EuroNexus Digital Audio Codec

Section

Schematics

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Comrex has been building reliable, high quality broadcast equipment since 1961. Our products are used daily in every part of the world by networks, stations, and program producers.

Every product we manufacture has been carefully designed to function flawlessly, under the harshest conditions, over many years of use. Each unit we ship has been individually and thoroughly tested. Most items are available off-the-shelf, either directly from Comrex or from our stocking dealers.

Comrex stands behind its products. We promise that if you call us for technical assistance, you will talk directly with someone who knows about the equipment and will do everything possible to help you.

Our toll free number in North America is 800-237-1776. The toll free number from the United Kingdom is 0-800-96-2093. Product information along with Engineering Notes and User Reports are available through our Fax-on-Demand system. Simply dial 978-264-9973 from any TouchTone phone and follow the instructions.

This information can also be found on the World Wide Web at http://www.comrex.com. Our internet E-Mail address is info@comrex.com.

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All equipment manufactured by Comrex Corporation is warranted by Comrex against defects in material and workmanship for one year from the date of original purchase, as verified by the return of the Warranty Registration Card. During the warranty period, we will repair or, at our option, replace at no charge a product that proves to be defective, provided you obtain return authorization from Comrex and return the product, shipping prepaid, to Comrex Corporation, 65 Nonset Path, Acton, MA 01720 USA. For return authorization, contact Comrex at 978 263-1800 or fax 978 635-0401.

This Warranty does not apply if the product has been damaged by accident or misuse or as the result of service or modification performed by anyone other than Comrex Corporation.

With the exception of the warranties set forth above, Comrex Corporation makes no other warranties, expressed or implied or statutory, including but not limited to warranties of merchantability and fitness for a particular purpose, which are hereby expressly disclaimed. In no event shall Comrex Corporation have any liability for indirect, consequential or punitive damages resulting from the use of this product.

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Section 1. Introduction

The Comrex EuroNexus is a device designed to send and receive either 7.5 kHz or 15 kHz audio on ISDN digital telephone circuits. Its functions and pieces are best broken down and described individually:

The Codec

Codec is an acronym for **Co**der/**Dec**oder. We define this as the part of the EuroNexus which takes in an analog audio signal, converts it to a digital bit stream, and performs operations on this bit stream to remove redundant information. This operation is known as Digital Audio Compression. The codec section also takes an incoming, previously compressed bit stream and converts it to analog audio. In the EuroNexus codec, the analog audio inputs and outputs are available to the user. The input and output compressed bit streams are connected internally to the terminal adapter section. There are different types of compression, and the type is often defined by the name of the algorithm employed. The EuroNexus uses the international standard G.722 algorithm, and it is also capable of a higher speed version of G.722 which provides 15 kHz bidirectional audio at 112/128 kb/s. For more information on this subject, see "Technical Details" on pages 20-23.

The Terminal Adapter

We call this the "TA" for short. This section can be thought of as a modem but one that only works on a special type of telephone line. This line is called an **I**ntegrated **S**ervices **D**igital **N**etwork line or ISDN. A description of this service is included on page 18. The TA takes the encoded audio from the codec and feeds it to the telephone line. It also feeds audio data from the phone line to the codec. It allows you to dial and answer ISDN phone calls and provides the functions required to "handshake" with the ISDN line as well as to troubleshoot problems should they occur. The EuroNexus TA can also combine the two ISDN "B" channels using a standard called BONDING. This allows for a transmission rate of 112/128 kb/s on ISDN. For more information on this subject, see "Inverse Multiplexing" on page 23.

The Command Processor

This is the "brain" of the EuroNexus. It communicates with the codec and TA, sets them to the correct modes, and provides the user interface for configuring and dialing the TA. It also provides the ancillary data function and allows you to communicate to the TA via computer.

Portable/Rackmount

The EuroNexus is available in portable or rackmount (2 RU) versions. The electronics and all functions described in this manual are identical in both cases.

SECTION 2. BASIC OPERATIONAL INSTRUCTIONS

AUDIO CONCEPTS

The EURONEXUS has two audio inputs and two audio outputs. The main input and output are on female and male 3 pin XLR connectors respectively. These are designed for professional level, balanced audio signals. They can be interfaced with other kinds of "consumer" equipment, but the system performance may suffer. The input audio may also be applied to a mini jack, designed to be compatible with portable tape recorders. This input level is fixed, and the audio received from it is mixed with the main audio input. The audio output is also available on a stereo headphone jack. See the "EURONEXUS Specifications" section on pages 27-28 for hookup information.

There are three audio controls on the EURONEXUS front panel, along with one switch. The switch is designed to choose what type of audio signal is applied to the main XLR input. The user may choose between a MIC or LINE level. If you are connecting a microphone directly to the EURONEXUS or if you are using a mixer or a console with an output labeled "microphone level out," you will want this switch set to MIC. Most other users will want this switch set to LINE mode. In either mode, you may use the AUDIO INPUT level control (green) to raise or lower the input level to the EURONEXUS. The output audio of the EURONEXUS is a mixture of the audio from the decoder section along with the audio being sent to the encoder. This is so you can monitor what you are sending as well as what you are receiving. If you do not wish to receive any of your own audio, simply turn the LOCAL PROGRAM control (red) all the way down and adjust the RETURN AUDIO (yellow) to the correct level for your system. If you wish to receive some of your own audio, adjust the relative levels of the local and return audio to suit. In a typical remote broadcasting application, the LOCAL PROGRAM control would always by turned down (off) at the studio. This prevents over the air broadcast of audio being sent to the remote site. The EURONEXUS headphone output features the same mix of audio, adjustable via the same output level control.

When setting levels, adjust the INPUT LEVEL control first. You do not need to place a call in order to set this level. Simply feed some audio into the EURONEXUS at the level you will typically use. Adjust the INPUT LEVEL control until the PEAK indicator on the EURONEXUS front panel lights just occasionally on program peaks. This indicates that the internal peak limiter is active on occasional peaks, and the input level is correct. If the input level suddenly increases, the limiter will protect the audio and keep it from clipping. If the PEAK light never comes on during your program audio, you may be underdriving the audio circuitry which can create noise problems. If the PEAK light is on most of the time, you run

the risk of overloading the limiter and causing distortion. If using the tape input jack, you will need to adjust to the output level of your tape machine until the PEAK light comes on occasionally.

You may also adjust the local program output without placing a call. This control is primarily for those who will be monitoring only the output of the EuroNexus and need to hear themselves as well as the return audio (as an example, the host of a call-in talk show at a remote location whose calls are being taken at a radio station). The outgoing EuroNexus channel is used to send the host to the station, and the return EuroNexus channel is used to send the callers to the host. The host will hear a mix of himself and the callers. In this scenario, the station where the callers are being received must send a mix-minus back to the host (that is the callers and any commercial breaks but not the host's voice, which will be mixed in locally by the EuroNexus).

With the input level set correctly, adjust the LOCAL PROGRAM control until the level is appropriate for the system or for your headphones. Users who do not wish to have any local audio mixed with the output will turn this control all the way down. After you have completed the rest of the setup procedures and established your first call, you can set the RETURN AUDIO control.

Before you Start

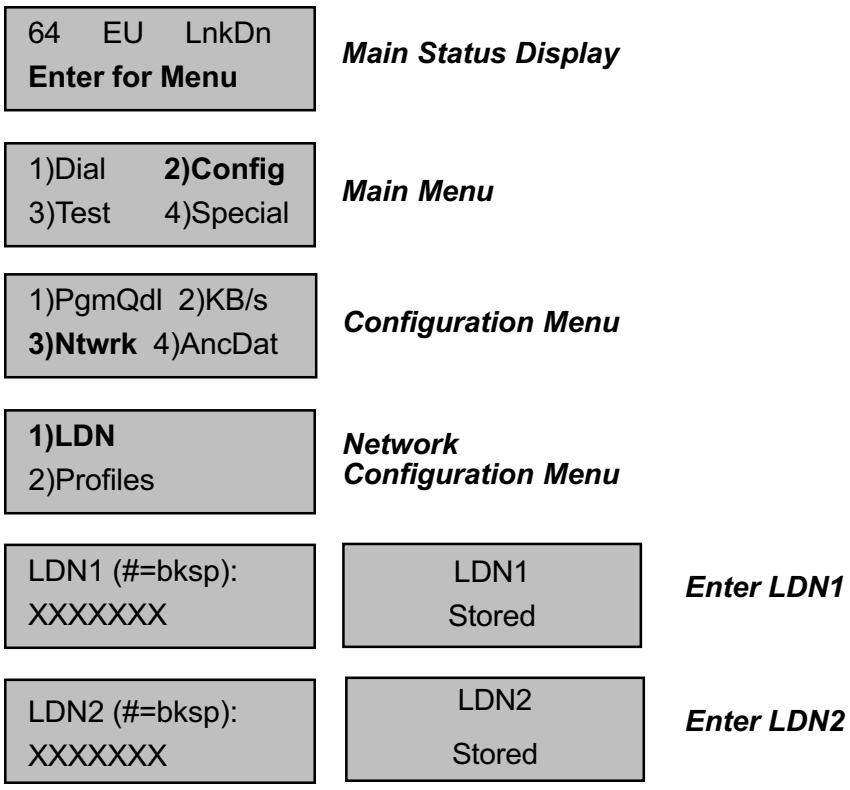
You will need to know the local telephone numbers of each of the "B" Channels of the ISDN line. Look for the number dialed to establish a local call to the ISDN line and exclude any city, province, or county codes. These numbers are known as LDNs and must be entered into the EuroNexus before use.

Note: If you are installing the EuroNexus *for a full time application, we recommend protecting it with a Universal Power Supply with built-in surge protection. A model in the 250 watt category should be fine. They are available from computer and eletronic stores.*

Entering the LDNs

Before attaching the ISDN line, power up the EuroNexus by plugging the external supply to A/C and turning the switch on the rear panel of the EuroNexus to on. ***Do not connect to the ISDN line before entering the LDNs***. After a few seconds, the Main Status Display will appear. Don't be concerned with the *LnkDn* message at this point. Press the enter key on the keypad to access the Main Menu. Press **2** on the keypad to select the Configuration Menu. Press **3** on the keypad for the Network Configuration Menu. Press **1** on the keypad to enter the LDNs.

If LDNs were previously programmed into your EuroNexus, they will appear. If they are correct, press enter until you return to the Network Configuration Menu. If you wish to change a previously programmed LDN or if you make a mistake while entering the number, press the **#** key to backspace until the number is cleared, and then enter the correct number.



*Note: The LDN is the **L**ocal **D**ialing **N**umber for your line. It is the last seven digits of the telephone number for that ISDN "B" Channel, and does not include any area, country, or city codes. The LDNs are necessary for BONDING to combine the two channels together for data rates greater than 64 kb/s. For example: The Comrex ISDN EuroNexus test line phone number is 978-929-9806 and the LDN is 929-9806. Some ISDN lines have a different number for each of the two channels; some use the same number for both. If you have only one number, program it into both the LDN menus.*

Connecting the ISDN Line

After the LDNs are programmed correctly, press the CANCEL key until you are again at the Main Status Menu. Now, attach the ISDN line to the telephone connector on the rear of the EuroNexus. In about one minute, the *LnkDn* status message should change to OK. This means that the EuroNexus has correctly "shaken hands" with the telephone company along the ISDN line. If the line is removed or the EuroNexus turned off, this handshake will need to take place again.

Main Status Display

Note: The Main Status Display also shows the data rate selected (see next section for programming) and the switch type selected (EU=EURO ISDN).

Selecting the Data Rate

Now that the EuroNexus has been set up for your ISDN service, you will need to tell it a few things about what you want to accomplish. The first selection will be data rate. The EuroNexus can communicate at four different data rates: 56, 64, 112 or 128 kb/s. Most European ISDN operation is at 64 and 128 kb/s. The 56 or 64 kb/s data rates use only one digital telephone connection, and you will only be billed for one ISDN phone call. The 112 and 128 kb/s rates actually place two different calls between points (although it looks to you like one call is placed), and you are billed for twice the connect charges.

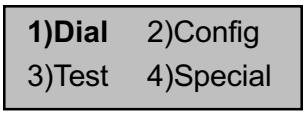
Audio bandwidth varies with data rate. At 56 and 64 kb/s, the EuroNexus carries 7.5 KHz audio bandwidth. This is nearly transparent audio for voice applications, although you might notice a slight cutoff at the "ss" sound in voices. At 112 or 128 kb/s, the EuroNexus carries through 15 kHz audio, providing full, FM radio quality bandwidth for voice and music. There is little perceivable difference between 56 and 64 kb/s (and also 112 and 128 kb/s). The 56 and 112 kb/s rates are provided for compatibility with telephone systems outside Europe, including ISDN circuits which may not allow clear channel 64 kb/s transmission, or "Switched 56" circuits. If you are using ISDN on both ends of your system, you should attempt to connect first at 64 (or 128) kb/s and if you experience problems, try backing down to 56 (or 112) kb/s.

To select your data rate, press ENTER from the Main Status Display. Press **2** for *CONFIG*, and then press **2** again to select KB/S. Press the appropriate number to select the data rate you want to use.

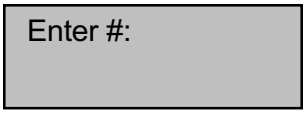
64 EU OK **Enter for Menu**	***Main Status Display***
1)Dial **2)Config** 3)Test 4)Special	***Main Menu***
1)PgmQdl **2)KB/s** 3)Ntwrk 4)AncDat	***Configuration Menu***
1)56K 2)64K 3)112K 4)128K	***Select Data Rate***

Placing a Call

There are two ways to place a call with the EuroNexus. You can dial manually or use the Quick Dial option for automatic dialing. To manually dial, press ENTER to access the Main Menu. Press **1** to select DIAL, key in the number you wish to dial, and press the ENTER key to start dialing. If you make a mistake, simply press the **#** key until the number is cleared, and then enter the correct number. If at any point you wish to terminate the call, simply press the HANGUP key.



Main Menu

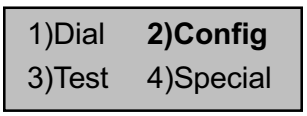


Key in number and press ENTER

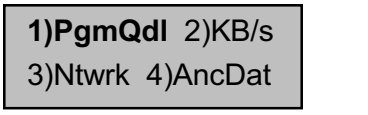
To place a QDial call, simply press the QDIAL key while in the Main Status Display, followed by the QDial number (01-39) that you wish to dial. Programming QDial is discussed below.

Programming QDial

The EuroNexus has 39 memory locations which allow you to store a number and dial it quickly using the Q-DIAL button on the keypad. To program your QuickDial memory, press **2** to select CONFIG from the Main Menu. Then press **1** to select PGMQDL. Enter your memory index number (01-39), and then input the dialing number (up to 30 digits). If a number was programmed into that QDial location previously, it will appear. You may erase the number or backup if you make a mistake using the **#** key. Press ENTER when your number is complete. Press CANCEL until you reach the Main Status Display. The QDial numbers will remain in memory, even if the EuroNexus loses power.



Main Menu



Configuration Menu

PROGRAMMING THE QDIAL (CONT.)

QDIAL #: (01-39) _	***Select the QDial index number and press the ENTER key***
Enter # to save:	***Enter the QDial number to be stored***

LAST NUMBER REDIAL

Redialing the last number is easy — press the QDIAL key and 00. The last number you dialed from the EURONEXUS will be redialed. However, the QDIAL key will only work when you can see the Main Status Display.

RECEIVING CALLS

As long as your options are set to be compatible with the incoming device, the EURONEXUS should autiomatically answer the incoming call and "wake-up," providing full duplex audio.

ANCILLARY DATA SELECTION

Ancillary data provides a low speed data channel along the same ISDN phone call used for the coded audio. It has little impact on the audio quality and allows two computers (or other asynchronous devices) to communicate at 4800 baud. The 4800 baud rate is fixed regardless of the data rate selected. The one thing to note about ancillary data is that both EURONEXUS units MUST be configured the same way with ancillary data on or off. If the Ancillary Data Mode is mismatched between two EURONEXUS units, the audio channel will not work correctly. **If communicating to a compatible device which is not a EURONEXUS unit, the Ancillary Data Mode should always be off.**

To set this mode, press **4** to select ANCDAT from the Configuration Menu. Then select ANC DAT ON or ANC DAT OFF by pressing **1** or **2** on the keypad. Press the CANCEL key twice to return to the Main Status Display. If you have selected ANC DATA ON, this will be indicated on the display. Configuration and connection of ancillary devices is covered in the "About Ancillary Data" section on pages 24 - 26.

1)PgmQdl 2)KB/s 3)Ntwrk **4)AncDat**	***Configuration Menu***
1)Anc Data Off 2)Anc Data On	***Ancillary Data***

ISDN Line Profiles

For some users who carry their EuroNexus between different ISDN equipped locations, it can become difficult and confusing to reprogram all the necessary information about the ISDN line into the EuroNexus each time it is moved. The EuroNexus eases this task, by allowing you to create nine "profiles" for ISDN lines, which simply need to be "loaded" at each location.

To access the profile features, press the ENTER key from the Main Status Display. Press **2** for CONFIG, then **3** for NTWRK, and finally **2** for PROFILES.

64 EU LnkDn **Enter for Menu**	***Main Status Display***
1)Dial **2)Config** 3)Test 4)Special	***Main Menu*** ***Select 2 for CONFIG***
1)PgmQdl 2)KB/s **3)Ntwrk** 4)AncDat	***Configuration Menu*** ***Select 3 for the NTWRK***
1)LDN **2)Profiles**	***Network Menu*** ***Select 2 to load and store profiles***

To store a profile, select option **1**.

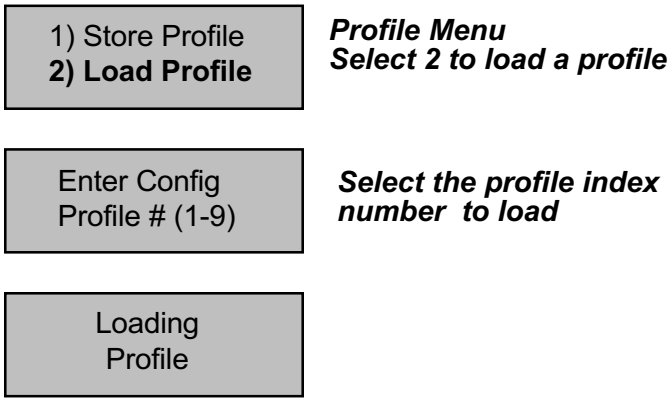
1) Store Profile 2) Load Profile	***Profile Menu*** ***Select 1 to store a profile***

You will be prompted for a profile index #:

Enter Config Profile # (1-9)	***Select which user profile you would like to set up (1-9)***

You will be prompted for LDNs, Anc Data Mode, and Data Rate for the profile. If an LDN has been entered previously for a profile, it will appear on the LCD display. You may use the **#** key to back over the entry until it is cleared or press ENTER if the numbers are correct. The profiles will be stored in memory even if the EuroNexus is powered off.

To load a stored profile, follow the directions to access the profile features (on page 11). Once in the Profile Menu, select option **2** and then enter the appropriate profile index number (1 - 9). The EuroNexus will automatically load all the preset parameters.

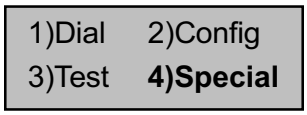


The LCD display will show “loading profile” for several seconds. When finished, the EuroNexus will be configured to all the new LDN, Anc Data, and Data Rate information contained in the profile.

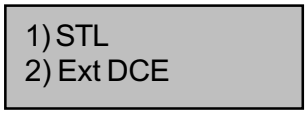
Repeat all the steps to store and load multiple profiles. You may wish to attach a label to the EuroNexus indicating which profile number applies to which ISDN location.

Section 3. Special Operational Modes

The EuroNexus has two "special" operational modes: *STL Backup Mode* and *External DCE Mode*. These modes are accessed by pressing **4** to select SPECIAL from the Main Menu.



Main Menu



Special Menu

While these special modes are engaged, the other menus are disabled. For this reason you will want to make sure all settings (LDNs, ancillary data, and data rate) are correct before you enter any "special" mode.

STL Backup Mode

This mode allows the EuroNexus to automatically dial the number stored in QDial position 01. To set up STL Backup Mode:

1) Set the EuroNexus options as you need them (LDNs, ancillary data, and data rate).
2) Enter STL Backup Mode via the special menu.
3) Connect pins 1 and 18 on the EIA 530 connector to a contact closure which will close when the EuroNexus is needed.

The EuroNexus will dial QDial 01 when two pins are connected on the rear panel EIA 530 connector. It will disconnect when the pins are opened or STL Backup Mode is exited. To exit STL Backup Mode press the CANCEL key. If the EuroNexus should lose power while in STL Backup Mode, it will return to it when power is re-applied.

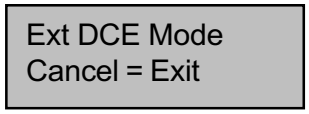
STL Backup Mode is also useful in providing "fail-safe" remote operation. A user can hardwire together pins 1 and 18 on the EIA 530 connector. When it's time to place a call, the user enters STL Backup Mode (having preset all the EuroNexus parameters). The EuroNexus will immediately dial QDial 01 and connect. If at any point the connection should be lost, the EuroNexus will detect this and immediately redial the number. When the call is to be disconnected, exit STL Backup Mode by pressing the CANCEL key. The pin closure will have no effect on operation other than STL Backup Mode.

External DCE Mode

This mode disconnects the terminal adapter from the codec inside the EuroNexus and allows you to connect to an external terminal adapter, DSU, satellite terminal, etc.

In this mode, the EuroNexus works very much like a Comrex DXP.1 or DXR.1, except that it will allow for ancillary data transmission. The EIA530 connector may easily be adapted to V.35 or X.21 via adapter cables available from Comrex. The codec section will automatically detect the incoming data rate, so it is not necessary to set it correctly on the EuroNexus menu.

If you are using ancillary data while in External DCE Mode, you need to set AncDat to ON (see page 10) before going into External DCE Mode. When you select External DCE Mode, the EuroNexus screen will appear as below and will remain that way until you choose to exit External DCE Mode. Press CANCEL at any time from the front panel to exit External DCE Mode. The EuroNexus will automatically return to this mode if power is lost.



Note: External DCE Mode provides access to the codec section, not the TA section. The EuroNexus cannot be used as a stand-alone terminal adapter (say, for use with another codec).

Section 4. EuroNexus Menu Selection Tree

EuroNexus Main Status Display.
In this sample display, the EuroNexus is set to dial at 128 kb/s (for 15 kHz audio). The switch type is Euro ISDN. The OK in the upper right hand corner shows that the inital handshake with the line was successful.

- 1)Dial — Enter # to Dial
  (Press the # key to backspace. Press CANCEL to exit. Press ENTER to dial.)
- 2)Config
  - 1)PgmQdl — QDial #: (01-39) _
    (Press the # key to backspace. Press CANCEL to exit. Press ENTER to store number.)
  - 2)KB/s
    - 1)56K
    - 2)64K
    - 3)112K
    - 4)128K
  - 3)Ntwrk
    - 1)LDN
      - LDN1 (#=bksp): _
      - LDN2 (#=bksp): _
    - 2)Profiles
      - 1)Store Profile — Enter Config ** / Profile #: (1-9)
      - 2) Load Profile — Enter Config / Profile #: (1-9)
  - 4) AncDat
    - 1) Anc Data Off
    - 2) Anc Data On
- 3)Test — Codec Loopback Cancel = Exit
- 4)Special
  - 1)STL — STL Backup Mode Cancel = Exit
  - 2)Ext DCE — Ext DCE Mode Cancel = Exit

** Once the Profile number has been selected, the menu will automatically sequence through the standard menus for storing LDNs, Anciliary Data and Data Rate.

SECTION 5. TROUBLESHOOTING

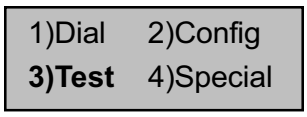
The Comrex EuroNexus coding algorithm eliminates redundancy in audio. For this reason, the EuroNexus cannot be subjected to traditional specifications of distortion and signal-to-noise ratio. Most tests done with the codec should be by subjective listening between the original source material and codec-processed audio. Because of the algorithm's dynamic processing properties, tests done with tones tend to prove little.

Unlike analog technology, which might work but just be a little off, digital technology tends to either work perfectly or not at all! The trick is to isolate the source of the problem to either the telephone network or the equipment attached to it, so you know where to turn for a solution. The EuroNexus provides a simple diagnostic function to help you do this: Codec Loopback.

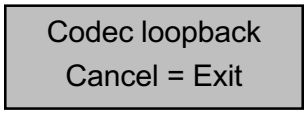
CODEC LOOPBACK

This test examines the codec portion of the EuroNexus, independent of the built-in TA or the digital circuit. Audio must be fed into the unit through the AUDIO IN plug, and you must be able to monitor the AUDIO OUT. Be certain to turn the LOCAL PROGRAM volume control all the way down so that you are sure you are monitoring the CODEC RETURN audio only. Power must be connected to the EuroNexus, and it needs to be turned ON. You do not need to be connected to an ISDN line (or other type of digital service). This test cannot be run while a call is placed.

To enter the Codec Loopback test menu, press **3** from the Main Menu. This activates two things. It puts the local clock into use to drive the signal, and it connects the encode and decode channels.



Main Menu



Codec Loopback status display

Expected Results in Codec Loopback Test

You will hear the same audio in your headphones that is being fed into the EuroNexus. The READY light should be on. *Note: There may be a few seconds of noise before your audio is heard.*

If you do not hear audio or it is distorted:

- Check your connections
- Make sure the power light on the front panel is on
- Make sure the peak light is flashing occasionally
- Insure that the mic/line switch is in the correct position

If there is still a problem, please contact Comrex to arrange for repair of the EuroNexus.

SECTION 6. ABOUT ISDN

ISDN stands for Integrated Services Digital Network, and it is a special type of telephone system. While most telephone lines are capable of carrying only analog audio, ISDN lines actually carry high speed data. Like plain old analog phone lines, ISDN lines are linked between the telephone company and the customer premises via a single pair of wires, called the local loop. The signal carried on the local loop is fundamentally different than plain old telephone service. Ordinary phones, modems and fax machines will not work on them without special interface equipment.

Once a call is placed on an ISDN line, it is treated by the telephone company very much the same way a voice call is. Most of the technology of ISDN lies in the link between the phone company and the customer. The single ISDN phone line has the capability of carrying two, independent telephone channels. These are called “B” channels, and an ISDN user may place a call on either one or both “B” channels simultaneously. The device used to place and answer calls on an ISDN line is called a *terminal adapter*.

When used for data, each “B” channel of an ISDN line has the capacity of 64,000 bits per second (64 kb/s). The two “B” channels may be dialed to the same location and their capabilities “summed” together for a total throughput of 128 kb/s. Some ISDN networks use a small piece of this data so they allow the user a little less throughput. The user may have 7/8 of the “B” channel or 56 kb/s. Two “B” channels may then be summed to 112 kb/s.

Section 7. Ordering ISDN

The EuroNexus ISDN Codec supports data rates up to 128 kb/s.

You will request an ISDN Basic Rate Interface (BRI) line with:

- S/T interface reference point
- 2B1Q line coding

  and either
- 2B+D Service (supports up to 128 kb/s)

  or
- 1B+D Service (supports up to 64 kb/s)

Note: We suggest that you order 2B+D Service to allow maximum flexibility in using the EuroNexus since ordering 1B+D Service will restrict the EuroNexus to 7.5 KHz audio bandwidth.

The EuroNexus supports ETS 300 012 switch type and software protocol.

Request that the ISDN line allocate one DYNAMIC Terminal Endpoint Identifier (TEI) per phone number.

SECTION 8. TECHNICAL DETAILS

G.722 ALGORITHM

The codec is a system that encodes and decodes audio signals for transport over digital networks. At the transmit end, the information is encoded, and it is decoded at the receive end. Simple. Well, not so simple. As with most things in the world, if everyone created their own method of doing things, nothing would work together. Something as simple as the standardization of power plugs means that we don't think twice about buying appliances or electronic components. But we do think twice about what format our videotape is in—VHS or BETA. But at least it is a small field from which to choose. The same thing is happening with the compression algorithms used to encode and decode audio signals.

International standards bodies have formed to create standards. There are a different standards available (like VHS and BETA), and it is up to you to select which one you will implement. It is also up to you to insure that the vendor you select is implementing the standard with no changes (that can mean your equipment will not work with other manufacturers, and you will be boxed into a corner).

The international standard known as CCITT G.722 specifies the algorithm that codecs use to convert analog to digital signals and vice versa. The EURONEXUS follows this standard very carefully and can communicate with G.722 codecs from other manufacturers.

The EURONEXUS also incorporates a proprietary upgrade of G.722 which automatically doubles the audio bandwidth to 15 kHz when the codec "sees" a transmission rate of 112 or 128 kb/s. The EURONEXUS will automatically adjust to the transmission speed, and it is therefore not necessary to make any adjustments to the codec to change from standard G.722 to the upgraded version.

THEORY OF OPERATION

The Comrex EURONEXUS performs a digital algorithm in real time on sampled digital input audio. The unit is based on a high speed computer chip, known as a digital signal processor (DSP). The idea behind the codec (and any other DSP-based device) is to perform functions on analog signals which have been divided into samples taken at discrete times. These samples are then "quantized" (assigned a fixed value) and fed as a stream of binary numbers into the DSP.

The basic assumption of the codec is that digitized audio contains more information than is needed to reproduce it in analog form. By eliminating this redundant information, more audio information may be stored or transmitted.

As mentioned before, the input to the DSP portion of the codec is a series of discrete time samples. Each portion of the codec link (transmitter and receiver) contains a computer program which can predict the next sample based on previous values processed. This function is performed identically in the transmitter and receiver. The difference between the transmitter and receiver is that only the transmitter knows the true value of the next discrete time sample. Since it already possesses an approximation of this value, it can calculate the difference between the two numbers it possesses. This difference is what the transmitter sends to the receiver. The receiver uses this difference to calculate the true value. Since the difference signal contains less than the data sample, data rate is conserved.

In human speech (and most other audio) much more energy exists in the lower part of the audio spectrum than in higher frequencies. Therefore, the codec reproduces audio more accurately at the lower end than at the higher end. Using digital filters, audio is divided between high and low sub-bands, and each sub-band is sent through the encoder-decoder combination separately. The lower band can then use up the majority of the bits available, leaving only a few for the relatively less complicated high band.

Discrete time sampling and quantization of an analog waveform is known as Pulse Code Modulation (PCM). Since the codec algorithm uses differences between samples and since the predictors adapt automatically with changing values of previous input samples, we call the algorithm used Adaptive Differential PCM or ADPCM. When we add the concept of dividing and conquering individual bands, the process becomes Sub-band (SB) ADPCM. SB-ADPCM is defined as an international standard by the CCITT as recommendation G.722. The text of this specification is public information and is a good source for further information on this algorithm.

SYNCHRONIZATION

The transmitting codec forms its outgoing data into words, each consisting of seven or eight characters. The receiving codec is able to decode and decompress data intelligibly because it has identified the beginning and end of each 'word' it receives. This process of identifying and aligning with the correct word order is called synchronization.

The EURONEXUS uses a self synchronizing technique which allows the encoder to use the entire channel for audio data. With no overhead for synchronization data, the decoder can determine the sync position by performing an algorithm on the raw, incoming data. It takes about one second for the decoder to find sync and begin decoding data. The READY light on the front panel is an indication that the decoder is in sync.

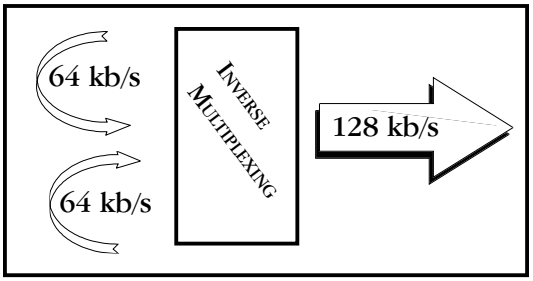
Every half second, the EURONEXUS rechecks to make sure that it is still in sync. If the network causes an error that makes the data stream line up differently, the codec can determine this and resync within one second. Remember, because the EURONEXUS is fully duplex, it is simultaneously encoding/compressing outgoing information and decoding/decompressing incoming information.

Inverse Multiplexing

Inverse Multiplexing, or IMUXing for short, sounds complicated but is actually quite simple. It means combining two or more lower data rate channels into one, higher data rate channel. It is an extremely important concept when working on digital phone lines like Switched 56 and ISDN, as digital transmission channels on these services come in chunks of 56 or 64 kb/s. These chunks have very little to do with each other normally. They may be routed differently throughout the telephone network and incur substantially different transmission path delay. Even the two "B" channels of a Basic Rate Interface ISDN installation offer no guarantee that both calls will be routed along the same path. On a North American coast-to-coast linkup, for example, the first "B" channel connection may be routed via Texas and the second via Michigan.

The IMUX must be able to measure the time delay between the two digital channels and delay the fastest so that it arrives synchronously with the slowest. This procedure is called "aggregation" and is performed differently with different IMUX protocols.

The EuroNexus Terminal Adapter uses an IMUX protocol called BONDING (the most widely used IMUX standard in North America) to send 15kHz on a BRI ISDN line.



SECTION 9. ABOUT ANCILLARY DATA

The EuroNexus provides an ancillary data channel which allows the user to send low speed data along the same digital telephone channel used for the EuroNexus audio. The vital information you need to know is that this channel has the following parameters:

4800 baud; 8 bits; no parity; 1 stop bit

Now, we will describe a few concepts:
The EuroNexus ancillary data channel is asynchronous. This is the most common format for information exchange between computers. An asynchronous data link simply provides a "pipe" which passes bits back and forth between the devices. What you do with this data is dependent completely on the computers and software used in the connection.

It is the nature of asynchronous data that we define a "baud rate." This is the rate at which individual bits run along the asynchronous link. In some asynchronous systems, however, a continuous stream of data at the specified baud rate will overload the system. This is because the baud rate specifies only the speed on the pipe feeding *into* the system. Further down, the pipe may narrow and less throughput is possible. Asynchronous communication allows flow control where the sending device will be triggered by the network when enough capacity is available to send more information. In the EuroNexus, the "pipe" has the same throughput all the way across, and flow control is not necessary.

Flow control works because asynchronous links do not need to send information at all times. When there are no characters for a computer to send a modem, for example, the asynchronous link is *idle*. When the computer has information to send, it will usually format this information into one or more bytes, attach a start and stop bit (so the receiving system knows where the byte begins and ends), send it off, and again make the line idle. In the most common application for ancillary data (two terminals with operators sending text characters back and forth) the asynchronous link is active only a small fraction of the time. During a file download, however, the link will most likely be constantly active, with one byte being sent immediately after the next (unless flow control is active).

The EuroNexus audio algorithm operates in one of three possible modes. It either formats its audio data into 8, 7, or 6 bit words. Without ancillary data engaged, the EuroNexus forms its codewords into 8 bit words at 64 and 128 kb/s and 7 bit words at 56 and 112 kb/s. With ancillary data engaged, the codewords are each sliced by one bit i.e. 7 bits at 64/128 kb/s and 6 bits at 56/112 kb/s, in order to make enough room to imbed the data. This "slicing" is done whether or not the ancillary data channel is active or idle, and the audio quality is reduced very slightly with a smaller codeword.

Here is a description of a typical ancillary data hookup:
Each EuroNexus operator will configure his unit for operation at the desired bit rate and engage the ancillary data function. The call will be completed. Each operator will attach a PC com port to the ancillary data connector on the EuroNexus (via a straight-through 9 pin cable) and load a terminal emulation program such as Windows™ terminal or Procomm™. Each will set the correct com port in software and set the communications parameters to 4800 baud, 8 bits, no parity, 1 stop bit. Flow control should be turned off.

In most ways, the link will resemble a normal modem connection. When a key is typed on one terminal, the ASCII byte corresponding to that character will be sent out the computer com port to the EuroNexus. The EuroNexus will embed this character into the data it is sending, and the EuroNexus on the far end will extract this character from the incoming data. It will then send the character to the other computer com port, and it will appear on the other display. Of course, since the channel is full duplex, this exchange may be happening in both directions simultaneously.

A few common options in terminal programs will ease communication:
a) Local echo — Engage this if you wish to see what you are typing on your own display. The EuroNexus cannot echo the characters you send back to your display. It can only send them to the other end. You must configure your communications program to do this.

b) CR-> CR-LF — When you type a carriage return (enter key), the CR character is all that is usually sent through the EuroNexus data link. Your program will likely interpret this correctly and send the cursor back to the beginning of the same line. Your program can probably be set to interpret the CR character as both a CR and LF (line feed) sending the cursor to the beginning of the next line. Your program can also usually be altered to send both characters when the enter key is pressed. Usually only one of the above options is required.

c) Other options — The software setup of your communications program may require additional parameters. Keep in mind that the EuroNexus data channel is simply a “pipe.” What bytes are sent and how they are interpreted is completely dependent on the software being used and how that software is configured.

Troubleshooting the Ancillary Data Channel

The loopback testing facility in the EuroNexus can aid in troubleshooting ancillary data connections. It is often difficult to find a fault in a problem like this, since the trouble could be at either end of the link. By loopback testing the ancillary data channel on each end, at least you can easily find which end has the trouble. To loopback test ancillary data:

1) Connect a computer serial port to the EuroNexus.
2) Run a program on the computer with basic serial communications functions, such as Procomm, Windows Terminal, or Win95 Hyperterminal.
3) Set the communications parameters as follows:
    4800 baud
    8 bits
    no parity
    1 stop bit
    echo off (half-duplex mode in Hyperterminal)
4) Make sure the software has the serial port chosen which is connected to the EuroNexus.
5) If not already done, configure the EuroNexus for Ancillary Data Mode (page 10).
6) Type some characters on your computer, and verify that you do NOT see them on your screen.
7) Go into the test menu on the EuroNexus, by pressing **3** from the Main Menu. The "ready" light should come on.
8) Type on your computer keyboard. You should see your characters echoed back to you on the screen.

If this test is successful, you have sent data down the cable to the EuroNexus, into the encoder, looped through to the decoder and back to your computer screen. If not successful, try the following:

1) Type "AT" (Enter). If you get a response "OK" then you are probably talking to a modem inside your computer, configured for the chosen com setting. Try a different configuration.
2) Try a different com port. Sometimes these ports "burn out," if connected wrong previously.
3) Remove any adapters, "dongles," or other connectors on the port.
4) Make sure you are using a "straight through" 9 pin to 9 pin cable. Do not use a null modem cable.

Section10. EuroNexus Specifications

Connections

Audio In:	3-pin XLR Female
Tape In:	1/8" 2-conductor mini jack
Audio Out:	3-pin XLR Male
Headphone Out:	1/4" stereo jack
ISDN “S/T” Interface:	RJ45 Modular Jack
Ancillary Data:	DB-9 Female
EIA 530 Data In/Out:	DB-25 Male
Power:	2.1 mm i.d. 5.5mm o.d., coaxial

Levels

Audio Inputs:

Impedance	10K ohms
XLR Mic Input levels	-85 to -40 dBu
XLR Line Input levels	-10 to +10 dBu
Tape Input level	-10 dBu (fixed)

Audio Outputs:

Line level output	+12 dBu maximum
Headphone output	1 watt

Ancillary Data:	RS232 electrical signals
EIA 530 Data In/Out:	RS422 electrical signals

Audio Bandwidth

56, 64 kb/s	20 Hz - 7.5 KHz
112,128 kb/s	20 Hz - 15 KHz

A/C Power Supply

5V 4 Amp; 100 to 240 VAC, 50/60 Hz

Size

Portable: 6.25”W x 9.5”D x 2”H (15.9cm x 24cm x 5cm)
Rackmount: 19”W x 8”D x 3.5”H (48cm x 20cm x 9cm)

Weight

Portable: Net 2.4 lbs (1 kg); Shipping: 6 lbs (2.7 kg)
Rackmount: Net 6.5 lbs (3 kg); Shipping: 11 lbs (5 kg)

PIN DESIGNATIONS

ISDN “S/T” Interface:
Physical: RJ45 8-pin modular jack

Main input:
Physical: 3-pin female XLR
Pin 1: Ground
Pin 2: + Audio In
Pin 3: - Audio In

Tape input:
Physical: 2-conductor 1/8" mini jack
Tip: + Audio In
Sleeve: Ground

Main output:
Physical: 3-pin male XLR
Pin 1: Ground
Pin 2: + Audio Out
Pin 3: - Audio Out

Headphone output:
Physical: 3-conductor 1/4" phone jack
Tip: Audio Out L
Ring: Audio Out R (same as L)
Sleeve: Ground

“Ready” Contact Closure:
Physical: 2-conductor 1/8" mini jack
Dry closure between Tip and Sleeve

Power:
Physical: 2.1mm i.d., 5.5mm o.d., coaxial
Outer shield: Ground
Inner core: +5V

EIA 530 Data in/out (DTE):

Pin 1	Shield
Pin 2	TX Data A
Pin 3	RX Data A
Pin 7	GND
Pin 9	RX Clk B
Pin 12	TX Clk B
Pin 14	TX Data B
Pin 15	TX Clk A
Pin 16	Rx Data B
Pin 17	RX Clk A
Pin 18	STL Mode trigger
Pin 24	DTR (RS232)

Ancillary Data in/out (DCE):

Pin 2	RX Data
Pin 3	TX Data
Pin 4	DTR (unused)
Pin 5	GDN
Pin 6	DSR (always valid)
Pin 7	RTS (unused)
Pin 8	CTS (goes valid on"ready")
Pin 9	RI (unused)