using the "B" command following the "ATD" will tell your Elite 2864I to automatically switch calls to the POTS port once the dialing is completed.

Type:

`ATDB17146930762<enter>` *(Dial a number for a POTS port call)*

Note: You must have an analog modem connected to your POTS port before you issue this command.

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 many 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&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&O0**. This means the modem will use fax/modem mode when you do not specify which communication mode to use in your dial command (ie. ATD or ATDT).

When you enter an AT&O*n* command, the Elite 2864I will respond as follows:

```
Switch Type: Northern Telecom DMS

DTE Mode: F/M/V Service: Fax/Modem/Voice Calling Party
Number :()
```

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
AT&N*n* or AT+FCLASS=*n*	Changes Fax/Modem settings
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 one of the following types of communication protocols:

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

In analog communication, the user information could be carried by:

- Modem
- Fax

- Voice

The section entitled “Answering a Call” on page 4-4 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 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 2864I will try to negotiate a connection using the proper ISDN protocol. When an analog call comes in, the 2864I will send the call to the POTS port as the factory default.

Digital Data

The Elite 2864I currently supports Circuit Switched Data (CSD) for ISDN data applications. The CSD protocols supported by the Elite 2864I include: V.120, X.75, and V.110. V.120 is the most popular protocol used in North America. Recently, some ISDN Internet service providers have started using synchronous Point-to-Point Protocol (PPP) to provide access for remote ISDN users. This protocol is also supported by the Elite 2864I. 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. The Elite 2864I is able to auto-switch for PPP, V.120, X.75, V.110, and modem/fax data types. In most cases, you can rely on the auto-switching feature for your applications. If you need more specific settings for answering calls, please refer to the section entitled “Answering a call using MSN” found later in this chapter.

Determining the Packet Length

The user’s information is sent on a frame-by-frame basis for V.120. 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, which is small enough that it should not create any problems. 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, each of these protocols can be assigned to an ISDN number using the following command:

AT&ZIn=s (where 's' is the MSN)	
&ZI0=s	assigns MSN 's' for ISDN data
&ZI1=s	assigns MSN 's' for ISDN data
&ZI2=s	assigns MSN 's' for ISDN data
&ZI3=s	assigns MSN 's' for ISDN data
&ZI4=s	assigns MSN 's' for ISDN data
&ZI6=s	assigns MSN 's' to the internal fax/modem
&ZI7=s	assigns MSN 's' to the analog adapter

Table 4-1

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.

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.

For a voice (or voice-band-data) call, if the called_party_number matches with the MSN of the internal fax/modem or the analog adapter, the call will be delivered to the proper destination. However, there are times when an ambiguity of address matching exists. If the MSN settings are not able to help determine how to route an incoming analog calls, the modem checks to see if the "Force to POTS" setting is enabled (&L0). If &L0 is set, all analog calls will be routed to the POTS port. For more information on this subject, please refer to **Figure 16-2**.

Type:

`AT&L0<Enter>` *(Enable Force to POTS)*

Type

`AT&L1<Enter>` *(Disable Force to POTS)*

The Analog adapter (POTS port) has a higher priority to answer a voice or voice-band-data call. If the analog adapter is busy, the call will be forwarded to the internal fax/modem.

If the address-matching process is again unable to tell which protocol to use, the Elite 2864I will go into its "Data Answering Routine", by examining the B-channel data pattern and hence determine the protocol to use.

Data calls, digital or analog, are accepted in the same way as with a typical modem. When alerted, the Elite 2864I will send a RING message to the DTE in the following format:

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

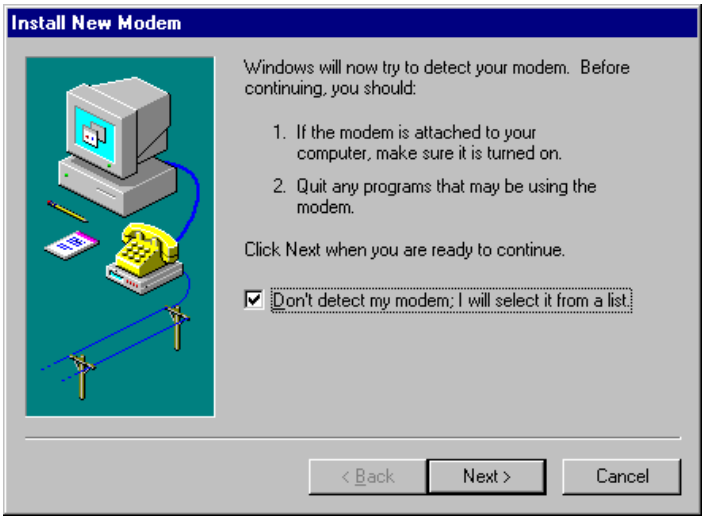
Chapter 5 - Setup for Windows 95 and NT

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

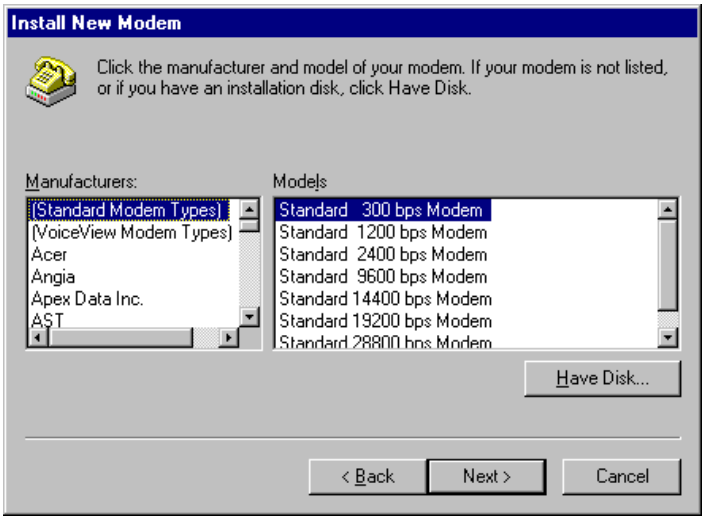
Installing the Windows 95 Driver (INF file)

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

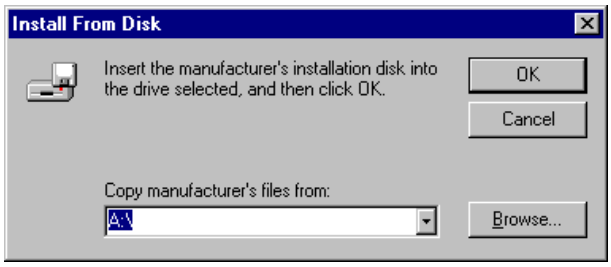
Double click “Modems”, then click the “Add” button. The following dialog box will appear.



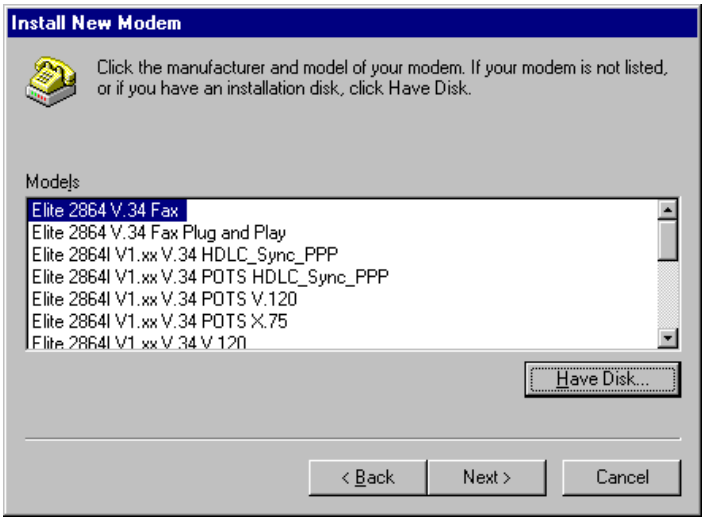
Select “Don't detect my modem; I will select from a list.”. Then click “Next”.



Click the “Have Disk” button.



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".



Select the protocol that your host is using. Generally, the defaults listed below will work. However, we recommend that you check with your ISP to verify the protocol they use.

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

Elite 2864I V2.xx v.34 HDLC_Sync_PPP"

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

Elite 2864I V2.xx v.34 V.120

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

Elite 2864I V2.xx v.34 V.120

If you dial up to CompuServe, select:

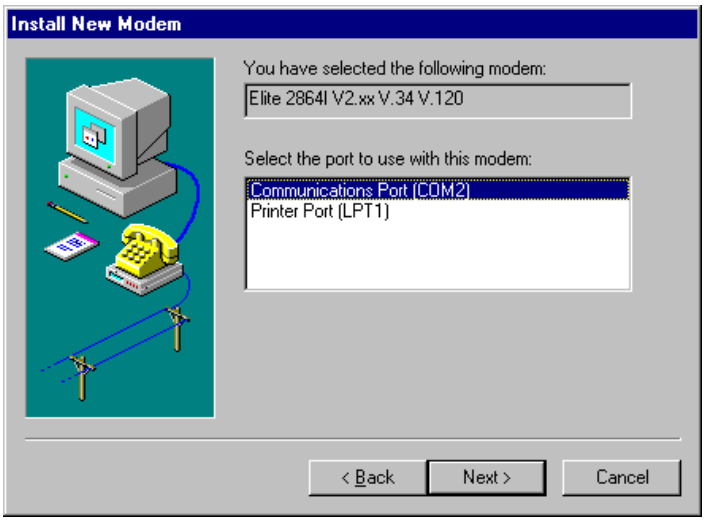
Elite 2864I V2.xx v.34 V.120

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

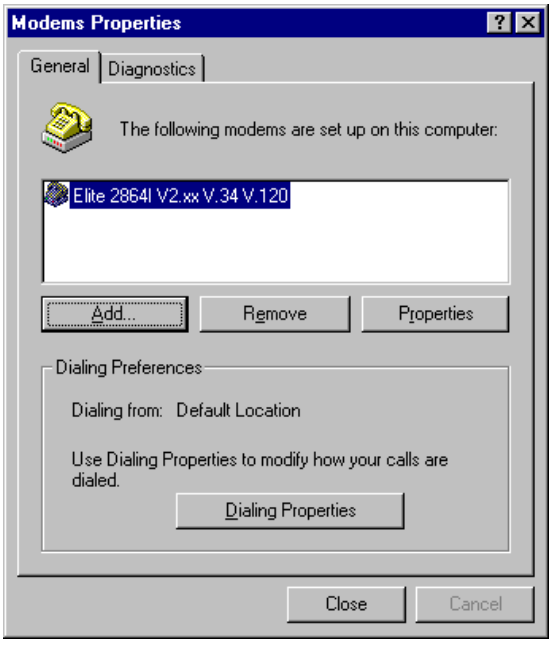
Elite 2864I V2.xx v.34 HDLC_Sync_PPP

Note: Some selections have the POTS option. These are configured so incoming calls will be routed to your modem's POTS port. If you would like this to happen, choose the proper ISDN protocol with the POTS option. Remember to use the "V2.xx" selection, not the "V1.xx" selections.

After you have completed the selections above, click "Next".



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

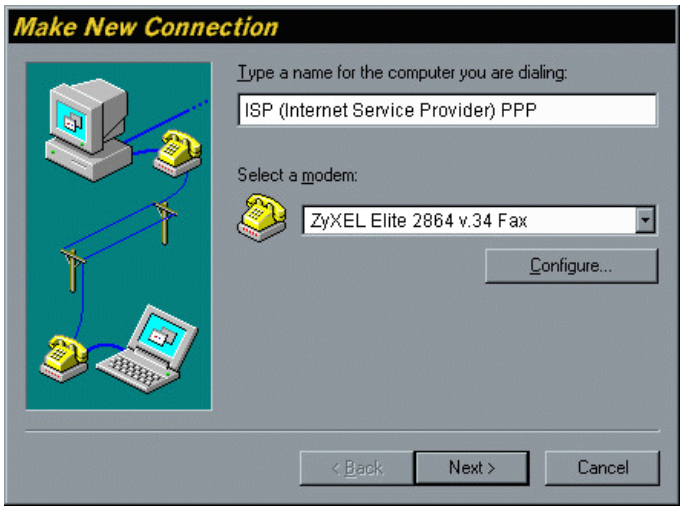


Click “Close”. This completes the installation of your Elite 2864I modem driver. You may now use programs such as “Dial-Up Networking” with your ZyXEL modem.

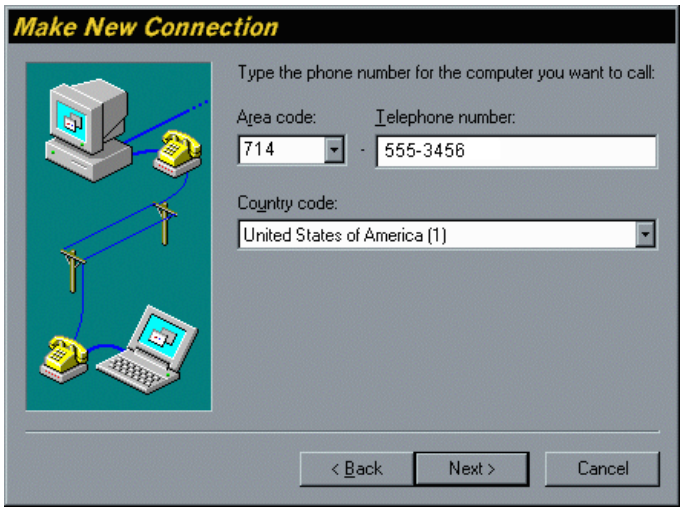
Configuring Windows 95 Dial-Up Networking

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.

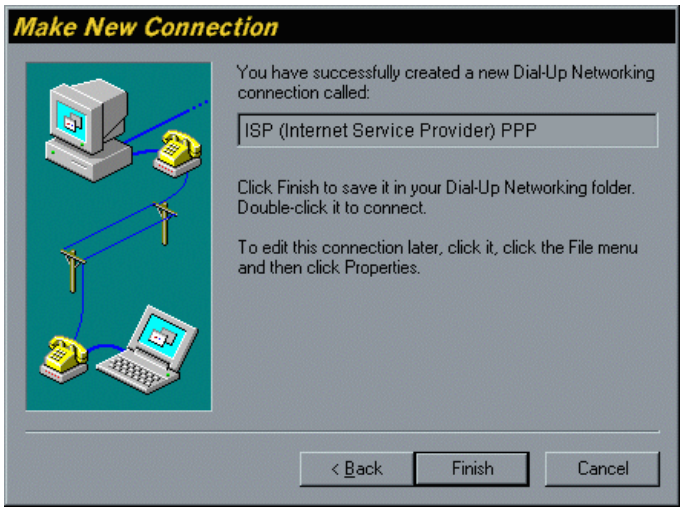
Double click on the “My Computer” icon and then double click on the “Dial-up Networking” icon. From within the Dial-up Networking folder, double click on the “Make New Connection” icon.



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

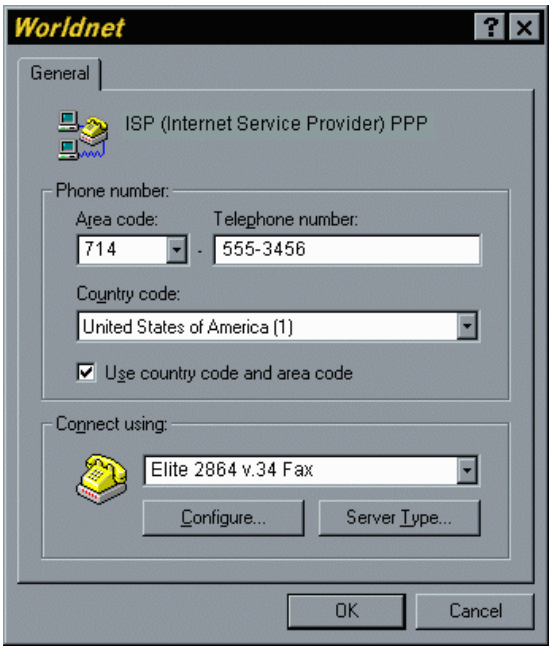


Enter the phone number to your ISP or whatever host you are calling into. Click on the “Next” button.

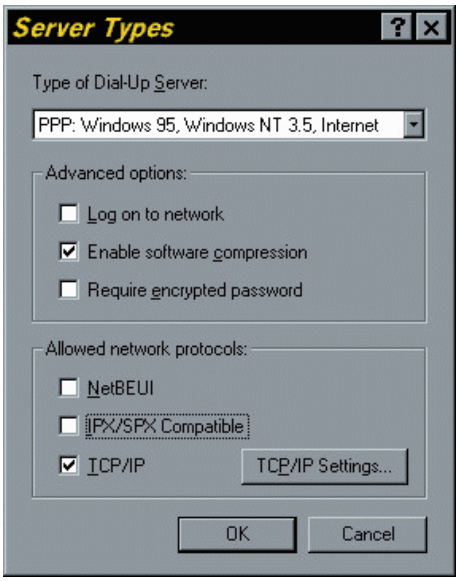


Click on the Finish button. A new icon is created in the Dial-up Networking folder.

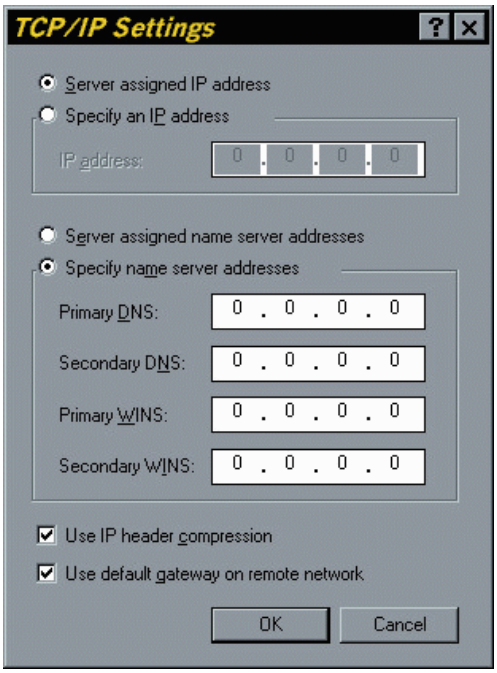
Right click on this icon, then select “Properties” from the menu.



Make sure your Elite 2864I modem appears in the “Connect Using”, then click on the “Server Type” button.



These options are mostly host or server specific. If you are using PPP, use the settings shown above. If you are connecting to a LAN, then select “Login to Network”. If your host requires an encrypted password, then you must select that setting. 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”. Once complete click on “TCP/IP Settings”.



If your host requires you to specify an IP address (Static IP), then click on the "Specify and 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 remote gateway" checked. When all of the selections have been made, click “OK”.

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

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

Windows NT RAS Setup

1. From the NT Program Manager open the “Main” program group and double click on “Control Panel”, then double click on Network. This will bring up Network Settings. If you have not already done so, create a Computer name and Workgroup name for your system.
2. In the “Network Software and Adapters Cards” group window, there is a list box. Scroll through this list and see if you have “Remote Access Service” listed as one of the installed components. If you do not, then click on the “Add Software” button and install the remote access service.
3. Find the .INF file (either from the driver disk or that you downloaded from ZyXEL) and copy it to replace the MODEM.INF in your \WINNT35\SYSTEM32\RAS directory. Then reboot your computer to load the new drivers into memory.
4. Once done, open “Control Panel” and “Network” then select the Remote Access Service option in the list box and click on the “Configure” button.
5. You will be presented with a new window. This is where you setup your modem. If your modem is not setup, click on “Add” to set it up.
6. Use the drop down list box to select the COM port your modem is connected to, then click “OK.” In the new dialog box, click on CANCEL to select the modem for yourself.
7. Here you can select whether you want dial out only capabilities, receive or both. Unless you intend to connect to your computer from another loacation, select "Dial out only". Click on OK and you will be returned to the previous window.
8. Find your modem in the list box and select it, then click on the “Network” button.
9. This is where you define the Dial out Protocol you will be using. Generally speaking, only “TCP/IP” should be selected. “IPX” should be selected only if you are connecting to a Novell Network. “NetBEUI” should be selected for a Windows Network. Once the selections are made, click OK. You should now reboot your computer.
10. Once your computer has rebooted, double click on the Remote Access Service group icon. Now double click on the Remote Access icon in this group.
11. If you already have a connection, just leave it as is. Otherwise it will tell you the phone book is empty and to “Press OK to add a new entry”. Just click OK, or the Add button if you have an existing entry and you will get the next window. From here, click on the “Advanced” button.
12. Type in a name for your connection in the “Entry Name” field, the phone number you wish to connect to in the “Phone Number” field, and a description of the connection (optional).
13. Now click on the down arrow button in the “Port” field and select the COM port your modem is attached to. Then click on the “Modem” button.
14. Inthis dialog box, click on the down arrow of the “Initial speed (BPS)” field and

select the maximum speed of your modem (DTE Speed). From “Hardware features”, select all three options. When all these selections are made, click on OK. You will then be returned to the previous window.

15. Click on the Network button. Select the PPP radio button, then select “TCP/IP”, and “Request LCP extensions (RFC 1570)”. Now click on the “TCP/IP Settings” button.
16. Click the IP address option that is required by your ISP (usually server assigned IP address). Now select the “Use specific name server addresses” and enter the DNS and DNS backup IP addresses given to you by your ISP. Also select the “Use VJ header compression” and “Use default gateway on remote network” selections if your ISP supports these features.
17. Click the OK buttons until you return to the “Edit Phone Book Entry” window, then click on the “Security” button. The rest of this is dependant on your ISP. If you are making an NT to NT server just check “Accept Authentication”, and click OK.
18. Finally Click OK again, then click “Dial.” Your 2864I will dial the number and establish a connection.

Chapter 6 - Async to Sync PPP and SLIP

Internet and Remote Access PPP and SLIP

More and more Internet Service Providers 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 V.120 or asynchronous protocol 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 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 V.120 (see next chapter), as it provides data compression.

Note: At this time, the Elite 2864I only supports a single channel for HDLC PPP communication. We are currently working on a firmware update that supports Multilink PPP (RFC 1717) to allow channel bundling with PPP connections. You will be able to download the firmware update from our Web or FTP sites after the second quarter of 1996.

The following diagram shows the setup for connecting to an Internet Service Provider or Remote Access Server that uses an ISDN LAN router.

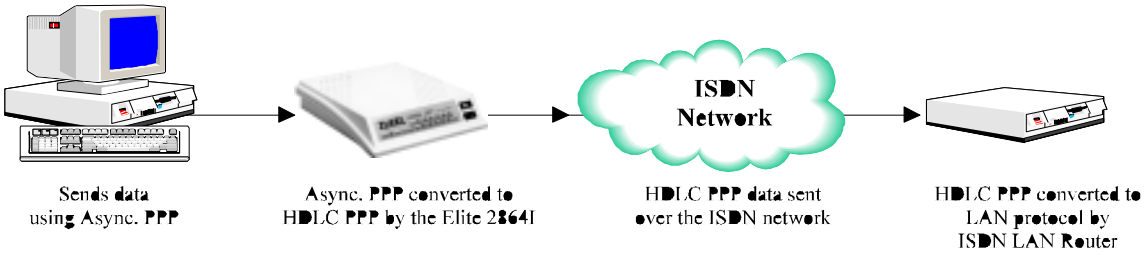


Figure 6-1

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: Northern Telecom DMS

   ISDN Outgoing Service: PPP Async-toSync Conv 64K
```

If the settings displayed match 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 Connection During Idle Time

If you are using the 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 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 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.

To allow the Elite 2864I to answer the incoming call, you need to set S0 to a value greater than 0 (ie. 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.

MSN Setup

Suppose you have more than one number (Multiple Subscriber Number) assigned to your ISDN line, and you only want calls made to a particular number to be answered by async to sync PPP. The Elite 2864I has a Multiple Subscriber Number table built-in that lets you specifically route calls for any given number to certain mode or to be answered in a specific way.

Look up Called_Party_Number and matching protocol on the AT&ZI*n* table. Use the specific protocol to answer a specific call (recognized by the number that caller dialed).

Command to issue

AT&ZI*n=s*

*'**n**'* can be a number from 0 to 4. The Elite 2864I will auto-switch to the correct ISDN protocol by examining the incoming data.

*'**s**'* is the Multiple Subscriber Number (this is the number assigned to your ISDN line by your local phone company)

Example: Suppose you have two numbers assigned to your ISDN line:

714-693-1111
714-693-2222

- You would like to have 714-693-2222 answered by your fax function.
- Then you want it directly routed to your HP laser printer for printing.
- You also want 714-693-1111 to be answered by the ISDN mode, HDLC PPP.

Type:

```
AT&ZI6=6932222<Enter>
```

(Assign SN, 6932222, to modem/fax mode)

```
ATS0=1+FCLASS=Z+FZF=1<Enter>
```

```
AT&ZI3=6931111<Enter>
```

(Assign SN, 6931111, to ISDN - HDLC PPP mode)

The value will be automatically saved without further instructions. The modem/fax protocol will be used to answer analog calls made to 693-2222 and HDLC PPP will be used to answer ISDN data calls made to 693-111

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 in the newer 2864I models. It may be added to older models by a Flash EPROM firmware update that will be available on ZyXEL's Web and FTP sites.

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 2864I dials the same number for both Multilink PPP connections. If the destination you are dialing requires a second telephone number to establish a second Multilink PPP channel, 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 be establish, 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.

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.

Dynamic Bandwidth Allocation

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

ATCE0	Disable the DBA function
ATCE1	Enable the DBA function (default)

Chapter 7 - V.120 ISDN Communications

This chapter describes how to set-up and configure your Elite 2864I with the 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. 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 support out-of-band signaling, 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.

To make a 56K V.120 call:

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

Elite 2864I responds:
`OK`

Type:
`AT&E1<Enter>` *(Select 56K data mode)*

Elite 2864I responds:
`OK`

Now you are ready to dial the phone number. If you need to save the setting into non-volitile RAM, issue the commands:

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 to:

```
AT&B20&E1&WZ0<Enter>
```

This way, you can combine all the commands into one line.

Use the ATDnnn command to make the call. Once the connection is made, you should see the following connect message:

```
CONNECT 115200/V120 56000/LAPD
```

This indicates that the connection is made with:

- DTE speed of 115,200bps
- Protocol V.120
- Data Speed 56,000bps
- Error Control LAPD

To enable V.42bis Data Compression, you can set the ISDN data mode to AT&K44. The default value for V.120 and LAPD error correction only, no data compression will be negotiated. With the &K44 setting, the 2864I will try V.42bis data compression. If the remote side doesn't support V.42, then LAPD error correction will be used.

You can try to enable AT&K44 and call our BBS at 714-263-0398. You should be able to see the V.42bis connection:

```
CONNECT 115200/V120 56000/LAPD/V42b.
```

Answering incoming calls

In most cases, there is no need to configure the 2864I to properly answer calls. The 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 2864I will automatically answer an incoming call. If S0=0, the DCE will simply report "RING" to your terminal and sound a ring notification.

Setting up MSN

Another reliable way to receive and route incoming calls is to use MSN. Here is how to set it up to answer an V.120 call.

If you have more than one number (Multiple Subscriber Number) assigned to your ISDN line, and you only want calls made to a particular number to be answered by V.120.

Suppose you have two numbers assigned to your ISDN line:

714-693-1111
714-693-2222.

- You'd like 714-693-2222 to be answered by modem/fax mode and route the faxes directly to your HP laser printer
- You'd like 714-693-1111 to be answered by ISDN-data or V.120 mode.

To set up such a command, issue the following:

`AT&ZI6=6932222` *(Assign SN, 693-2222, modem/fax mode)*

`AT&ZI2=6931111` *(Assign SN, 693-1111,ISDN-data mode)*

The value will be automatically saved without further instruction. Any call thereafter dialed into 693-2222 will always be routed to modem/fax mode, and any call dialed into 693-1111 will always be routed to ISDN mode.

You'll need to make sure that the modem/fax mode has been set up to receive fax only. You should also be certain that the fax you receive will be redirected to the HP laser printer connected to the parallel port of the 2864I. For details, please refer to the Chapter titled "Using Direct Fax Capabilities".

The following command should perform this function:

`ATS0=1+FCLASS=Z+FZF=0<Enter>`

You don't need 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.

For example, the following commands will yield the same results:

`AT&ZI6=2<Enter>`

`AT&ZI2=1<Enter>`

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 Singling is used). It is called a "Bundle Connection" (different from BONDING).

This type of channel bundling is supported between two ZyXEL 2864I's connections only, and uses Multiple Link Protocol (MLP). To make bundled connections to other ISDN TA's as well as ZyXEL TA's, refer to the section entitled "Multilink PPP" in the preceding chapter.

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 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 115200/V120M 128K/LAPD`

or

`CONNECT 115200/V120M 128K/LAPD/V42b` *(with data compression)*

V.42bis Data Compression

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.

Since the V.42bis algorithm needs an error-free transmission channel between the compression and decompression processes, it can only work with a protocol with error control competence. X.75 and V.120 are such protocols that can be used together with V.42bis data compression. The V.110, on the other hand, is just an R-interface layer 1 adaptation protocol without error-control and is, thus, inadequate for V.42bis.

To enable V.42.bis Data Compression over ISDN using V.120 or X.75 protocols, please refer to *"Invoking V.42bis Data Compression"* in the next chapter.

Chapter 8 - V.110 & X.75 ISDN Communication

This chapter will describe how to set-up and configure your Elite 2864I with X.75 and V.110 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 and V.110 Setup

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 (as defined in T.90) in ISDN. These services include both ISDN circuit-switched mode (DTE-DTE communication) and ISDN packet-switched mode (DTE-DCE communication). Table 3-1 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	ISO8208T.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	ATB0: Transparent ATB01: T.70 NL

Table 8-1

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 ATB20 (V.120). 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 2864I will make the wrong protocol selection.

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 also 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>
```

Note: The "<" and ">" are required characters for the DES_Key parameter

*Example: **ATCK<678901234567890>**<Enter>*

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 2864I just before it is needed.

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 = 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.

Making V.110 Calls

There are two modes of V.110 synchronous operation :

1. A**synchronous commands, synchronous data (AT&M1):** The 2864I accepts AT commands in asynchronous mode. Once the call is connected, it enters synchronous mode for data transmission.

2. **Synchronous mode (AT&M3):** The Elite 2864I accepts synchronous commands **(V.25 bis)** and exchanges data synchronously with a remote TA.

Asynchronous V.110 Calls

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

Table 8-2

Note: The highest async V.110 user rate is 38400bps. If the DTE speed is higher than this, the user rate will be 38400bps. The X bits in the 80-bit frame will be used for remote flow control.

Synchronous V.110 Calls

Use the following commands to configure V.110 for synchronous operation :

Command	**Function**
ATB10	64K or 56Kbps transparent mode
ATB13	User rate = 2400bps
ATB14	User rate = 4800bps
ATB15	User rate = 9600bps
ATB16	User rate = 14400bps
ATB17	User rate = 19200bps
ATB18	User rate = 48000bps
ATB19	User rate = 56000bps
ATB11	User rate = 64000bps

Table 8-3

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.

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

*Note: To avoid confusing with the **AT&K**n command used for modem error control and data compression, **&**K must be followed by two digits **(0**0 or **4**4).*

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 an XID frame with V.42bis request , if it is able to execute V.42bis; or ignore the XID or reply an XID frame with V.42bis reject or empty information field, if it is unable to execute V.42bis.

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, you had better to issue the AT&K00 command beforehand in order to get a quick connection.

Although not defined in X.75, XID frame is based on the encoding in ISO Standard 8885 and being used in V.42/V.42bis. In addition to the compression parameters, XID can be used to negotiate the packet parameters as window size, packet size, and so on. Thus we appeal to other vendors to use this scheme to make X.75 more compatible. Any suggestion on this issue is highly appreciated.

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.

Chapter 9 - Handling Analog Calls

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

Fax/Modem Setup

The use of the 2864I's modem/fax functions do not vary much from other modem/fax products. This is especially true if you are already familiar with the Elite 2864 or the U-Series products. We will go through the major differences between the 2864I and a regular modem/fax device so you can begin to apply your current knowledge of modem/fax products.

Summary of Differences between 2864 and 2864I

Function	Elite 2864I	Elite 2864
Data Voice Button	Can be used to force answer a call. It has limited function in an ISDN environment.	Can be used to force answer a call. When used with phone set connected to the modem's phone jack, the call can be manually switched between the modem and phone set.
Phone Jack	Not available	Available, and is connected to the same line as the modem.
Analog Adapter	Available	Not Available
Telphony and Voice	Available	Available
Leased Line Function	Not available	2 wire leased line functions standard, optional 4-wire leased line available
Password & Call Back Security	Available now	Available now
Simultaneous Data and Voice calls	Use the analog adapter for voice, while using one B channel for data communication.	Not available
Loopback testing	Analog loopback not available	Analog loopback available
Caller ID	From signaling information	FSK signal between first and second ring
Distinctive Ring and EDR	Not currently available	Use Ring pattern for Distinctive Ring, EDR supported

Table 9-1

In most cases, you should be able to use the same program set-up you used for the U-1496 modem to set up the Elite 2864I. We are also making drivers available for different application programs. Please check with ZyXEL's technical support staff, if you encounter any problems when running certain programs. Table 9-2 shows some of the most frequently used AT commands for your reference:

AT Command	Description
ATDM	Automatically dials out using modem/fax mode
ATDPM	Automatically dials out using modem/fax - pulse mode
ATDTM	Automatically dials out using the modem/fax - tone mode
ATZ	Initialize the modem
AT&D2	DTR Off causes the modem to hang up.
AT&D3	Same as &D2 but DTR Off causes the modem to hang up and reset to profile 0
AT&F	Loads factory setting into RAM as active configuration
AT&H3	Data flow control, DTE/DCE (S27.3-5). Hardware (CTS/RTS) flow control
AT&K4	To set V.42bis for modem mode
AT&K44	To set V.42bis for V.120, or X.75 modes
AT&N0	Data link mode option,, DCE to DCE. 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)
ATS0=0	S0=0 disables auto-answer; the range of rings is country specific

Table 9-2

Making a Call and Connecting Messages

A modem or fax call is usually initiated from your communication software. It can be a data communication program or a fax program. Before a call is made, the application software will first set up the modem/fax. This ensures that it will function properly with your software application and with the remote modem/fax. An initialization string is usually sent to the modem/fax device before the remote number is dialed.

Most software allows you to enter an additional initialization string in case the standardized initialization string doesn't work properly. Drivers should be located in your 2864I box (on the "Drivers" diskette). You can also get the latest drivers on ZyXEL's BBS, CompuServe Forum, Web site, and FTP site.

If you can not find a proper driver to install and work with the Elite 2864I, we suggest you select the U-1496 Series or the Elite 2864 Series. If you are not using the specific driver designated for the 2864I, you may be forced to alter the set-up string in order for it to work properly with your data communication/ fax programs.

You should select the highest communication speed your software supports (115.2Kbps or higher is needed to take advantage of some of the features of the Elite 2864I).

Change the dialing prefix from ATDT to ATDM if you frequently switch between ISDN data communication and modem/fax communication.

If your software does not allow you to do this, simply add AT&O0 to the beginning of the initialization string, so the modem/fax mode will be selected before any modem/fax configuration parameters are sent to the Elite 2864I.

Placing a Call from the Analog Adapter

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)*

2864I returns:

`CONNECT` *(Dialing is complete)*

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

Limitation

If you are using the Elite 2864I to do modem or fax communication, you should set your phone to Pulse dialing. This is because the Elite 2864I has dedicated all the DSP resources for modem communication. Therefore, it might have difficulty detecting the DTMF tone if Tone dialing is used. Once the phone number is dialed, you can switch back to Tone dialing, if you need to use DTMF tones.

Answering a Fax/Modem Call

Before an analog call can be answered, you will be required to make a decision as to how the Elite 2864I will route the call using the **AT&L*n*** command. This is called the "Force to POTS" setting.

The **AT&L1** command will set the Elite 2864I to handle all incoming calls, whether digital or analog. If you have S0 set (i.e. S0=1), the Elite 2864I will answer the call automatically, and try to handshake with the remote device. If S0 is not set (S0=0), it will report "RING" to the serial port that the Elite 2864I is connected to, and will make an audible notification.

If you want to have the POTS port (analog adapter) answer all of your analog calls, type:

`AT&L0<Enter>` *(This is the default setting)*

Or, if you want to have the Elite 2864I process all of your incoming calls, type:

`AT&L1<Enter>`

To save your selection to power-on profile 0, and reset, type:

`AT&W0<Enter>` (saves the selection)

`ATZ0<Enter>` (reset to power-on profile 0)

When the Elite 2864I is shipped, the default setting routes analog calls to the analog adapter. When a voice call comes in and if you have a phone connected to the analog adapter, it will ring. The internal modem/fax will not notice if a voice-band call has come in.

Answering with Multiple Phone Numbers

When you have two or more phone numbers (Multiple Subscriber Number or MSN) assigned to your ISDN line, you can program the Elite 2864I to direct incoming calls to the specific port you desire. The Elite 2864I has a built-in table that lets you program the digital modem to direct calls to the specific module (based on the number dialed) where you want the call to be routed.

Setting up MSN

Look up the Called-Party-Number and matching protocol on Table 6-1. Use the specific protocol to answer a specific call (recognized by the number that caller dialed).

Type:

`AT&ZIn=s<Enter>`

s = Multiple Subscriber Number (the number[s] assigned to your ISDN line by your local phone company.

n = 6 assign the MSN to the analog adapter.

n = 7 assign the MSN to internal modem/fax

Example:
Suppose the following two numbers are assigned to your ISDN line:

714-693-1111

714-693-2222

If you would like to have 714-693-2222 answered by the modem/fax mode, and 714-693-1111 to be answered the analog adapter when an analog call comes in. Issue the following commands:

`AT&ZI6=6932222<Enter>` (Assign 693-2222, to modem/fax mode)

`AT&ZI7=6931111<Enter>` (Assign 693-1111, to the analog adapter)

The value will be automatically saved without further instructions.
Any analog call made to you thereafter, dialed at 6932222, will always be routed to the mode/fax mode and analog calls dialed at 6931111 will always be forward to the analog adapter.

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. For example, the following commands will yield the same results:

```
AT&ZI6=2<Enter>
AT&ZI7=1<Enter>
```

For a complete list of the AT&ZIn Commands supported by the Elite 2864I, please refer to Chapter 13, "**AT Command Set Reference**."

Chapter 10 - Fax Operation

The Elite 2864I includes break through fax functions such as a direct fax receiving and printing feature that uses the modem's parallel port. Standalone fax receiving and storing is also available using the optional DRAM add-on. These operations are described in Chapter 11 - "Using Direct Fax Capabilities."

Fax Basics

Fax is the abbreviation for facsimile. There are four major parts in a normal facsimile machine: the scanner, encoding and decoding device, modem, and printer. Before a page can be sent, it is first scanned. The bit-mapped data is encoded with data compression and is then transmitted across the phone line by an internal modem module. The remote facsimile receives the data with its internal modem, decodes it back to bit-mapped image data, and prints it on paper.

Modem as a Fax

Modems can also be designed to include a fax transmitting and receiving function similar to a fax card. Since the modem's interface with the computer is the standard serial RS-232 interface, this interface is used for both modem and fax operations. Fax image coding and decoding must be done in the computer. Modem/Fax, also called fax/modem, can be either an external stand-alone unit or a plug-in card. External stand-alone units can be connected to any computer with a standard RS-232 serial port.

The Elite 2864I supports Group 3 send and receive facsimile functions. For normal fax operation, you must connect the modem to a computer, usually a PC. The computer serves as the input/output device for the fax function. The RS-232 serial connection or the ZyXEL parallel port interface connects the Elite 2864I and the computer. The Elite 2864I uses the same interface for both data and fax applications. In fax operations, the modem performs protocol handshaking and image data transfer. The computer handles image data creation, capturing, conversion, compression, decompression, retrieving, and storing.

In the sections below, we will describe the ITU-T T.30 fax protocol, the Class 1, 2, and 2.0 fax commands and ZyXEL extended fax AT commands. Also covered are the status report result codes, the flow control protocol associated with ZyXEL fax AT commands, and some specific fax applications. The instructions for using the included modem/fax/voice utility program are included on the software disk. Some distributors and dealers also include other software with the Elite 2864I. For help with such software, refer to the documentation that came with it.

ITU-T T.30 Fax Protocol

The ITU-T T.30 fax protocol describes the G3 fax handshake signals and procedures. The modem takes full control of this protocol, initiates, and terminates fax calls, manages

the communication session, and transports the image data. Therefore, the computer fax software is relieved of the T.30 protocol handling.

Besides T.30, the Elite 2864I allows for fax speeds up to 14400 bps when using a fax machine which complies with the G3 fax transmission standard. Speeds will fall back to 12000, 9600, or 7200 bps if the line quality is not good enough. When connected to a non-G3 fax device, the modem allows for fax speeds up to 9600 bps and will automatically fall back to 7200, 4800, and 2400 bps if the line quality is not good enough.

Fax Command Sets

The Elite 2864I supports four command sets for fax operation:

- Class 1 command set
- TIA PN-2388 Class 2 command set
- TIA 592 Class 2.0 command set
- ZyXEL Extended Fax AT command set

EIA Class 1 and Class 2/2.0 Fax Commands

The EIA class 1 and class 2 fax commands are a set of AT fax commands defined by EIA/TIA (Telecommunications Industry Association) for controlling fax/modems from a computer through the serial RS-232 interface. Fax/modems and fax software supporting this standard will work together.

Class 1 commands control the details of how the modem does on-line negotiation and control jobs whereas Class 2 commands allow the modem to do many negotiations automatically. The Class 1 protocol uses the modem to transmit the fax data only. The complete organizational overhead for this protocol is handled by the connected computer. The Class 1 command set is also called the TIA-578 standard.

Several revisions of the class 2 standard exist. Implementations conforming to different revisions may not work together. A formally approved version is the Class 2.0 command set, also called the TIA-592 standard.

The available Class 1 commands are listed first in this chapter. Following this are descriptions of the supported Class 2 commands. The newer TIA standard Class 2.0 commands are also listed. Interested programmers should consult the TIA document for command details and consult ZyXEL Technical Support for supported features. The later sections are related to the ZyXEL Extended Fax AT commands.

Class 1 Command Set

Command	Value	Description
+FCLASS=n		Service class selection
	n=0	Set to Data mode
	n=1	Set to Class 1 mode
	n=2	Set to Class 2 mode

	n=2.0	Set to Class 2.0 mode
	n=6	Set to ZFAX mode
	n=8	Set to Voice mode
	n=Z	Set to ZyXEL fax parallel port print and/or DRAM store mode. (See also Class Z AT+F commands)

Note: If S57.4=0 (default), the response to the +FCLASS=? command will not report Class 1 capability. This is due to the fact that some fax software packages may get confused by this response.

+FTS=n	0-255	Stop transmission and pause, in 10 ms units.
+FRS=n	0-255	Wait for silence, in 10 ms units.
+FTM=<MOD>		Transmit data with <MOD> carrier.
+FRM=<MOD>		Receive data with <MOD> carrier.
+FTH=<MOD>		Transmit HDLC data with <MOD> carrier.
+FRH=<MOD>		Receive HDLC data with <MOD> carrier.

The <MOD> parameter for the preceding commands take the following values:

Modulation Values

Value	Modulation	Speed	Requirements
3	V.21 ch. 2	300	required for FTH & FRH
	+FTH and +FRH support value 3 (V.21 ch. 2 / 300 bps) only.		
24	V.27ter	2400	required for FTM & FRM
48	V.27ter	4800	required for FTM & FRM
72	V.29	7200	required for FTM & FRM
73	V.17	7200	required for FTM & FRM
74	V.17 w/st	7200	required for FTM & FRM
96	V.29	9600	required for FTM & FRM
97	V.17	9600	required for FTM & FRM
98	V.17 w/st	9600	required for FTM & FRM
121	V.17	12000	required for FTM & FRM
122	V.17 w/st	12000	required for FTM & FRM
145	V.17	14400	required for FTM & FRM
146	V.17 w/st	14400	required for FTM & FRM

* w/st means with V.17 short training

Class 2 Command Set

The following Class 2 commands are supported and implemented per TIA PN2388 (8/20/90).

Command Syntax	Description
+<command>=<value>	Execute a command or set a parameter.
+<command>=?	Read permissible settings.
+<command>?	Read current setting.

Supported Commands (per TIA PN2388 8/20/90)

Command	Value	Description
+FAA=n		Auto-answer mode parameter:
	n=0	Answer as set by +FCLASS.
	n=1	DCE answers and auto-determines type.
+FBADLIN= <value>	0-255	Bad line threshold (number of consecutive bad lines for a bad page parameter): Determine if Copy Quality OK on the T.30 flow chart . <value>=0 to 255; a value of 0 implies that error checking is disabled.
+FBADMUL= <value>	0-255	Error threshold multiplier: Determine if "Copy Quality OK" on the T.30 flow chart . <value>=0 to 255; a value of 0 implies that error checking is disabled.
+FBOR=n		Phase C data bit order:
	n=0	Select direct bit order.
	n=1	Select reversed bit order in receiving mode for phase C data.
+FBUF?		Buffer size; read only parameter: Allow DTE to determine the characteristics of the DCE's buffer size.
+FCIG="string"		Local fax station ID string, for polling Rx.
+FCLASS=n		Service class selection: Refer to +FCLASS Class 1 command in previous section.
+FCON		DCE responds fax connection .
+FCQ=n		Copy quality check capability parameter
	n=0	No copy quality check capability.
	n=1	Only check 1D phase C data.
	n=2	Check both 1D and 2D phase C data.
+FCR=n		"Capability to receive" parameter
	n=0	DCE will not receive message data or poll a remote device.
	n=1	DCE receives message data or polls a remote device.

+FCTCRTY= <value>	0-255	ECM retry count; in Error Mode only: The sender will try to send a partial page 4 times. <value>=0 to 255; units of 4 retries. If the Continue To Correct (CTC) count is 0, it will not make any further attempts.
+FDCC=vr,br,wd,ln, df,ec,bf,st		DCE capabilities parameters.
	vr=0	Vertical resolution: Normal; 98 lpi.
	vr=1	Vertical resolution: Fine; 196 lpi.
	br=0	Bit rate: 2400 bit/s; V.27ter.
	br=1	Bit rate: 4800 bit/s; V.27ter.
	br=2	Bit rate: 7200 bit/s; V.29 or V.17.
	br=3	Bit rate: 9600 bit/s; V.29 or V.17.
	br=4	Bit rate: 12000 bit/s; V.17.
	br=5	Bit rate: 14400 bit/s; V.17.
	wd=0	Page width: 1728 pixels in 215mm.
	wd=1	Page width: 2048 pixels in 255mm.
	wd=2	Page width: 2432 pixels in 303mm.
	ln=0	Page length: A4; 297mm.
	ln=1	Page length: B4; 364mm.
	ln=2	Page length: unlimited length.
	df=0	Data compression format: 1-D; modified Huffman.
	df=1	Data compression format: 2-D; modified Read.
	ec=0	Error correction disabled.
	ec=1	Enable error correction mode.
	bf=0	Disable binary file transfer.
	st=0	Minimum scan time/line: 0 ms.
	st=1	Minimum scan time/line: 5 ms.
	st=2	Minimum scan time/line:10 ms (normal); 5 ms (fine).
	st=3	Minimum scan time/line:10 ms.
	st=4	Minimum scan time/line:20 ms (normal); 10ms (fine).
	st=5	Minimum scan time/line:20 ms.
	st=6	Minimum scan time/line:40 ms (normal); 20ms (fine).
	st=7	Minimum scan time/line:40 ms.
+FDCS=vr,br,wd,ln, df,ec,bf,st		Current session parameter; refer to +FDCC command.
+FDIS=vr,br,wd,ln, df,ec,bf,st		Current session negotiation parameter; refer to +FDCC command.
+FDR		Receive phase C data command; initiates document reception.
+FDT (=df,vr,wd, ln)		Transmit phase C data command: release the DCE to proceed with negotiation.

+FECM=n		Error mode control:
	n=0	Error mode is disabled.
	n=2	Error correcting mode is enabled, handled by the DCE alone, including buffering of partial pages.
+FET=n		End of page or document command:
	n=0	More pages; same document.
	n=1	End of document; another document follows.
	n=2	No more pages or documents.
	n=4	Procedure interrupt; another page follows.
	n=5	Procedure interrupt; end of document, another document follows.
	n=6	Procedure interrupt; end of document.
+FK		Regular fax abort command.
+FLID="string"		Local ID string parameter.
+FLO=n		Flow control options:
	n=0	No flow control.
	n=1	Set XON/XOFF software flow control.
	n=2	Set CTS/RTS hardware flow control.
+FLPL=n		Document for polling command:
	n=0	The DTE has no document available for polling.
	n=1	Indicate a document available for polling.
+FMDL?		Request DCE model .
+FMFR?		Request DCE manufacturer .
+FMINSP=n		Minimum phase C speed parameter:
	n=0	2400 bps.
	n=1	4800 bps.
	n=2	7200 bps.
	n=3	9600 bps.
	n=4	12000 bps.
	n=5	14400 bps.
+FPHCTO= <value>	0-255	DTE Phase C response timeout: Determine how long the DCE will wait for a command after reaching the end of data when transmitting in Phase C. <value>=0 to 255; 100 ms units.
+FPTS=n		Page transfer status
	n=1	Received page good.
	n=2	Page bad; retrain requested.
	n=3	Page good; retrain requested.
	n=4	Page bad; procedure interrupt requested.
	n=5	Page good; procedure interrupt requested.
+FREL=n		Phase C received EOL alignment:
	n=0	The EOL patterns are bit aligned as received.
	n=1	The last received bits of EOL patterns are byte aligned by the DCE, with necessary zero fill bits inserted. Refer to TIA PN-2388 for details.

+FREV?		Request the DCE revision identification.
+FSPL=n		"Enable polling" command:
	n=0	Disable polling.
	n=1	Enable polling.

All other +F commands are not supported, but the modem will respond OK. In many cases this means "don't care." See PN 2388 for command details.

Class 2 Command Responses

Response	Value	Function and Description
+FCFR		Confirmation .
+FCIG:"string"		Report remote ID response CIG.
+FCON		Facsimile connection response.
+FCSI:"string"		Report remote ID response CSI.
+FDCS:vr,br,wd,ln, df,ec,bf,st		Report session parameters response; refer to +FDCC=.... command.
+FDIS:vr,br,wd,ln, df,ec,bf,st		Report session negotiation parameters response; refer to +FDCC=.... command.
+FDTC:vr,br,wd,ln, df,ec,bf,st		Report remote capabilities response; refer to +FDCC=.... command.
+FET:n		Post page message response; refer to the +FET=n command.
+FHNG:n		Call termination status response.
	n=00	Normal and proper end of connection.
	n=10	Transmit error on phase A hang up code.
	n=20	Transmit error on phase B hang up code.
	n=40	Transmit error on phase C hang up code.
	n=50	Transmit error on phase D hang up code.
	n=70	Receive error on phase B hang up code.
	n=90	Receive error on phase C hang up code.
	n=100	Receive error on phase D hang up code.
+FNSC:"HEX string"		Report the non-standard facilities command frame.
+FNSF:"HEX string"		Report the non-standard facilities frame response.
+FNSS:"HEX string"		Report the non-standard setup frame response.
+FPOLL		Remote polling indication.
+FPTS:n		Receive page transfer status response; refer to +FPTS=n command.
+FTSI:"string"		Report remote ID response TSI.
+FVOICE		Transition to Voice response.

Class 2 Flow Control

Flow control is necessary to match the DTE-DCE data rate to the line signaling rate while transmitting or receiving Group 3 (T.4) data. In Class 2 fax mode, both hardware (RTS/CTS) and software (XON/XOFF) flow control are enabled.

CLASS 2.0 "AT+F" COMMAND SET

Command Syntax	Description
+<command>=<value>	Execute a command or set a parameter.
+<command>=?	Read permissible settings.
+<command>?	Read the current setting.

Commands

Command	Value	Description
+FAA=n		Auto-answer mode parameter:
	n=0	DCE answers as set by +FCLASS.
	n=1	DCE answers and auto-determines call type.
+FBO=n		Phase C data bit order:
	n=0	Select direct bit order.
	n=1	Select reversed bit order in receiving mode for phase C data.
+FBS?		Buffer size parameter read only.
+FCC=vr,br,wd,ln, df,ec,bf,st		DCE capability parameter. Refer to +FDCC Class 2 command in previous section for parameter settings.
+FCLASS=n		Service class selection. Refer to +FCLASS Class 1 command in previous section.
+FCO		DCE response fax connection made.
+FCQ=<rq>,<tq>		Copy quality check capability parameter
	rq=0	DCE Receive Copy Quality Checking disabled.
	rq=1	DCE Receive Copy Quality Checking enabled.
	rq=2	DCE Receive Copy Quality Correction enabled.
	tq=0	DCE Transmit Copy Quality Checking disabled.
	tq=1	DCE Transmit Copy Quality Checking enabled.
	tq=2	DCE Transmit Copy Quality Correction enabled.
+FCR=n		"Capability to receive" parameter
	n=0	DCE will not receive message or poll a remote device.
	n=1	DCE receives message data or polls a remote device
+FCT=n	0-255	DTE phase C time-out parameter. n=0-255, 1 units.
+FDR		Receive phase C data command initiates document reception
+FDT		Transmit phase C data command: releases the DCE to proceed with negotiation
+FEA=n		Phase C received EOL alignment parameter
	n=0	Determine that T.4 EOL patterns are bit aligned (as received).
	n=1	Determine that the last received bits of T.4 EOL patterns are byte aligned by the DCE, with

		necessary zero fill bits inserted.
+FIE=n		Procedure interrupt parameter
	n=0	Procedure interrupt requests from the remote station are ignored, and not reported to the DTE.
	n=1	Procedure interrupt requests from the remote station are accepted, negotiated and reported using the +FVO response.
+FIP		Initialize facsimile parameters to factory default.
+FIS=vr,br,wd,ln, df,ec,bf,st		Current session parameter. refer to +FDCC Class 2 command in previous section parameter settings.
+FKS		Session termination command.
+FLI="string"		Local ID string parameter.
+FLO=n		Flow control options:
	n=0	No flow control.
	n=1	Set XON/XOFF software flow control.
	n=2	Set CTS/RTS hardware flow control.
+FLP=n		Document for polling command:
	n=0	The DTE has no document for polling.
	n=1	Indicated document available for polling.
+FMI?		Request DCE manufacturer identification.
+FMM?		Request DCE model identification.
+FMR?		Request DCE revision identification.
+FMS=n		Minimum phase C speed parameter. refer to +FMINSP Class 2 command in previos section for parameter settings.
+FNR=rpr, tpr, idr, nsr		Negotiation message reporting control parameters:
	rpr=0	Receiver parameters are not reported. +FIS: and +FTC: response reports are suppressed.
	rpr=1	Receiver parameters are reported. +FIS: and +FTC: response reports are generated.
	tpr=0	Transmitter Parameters are not reported. +FCS: response reports are suppressed. (+FCS parameter is still loaded)
	tpr=1	Transmitter Parameters are reported. +FCS: response reports are generated.
	idr=0	ID Strings are not reported. +FTI: +FCI: and +FPI: response reports are suppressed.
	idr=1	ID Strings are reported. +FNF:, +FNS: and +FNC: response reports are generated.
	nsr=0	Non-standard frames are not reported. +FTI: +FCI: and +FPI: response reports are suppressed.
	nsr=1	Non-standard frames are reported. +FTI:, +FCI: and +FPI: response reports are generated.
+FNS="string"		Non-standard byte string parameter. "string": string of hexadecimal coded octets.

+FPI="string"		Local fax station ID string, for polling Rx.
+FPP=n		Packet protocol control parameter:
	n=0	Disable the DCE-DTE packet protocol.
	n=1	Enable the DCE-DTE packet protocol. All multi-character messages from the DCE are sent to the DTE using a simple packet protocol data link.
+FPR=n		Serial port rate control parameter:
	n=0	Automatic DTE rate detection by the DCE.
	n>0	Serial rate is fixed at the value multiplied by 2400 bps. For example, when n=8, the DTE rate is equal to 19200 bps (8x2400).
+FPS=n		Page transfer status: refer to the +FPTS Class 2 command in previous sections for settings.
+FRQ=pgl, cbl		Quality thresholds parameters:
	pgl= 0-64 (HEX value)	Specify the percentage of good lines (e.g. with negotiated number of pixels) required for a page considered acceptable. The percentage of good lines would be computed by the equation: 100 x (<lc> - <bl>) / <lc> lc: total line count as reported in the +FPS: response. bl: bad line count as reported in the +FPS: response. If the resulting value is less than the value in <pgl>, the page is unacceptable.
	cbl= 0-FF (HEX value)	Specify the maximum tolerable number of consecutive bad lines. If this value is exceeded for a given page, the DCE shall consider the page unacceptable.
+FRY=n	0-255	ECM retry value n=0-255, units of 4 retries.
+FSP=n		Enable polling command:
	n=0	Disable polling.
	n=1	Enable polling.

Class 2.0 Command Responses

Response	Value	Function and Description
+FCI:"CSI ID string"		Report remote ID response, Called Station ID (CSI).
+FCO		Fax connection established response.
+FCS: vr, br, wd, ln, df, ec, bf, st		negotiated session parameters (DCS frame information) response. Refer to +FIS=… command for a description of sub-parameters.
+FET:<ppm>		Post page message response:
	ppm=0	Another page next, same document.

	ppm=1	Another document next.
	ppm=2	No more pages of documents.
	ppm=3	Another page next, same document, procedure interrupt requested.
	ppm=4	Another document next, procedure interrupt requested.
	ppm=5	No more documents or pages, procedure interrupt requested.
+FHS:<hsc>		termination status:
	hsc= 0-0F	Call placement and termination. Refer to TIA-592 for details.
	hsc= 10-1F	Transmit phase A and miscellaneous errors. Refer to TIA-592 for details.
	hsc= 20-3F	Transmit phase B hang up codes. Refer to TIA-592 for details.
	hsc= 40-4F	Transmit phase C hang up codes. Refer to TIA-592 for details.
	hsc= 50-6F	Transmit phase D hang up codes. Refer to TIA-592 for details.
	hsc= 70-8F	Receive phase B hang up codes. Refer to TIA-592 for details.
	hsc= 90-9F	Receive phase C hang up codes. Refer to TIA-592 for details.
	hsc= A0-BF	Receive phase D hang up codes. Refer to TIA-592 for details.
+FIS:vr, br, wd, ln df, ec, bf, st		emote fax station capabilities (DIS frame information) response refer to +FIS=... command for a description of sub-parameters.
+FNC: "NSC FIF string"		Report NSC (non-standard Commands) frame
+FNF: "NSF FIF string"		Report NSF (non-standard Facilities) frame.
+FNS: "NSS FIF string"		Report NSS (non-standard Setup) frame.
+FPI: "CIG ID string"		Report remote ID response-Polling Station ID (CIG).
+FPO		Remote polling indication.
+FPS:ppr, lc, blc, cblc, lbc		.30 phase C page reception response:
	ppr=1	Received page good.
	ppr=2	Page bad; retrain requested.
	ppr=3	Page good; retrain requested.
	ppr=4	Page good; remote request for procedure interrupt accepted.
	ppr=5	Page bad; retrain requested; remote request for procedure interrupt accepted.

	The receiving DCE may count <lc>, <blc>, <cblc> and <lbc> due to DCE buffer overflow and report them: lc: line count blc: bad line count cblc: maximum consecutive bad line count lbc: lost byte count
+FTC: vr, br, wd, ln, df, ec, bf, st	emote fax station capabilities (DCT frame information) response refer to +FIS=... command for the description of sub-parameters.
+FTI: "TSI ID string"	Remote ID response-Transmit Station ID (TSI).
+FVO	Report transition to voice.

Extended Fax AT Commands

These commands are unique to the ZyXEL modems. The computer controls the modem through a set of extended fax AT commands and the modem responds with a set of status report result codes. During data state, compressed fax image data is flowing between the modem and computer. The default serial connection speed is 38400 bps, and it is higher than the fax link rate. CTS/RTS hardware flow control is used to regulate the data flow.

The modem accepts the extended fax AT commands to set the modem mode and fax parameters. Besides the extended fax AT commands, the modem accepts all the other AT commands described in this chapter. For instance, you can use ATD to make a fax call, or ATA to answer an incoming fax call. When using the extended Fax AT commands, you need to send the command ATFCLASS=6 first. Following are the fax related AT commands:

Mode Setting

#F	Set the modem into V17G3 FAX mode same function as the extended AT command AT&N32.
#B0	Set fax receiving mode. The connection parameters and received fax data are sent to DTE continuously following the connect message. (Default)
#B1	Set fax receiving mode. The messages are separated from the received fax data. The modem sends CONNECT FAX and ZyXEL first, then it waits for the DC2 character (hex18) to send the fax data. When the modem receives a DC2 from the DTE, it starts to send the fax connection parameters /SnnnnVnTnRnLnCnP<string><CR><LF> then the received fax data. In this mode, the modem will wait for DC2 at the beginning of every page. The DTE software should detect the page separator RTC and then sends the DC2 to receive the next page of fax data. This mode is used with a BBS receiving faxes.
#B2	This mode is for the polling feature of the modem. In this mode, the modem will send a polling signal to the remote fax device to ask to

	receive a fax from the remote fax device. The received fax data will be sent to the DTE continuously following the message.
#B3	Displays the ring cadence.

Parameter Setting

#V0	Set to normal vertical resolution.
#V1	Set to high vertical resolution.
#T0	Set to one dimensional coding scheme.
#T1	Set to two dimensional coding scheme.
#R0	Set recording width: 1728 picture elements along a scan line length of 215 mm.
#R1	Set recording width: 2048 picture elements along a scan line length of 255 mm.
#R2	Set recording width: 2432 picture elements along a scan line length of 303 mm.
#L0	Set maximum recording length: A4 (297 mm).
#L1	Set maximum recording length: B4 (364 mm).
#L2	Set maximum recording length: unlimited.
#C0	Set minimum scan line time capability the receiver: 20 ms at 3.85 line/mm, T(7.7)=T(3.85).
#C1	Set minimum scan line time capability the receiver: 5 ms at 3.85 line/mm, T(7.7)=T(3.85).
#C2	Set minimum scan line time capability the receiver: 10 ms at 3.85 line/mm, T(7.7)=T(3.85).
#C3	Set minimum scan line time capability the receiver: 20 ms at 3.85 line/mm, T(7.7)=1/2 T(3.85).
#C4	Set minimum scan line time capability the receiver: 40 ms at 3.85 line/mm, T(7.7)=T(3.85).
#C5	Set minimum scan line time capability the receiver: 40 ms at 3.85 line/mm, T(7.7)=1/2 T(3.85).
#C6	Set minimum scan line time capability the receiver: 10 ms at 3.85 line/mm, T(7.7)=1/2 T(3.85).
#C7	Set minimum scan line time capability the receiver: 0 ms at 3.85 line/mm, T(7.7)=T(3.85).
#P<string>	Set local phone number the phone number following the character 'P' can up to 25 characters. The modem will exchange this phone number with the remote fax machine during initial handshaking.

Status Report Result Codes

When the modem is set in the fax mode, each ATD or ATA command will make the modem try to establish a fax connection and the modem will send a status report result code back to the DTE (computer).

NO DIAL TONE	Tried to dial but no dial tone is detected.
NO CARRIER	Handshake fails or no carrier is detected or time-out.

BUSY	Other party's phone line is busy.
NO ANSWER	Quiet answer is not detected before time-out.
CONNECT FAX…	See below.

When a fax connection is successfully established the modem returns this message:

`CONNECT FAX/SnnnnVnTnRnLnCnP<string>`

This message includes the connection speed and the fax parameters.

Snnnn	Fax connection speed; nnnn is a 4-digit number representing the connection speed. nnnn =1440, 1200, 9600, 7200, etc., 1440 and 1200 stand for 14400 and 12000.
Vn	Vertical resolution; n = 0 or 1.
Tn	Coding scheme; n = 0 or 1.
Rn	Recording width; n = 0, 1, or 2.
Ln	Recording length; n = 0, 1, or 2.
Cn	Scan line time; n = 0 to 7.
P<string>	Remote fax number.

After each fax disconnection, the following result code is sent back to the DTE:

`DISCONNECTnP<string>`

This result code informs DTE of the disconnecting status.

DISCONNECT0	Disconnect with remote confirmation.
DISCONNECT1	Disconnect without remote confirmation.
P<string>	Remote fax number.

The basic AT commands ATV0 and ATQ1 do not affect the above CONNECT and DISCONNECT status report result codes. The modem will always return the same status format as above.

Flow Control

In extended fax AT command mode, the modem always uses hardware (CTS/RTS) flow control. The flow control signaling used sending a fax is:

CTS is used by the modem to flow control the DTE. When the modem turns CTS off, the buffer inside the modem is full and cannot accept any more data. The computer should send data only when CTS is ON.

RTS is used by the computer to signal the modem that the fax message is finished. As soon as RTS off is detected, the modem starts the post message handshaking to make sure that the remote facsimile has received the fax

message successfully. Then it hangs up the phone and sends a status report to the DTE.

If you want to send a multi-page fax, just add the RTC signal between the fax message of two pages. The modem detects the RTC signal automatically, handshakes the multi-page procedure with the remote facsimile and sends the next page message.

The following flow control signaling is used while receiving a fax:

CTS is not used when receiving fax.

RTS is used to inform the modem that the computer cannot accept data at this moment. The modem will not pass received data to the DTE if RTS is turned off.

When finished receiving the fax message, the modem will turn off CD then send a status report result code to the DTE.

Fax Reception from within a BBS System

The Elite 2864I can automatically detect data and fax calls and allow a BBS software to receive faxes on the same phone line. To allow your BBS to receive incoming faxes, make the following set-up changes in your BBS:

1) Add the string #B1+FCLASS=6 to the init string. Be sure the +FCLASS=6 command is the last command.

2) Change one of the messages in the list to CONNECT FAX.

3) Set the external mail string to ZyXEL and give it an error level.

4) In your BBS batch file, if the error level matches the external mail, execute `rcvfax 2 /p:comport [/w:workpath].`

This setting will enable the BBS to receive a fax and store it automatically.

The following is a sample setting for the FrontDoor system:

Add to the init string : **X7#B1+FCLASS=6**

Change the connection message to:

Messages		
300	CONNECT	
1200	CONNECT	1200
1275	CONNECT	FAX
2400	CONNECT	2400
4800	CONNECT	4800
9600	CONNECT	7200
19200	CONNECT	9600

38400	CONNECT	14400

Set external mail as:

External Mail		
String		Error Level
1	ZyXEL	100
2	ZyXEL	100
3	ZyXEL	100

The following is a sample setting in the BINKLEY.CFG file for a Binkley system.

```
Init AT&FX7S0=1#B1+FCLASS=6
ExtrnMail ZyXEL errorlevel
```

Chapter 11 - Using Direct Fax Capabilities

The Elite 2864I can be used in conjunction with a PCL or Postscript compatible laser printer to act as a plain paper fax machine. When configured in the following manner, the Elite 2864I and printer operate will perform their fax operations regardless of whether the computer's power is on or off.

Direct FAX Reception and Printing

To connect the Elite 2864I for direct fax printing, use a Centronics type printer cable and a DB25 female-female gender converter to connect the modem's parallel port connector to the laser printer.

The modem must be connected to the PC's serial port to initiate the following command:

```
AT+FCLASS=Z<Enter>
```

The modem will enter into direct fax reception and print mode. You also need to set S0 register to a finite number to enable auto answering.

To further detail operation in Class Z mode, the special command AT+FZF has been implemented to define the fax reception mode under Class Z operation.

This command selects ZyXEL Fax Reception Mode for parallel port, auto-data and DRAM storage. The usage is as follows:

AT+FZF=n

n=0	**Fax to printer, hang up if data.** Upon incoming calls the modem will check whether an active printer is connected. If so, the modem will answer the call and print the fax, otherwise it will not answer. If the modem answers and the call is not a fax call, it will hang up. Note that the modem is in printer (PRP) mode only during fax printing, it will the serial port connection if it is connected. (Default)
n=1	**Fax to printer, data to serial port.** When a call comes in, the modem will check if there is an active printer connected to the parallel port or an active DTE connected to the serial port. If either one is connected, the modem will answer; otherwise it will not answer. If the modem answers and the call is a fax call, it will check whether an active printer is connected or not. If , the modem will print the fax; otherwise it will hang up. If the call is a data call, the modem will check if an active DTE is connected to the serial port or not. If it will connect to the DTE through the serial port; otherwise it will hang up.

The +FZF command is only effective in Class Z operation. It only defines the reception mode under Class Z. For transmission, the DTE can send the appropriate +FCLASS command first before starting a transmission.

- To return to fax reception and print mode later, the DTE needs to issue +FCLASS=Z and +FZF command again after finishing the transmission.

- To leave the fax reception and print mode, enter a +FCLASS command to set the modem to a different Class mode.

You can also enter commands through the parallel port and have the modem operate +FZF=0 mode. But then you will often need to switch the modem parallel port connection between a PC and a printer .

The modem supports laser printers compatible with HP LaserJet-II printers or laser printers supporting the HP PCLII programming command language. This includes essentially all HP-compatible laser printers on the market.

Different laser printers may have different print speeds. The fax receiving speed depends on the fax connection speed. For current standards the connection speed is from 2400 bps up to 14400 bps. The printer speed must be greater than or equal to the fax receiving speed, otherwise a fax data overrun will occur. If the printer is slow, the modem will adjust the minimum scan time per line parameter in order for the remote site send the fax at a slower rate (with a higher "minimum scan time per line" parameter). When a laser printer is connected to the modem and both are turned on, the command:

```
AT+FZT
```

will cause the modem to test the printer speed and store the speed parameter in nonvolatile memory. The printer will print one test page. The modem also sets the **st** (scan time) parameter in the **+FCC** Class 2.0 command according to the speed parameter. In the first Class Z mode operation after being turned on, the modem sets a default **st** parameter according to the speed parameter stored in nonvolatile memory. The user can override the **st** setting by using the **+FCC** command.

Two laser printer resolutions can be selected using **+FZR** command:

```
+FZR=0     Resolution: 300 dpi
+FZR=1     Resolution: 150 dpi
```

The default is 300 dpi. 150 dpi is not recommended because of printing quality degradation of you are using a very slow laser printer, 150 dpi will speed up the fax receiving process. **AT+FZS** command to select the paper size:

```
+FZS=0    LETTER (8.5“ x 11“)
+FZS=1    LEGAL (8.5“ x 14“)
+FZS=2    A4 (210 mm x 297 mm)
```

Standalone FAX Reception and Storing

With the DRAM option installed, you can program the Elite 2864I to receive faxes and store them in DRAM. To do so, use the **AT+FCLASS=Z** command to set the modem to work in the Class Z mode. Also, you need to use the **+FZF=n** command to set the modem to work in one of the following modes:

n=2	**Fax to DRAM and printer, hang up if data**. The modem always answers. If it is a fax call, the received fax pages will be stored in DRAM; if an active printer is connected to the parallel port, the fax pages are also sent to the printer. The modem will hang up if the call is not a fax call.
n=3	**Fax to DRAM, hang up if data**. The modem always answers. If it is a fax call, the received fax pages will be stored in DRAM; if it is not a fax call, the modem will hang up.
n=4	**Fax to DRAM and printer, data to serial port**. The modem operates as with n=2 except that the modem will connect to the serial port if the incoming call is a data call. If no active DTE is connected to the serial port, the modem will hang up.
n=5	**Fax to DRAM, data to serial port**. The modem operates as with n=3 except that the modem will connect to the serial port if the incoming call is a data call. If no active DTE is connected to the serial port, the modem will hang up.

The modem will respond OK to the **+FZF=n** (n=2-5) command if the DRAM option is installed. Otherwise, it will return an ERROR response.

The Elite 2864I makes a record of every stored fax page if it has also been printed at reception. In class Z mode, you can have the modem print the unprinted fax pages stored in DRAM by sending an **AT+FZP** command to the modem.

- If there are no unprinted fax pages, the modem will return **OK.**
- If there are unprinted fax pages and an active printer is connected to the parallel port, the modem will print the unprinted fax pages and return OK.
- If there are unprinted fax pages, but no active printer is connected, the modem will return **ERROR.**

You can also print fax pages stored in DRAM without turning on a computer to issue commands. In Class Z mode, with an active printer connected to the parallel port, pushing the D/V button on the front panel will cause the modem to send unprinted fax pages to the active printer.

Sending Stored Faxes to your PC

You can use your existing fax software package to retrieve fax pages stored in DRAM. Use either the parallel port or the serial port to connect your computer to the Elite 2864I and run your favorite fax program. When the fax program sets the modem to fax Class 2 or Class 2.0 mode, the modem will emulate fax calls coming in, have the fax program receive the fax calls, and then dump all stored fax pages to the fax program. Note that each stored fax call, either single-page or multiple-page, will cause the modem to emulate

a separate fax call and the fax program will store and log them as a separate fax reception.

There are two S-register bits reserved to control the printing or downloading of fax pages stored in DRAM. For printing to laser printer:

Register	Bit	Value	Function
S71	5	0	The modem will not print stored fax pages that have already been downloaded to a computer fax program, but have not been printed.
S71	5	1	The modem will print stored fax pages.

Default value for S71.5= 0

For downloading faxes to a computer fax program:

Register	Bit	Value	Function
S71	4	0	The modem will not download fax pages which have already been printed, but have not been downloaded to a computer fax program.
S71	4	1	The modem will download printed pages.

Default value for S71.4=0

The FAX LED indicator on the front panel of the Elite 2864I will flash if the modem's DRAM is storing fax pages which will either be printed to a printer or downloaded to a computer fax program. This also depends on the setting of **S71.5** and **S71.4**.

Chapter 12 - Advanced Voice Capability

Voice capability stands for the modems ability to digitize incoming voice messages, which the computer stores and forwards. It also means the modem can playback the recorded digitized voice either off-line for local message listening or on-line for a message announcement. For interactive voice applications, DTMF tone detection capability is important so a computer can react according to the remote caller's touch tone input.

Voice Data Compression

The main issue in digitized voice mode is the amount of storage required. A good phone quality voice digitization will produce about 64 Kbits of data for each second of voice recording. The hard disk will be filled up quickly by digitized voice data at this digitization rate. Speech compression is needed to reduce the rate of digitized data. A relatively simple ADPCM (Adaptive Differential Pulse Code Modulation) algorithm can reduce the speech data rate to half the rate and maintain about the same voice quality. This algorithm can also be used to reduce the speech data rate to 1/3 or 1/4 of the original rate, but with voice quality degradation. Reducing the speech data rate further and maintaining good voice quality require a sophisticated and complicated signal processing algorithm. It also requires a lot of digital signal processing computation power.

The Elite 2864I supports seven voice digitization schemes:

Compression Method	Bits/Sample	Rates (samples/second)
ZyXEL 2 ADPCM	2	7200, 8000, 9600, 11025
ZyXEL 3 ADPCM	3	7200, 8000, 9600, 11025
ZyXEL 3 ADPCM (new)	3	7200, 8000, 9600, 11025
ZyXEL 4 ADPCM	4	7200, 8000, 9600, 11025
DVI ADPCM	4	7200, 8000, 9600, 11025
A-law PCM	8	7200, 8000, 9600, 11025
Mu-law PCM	8	7200, 8000, 9600, 11025

Note: The New 3-ADPCM scheme is a 3-bit ADPCM scheme with added sync bits in the voice data. This helps to avoid loss of data synchronization due to data errors or data loss. It is the recommended 3-bit ADPCM scheme. It will automatically recover from data errors when playing without producing noisy voice signals.

Automatic Detection of Voice, Fax and Data

Since there is no way to standardize the way a human voice should behave in telephone calling and answering, it is difficult, if not impossible, to automatically make a distinction between voice, fax, and data calls. A common way of accomplishing this task is the combined use of a digitally recorded voice message and DTMF tone detection. The voice message instructs the caller to press one number on the touch-tone keypad if they want to send a fax, or another number if they want to talk. By detecting which DTMF

tone was sent, the modem and software can switch to the appropriate mode and handle your call accordingly. If no tone is received by the timeout, the 2864I will assume it is a data call and begin its modem handshaking process.

The shortcoming of this process is that some modems will be confused by the initial voice message portion, and will not be able to connect. Even if the data call is successfully connected, the long delay before handshaking may not be acceptable in some applications.

Some software packages use an initial period of silence when answering, and detect if there is voice energy to decide if it is a voice call.

The 2864I can recognize a fax or data call more quickly if a calling tone is received. In this case, the voice announcement can be omitted.

Voice States and Operation Modes

The Voice Mode DCE control interface for the 2864I basically follows the TIA TR29.2 committee IS-101 Interim Standard. ZyXEL is continuously enhancing its modems' voice capability and voice feature implementation. Please refer to the manual amendment or firmware release notes for updated details. ZyXEL S-register S48.5 for the IS-101 compatibility flag. When this bit is off (default), the 2864I uses the U-1496 modem voice command set. If the bit is set, the 2864I is compatible with the IS-101 standard.

In ZyXEL voice mode that roughly correspond to the flow direction of the digitized voice dat the Voice Command State (no data transfer other than event reports), the Voice State (digitized voice data transfer from DTE to the DCE), and the Voice State (digitized voice data transfer from DCE to the DTE). Note that the voice data DTE/DCE transfer is half-duplex.

The DCE may issue event detection reports at any time, regardless of the DCE state. These reports may be tone or cadence events such as calling tone. ZyXEL provides the Service Level C Event Detection Capabilities of IS-101 as follows:

Event Description	DCE Voice State
RING	Command
Ringback	Command
Fax or Data Answer (e.g., 2100 Hz)	Command
BUSY	Receive, and Command
DIALTONE	Receive, and Command
DTMF Received	Receive, Transmit, and Command
Fax Calling Tone	Receive, Transmit, and Command
Presumed Hang-up (SILENCE) Time-out	Receive
Presumed End of Message (QUIET) Time-out	Receive
Mandatory Receive Buffer Overrun	Receive
Mandatory Transmission Buffer Underrun	Transmit

Voice Command State

The DCE is in the Voice Command State and ready to accept commands when the DCE is operating in voice mode and is not communicating with a remote station, nor with any local devices which are capable of translating analog signals to voice (e.g., speaker) or translating voice to analog signals (e.g., microphone). The DCE considers data transfers from the DTE commands, and returns responses back to the DTE after completing the processing of the commands. While accepting or processing commands, the DCE also monitors the line which connects the DCE to the remote station or to the local device to detect events, which the DCE later reports to the DTE pertaining to signals carried over the line, such as tones, and pertaining to PSTN generated control and notification signals, such as ringing.

The Voice Command State provides several DTE options. The modem may wait for an unspecified time after playing a welcome message, or switch to other modes as part of a DTE call discrimination algorithm.

Voice Data State

The DCE is in Voice Data State when the DCE is operating in voice mode and is communicating with a remote station or with one or more local devices which are capable of translating analog signals to voice (e.g., speaker) or translating voice to analog signals (e.g., microphone). The DTE transfers data to the DCE for transmission to the remote station, and the DCE transfers data to the DTE after reception from the remote station. The DCE monitors data and the control signals to detect events which the DCE later reports to the DTE pertaining to the line connecting the DCE and the remote station, and pertaining to requests from the DTE. Voice Data State has two sub-states: Voice Transmission State and Voice Reception State.

Voice Transmission State

The DCE is in Voice Transmission State when the DCE receives digitized data from the DTE, converts the binary data into an analog signal, and transmits the analog signal to the remote station or to one or more local device destinations such as a speaker. While transmitting the data, the DCE - (1) - monitors the line which connects the DCE to the remote station or to one or more local devices to detect events which the DCE reports to the DTE and - (2) - does not expect to receive, digitize, or process any incoming analog signals for transfer to the DTE. Events detected when monitoring are notification signals such as **busy**.

To leave the Voice Transmission State you may use either of the following two methods:

1) A <DLE><ETX> shielded code is received from the DTE.
2) A DTE/DCE inactivity timer time-out occurs

Item (1) is the DTE -initiated method to terminate the Voice Transmission State, and item (2) is a DCE-initiated means of terminating the Voice Transmission State. Upon termination of the Voice Data State, the DCE will enter the Voice Command State.

Voice Reception State

The DCE is in the Voice Reception State when the DCE digitizes the analog signal from the remote station or from local device sources such as a microphone. The analog signal is converted into binary data, which is compressed or otherwise processed. The resulting data is transferred to the DTE. While receiving the data, the DCE

(1) monitors the line we which connects the DCE to the remote station or to one or more local devices t detect events which the DCE reports to the DTE. These events pertain to signals carried over the line such as tones, and to PSTN -generated control and notification signals such as ringing.

(2) does not expect to receive digitized data from the DTE, perform conversion, or transmit the analog signal to the remote station or to one or more local devices.

The ZyXEL 2864I provides two ways to leave the Voice Reception State:

(1) A <DLE><!> shielded code is received from the DTE.

(2) Characters other than <XON>, <XOFF> or a shielded code is received from the DTE.

Items (1) and (2) are DTE--initiated means of terminating the voice reception. After termination of the Voice Data State, the DCE enters the Voice Command State.

Events and Actions with Shielded Code

Event Detection and Reporting

The voice mode may return many more event detection reports than the familiar RING result code used in data/fax modems. While in voice mode, the DCE can detect DTMF tones. The DCE will report the event to the DTE at the time of detection by inserting a <DLE> shielded code into the data to the DTE. The form of the report is <DLE><code>, <code> can be one of the possible character values listed in the following table:

<code>	**Event Report Description**
<DLE> (0x10)	Two contiguous <DLE><DLE> codes indicate a single <DLE> in the data stream.
<SUB> (0x1A)	<DLE><DLE> in the data stream.
<DC2> (0x12)	Concatenate reception data streams. The DCE sends this code to indicate the start of a new voice data stream with the same parameters as the last stream for the purpose of a timing mark. The DCE resets its compressors before transmitting the data after the <DLE><DC2> codes. This resync generation timer is defined by the command AT+VSY.
<ETX> (0x3)	End Data State. The DCE sends this code to indicate the end of the voice data.
1 (0x31)	DTMF 1

<code>	Event Report Description
2 (0x32)	DTMF 2
3 (0x33)	DTMF 3
4 (0x34)	DTMF 4
5 (0x35)	DTMF 5
6 (0x36)	DTMF 6
7 (0x37)	DTMF 7
8 (0x38)	DTMF 8
9 (0x39)	DTMF 9
0 (0x30)	DTMF 0
A (0x41)	Extended Keypad DTMF A
B (0x42)	Extended Keypad DTMF B
C (0x43)	Extended Keypad DTMF C
D (0x44)	Extended Keypad DTMF D
* (0x2A)	Extended Keypad DTMF *
# (0x23)	Extended Keypad DTMF #
o (0x6F)	Buffer Overrun.
c (0x63)	T.30 fax calling tone (1100Hz). The time interval between reports is 4.0 seconds.
e (0x65)	Data modem calling tone (1300Hz). The time interval between report is 4.0 seconds.
h (0x68)	Line current break (local phone goes onhook).
H (0x48)	Line current detected (local phone goes offhook).
s (0x73)	Silence detected. The DCE has determined that there was no voice energy present at the beginning of the voice receiving session followed by a period of silence greater than the amount of time selected by the +VSD command.
q (0x71)	Quiet detected. The DCE has determined that there was voice energy present at the beginning of the voice receiving session followed by a period of silence greater than the amount of time selected by the +VSD command.
$ (0x24)	Bong Tone (300Hz for 1 second).
l (0x6C)	Loop current interruption. This may be a remote hang-up.
b (0x62)	BUSY. If the DCE continues to detect BUSY , it may report this event repeatedly. The delay between reports is 4.0 seconds.
u (0x75)	Transmission Buffer Underrun. The DCE will report this code if the DCE's buffer becomes empty without first receiving a <DLE><ETX> or a <DLE><CAN> command.
a (0x61)	Data answer tone. The delay between reports is 4.0 seconds.

Action Voice Commands in Voice Data State

The DTE may initiate actions by inserting a <DLE> shielded code the data to the DCE. The form of the action is <DLE><code>, where <code> is one of the possible character values listed in the following table:

<code>	Action Command Description
<NUL> (0x0)	Does nothing. The DTE can use the code to refresh the DTE/DCE Inactivity Timer, instead of XON.
<DLE> (0x10)	Two contiguous <DLE><DLE> codes indicate a single <DLE> is in the data stream.
<SUB> (0x1A)	<DLE><DLE> in the data stream.
u (0x75)	Turn up the volume or gain by one unit.
d (0x64)	Turn down the volume or gain by one unit.
p (0x70)	Pause Data State: The DCE suspends sending analog data to the currently selected analog destination. While pausing, the DCE will maintain the contents of its internal buffer and the state of its compressors, continue in the Data State, and send silence to the analog destination.
r (0x72)	Resumes Data Transmission State: The DCE resumes sending the contents of the DCE buffer to the currently selected analog destination. Before resuming sending the analog signal to the analog destination, the DCE will not reset the contents of its internal transmission buffer, nor reset the compressors.
<ETX> (0x3)	Ends Data Transmission State: The DTE sends this code to signify the end of the voice data from the DTE and cause the DCE to return to the Voice Command State. The DCE will complete the transmission of the contents of its buffer before switching to the Voice Command State and returning the OK result code
<DC4> (0x14)	Clears the transmission buffer of voice data and ends Data Transmission State: The DTE sends this code to indicate the end of the voice data from the DTE and cause the DCE to return to the Voice Command State. The DCE will clear its internal transmission buffer before switching to the Voice Command State and returning the OK result code.
<CAN> (0x18)	Clears the transmission buffer of voice data: This code commands the DCE to (1) clear its internal transmission buffer; (2) get ready for a new voice data stream with the same parameters as the last stream; and (3) reset its compressors and send silence over to the analog destination while paused.
<FS> (0x1C) or <DC2>(0x12)	Concatenate data streams: The DTE sends this code to indicate the start of a new voice data stream with the same parameters as the last stream without first returning to the Voice Command State. The DCE will transmit the remainder of its internal transmission buffer and reset its compressors before transmitting the data following the <DLE><FS> or <DLE><DC2> codes.
! (0x21)	End Data State The DTE sends this code to indicate the end of voice data reception and the return to Voice Command State. The DCE will discard the contents of its buffer before switching to the Voice Command State and returning the OK result code.

Voice AT Commands

The following is a summary of the supported voice AT commands:

AT Command Syntax

AT is the command line prefix. Voice commands take one of the following forms:

+V<CM>?	Read current setting.
+V<CM>=?	Read permissible settings.
+V<CM>=<string>	Set single-value parameter.
+V<CM>=<value string>	Set compound parameter.

<CM> represents a two-letter command syntax. A value string consists of values separated by commas or semicolons. The first two command forms are for read actions, the last two are for write actions. A command line may have both action types or be just read or write type only.

Response Syntax

For each command line received, the modem issues a response to each command in the command line followed by a final response.

Each command response is of the form:

<CR><LF>
<value> (or) <value range> (response to ? or =? command)
<CR><LF>

The final response is

```
<CR><LF>
OK (or) ERROR    (Command line response)
<CR><LF>
```

The ASCII character combination <CR><LF> is not shown in the explanations below. The final response is OK if all the commands in the command line have been successfully executed, otherwise it is ERROR.

Flow Control

Flow Control is necessary to match the DTE-DCE data rate to the line signaling rate and to the requirements of analog conversion of the voice signals and data. For ZyXEL 2864 series modems, both software XON/XOFF and hardware RTS/CTS flow control are used the software flow control is the default setting. The DTE may turn off the flow control, but some other method be used to avoid overrun of the buffer.

The DTE can select the flow control method in voice mode by using the +FLO command (defined in Class 2 and 2.0).

Supported Commands For Voice Mode Operation

- ATD (with +FCLASS=8)

This command causes the DCE to dial a phone number. The DCE uses the current destination setting to perform a dial action. If +VLS is equal to zero at the time of the ATD command, the DCE will return an ERROR result code.

The DCE attempts to determine when the remote station has gone offhook by ringback detection and disappearance (see the +VRA and +VRN commands, respectively). Once the DCE has determined with high confidence that the remote station has gone off hook, the DCE returns the OK result code. For example, the DCE reports this result code when the DCE has determined on answer that the remote station is a data modem. The DCE may also issue this result code when the DCE has assumed that the remote station has gone offhook by actions associated with the +VRA and the +VRN commands.

The DCE issues the NO ANSWER result code when the DCE has continuously detected ringback for the amount of time specified in S-register S7.

- ATH (with + FCLASS=8)

This command causes the DCE to hang up the phone. In voice mode, this command is equivalent to the +VLS=0 command, and the DCE to the data mode (+FCLASS=0) with auto-baud, regardless of the state of the +VNH command. When the +VNH=0 command is in effect and the DCE is not in voice mode, the ATH command behaves as for the data mode.

This command does not change any of the voice mode parameters such as +VSM, +VSD, etc. When the +VNH=1 or +VNH=2 command is in effect and the DCE is not in voice mode, the DCE issues an OK result code as a result of the ATH command, but the DCE may or may not go on-hook depending on the setting of the +VNH command. As part of the call discrimination algorithm, the DCE may switch to other modes, such as facsimile or data, in order to try handshakes in these modes. Voice mode does not support the ATH1 command.

- AT+FCLASS=<mode>

This command selects a DCE mode – data, fax, or voice. The DCE recognizes the value of 8 as the Voice Mode.

<mode>	**DCE mode**
0	Data Mode
1	Fax Mode, Service Class 1 (TIA/EIA-578)
2	Fax Mode, Service Class 2 (TIA PN-2388)
2.0	Fax Mode, Service Class 2.0 (TIA/EIA-592)
6	Fax Mode, ZyXEL Fax AT Commands
8	Voice Mode (TIA IS-101)
Z	ZyXEL fax parallel port print and/or DRAM store mode

The DCE returns the OK result code if the DCE accepts the command. The DCE returns the ERROR result code if the <mode> subparameter is not permitted.

- AT+FCLASS?

The DCE returns the current mode setting followed by the OK result code.

- AT+FCLASS=?

The DCE returns permitted modes. The response is (with S57.4=1):

```
0,1,2,2.0,6,8,Z
OK
```

- AT+VLH=?

This enables the DTE to inquire the hook status of the connected local phone. The DCE will return 0 for on-hook and 1 for off-hook status.

- AT+VNH=<hook>

The DCE enables or disables automatic hang-up to a varying degree for data and fax modes.

<hook>	**Hook Control Description**
0	The DCE retains automatic hang-ups as is normal in the other mode such as hanging up the phone when the DCE does not detect a data carrier within a given time interval). (Default)
1	The DCE disables automatic hang-ups usually found in the other Non-Voice Mode.
2	The DCE disables automatic hang-ups in the other Non-Voice Mode. The DCE only performs a ”logical” hang-up (returns the OK result code).

- AT+VNH?

The DCE returns the current hang-up setting, followed by the OK result code.

- AT+VNH=?

The DCE returns permitted hang-up modes. The response is :

```
0,1,2
OK
```

- AT+FLO=<method>

The DCE selects the type of flow control provided and used.

<method>	**Flow Control Method**
0	XON/XOFF and RTS/CTS flow control turned off
1	Use software XON/XOFF flow control in either direction.
2	Use hardware RTS/CTS flow control.

The DCE returns the OK result code if the DCE accepts the command. The DCE returns the ERROR result code if the <method> subparameter is out of range.

- AT+FLO?

The DCE returns the current flow control setting, followed by the OK result code.

- AT+FLO=?

The DCE returns permitted flow control methods. The response is :

```
0,1,2
OK
```

Action Voice Commands for Voice Mode Operation

- AT+VIP

The DCE will initialize all voice parameters to the default settings as follows:

Parameter	Related Commands	Default Value
Silence threshold	+VSD	15
Hang-up code	+VNH	0
Compression method	+VSM	2 (2-bit ADPCM)
Beep tone interval	+VTD	50 (unit: 10 ms)
Inactivity timer	+VIT	70 (unit: 0.1 s)
Silence interval	+VSD	70 (unit: 0.1 s)
Ringback timer	+VRA	70 (unit: 0.1 s)
Ringback timer	+VRN	10 (unit: 1 s)
Reception Gain	+VGR	0
Transmission Gain	+VGT	128
Resync timer	+VSY	0 (disabled)
DTMF detection interval	+VDD	8 (unit: 5 ms)
and threshold		5
Flow control method	+FLO	1 (software)

The DCE returns the OK result code if DCE accepts this command or returns the ERROR result code if the DCE is not connected to at least one voice I/O device.

- AT+VRX

The DCE starts the voice reception process by first returning the CONNECT result code to the DTE. After this is reported, the DCE sends <DLE> shielded voice data to the DTE. There are three ways to leave the Voice State:

(1) The DTE sends a character other than <XON>, <XOFF> or a shielded code.

(2) The DTE sends a <DLE><!> shielded code.

(3) A DTE/DCE Inactivity Timer time-out .

Upon termination of the voice state, the DCE will append a <DLE><ETX> character pair, followed by the OK result code. The DCE then returns to Voice Command State.

The Inactivity Timer is in effect while the reception operation is in progress. If the DTE wishes to use this timer and stop the DCE from performing unwanted restarts, the DTE must assure that there is data sent from the DTE to the DCE often enough to refresh the timer; the DTE may use the <DLE><NUL> shielded code as a no-operation command to refresh the timer.

- AT+VTS=<string>

This command causes the DCE to issue DTMF single frequency tones, and optionally, double frequency tones. The DCE accepts <DLE><!> to abort playing tones, the OK result code, and to the Voice Command State.

The tone generation string consists of elements in a list with each element separated by a comma. Each element can be:

1) A single ASCII character in the set 0-9, A-D, #, and *. The DCE interprets the single ASCII character as a DTMF digit with a duration given by the +VTD command.

2) A string enclosed in square brackets, "[]". The DCE interprets the values in square brackets as a general dual tone and duration selection. The quantity within the square brackets consists of a three element list. The first element is the first frequency, the second element is the second frequency, and the third element is the tone duration in 10 ms intervals.

3) A string enclosed in curly braces, "{}". The DCE interprets the quantity in the braces as a DTMF tone with a different duration than that given by the +VTD command. The quantity in the curly braces consists of a two element list. The first element is the DTMF tone character and the second element is the tone duration in 10 ms intervals. For every inter-element comma in the list, the DCE pauses for an interval set by the +VTD command.

- AT+VTS=?

This command causes the DCE to report the allowable tone frequency range and duration range. The ZyXEL 2864 series two tones, both in the frequency range of 20 to 4800 Hz, and a duration range from 0 to 10 seconds. The response is as follows:

```
(20-4800),(20-4800),(0-1000), 0-9, A-D, *, #
OK
```

- AT+VTX

This command causes the DCE to start the voice transmission process. The DCE begins the Voice Transmission Mode by returning the CONNECT result code to the DTE. After this report, the DCE accepts <DLE> shielded voice data from the DTE. The DTE shall send the data in the format previously selected by the +VSM command and use the flow control method selected by the +FLO command.

There are two ways to leave the Voice Transmission State:

(1) The DTE sends a <DLE><ETX> shielded code.

(2) A DTE/DCE Inactivity Timer time-out.

Item (1) is the DTE initiated means of terminating the Voice Transmission State, and item (2) is a DCE-initiated means of terminating the Voice Transmission State. Upon termination of the Voice Transmission State, the DCE sends the OK result code and returns to Voice Command State.

Configuration Commands for Voice Mode Operation

- AT+VGR=<gain>

This command causes the DCE to set the gain for the received voice samples. The gain is an unsigned octet value. The normal value is 128. A value larger than 128 indicates a larger gain than normal, and a value smaller than 128 indicates a gain smaller than normal. A gain value of 56 corresponds to -18 dB gain, 128 for 0 dB, and 200 for 18 dB, in 0.25 dB steps. A value of zero invokes Automatic Gain Control on the DCE. The gain range is 56 to 200 and the default value is 0.

The DCE returns the result code OK if DCE accepts this command, or it returns the result code ERROR if the <gain> parameter is out of range.

- AT+VGR?

The DCE will return current gain, followed by the OK result code.

- AT+VGR=?

The DCE will return all permitted values for the gain. The response is:

```
56-200
OK
```

- AT+VGT=<level>

This command causes the DCE to set the volume level, either by amplifying or attenuating the signal, for the transmitted voice samples. The transmission gain (or attenuation) is an unsigned octet value. The default value is 128. A value larger than 128 indicates a larger gain than normal, and a value smaller than 128 indicates a gain smaller than normal. The level range is 56 to 200. A gain value of 56 corresponds to -18 dB gain, 128 for 0 dB, and 200 for 18 dB, in 0.25 dB steps.

The DCE returns the result code OK if DCE accepts this command, or it returns the result code ERROR if the <level> parameter is out of range.

- AT+VGT?

The DCE returns the current gain, followed by the OK result code.

- AT+VGT=?

The DCE returns permitted values for the gain. The response is:

```
56-200
OK
```

- AT+VIT=<timer>

This command sets the inactive timeout value for the DTE/DCE Inactivity Timer. The default value is 7 seconds. Acceptable values are 0 to 255 with a unit of 0.1 second. The DTE can disable the Inactivity Timer by setting the value to zero.

The DCE returns the OK result code if DCE accepts this command, or it returns the ERROR result code if <timer> is out of range.

- AT+VIT?

The DCE returns the current Inactivity Timer timeout value, followed by the OK result code.

- AT+VIT=?

The DCE returns the permitted Inactivity Timer timeout values. The units are in 0.1 seconds. The response is :

```
0-255
OK
```

- AT+VLS=<device>

This command causes the DCE to select a voice I/O device. The permitted <device> is as follows:

<device>	**Description**
0	No voice I/O devices connected. Local phone connects to telco line. The DCE is on-hook.
1	Voice I/O through local phone connected to POTS Port. Local Phone provided with power to detect hook condition. The DCE is on-hook.
2	Voice I/O through Telco Line. The DCE is off-hook.
8	Voice Input through External Microphone. Local phone connects to Telco Line. The DCE is on-hook.
16	Voice output to Internal Speaker. Local Phone connects to Telco Line. The DCE is on-hook.

The DCE returns the VCON result code (returns OK if S48.5=1) if the DCE accepts this command, or it returns the ERROR result code if the <device> value is not permitted.

- AT+VLS?

The DCE will return the current I/O device followed by the OK result code.

- AT+VLS=?

The DCE will return permitted I/O devices. The response is:

```
0,1,2,8,16
OK
```

- AT+VSD=<sds>,<sdi>

This command causes the DCE to set the silence detection sensitivity and the required period of silence before the DCE can report silence detected at the end of a voice reception either with the "Presumed End of Message" (QUIET) or "Presumed Hang-up" (SILENCE) event reports.

<sds>: DCE silence detection threshold level a larger value of this subparameter implies that the DTE wants the DCE to treat noisier condition as silence. The actual value of this subparameter has no physical meaning. The range of the sensitivity <sds> is from 0 to 31. A value of zero disables the silence detection. The default value is 15.

<sdi> : The required period of silence before the DCE can report silence detected either with the "Presumed End of Message" (QUIET) or "Presumed Hang-up" (SILENCE) event report. A value of zero disables the DCE silence detection. The range of the interval <sdi> is from 0 to 255 in units of 0.1 seconds. The default value is 70 (7 seconds).

The DCE returns the OK result code if DCE accepts this command, or it returns the ERROR result code if <sds> or <sdi> is out of range.

- AT+VSD?

This command causes the DCE to report current <sds> and <sdi> settings. The form of the response is:

```
<sds>,<sdi>
OK
```

- AT+VSD=?

This command causes the DCE to report the permitted range of <sds> and <sdi>. The response is:

```
(0-31),(0-255)
OK
```

- AT+VSM=<cml>,<vsr>

This command causes the DCE to select a compression scheme and sample rate as follows:

<cml>	Compression Scheme	Bits/Sample	<vsr> possible values
2	ZyXEL 2 ADPCM	2	7200, 8000, 9600, 11025
3	ZyXEL 3 ADPCM	3	7200, 8000, 9600, 11025
30	ZyXEL 3 ADPCM (new)	3	7200, 8000, 9600, 11025
4	ZyXEL 4 ADPCM	4	7200, 8000, 9600, 11025
40	DVI ADPCM	4	7200, 8000, 9600, 11025
80	A-law PCM	8	7200, 8000, 9600, 11025
81	Mu-law PCM	8	7200, 8000, 9600, 11025

The DCE returns the OK result code if DCE accepts this command, or it returns the ERROR result code if any of the values are out of range.

- AT+VSM?

This command causes the DCE to report the current compression setting in the following form:

```
<cml>;<vsr>
OK
```

<cml> is the compression method level, and <vsr> is the voice sample rate.

- AT+VSM=?

This command causes the DCE to report all the supported compression methods.

The DCE will report all the possible settings in the following form:

```
<cml>; <scheme>; <bits/sample>; (<vsr>,...)
3; ZyXEL ADPCM; 3; (7200,8000,9600,11025)
etc...
```

The first item in each line is the compression method level, the second item is the compression scheme, the third item is the number of bits per sample, and the fourth item is the sampling rate.

- AT+VTD=<dur>,<int>

This command causes the DCE to set the default DTMF tone generation duration <dur> and comma pause interval <int> used in conjunction with AT+V**TS** command.

The range of <dur> and <int> is from 0 to 255. The units are 10 msec. The default value for <dur> is 50 (500 ms) and for <int> is 7 (70 ms).

The DCE returns the OK result code if DCE accepts this command, or it returns the ERROR result code if any of the <dur> or <int> values is out of range.

- AT+VTD?

The DCE returns the current beep duration and pause interval setting followed by the OK result code.

- AT+VTD=?

The DCE returns the permitted values for the beep duration and pause interval. The response is:

```
(0-255), (0-255)
OK
```

- AT+VDD=<dds>,<ddi>

This command causes the DCE to set the DTMF detection threshold and the required period of continuous DTMF tone detection before the DCE can report a DTMF event.

<dds> : The DCE uses this subparameter to select the sensitivity threshold level of DTMF detection; a lower value of this subparameter implies that the DTE wants the DCE to detect the DTMF tone more sensitively. The range of

the threshold <dds> is from 0 to 15. A value of zero disables the DTMF detection. The default value is 5.

<ddi> : The required period of continuous DTMF tone detection before the DCE can report a DTMF event. A value of zero disables the DTMF detection. The range of the interval <ddi> is from 0 to 255 in units of 5 ms. The default value is 8 (40 ms).

The DCE returns the OK result code if DCE accepts this command, or it returns the ERROR result code if anf the <dds> or <ddi> values is out of range.

- AT+VDD?

This command causes the DCE to report the current <dds> and <ddi> settings. The format of the response is:

```
<dds>,<ddi>
OK
```

- AT+VDD=?

This command causes the DCE to report the permitted range of <dds> and <ddi>. The response is:

```
(0-15),(0-255)
OK
```

- AT+VSY=<timer>

This command sets the DCE's voice recording resync timer. The range of <timer> is from 0 to 255 in 50 ms units. The default value is 0 (disable). A value of 0 disables resync generation. In Voice Mode, the speech coder is reset and generates a resync symbol - <DLE><DC2> in the voice data according to this timer interval.

The DCE returns the OK result code if DCE accepts this command, or it returns the ERROR result code if the <timer> value is out of range.

- AT+VSY?

The DCE returns the current resync timer value, followed by the OK result code.

- AT+VSY=?

The DCE returns permitted interval of resync timer. The response is:

```
0-255
OK
```

Note: *AT+VSY is not defined in IS-101. IS-101 did define that the DTE can send a <DLE><FS> code to have the DCE reset its decompressor and concatenate following voice data. IS-101 did not have a command to have the DCE periodically reset its compressor and generate resync symbols in voice recording mode.*

Voice Data Format

The voice data file format is described in the ZFAX documentation on the software floppy disk. Compressed voice data has a continuity property, i.e., you cannot cut and paste to edit the voice files. In order to enable editing, resync symbols can be inserted into ADPCM voice data at regular intervals. Use the AT+VSY command to set the resync interval. Set AT+VSY=0 (default) to disable resync generation. The unit of a resync interval is 50 ms. The ADPCM coder is reset with every resync symbol, thus the ADPCM voice data will not depend on history. If you convert the compressed voice data into the uncompressed PCM data file, you can always edit the PCM file with no problem. The resync symbol is a shielded <DLE> code - <DLE><DC2> (hex 10 and 12).

Note: *The resync symbol can also be used as a timing mark.*

Examples of Voice Mode Operation

Recording a greeting message

(Connect a telephone set to the PHONE RJ11C jack).

Commands	DCE Responses	Description
AT+FCLASS=8	OK	Switch to voice mode.
AT+VSM=?	See table on page 12-14	List the compression schemes
AT+VSM=4	OK	Select 4-bit ADPCM compression method.
AT+VLS=1	VCON	Activate the telephone set on the PHONE jack.
AT+VRX	CONNECT <DATA>	Start recording.
<DLE><!>	<DATA> <DLE><ETX> OK	Stop recording, and return to command state.
AT+VLS=0	OK	Deactivate the telephone on the PHONE Jack.
AT+FCLASS=0	OK	Return to data mode.

Playing a voice file through the internal speaker

Commands	DCE Responses	Description
AT+FCLASS=8	OK	Switch to voice mode.
AT+VSM=?	See table on page 12-14	List the compression schemes
AT+VSM=2	OK	Select 2-bit ADPCM compression method.
AT+VLS=16	VCON	Activate internal speaker.
AT+VTX	<DATA> <DLE><ETX> OK	Start replay, then return to the command state.
AT+VLS=0	OK	Deactivate internal speaker.

Commands	DCE Responses	Description
AT+FCLASS=0	OK	Return to the data mode.

Playing a voice file through the phone line

Commands	DCE Responses	Description
AT+FCLASS=8	OK	Switches to voice mode.
AT+VSM=?	See table on page 12-14	List the compression schemes
AT+VSM=4	OK	Select 4-bit ADPCM compression method.
AT+VLS=2	VCON	Connect to line.
AT+VTX	CONNECT <DATA> <DLE><ETX> OK	Start replay. Return to command state.
AT+VLS=0	OK	Deactivate line connection.
AT+FCLASS=0	OK	Return to the data mode.

Act as a Voice answering machine

Commands	DCE Responses	Description
AT+FCLASS=8	OK	Switch to voice mode.
AT+VSM=?	See table on page 12-14	List the compression schemes
AT+VSM=4	OK	Select 4-bit ADPCM for greeting message.
AT+VLS=2	VCON	Connect to line.
AT+VTX	CONNECT <DATA> <DLE><ETX> OK	Start to play greeting message. Return to command state.
AT+VSM=2	OK	Change to 2-bit ADPCM for recording.
AT+VRX	CONNECT <DATA> <DLE>**b** *or* <DLE>**q**	Start recording. DCE detects **b**usy tone *or* long period of **q**uiet.
<DLE><!>	 <DATA> <DLE><ETX> OK	Stop recording. DCE delivers remaining data. Return to command state.
AT+VLS=0	OK	Deactivate line connection.
AT+FCLASS=0	OK	Return to data mode.

Act as a Fax answering machine

Command	DCE Response	Description
AT+FCLASS=8	OK	Switch to voice mode.
AT+VSM=?	See table on page 12-14	List the compression schemes
AT+VSM=4	OK	Select 4-bit ADPCM for greeting message.
AT+VLS=2	VCON	Connect to line.
AT+VTX	CONNECT <DATA> <DLE>**c** *or* <DLE>'**n'** <DATA> <DLE><ETX> OK	Start to play greeting message. T.30 fax **c**alling tone *or* DTMF digit '**n**' detected. Return to command state.
AT+FCLASS=2	OK	Switch to fax mode.
ATA	Try to handshake fax mode.	Answer fax call.

Note: *If a modem data tone is detected - a <DLE>e response, the modem should be switched to data mode*

Act as a Data answering machine

Command	DCE Response	Description
AT+FCLASS=8	OK	Switch to voice mode.
AT+VSM=?	See table on page 12-14	List the compression schemes
AT+VSM=4	OK	Select 4-bit ADPCM for greeting message.
AT+VLS=2	VCON	Connect to line.
AT+VTX	CONNECT <DATA> <DLE><ETX> OK	Start to play greeting message. Return to command state.
AT+VSM=2	OK	Change to 2-bit ADPCM for recording.
AT+VRX	CONNECT <DATA> <DLE>**s**	Start recording. DCE detects **s**ilence.
<DLE><!>	 <DATA> <DLE><ETX> OK	Stop recording. DCE delivers remaining data. Return to command state.
AT+FCLASS=0	OK	Switch to data mode
ATA	Try handshake data mode.	Answer data call.

Note: *If a modem data tone is detected (a <DLE>e response) , the modem should be switched to data mode.*

Chapter 13 - AT Command Set Reference

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 command state.

An AT command prefix (ATtention) must precede each command line, and up to 40 characters can be entered in a command line with a single AT prefix.

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.

AT Command Descriptions

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.	
A		Go on-line in answer mode. (See also S39.2, S43.6)	
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	

Command	Options	Function & Description	Ref.
B*nn*		Select ISDN Teleservice 'B' must be followed by two digits.	S82 S102
	B00	X.75 Transparent	
	B01	X.75 T.70	
	B10	64X or 56Kbps transparent mode	
	B13	V.110 user rate = 2400 bps	S117
	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 = 48000 bps (sync only)	
	B19	V.110 user rate = 56000 bps (sync only)	
	B20	V.120	
	B40	PPP async to sync conversion	
	B41	SLIP async to sync conversion	
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	
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.	

Command	Options	Function & Description	Ref.
CP*n*		Loopback 4 control	S83.0
	CP0	Disable Loopback 4	
	CP1	Enable Loopback 4	
CR*n*	n=0-3 0 *	Resumes a previously suspended call, n is the call identifier(Europe)	
CS*n*	n=0-3 0 *	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>	
DB*s*		Dial s (number and options) that follows for the Analog adapter (POTS port)	
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	
DS*n*	n=0-39	Dial number stored in non-volitile RAM at location 'n'.	S44.3
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 a/b adapter	
I*n*		Display inquired information	
	I0	Display product code, same as 'ATI'.	
		Results: 28641 (USA) 28642 (DSS1) 28643 (1TR6)	

Command	Options	Function & Description	Ref.
	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 (see following section for description of output.)	
L*n*	n=0-7 4 *	Speaker volume control. The higher the value, the higher the volume.	S24.5-7
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=0-7 5 *	Ring volume control.'N0' will disable the audio ring function.	S24.1-3
O		Return to on-line state	
O1		Force modem to request a retrain.	
P*n*		D-channel protocol selection(USA) for American Version	S86
	P0 *	Northern Telecom proprietary ISDN	
	P1	National ISDN 1 (1 SPID)	
	P2	reserved for National ISDN (2 SPID)	
	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'.	
SPIDr=*nnn*...		User enters Service Profile ID nnn...(USA)	
	SPID0	First SPID number	
	SPID1	Second SPID Number, if any	
SPID?		Display the SPID setting(s)	

Command	Options	Function & Description	Ref.
T		Repeat last user-to-user information (Europe)	
Tn<string>		The <string> will be sent to the called party via a user-to-user information element in the next message. Characters other than the alpha-numeric 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 characters	
	T7	ITU-TS recommendation V.120 rate adaption	
	T8	Q.931 user-network call control message	
UPX		Download firmware to the Flash EPROM usin Xmodem protocol	
Vn		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.	
Xn	n=0-7 5 *	Result code options, see the Options Table	S23.3-5
Zn	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 ATI2 Output:

The Link Status Report output appears as follows:

```
ZyXEL MODEMS LINK STATUS REPORT

Chars Sent              0     Chars Received          0
Octets Sent             0     Octets Received         0
Blocks Sent             0     Blocks Received         0
Blocks Resent           0     Max Outstanding         0
Max Block Size          0     Retrains Requested      0
Link Duration           0     Retrains Granted        0
FRN Requested           0     FRN Granted             0
FCS Errors              0     Round Trip Delay        0
Xmitter Underrun        0     Receiver Overrun        0
Last Speed/Protocol     14400

Disconnect Reason       Local hang up
```

Data Type	Description
Chars	Data received from or sent to DTE (PC). (Formatted as 7,E,1 or 7,O,1 or 8,N,1 etc.)
Octets	Data received from or sent to remote modem in error control mode. (Compressed if data compression was enabled.)
Block	Framed Octets. (Delimited by the unique bit pattern "01111110" known as a flag.)

Output Parameter	Output Value Description	
Chars Sent	Number of characters DTE has sent to modem	
Chars Received	Number of characters modem has sent to DTE	
Octets Sent	Number of data bytes sent to remote modem	
Octets Received	Number of data bytes received from remote modem	
Blocks Sent	Number of data blocks sent to remote modem	
Blocks Received	Number of data blocks received from remote modem	
Blocks Resent	Number of blocks resent due to remote modem request. (If there were many blocks resent, you may have experienced line trouble or protocol incompatibility.)	
Max Outstanding	Maximum blocks received without acknowledgment by remote modem.	
Max Block Size	Maximum octets contain in a block	
Retrains Requested	The number of times local modem requested retrain.	
Link Duration	Total link duration time (in minutes).	
Retrains Granted	The number of times remote modem requested retrain.	
T401 Timeouts	For protocol maintenance, modem probably recovered.	
T402 Timeouts	For protocol maintenance, modem probably recovered.	
FCS Errors	Errors in frame (block) checksum. (If there were many FCS Errors, you may have experienced problems on the line.)	
Round Trip Delay	Time (Units 1/2400 sec.)	
Xmitter Underrun	For modem's processor power measurement.	
Receiver Overrun	For modem's processor power measurement.	
Disconnect Reason	Local Hang-up Carrier Lost Resent Expiration Break Timeout Carrier Lost 1 (No handshaking response)	Remote Hang-up On-Line (Not disconnected) Protocol Error DTR Dropped Carrier Lost 2 (Remote hang-up, busy tone)

Extended "AT&" Command Set

Command	Options	Function & Description	Ref.
&Bn		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)	
&Cn		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)	
&Dn		Data Terminal Ready (DTR) options. (See also S25)	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.	
&En		B channel line speed for ISDN data call	S118.2
	&E0 *	64Kbps	
	&E1	56Kbps (Default for American ISDN)	
&F		Load factory settings to RAM as active configuration.	
&Gn		Guard tone options (for internal fax/modem)	S28.4-5
	&G0 *	No guard tone (within USA, Canada).	
	&G2	1800 Hz guard tone.	
&Hn		Data flow control, DTE/DCE.	S27.3-5
	&H0	Flow control disabled.	
	&H3 *	Hardware (CTS/RTS) flow control	
	&H4	Software (XON/XOFF) flow control.	
&Jn		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	

Command	Options	Function & Description	Ref.
&Kn		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 S38.5, S41.0).	
	&K3	V.42+MNP4.	
	&K4 *	V.42+V.42bis, compatible with &K2 (See also S38.5).	
&Knn		V.120/X.75 compression control. &K must be followed by two digits.	S83.2
	&K00	Disable V.42bis	
	&K44	Enable V.42bis	
&Ln		Force to POTS setting.	S84.5
	&L0	Force Analog calls to POTS port.	
	&L1	Do not Force Analog calls to POTS port. All calls will be processed by Elite 2864I.	
&Nn		Modem link mode options (DCE/DCE). (See also S43.7, S48.1)	S19
	&N0 *	Multi-Auto, auto negotiate highest possible link rate: V.34, ZyX 19200, ZyX16800, 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)	
	&N3	V.32 9600T/9600/7200T/4800	
	&N4	V.32 9600/7200/4800	
	&N5	V.32 4800	
	&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	

Command	Options	Function & Description	Ref.
	&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	
&On		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 (POTS port)	
&Sn		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)	
&Tn		Modem testing.	
	&T0	Terminate test in progress.	
	&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	
&Vn		View profile settings.	
	&V0	View current active settings.	
	&Vn	View the (n-1) user profile settings (n=1-4)	
	&V5	View factory default settings.	
	&V6	View a/b adapter's setting	
&Wn	n=0-3	Write current settings to user profile n in non-volitile RAM. (See also S35.6)	

Command	Options	Function & Description	Ref.
&Yn		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.	
&Zn=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.	
&ZIn=s		MSN setting. 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=0~4	Assigns the phone number ‘s’ for ISDN data. (V.120, V.110, X.75, PPP, SLIP)	
	n=6	Assign the phone number ‘s’ for internal fax/modem	
	n=7	Assign the phone number ‘s’ for the Analog adapter (POTS port)	
&ZI?		Display the phone number (including subaddress , if any) for various B-channel protocols	
&Z?		Display all the phone numbers stored in non-volitile RAM.	

Extended "AT*" Command Set

Command		Function & Description	Ref.
*Cn		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.	
*Dn	n=0-39	Set default dial pointer at telephone directory location n.	S29
	*D0 *	(See also S35.4 and S38.0)	
*En		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).	
*Hn	n=0-39	Modify user password table at location n.	
*Qn		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	

For the ‘AT+F’ commands, refer to Chapter 10 - “Fax Operation”
For the ‘AT+V’ commands, refer to Chapter 11 - “Advanced Voice Operation”

Chapter 14 - Status Registers and Result Codes

S-registers (status registers) contain values that determine and reflect how your modem operates and executes commands. You can read their 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.

The Elite 2864I is equipped with 128 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 commands 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 Analog Adapter’s setting

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 r 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.**
	10001000	136	$88	01000000	64	$40
OR	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

- Using the ***result*** decimal value, do an ATS38=n to set the register.

S-Register Descriptions

The descriptions for each S-register. In most bitmapped S-registers, the default bit value is 0 (which is the normal situation) and only the non-default situation is 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	+Def./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

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	

Command	bit	dec	hex	Function and description	Ref.
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=	bit	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 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, same	+000/&Nn
		0-73	0-49	setting value as 'AT&Nn' command	
S20=		dec	hex	DTE speed (bps). Auto detected from AT command	+003
		0	0	230400	
		1	1	115200	
		2	2	76800	
		3	3	57600	
		4	4	38400	
		5	5	19200	
		6	6	16800	
		7	7	14400	
		8	8	12000	
		9	9	9600	

Command	bit	dec	hex	Function and description	Ref.
		10	A	7200	
		11	B	4800	
		12	C	2400	
		13	D	1200	
		14	E	460800	
		15	F	300	
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

Command	bit	dec	hex	Function and description	Ref.
		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	16-119	10-70	- Speaker volume control, increments of 16 in decimal value	L0-7
S25=	all	0-255	0-FF	Detect DTR Change in &M1 mode immediately after establishment of connection: determines how many seconds delay between connection examination of DTR, allowing ISDN/modem to be moved without disconnecting call.	+000
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 *Q1 is poor	
		128	80	Adaptive rate (auto fall-back /forward) when signal quality changes	*Q2 S41.2
		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

Command	bit	dec	hex	Function and description	Ref.
S32=		0-255	0-FF	Holds the ASCII decimal value of the XOFF	+019
S35=	bit	dec	hex	Bit mapped register	+000
	4	16	10	When Data/Voice swith is pressed, modem will dial the default number.	*Dn S29
	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
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:	+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	S27.6 *n
	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	

Command	bit	dec	hex	Function and description	Ref.
	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 seconds 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	&Zn S38.0
	4	16	10	DSR follows DTR (see also S41.5)	&Sn
S56=	bit	dec	hex		+050
		0-255	0-FF	Hook flash detect time for Analog Adapter (POTS port); units 10ms	
S62=	bit	dec	hex	Bit mapped register	+000
	0	0 *	0	Force the modem to use the new values of S18 to fix the baud rate when answering.	
		1	1	Force the modem to use the old values of S18 (compatible with 1496 series modem) to fix the baud rate when answering.	
S71=	bit	dec	hex	Bit mapped register	
	4	0 *	0	The modem will not print stored fax pages that have already been downloaded to the computer	
		16	10	The modem will print stored fax pages	
	5	0 *	0	The modem will not upload fax pages to the computer that have already been printed	
		32	20	The modem will upload printed fax pages to the computer	
S72=	bit	dec	hex	Bit mapped register; Printer Type	
	0	0	0	HP PCL: DeskJet 500, LaserJet II ser.	
		1	1	HP PCL: LaserJet III series	
	1	2	2	PostScript Level I printer	
S73=	bit	dec	hex	Bit mapped register; Fax printing flag	
	0	0 * 1	0 1	Print faxes through parallel port Print faxes through serial port	
	1	0 * 2	0 2	Fast PCL printing ON Fast PCL printing OFF	
	2	0 * 4	0 4	Resolution 300dpi Resolution 150dpi	

Command	bit	dec	hex	Function and description	Ref.
	3	0 8 *	0 8	Do not resize Resize	
	4-6	16 * 32 64	10 20 40	Paper size LETTER Paper size LEGAL Paper size A4	
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	Not sending Low Layer Compatibility information for ISDN data call	
		64	40	Sending Low Layer Compatibility for ISDN data call	
	7	0 *	0	Not sending Low Layer Compatibility information for a/b adapter	
		128	80	Sending 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	
		70		X.75 64000 BTX	
		71		X.75 56000 BTX	
		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 for DTE channel 1:	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
S84=	bit	dec	hex		
	0-2			Embedded protocol analyzer control	CCn
	0	1	1	Capture DTE-DCE interface protocol information	

Command	bit	dec	hex	Function and description	Ref.
	1	2	2	Capture the B-channel (X.75 or V.120) frames	
	2	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	Force calls to POTS Port	&L0
		32	20	Do Not force calls to POTS Port	&L1
S86=		dec	hex	D-channel protocol selection(USA) The following number is valid 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-multipoint (1 SPID mode)	
		6	6	AT&T custom point-to-multipoint (2 SPID mode)	
S87=	bit	dec	hex		
	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 all right	
		2	2	Triple DES is preferred	
	2	0	0	PKDS on, key automatically generated	
		4	4	no PKDS, key in the key words	
	3	0	0	If DES link cannot be established then keep connection.	
		8	8	If DES link cannot be established then disconnect the call	
	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)	
S102=	bit	dec	hex	Outgoing ISDN data type. Value has the same definition as S82	Bnn

Command	bit	dec	hex	Function and description	Ref.
S117=				V.110 user rate	B1n
S118=	bit	dec	hex		
	1	0	0		
	2	0	0	Default B channel line speed is 64Kbps for ISDN data call	&E0
		4	4	Default B channel line speed is 56Kbps for ISDN data call	&E1
	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 adapter	
	6	0 *	0	Enable analog adapter to accept global calls	
		64	40	Forbid the analog adapter to accept incoming calls with MSN unmatched (including global calls, see AT&ZI=s)	
	7	0 *	0	Enable analog incoming calls	
		128	80	Reject analog incoming calls	
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	Inbound call ignored when no MSN (EAZ) is matched	
		8	8	Inbound call accepted using default protocol when no MSN (EAZ) is matched	
	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 subaddress, and match with the called_party_subaddress for inbound call routing	
S120=	Accumulated charging unit (MSB byte) for B1 channel				
S121=	Accumulated charging unit (LSB byte) for B1 channel				
S122=	Accumulated charging unit (MSB byte) for B2 channel				

Command	bit	dec	hex	Function and description	Ref.
S123=	Accumulated charging unit (LSB byte) for B2 channel				
S124=		dec	hex	Empty IP packet interval for PPP	+000
		0-255	0-FF	Units of 1 sec.	

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.
Note:	'AT' is omitted when an AT command is referred to in the 'Reference' column..

Result Code Options

"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		%	%	%	%	@		

ATV0	ATV1	X0	X1	X2	X3	X4	X5	X6	X7
33	CONNECT 62400		%	%	%	%	@		
34	CONNECT 41600		%	%	%	%	@		
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 12800		%	%	%	%	@	$	#

* 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>
@	For internal fax/modem: CONNECT DTE_Speed/Protocol DCE_Speed/Error_Control ** Example: `CONNECT 38400/V.32bis 14400/V.42bis` For ISDN data call: <cr><lf>CONNECT DTE_Speed/Protocol DCE_Speed/Error_Control[/Data_Compression]<cr><lf>
$	<cr><lf>CONNECT DCE_Speed[/Error_Code]<cr><lf> Example: CONNECT 14400/ARQ
#	For internal fax/modem: CONNECT DCE _Speed/Error_Code/Error_Control ** Example: CONNECT 14400/ARQ/ MNP5 For ISDN data call: <cr><lf>CONNECT DCE_Speed/Error_Code/Protocol DCE_Speed/Error_Control [/Data_Compression]<cr><lf>

** Data compression included. 'SREJ' is appended if a V.42 connection with selective reject is established.

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 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
```

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

Chapter 15 - Diagnostics and Protocol Analyzer

Diagnostics

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.

The Elite 2864I ISDN modem provides several diagnostic capabilities:

- Embedded Protocol Analyzer
- Power-on Self-test
- Analog Loopback Test (For internal fax/modem only)
- Analog Loopback with Self-Test (For internal fax/modem only)
- Local Digital Loopback Test
- Remote Digital Loopback Test (For internal fax/modem only)
- Remote Digital Loopback with Self-Test (For internal fax/modem only) Re-transmission Indicator
- Link Status Report (For internal fax/modem only)
- ISDN Modem Reset

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 Elite 2864I will also test the ISDN daughter board to make sure that the interface circuits are ready to perform.

Main-Board's Self-test

The HLD LED will be ON during power-on main-board self-test. The LED will be OFF after the test, if it tested out OK. The LNK LED flashes if the test fails. The number of times the LED blinks indicate the number of errors according to the following table:

# of Flashes	Error Description
1	ROM code checksum error
2	System RAM fail

# of Flashes	Error Description
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 Elite 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-test:

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	off	off	Interface test 2 with Siemens 2086 chip
6	off	off	on*	Interface test 3 with Siemens 2086 chip

The LED lights up while test is going and blinks if the test fails. The LNK LED lights 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.

If the B2 light blinks while the Elite 2864I is powered on, it might be because the connection between your Elite 2864I and the NT-1 device is not properly made. Another reason may be related to an improper phone line set up. You should either check the connection between the Elite 2864I and your NT-1, or you should disconnect the ISDN line from the Elite 2864I and power it off. Wait 5 seconds, then power it back on

Resetting The Modem

If you change the modem's setting and cannot get it back, or you just want to get back to the factory default state, the following reset procedure will reset the modem to the factory state. On the LED models, this procedure also causes the modem to run a self-test. It is a good way to test the modem hardware.

Holding the DATA/VOICE key down for a few seconds while powering up the modem, will reset the modem. The modem will also run a continuous analog loopback self-test. Printable characters will be shown on the terminal connected to the modem's DTE port.

After a few seconds, the CD, DSR, CTS, PWR, MDM, and SP LEDs should light. If not, there is a hardware problem. Contact the nearest service center for help. If SQ flashes, the number of flashes indicates the corresponding error number.

Loopback Test (AT&T1)

If the Elite 2864I is in the internal fax/modem channel (modem/fax mode), it is the analog loopback test mode. Issuing an AT&T1 will initiate the loopback test. If the Elite 2864I is in the ISDN data mode, the AT&T1 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 TA and RS-232 cable, except the passive front-end of the ISDN S/T interface.

During this test, data from the terminal or computer is sent through the DTE interface to the ISDN modem's transmitter and is packetized to the proper frame format according to the B-channel protocol selected. It is then looped back to the receiver, de-packetized, and sent through the DTE interface back to the terminal or computer's screen. You can tell if anything is wrong by looking at the screen. The screen should show the data you have sent to the ISDN modem.

Loopback with Self-test (AT&T8)

If the Elite 2864I is in fax/modem mode the AT&T8 command is the analog loopback with self-test. If the Elite 2864I is in the ISDN data mode, the AT&T8 command will invoke an ISDN loopback connection with a self-test. The data is generated by the ISDN modem and will go through the same path as the Loopback test goes through. The data pattern is in printable ASCII characters. You can see the result on the screen. The looped back data is compared with the transmitted data. Should an error occur, the LNK LED will start to flash. Sending any character through the DTE interface to the ISDN modem will discontinue the test.

Using The Embedded Protocol Analyzer

Setting up the Embedded EPA

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 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 in 0.01 second. The following commands determine the kind of protocol data to be captured by the EPA:

AT Command	**Description**
ATCDn	
CD0	Disable the capture of D-channel protocols
CD1	Enable the capture of D-channel protocols (default)
ATCBn	
CB0	Disable the capture of B-channel protocols (default)
CB1	Enable the capture of B-channel protocols
ATCCn	
CC0	Disable the capture of DTE-DCE interface protocols (default)
CC1	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 follow:

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 pop up this control menu.

Chapter 16 - Elite 2864I General Reference

This chapter is included as a general reference to the connectors, interfaces, protocols, and standards used by the Elite 2864I, including definitions of many of the communications-related terms used in this manual.

Front Panel and LED Lights

This section describes the functions of the ZyXEL Elite 2864I front and back panels.

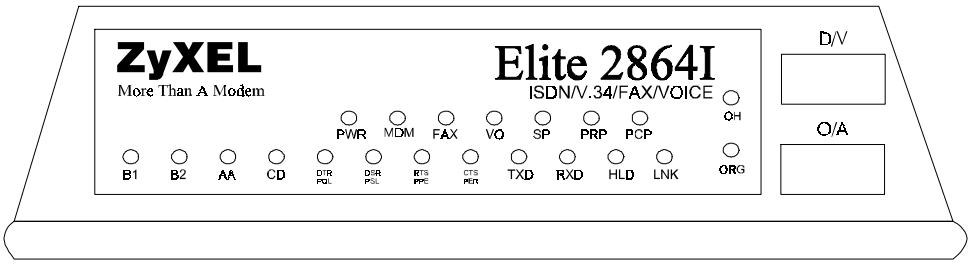


Figure 16-1

PWR — Power on indicator - lights up when the Elite 2864I is turned ON.

MDM — Modem active indicator - lights up when the Elite 2864I operates in modem mode.

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

VO — Voice mode indicator - lights up when the Elite 2864I operates in voice mode.

SP — Serial port active indicator - lights up when the Elite 2864I is using the serial port for DTE communication.

PRP — Printer parallel port active indicator - lights up when the Elite 2864I is using the parallel port to drive a printer for fax printing.

PCP — PC parallel port active indicator - lights up when the Elite 2864I is using the parallel port to communicate with a PC's bi-directional parallel port.

B1 — B1 channel connection indicator - lights up when B1 channel is in use. A single blinking LED indicates data transmission is protected by Data Encryption Standard (DES).

B2	B2 channel connection indicator - lights up when a B2 channel is in use. A single blinking LED indicates data transmission is protected by Data Encryption Standard (DES).
AA	Auto-answer indicator - lights up when the Elite 2864I is in the Auto Answer mode; it flashes when it rings.
CD	Carrier detect indicator - lights up when a valid carrier is present 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 terminal ready indicator - lights up when the DTE or Computer indicates it is ready for communication by raising the corresponding RS232 signal. Printer mode: Printer on-line indicator - indicates the signal status of "Select" from the printer. It lights up when the printer is selected and is available for data transfer.
DSR/PSL	DTE mode: Data set ready indicator - lights up when the Elite 2864I is ready for communication. Printer mode :Printer select signal - indicates the signal status of "Select-In" from the Elite 2864I to the printer. It lights up when printer is enabled to input data.
RTS/PPE	DTE mode: Request to send indicator - indicates the signal status of the RS-232 signal RTS from DTE. RTS is used for hardware flow control in asynchronous data transmission. Printer mode: Printer paper end indicator; lights up when the printer runs out of paper. It indicates the signal status of PE from the printer.
CTS/PER	DTE mode: Clear to send indicator - lights up when the Elite 2864I can accept data for transmission. Printer mode: Printer error indicator - 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 the printer.
TXD	Transmit data indicator - flashes when the DTE/Computer is transmitting data to the Elite 2864I.
RXD	Receive data indicator - lights up when the DTE/Computer is receiving data from the Elite 2864I.

HLD — Call hold indicator - lights up when the telephone (connected to the analog adapter) is in Hold condition.

LNK — Physical layer (layer 1) active indicator - lights up when Layer 1 of the S interface is active; flashes when the data link layer of the D channel is in multiple frame mode. LNK is also used as a self test indicator for internal fax/modem initialization. In this case, the Elite 2864I's LED LNK behaves just like the Elite 2864's LED SQ. It lights up when signal quality is good and flashes when it is marginal.

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

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

Elite 2864I Front Panel Switches

D/V — A toggle switch that allows you to answer a call manually when the Elite 2864I is not set up to automatically pick up a call. Press the button once to connect the call. Press it again, and the call will be disconnected.

O/A — A toggle switch that determines whether the Fax/Modem is in originate mode or answer mode when it goes off-hook (by pushing the D/V switch).

Elite 2864I Back Panel

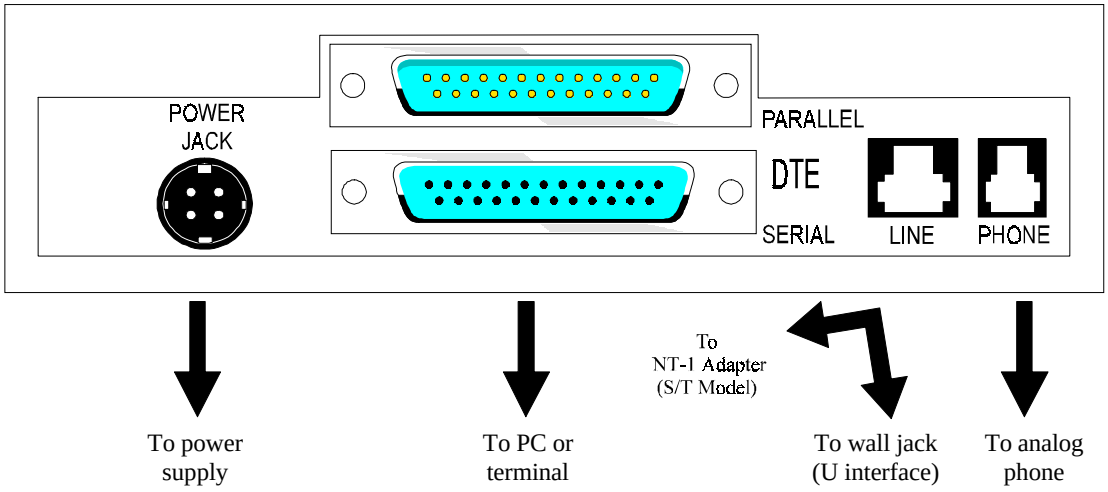


Figure 16-2

The diagram above shows the rear panel of the Elite 2864I. The following explains the connectors on the rear 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 to the power jack.

PARALLEL Parallel port DB25 male connector for connection to a PC's parallel port or a printer's Centronics compatible port.

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

LINE ISDN RJ45 terminal jack. For the Elite 2864I-S/T, this is for connection to a S/T interface. For the Elite 2864I-U, this connects the U interface.

PHONE Analog adapter RJ11 terminal jack connects analog telephone equipment.

Multiple Logical Communication Modes

In order to meet your personal communication needs, the Elite 2864I has 3 major communication modes built-in.

1. ISDN mode
2. Analog modem/fax/voice mode
3. Analog port (POTS) mode

The 2864I has two physical DTE ports (Serial & Parallel); only one can be active at any given time. In order to communicate with multiple channels, a special set of AT commands was created.

DTE Interface

DTE and DCE are terms used in data communication. DTE stands for Data Terminal Equipment and DCE stands for Data Communication Equipment. The computer or terminal is the DTE and the modem is the DCE.

To meet the increasing demand of data bandwidth between DTE (Data Terminal Equipment) and DCE (Data Communication Equipment), ZyXEL ISDN adopts several kinds DTE interfaces:

- RS-232 with speeds up to 460.8 Kbps.
- ZyXEL Parallel Port Interface (ZyPPI).

This is a special interface connected to PC's printer port. ZyXEL has developed two drivers for ZyPPI:

- Fossil driver under DOS

- COM port device driver for Windows

The files are included on the *"Firmware & Drivers"* disk provided with your modem.

Operation Modes of DTE Interface

There are two operation modes for the DTE interface:
- Simplex mode is used for conventional AT command question
- Multiplex mode is used as an internal interface for ZyXEL CAPI drivers.

In the **simplex mode**, operating an ISDN modem is similar to operating any ordinary modem. The DTE interface will be either in the command state or in the data state, and only one data connection session is available at any one time. The simplex mode is designed for the AT command users. To invoke various functions of the 2864I, e.g. fax/modem, ISDN data call, or the analog adapter, the users only need to use the corresponding AT commands. The guides and descriptions, in the rest of this manual, if not otherwise specified, are applicable to the simplex mode. Please note that simplex mode is also the power-on default mode of the DTE interface.

The **multiplex mode** is designed for ZyXEL CAPI drivers. It can also be used by a third party to develop various drivers on different platforms for public domain or for commercial purpose. Conceptually, there are four DTE channels in the multiplex mode:

DTE channel 0	for internal fax/modem
DTE channel 1	for ISDN data
DTE channel 2	for ISDN data
DTE channel 3	for the analog adapter

In the multiplex mode, all the commands and data are *packetized.* Each packet has its own destination address through which all the DTE channels can be accessed individually in lieu of multiplexing. Since it is not intended for the general users, the specification and manual of the multiplex mode is available only upon request. Interested parties are welcome to contact ZyXEL Dealers for more information.

Serial Port

A serial port is the serial data connector together with its internal circuit on the DTE or DCE with electrical and mechanical characteristics according to RS-232C. Since some signals travel from the DTE port to DCE port, and some signals travel in the opposite direction, the signal pin is a transmitter on one port and a receiver on the other. The DTE serial port is different from the DCE serial port in terms of signals on the connector pins. There are also mechanical differences in terms of male (with pins) or female (with holes) connectors.

RS-232C or EIA-232D/E

RS-232C is the Recommended Standard (RS) of the Electronic Industries Association (EIA), defining the serial communication interface between a DTE and a DCE. The 232 is basically a serial number for the defined standard. Sometimes it is necessary to redefine a standard, or to revise it. The most commonly used revision of the RS232 standard is the "C" revision. For the "D" revision, the prefix was changed to EIA. Except for a few signals which were added but not commonly used, there is no practical difference between the "C" and "D" revisions. There is now a new revision with the ”E“ suffix. The RS-232C standard is equivalent to the ITU-T V.24 and V.28 standard.

Synchronous and Asynchronous Communication

There are two kinds of serial data communication. One is called synchronous, and the other is called asynchronous. In synchronous communication, data is transmitted and received bit by bit and is timed by an accompanying clock signal. In asynchronous communication, data is sent character by character (or octet by octet), and the idle time between characters is variable. Since no clock signal is sent, character timing is recovered from the data itself.

A PC's COM1 and COM2 are asynchronous serial ports. Most PCs' and UNIX systems' serial data communications are asynchronous.

UART

A UART (Universal Asynchronous Receiver Transmitter) is the device used in a DTE or DCE for asynchronous data reception and transmission. The standard UART device used in PCs is of the NS16450 type. For high-speed serial data transfers (38400 bps and up), the PC may not serve the UART fast enough and data may be lost. In this case, a UART with data buffer is needed, such as the NS16550A type device.

Serial RS-232C Cable

A serial RS-232C cable is used to connect a DTE port to a DCE port. Do not use a null-modem cable (which may be used to connect two DTEs directly with each other through their serial ports). A normal RS-232C connector has 25 pins, and a normal RS-232C cable has 25 wires. Many signals in the RS-232C are not used in common applications, and a 9-wire RS232C cable is sufficient in most applications. The PCAT's serial port has only 9 connector pins, thus eliminating unnecessary pins. For high-speed DTE-DCE communication, use a low-capacitance cable (as short as possible).

PC Parallel Port Operation

If the modem's parallel port is connected to a PC's parallel port, the PC can communicate with the modem through the parallel port link. Be sure that your PC has a bi-directional parallel port. The modem's parallel port will not work with the old unidirectional parallel port. You need not have EPP nor ECP capability on your parallel port.

Using the parallel port, the PC sends and receives 8 data bits at a time to and from the modem. However, for your communications software package the modem appears to be

a serial device. A device driver has to be installed to shield the communication software from the actual difference in the hardware setup. The parallel port link accepts hardware and/or software flow control, but setting the serial port speed is only a dummy function; it has no effect on the parallel link.

The parallel port link only supports asynchronous mode communication. Synchronous mode is not supported. The modem buffers the data to and from the PC, direct asynchronous mode is not supported.

Parallel Port under Windows

You need to install a driver in order to use your Windows comm or fax program. ZyXEL has developed Windows parallel port drivers for which instructions are included on the program disk containing the drivers.

Parallel Port under DOS

When the DOS comm or fax program directly accesses the serial port, it is not possible for a driver program to intercept the access and redirect it to the parallel port. However, the access can be redirected to the parallel port if a comm or fax program accesses the serial port through a fossil driver, by changing the fossil driver. A fossil driver is included on the companion software disk.

Parallel Port Speed Limit

Although there is no speed limitation on the parallel port, some parallel port I/O read/write operations need to be done for every data byte transfer across the parallel port link. This limits the maximum parallel port transfer speed. The operating system and/or the comm/fax program also does a lot of overhead processing for data received or transmitted as well as for port maintenance. This also limits the maximum speed with which a PC can manage data passing through the parallel port. For the Windows user interface, or the DOS FOSSIL driver, the latter is even a dominating factor. One benefit of the parallel port is that data overruns will not occur, no matter how slow the software retrieves data from the port. This is important in the Windows environment.

ZyXEL Parallel Port Adapter

ZyXEL is developing a special parallel port adapter that will make parallel port transfers much faster between a PC and the Elite 2864I. The speed limitation in this case will be determined by how fast and how efficient the PC software program can handle the data.

The operation instructions for this special parallel port adapter are included in the adapter manual. Check ZyXEL's announcements for availability, which is expected to be within a few months of the Elite 2864I's release.

Parallel or Serial Port Operation

The Elite 2864I is equipped with both parallel port and serial ports for DTE connection. Note however that only one out of three connection modes may be active at any one time. The available modes are:

- SP: Serial port mode
- PRP: Printer parallel port mode
- PCP: PC parallel port mode

A port is active only when it is driven and/or terminated externally. (i.e. the connected device must be turned on and must drive the port). An exception to this is the serial port. The modem defaults to the serial port if no active parallel port device is connected, regardless of whether an active serial DTE is connected or not.

The modem makes its port selection based on the serial port DTR signal.

- If it is ON, the modem defaults to serial port (SP) mode.
- If it is OFF, the modem seeks for an active parallel port device.
- If an active PC parallel port is connected, the modem will operate in PCP mode.
- If an active printer is connected, the modem will operate in PRP mode.
- If no active parallel port device is connected, the modem will default to SP mode.
- If both the modem's serial and parallel ports are actively connected and the parallel port is connected to a PC parallel port, the modem makes the port selection based on the serial port DTR signal. The serial port DTE can control the modem's active port through its DTR signal.
- If both the modem's serial port and parallel port are actively connected and the parallel port is connected to a printer, the modem also makes its port selection based on the serial port DTR signal.

  a) If the serial port DTR signal is OFF, the modem operates in PRP mode. I

  b) If the serial port DTR signal is ON, the modem operates in SP mode.

- In Class Z mode operation for fax receiving and printing, the modem will temporarily switch to PRP mode to print incoming faxes.
- If you use a serial port DTE that does not provide a DTR signal, make sure that no parallel port device is connected to the modem and that the modem defaults to serial port mode. You also need to set the modem DTR setting permanently to ON (&D0).

When to Use a Serial or a Parallel Port

You can choose to use either the RS-232 serial connection or the parallel port connection to connect the Elite 2864I to your computer. You should base your selection on your

computer system, operating system, and the applications you are using. Since most PCs only support DTE speeds up to 115,200bps, we recommend that you obtain an enhanced (high speed) serial card that can support DTE speeds of up to 230,400bps or higher if you plan to use bundling protocol. If you are using the Elite 2864I with Windows 95, Windows 3.1/3.11, or DOS, the ZyXEL Parallel Port Interface drivers are available for connection between the Elite 2864I and your PC parallel port.

Advantages of using a Serial (RS232C) connection:

1. It provides the most compatibility and should work with all different types of computer systems, operating systems or applications.
2. It allows you to free up the parallel port on your Elite 2864I for a more convenient use.
3. Faxes can be received by the Elite 2864I and sent directly to your local HP DeskJet, PS laser printer (a printer connector is shipped with your Elite 2864I).

Advantages of using a Parallel connection:

1. It provides higher throughput than a regular serial port connection.
2. It consumes less CPU overhead than regular serial connections when heavy data communication is taking place.

Note*:* Please read through the installation portion of this manual. Make sure that you never connect the modem's serial connector to your computer parallel port; or connect your modem's parallel connector to your computer's serial port. This could damage your computer or your modem.

Modem Standards and Speeds

The ITU-T or ITU-TSS (International Telecommunications Union - Telecommunications Standardization Sector) is the international standard-making body for telecommunications. Their primary function is to draft recommendations. The recommendations they make for modem applications have a "V" prefix and are called V-series recommendations. The most commonly used ITU-T modem standards for 2-wire dial-up lines are:

Standard	Speed (bps)
V.34	28,800-2,400
V.32bis*	14,400/12,000/7,200
V.32	9,600/4,800
V.22bis*	2,400/1,200
V.22	1,200
V.21	300
V.23	1,200/75

* *bis* is the old French word for *second*

Table 16-1

In the US, Bell Systems used to create de facto standards such as Bell 212A for 1200 bps modems and Bell 103 for 300 bps modems. Nowadays, newer and higher speed modems generally follow the ITU-T standards.

The ZyXEL Elite 2864I supports all the above mentioned modem standards and are compatible with most standard modems.

Built-In Intelligent Modem

Modem is a compound word combining MOdulator and DEModulator. A modem is used for data communications. Refer to your ZyXEL Modem Reference Manual for a standard modem setup and application.

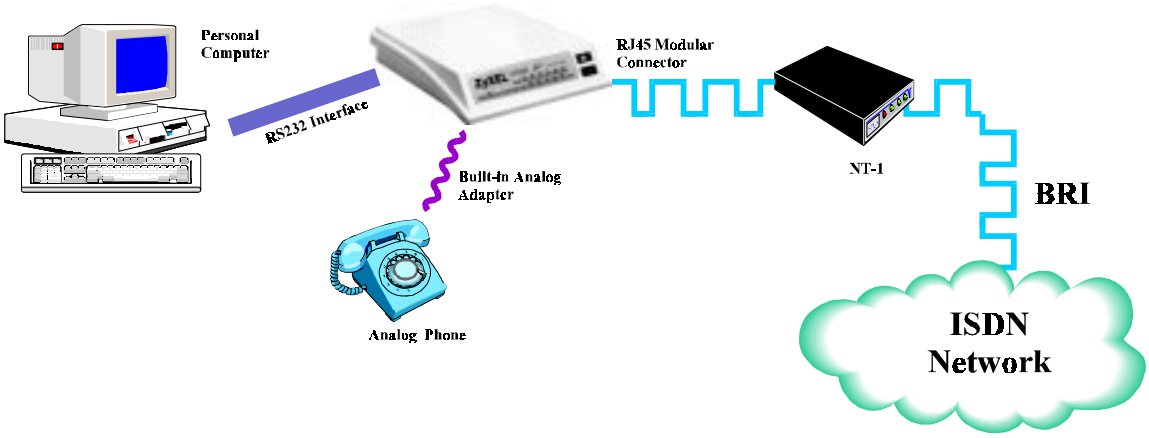


Figure 16-1

Modems are essentially, telephones for computers. A modem translates computer data into analog signals (modulation) that can travel through the telephone network to reach another modem. The receiving modem translates the analog signals back into data (demodulation) and sends the information to the receiving-end computer.

With earlier modems, functions, settings, and operations were relatively simple. Everything was controlled by manual switches or by wire-strapping settings - no computer control was provided.

With an *intelligent modem*, functions such as dialing and answering are controlled by the computer or by the terminal to which it is connected through the same RS232 serial interface used for data connection.

An intelligent modem operates in one of two states - the command state or the data state. In command state, the modem interprets data received from the serial interface as commands and sends back an action result in response. In data state, the modem modulates the data received from the serial interface and sends the demodulated data to the serial interface as received data. The user needs to know whether the modem is in the command state or data state and how to switch it.

Built-In Intelligent Modem Features

Auto Detection of Fax or Data Call

Fax and data modems have different handshaking signal sequences at the beginning of a call as specified by the ITU-T. It is possible to automatically detect whether an incoming call is from a modem or a fax device by testing and recognizing its initial handshaking sequence. A modem with this capability can make a computer process both data and fax calls on the same phone line. One example is a BBS (Bulletin Board System) which can also receive faxes. The Elite 2864I not only detects data and fax calls automatically, but also includes a fax reception and printing program which enables a BBS to receive and print faxes.

Error Correction

In synchronous data communication, data is checked and corrected in the host by the so-called "link layer protocol" to ensure data integrity. Normally, no data checking is provided in the host for asynchronous data communication. However, file transfer protocols which include error checking are available with asynchronous hosts.

Nowadays, intelligent modems incorporate error correction protocols inside the modem for asynchronous data communication, and it is transparent to the host. The modem packs the asynchronous data characters into blocks. The data is transmitted as synchronous data between the modems. The data blocks are error checked at the remote end, and erroneous blocks are retransmitted.

The most commonly used error correction protocols are MNP 4/3 and V.42 for modem and LAPB and LAPD for ISDN data protocol.

Data Compression

Intelligent modems use redundancy removing methods to reduce the number of data bits actually sent for asynchronous character transmission. The full character data is recovered at the other end, thus increasing the total throughput of the modem data transmission.

The data compression protocols commonly used by modems are MNP 5 and V.42bis. (See definitions below.)

Data compression works on redundancy removing, and its efficiency is dependent on both the compression algorithm and data statistics.

MNP Protocols

MNP (Microcom Network Protocol) is a set of protocols first introduced by Microcom, Inc., and later used by many modem manufacturers. It consists of many classes. Classes 1 to 4 are for error correction, and class 5 is for data compression. MNP class 5 is a data compression protocol with a maximum efficiency of 2 to 1 and is commonly used with

MNP-4 for error correction. MNP class 1 and 2 are obsolete. Class 4 is used for error correction and class 3 is used internally.

V.42bis and V.42

V.42bis and V.42 are data compression and error correction standards set by the ITU-T. V.42bis has a better data compression efficiency than MNP-5 and is a more advanced compression scheme. V.42bis is used with V.42 for error correction.

Xmodem, Ymodem, and Zmodem

These are file transfer protocols. They conduct error checking and ensure data integrity of the file transferred. Some variations of these protocols also appear, like Xmodem-1k, YmodemG, etc. Whenever possible, we recommend the use of Zmodem for added security and high flexibility.

The "G" types of protocols do not include error checking. Although they allow very high throughput rates, they can only be safely used only when the modems use MNP4 or V.42 error protocols and when there is no speed overrun on the computer's serial port.

V.25bis Commands

V.25bis is a dialing command set standard defined by the ITU-T. It supports both asynchronous and synchronous dialing. AT command dialing is widely used in asynchronous environments because it supports many more functions than just dialing. However, AT commands support only asynchronous dialing.

In synchronous environments, V.25bis is preferred. Synchronous V.25bis dialing is used in many IBM mainframe and mini--environments where synchronous communications are used.

The Elite 2864I supports both asynchronous and synchronous V.25bis dialing. The modem supports the bit-oriented HDLC (High-level Data Link Control) synchronous protocol which most synchronous communication links use. Appendix C lists the commands and their formats.

Call Type Switching

Outgoing Calls

The ZyXEL Elite 2864I has built-in automatic communication mode switching. For example if you use:

- "ATDI *xxx-xxx-xxxx*" as your dialing string, the Elite 2864I will automatically switch to ISDN data mode and dial out over your ISDN line.
- "ATDM *xxx-xxx-xxxx*" as your dialing string, the Elite 2864I will automatically switch to modem/fax mode and will dial out using the built-in analog modem.
- "ATDB *xxx-xxx-xxxx*" as your dialing string, the Elite will automatically forward all communication to the equipment that is connected to the POTS port.

Incoming Calls

When an ISDN call comes in, as we have explained, the user information can be carried by one of the following protocols:

- V.120
- HDLC PPP or SLIP
- V.110
- V.34 data
- G3 fax
- POTS

Your ZyXEL 2864I processes incoming calls in a very specific manner. The explanation and diagram below will help you to understand the algorithm used for this process.

The Elite 2864I uses a series of filtering processes to determine what protocol to use when answering an incoming call. When a call comes in, the Elite 2864I will first check if Multiple Subscriber Number (MSN) has been and handle the call accordingly. MSN is a setting for users to decide how to handle the incoming call based on the number that caller dialed.

If the MSN setting doesn't provide enough information to process the call, the &L*n* setting will be checked. &L*n* is a command tells the Elite 2864I whether or not to force incoming calls to the POTS port.

&L0 (Incoming calls are forced to the POTS port). *Default*
&L1 (Elite 2864I will answer the call).

If the call cannot be routed using MSD or &L*n*, and the Elite 2864I is in Auto-Answer mode, , the call will be received using the ZyXEL Elite 2864I Data Answering Routine.

If the modem is not in Auto-Answer mode it will notify the DTE channel and allow the software to decide how to answer the call.

If all these attempts fail the Elite 2864I will disconnect the call.

The following flowchart outlines the entire routing process.

Incoming Call Routing Diagram

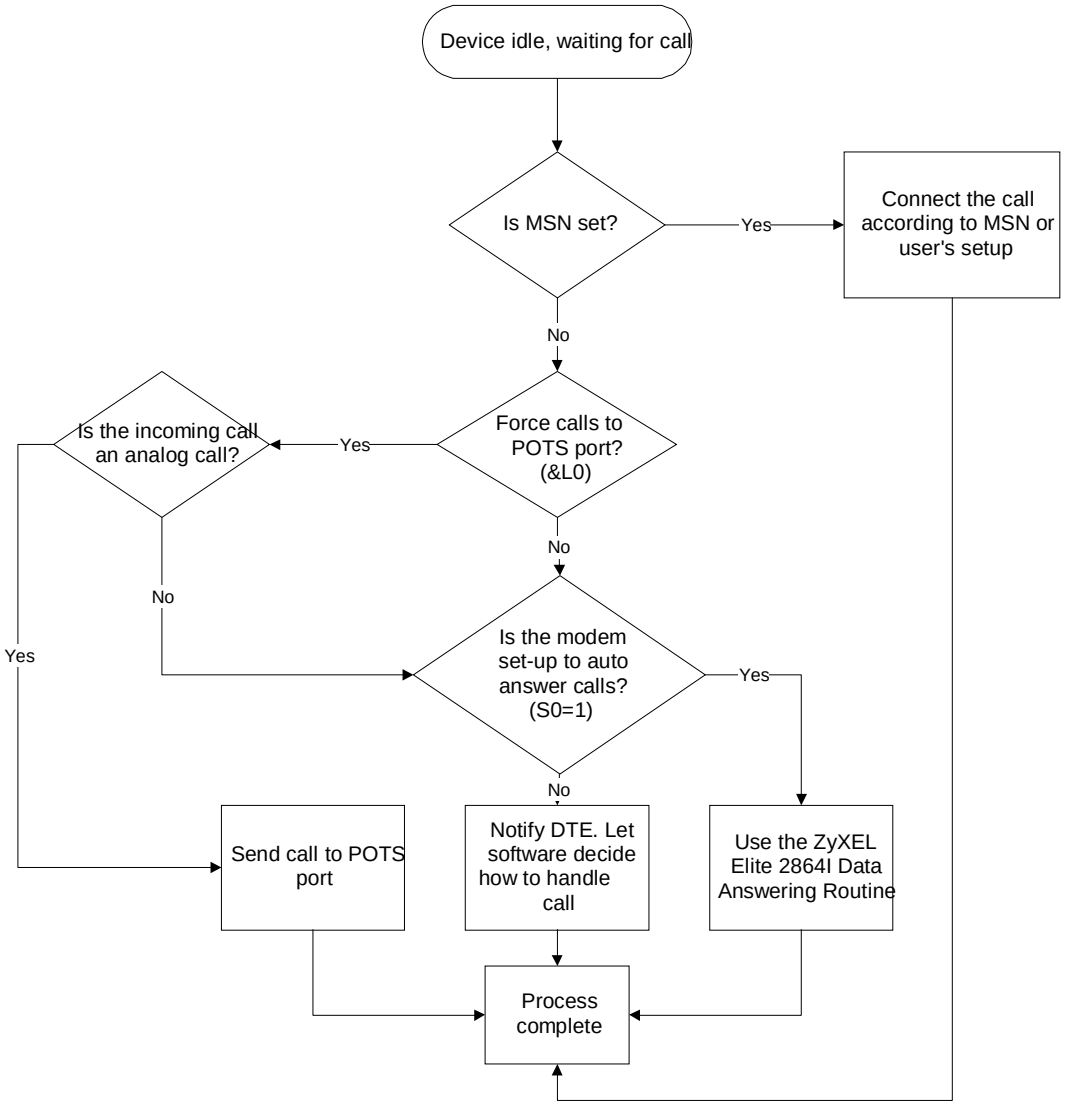


Figure 16-2

Chapter 17 - ISDN General Reference

This chapter is designed to get you acquainted with ISDN. It includes explanations of all the technical terms you need to know and will even take the guess-work out of setting up ISDN communications with your local telephone company.

ISDN or **Integrated Services Digital Network** is a global system that provides a variety of high speed digital communication solutions, while maintaining compatibility with existing analog voice, modem, data and fax protocols.

ISDN is based on various standards that define communications between switches and the equipment that connects to them. These standards allow most types of equipment to communicate across different types of switches in every part of the world.

The implementation of "network switches" by telephone companies differs from country to country. We will focus our discussions to the North American continent. If you plan to use the Elite 2864I in an area other than North America, please contact your local ZyXEL distributor for specific documentation and firmware and hardware upgrades to ensure proper operation of the ZyXEL Elite 2864I with your local ISDN switch and network.

In North America, a separate ISDN standard called National ISDN (NI-1) is currently being adopted by network providers and equipment manufacturers. When fully deployed, NI-1 will make the installation of ISDN equipment much easier. Currently, many different types of custom signaling protocols are used. Therefore, you will need to configure your ZyXEL Elite 2864I for the type of signaling that is used by the network it is connected to.

Basic Rate Interface (BRI)

When you order a Basic Rate Interface (BRI) ISDN line, you receive what is known as the "2B+D" service. This provides two B channels that can transmit at 64Kbps per channel for user information and a D channel that can communicate between the user and the ISDN network at 16Kbps.

The D channel is used to manage communication between the equipment and the switch. It is used mainly to exchange signal messages with the switch, and for setting up and releasing calls. In most cases, if there is any incompatibility issue raised, it is the D channel signaling protocol that is causing the problem. Currently, the Elite 2864I does not allow the user to use the D channel for sending and receiving user data.

Out-of-band signaling - Some switches transmit all the network signals through the D channel, allowing both B channels to be used exclusively for your communication. This allows a throughput of 128Kbps (64Kbps per channel). However, not all switches support out-of-band signaling at this time. For the switches that do not support out-of-

band signaling, network signals are transmitted through the B-channels only, which reduces the bandwidth to 56Kbps.

The Elite 2864I currently supports the following switch types and D-channel protocols:

- AT&T 5ESS Custom and National ISDN-1 protocol
- Northern Telecom DMS-100 Custom and National ISDN-1 protocol
- Siemens EWSD National ISDN-1 protocol

In the following section, you will learn how to configure your Elite 2864I to work with each one of these switches. Also provided, is information you will need when ordering your ISDN line for the Elite 2864I.

Rate Adaptation & B channel protocol

The Elite 2864I currently supports the following Protocols:

- V.120
- X.75
- V.110
- Async to Sync. PPP or SLIP

The B channels are used for carrying user communication information. This information can be data, voice or fax. Voice and analog data must be sent on the B channels. Unlike the asynchronous communications between most PC computers and your Elite 2864I, the B channel operates in synchronous mode. In order to convert the asynchronous communication to synchronous communication, it is necessary to use a Rate Adaptation protocol.

In North America, V.120 is the most popular rate adaptation Protocol used. V.120 is an ITU-T protocol that supports synchronous and asynchronous rate adaptation and provides link-layer error control. ZyXEL also implements V.42bis data compression and/or channel bundling on top of V.120, allowing the user to achieve even higher data communication throughput.

Channel Bundling combines two B channels' bandwidth for one communication session. This combination establishes a 128Kbps or 112Kbps communication link.

The Elite 2864I also supports HDLC asynchronous to synchronous conversion for Point-to-Point Protocol (PPP) and Serial Line Internet Protocol (SLIP). These protocols are very popular for Internet access and Remote Access applications.

Currently, most of us still use Plain Old Telephone Service (POTS) for our regular communication needs. The Elite 2864I provides a POTS port for you to connect analog devices. This lets you continue to use analog communications. You can connect phones, fax machines, or modems to the POTS port, while using one of the idle B channels (even if the Elite 2864I is busy doing data communications). The POTS port is fully functional, with one limitation, which we will cover in the analog adapter section.

The ZyXEL Elite 2864I comes equipped with a built-in V.34 (28,800bps) modem and G3 (14,400bps) fax function. This allows you to use one of the B channels to communicate with remote modems or fax machines.

Terminal Adapter

A Terminal Adapter (TA) allows users to send and receive data over the ISDN network. The Elite 2864I is more than a Terminal Adapter. It is an integrated TA and fax/modem, allowing users to get the best of both ISDN data and analog data. Users can send and receive both data and voice simultaneously by using both B channels. The analog adapter in the Elite 2864I allows users to connect an analog device to the TA to make out-going calls as well as receive in-coming calls. With its auto detect feature, the Elite 2864I monitors incoming calls from both analog or digital devices. It monitors these calls without user intervention and makes connections accordingly.

For example, you can set up the 2864I to receive analog calls via the built-in V.34 modem/fax or route the calls to the POTS port allowing your analog device to receive the call.

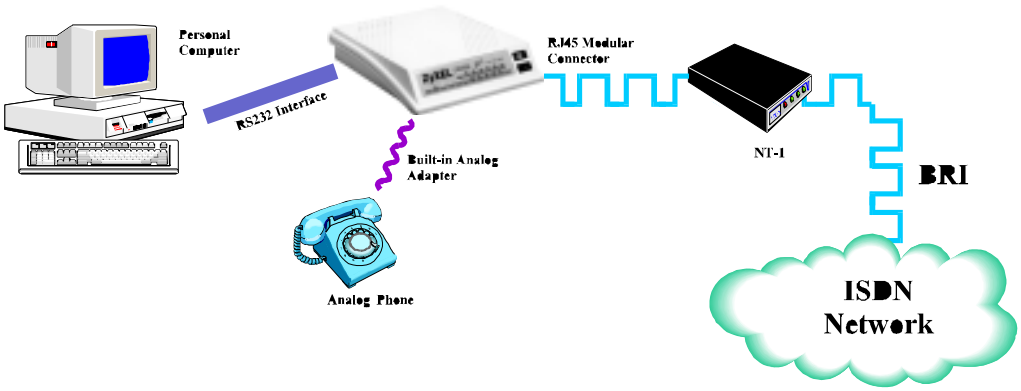


Figure 17-1

The Elite 2864I, with the NT-1 optional adapter, offers the ability to transmit data and voice through digital devices, such as an ISDN phone.

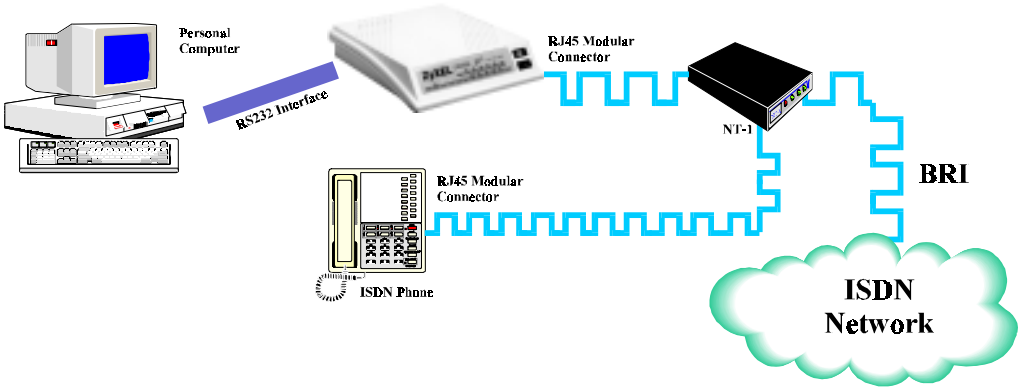


Figure 17-2

ISDN Basic Rate Interface Points

In the interest of supporting deregulated Customer Premises Equipment (CPE), the Exchange Carrier Standard Association in the United States established a basic rate transmission standard for CPE. These standards are defined for equipment to connect to different reference points of the ISDN link. Some of these reference points are S, T, and U. They have very specific definitions and provide standard interfaces for equipment connected to them. The following diagram shows these interface points.

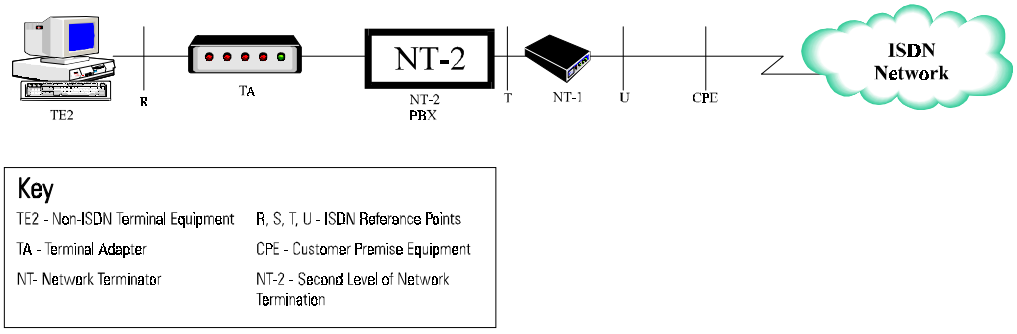


Figure 17-3

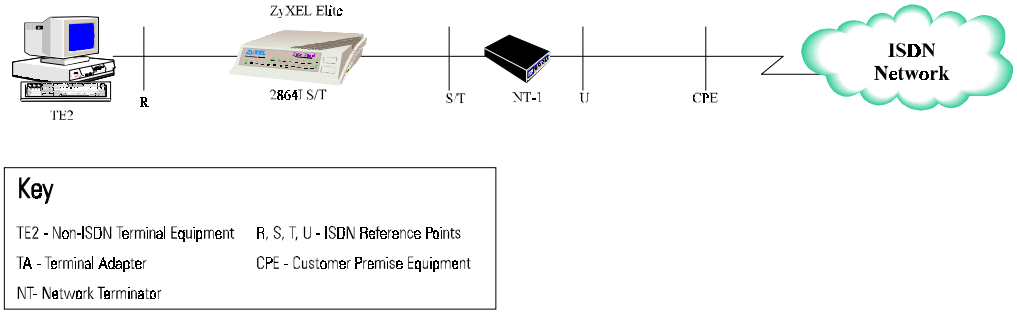


Figure 17-4

Not all the interfaces must exist in actual implementations. For example, not all the houses are equipped with a PBX (NT2) - in this case, the U interface is provided by the NT-1. The ZyXEL Elite 2864I-S/T connects to the NT-1.

An ISDN terminal adapter can be constructed with the functionality of a NT-1. In this case, the terminal adapter will connect directly to the U-interface. The Elite 2864I-U connects you directly to a U-interface without an NT-1, which can sometimes be quite expensive.

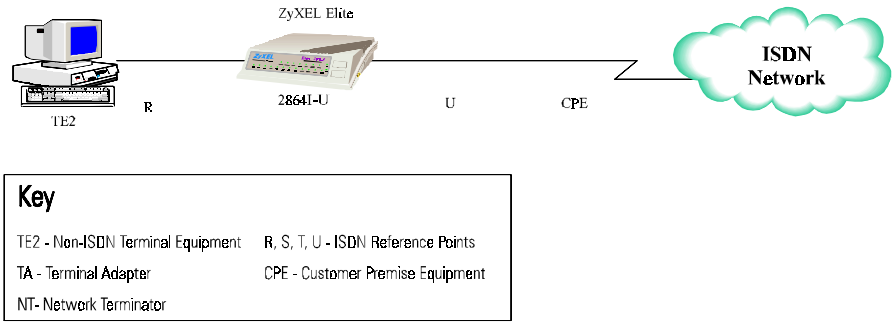


Figure 17-5

The Elite 2864I comes with two different types of interfaces:

- The Elite 2864I-S/T comes with a S/T interface
- The Elite 2864I-U comes with a U interface

You can connect the Elite 2864I-U direct to the ISDN jack installed by the phone company. The Elite 2864I-S/T requires an NT-1 interface in between. The following section explains this in detail.

Ordering Your ISDN Line

Phone companies have significantly simplified the ordering process for ISDN lines. In Table 17-1, you will find a list of all the regional RBOC's and a telephone number to call to order your ISDN line.

Phone Company	Phone Contact	World Wide Web
Amertiech	800-TEAM-DATA	www.ameritech.com
Bell Atlantic	800-570-ISDN	www.bellatlantic.com
Bellsouth	800-858-9413	www.bellsouth.com
Nynex	800-GET-ISDN	www.nynex.com
Pacific Bell	800-4PB-ISDN	www.pacbell.com
Southwest Bell	800-734-7630	www.swbell.com
US West	800-603-6000	www.uswest.com

Table 17-1

ISDN Service Ordering Information

The following guidelines can be used to order basic BRI-ISDN service from the telephone company.

Local ISDN Switch

The Elite 2864I series supports the switch types and protocols listed below. Before you order your ISDN line you will need to call your local phone company and find out what switch they use. After you have got this information simply fax them the appropriate order form created below. Ordering an ISDN line through your local phone company will generally take 10 to 15 working days.

Select the switch type that your local phone company uses and fax them the appropriate order sheet:

- ☐ AT&T 5ESS - Point-to-Point
- ☐ AT&T 5ESS - Multipoint
- ☐ Northern Telecom DMS-100
- ☐ Siemens EWSD

ZyXEL ISDN Order Form - Switch: AT&T 5ESS

NI-1, Point-to-Point or Multipoint

To order ISDN service for the AT&T switch, simply provide the table below to your local phone company. You can normally photocopy and fax this order form to them.

General Information:

First Name:_____ Last Name:_____

Address: _____

City: _____ State: _____ Zip:_____

Tel (Analog): _____

ISDN Line Configuration Table:

Line Type	Standard (2B+D) NI-1 or Custom
Data Line Class	Point-to-Point(PP) or Multipoint
Line Code	2B1Q
Interface Type	U interface with RJ45 jack
B1 Service	On Demand (DMD)
B2 Service	On Demand (DMD)
Access Rate	64Kbps
Maximum B Channels	2
Circuit-switched Voice	2
Circuit-switched Voice Channel	Any
Circuit-switched Data	2
Circuit-switched Data Channel	Any
D Channel Packet	No
Electronic Key Telephone Sets (EKTS)	No
Terminal Type	Type A

Information the phone company must provide:

Switch Protocol: ☐ NI-1 ☐ Point-to-Point ☐ Multipoint
Number of Spids: ☐ 0 ☐ 1 ☐ 2
ISDN Number 1 _____ Spid #1_____
ISDN Number 2 _____ Spid #2_____

ZyXEL ISDN Order Form - Switch: DMS-100

NI-1 or Custom

To order ISDN service for the DMS-100 switch, simply provide the table below to your local phone company. You can normally photocopy and fax this order form to them.

General Information:

First Name:_____ Last Name:_____

Address: _____

City: _____ State: _____ Zip:_____

Tel (Analog): _____

ISDN Line Configuration Table:

Features	Value
Line Type	Standard (2B+D) NI-1 or Custom
Line Code	2B1Q
Interface Type	U interface with RJ45 jack
Access Rate	64Kbps
Directory Numbers, Logical Terminals	2
Bearer Service	Circuit Switch Voice and Data on any B Channel
Circuit Switched Service	Yes
Packet Switched Service	No
Terminal Endpoint Identifier (TEI)	Dynamic
Electronic Key telephone sets (EKTS)	No
Call Appearance Handling (CACH)	No

Information the phone company must provide

Switch Protocol: ☐ NI-1 ☐ Custom
ISDN Number 1 _____ Spid #1_____
ISDN Number 2 _____ Spid #2_____

ZyXEL ISDN Order Form - Switch: EWSD

NI-1 only

To order ISDN service for the DMS-100 switch, simply provide the table below to your local phone company. You can normally photocopy and fax this order form to them.

General Information:

First Name:_____ Last Name:_____

Address: _____

City: _____ State: _____ Zip:_____

Tel (Analog): _____

ISDN Line Configuration Table:

Features	Value
Line Type	Standard (2B+D) NI-1
Line Code	2B1Q
Interface Type	U interface with RJ45 jack
Access Rate	64Kbps
Directory Numbers, Logical Terminals	2
Bearer Service	Circuit Switch Voice and Data on any B Channel
Circuit Switched Service	Yes
Packet Switched Service	No
Terminal Endpoint Identifier (TEI)	Dynamic
Electronic Key telephone sets (EKTS)	No

Information the phone company must provide:

Switch Protocol: ☐ NI-1 ☐ Custom
ISDN Number 1 _____ Spid #1_____
ISDN Number 2 _____ Spid #2_____

ISDN Service Ordering Checklist

1. Confirm the switch that has been installed. If it is an AT&T 5ESS switch, then the phone company must inform you whether it is Point-to-Point or Multi-point. Either option must then be programmed into the Elite 2864I modem.

2. Note whether the switch is using a Custom protocol or National ISDN-1 (NI-1).

3. If the line is not an AT&T Point-to-Point, you should receive a unique SPID number for each of the B channels. Then both SPID numbers must be programmed into the Elite 2864I modem. The Elite 2864I configuration will be explained in the following chapters. Please take careful note of the prefixes and suffixes.

4. Confirm the 7-digit Local Directory Number (LDN) for each of the B channels.

Note: These parameters are very important in installing the Elite 2864I. They will allow the Elite 2864I to perform to its maximum potential.

What are SPIDs?

The Service Profile Identifier (SPID), is a string of 3 to 20 numeric digits that is assigned to the user by the telephone company. The user must program the SPID into the terminal. The terminal will send this information (SPID) to the central office before it is initialized. When the switch receives the SPID, it will then allow the user to begin to dial out and receive calls.

Chapter 18 - Upgrading Your Modem

This chapter describes how to upgrade flash EPROM and add DRAM memory modules.

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.

1. Obtain the new firmware from ZyXEL's BBS, WWW, or FTP site. Refer to the chapter entitled "Contacting ZyXEL."
2. Turn on your PC and Elite 2864I modem.
3. Start any communications program that supports the Xmodem protocol.

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 E2864I.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:

- Turn off the modem.
- Press the O/A button while turning on the modem, then release the button after a few seconds. A kernel program, responsible for the update process, takes control of the modem. It accepts a limited set of AT commands, including the ATUPX command.
- Repeat steps 1 through 6 to upload a file that contains valid firmware for your modem.

Installing DRAM

The following procedure describes how to install either 4 MB or 8 MB of optional DRAM to your Elite 2864I. This installation allows your modem to store fax pages in memory.

This installation requires you to have a flat-blade screwdriver and one, two, or four

DRAM chips (Texas Instruments TMS461400-70 DJ chips are recommended). If you have a problem locating these chips, please contact ZyXEL Technical Support at (714) 693-0808.

Note: Use extreme care when handling DRAM chips and touching the components on your modem's printed circuit board. Both contain sensitive components that are prone to damage from electrostatic discharge. Always follow anti-static precautions while handling electronic components.

To upgrade the DRAM in your Elite 2864I modem:

1. Remove the screw on the bottom-center of the modem.

2. Use a flat-blade screwdriver to gently pry the tabs located on either side of the modem.

3. Remove the top cover of the modem.

4. Find the four empty DRAM sockets, labeled U26, U27,U38, and U39. Facing the front of the modem, you can find these sockets centered along the right side of the printed circuit board.

5. Align the dot or notch on the chip with the notch on the modem socket.

6. Install the DRAM chips (Texas Instruments TMS 461400-70 DJ chips are recommended) as follows:

    - To install 2MB of DRAM, install one chip in DRAM socket U38.

    - To install 4MB of DRAM, install chips in DRAM sockets U38 and U39.

    - Top install 8MB of DRAM, install chips in DRAM sockets U26, U27, U38 and U39.

7. Carefully align the tabs on the top cover with the slots at the base of the modem, then replace the top cover and the screw you removed.

This completes the DRAM installation procedure.

Chapter 19 - Contacting ZyXEL

ZyXEL takes pride in it products and its customers. We are continually striving to improve our line by engineering them with your current and future needs in mind.

To help us in that effort, we encourage your comments. For your convenience, we have listed below various means by which you can contact ZyXEL directly:

ZyXEL Phone Numbers

Voice Telephone Numbers

You can reach ZyXEL in the U.S. between 8:00 am and 5:00 PM PST at (714) 693-0808

In Taiwan: 011-886-35-774848

Fax Numbers

ZyXEL provides the following 24-hour fax numbers for technical support and other comments.

In the U.S.: (714)693-8811

In Taiwan: 011-886-35-782439

ZyXEL BBS Number

ZyXEL operates a 4-node BBS 24 hours a day. This BBS contains updates to ZyXEL's ZFAX communications software, modem configuration guidelines, software set-up instructions, and the latest firmware. Sysop pricing information and order forms are also available from the BBS.

To call the ZyXEL analog BBS , configure your modem 8 data bits, no parity bit, and 1 stop bit. Then dial (714) 693-0762.

To call the ZyXEL ISDN BBS using one B channel, configure your modem and then dial (714)263-0398.

To call ZyXEL ISDN BBS using both B channels, configure your modem and then call (714)263-0398 + (714) 263-0498.

Online Access

You can also contact ZyXEL via the Internet using E-mail, our Web site, or FTP, and through CompuServe.

Internet

E-mail

Sales inquiries: sales@zyxel.com
Technical support: support@zyxel.com ; in the U.S.
or support@zyxel.hinet.net ; outside the U.S.

World Wide Web

ZyXEL has a home page on the World Wide Web(WWW). If you have a WWW browser, such as Netscape, you can access this page at the following location: http://www.zyxel.com

FTP

Information, such as ZyXEL software and ROM updates for the U.S. can be found at this FTP address: ftp.zyxel.com
for European versions and related files, use the address: ftp.zyxel.co.at

CompuServe

CIS ID: 71333,2734
Forum: GO ZyXEL

Appendix A - Phone Jack Pinout Assignments

The Elite 2864I features one RJ-45 phone jack and one RJ-11 phone jack. The RJ-45 (ISDN S) jack is for ISDN line connection (S/T interface), and the RJ-11 jack (PHONE) (it is also known as an analog adapter in European countries) is for an optional connection to analog telephone equipment such as a telephone set or answering machine, fax machine or analog modem.

The signals on the RJ-45 pins of S/T interface are:

1. Not Connected
2. Not Connected
3. RCV +
4. XMT +
5. XMT -
6. RCV-
7. -48V
8. -48V RTN

The signals on the RJ-11 analog adapter pins are:

1. Not Connected
2. Ring
3. Tip
4. Not Connected

For the U interface model, the signals on the RJ-45 pins are:

1. Not Connected
2. Not Connected
3. Not Connected
4. Ring
5. Tip
6. Not Connected
7. -48V
8. -48V RTN

Appendix B - Parallel Port Connector Pinouts

Signal Pin	Signal Name	Description	Direction Adapter to Printer
1	STROBE	Strobe Pulse	⇨
2	DATA 0	Data signal; bit 0	⇔
3	DATA 1	Data signal; bit 1	⇔
4	DATA 2	Data signal; bit 2	⇔
5	DATA 3	Data signal; bit 3	⇔
6	DATA 4	Data signal; bit 4	⇔
7	DATA 5	Data signal; bit 5	⇔
8	DATA 6	Data signal; bit 6	⇔
9	DATA 7	Data signal; bit 7	⇔
10	ACKNLG	Acknowledge signal; data is received by printer and printer is ready to accept other data.	⇦
11	BUSY	Busy signal; printer is not ready for receiving data.	⇦
12	PE	Paper end	⇦
13	SLCT	Printer is in the selected state; printer on line.	⇦
14	AFTD	Autofeed; paper is auto fed one line after every line printing	⇨
15	ERROR	Printer is in error state	⇦
16	INIT	Reset printer to initial state.	⇨
17	SLCT IN	Enable printer for data entry	⇨
18	GND	Ground	-
19	-	Not connected	-
20	GND	Ground	-
21	GND	Ground	-
22	GND	Ground	-
23	-	Not connected	-
24	GND	Ground	-
25	GND	Ground	-

Note: "Direction" column refers to the direction of signal flow. When the Elite 2864 ISDN or modem parallel port is connected to a PC parallel port, it emulates the printer side. Similarly, when the ISDN/modem parallel port is connected to a printer, it emulates the adapter side.

Appendix C - V.25bis Command Set

This appendix lists the V.25bis command set supported by the Elite 2864I. The commands support both asynchronous and synchronous dialing.

To enable V.25bis commands use the AT command:

```
AT*I1
```

For synchronous applications, the modem is permanently set in normal situations for use with one application. Save the desired settings in the power-on profile, and the modem will be initialized to synchronous mode (&M3) with V.25bis command enabled (*I1) when turned it is turned on.

A special command RST is provided to get the modem back to asynchronous AT command mode from V.25bis mode. You can enter this RST command in either synchronous or asynchronous V.25bis mode.

Syntax	Command with Parameters*	Description
CRN	CRN <dialstring>**	Call request with number provided.
CRS	CRS n	Call request with number from memory, 0 # n # 49; n is the memory location.
PRN	PRN n; <number>	Saves <number> to address n (0 # n #49).
RLN	RLN***	Requests list of all stored numbers.
DIC	DIC	Ignores incoming call.
CIC	CIC	Accepts incoming call.
CFI	CFI XX	Call failure indication: ET Engaged Tone. NS Number is not stored. RT RING Tone. AB Abort Call. NT Answer Tone is not detected.
INC	INC	Incoming call.
VAL	VAL	Valid.
INV	INV	Invalid.
LSN	LSN n; <number>	List of stored numbers. (Response to RLN)
RST	RST	Changes to the asynchronous AT command mode.

* Commands and parameters may be separated by spaces.

** Dial modifiers: See the ATD command.

*** RLN is answered with several LSN displays Every LSN corresponds to a memory location.