DX200 ISO/MPEG Layer II Codec

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. The toll free number from the United Kingdom is 0-800-96-2093. 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, 65 Nonset Path, Acton, MA 01720 USA. For return authorization, contact Comrex at 800-237-1776 or 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 design ideology of the DX200 is to provide a low-cost solution for sending high quality audio on digital phone lines. Therefore, the DX200 has no "light show" on the front panel, no flashy glass and no LCD display. Rather, it is designed to function well, without these decorations, allowing trouble free operation at very low cost.

In terms of actual electronic circuits, the DX200 benefits from its highly efficient design. Using three fixed-point DSP chips, we have been able to design the same amount of processing power into our system as others who use two or three times as many processors. In fact, our implementation of ISO/MPEG Layer II is more complex than most other implementations, using a more advanced psychoacoustic model on the encoder while still achieving 100 percent standard compatibility. All of the intelligence of the codec is contained in three low-speed eproms, which are downloaded to the processors at reset. This allows us to provide firmware upgrades which require only a "chip swap" by the user.

The user interface on the DX200 is primarily designed for "set and forget" operation. The lack of front panel controls eliminates the possibility for inadvertent reconfiguration, resulting in greater overall system reliability for fixed applications. All information is easily programmed via DIP switches on the rear panel. For those users who need the ability to change the DX200 settings "on the fly," an optional 1 U rack unit is available, with front panel control buttons and LCD display.

We hope you enjoy using the DX200 from Comrex and welcome your comments on how to make our products perform better for you, our customer.

ABOUT THE ALGORITHM

The DX200 uses ISO/MPEG Layer II coding to send full bandwidth stereo audio over digital transmission paths as low as 112 Kb/s, allowing, for instance, high quality, wideband stereo on a single Basic Rate ISDN phone line. The DX200 is capable of most Layer II modes, ranging from 11 KHz mono on one SW56 or 64 Kb/s circuit to 20 KHz stereo or dual mono at transmission speeds of 254 Kb/s to 384 Kb/s. It includes a choice of input sampling rates at 24, 32 and 48 KHz and may be user-configured for a variety of output data rates for stereo, joint stereo, dual mono or mono operation. The decoder extracts all information from the incoming data and automatically adapts to the appropriate mode.

There is a built-in Inverse Multiplexer (IMUX) which combines two independent 56/64 or 112/128 Kb/s channels, allowing the codec to be used on SW56, ISDN or dedicated digital lines. Two choices of IMUX are available to provide broad industry compatibility. The IMUX may be disabled for use on T1, satellite channels or wireless modems.

The DX200 also includes the international standard G.722 algorithm. This implementation of G.722 has the standard 7.5 KHz audio bandwidth at 56/64 Kb/s. TURBO G.722, is a proprietary Comrex enhancement to G.722 which provides 15 KHz at data rates of 112/128 Kb/s.

The DX200 offers a dizzying array of options such as sampling rates, data rates and modes. In general, your data rate is fixed by the type of digital service you use. Once your data rate is determined, a mode choice must be made. As a rule of thumb, voice applications and circuits of 56 or 64 Kb/s should be in mono mode. For low data rate stereo applications at 112 or 128 Kb/s, choose the joint stereo mode. For higher capacity data circuits, the normal stereo mode is appropriate. Finally, you must choose a sampling rate. This choice has a direct correlation to overall quality and bandwidth. The higher the sampling rate, the higher the overall bandwidth and the less the overall quality. A good choice for FM broadcast applications is 32 KHz, but 48 KHz may be necessary for compatibility reasons. The best choice at data rates of 56 or 64 Kb/s is usually 24 KHz. In G.722 mode, the DX200 always operates in mono and the sampling rate is automatically chosen based on the transmission data rate.

SECTION 2. PHYSICAL CONNECTIONS

GENERAL SPECIFICATIONS

Connections

Audio in: (2) 3-pin XLR female
Audio out: (2) 3-pin XLR male
Data in/out: EIA-530 on DB25 connector adaptable to V.35 or X.21 via external cable

Levels (internally selectable)

Audio output: -10,0,+4 dBu
Audio input: -10,0,+4 dBu

Power (switching supply)

100 to 240 VAC 50/60 Hz
Drain: 45 watts max.

Size

19"W x 11"D x 1.75"H
48cm x 28cm x 4.5cm

Weight

6.5 lbs; 2.6 Kg

AUDIO CONNECTIONS

Pin #	Function
1	Ground
2	Balanced audio high
3	Balanced audio low

Comrex recommends that all equipment being connected to the DX200 have balanced audio inputs and outputs. If this is not possible, connect your unbalanced inputs as follows:

Inputs:	Pin 2 to audio high, Pins 1 and 3 to ground
Outputs:	Pin 2 to audio high, Pins 1 and 3 to ground

When using Stereo mode, connect both left and right inputs and outputs on the DX200. When using Mono operation, only the left input channel needs to be connected (right channel is ignored). In Mono mode, audio out is provided on both left and right outputs. The AUDIO IN is located on 3-pin female XLR connectors, and the AUDIO OUT is on 3-pin male XLR connectors. The levels of these audio connections are factory set for 0 dBu nominal (775 mV). These may be changed internally as shown on pages 16 & 17.

Data Port Connections

The DX200 port 0 and port 1 are 25-pin "D" type connectors with the following pinouts:

Pin #	Function
1	Shield
2	TX Data A
3	RX Data A
7	Ground
9	RX Clock B
12	TX Clock B
14	TX Data B
15	TX Clock A
16	RX Data B
17	RX Clock A
20	DTR A
23	DTR B

Pin 24 is reserved

Note: If you are using the internal IMUX, connect to both ports 0 and 1. If not, connect only to port 0.

Normally, these connections are made to your ISDN Terminal Adapter or your DSU/CSU. The data on these connectors conforms to EIA530. Assuming your terminal equipment uses this same connector, you will need a 25-pin straight-through cable to connect to these ports. Comrex has provided two of these cables with your unit.

If your terminal equipment uses a protocol other than EIA530, a converter cable will be required. Optional adapter cables for V.35 and X.21 connections are available through Comrex. If you want to construct your own adapter cables, see details on the following page.

Note: Terminal equipment that uses unbalanced protocols such as RS232 are not suitable for use with the DX200. Simply because terminal equipment uses a 25-pin D connector does not mean that it uses EIA530. Implementations of this sort vary widely. Check that the equipment specifically mentions EIA530 or RS530 as the protocol for its data port. Otherwise, it will not work.

Power Connections

The DX200 will work from any AC power from 100 to 240 VAC. The internal switching power supply will automatically adapt to any AC power in that range. Be sure to use a grounded, three pin power cord.

V.35 and X.21 Connections

Pin Connections for Comrex EIA530 (DB-25) to V.35 Cable

EIA530 (DB-25F)	Signal	V.35 (34-pinM)
1	Shield	A
2	Transmit Data A	P
3	Receive Data A	R
7	Ground	B
9	Receive Clock B	X
12	Transmit Clock B	AA
14	Transmit Data B	S
15	Transmit Clock A	Y
16	Receive Data B	T
17	Receive Clock A	V
24	Data Terminal Ready	H

Pin Connections for Comrex EIA530 (DB-25) to X.21 Cable

EIA530 (DB-25F)	Signal	X.21 (DB-15M)
2	Transmit Data A	2
20	Data Terminal Ready A / Control	3
3	Receive Data A	4
6	Data Set Ready A / Indication	5
15, 17	Clock A	6
7	Ground	8
14	Transmit Data B	9
23	Data Terminal Ready B / Control	10
16	Receive Data B	11
22	Data Set Ready B / Indication	12
9, 12	Clock B	13
1	Shield, Ground	Shell

SECTION 3. DIGITAL CIRCUITS AND TERMINAL EQUIPMENT

DIGITAL TELEPHONE SERVICE

The first and most important consideration in using the DX200 is to determine what type of digital circuit will be used. If the DX200 is to be used periodically at multiple locations, then a dial up service such as ISDN is appropriate. If the application calls for point-to-point 24/7 usage - or even more than a few hours of use per day, a dedicated digital link will probably be more cost-effective than a dial-up service. Also, the overall data capacity of the digital service must be considered. The data rates required for the various operating modes of the DX200 can be found on page 11 in the "Setup" section. Of course, budget considerations often determine the selection of the digital service. Please remember, however, that a higher data rate will result in better overall audio quality.

Throughout this manual, we refer to two data rates: 56 and 64 Kb/s. These rates, and multiples of them, are the most common you will experience with digital telephone services. When you place a normal phone call on the public telephone network, a 64 Kb/s data link is established between the telephone company central office nearest you and the one nearest the called party. This data connection is converted to an analog signal before it gets to the pair of wires between the telephone central office and the person you called.

Most digital telephone circuits are based on the concept of using this same digital telephone network channel and extending the digital portion to the user, eliminating the analog section. Basic rate ISDN allows the user to access two of these channels, which are multiplexed onto the same pair of wires and sent to the user. Each of these phone channels may be dialed independently and may be used for voice or for different types of data transmission. The DX200 (and most other codec type devices) utilize a mode of ISDN known as Circuit Switched Data, which provides a synchronous 64 Kb/s channels on a call. Both channels of an ISDN line may be used simultaneously to add together the data capacity of each channel as discussed in the IMUX section. It is also possible to "stack up" ISDN lines to provide even higher data capacity for demanding applications. (See Section 7 starting on page 21 for a complete discussion of this.)

Note: In North America, some of the public telephone networks use a form of signaling which limits the user bandwidth to 56 Kb/s channels. In this case, both ends of the telephone link must set their equipment for this lower data rate. In some areas, the 56 Kb/s (or multiples of it) setting may be "safer," allowing all calls to complete properly regardless of where they are located.

Also in North America, since ISDN was slower to proliferate than in many other parts of the world, the Circuit Switched Data capabilities are sometimes only available in a simpler service called Switched 56. As the name implies, Switched 56 is always limited to 56 Kb/s but can interoperate successfully with an ISDN line set for this speed. Multiple Switched 56 lines would be required to achieve higher data rates.

Dedicated 56 Kb/s or 64 Kb/s telephone lines (point to point) have been available for quite some time. They may provide a significant cost saving for applications that require full time or near full time exchange of audio. In North America, this is called DDS service. Sometimes, dedicated links of higher data rates are available (256 and 384 Kb/s) and are known as fractional T1 (or E1). Wireless modems and portable satellite earth stations may be used with codecs. Comrex has an extensive engineering note library describing these applications. Contact us for further details.

Terminal Equipment

Whatever type of digital telephone channel you use, you will need some sort of device to link the DX200 to the data channel. For ISDN, this is known as a Terminal Adapter and with Switched 56, it is known as a DSU/CSU. We are happy to recommend a specific TA or DSU/CSU that is appropriate to your application. At the minimum, any terminal equipment you choose should have:

- Synchronous data port capable of V.35, RS530, X.21 or other balanced data protocol
- Dial pad (for ISDN or SW56)
- Local and remote loopback capability
- V.120 rate adaptation (used for 56/64 conversion)

Other important but not required features:

- Dual data ports (for terminal adapters)
- RS232 remote dialing
- BONDING Inverse MUX capability (for terminal adapters)
- Memory dial (for ISDN or SW56)

With dial up digital networks the receiving end of the call answers automatically. This allows unattended operation at one end of the link.

SECTION 4. SETUP

RECOMMENDED OPERATING MODES

How you use the DX200 will depend on your individual requirements for quality, the need for mono or stereo, processing delay, and the amount and type of digital transmission bandwidth available. A close look at your application will determine the best setup for the DX200. Typical setup configurations are shown starting on page 30. As a rule, the more demanding the settings, the more likely it is for artifacts to appear in your audio during critical passages. The most demanding work is at higher sampling rates, lower data rates, high audio bandwidth and discrete stereo modes. Let's review some of the choices for ISO/MPEG Layer II. The G.722 Algorithm is explained in greater detail on pages 25-26. *Note: 2x56, 2x64, 2x112 and 2x128 data rates refer to the use of the built-in IMUX.*

Audio	Mode	Data Rate (in Kb/s)	Sampling Rate
11 KHz	Mono	56, 64	24 KHz
11 KHz	Stereo, Dual Mono	112, 128, 2x56, 2x64	24 KHz
15 KHz	Mono	112, 128, 2x56, 2x64	32 KHz
20 KHz	Mono	112, 128, 2x56, 2x64	48 KHz
13.5 KHz	Joint Stereo	112, 128, 2x56, 2x64	32 KHz
20 KHz	Joint Stereo	112, 128, 2x56, 2x64	48 KHz
15 KHz	Stereo, Dual Mono	224, 256, 384, 2x112, 2x128	32 KHz
20 KHz	Stereo, Dual Mono	224, 256, 384, 2x112, 2x128	48 KHz
7.5 KHz	Mono	56, 64	G.722
15 KHz	Mono	112, 128	G.722

Note: If the DX200 Remote Control panel is being used, all DIP switches on the back of the DX200 must be in the down position. All selections/ changes must be made via the Remote Control Panel.

TRANSMISSION BIT RATE

DIP SWITCHES C4, C5 & C6

DDD = 56 OR 2x56 KB/S
DDU = 64 OR 2x64 KB/S
DUD = 112 OR 2x112 KB/S

DUU = 128 OR 2x128 KB/S
UDD = 224 KB/S
UDU = 256 KB/S
UUD = 384 KB/S

This is the data rate you have available for sending your audio. A single Switched 56 circuit provides 56 Kb/s, and a BRI ISDN line can deliver 128 Kb/s. It is also possible to stack up ISDN lines for 256 and 384 Kb/s or to use other data transmission paths of variable data rates such as fractional T1, satellite, etc. There is usually less control over the data rate than any other selection. Keep in mind, however, that if extra data channel capacity is available, the overall sound quality will improve with its use.

Sampling Rates

DIP Switches C7 & C8

DD = 24 KHz
DU = 32 KHz
UD = 48 KHz
UU = G.722

The DX200 provides four choices of sampling rates:

Sampling Rate	*Bandwidth*
48 KHz	20 KHz
32 KHz	15 KHz
24 KHz	11 KHz
G.722	7.5/15 KHz

The sampling rate you select will depend on the transmission rate available and the audio bandwidth required. See "Recommended Operating Modes" on the previous page.

Encode Modes

DIP Switches C2 & C3

DD = Stereo
DU = Joint Stereo
UP = Dual Mono
UU = Mono
(decoder automatically detects mode)

Four modes are available with the DX200. These are discussed in order from least to most demanding. For the best audio quality, use the least demanding mode that will suit your application.

Mono — Encodes only single channel (Left), offering the least demanding mode.

Joint Stereo **—** Uses special techniques to eliminate perceptual redundancy between Left and Right channels. For this reason, audio information on Left and Right channels must be related. This is the least demanding mode for stereo.

Stereo — Left and Right channels are kept completely independent, but the available coding bits are allocated dynamically, as needed, between Left and Right. This is the best mode for "discrete" stereo.

Dual Mono — The most demanding mode, allowing completely independent programming to be sent on Left and Right channels. Available bits are allocated evenly between Left and Right channels.

Encoded Error Protection

DIP Switches B7 & B8

DD = Standard CRC
UD = CRC disabled
(decoder automatically detects CRC mode)

The DX200 provides several options for error protection. For normal operation, the standard ISO/MPEG error protection should be used. This will provide compatibility with other Layer II codecs which correctly follow the ISO/MPEG standard. Error protection on the encoder can also be disabled, allowing slightly more digital bandwidth for digital audio. This may be required if the DX200 bitstream is interfaced with hard disk based Layer II coding systems, which often do not use error protection.

The other error protection option enables a special "pre-standard" form of error protection, used by some early Layer II codecs, like those manufactured by MUSICAM & CCS Audio Products Inc.

The dip switch selections for error protection only affect the DX200 encoder. The decoder section automatically detects and adapts to any of these modes.

CCS Compatible Checksum

DIP Switches B7 & B8

DU = CCS Compatible CRC
(decoder automatically detects CRC mode)

By using this option, the DX200 encoder will add a pre-ISO/MPEG version of the error correction header to each frame. This will allow communications with very early versions of Layer II codecs. Normally, this mode should remain set to Standard CRC. If you encounter difficulty when communicating with older codecs, switch to CCS Compatible mode.

Inverse Mux (IMUX)

DIP Switches B5 & B6

DD = RE Compatible
DU = CCS/Telos Compatible

This refers to the "summing together" of two independent data channels to create one, higher speed channel. The DX200 offers two different types of IMUX. The first version is compatible with codecs built by RE. The second is compatible with codecs built by Telos (Layer II capable units only), MUSICAM & CCS.

Note on MUSICAM codecs: For compatibility, the CDQ2000 DIP switch #6 must be in the UP position so the decoder may operate independently of the encoder. On the PRIMA model, this is done by setting the front panel option to "DECODER/GENERAL/INDEP." or serial port command "DIN YES."

G.722 Modes

In addition to standard G.722, the DX200 offers the G.722 TURBO mode. To use G.722 TURBO, you will need a Terminal Adapter with a built in IMUX such as BONDING.

Note: The data rate settings on the DX200 are altered for TURBO mode. The unit must be set for 1/2 the actual data rate when used in TURBO mode. In other words, set the data rate selection to 56 Kb/s for normal G.722 at 56 Kb/s and for TURBO G.722 at 112 Kb/s. Set the data rate selection for 64 Kb/s for normal G.722 at 64 Kb/s and for TURBO G.722 at 128 Kb/s.

Quality Guidelines

Gauging the audio quality of the DX200 at any particular rate or mode is more art than science. There are certain combinations that perform best by most standards and others that are to be avoided.

- We recommend using only mono mode at data rates of 56 Kb/s or 64 Kb/s.

- 56 and 64 Kb/s sound most acceptable at a sampling rate of 24 KHz.

- At data rates of 112 and 128 Kb/s (and 2x56 and 2x64 Kb/s), joint stereo or mono modes should be used at sampling rates of 32 and 48 KHz. Any mode may be used with 24 KHz sampling.

- Few limitations exist at data rate of 224 Kb/s and above, except that mono operation is not possible and neither is 24 KHz sampling.

Final Setup Considerations

Now that you have connected audio to the DX200, attached the appropriate data ports and made your DIP switch selections, it may be valuable to run some tests before trying to complete a connection.

The Internal loopback test is described on page 18. Although this may require you to change some of your DIP switch settings temporarily, it will determine whether the DX200 is operating correctly. If you are not able to receive audio sent into the DX200 when internal loopback is properly set, contact Comrex for technical assistance.

The other test which may be valuable at this point is the Terminal equipment loopback on page 19. This test allows you to set the DIP switches to the position you have chosen and listen to your own audio as it is looped through your Terminal Adapter or CSU/DSU. This test will verify not only the DX200 but also the DIP switch configuration, the cable(s), and the DTE interface of your terminal equipment.

If both of these tests pass, your DX200 is ready to use. Be sure to contact Comrex if you have any questions or problems regarding operation of this codec.

Note: A full DIP Switch Setting Chart can be found on Page 29 of this manual.

SECTION 5. INTERNAL SETTINGS

The DX-200 has been factory configured to meet the majority of requirements. However, in this section, we provide information on settings which may be changed to meet special needs. These settings include:

- CLOCK SIGNAL
- DATA RATE FOR CLOCK LOOPBACK
- NOMINAL INPUT LEVEL
- NOMINAL OUTPUT LEVEL

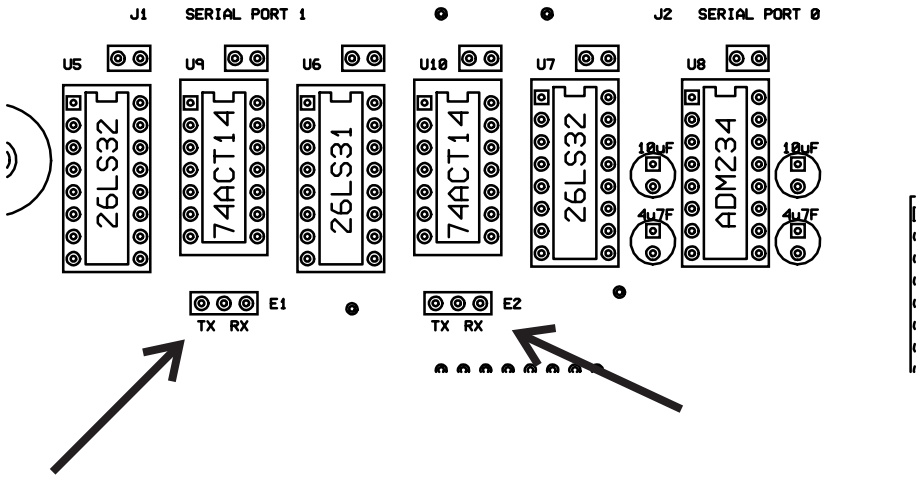
Changes are made via internal jumpers on the main PC board. In order to access these jumpers, you must remove the top cover of the chassis.

Note: Always disconnect power from the DX200 before removing the cover.

To change the setting, remove the hood that fits over the pins on the jumper block, then slide it over the new pin settings.

E1, E2 DCE clock select

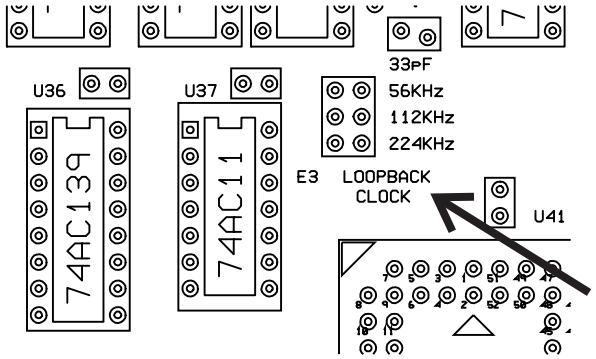
These jumpers determine which EIA530 clock signal is sampled for port 0 (E2) and port 1 (E1). They are factory configured to sample the RX clock, but they may be moved to the TX position to sample the TX clock. This is not normally required.



E3 Loopback clock

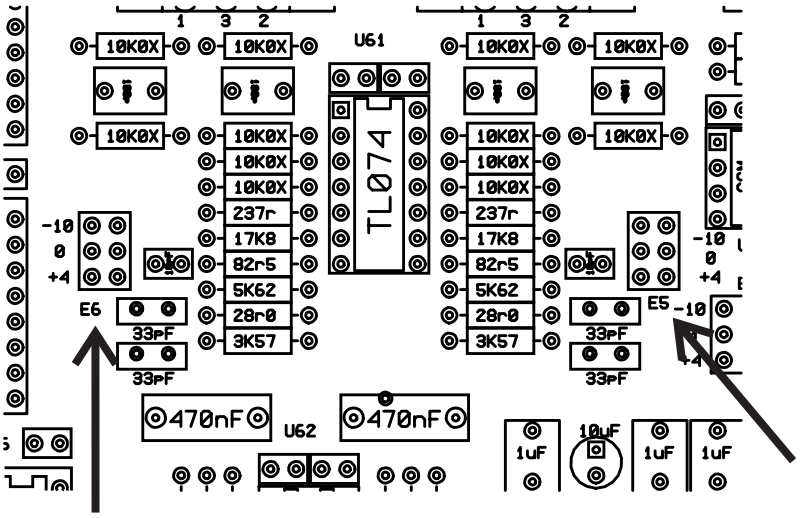
This jumper determines the data rate used when clock loopback is selected. Factory set to 112 Kb/s, this jumper may be changed to 56 or 224 Kb/s.

Note: If this jumper is changed, the DATA RATE DIP switches must be set for the newly selected rate whenever initiating a clock loopback.



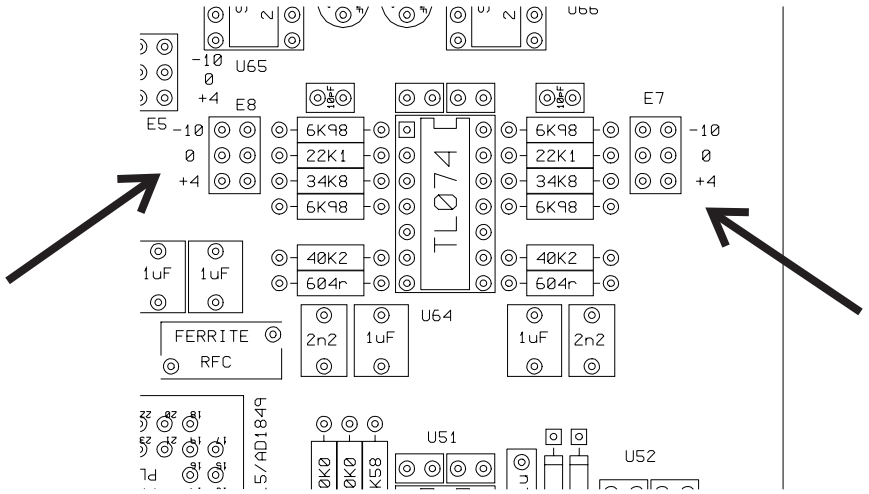
E5, E6 Nominal input level

Factory configured for 0 dBu, this level may be changed for left channel (E5) or right channel (E6) to -10 dBu (useful for interfacing to consumer equipment) or to +4 dBu (for some professional systems).



E7,E8 Nominal output level

Factory configured for 0 dBu, this level may be changed for left (E7) or right (E8) channel to -10 dBu or +4 dBu.



SECTION 6. TROUBLE SHOOTING

CHECK FIRST

It is absolutely vital that the SAMPLING RATE, DATA RATE, and IMUX DIP switches be set identically on each end of the connection. If you have any doubt about how the other codec is configured, check it out before trying to connect. If the DATA RATE, SAMPLING RATE, or IMUX DIP switches are mismatched, the codecs will not be able to communicate. This is usually indicated by the READY light on the front panel turning red. It is not required that you have the mode settings or the Error Protection settings identical on each end of your link. However, eliminating Error Protection may inhibit communication with some non-Comrex gear.

INTERNAL LOOPBACK

An internal loopback test will show that the DX200 is working correctly. Check that the audio connections are made and the power cord is plugged in.

The DX200 DIP switches on the rear panel should be set to the following positions:

CLOCK LOOPBACK	UP
DATA LOOPBACK	UP
IMUX	DOWN
ENCODER MODE	MONO OR JOINT STEREO
ENCODED ERROR PROTECTION	DOWN & DOWN
BITRATE	112 KB/S (INTERNAL CLOCK RATE)
SAMPLING RATE	ANY SETTING IS FINE

Note: If the DX200 Remote Control panel is being used, all DIP switches on the back of the DX200 must be in the down position. Press ENTER to access the main menu and use the DOWN arrow key until you reach the OTHER menu. Press ENTER to select this menu, scroll through until you find LOOPBACK.

The READY light on the front panel will be green, and you will hear audio sent into the DX200. If this is not happening, check the DIP switch settings. Then disconnect power and reconnect it. If the unit does not loop back at this point, contact Comrex for service.

The audio should be adjusted such that the red PEAK light on the front panel blinks about 15% of the time. If this light is on all the time, too much level is being fed to the DX200. If this light is never on, too low a level is being used. This audio adjustment may be made before any calls are placed. Both input and output levels are factory set a 0 dBu. These levels can be changed via internal jumpers as described on page 16 & 17.

If the internal loopback test gives the expected results and you are not getting the expected audio output, you can do a remote terminal loopback test.

Terminal Equipment Loopback

This test can usually be done without completing a call. Most terminal equipment has a "local" or "DTE" loopback feature that allows all data to be looped through the port connected to the codec.

Clock Loopback	Down
Data Loopback	Down
Imux	Application Specific
Encoder Mode	Application Specific
Encoded Error Protection	Down & Down
Bitrate	Application Specific
Sampling Rate	Application Specific

(If you are using the internal IMUX, both channels must be looped back on your terminal equipment.)

Note: When set to the 56 Kb/s data rate with the Imux DIP switch in the Down position, the mode MUST be set for mono.

With your terminal equipment looped back, you will hear your audio being encoded and decoded at the sampling rate, data rate, and mode you selected. If the audio quality is poor, if there is no sound or if the ready light on the front panel is red or off, check the DIP switch settings, power the unit down temporarily and try again.

Additional Trouble Shooting

Symptom	Check
Poor Audio Quality, Ready light is off, No Sound	1. Double-check your DIP switch setting. 2. Power the unit down temporarily.
Ready light is red	1. DX200 is set to an unsupported mode (56 Kb/s stereo or 256 Kb/s mono). 2. Data rate, sampling rate or IMUX switches are not in sync. 3. A sampling rate unsupported by the DX200 is being used by the far end encoder (e.g. 44.1 KHz).
Audio is present but distorted and the **IMUX** is being used	1. When using the Internal IMUX, you MUST be sure that port 0 is linked to port 0 at the other end of the circuit and that port 1 is connected to port 1 at the other end of the circuit. Any line mismatch will produce distorted audio.

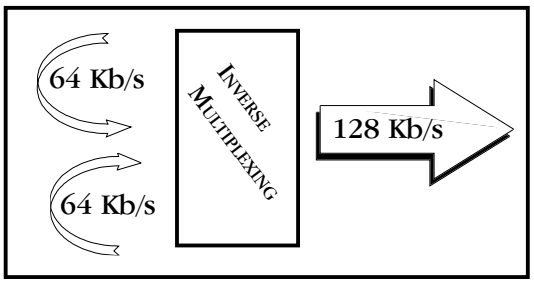
If you have any problems or simply need a question answered, please call us at 978 263-1800. Our toll free number in North America is 800 237-1776. The toll free number from the United Kingdom is 0 800-96-2093. Product information along with Engineering Notes and User Reports are available through our 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.

SECTION 7. TECHNICAL DISCUSSIONS

ABOUT 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 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. An IMUX will usually have some way to monitor the integrity of its aggregation throughout the digital linkup and to reset should a problem occur.

The DX200 has the capability to IMUX two digital channels. This makes it possible to easily obtain a 112 or 128 Kb/s channel using a BRI ISDN or a pair of Switched 56 lines. To use the internal IMUX, you must connect data lines both to port 0 and port 1 on the rear panel of the DX200. Both channels must be active, and the IMUX IN selection must be made on the rear panel DIP switches.

When using BRI ISDN, you will find that several reasonably priced terminal adapters have an IMUX built into them, usually using a protocol called BONDING. These IMUXes work quite well and may be used instead of the built-in IMUX on the DX200. In this case, you will connect data only to port 0 on the rear panel of the DX200. The IMUX DIP switch should be set to DOWN for operation in this mode.

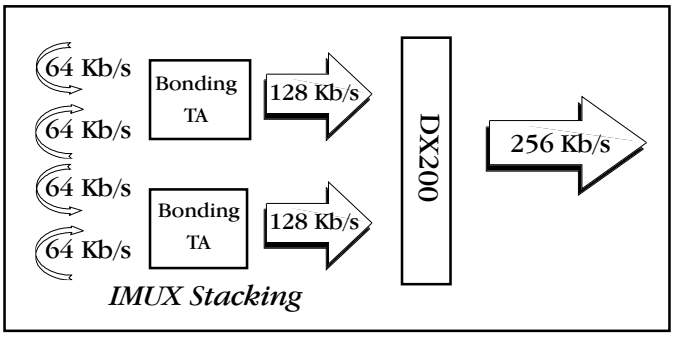
Note: Internal Inverse Multiplexing is not available when using G.722 in the DX200.

INVERSE STACKING

Another feature of the internal IMUX in the DX200 is the ability to aggregate two, independent 112 or 128 Kb/s channels. This allows for "IMUX stacking." Here is an explanation:

Simple and inexpensive equipment is widely available to IMUX two 56 or 64 Kb/s channels. In order to achieve higher data rates of 224 or 256 Kb/s, expensive equipment is required to IMUX four or more channels together. The DX200 allows the user, with the use of BONDING terminal adapters, to IMUX channels using two terminal adapters, and then IMUX the outputs of the terminal adapters within the DX200. This is "IMUX stacking" and it provides an extremely inexpensive method of providing very high quality audio. Quality critical applications will benefit from this higher data capacity, as it relates directly to higher audio quality.

To stack IMUXes, connect the output of one Terminal Adapter to port 0 and the other to port 1. Set the IMUX DIP switch to the UP position and then configure the terminal adapters to use their BONDING IMUXes. The DX200 will aggregate the two, higher data rate channels providing double the data rate.



IMUX Stacking

Compatibility

There are thousands of ISO/MPEG Layer II codecs currently in use around the world and there are two main compatibility issues among different brands of ISO/MPEG Layer II codecs. First is the actual implementation of the algorithm and second is the design on the IMUX. The DX200 follows the ISO/MPEG Layer II standard and is compatible with other codecs that correctly follow the standard. It also includes the most widely implemented IMUXes, which are selectable via DIP switches. You may also choose to use an external IMUX, such as BONDING, in your Terminal Adapter. With either the internal DX200 IMUX or an external IMUX, the data rate DIP switches MUST be set to the data rate being used on port 0.

It is important that whatever IMUX scheme is chosen for one end of the digital link is repeated for the other end. The DX200 internal IMUX is not BONDING compatible, so you may not use an external IMUX on one end and the internal IMUX on the other. When using the Internal IMUX, you MUST be sure that port 0 is linked to port 0 at the other end of the circuit and that port 1 is connected to port 1 at the other end of the circuit. Any line mismatch will produce distorted audio.

Input and Output Levels

The nominal input and output levels to the DX200 are arbitrary. They represent what a typical user might feed in and expect out from a device. Digital systems are often specified in terms of full scale input and output levels. We have found this to be confusing and have made our selections based on general usefulness.

The peak light is triggered by a fast peak detector whose threshold is set 3 dB below the clipping level of the A/D converter. This peak level is 12 dB above the nominal reference given, so that when the peak light is flashing occasionally on uncompressed audio, few peaks should ever hit the A/D ceiling. If you feed compressed audio, or if your needs are atypical, you may wish to revise what we have termed as nominal level using this information.

Often we field questions regarding signal-to-noise specs of our codecs. Although these types of measurements are difficult to quantify in a perceptual codec, we use this guideline. On silence, the noise floor of the DX200 should be about 75 dB below the clipping level of a tone, if measured with a 22 KHz filter on an Audio Precision System One using balanced, shielded inputs and outputs.

ISO/MPEG Layer II Algorithm

In audio terms, an algorithm is the set of instructions and computations that a coding device uses to apply a degree of data reduction. The basic assumption of a codec is that digitized audio contains more information than is needed to reproduce it in analog form. By eliminating this redundant information, more audio bandwidth may be stored or transmitted at lower data capacities. Several data reduction standards exist along with some proprietary data reduction schemes. The DX200 employs two of the most popular standard algorithms available: ISO/MPEG Layer II and G.722 (with both standard 7.5 KHz and high speed 15 KHz capability).

The ISO/MPEG Layer II algorithm uses perceptual masking information to determine which pieces of the input audio are actually perceived by the human ear and which are not. There is very little hard evidence to determine what can be perceived by humans. However, several studies have produced a “masking curve” that is placed across the spectrum of a signal to determine where this point theoretically lies.

The function of the encoder is to apply this curve, and then allocate the available digital bandwidth only to the audio information above the curve. It may take several attempts to allocate the available bits in the most efficient manner. The encoder scales the information it extracts

and packs it together very efficiently. Then a header is applied (containing error checks, mode information and sync words) before it sends off the information. The decoder is much simpler, unpacking the pertinent information and using table derived information to recreate the linear digital audio.

The ISO/MPEG Layer II algorithm is among the most widely implemented of its type, and has undergone extensive testing and evaluation. Its performance will vary dramatically with selections of different sampling frequencies, data rates, and modes.

G.722 Algorithm

G.722 is an international ITU standard, and there are more codecs worldwide using G.722 than any other algorithm. Almost all G.722 codecs work with one another, so this mode provides the greatest chance for compatibility with the "outside world." G.722 implements a process known as Sub-Band Adaptive Differential Pulse Code Modulation, or (SB)ADPCM. The text of this specification is public information and is a good source for a more in-depth understanding of the algorithm. Two sources for obtaining this document are OMNICOM 713-281-1135 and Global Engineering Documents 1-800-854-7171. Comrex's implementation of TURBO G.722 involves doubling the input and output data rates, providing twice the audio bandwidth.

The G.722 coding algorithm makes the DX200 compatible with all Comrex DXR and DXP series codecs, as well as most other G.722 coding systems. As well as normal G.722, the DX200 supports a special version we call TURBO G.722. This is a wider band G.722 version which is supported in the DXR.1, DXP.1, Nexus, EuroNexus, and Envoy products from Comrex.

G.722 is a different type of algorithm than ISO/MPEG Layer II in many ways. First of all, G.722 processes audio sample by sample, rather than processing a large window of audio at once. For this reason, G.722 has much lower delay than ISO/MPEG Layer II. It is much easier to communicate back and forth across codec channels using G.722. Also, G.722 tries its best to reproduce the input waveform exactly, rather than reproducing only what the ear can perceive (although it sacrifices resolution where it is needed the least).

Our basic G.722 algorithm works only at two data rates — 56 and 64 Kb/s. The dip switches must be set to either of these data rates for G.722 to work correctly. Our TURBO algorithm "overdrives" the input

circuitry by a factor of two. TURBO can be accomplished at 112 or 128 Kb/s as long as the data rate is "miss set" to 1/2 the true data rate.

In order to use TURBO G.722 , you must keep the data rate setting at either 56 or 64 Kb/s, even though you have a data rate of 112 or 128 Kb/s. In other words, set the codec for a data rate of 56 Kb/s to use G.722 TURBO at 112 Kb/s. Likewise, set the codec for 64 Kb/s when using G.722 TURBO at 128 Kb/s.

Sampling Rate	Data Rate Switches	Data Rate	Mode	Bandwidth
G.722	56 Kb/s	56 Kb/s	G.722	7.5 KHz
G.722	64 Kb/s	64 Kb/s	G.722	7.5 KHz
G.722	56 Kb/s	112 Kb/s	G.722 TURBO	15 KHz
G.722	64 Kb/s	128 Kb/s	G.722 TURBO	15 KHz

The TURBO algorithm requires a single data stream in the "serial port 0" connector. You cannot use the internal IMUX in G.722 mode. Most TURBO users rely on ISDN terminal adapters with a BONDING IMUX to supply the 112 or 128 Kb/s data rate.

CODING DELAY

There is a significant difference in the degree of coding delay among the available algorithms. With its fixed 4:1 data reduction, the G.722 process produces a minimal coding delay of about 6 mS. ISO/MPEG Layer II produces a delay of 6X the frame length, which varies with the sampling rate used. At 48 KHz sampling, the delay is 144 mS. At 32 KHz sampling, the delay is 216 mS, and at 24 KHz sampling, the delay is 288 mS. These figures are for a single pass through an encoder and decoder and do not include transmission delays. In live, remote broadcast situations, the coding delays of ISO/MPEG Layer II require that a mix-minus feed be used back to the remote site. See "About Mix Minus" on pages 27-28 for further details.

The impact of coding delay is most apparent when program monitoring is required on the return channel of the codec. Even with the small delay of G.722, a mix-minus return feed is desirable. For live, interactive programming such as talk formats, interviews, etc., the higher coding delay of the ISO/MPEG algorithm may hinder the flow of the conversation (even with a mix-minus return), and use of the G.722 mode may be a better choice.

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.

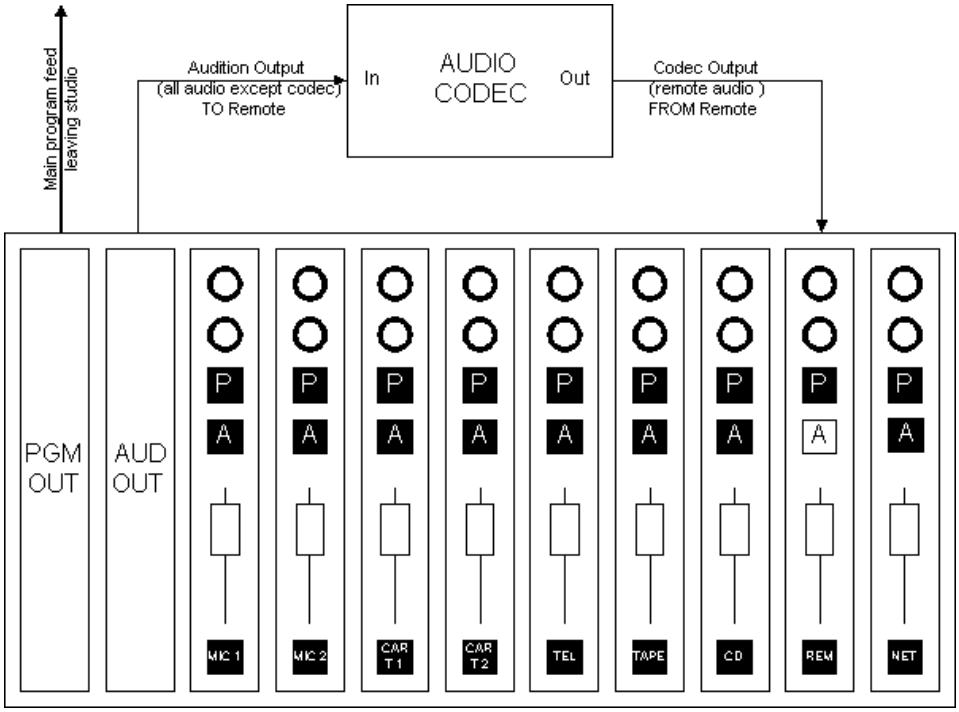
The problem comes when there is a time delay in getting audio to and/or from the studio. In this case, the remote talent hears a delayed version of their voice in the headphones and may find this very distracting. Even a remote done with simple equipment or a frequency extender on plain phone lines may 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.

SECTION 8. DX200 DIP SWITCH SELECTIONS

D = DIP SWITCH DOWN
U = DIP SWITCH UP

A1 CLOCK LOOPBACK
D = Normal
U = Loopback

A2 DATA LOOPBACK
D = Normal
U = Loopback

B1-4 RESERVED

B5 & B6 IMUX TYPE
DD = RE Compatible
DU = CCS/Telos Compatible

B7 & B8 CRC (Encoder Error Protection)
DD = Standard CRC
DU = CRC disabled
UD = CCS Compatible CRC
(decoder automatically detects CRC mode)

C1 IMUX (Inverse Multiplexer)
D = IMUX disabled
U = IMUX in

C2 & 3 ENCODER MODE
DD = Stereo
DU = Joint Stereo
UD = Dual Mono
UU = Mono
(decoder automatically detects mode)

C4, C5 & C6 TRANSMISSION BIT RATE
DDD = 56 or 2x56 Kb/s
DDU = 64 or 2x64 Kb/s
DUD = 112 or 2x112 Kb/s
DUU = 128 or 2x128 Kb/s
UDD = 224 Kb/s
UDU = 256 Kb/s
UUD = 384 Kb/s

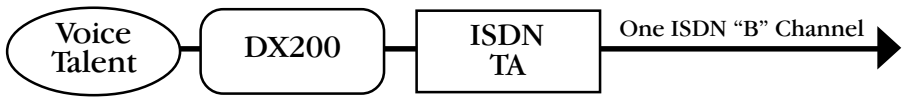
C7 & C8 SAMPLING RATE
DD = 24 KHz
DU = 32 KHz
UD = 48 KHz
UU = G.722

Note: In order to use G.722 TURBO, you must keep the data rate settings at either 56 or 64 Kb/s, even though you have a data rate of 112 or 128 Kb/s. In other words, set the codec for a data rate of 56 Kb/s to use G.722 TURBO at 112 Kb/s. Likewise, set the codec for 64 Kb/s when using G.722 TURBO at 128 Kb/s.

SECTION 9. TYPICAL SETUP CONFIGURATIONS

VOICE-OVER SERVICE — ONE 11 KHZ MONO FEED

Only one single ISDN "B" Channel is available.



Sampling Rate: 24 KHz
Mode: Mono
Data Rate: 56 or 64 Kb/s

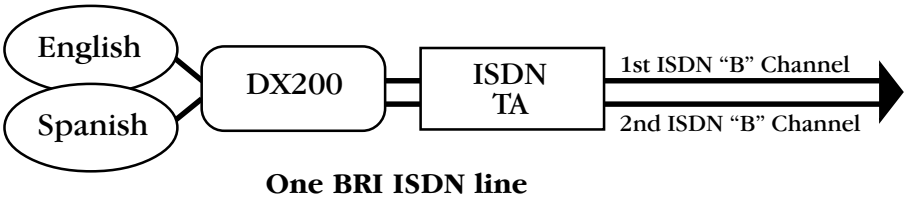
DIP Switch Positions:

A1	A2	B7	B8	C1	C2	C3	C4	C5	C6	C7	C8
D	D	D	D	D	U	U	D	D	D	D	D
									U (64 Kb/s)		

D = DIP Switch Down
U = DIP Switch Up

DUAL LANGUAGE SPORTS BROADCAST — TWO 11 KHZ MONO FEEDS

This is voice only and cost sensitive. Discrete channels are required.
Note: This configuration implies the use of internal IMUX.



One BRI ISDN line

Sampling Rate: 24 KHz
Mode: Dual Mono
Data Rate: 2x56 or 2x64 Kb/s

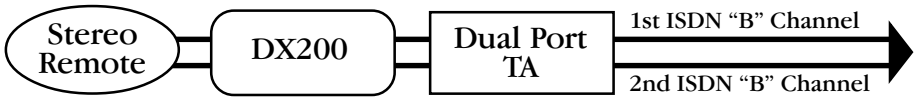
DIP Switch Positions:

A1	A2	B7	B8	C1	C2	C3	C4	C5	C6	C7	C8
D	D	D	D	U	U	D	D	D	D	D	D
									U (2x64)		

D = DIP Switch Down
U = DIP Switch Up

FM Stereo Remote Broadcast to Another DX200 or to Non-Comrex ISO/MPEG Layer II Codecs

Direct-to-air music and voice, with no satellite distribution. This is probably a cost sensitive application. *Note: This configuration implies the use of internal IMUX.*



One BRI ISDN line

Sampling Rate: 32 or 48 KHz
Mode: Joint Stereo
Data Rate: 2x56 or 2x64 Kb/s

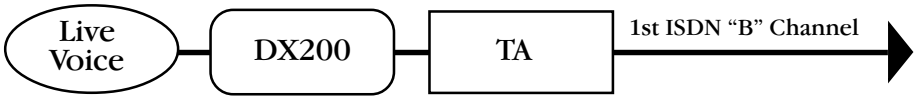
DIP Switch Positions:

A1	A2	B7	B8	C1	C2	C3	C4	C5	C6	C7	C8
D	D	D	D	U	D	U	D	D	D	D	U
									U (2x64)		
									U	D (48 KHz)	

D = DIP Switch Down
U = DIP Switch Up

Live Voice Programming — One 7.5 KHz Mono Feed

When minimal delay or maximum compatibility with other G.722 codecs is required.



One BRI ISDN "B" Channel

Sampling Rate: G.722
Mode: Mono
Data Rate: 56 or 64 Kb/s

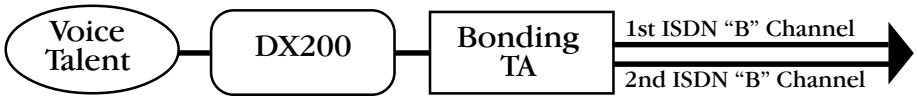
DIP Switch Positions:

A1	A2	B7	B8	C1	C2	C3	C4	C5	C6	C7	C8
D	D	D	D	D	U	U	D	D	D	U	U
									U (64 Kb/s)		

D = DIP Switch Down
U = DIP Switch Up

Connecting to a Comrex Nexus or Envoy for a 15 KHz, Low Delay Live Mono Feed

Wideband audio requirement with low delay for interactive programming. *Note: Bonding TA is required.*



One BRI ISDN Line

Sampling Rate: G.722
Mode: Mono
Data Rate: 112 or 128 Kb/s

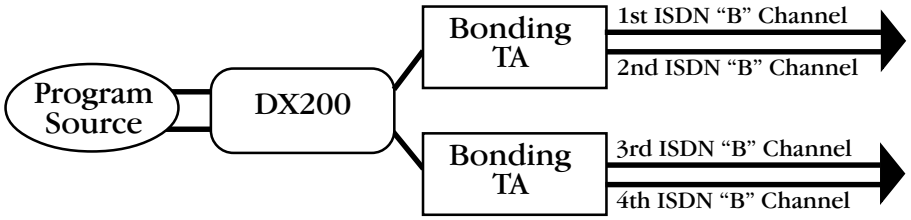
DIP Switch Positions:

A1	A2	B7	B8	C1	C2	C3	C4	C5	C6	C7	C8
D	D	D	D	D	U	U	D	U	D	U	U
									U (128 Kb/s)		

D = DIP Switch Down
U = DIP Switch Up

Production House Transfer of Source Programming — 20 KHz Stereo

Audio is likely to be processed and undergo more data reduction before presented. Near CD quality is needed.



Two BRI ISDN Lines

Sampling Rate: 48 KHz
Mode: Stereo
Data Rate: 256 Kb/s

DIP Switch Positions:

A1	A2	B7	B8	C1	C2	C3	C4	C5	C6	C7	C8
D	D	D	D	U	D	D	U	D	U	U	D

D = DIP Switch Down
U = DIP Switch Up

SECTION 10. DX200 REMOTE CONTROL PANEL (OPTIONAL)

CONNECTION

The DX200 Remote Control is designed for those users who need to change selections on a frequent basis. The choices are the same as those available through the DX200 back panel dip switches. The DX200 Remote Control is a 1 U rack unit that should be mounted near the unit. It is connected to the DX200 with a DB-25 to DB-25 cable supplied with the remote control unit. The cable attaches to the remote control unit and the DB-25 connector on the back of the DX200 labeled remote control. Power to the remote control is supplied through the DX200.

Once the remote control unit is installed and hooked up, you are ready to make some choices.

Note: When using the remote control panel all DIP switches on the back of the DX200 must be in the down position.

PROCEDURES

To start, press CANCEL until the current settings for data rate, mode and sampling frequency appear. By pressing ENTER, the main menu will be displayed, starting with DATA RATE. Main menu choices are DATA RATE, MODE, SAMPLING FREQUENCY, QUICK SETUP and OTHER.

Use the UP and DOWN arrow keys to move to another menu item. When the item you want to change appears, press ENTER. This will move you into the choices for that selection. Again, scroll through the choices via the UP or DOWN arrow. When you see what you want, press ENTER. If you don't want to make a change, press CANCEL. This takes you back to the main menu.

Once you have made all your selections, pressing CANCEL will show you the data rate, mode and sampling frequency selected. These selections will remain in nonvolatile memory if power is lost. Specific selection choices are shown on the next page.

REMOTE CONTROL PANEL SELECTIONS

Data Rate

56 Kb/s	64 Kb/s	112 Kb/s
128 Kb/s	224 Kb/s	256 Kb/s
384 Kb/s	2x56 Kb/s	2x64 Kb/s
2x112 Kb/s	2x128 Kb/s	

Mode

Stereo	Joint Stereo	Mono	Dual Mono

Sampling Frequency

24 KHz	32 KHz	48 KHz	G.722

Other

IMUX	*Error Protection*	*Loopback*
CCS/Telos Compatible	Off	Engaged
RE Compatible	On	
	CCS Compatible	

Quick Setup

56 Kb/s	24 KHz	Mono
64 Kb/s	24 KHz	Mono
2x56 Kb/s	32 KHz	Mono
2x64 Kb/s	32 KHz	Mono
2x56 Kb/s	48 KHz	Mono
2x64 Kb/s	48 KHz	Mono
2x56 Kb/s	24 KHz	Stereo
2x64 Kb/s	24 KHz	Stereo
2x56 Kb/s	32 KHz	Joint Stereo
2x64 Kb/s	32 KHz	Joint Stereo
2x56 Kb/s	48 KHz	Joint Stereo
2x64 Kb/s	48 KHz	Joint Stereo
112 Kb/s	32 KHz	Mono
128 Kb/s	32 KHz	Mono
112 Kb/s	48 KHz	Mono
128 Kb/s	48 KHz	Mono

Note: In order to use G.722 TURBO, you must keep the data rate setting at either 56 or 64 Kb/s, even though you have a data rate of 112 or 128 Kb/s. In other words, set the codec for a data rate of 56 Kb/s to use G.722 TURBO at 112 Kb/s. Likewise, set the codec for 64 Kb/s when using G.722 TURBO at 128 Kb/s.