

Digital Transmission Networks

Your MUSICAM USA audio codec is more than just an ISDN codec

1. Overview

It is important to consider your digital transmission facility when configuring your codec. The terrestrial digital network falls into two broad classifications: dedicated networks and switched networks.

The dedicated network is, as the name implies, a dedicated path between two points. Examples of dedicated services are Switched-56, Fractional-T1, T1 and E1. Typically, dedicated service is more expensive on a monthly basis than ISDN, but should be used if continuous connectivity is anticipated. If a dedicated or leased line is appropriate, it must have a CSU/DSU (Customer Service Unit/Data Service Unit) installed at each end. These devices are responsible for converting the codecs digital output into signals compatible with the network. CSU/DSUs are relatively inexpensive, readily available from numerous manufacturers and require no special instructions.

All **CDQPrima** and **Prima LT** models may be ordered with ISDN Terminal Adapters to connect to the ISDN digital switched network. **CDQPrima** 100 series units and the **Prima LT** can hold a single terminal adapter with capacity for 128 kb/s (2 ISDN 'B' channels)¹. **CDQPrima** 200 series units and the **Prima LT Plus** can hold up to three Terminal Adapters and can access up to six 'B' channels internally. This gives

¹With external terminal adapters or CSU/DSU's, connect rates as high as 384 kb/s are supported.

you the ability to connect at data rates up to 384 kb/s over ISDN, or to connect with multiple destinations (point-to-multipoint) simultaneously. Please note that a separate, outboard NT-1 (network termination device) is required for North American operation when using the TA101 or TA201 Terminal Adapters, but is not needed with the TA301 Terminal Adapter. Connections to the Switched-56 network require an external interface device for dialing and call setup.

We recommend using an internal terminal adapter when connecting to ISDN. This allows you to use all of the powerful dialing features and Speed Dial tables standard in all *CDQPrima* and *Prima LT* models.

The digital switched network is attractive when occasional use is required, because the cost of the service is computed based on a monthly fee plus the actual time the service is used. This is exactly like a conventional telephone, and the rates charged by the service providers are relatively inexpensive and may be comparable to standard telephone rates. Please note, however, that the rates do vary considerably from location to location, even within the same region.

Two examples of switched long distance terrestrial networks are the Switched-56 and ISDN networks, provided by carriers such as AT&T, MCI, Sprint, and others. Appendix F lists several phone numbers and faxable information for ordering ISDN service in North America. We recommend faxing this ordering and provisioning information directly to your service provider when ordering your ISDN service. We have found that doing this saves considerable time and aggravation. Contact your sales representative in your country for additional Information.

K**hint:**

Both dedicated and switched facilities are digital networks and are appropriate for use with your codec. Some service providers may use digital lines that were designed for speech and include digital echo cancelers. The effect of these echo cancelers is to modify the digital bitstream in an attempt to remove what it believes to be echoes. This modification of the digital bit stream is disastrous to the codec because it expects the receiver to receive a binary 1 when it transmits a 1. Fortunately, using a proper CSU/DSU easily disables the echo cancelers. In particular, a CSU/DSU must be equipped with an echo canceler disabler if it is to be used in a network that uses echo cancelers. This is a common option in switched CSU/DSUs.

The AT&T Switched-56 network, and *most* ISDN networks, are intended for data and voice and do not require echo suppression facilities in the CSU/DSU or Terminal Adapter.

There is another consideration when using the terrestrial switched 56 kb/s network, and that is four-wire versus two-wire. In various regions of the United States, different regional operating companies use different technologies to transmit the 56 kb/s data from the customer premises to the central office. These two technologies are called two-wire and four-wire. When ordering the local phone line (known as the local loop), you must inquire about the circuit type and then order an appropriate CSU/DSU. **If available, we recommend the 2-wire system.**



Please remember that both dedicated and switched digital facilities are wire-line services, and the service provider can not and does not guarantee error-free service. A typical circuit may have a background error rate in the order of 10^{-9} , and an alarm is not issued until the error rate falls to 10^{-6} . This can result in several errors per day in a typical ISDN or dedicated circuit.

Satellite facilities require no special attention. Only a standard data line is required, with bit rates (56-384 kb/s) based on your application. Two-wire and four-wire service may be used within a single region, usually distance dependent. Again, the wire-line portion of the link is subject to the same error rate as mentioned above. In addition, the satellite or microwave link is subject to rain attenuation and multipath fading, which can be severe in certain geographic areas.

Your codec is relatively immune to digital bit errors. If a binary 1 is occasionally changed to a 0 or vice versa, it has minimal impact. Synchronization is maintained even during error bursts of up to 0.1 second. However, in either satellite or terrestrial facilities, a slip (the complete loss or addition of a bit) causes the receiver circuitry to lose lock and then require reframing. This entire process is statistical, but usually only takes about 0.2 seconds. During this time, the decoder mutes and no audio is output.

1.1 Digital Transmission Facilities

1.1.1 Dedicated Data Service ("Nailed-Up" DDS)

This is the original digital data service. It provides 56 or 64 kb/s over a dedicated circuit. This technology is based on the telephone company's

internal 64 kb/s systems, but for 56 kb/s services, one bit out of each eight is robbed from the user for use by the telephone company to provide signaling information. This signaling information conveys information such as billing information and on/off hook status. Dedicated lines are available in either two or four wire configurations. We recommend the two-wire system if it is available in your area. This provides a more robust path with fewer bit errors. In some areas, Dedicated Data Service is available at bit rates higher than 64 kb/s.

1.1.2 Switched-56

Switched-56 was the first switched digital transmission technology provided by the telephone companies. It uses the same 56 kb/s transport technology within the telcos as the DDS service described above.

1.1.3 ISDN Basic Rate Interface (BRI)

ISDN (Integrated Services Digital Network) is a new technology that is used to transport either 112 or 128 kb/s on a single wire pair. With ISDN, a single copper wire pair from the telephone company central office to the customer premises (a Basic Rate Interface, or BRI) can transport two 'B' (Bearer) channels and one 'D' (Delta) channel. Each B channel can be either 56 or 64 kb/s and the D channel transmits 16 kb/s.²

ISDN is true computer-to-computer communication, because it allows the central office computer to communicate with the customer premises computer. This customer premises computer is called a Terminal Adapter (TA). This sophisticated computer-to-computer communication is accomplished over the 'D' channel and does not rob any bits from either of the 'B' channels. Since the central office computer is in contact with the customer premises computer, sophisticated communication is possible. For example, the central office computer can ask the customer premises computer if it will accept a data call at 64 kb/s.

ISDN is the low cost switched digital interconnect method provided by the telephone companies. In many areas, the cost for ISDN service is similar to those of a normal analog telephone line.

²In some areas, the 16 kb/s 'D' channel is not provided to the customer and is used by the service provider for signaling and billing. The *CDQPrima* does not require this channel for operation.

1.1.4 Primary Rate ISDN (T1 & E1)

While Basic Rate ISDN provides two channels of 64 kb/s service, Primary Rate ISDN provides up to 23 64 kb/s 'B' channels and 1 64 kb/s 'D' channel (1.544 Mbps). As with Basic Rate ISDN, Primary Rate ISDN is also a switched service, allowing dial in and out.

T1 provides 24 64 kb/s channels (North America) and E1 provides 32 64 kb/s channels. This increased bandwidth comes at an additional cost; however, many regional telcos are making T1 service available at competitive rates, making fractional T1 attractive for STL (studio-to-transmitter link) applications. Unlike Primary Rate ISDN, T1 and E1 services are not switched, providing point-to-point service only. Since your codec uses a maximum bit rate of 384 kb/s, an external device must be used to pull off only a fraction of the capacity of the PRI, T1 or E1 service.

1.1.5 Long-Distance Interconnectivity (56-to-64kb/s)

ISDN and 56 kb/s switched services are available internationally. 56 kb/s ISDN interconnects with Switched-56 both nationally and internationally, where available. This capability provides worldwide low cost connectivity that was previously unavailable.

1.1.6 International PSDN

International public switched digital networks traditionally have been provided by government-run monopolies known as Post Telegraph and Telephone (PTT) companies. Many countries are deregulating and privatizing telecoms, but the implementation and characteristics of public switched digital services within a country's PTT are uniform, even through they differ from country to country.

The predominant switched digital service available in Europe and countries outside North America is ISDN BRI. PTTs offer switched 64 kb/s service over these lines, two B channels (64 kbps each) per BRI line (basic rate). Some countries outside the US also offer ISDN PRI (primary rate). In either case, CCITT Q. 931 is the international standard for ISDN signaling.

MUSICAM USA's codecs operate with ISDN BRI services offered throughout Europe, North America, Hong Kong, Japan and NET5 compliant PTT administrations in Europe and Asia.

MUSICAM USA's international products inter-operate with all US products over 56 or 64 kb/s carrier services. They inter-operate at

higher bit rates when used with CCS Inverse Multiplexing CCSIMUX or ITU-T J.52 BONDING as described in the corresponding section.

1.1.7 Other Digital Transmission Paths

While terrestrial facilities such as ISDN are popular, there are several other technologies for digital transmission that you may wish to consider. RF transmission facilities form another class of transmission and are an alternative to terrestrial transmission.

1.1.7.1 Spread-Spectrum

Spread spectrum RF transmission allows multiple transmitters to operate at the same frequency without interference. There is a practical limit for the number of transmitters that can be simultaneously transmitting, but spread spectrum modulation is a useful method considering current US FCC regulations permitting low power spread-spectrum transmitters in the 900 MHz frequency region.

Spread spectrum can be used for point-to-point or point-to-multipoint transmission, although its primary application is in point-to-point.

Digital spread spectrum transmission communications systems are an excellent medium for use with the **CDQPrima**.

1.1.7.2 Satellite Links

Satellite transmission is used primarily for point-to-multipoint transmission. Such systems are used to broadcast to many listeners.

The **CDQPrima** is perfectly suited to work with digital satellite systems, and MUSICAM USA has a long history of working with satellite providers to achieve optimum system performance.

1.1.7.3 Other Digital Transmission Systems

New, packetized, transmission systems are being deployed that provide high capacity at a low cost. Some examples are Frame-Relay, ATM and DSL.

Generally, only Frame Relay has the potential to operate with your codec provided the following criteria are met:

- Synchronous, bi-directional data transfer must be assured.
- The bit rate must be fixed in both directions to an allowable bit rate. The bit rate need not be the same in both directions, but once configured, it should not change.

- If the transmission is packetized, you must insure that your codec sees all packets in the exact order in which they are sent. Although packetized transmission systems may guarantee that all packets sent will reach their destination, they generally do not guarantee that the packets will be received in the same order. Your does not have any internal buffering, so received packets must be put in order externally.
- The system must provide continuous clock and data to the codec. Your codec derives timing from the network, so a continuous clock is a requirement.
- The interface used, either X.21, RS422 or V.35 must comply with industry standards.