Nexus Digital Audio Codec

SECTION

About Comrex

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. Product information, Engineering Notes and User Reports are available on the World Wide Web at http://www.comrex.com. Our internet E-Mail address is info@comrex.com.

Warranty and Disclaimer

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, 19 Pine Road, Devens, MA 01432 USA. For return authorization, contact Comrex at 978-784-1776 or fax 978-784-1717.

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 Nexus 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 Nexus 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 Nexus 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 Nexus 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 the "G.722 Algorithm" section on page 31.

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 27. 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 TA in the Nexus includes a section called the NT1 which is a conditioning circuit that interfaces with the phone line. This eliminates the requirement for another external box on your circuit. The Nexus TA also can 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 the "Inverse Multiplexing" section on page 34.

THE COMMAND PROCESSOR

This is the "brain" of the Nexus. 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.

SECTION 2. NEXUS MENU SELECTION TREE

In this sample display, the Nexus is set to dial at 128 kb/s (for 15 kHz audio). The switch type is National ISDN 1. The OK in the upper right hand corner shows that the inital handshake with the line was successful.

- 1) Dial — Enter #:
- 2) Config
  - 1) PgmQdl — Qdial #: (01-39) — Enter # to save:
  - 2) KB/s
    - 1) 56K
    - 2) 64K
    - 3) 112K
    - 4) 128K
    - 5) 128K Leased Mode
    - 6) 128K LDM Master
    - 7) 128K LDM Slave
  - 3) Ntwrk
    - 1) Switch
      - 1) 5ESS
      - 2) DMS-100
      - 3) NI-1
    - 2) SPID
      - SPID1 (CNCL=bksp) — SPID Stored
      - SPID2 (CNCL=bksp) — SPID Stored
    - 3) LDN
      - LDN1 (CNCL=bksp) — LDN Stored
      - LDN2 (CNCL=bksp) — LDN Stored
    - 4) Profiles
      - 1) Store Profile — Enter Config Profile #: (0-9)**
      - 2) Load Profile — Enter Config Profile #: (0-9)
  - 4) AncDat
    - 1) Anc Data Off
    - 2) Anc Data On
- 3) Test
  - 1) TA Loopback — TA Loopback Cancel = Exit
  - 2) Codec Loopback — 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 SPIDs, LDNs, Switch Type, Anc Data (on/off), and Data Rate.

SECTION 3. BASIC OPERATIONAL INSTRUCTIONS

AUDIO CONCEPTS

The Nexus 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 "Nexus Speifications" on page 39 for hookup information.

There are three audio controls on the Nexus 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 Nexus, 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 Nexus. The output audio of the Nexus 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 control (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. The Nexus 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 Nexus at the level you will typically use. Adjust the INPUT LEVEL control until the PEAK indicator on the Nexus 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 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 Nexus 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 Nexus channel is used to send the host to the station, and the return Nexus 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 Nexus).

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

The Switch Type, SPID numbers (Service Profile IDentifiers), and Local Dialing Numbers (LDNs) have to be programmed into the Nexus before it is connected to an ISDN line and whenever it is moved to a new line.

This data is provided by the telephone company, and it is unique to the specific ISDN line to which you are connecting. Don't let your ISDN installer leave without being certain that you have the correct information in hand. Otherwise, it can result in the Nexus not working at all, or “partially” working and can require time-consuming troubleshooting. Incorrect phone company information is the number one source of difficulty when configuring ISDN equipment. The second is incorrectly installed phone lines, which we deal with in the “Look for the Big OK” section on pages 23 - 24.

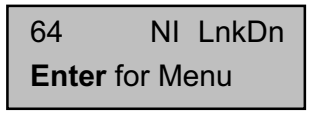
The Switch Type, SPIDs, and LDNs need to be programmed into the Nexus *before it is attached to the ISDN line*. If you reenter any of these values once the Nexus has “shaken hanks” with the line, disconnect the Nexus from the line temporarily or power it down momentarily in order to initiate a new “handshake.” Any information entered into the Nexus will be saved if it is turned off or loses power, so you will not need to reprogram the line information unless you move it to another ISDN line.

Note: If you are installing the Nexus 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.

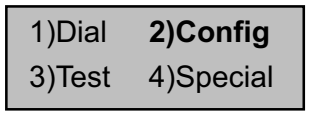
Selecting the Switch Type

The telephone company will need to tell you the switch type so you can select it on the Nexus. The switch type describes the type of equipment on the telephone company's end of the ISDN line. The choices are AT&T *5ESS*, Northern Telecom *DMS-100*, and National ISDN 1 (NI1). Note that the AT&T and Northern Telecom switches can work in NI1 mode, so if this is the case NI1 is the correct choice. *5ESS* or *DMS-100* should only be selected if the telephone company has specified these custom configurations for your line. If in doubt about this choice, contact the company that installed your ISDN line.

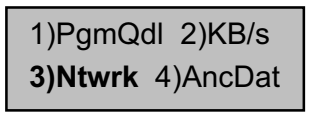
Before attaching the ISDN line, be sure you have the above information, and then power up the Nexus by plugging the external supply to A/C and turning the switch on the rear panel of the Nexus to ON. *Do not connect to the ISDN line before entering the switch type, SPIDs, and LDNs.* After a few seconds, the Main Status Display will appear. Don't be concerned with the LNKDN display 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. Select **1** on the keypad to enter the Switch Type Menu and make the appropriate selection. The Nexus will store your selection and return to the Network Configuration Menu.



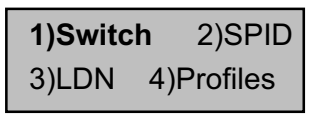
Main Status Display



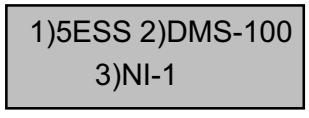
Main Menu

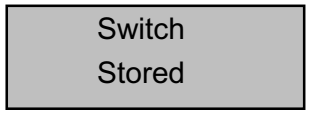


Configuration Menu



Network Configuration Menu





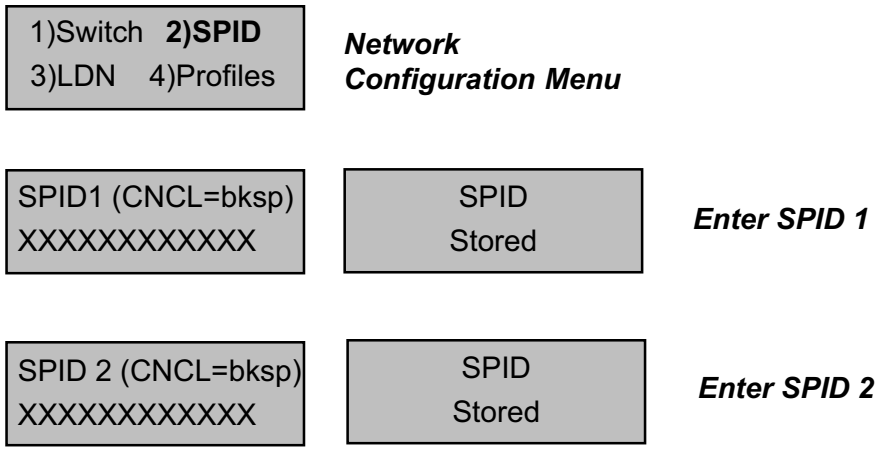
Select Switch Type

Entering the SPIDs

You will now program the exact **S**ervice **P**rofile **ID** Number that the telephone company gave you for each channel of your ISDN line. This number is used to handshake between the telephone company and the Nexus. Press **2** while in the Network Configuration Menu to begin entering the SPIDs. After SPID 1 is programmed, press ENTER. The SPID 2 menu will appear. After programming SPID 2, press ENTER to return to the Network Configuration Menu.

If SPIDs were previously programmed into your Nexus, they will appear after a short pause. If they are correct, press ENTER until you return to the Network Configuration Menu. If you wish to change a previously programmed SPID or if you make a mistake while entering the number, press the CANCEL key to backspace until the number is cleared, and then enter the correct number.

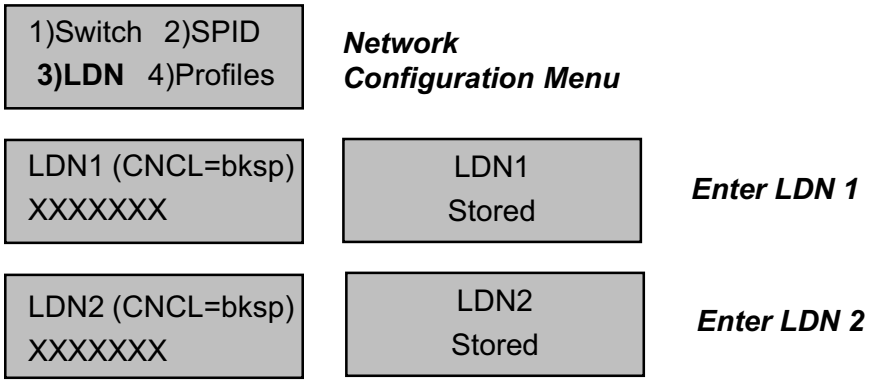
Note: Some ISDN lines use two SPIDs, some use one, and some use none at all. Often, your SPID resembles your phone number plus area code with leading or trailing digits. If your line was configured for two SPIDs, you must enter the appropriate numbers exactly as they have been given to you by the phone company into the SPID 1 and SPID 2 menus. If your line has only one SPID, program that number into <u>both</u> SPID 1 and SPID 2 menus. If you have ordered service on only one "B" channel (1B+D), enter the SPID number into SPID 1 and leave SPID 2 blank. Finally, if your line has no SPIDs, verify that there are no numbers programmed into SPID 1 and SPID 2.



ENTERING THE LDNS

Now you will program the local phone numbers for your ISDN line. From the Network Configuration Menu, press **3** to begin entering the LDNs. After LDN 1 is programmed, press ENTER. The LDN **2** menu will appear. After you have programmed LDN **2**, press ENTER to return to the Network Configuration Menu.

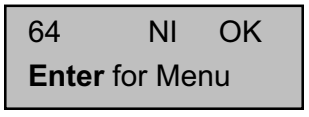
If LDNs were previously programmed into your Nexus, they will appear. If they are correct, press ENTER until you return to the Network Configuration Menu. If you wish to change a previously programmed LDN or if you make a mistake while entering the number, press the CANCEL key to backspace until the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



Note: The LDN is the Local Dialing Number for your line. It is usually only seven digits long. Do not include your area code in the LDN. For example: The Comrex ISDN Nexus test phone number is 978-772-9404, and the LDN is 772-9404. 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 switch type, SPIDs, and LDNs are programmed correctly, press the CANCEL key until you are again at the Main Status Display. Now attach the ISDN line to the telephone connector on the rear of the Nexus. In about one minute, the LNKDN status display should change to OK. This means that the Nexus has correctly "shaken hands" with the telephone company along the ISDN line. If the line is removed or the Nexus is turned off, this handshake will need to take place again. If the OK signal does not appear within about a minute, refer to the "Look for the Big OK" section on pages 23-24. *Note: The Main Status Display also shows the data rate selected (see next section for programming) and the switch type selected.*

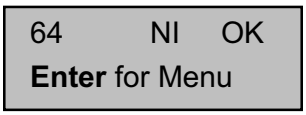


Selecting the Data Rate

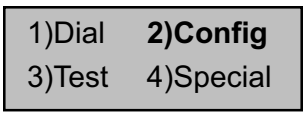
Now that the Nexus has been set up for your ISDN service, you will need to tell it a few things about what you want to accomplish. The first selection will be data rate. The Nexus can communicate at four different data rates: 56, 64, 112 or 128 kb/s. The 56 or 64 kb/s data rates use only one "B" Channel, and you will only be billed for one ISDN phone call at these rates. The 112 and 128 kb/s rates actually place two different calls between points using both "B" Channels (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 Nexus 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 Nexus 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 (as well as 112 and 128 kb/s). The 56 and 112 kb/s rates are provided for compatibility with ISDN lines which do not provide clear channel 64 kb/s transmission and also to interwork with Switched 56 systems. 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.

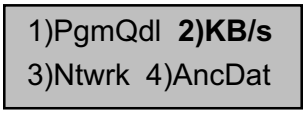
To select your data rate, press ENTER from the Main Status Display. Press **2** for CONFIG and then press **2** again to select KB/S. Select the appropriate number of the data rate you want to use. Press ENTER to store. Use the CANCEL key to return to the Main Status Display. Under most circumstances, two Nexus which are set to different data rates will negotiate down to the setting of the lowest unit (however, this feature is dependent on the network and may not always work). This allows for a unit which accepts incoming calls to be set to 128 kb/s and automatically adjust to take calls from units set to lower rates.



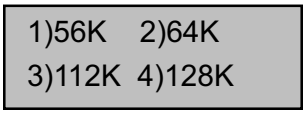
Main Status Display



Main Menu



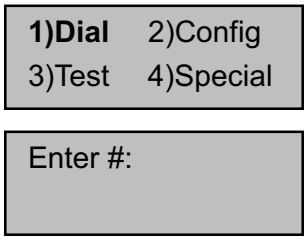
Configuration Menu



Select Data Rate

Placing a Call

There are two ways to place a call with the Nexus. 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 CANCEL 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

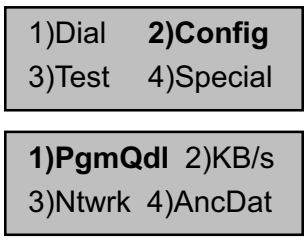
***Key in number and press* ENTER.**

Note: ISDN dialing numbers use the same local and international access and area codes as normal analog calls, i.e. if you use a "1" before a number for a normal long distance call, use a "1" before the ISDN number.

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 Nexus 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. 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 CANCEL key. Press ENTER when your number is complete. Press CANCEL unitl you reach the Main Status Display. The QDial numbers will remain in memory, even if the Nexus loses power.



Main Menu

Configuration Menu

PROGRAMMING 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 Nexus 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 Nexus should autiomatically answer the incoming call and "wake-up," providing full duplex audio.

ANCILLARY DATA

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 Nexus MUST be configured the same way with ancillary data on or off. If the ancillary data mode is mismatched between two Nexus, the audio channel will not work correctly. If communicating to a compatible device which is not a Nexus, 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 35-36.

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 Nexus between different ISDN equipped locations, it can become difficult and confusing to reprogram all the necessary information about the ISDN line into the Nexus each time it is moved. The Nexus eases this task, by allowing you to create ten "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 **4** for PROFILES.

56 NI OK Enter for Menu	***Main Status Display***
1)Dial **2) Config** 3) Test 4) Special	***Main Menu*** ***Select 2 for CONFIG***
1) PgmQdial 2)KB/s **3)Ntwrk** 4)AncDat	***Configuration Menu*** ***Select 3 for the NTWRK***
1)Switch 2)SPID 3)LDN **4)Profiles**	***Network Menu*** ***Select 4 to load and store PROFILES***

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

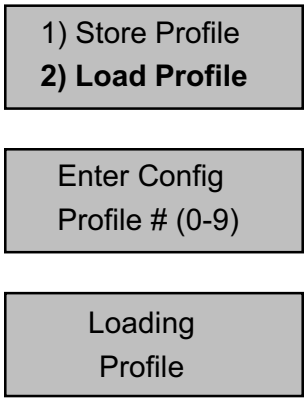
1) Store Profile 2) Load Profile	***Profile Menu*** ***Select 1 to store a profile***

You will be prompted for a profile index #:

Enter Config Profile # (0-9)	***Select which user profile you would like to set up (0 - 9)***

You will be prompted for the SPIDs, LDNs, switch type, anc data mode, and data rate for the profile. If a SPID or LDN has been entered previously for a profile, it will appear on the LCD display. You may use the CANCEL key to back over the entry unil it is cleared or press ENTER if the numbers are correct. The profiles will be stored in memory even if the Nexus is powered off.

To load the stored profile, follow the directions to access the profile features (page 14). Once in the Profile Menu, select option 2 and then the appropriate profile index number (0 - 9). The Nexus will automatically load all the preset parameters.



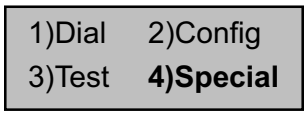
Profile Menu
Select 2 to load a profile

Select the profile index number to load

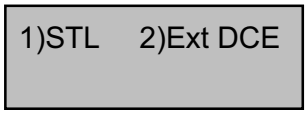
Repeat all the steps to store and load multiple profiles. You may wish to attach a label to the Nexus indicating which profile index number applies to which ISDN location.

SECTION 4. SPECIAL OPERATIONAL MODES

The Nexus has two "special" operational modes: STL Backup Mode and External DCE Mode. To access these modes press 4 to select SPECIAL from the Main Menu.



Main Menu



Special Menu

Note: While these special modes are engaged, the other menus are disabled. For this reason you will want to make sure all settings are correct before you enter any "special" mode.

STL BACKUP MODE

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

1) Set the Nexus options as you need them (data rate, anc data, etc.).
2) Select 1 for STL via the Special Menu.
3) Connect pins 1 and 18 on the EIA 530 connector to a contact closure which will close when the Nexus is needed.

The Nexus will dial QDial 01 when the pins are closed together. 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 Nexus 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. Simply hardwire together pins 1 and 18 on the EIA connector. When ready to place a call, enter STL Backup Mode (having preset all the Nexus paramenters). The Nexus will immediately dial QDial 01 and connect. If at any point the connection should be lost, the Nexus 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.

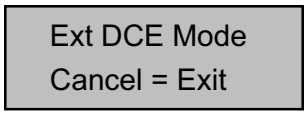
External DCE Mode

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

In this mode, the Nexus works very much like the 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 Nexus.

If you are using ancillary data while in External DCE Mode, you need to set AncDat to ON (see page 13) before going into External DCE. When you select the External DCE Mode, the Nexus screen will appear as below. Press CANCEL at any time to leave External DCE Mode. The Nexus 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 Nexus cannot be used as a stand-alone terminal adapter (say, for use with another codec).

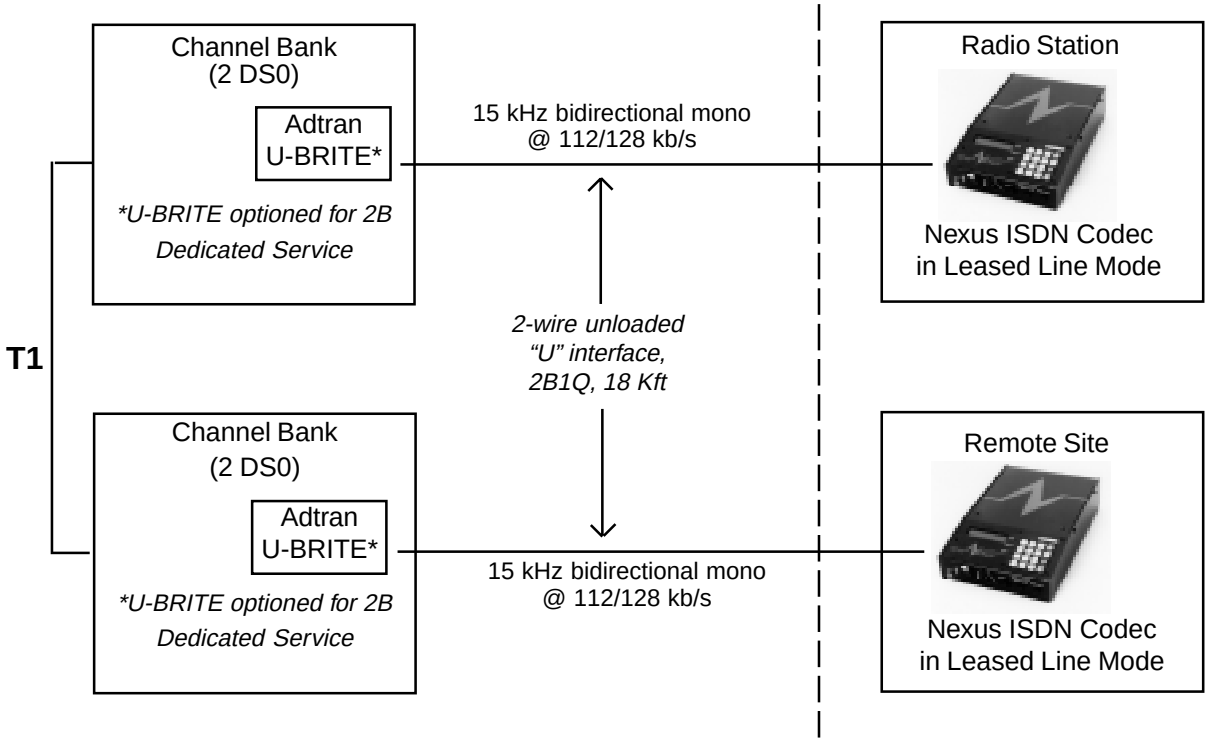
SECTION 5. ADDITIONAL FUNCTIONS

LEASED LINE MODE

The Nexus has the ability to enter a special mode for connection on "leased" or "nailed up" ISDN circuits. Although this service is not as common as ISDN, some of the more progressive telephone companies have tariffed it. This provides a full-time, dedicated 128 kb/s link. See the diagram below for an example of "nailed up" ISDN service.

To set your Nexus for leased line mode, enter the CONFIG menu and then the KB/S menu. Although the menu shows only the four options described in the manual, if you select option 5 here, you will enter Leased Line Mode. Attach the leased ISDN line to the Nexus via the same jack used for dial-up ISDN. If a Nexus is connected at the other end of the leased line, the units should handshake within about one minute, and the READY light should turn green.

In Leased Line Mode, the Nexus operates only at 128 kb/s. The only other option you should need to set is the ancillary data on/off option (see page 13). As with dial-up operation, ancillary data option must be set the same on each end of the link. The Nexus will automatically return to Leased Line Mode if power is lost.



LDM Mode

The Nexus has the ability to operate as a Limited Distance Modem (LDM) on a "dry pair," or plain old copper wire pair. This can be useful when connecting two local points where ISDN is not available, but unloaded and unequalized telephone loops (pairs of wires) are. This mode is not for use on plain old "subscriber" telephone lines. The service must be a simple pair of wires running from point A to point B (these may exist already within your local telephone plant, or may be purchased from the phone company as an unequalized broadcast loop, or simply as an "alarm pair"). There is a distance limitation in this mode, and it depends on the gauge of wire used and other environmental factors. In general, use 18,000 feet as a limit when using typical telephone gauge wire.

In this mode, one of your Nexus will be configured as the "Master" (this Nexus provides the clocking signal to the wire) and the other as a "Slave" (this Nexus uses the clocking signal on the wire). The units will provide a completely independent wideband audio channel in each direction on the single pair of wires.

To enter LDM Mode, select KB/S in the CONFIG menu. Although the menu shows only four options, if you select option 6 here, you will enter LDM Master Mode. Option 7 will enter LDM Slave Mode. It doesn't matter which Nexus you configure for master or slave, only that one is programmed as each. Now you can attach the wire pair to the Nexus as you would an ISDN line, using the center two pins of the RJ-11 connector. Within about a minute, the Nexus should wake up, the ready lights should turn green, and your audio link should appear. If either Nexus should lose power, they will return to this mode when power is restored.

The Nexus always connects at 128 kb/s in LDM Mode, so the only control you need to preset is the ancillary data on/off control (see page 13). As on ISDN, this mode must be selected the same way on each Nexus.

LDM mode is also a good way to "prove out" a pair of Nexus even without connection to ISDN. You can simply connect an RJ-11 cable between your Nexus, and when you enter LDM Mode, a connection will complete between the units.

SECTION 6. TROUBLESHOOTING

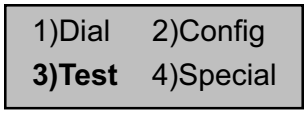
The Comrex Nexus coding algorithm eliminates redundancy in audio. For this reason, the Nexus cannot be subjected to traditional specifications of distortion and signal-to-noise ratio. Most tests done with the codec should be by subjective listening between the original source material and codec-processed 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 to for a solution. The Nexus provides some simple diagnostic functions to help you do this: Codec, TA, and Remote Loopback.

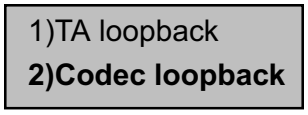
CODEC LOOPBACK

This test examines the codec portion of the Nexus, 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 Nexus, 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.

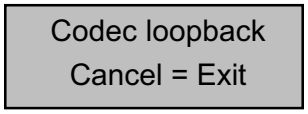
To enter the Loopback Test Menu, press **3** from the Main Menu. Then press **2** for CODEC LOOPBACK. This activates two things. It puts the local clock into use to drive the signal, and it connects the encode and decode channels. Press CANCEL at any time to exit Codec Loopback.



Main Menu



Loopback Test Menu



Codec Loopback Status Display

Expected Results in Codec Loopback Test

You will hear the same audio in your headphones that you are feeding into the system, and 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:

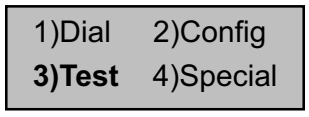
- Check your connections.
- Make sure the power light on the front panel is on.
- Make sure the peak light is flashing occasionally.
- Insure that the mic/line switch is in the correct position.

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

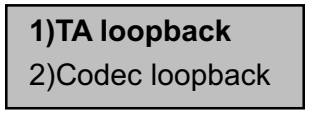
TA Loopback

This function tests the terminal adapter and the codec portions of the Nexus together. 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 Nexus, 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.

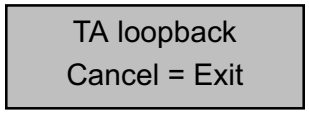
To enter the Loopback Test Menu, press **3** from the Main Menu. Then press **1** for TA LOOPBACK. This will send your audio through the encoder to the TA and back through the decoder, without going onto the network. Press CANCEL at any time to exit TA Loopback.



Main Menu



Loopback Test Menu



Codec Loopback Status Display

Expected Results in the TA Loopback Test

You will hear the same audio in your headphone that you are feeding into the system, and the READY light should be on. *Note: There may be a few seconds of noise before your audio is heard*. Also, there will be a noticeable delay in the audio returned to the decoder from the TA. This delay is a function of the TA loopback test and does not reflect actual coding delay in program transmission.

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 Nexus.

Remote Loopback Test

This test checks out the Nexus together with the ISDN line (or other digital circuit). To run this test, you must have a call connected at either 56 or 64 kb/s. While the call is connected, press the QDIAL button. In a few seconds, the LCD display should change from an ON LINE indication to REMOTE LOOPBACK. The READY light will go out momentarily and come back on. You should hear your own audio at the output of the Nexus. Press CANCEL to return to normal transmission.

If this test is successful, this shows that both your Nexus and the digital circuit are OK, and the problem is likely to be with the far end equipment. If the test is not successful, and you have been able to do a successful TA loopback through the Nexus, the problem is likely to be with your telephone circuit. Look for the Big OK! Most problems with ISDN occur during the initial setup of the line. In order for the Nexus to work, there must be an OK message in the upper right corner of the Nexus LCD screen. If any other message appears (Lnk Dn or Lnk A through F - or in older Nexus versions: T1ok, T2ok, etc.), the initial “handshake” with the ISDN line has not been completed and a call cannot be made. See the next section "Look for the Big OK."

Look for the Big OK

Most problems with ISDN occur during the initial setup of the line. In order for the Nexus work, you must program some information specific to your ISDN line, and there must be an "OK" message on the display. If any other message appears, the initial handshaking with the ISDN line has not been completed, and a call cannot be made.

Prior to programming the Nexus, you need some information from the telephone company. This may have been written on the ISDN jack, or on a tag or paper left by the installer. If not, you should contact the telephone company and ask for the following:

SPID Numbers: You will usually be given two of these. They normally contain the phone numbers of the two "B" channels of your ISDN line, possibly with some extra digits before or after the number. The most common format is XXX-XXX-XXXX-0101, where the X's represent the 10-digit phone number, including area code.

Switch Type: The Nexus has three choices for switch type, NI-1 (National ISDN-1), DMS-100 and 5ESS. These refer to the type of switching equipment your telephone company has at the other end of your ISDN line. Regardless of the make or model of their switch, if they are using the National ISDN 1 or 2 software, the correct choice would be NI-1. Also note that if the SPID numbers end in "0101", you can assume that NI-1 would be the switch type.

LDNs: The local dialing numbers are almost always just the 7-digit local telephone numbers without the area code or the extra digits found in the SPIDs.

Once you have this information, unplug the ISDN line from the Nexus, and program the unit according to the instructions (pages 8-10). With all of the numbers and choices stored, go back to the top menu and plug the line back in. You should now see a series of messages on the LCD screen (some may be skipped), ending in "OK". Allow a minute or so for the process to complete.

Link Message	**Description**
Lnk Dn	No activity has been detected on the ISDN line.
Lnk A	Layer 1 (Physical handshake accomplished with line).
Lnk B	Terminal Endpoint Identifier 1 is being retrieved.
Lnk C	Terminal Endpoint Identifier 1 is OK.
Lnk D	Service Profile ID 1 is OK.
Lnk E	Terminal Endpoint Identifier 2 is being retrieved.
Lnk F	Terminal Endpoint Identifier 2 is OK.
OK	SPIDs are OK, handshaking is completed.

If the unit stops at Link Down, there is a basic communication problem with the ISDN line, possibly due to a physical wiring problem. Check that you are plugged into the correct jack, and that your telephone cord is OK.

If the display stops at an intermediate point, unplug the line, and check the numbers you have entered, particularly the SPIDs. You may have transposed some digits or made another mistake. Focus on SPID 1 if the message stops at Link B or C, and on SPID 2 if it stops at Link E or F. Also, be sure that you have correctly chosen the switch type. Plug the line back into the unit, and see if the problem is solved.

Still can't get the "OK"? Assuming you haven't made a "typo" (go ahead, check those SPIDs again), the telephone company may have given you incorrect information. You may save some time by simply calling them and asking for it over the phone. Otherwise, here are some tips that may help you out:

• New ISDN lines are usually installed with SPIDs consisting of the area code, local number and "0101" at the end. The correct switch type for these lines is NI-1. It may be worth trying this combination.

• NI-1 is the proper choice for most new ISDN installations.

• There is a flavor of ISDN provisioning called "5ESS custom point-to-point" that may not require SPIDs or LDNs. If you think that is possible in your case, try removing them, and selecting "5ESS" for the switch type. Do note, however, that you may sometimes get a false "OK" when no SPID numbers are entered. You will not be able to place calls in that case.

• If there has been a recent area code change at your location, you may want to try both the new and old area codes.

• On pages 25&26, we list some conventional wisdom about SPIDs and switches, gleaned from many years of experience with ISDN. Some of this information is becoming dated, but it may be useful on older lines or in areas that are slow to update their ISDN practices.

• If none of this helps, Comrex Tech Support may be the solution. Remember, though, that we are quickly going to ask whether you have verified the line information with the telephone company, so you should do that first.

Once you have the "OK" on the screen, you should be able to place and receive calls. Comrex Tech Support would be happy to help with these initial tests.

Using Long Distance Access Codes

A frequent problem with new ISDN installations is being unable to place a long-distance call. Unless you have made arrangements with a long-distance company to provide service on that line, you may be in this position. We strongly suggest using one of the major long-distance companies for ISDN calling. You may be able to temporarily make calls by entering the "1010" number for that company, but it is usually best to actually sign up for service. Here are some useful "1010" numbers:

- AT&T 1010288
- MCI 1010222
- Sprint 1010333

Some Known SPID Formats

Information from ISDN, What Every Broadcaster Needs to Know,
courtesy Douglas A. Lane, 1900 Woodland Drive, North Reading, MA 01864

7 digits = local dialing number
10 digits = area code + local dialing number
NI1 = National ISDN 1

	Switch Type	SPID Format
Ameritech	AT&T 5ESS Custom	01 + 7 digits + 0
	AT&T NI1 (5E8)	01 + 7 digits + 011
	AT&T NI1 (5E9)	10 digits + 0111
	DMS100 - NI1	10 digits + 0111
	DMS100 Custom	10 digits + 0
	Siemens NI1	10 digits + 0111
Verizon (Formerly Bell Atlantic)	AT&T NI1	01 + 7 digits + 000
	DMS100 NI1	10 digits + 100
	Custom ISDN	01 + 7 digits + 0
	AT&T Point-to-Point	no SPIDS or LDNs needed
	AT&T NI1	10 digits + 0000
	DMS100 NI1	10 digits + 0001
Bell Canada	DMS100 NI1	7 digits + 00
Bell South	AT&T NI1	10 digits + 0100
	DMS100 Custom	10 digits + 34 or 4
	DMS100 NI1	10 digits + 0100
	NI-1	10 digits + 0 or 00 or 000
Verizon (Formerly GTE, NC)	DMS100 NI1	10 digits + 0100 or 0000
Verizon (Formerly GTE, OR)	AT&T NI1	01 + 7 digits + 000
	AT&T Custom	01 + 7 digits + 0000

Pac Bell	AT&T Custom	01 + 7 digits + 0
	AT&T NI1	01 + 7 digits + 000
	DMS100	*(Note: There may be different suffixes for the B1 channel and the B2 channel)*
		10 digits + 1 (B1) & + 2 (B2)
		10 digits + 10 (B1) & + 20 (B2)
		10 digits + 100 (B1) & 200 (B2)
		10 digits + 1000 (B1) & 2000 (B2)
		10 digits + 01 (B1) & 02 (B2)
		10 digits + 010 (B1) & 020 (B2)
		10 digits + 0100 (B1) & 0200 (B2)
		or 10 digits + 1
SNET	AT&T NI1	01 + 7 digits + 000
	Custom	10 digits + 0101
SW Bell	DMS100	10 digits + 01
	AT&T NI1	10 digits + 000
	Siemens NI1	10 digits + 0100
Qwest (Formerly US West)	AT&T NI1	01 + 7 digits + 000
		or 7 digits + 1111
		or 10 digits + 1111
	AT&T Custom	01+ 7 digits + 0

SECTION 7. ABOUT ISDN

ISDN stands for Integrated Services Digital Network, 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, and 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 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 8. ORDERING ISDN

ISDN SERVICE ORDER INFORMATION

The Nexus ISDN Codec includes both NT1 and Terminal Adapter functionality and supports data rates up to 128 kb/s.

If the telephone company handling your ISDN service order uses the Bellcore National ISDN "Capability Package" designations, simply ask for Capability Package M (or Generic Data M).

For telephone companies requiring the full details, request an ISDN Basic Rate Interface (BRI) line with:

- U-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 Nexus since ordering 1B+D Service will restrict the Nexus to 7.5 kHz audio bandwidth.

The Nexus supports the following switch types and software protocols:

- AT&T 5ESS - Custom, 5E6 and later software
- NTI DMS-100 - BCS-32 and later software (Pvc1)
- National ISDN 1 compatible (may be a Siemens switch, AT&T 5ESS NI1 switch, Northern Telecom PVC2, or other switch)

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

With an AT&T 5ESS Custom Switch

With an AT&T 5ESS switch most telephone companies provide the option of Point-to-Point (one telephone number which operates both B-channels and no SPIDs) or Point-to-Multipoint (two telephone numbers and two SPIDs or Service Profile IDentifiers — one for each "B" channel). Either service may be used with the Nexus.

Request the following features:

Feature - Value
B1 Service - On Demand (DMD)
B2 Service (if two B channels are ordered) - On Demand (DMD)
Data Line Class - Point-to-Point or Point-to-Multipoint
Maximum B Channels - 2 if 2B+D, 1if 1B+D
Circuit Switched Voice Bearer (CSV) Channel Any Number of CSV calls - 1 (for testing)
Circuit Switched Data (CSD) Bearer Channels Any Number of CSD calls - 2 if 2B+D, 1 if 1B+D
Terminal Type - Type A

Turn the following features OFF:

Packet Mode Data
Multiline Hunt Groups
Multiple Call Appearances
Electronic Key Telephone Sets (EKTS)
Shared Dictionary Numbers
Accept Special Type of Number
Intercom Groups
Network Resource Selector (Modem Pools)
Message Waiting
Hunting
InterLata Competition

With a DMS-100 Northern Telecom Switch

When accessing a DMS100 switch you are required to have two phone numbers and two SPIDs. Therefore all service is Point-to-Multipoint.

Request an ISDN Basic Rate Interface (BRI) with:

Line type - Basic Rate, Functional
Electronic Key Telephone Sets (EKTS) - No
Call Appearance Handling (CACH) - No
Non-initializing Terminal - No
Packet Switched Data Service - No
TEI - Dynamic

Bearer Service - Circuit Switched Voice and Data permitted on any B Channel (Packet mode data not permitted).

Checklist for all Switch Types

After you have placed your order, make sure that the phone company provides you with the following information for programming the Nexus.

ISDN Switch Type
ISDN Local Dialing numbers or LDN
SPIDs with prefixes and suffixes (if your switch type needs SPIDs)

SECTION 9. 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. 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' equipment 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 Nexus follows this standard very carefully and can communicate with G.722 codecs from other manufacturers.

The Nexus 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 Nexus 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 Nexus 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 a international standard by the CCITT as recommendation G.722. The text of this specification is public information, and it 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 Nexus 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.

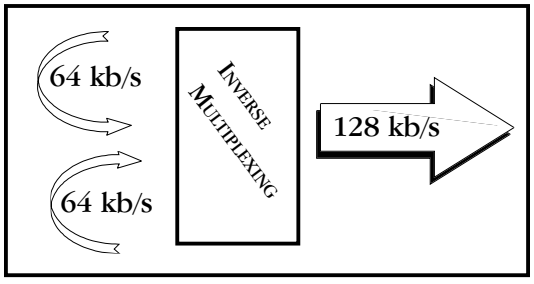
Every half second, the Nexus rechecks to make sure that it is still in sync. If the network causes an error that makes the data stream line up differently, the codec can determine this and resync within one second. Remember, because the Nexus is fully duplex, it is simultaneously encoding/compressing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



About Ancillary Data

The Nexus provides an ancillary data channel which allows the user to send low speed data along the same digital telephone channel used for the Nexus 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 Nexus 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 Nexus, 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 Nexus 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 Nexus 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 Nexus 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 Nexus (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 Nexus. The Nexus will embed this character into the data it is sending, and the Nexus 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 Nexus 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 Nexus 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 Nexus 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 Nexus 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 Nexus.

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 Nexus.

5) If not already done, configure the Nexus for ancillary data mode.

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 Nexus, and select TA LOOPBACK. 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 Nexus, into the encoder, looped it 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.

Nexus 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 "U" Interface: RJ11C 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

Power

External supply: 5V 2.5 Amp; 100 to 240 VAC, 50/60 Hz

Size

6.25"W x 9.5"D x 2"H

Weight

Net: 2.4 lbs; Shipping: 6 lbs

ISDN Connection

BRI ISDN lines can be terminated by the telco on either a 6-pin RJ11C modular jack or an 8-pin RJ45 jack. The Nexus ISDN "U" Interface connector is an RJ11C connector. If the telco provides an RJ11C jack, then the standard modular telephone cord provided with the Nexus is the correct cable for connecting the Nexus to the ISDN line. If the telco uses an RJ45 jack, the supplied cable will still work if care is taken to insert the 6-pin RJ11 plug into the 8-pin RJ45 telco jack exactly in the center (leaving a spare pin on each side of the RJ45 jack). Be certain that the pins are aligned correctly.

Alternatively, custom RJ11 to RJ45 connecting cables can be ordered through companies such as Black Box Corporation: 412-746-5500 or Digi-Key: 800-344-4539.

PIN DESIGNATIONS

ISDN “U” Interface:
- Physical: RJ11C 6-pin modular jack
- Pin 3: Tip
- Pin 4: Ring

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 20	DTR A
Pin 23	DTR B
Pin 24	DTR (RS232)

Ancillary Data in/out (DCE) :

Pin 2	RX Data
Pin 3	TX Data
Pin 4	DTR (unused)
Pin 5	GND
Pin 6	DSR (always valid)
Pin 7	RTS (unused)
Pin 8	CTS (Goes valid on “ready”)
Pin 9	RI (unused)

SECTION 10. ABOUT MIX-MINUS

Even the simplest remotes are a two-way process. The remote site must send its audio to the studio and receive a return feed to monitor the programming. This return feed may be done over a radio station's regular transmitter (with an AM or FM radio at the remote), a special radio link or a telephone circuit. This feed may just go to headphones at the remote, and it may also be put on speakers for the local audience.

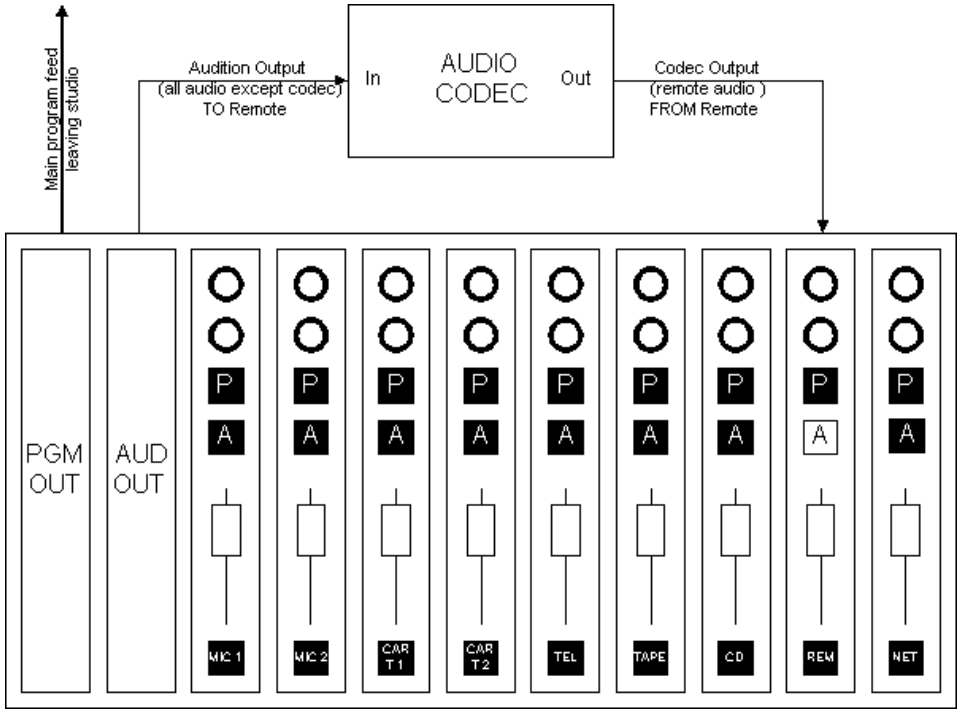
The problem comes when there is a time delay in getting audio to and/or from the studio. In this case, the remote talent hears a delayed version of their voice in the headphones and may find this very distracting. Even a remote done with simple equipment or a frequency extender on plain phone lines may have this problem on a long-distance call. All remotes using ISDN, Switched-56 and POTS codecs will have delays each way as signals are processed from analog to digital, compressed, uncompressed and converted back to analog audio. Some digital compression schemes, such as G.722, result in shorter delay times, but there will still be a "reverb" effect in headphones at the remote site, if their audio is sent back from the studio. In any of these cases, it may not be possible for the remote people to listen to an off-air or program channel feed.

The solution is **mix-minus**. A mix-minus feed has a mix of all of the programming on the radio station (or network) **minus** the audio from the remote. In other words, the station or network doesn't send the remote audio back to the remote. At the remote end, this mix-minus feed is converted back to an "air monitor" by mixing in the local audio from the remote.

For radio stations, in addition to fixing the time delay problem, using a mix-minus feed has two other advantages. First, if the station uses a 6-7 second delay to allow editing of phone calls, pre-delay audio can be sent to the remote site. Second, if there is a PA system at the remote, they will be able to run the speaker levels higher with the mix-minus audio. This is because the remote microphone audio is not running through the station's audio processing, and the levels stay under the control of the remote operator.

The simplest way to do one mix-minus feed in a typical radio studio is to use the Audition or second program channel. On many audio consoles, each fader's output may be sent to both Program and Audition. If your board will allow those feeds simultaneously, just set all of the modules to Program and Audition, **with the exception of the one carrying the remote audio. Set that one to Program only.** The Audition channel will then be a mix of everything on the console except the remote. That will be your mix-minus, and it should be sent to the remote site.

One caution — make sure that audio is being sent to and from any telephone modules you may have in the console. They may have been designed to work with only one channel at a time — either Program or Audition, but not both. If so, you will have to check with your "tech guy" or the board manufacturer for advice. If you use multiple audio codecs, you should investigate the Comrex Mix-Minus Bridge. This will allow you to expand one Program/Audition setup to handle five codecs or other remote audio devices. It also provides IFB (talkback) to remote sites.



"I'm Using Mix-Minus, and I Still Hear an Echo!"

If you are doing a call-in talk show on the road, the remote people may complain of hearing an echo when a caller is put on the air. With the telephone pot down, everything is OK. The culprit is the telephone hybrid being used to put callers on the air. Some of the remote audio is "leaking" through the hybrid and mixing with the caller audio. Modern digital hybrids do a much better job of preventing this than the older units that had to be manually "tweaked" for each call. If you are using a digital hybrid and having this problem, dig out the manual and redo the hybrid's initial setup.