CDQ1000

Technical Manual

Multi-rate Digital Audio Codec

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Introduction

The CDQ1000 Digital Audio Codec is a member of the CCS MUSICAM Codec Family. It was designed at the request of radio broadcasters and recording artists who desire more audio bandwidth and fidelity than our popular 7.5kHz Micro 56, 64 and 66i CodecUsing an enhanced MUSICAM compression at 24kHz sampling rate, the CDQ1000 is the first codeccapable of transmitting full 10kHz of digital audio with the convenience and economy of a single switched 56 or ISDN Dial-Up circuit. It is distinguished by the following features:

- Mono Operation
- Operation at data rates of 56 or 64kbps
- Auto sensing of the data rate
- 4 Algorithm Modes
    a. G.722
    b. H.221
    c. MUSICAM at a sampling rate of 48kHz
    d. MUSICAM at a sampling rate of 24kHz
- Low Cost

The CDQ1000 is unique in its ability to operate in four different modes. In the G.722 mode, the CDQ1000 is fully compatible with the industry standard CCITT G.722 codecs, like the popular CCS MICRO56, MICRO64 and MICRO66.

The H.221 mode of operation is fully compatible with industry standard CCITT H.221 codecs.

Operating in the MUSICAM 48kHz sampling rate mode, 8.2kHz bandwidth, it interoperates with any ISO 11172-3 Layer-II (MPEG) MUSICAM unit including the CCS CDQ2000 Codec. In the 24kHz sampling rate modes, 10kHz bandwidth, the CDQ1000 provides enhanced audio quality and operates with other CDQ1000's. It is expected that this feature of the CDQ1000 will be part of the ISO MPEG2 standard.

For ease of operation, the CDQ1000 automatically determines the type of the far end device and adjusts the compression algorithm to the highest quality possible based on the far end equipment. Alternatively, it can be set manually to communicate in one of its three specific compression modes.

This type of flexibility has never been available and represents a new standard for mono communications in both performance and price. Now, one codeccan connect to all the world's most popular digital audio codec's. The CDQ1000 characterizes CCS' commitment to CRYSTAL CLEAR DIGITAL AUDIO transmission.

Quick Start for the CDQ1000

The simplest method of operation of the CDQ1000 is to set the front panel switches as shown on page 4 for internal loopback. This tests the entire system with the exception of the V.35, X.21 interface. No other equipment is needed except an audio system. In this configuration, the analog input signals are compressed and looped back to the decoder section. The following configuration provides 10kHz of bandwidth using MUSICAM compression.

Front Panel Switch Selection

Loopback	In
Auto Detect	All Auto Detect switches (3) must be off (Down).
Coding	MUSICAM
Sampling Rate	24kHz
Bit Rate	56k

Rear Panel Dip Switches

1	Down
2	Down
3	Down
4	Down
5	Down
6	Down
7	Down
8	Down
9	Down
10	Down

Now observe the front panel. The following LED's will be illuminated:

Line Rate	56k
Coding	MUSICAM
Clock Rate	24k

If all the toggle switches are set and all the LED's illuminate properly, connect the audio and begin testing. Remember that the maximum level is +18 dBu and the input impedance is set at the factory to high impedance bridging mode.

To test 64kbps, simply place the toggle switch in the down position and wait for the CDQ1000 to lock to the new data rate.

To test 8.2kHz operation place the Sampling Rate toggle switch in the 48k position and wait for the CDQ1000 to lock the new bandwidth. To test 7.5kHz operations place the Coding toggle switch in the G.722 mode and wait for the CDQ1000 to lock in.

Digital Interfaces

The CDQ1000 family provides a variety of digital interfaces; V.35, X.21 leased circuits and RS422. Each of these digital interfaces requires clock and data to be exchanged between the CDQ1000 and the terminal equipment. The CDQ1000 always expects the clock to be provided by the terminal equipment. The encoder section outputs data synchronized with the clock and the decoder section expects the data to be synchronized with the clock.

The data and clock lines are differential requiring a pair of wires for each signal. The control lines in the V.35 interface are single ended and require only one wire for each signal. The X.21 control lines are differential. The RS422 interface does not support any control lines. Any input control lines defined are ignored by the CDQ1000 and any output control lines defined are held at constant values. See Appendix A for the definition of the pins used for each type of interface.

Each interface defines a voltage level for each of the signals and in the case of V.35 and X.21; a connector type is also defined. The connector defined in the V.35 specification is not used by the CDQ1000 because of its size. Instead, a smaller DB25 connector is used. In the case of the V.35 interface, the CDQ1000 conforms to the electrical specification but requires an adapter cable to convert the DB25 connector to the connector specified in the V.35 specification. The connector and the pin-out chosen for the V.35 interface in the CDQ1000 are a common deviant found in many systems. It is important to remember that V.35 has a separate clock for transmitted and received data. Appendix D describes the pin-out required for a DB25 to V.35 adapter cable.

The RS422 interface specification only defines the electrical voltages at the interface and leaves the pin-out and meaning of the pins to the hardware designer. The RS449 interface specification utilizes the electrical specifications of RS422 but specifies a mechanical connector. RS449 also specifies numerous control signals along with clock and data. The CDQ1000 RS422 interface pin-outs is specified in Appendix A. The RS422 interface also has a separate clock for the transmitted and received data. The CDQ1000 RS422 interface also echoes the transmitter clock. If the terminal equipment clocks the encoder data with the echoed clock, then the CDQ1000 may be located up to 4000 feet from the terminal equipment without having to worry about the encoder to clock skew.

The X.21 interface specification is a very complex specification. The general specification allows a mechanism for communication between the customer equipment and the network. This communication path can be used for things such as dialing. A sub-set of the specification, called leased circuit, restricts the interconnection to only clock and data and a very simple control signal. The mechanical connector required is the DB15 with the pin-out specified in Appendix A. The electrical specification is RS422.The X.21 interface has only one clock for both the transmit and received signals.

Since the X.21 utilizes the RS422 electrical interface, the CDQ1000 can use the same connector for both interfaces. In the case of the X.21 interface, the single clock is used internally for both the transmit and received timing. The selection of the type of digital interface is governed by rear panel dip switches. See Appendix B for the appropriate settings.

Ancillary Data Port

The CDQ1000 provides for transmission of asynchronous data via a RS-232 interface when operating in the MUSICAM compression mode. This interface provides a transparent channel for the transmission of 8 data bits. The data format is 1 start bit, 8 data bits, 1 stop bit and no parity bits. This interface is capable of transmitting at the maximum data rate selected by the units' data rate dip switches and thus no data pacing such as XON/XOFF or CTS/RTS is provided. Appendix C describes the units dip switches.

The encoder section RS-232 data rate can be set at 300, 1200, 2400, 3600, 4800, 9600, 19200 or 38400 bps. The use of the ancillary data channel decreases the number of bits available to the audio channel. The reduction of the audio bits only occurs if ancillary data is actually present. The data rate can be thought of as a maximum data rate and if there is no ancillary data present, then no data bits are transmitted. A typical example of this situation occurs when the CDQ1000 encoder is connected to a terminal. The character is sent at the data rate specified, each time the user types a character.
The setting of the receiving codec data rate selection dip switches must be done considering the setting of the transmitting codec. The receiving unit dip switches must be an equal or higher data rate relative to the transmitting unit. For example, it is possible to set the receiving codec ancillary data rate to 3600bps. In this case, the transmitting codec data rate may be set to any value from 300 to 3600bps. The maximum sustained data rate is controlled by the transmitting

The algorithm for the transmission of ancillary data is for the encoder to look during each MUSICAM frame interval (24 milliseconds at 48 kHz sampling or 48 milliseconds at 24 kHz sampling) and see if any ancillary data is in its input buffer. If there are characters in the encoder's section input buffer, then the maximum number of characters consistent with the selected data rate are sent. The table below shows the maximum number of characters sent for each data rate during a frame interval.

Number of Characters at:

Data Rate	48 kHz	24 kHz
300	1	2
1200	4	8
2400	8	15
3600	11	22
4800	15	29
9600	29	58
19200	58	116
38400	116	231

The CDQ1000 provides no error detection or correction for the ancillary data. The user assumes the responsibility for the error control strategy of this data. For example, at an error rate of 10-5 (which is relatively high) and an ancillary data rate of 1200bps, 1 out of every 83 character will be received in error. Standard computer data communication protocol techniques can be used to maintain data integrity.

When designing an error protection strategy, it must be remembered that the CDQ1000may occasionally repeat the last 24 milliseconds of audio under certain error conditions. The effect on the audio is nearly imperceptible. However, the ancillary data is not repeated.

Auto Detect Mode

When the CDQ1000 is in the auto detect mode (all 3 AUTO DETECT switches in the up position, see page 4), the unit first determines the input data bit rate. This is accomplished by observing the input clock rate. This produces a successful result when the unit finds either input at 56 kbps or 64 kbps. Any other input bit rate will cause the unit to never operate successfully.

Once the bit rate has been determined, the CDQ1000 has to determine whether the input data stream are MUSICAM frames or G.722/H.221 frames.

MUSICAM frames are identified by the ISO MPEG standard bit patterns at the start of each frame. These bit patterns are called frame headers. The CDQ1000 in MUSICAM mode can decode data at either 24 kHz or 48 kHz sampling rates. If either of the proper frame header is matched in the input stream for a reasonable brief period of time, the unit is framed as MUSICAM data. The front panel indicator lights will reflect the determined bit rate, sampling rate and MUSICAM data type. The unit will output MUSICAM frames accordingly.

If MUSICAM frames are not found, the CDQ1000 tries to match on either G.722 or H.221 input data. These input types are also determined by trying to match known bit patterns in an effort to achieve framing.

The H.221 mode operates at the 64 kbps data rate only. If H.221 frames are found, the unit will illuminate the 64 kbps indicator and the G.722 indicator. The G.722 indicator will blink as an indication that H.221 data has been framed on. The unit will generate H.221 output as a result.

If H.221 frames are not found, the unit looks for G.722 input data. G.722 frames can be found at either 56 kbps or 64 kbps data rates. If G.722 frames are detected, the proper bit rate indicator is lit and the G.722 indicator will come on and stay steady. The unit then outputs audio in the G.722 mode.

NOTE: There is a dip switch on the back panel that can control H.221 operation when the unit is operating at 64 kbps (see the description of switch 7 in Appendix C.) When this switch is in the up position, the unit is forced to H.221 mode when not in MUSICAM mode. This means that a unit operating in auto detect mode and not finding MUSICAM at 64 kbps will ONLY try to frame on H.221 input data and never try to frame on G.722.

Front Panel Description

LED Status Indicators

Loopback (Internal): Depressing this switch causes the output of the encoder section to be directed to the decoder section. This tests the entire system with the exception of the final digital line drivers and receivers.

Line Rate: This LED indicates that the codec is operating at 56kbps or 64kbps.

Coding: This LED indicates that the codecis operating in MUSICAM or G.722 compression mode. solid G.722 LED: G.722 compression Mode. Blinking G.722 LED: G.722 compression mode with H.221 framing inserted.

Decoder Alarms:

FRAMED This LED is illuminated if proper framing of the received digital bit stream has NOT been achieved.

PLL This LED is illuminated when the digital clock input is not functioning properly.

OVLD The illumination of this LED indicates that the peak analog output of the channel is within 4db of the maximum output level.

BERR This LED is illuminated if a bit error has been detected by the receiver.

Encoder Alarms

PLL This LED is illuminated when the digital clock input is not functioning properly.

OVLD The illumination of this LED indicates that the peak analog input of the channel is within 4db of the maximum input level.

Clock Rate This LED indicates that the codecis operating at 24kHz or 48kHz sampling rate and will illuminate only when MUSICAM coding is selected.

Toggle Switches

Auto Detect: There are 3 Auto Detect toggle switches. Placing the toggle switch in the Up position activates Auto Detect. Manual mode is activated when the toggle switch is in the Down position. When a switch is in the Auto Detect position, toggling the switch directly to its right has no effect.

To operate in the fully Auto Detect mode, it is recommended that all 3 switches be in the Up position at the same time.

Bit Rate:

56k Placing the toggle switch in this position, directs the codec to operate in 56kbps. 56kbps data rate is very popular in North America for switched 56 networks.

64k Placing the switch in this position, directs the codec to operate in 64kbps. 64kbps is used for ISDN networks.

Coding

MUSICAM Mode Placing the switch in this position, directs codec to operate in the MUSICAM ISO 11172-3 Layer II mode. Under MUSICAM and 24kHz sampling rate the analog bandwidth will be 10kHz. This mode allows the CDQ1000 to communicate with other CDQ1000's for the highest quality transmission possible.

When MUSICAM is used with 48kHz sampling rate the analog bandwidth will be 8.2kHz. This mode of operation allows the CDQ1000 to communicate with the CCS CDQ2000 MUSICAM Codec in mono mode at 56 or 64 kbps.

G.722 Mode Placing the switch in this position, directs the codec to operate in either G.722 mode or H.221 mode. Refer to Appendix C for the description of the dip switch controlling H.221 operation.

If the unit is operating at 56 kbps data rate, only the G.722 mode applies. At 64 kbps, the unit operates in H.221 mode if the back panel dip switch is up. Otherwise, the unit will operate in G.722 or H.221 mode based on the input data stream detected by the decoder.

Whether in G.722 mode or H.221 mode, the CDQ1000 communicates with industry standard codecs operating in the like mode.

***Sampling Rate:** *The Sampling Rate Selector only applies to MUSICAM Mode.

24k or 48k Placing the switch in this position, directs the codec to operate at either 24k or 48k sampling rate when MUSICAM coding is selected.

G.722/H.221 Under G.722 or H.221 compression the sampling rate is set at 16kHz and is not user selectable.

Rear Panel Description

Audio Output: The XLR male connector outputs audio at a peak level of +18 dBu with an output impedance of 60 ohms balanced. See Appendix A or the pin-out of this connector.

Audio Input: The XLR female connector accepts analog audio input at a peak level of +18 dBu. An internal jumper can be set for 600 ohm or 20,000 ohm input impedance. See Appendix A for the pin-out of this connector.

V.35: The V.35 connector is used for connection to digital communication equipment such as a CSU/DSU or a leased line modem. See Appendix A for the pin-out of this connector. See Appendix C for the dip switch settings to enable this interface.

Alarm: This connector presents the alarm relay contacts. This relay closes whenever the front panel achieves framing.

X.21/RS422: The X.21 connector is used for connection to digital communication equipment such as an ISDN terminal adapter. See Appendix A for the pin-out of this connector. See Appendix C for the dip switch settings to enable this interface.

RS232: This connector is used for the input of ancillary data. The ancillary data functions under MUSICAM compression only. Maximum ancillary data rate is 38400bps. See Appendix A for the pin-out of

Dip Switches: These switches control various options of the unit. See Appendix C for the dip switch definitions.

Power: This connector is used to connect the CDQ1000 via an IEC power cable. The voltage required by the CDQ1000 can be from 94 to 250 volts AC at 50 to 60 Hz.

Appendix A

CONNECTORS

V.35 Connector: (DB25 Connector)

1	Protective ground
7	Signal ground
3	Received data A-wire (input)
16	Received data B-wire (input)
17	Receiver signal element timing A-wire (input)
12	Receiver signal element timing B-wire (input)
15	Transmitter signal element timing A-wire (input)
14	Transmitter signal element timing B-wire (input)
2	Transmitted data A-wire (output)
13	Transmitted data B-wire (output)
20	Data terminal ready (output)*
4	Request to send (output) *
8	Received line signal detector (input) *

Connector: DB25S (female)

* Unused by CDQ1000

X.21 Connector

1	fg	frame ground
2	t(a)	Transmitted data A-wire (output)
3	c(a)	Control element A-wire (output) **
4	r(a)	Receiver data A-wire (input)
5	i(a)	Indicator element A-wire (input) *
6	s(a)	Timing element A-wire (input)*
7	b(a)	Byte timing A-wire (input)
8	sg	signal ground
9	t(b)	Transmitted data B-wire (output)
10	c(b)	Control element B-wire (output) **
11	r(b)	Receiver data B-wire (input)
12	i(b)	Indicator element B-wire (input) *
13	s(b)	Timing element B-wire (input) *
14	b(b	Byte timing B-wire (input)
15		No connection

Connector: DB15S (female)

**B>A always

*unused by CDQ1000

RS422 Connector

1	fg	frame ground
2	t(a)	Transmitted data A-wire (output)
3	c(a)	Transmit timing echo A-wire (output)
4	r(a)	Receiver data A-wire (input)
5	i(a)	Indicator element A-wire (input) *
6	s(a)	Receiver timing element A-wire (input)
7	b(a)	Transmit timing A-wire (input)
8	sg	signal ground
9	t(b)	Transmitted data B-wire (output)
10	c(b)	Transmit timing echo B-wire (output)
11	r(b)	Receiver data B-wire (input)
12	i(b)	Indicator element B-wire (input) *
13	s(b)	Receiver timing element B-wire (input)
14	b(b)	Transmit timing B-wire (input)
15		No connection

Connector: DB15S (female)

* unused by CDQ1000

RS422 is identical to X.21 except that there are separate clocks for the receiver and the transmitter. Also the RS422 echoes the transmitter clock.

RS232 Interface Connector - Encoder and Decoder

1	Not used
2	Transmitted data (output) *
3	Received data (input) **
4	Not used
5	Signal ground
6	Not used
7	Not used
8	Not used
9	Not used

Connector: DB9P (male)

* The decoder section outputs data on this pin. The received data pin (pin 3) is not used by the decoder.

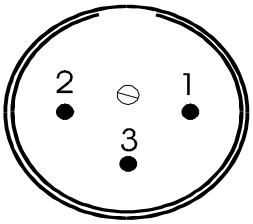
** The encoder section receives data on this pin. The transmitted data pin (pin 2) is not used by the encoder.

The RS232 data consists of 1 start bit, 8 data bits and 1 stop bit. No parity bit is included. The CDQ1000 provides a transparent channel for transmitting 8 bit bytes of information.

Audio Input Connector:

1. Ground
2. +Input
3. -Input

Connector: XLR Female



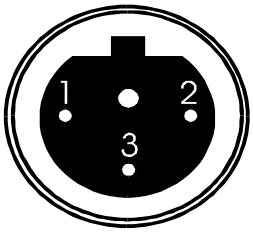
Audio Output Connector:

1. Ground

2. +Output

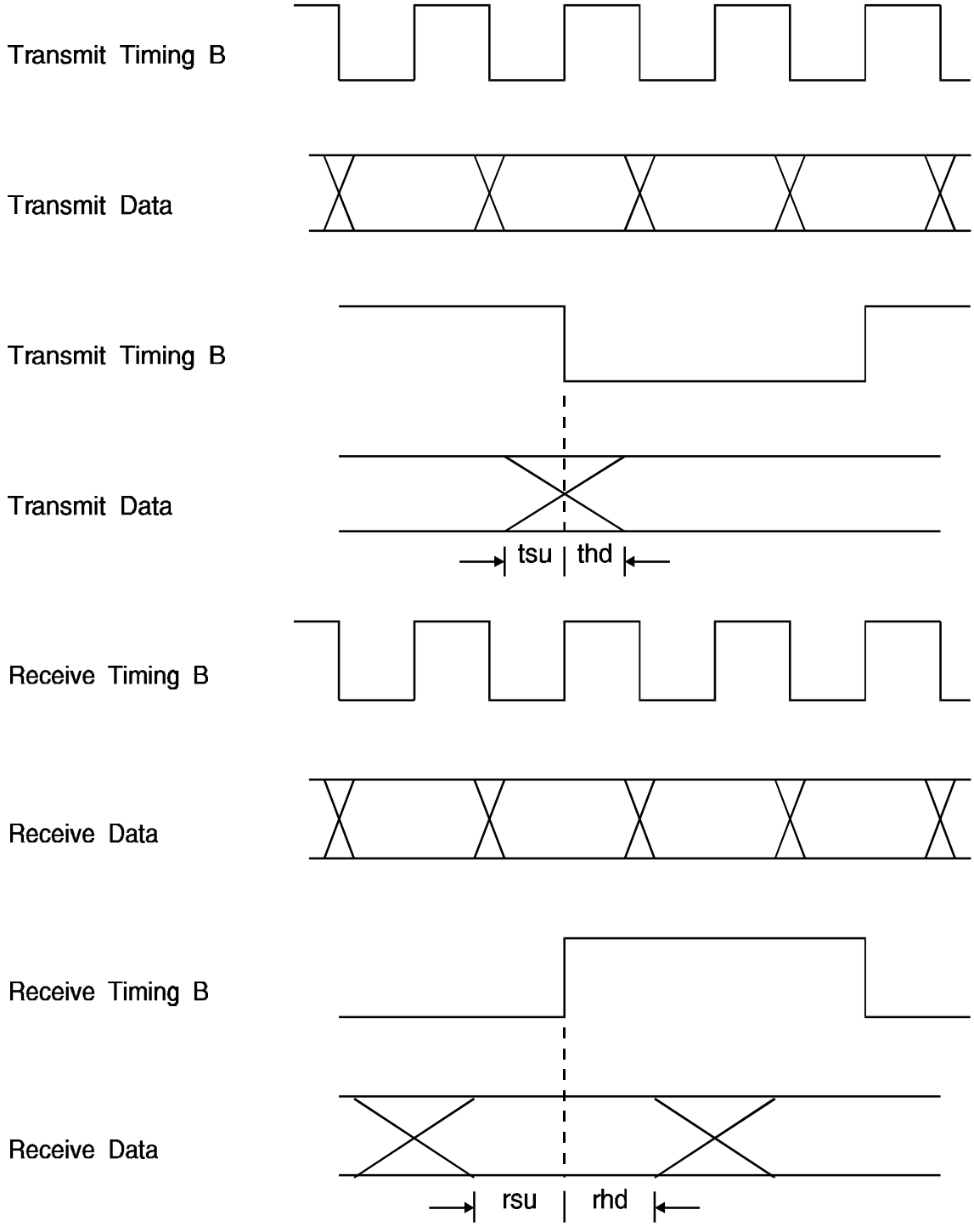
3. -Output

Connector: XLR Male



Appendix B

Digital Audio Timing



rsu = rhd = tsu = thd = 1 us

Appendix C

Rear Panel Dip Switches

1 Analog Bandwidth

2 Analog Bandwidth

Bit Rate	Mode	Analog BW Dip Switch1 2 Dn-Dn	Analog B W Dip Switch1 2 Up-Up	Analog B W Dip Switch1 2 Dn-Up	Analog B W Dip Switch1 2 Up-Dn	Sampling Rate
56k	Mono	8.25k	6.00k	6.75k	7.50k	48k
64	Mono	8.25k	6.00k	6.75k	7.50k	48k
56k	Mono	10.125k	9.00k	9.375k	9.750k	24k
64k	Mono	10.125k	9.00k	9.375k	9.750k	24k

3 Ancillary Data Baud Rate b0

4 Ancillary Data Baud Rate b1

5 Ancillary Data Baud Rate b2

b2	b1	b0	Rate
Dn	Dn	Dn	300
Dn	Dn	Up	1200
Dn	Up	Dn	2400
Dn	Up	Up	3600
Up	Dn	Dn	4800
Up	Up	Dn	9600
Up	Up	Up	19200
Up	Dn	Up	38400

6 Up ISO MPEG bit stream

Dn CCS MUSICAM bit stream

7 Up G.722 with forced H.221 framing mode at 64kbps

Dn Auto detect either G.722 or H.221 (at 64 kbps)

8 Not Used

9 Digital Interface Selection

10 Digital Interface Selection

9	10	I/F Type
Dn	Dn	V.35
Dn	Up	X.21
Up	Up	RS422

Appendix D

DB25 to V.35 Adapter Cable

(CCS 601650-L1)

V.35	**Name**	**DB25**
R	RDA	3
T	RDB	16
	,	
V	RETA	17
X	RETB	12
Y	TETA	15
AA	TETB	14
	TDA	2
P, S	TDB,	13
C	RTS	4
A	FG	1
B	GND	7 connect to shield at 1 end
H	DTR	20
F	RSD	8
J	RI,	21

, Connectors: DB25 - DB25P (male)
V.35 - AMP 200517-2 Block & AMP 201357-1

Paired pins should be connected to paired wires. Unpaired wires may be connected without regard to pairing.

Appendix E

CDQ1000 Specifications

CCITT G.722

Sampling Rate	16kHz
Frequency Response	20Hz-7.5kHz0.3db
THD	0.8% at 1kHz
Signal to Noise	66db referred to +18dbu
Max Input/Output Levels	, +18db or +10db
Nom Input/Output Levels	+8db or + 0db
Output Impedance	60ohms balanced (active)
Input Impedance,	600ohms balanced or 20k bridged
AD Converter	16 bit sigma delta
DA Converter	18 bit sigma delta
Analog Input Connector	Female XLR
Analog Output Connector	Male XLR
Overload Indication	+14dbu @/18dbu Peak
Coding	CCITT G.722
Digital Clock Input	Requirement, 200ppm
Digital Interface	V.35,, X.21
Size	19" x 1.72" x 10"
Displays	LED
Power	90-250 volts
Data Rate	56/64kbps
Status Output	Form C Summary Alarm

CDQ1000 Specifications

MUSICAM

Sampling Rate	48kHz or 24kHz
Frequency Response	20Hz-8.2k<M>Hz 0.3db at 48kHz,, 20Hz-10kHz
THD	0.8% at 1kHz
Signal to Noise	84db referred to +18dbu at 48kHz,, 80db referred to +18dbu at 24kHz
Max Input/Output Levels	+18db
Nom Input/Output Levels	+8db
Output Impedance	60ohms balanced (active)
Input Impedance,	600ohms balanced or 20k bridged
AD Converter	16 bit sigma delta
DA Converter	18 bit sigma delta
Analog Input Connector	Female XLR
Analog Output Connector	Male XLR
Overload Indication	+14dbu
Coding	ISO 11172-3 Layer 2 in Mono Mode at 48kHz and 24kHz
Ancillary Data Path	300,, 1200,, 2400,, 3600,, 4800,, 9600,, 19200,38400
Digital Clock Input	Requirement, 200ppm
Digital Interface	V.35,, X.21/RS422a.
Size	19" x 1.72" x 10"
Displays	LED
Power	90-250 volts
Data Rate	56/64kbps
Status Output	Form C Summary Alarm