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MEGALINK® SERVICE, MEGALINK® CHANNEL SERVICE, MEGALINK® PLUS SERVICE, AND MEGALINK® LIGHT SERVICE INTERFACE AND PERFORMANCE SPECIFICATION

Technical Reference

October, 1999

NOTICE

This Technical Reference describes MegaLink® Service, MegaLink® Channel Service, MegaLink® Plus Service, and MegaLink® Light Service**.** It describes signals as they appear at the Network Interface (NI), between BellSouth Telecommunications, Inc. (BST) and Customer Installations.

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If further information is required, please contact:

Director – Transport Systems Engineering
BellSouth Telecommunications, Inc.
1884 Data Drive
Birmingham, Alabama 35244

MEGALINK® SERVICE, MEGALINK® CHANNEL SERVICE MEGALINK® PLUS SERVICE, AND MEGALINK ®LIGHT SERVICE INTERFACE AND PERFORMANCE SPECIFICATION

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MEGALINK® SERVICE, MEGALINK® CHANNEL SERVICE MEGALINK PLUS® SERVICE, AND MEGALINK® LIGHT SERVICE INTERFACE AND PERFORMANCE SPECIFICATION

1. General

The requirements in this document were developed to establish a practical interface. Compliance with these specifications should provide a satisfactory interface in a high percentage of installations. If cases arise that have not been adequately addressed in this document, any resulting problems should be resolved through the cooperation of the user, BellSouth Telecommunications, Inc. (BST) and equipment suppliers. BST encourages customer participation to ensure an orderly, functional and mutually trouble−free interface at all locations.

1.1 Scope

This Technical Reference (TR) describes physical, protocol and performance requirements at the Network Interface (NI) necessary for compatible operation between BST and the Customer Installation (CI). This TR describes MegaLink Service, MegaLink Channel Service, Megalink Plus Service, and MegaLink Light Service metallic 4 wire DS1 interfaces offered by BST. Customers should consult the tariff or a Marketing Representative for availability.

1.2 Use of this Document

Network Interface (NI) specifications have been established based upon Industry Standards developed by the American National Standards Institute (ANSI) and Telcordia (formerly Bellcore). This TR articulates BST variations from these standards and provides clarification of interface requirements as necessary.

This document provides NI compatibility requirements and is not an equipment specification. The NI information in this document complements the equipment information in Part 68, Subpart D, of the FCC Rules and Regulations which contains requirements for the registration of customer−installation equipment to protect the network from harm. Tariffs, contracts, or regulatory acts in various jurisdictions may contain more stringent requirements than those in this document.

The physical connection of customer−provided equipment is addressed in the paragraphs of this TR that describe the mechanical interface and in Part 68, Subpart F, of the FCC Rules and Regulations as supplemented by Public Notice 2526 (February 1986) and in Committee T1 Technical Report Number 5.

1.3 Reason for Reissue

This Technical Reference (TR) is being reissued to generally update the previous issue and specifically reflects the following:

- Addition of MegaLink Light Service

- Revised ANSI T1.403−1999, *Network and Customer Installation Interfaces - DS1 Electrical Interface*
- Remove DS1 robbed bit−signaling information now contained in ANSI T1.403.02−1999
- Remove wording covering powering arrangements for circuits installed before February 1988 to align specification with ANSI T1.403 requirements
- Addition of Customer Installation/Network Installation sectionalization signals and messages based upon revised ANSI standards

2. Service Description

MegaLink is a family of services within a Local Access Transport Area (LATA) that utilize a 1.544 Megabit per second digital bit stream (DS1) for simultaneous two−way transmission. MegaLink uses a serial, bipolar, return−to−zero, isochronous, digital facility. The family of MegaLink services includes the following:

(a) MegaLink Service is a point−to−point service that utilizes the entire DS1 capacity between two points within a LATA.

(b) MegaLink Channel Service (MCS) is a DS1−rate transport service which includes multiplexing to enable the user to access one or more DS0 channels between a Customer Premises and its Serving Wire Center (SWC), or extended through its SWC to another central office.

MCS provides channelization capability for the customer in a central office. It is provided in packages based on multiple voice grade channel equivalents (DS0) where 24 voice grade channels are equal to a DS1. This service provides local channels and/or interoffice channels for network exchange access, Broadband Exchange Line Service, Foreign Exchange Service, Centrex Type Services, off−premises stations, tie lines, WATS lines, analog data channels, and digital data services at 2.4 Kbit/s, 4.8 Kbit/s, 9.6 Kbit/s, 19.2 Kbit/s, 56 Kbit/s, 64 Kbit/s and 1.544 Mbit/s data rates.

(c) MegaLink Plus Service provides local loop transport between a customer designated premises and its normal Serving Wire Center (SWC). This service utilizes self−healing structurally diverse fiber based loop facilities with high performance and reliability parameters designed to limit single points of failure. MegaLink Plus is available to customer locations where existing loop facilities are fiber based and utilize structurally diverse routes. For locations where loop facilities are not available to satisfy customer requests for MegaLink Plus Service, special construction charges as set forth in the applicable BST tariff will apply.

MegaLink Plus Service is furnished on a link (partial) basis for connection at the normal SWC to another MegaLink Plus Service, Centrex Type Services[1], MegaLink Channel Service, FlexServ® Service, LightGate® Service, or SMARTRing® Service. Connectivity between MegaLink Plus Service and other services may be furnished via a MegaLink Service Interoffice Channel between central offices.

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[1] Connection from a MegaLink Plus Service or a MegaLink Light Service to Centrex Type Services may not be available from all Serving Wire Centers.

(d) MegaLink Light Service provides local loop transport between a customer designated premises and its normal SWC. This service utilizes a fiber–based local channel (loop) transport link between a customer designated premises and its normal Serving Wire Center (SWC). When MegaLink Light Service is request at locations where loop facilities are not available to satisfy customer requests for MegaLink Light Service, special construction charges will apply as set forth in the applicable BST tariff.

MegaLink Light Service is furnished on a link (partial channel) basis for connection at the normal SWC to Centrex Type Services, MegaLink Channel Service, FlexServ® Service, LightGate® Service, or SMARTRing® Service. Connectivity between MegaLink Light Service and these other services may be provided via a MegaLink Service Interoffice Channel between central offices. Except for MegaLink Service and MegaLink Plus Service, those services connectable to a MegaLink Service Interoffice Channel or MegaLink Light Service Local Channel may be utilized for completion of a customer's point–to–point channel service.

The Marketing representative has additional details on these services.

3. DS1 Interface

This section defines the DS1 Network Interface (NI) requirements. It denotes existing documentation which details electrical and signal specifications and provides BST variations and clarifications. The physical layer of the DS1 NI is delineated in the following specifications.

ANSI T1.403	*Network and Customer Installation – DS1 Metallic Interface*
GR–342–CORE	*High–Capacity Digital Special Access Service Transmission Parameter Limits and Interface Combinations*

ANSI T1.403 applies to end–user interfaces and GR–342–CORE applies to Carrier interfaces.

A sketch of the DS1 NI is shown in Figure 1. The signal delivered to the NI by BST is identified as the BST signal, and the signal delivered to the NI by the customer is identified as the Customer Installation (CI) signal.

3.1 Framing Format

The DS1 signal must be framed in either the Superframe (SF) format or the Extended Superframe (ESF) format. The same framing format shall be used in both directions of transmission. Use of ANSI T1.403 ESF is strongly recommended to support improved testing and in–service performance monitoring.

3.2 Clear Channel Capability

BST uses the Bipolar with Eight Zero Substitution (B8ZS) method to provide a Clear Channel Capability (CCC). This supports transport of a framed DS1 signal with unconstrained payload bits. BST does not support the Zero−Byte Time Slot Interchange (ZBTSI) method of providing CCC.

3.3 Maintenance Signals

Maintenance signals are transmitted in−band and in the data link of the ESF format. Section 9 of this Technical Reference and ANSI T1.403 provide additional information regarding specific maintenance, alarm and loopback signals.

3.4 End−User Interface

DS1 end−user (EU) interface requirements are defined in ANSI T1.403. At an EU customer NI, some of the electrical requirements for the BST signal differ from corresponding requirements for the CI signal.

3.4.1 BST Signal at Network Interface

The signal requirements will be met at the signal regenerator output nearest the NI. A normalized and isolated pulse shall fit the (template) mask shown in Figure 2. An isolated pulse will have a peak−to−base amplitude of between 2.25 and 3.6 volts. At the NI, the pulse characteristics will be those of this BST standard pulse transmitted through a cable pair with a loss in the range of 0 to 16.5 dB at 772 kHz between 100 ohm terminations as shown in Figure 1.

3.4.2 Customer Signal at Network Interface

The signal requirements will be met at the output of the customer Network Channel Terminating Equipment (NCTE) when its Line Buildout (LBO) is set to 0 dB. A normalized and isolated pulse shall fit the (template) mask shown in Figure 2. An isolated pulse shall have a peak−to−base amplitude of between 2.4 and 3.6 volts. At the NI, the pulse characteristics shall be those of a standard pulse transmitted through a cable pair with a loss in the range of 0 to 5.5 dB at 772 kHz between 100 ohm terminations as shown in Figure 1. When additional customer attenuation is required, it may be inserted by selecting the appropriate LBO setting in the NCTE (0, 7.5, 15 dB). The NCTE LBO should be set to zero, unless the customer is advised otherwise by BST. It is the customer’s responsibility to properly option the NCTE to provide the required LBO setting. Failure to provide the specified LBO will jeopardize performance of the customer’s service and has the potential to adversely impact the performance of other BST provided services.

3.4.3 Mechanical Interface

One balanced twisted pair shall be used for each direction of transmission. Interconnection at the DS1 End−User NI is through one of four Universal Service Order Code (USOC) connectors, RJ48C, RJ48X, RJ48M, RJ48H, as shown in ANSI T1.403 and Part 68 of the FCC Rules and Regulations as revised by Public Notice Numbers 4609 (September 21, 1988) and 4572 (October 3, 1988). The RJ48C or RJ48X jack is used for single DS1 line installations, and the RJ48M (8 DS1s) or RJ48H (12 DS1s) may be used for multiple circuit installations. These have a jack to the network and a plug from the CI installation and are shown in Figures 3, 4, 5, and 6.

Alternatively, an appropriate DS1 rate digital cross connect panel may function as the interconnection arrangement at the NI.

3.4.4 Customer Responsibility

End−user customers are required to provide registered equipment to protect the network from harm. NCTE provides network protection, signal recovery, LBO and test access functionality. These NCTE functions are normally included in a device called a Channel Service Unit (CSU)[1].

4. Powering Arrangements

Direct−current power shall not be delivered to the MegaLink Service NI by either BST or the CI. The CI shall not apply voltages to the NI other than those described in this specification.

5. MegaLink Channel Service (MCS)

MegaLink Channel Service (MCS) is available with customer provided channelization equipment on the customer premises and is offered in various basic system capacities and feature activation types. Individual channel services are made available by selecting the specific feature activation equipment desired in a basic system. The customer may channelize all or part of a MCS package to activate voice and data facilities for interconnection with the exchange network, voice grade and data facilities for private line channels, as well as other MegaLink Channel Services. The customer may also choose to not channelize all or part of a MCS package, allowing direct connection to other DS1 services.

5.1 MCS with Channelization Equipment Provided by the Customer

Figure 7 is an illustration of a 4 wire DS1 interface with channelization equipment provided by the customer. The connector at the NI is RJ48C for one DS1 line. Customer provided Network Channel Terminating Equipment (NCTE), Channel Service Unit (CSU) or other appropriate Termination Equipment (TE), shall be provided by the customer on the CI side of the NI.

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[2] In keeping with FCC Docket 81−216 these functions cannot be provided by a regulated Local Exchange Carrier at an end−user's premises.

5.2 Multiplex Standards

In order to assure proper operation with BST provided central office multiplex, the customer's channelization equipment must adhere strictly to form and protocol standards. Separate standards exist for the multiplex channel bank, for voice frequency encoding, for various signaling schemes, and for subrate digital access.

5.3 Coder/Decoder Requirements

The transmission of voice or voiceband analog information over a digital media necessitates analog to digital (A/D) and digital to analog (D/A) conversions. These conversions are governed by a sampling and quantization technique called Pulse Code Modulation (PCM). Its characteristics, decision levels and code assignments are covered in subsequent paragraphs.

Optimum performance in any transmission system usually dictates that small signals be re−emphasized for greater noise margin. The process is appropriate for digital as well as analog systems. MegaLink service utilizes a precise piecewise linear approximation to a μ255 law, which is defined as follows:

$$|Y| = \frac{\ln(1 + \mu|X|)}{\ln(1 + \mu)}, m\mu = \mu = 255$$

X = Compressor Inputs
Y = Compressor Output
Both normalized to unity

Compressed inputs are sampled and encoded at the frame rate of 8000 times per second. In 5 out of 6 frames, the sample is encoded into an 8 bit byte for insertion into the time slot allocated to the associated channel. In every sixth frame, however, one bit is stolen for the transmission of channel supervisory information and PCM encoding is limited to 7 bits.

The digital coding and decoding process will introduce a certain amount of distortion into the recovered signal. This distortion would approach zero if the number of samples per second and the number of possible states per sample were increased. The 8000 Hz sampling rate and 255 sampling states of PCM allows for excellent voiceband fidelity. Nevertheless, samples that fall between allowed sampling states are subject to impairments known as quantizing distortion.

The minimization of quantizing error demands that both telephone company and customer premises CODECs utilize an identical transfer characteristic. Figure 8 shows the transfer character for normal 8 bit PCM words. The output levels (Y's) are always midway between the decision levels (X's). The output levels are given by:

$$Y_0 = X_0 = 0$$

$$Y_n = \frac{(X_n) + (X_{n+1})}{2}, n = 1, 2, ...127$$

To further minimize distortion, the transfer characteristic of the abbreviated 7 bit words (used during signaling frames) differs from that of the normal 8 bit PCM words. Figure 9 shows the transfer characteristic for the 7 bit PCM words. Except for the level closest to zero, the output levels (Z's) are also midway between the decision levels (X's). These output levels are given by:

$$Z_n = X_{2n-1,} n = 1, 2.....64$$

Figure 10 lists the relative magnitudes of the decision levels (X's). The decision levels are placed symmetrically about zero, i.e., negative and positive potentials are treated equally. The maximum decision level magnitude given in Figure 10 has been normalized to a value of 8159 units so that all magnitudes may be represented by integer values. The magnitude of the peak value of a +3 dBm0, 1 kHz single−frequency signal is slightly less than that of the largest decision level (8159 units).

5.4 Standard Level Digital Milliwatt Signal

The repetitive transmission of the following sequence of codes in a given channel will be decoded in a properly aligned receiving terminal as a 0 dBm 1 kHz signal across 600Ω.

DIGIT NO.	1	2	3	4	5	6	7	8
	0	0	0	1	1	1	1	0
	0	0	0	0	1	0	1	1
	0	0	0	0	1	0	1	1
	0	0	0	1	1	1	1	0
	1	0	0	1	1	1	1	0
	1	0	0	0	1	0	1	1
	1	0	0	0	1	0	1	1
	1	0	0	1	1	1	1	0

5.5 Code Assignments

The assignment of PCM words and decoder levels are specified in Figure 11 in terms of coding ranges (decision levels). The code assignment provides a sign and ones complement magnitude coding, resulting in a high ones density in the output data stream for the encoding of speech.

The W bits in the PCM word column are required to guarantee that the output data stream never includes more than 15 consecutive zeros. This is a requirement related to T1 line clock recovery.

5.6 Prohibited Code Words

When a channel position in the bank is unequipped, the code word(s) emitted for that channel time slot must correspond to a near−zero voltage level. This minimizes stress on the far end receiving channel unit filter and contributes to a high ones density. In particular, code words corresponding to signals of either polarity, of magnitude greater than X_{48} are prohibited in time slots for unequipped channel positions.

When the analog input of an equipped channel in the bank is terminated in an appropriate idle channel impedance (with no speech or other signal energy present), the code words emitted for that channel time slot must correspond to a near−zero voltage level. It is required that code words corresponding to signals of either polarity of magnitude greater than X_{16} are prohibited under these conditions.

An unequipped channel must result in a 1 in the “A” signaling channel bit in the DS1 bank output signal.

5.7 Voice Frequency Characteristics

The requirements placed on the voice frequency (VF) side of the PCM bank are intended to provide quality speech and modulated data transmission, while insuring protection of the network from excessive signal levels, noise induction and echoes. VF characteristics are covered in this section because of their interrelationship with the digital encoding process.

5.8 Transmission Levels

All transmission levels are dependent upon the definition of the digital milliwatt, and upon the selection of proper transmission level points (TLPs) at the VF inputs to PCM channel units. Using the TLP concept, the power present at a point in a circuit is described by stating what this power would be if it were measured at the 0−TLP. The units used to specify the power in this case are dBm0.

The digital milliwatt is directly related to VF power levels. An input of a 0 dBm0, 1 kHz signal to a VF channel unit of a properly aligned transmitting terminal will be encoded such that a 0 dBm0, 1 kHz signal is produced in the corresponding channel of a properly aligned receiving terminal − the same as that produced by the digital milliwatt.

Voice and voiceband data signals are never allowed to be as high as 0 dBm0. Voice signals are always characterized as −16 dBm0; voiceband data is treated as a −13 dBm0 signal. The average voice power is thus expected to be 16 dB below TLP at any point on a circuit. Data signals are expected to reside 13 dB below TLPs.

TLPs will normally be specified by the telephone company in accordance with Figure 13. Other TLPs, and associated circuit losses, may be accommodated. The customer should discuss this with his Account Executive.

Figure 12 shows a 4−wire voiceband data circuit arranged for standard transmit and receive TLPs of +13 dB and −3 dB respectively. The data level is −13 dBm0, or 0 dBm, at the modem transmit interface.

5.9 Induced Noise and Crosswalk

Induced noise and crosstalk are unwanted circuit characteristics that may disturb or even mask normal conversation. Since these are voice frequency impairments subject to trans–circuit attenuation, noise and crosstalk will normally be perceived as most objectionable by the user nearest the source. They may, however, be directional in the outbound path and thus be apparent only to the far–end user. In order to preclude the perception of network originated problems the following specifications are placed on the customer PCM bank for idle channel noise and crosstalk.

Idle Channel Noise	23 dBrnC0
Crosstalk	60 dB loss between any two VF channels at all frequencies between 70 Hz and 3000 Hz; 50 dB loss between any two VF channels at all frequencies between DC and 4 kHz.

5.10 Return Loss

Return loss is a measure of the impedance balance quality between a source and a sink at an interface point. Perfect balance allows complete energy transfer and no reflections, or echoes. Poor balance will result in inferior talker echo performance for signals originated at either end of a connection. The near–end user, however, may not perceive the problem due to minimal echo path delay. The far–end user is most likely to be effected, and thus poor balance may be perceived as a network problem.

Return loss requirements are specified for two–wire terminations. They apply where standard TLPs are accepted. Where additional gain is allowed in the transmit or receive path, the requirements will be increased in direct proportion to that gain.

2–Wire Return Loss Requirements

Echo (ERL)	6 dB,	18 dB Recommended
Singing (SRL)	3 dB,	12 dB Recommended

Other impairments may also affect transmission quality through the customer PCM multiplex equipment. Their impact will be mostly upon the customer himself, however, and this document will not address these specifications.

5.11 Robbed–Bit Signaling

The establishment of precise protocol rules achieves signaling compatibility between digital channel banks. Some channelized DS1 applications use robbed–bit signaling to provide per–channel circuit signaling information. In these applications, eight bits are available for the payload in each channel during 5 out of 6 frames. Every sixth frame, the least significant bit (8th) of each time slot shall be used (robbed) to provide per–channel circuit signaling.

The contents and meaning of the signaling bits depend on the type of signaling used by the circuit provided over the channel. The SF and ESF robbed−bit signaling states for the six types of circuit signaling listed below shall be consistent with the requirements delineated in ANSI T1.403.02, *DS1 Robbed−bit Signaling State Definitions.*

- Loop−Start
- Ground−Start
- Loop Reverse−Battery (Customer Installation Provided LCF)
- Network Provided Reverse−Battery
- E & M
- Customer Installation Provided Loop−Start Supervision

For interoperability, the network and the CI shall use compatible robbed−bit signaling states for each type of circuit signaling. The signaling state definitions shall apply when the signaling states received by the CI are generated by network equipment and the signaling states sent by the CI are meant to be acted on by network equipment. These definitions may not be applicable when both ends of a channel are terminated in CIs.

Under normal operation, undefined signaling states should only exist during the transition from one signaling state to another signaling state. The duration of these signaling state transitions should not exceed 3 milliseconds.

5.11.1 SF Framing Format

In the superframe format (SF), bits shall be robbed in the sixth and twelfth frame to derive the signaling channel. The bit from the sixth frame is called the A bit and the bit from the twelfth frame is called the B bit.

5.11.2 ESF Framing Format

In the extended superframe format (ESF), bits shall be robbed in the 6th, 12th, 18th, and 24th frames to derive the signaling channel. These bits are called the A, B, C, and D bits, respectively. It may appear that the ABCD structure of ESF repeats the AB structure of SF (e.g., ABAB), however, this is not always the case.

5.12 Subrate Digital Data

D−type channel bank systems, when equipped with dataport channel units, provide a way to implement a Digital Data System (DDS) connection between a customer provided data signal and the network. Synchronous digital data formats are specified in ANSI T1.107. MCS supports subrate digital data in the dataport mode (DS0−A format). With dataport, bit stuffing constraints limit the efficiency of bit stream usage to one subrate digital channel per PCM channel replaced. In some locations, subrate multiplexing using the DS0−B format described in ANSI T1.107 may be available through a Special Service Arrangement (SSA). Customers desiring this capability should contact a BST Marketing representative regarding availability.

Generic requirements for dataport channel unit compatibility in the DDS network are contained in Telcordia (formerly Bellcore) Technical Advisory TA−TSY−00007, *Digital Channel Bank Requirements for Dataport Channel Unit Functions,* Issue 3, April 1986.

6. Synchronization

To insure proper operation when connected to the BST digital network, channelized DS1 circuits should follow the guidelines of Telcordia (formerly Bellcore) GR−436−CORE, *Digital Network Synchronization Plan*. Timing information may be transmitted as part of the DS1 signal. Improper timing will result in transmission impairing slips, which can cause loss of data information.

End−User synchronization may be achieved by deriving timing from a BST channelized DS1, by deriving timing from a different DS1 traceable to a Primary Reference Source (PRS) and timing all other facilities from it, or by providing timing traceable to a PRS. For BST services with central office channelization, it has been recommended that the customer equipment be loop−timed (slaved) to the incoming bit stream from the network.

It is important to note that Synchronous Optical Network (SONET) facilities may be used to transport the MegaLink family of services. SONET facilities may introduce DS1 phase transients as a result of pointer adjustments. Characteristics of the phase transients at the Network Interface have been addressed in the latest version of ANSI T1.403. Customer equipment must be capable of accommodating these phase transients. Further information about phase transients due to SONET pointer adjustments is contained in ANSI T1.403.

7. Performance

The performance objectives for MegaLink Service are stated in terms of Error Free Seconds (EFS), Severely Errored Seconds (SES), and Service Availability. The objective pertains to the BST provided DS1, 1.544 Mbit/s bit stream on the network side of the NI in Figure 1. The performance of DS1 subrate services are covered in documents that pertain to those services. Verification of circuit performance up to the NI may be performed by BST using a variety of testing techniques.

Performance of customer provided cable and equipment on the CI side of the NI is not the responsibility of BST. Proper performance of the network circuit at the NI does not imply that the same performance will occur at some other location on the CI side of the NI, which may be some distance away over connecting cable and equipment.

7.1 Error Free Seconds

An EFS is defined as any second in which there is no bit errors. Conversely, an Errored Second (ES) is one in which there is one or more bit errors. ES are typically transient in nature, arise from a variety of causes, and have a small probability of occurring at any given time. EFS objectives are long term, i.e., 30 days or more.

7.2 Severely Errored Seconds

A SES is defined as any second in which the Bit Error Ratio (BER) is $1X10^{-3}$ or worse. BER is the ratio of the number of logical bit errors received to the total number of bits transmitted in a given time interval. The SES objectives are long term.

7.3 Annual Service Availability

Circuit Availability is a measure of the amount of time that the service is “usable” by the customer. According to the American National Standards Institute (ANSI) a service is assumed to be in the available state unless a transition to the unavailable state is observed without a subsequent transition to the available state. The transitions between the available and unavailable states are:

- Transition to the unavailable state occurs at the beginning of 10 consecutive SES.
- Transition to the available state occurs at the beginning of 10 consecutive seconds, none of which is a SES.

7.4 Service Quality Objectives

Service quality objectives on the network side of the End–User (EU) NI are stated in terms of Error Free Seconds (EFS), Severely Errored Seconds (SES) and Annual Service Availability.

7.4.1 MegaLink Objectives

MegaLink Service DS1 performance objectives are contained in Table 7–1.

Table 7–1. MegaLink Service Quality Objectives (DS1 Long– Term Performance)

Performance Parameter	EU to Central Office Objectives	EU to EU Objectives
%Error Free Seconds (%EFS)	EFS > 99.75%	EFS > 99.50%
%Severely Errored Seconds (%SES)	SES < 0.010%	SES < 0.020%
%Annual Service Availability	Availability > 99.925%	Availability > 99.9%

7.4.2 MegaLink Plus Objectives

MegaLink Plus Service DS1 performance objectives are contained in Table 7–2.

Table 7–2. MegaLink Plus Service Quality Objectives (DS1 Long– Term Performance)

Performance Parameter	EU to Serving Wire Center Objectives	EU to EU Objectives
%Error Free Seconds (%EFS)	EFS > 99.95%	EFS > 99.875%
%Severely Errored Seconds (%SES)	SES < 0.010%	SES < 0.020%
%Annual Service Availability	Availability > 99.98%	Availability > 99.95%

MegaLink Plus End–User (EU) to Serving Wire Center (SWC) objectives apply to just the MegaLink Plus link. MegaLink Plus EU to EU objectives apply to applications between two MegaLink Plus customer locations interconnected via MegaLink facilities or applications between a MegaLink Plus customer location and a distant Central Office interconnected via MegaLink facilities.

7.4.3 MegaLink Light Objectives

MegaLink Light Service DS1 performance objectives are contained in Table 7−3

Table 7−3. MegaLink Light Service Quality Objectives
(DS1 Long− Term Performance)

Performance Parameter	EU to Serving Wire Center Objectives	EU to Distant Central Office Objectives
%Error Free Seconds (%EFS)	EFS > 99.95%	EFS > 99.875%
%Severely Errored Seconds (%SES)	SES < 0.010%	SES < 0.020%
% Annual Service Availability	Availability > 99.95%	Availability > 99.925%

MegaLink Light End−User (EU) to Serving Wire Center (SWC) objectives apply to just the MegaLink Light link. MegaLink Light EU to distant Central Office objectives apply to applications between a customer location and a distant Central Office.

8. Operational Maintenance

Maintenance of BST provided DS1 circuits on the network side of the NI is the responsibility of BST. In the event of reported trouble, an attempt to diagnose and isolate the source of the trouble will be made with a variety of verification and testing techniques. Once the trouble has been confirmed and isolated a dispatch will be made to correct it.

The greatest difficulty occurs in situations where trouble reports cannot be confirmed by remote diagnostics. The company will offer to dispatch to the customer's premises for additional testing, but with the understanding that maintenance charges may apply. The trouble resolution process will be slowed considerably.

This situation is of course frustrating to the customer as well as to telephone company. It is in the customer's interest to try to avoid requesting the telephone company to expend time attempting to isolate a problem that may exist in the customer's equipment.

Customer provided NCTE with ANSI T1.403 ESF capabilities in conjunction with proper test equipment supports improved testing, maintenance and in−service performance monitoring capabilities. This enhances the likelihood of achieving the circuit quality objectives.

9. Maintenance Signals

Maintenance signals are transmitted in−band in the SF format and in the data link of the ESF format. ESF is not universally available and is not always provisioned with full features. The Marketing Representative has location−specific details.

In the SF format, the following framed codes may be used within the Network to support out−of−service maintenance operations. These codes are used in repetitive pulse patterns of at least 5 seconds. Network equipment may block customer transmission of long sequences of these patterns:

11000 (2 in 5)
11100 (3 in 5)
10100

9.1 Remote Alarm Indication

The Remote Alarm Indication (RAI) is widely known in the industry as a yellow alarm. The RAI/Yellow signal shall be transmitted in the outgoing direction when DS1 terminal equipment located in either the network or the CI determines that it has effectively lost the incoming signal. An RAI/Yellow signal shall be transmitted to the NI in the following forms:

> Superframe Format: For the duration of the alarm condition, but for at least one second, bit two in every eight−bit channel time−slot shall be a zero. This arrangement shall be used even if the payload is not channelized.[3]
>
> Extended Superframe Format: For the duration of the alarm condition, but for at least one second, a repeating 16 bit pattern consisting of eight "ones" followed by eight "zeros" shall be transmitted continuously on the ESF data link, but may be interrupted for a period not to exceed 100 milliseconds per interruption (see ANSI T1.403).
>
> Both Formats: For either framing format, the minimum time between the end of one transmission of RAI/Yellow and the beginning of another transmission of RAI/Yellow shall be one second. Certain services provided by the network may require longer time intervals than these minimum values, or may require unequal "on" and "off" intervals, or both longer intervals and unequal "on" and "off" intervals.

9.2 Alarm Indication Signal

The Alarm Indication Signal (AIS) shall be an unframed, all−ones signal. An AIS should be transmitted to the NI upon a loss of originating signal, or when any action is taken that would cause a signal disruption (e.g., line loopback). The AIS is removed when the condition triggering the AIS is terminated.

9.3 Customer Installation/Network Installation Trouble Sectionalization

Customer Installation (CI) and Network Installation (NI) signals and messages are intended for application at a point within the network as close as is practicable to the NI so that the sectionalization provided will place trouble within the network or within the CI. The CI shall not generate these signals and messages, and is not required to detect them.

9.3.1 Trouble Sectionalization Signals

Alarm Indication Signal−Customer Installation (AIS−CI) and Remote Alarm Indication − Customer Installation (RAI−CI), as defined in ANSI T1.403, are intended for use in the network to differentiate whether a trouble exists within the network or within the CI.

Although the two signals may be applied independently, they are intended to be used together to locate trouble in either direction of transmission to either side of the point of application of the signals.

[3] It is recognized that some existing unchannelized equipment does not transmit the RAI/Yellow signal.

9.3.1.1 Alarm Indication Signal - Customer Installation

AIS−CI is a variant of AIS. AIS−CI is generated within the network and is transmitted toward the network, away from the CI, when either an AIS defect or a LOS defect has been detected in the signal received from the CI. AIS and LOS defects are defined in ANSI T1.231. This signal may transit the NI from the network to the CI as a result of far end action. The CI shall respond to this signal only in as far as it is within the definition of AIS

Generation of AIS−CI is optional. If provided, AIS−CI shall meet the requirements defined in ANSI T1.403.

9.3.1.2 Remote Alarm Indication - Customer Installation

RAI–CI is a variant of RAI. The purpose of RAI–CI is to indicate that RAI has been detected in the signal from the CI and that the defect or failure which caused the origination of that RAI is not found in the signal from the network. RAI–CI may thus be used to determine whether a problem which has been detected, is in the network, or in the CI in the direction of transmission toward the CI. This signal may transit the NI from the network to the CI as a result of far end action. The CI shall respond to this signal only in as far as it is within the definition of RAI.

Generation of RAI–CI is optional. If provided, RAI–CI shall meet the requirements defined in ANSI T1.403.

9.4 Loopbacks

Loopbacks are used by Carriers and end–users as a maintenance tool to aid in problem resolution. The codes and protocols described in ANSI T1.403 may be used by the Carrier for trouble isolation or by the end–user for CI–to–CI testing.

Two types of loopbacks are defined in ANSI T1.403, line and payload loopback. Both are applicable for signals using the ESF format; only the line loopback is applicable for signals using the SF format. Line loopbacks result in a full 1.544 Mbit/s loopback of the signal received by the CI from the NI. Payload loopbacks result in a 1.536 Mbit/s loopback of the payload of the signal received by the CI from the NI maintaining bit–sequence integrity[4] for the information bits.

9.4.1 Loopback Control Signaling in the SF Format

The protocol currently in use by the carriers for network access to the CI line loopback feature is in–band signaling control. Only the CI may respond to the in–band control line loopback codes..

Activation Signal: The in–band activation signal for a line loopback shall be a framed DS1 signal consisting of repetitions of four “zeros” followed by one “one”, lasting for at least 5 seconds, with the framing bits replacing bits of the pattern.

Deactivation Signal: The in–band deactivation signal for a line loopback shall be a framed DS1 signal consisting of repetitions of two “zeros” followed by one “one”, lasting for at least 5 seconds, with the framing bits replacing bit of the pattern.[5]

[4] This requires that the timing of the transmitted signal be synchronized with the timing of the received signal.

[5] Embedded network equipment exists which may react to the line loopback deactivate code and block the code from reaching the CI. When this occurs, manual intervention is required to deactivate the CI line loopback.

9.4.2 Loopback Control Signaling in the ESF Format

The activation signal for a line loopback shall be by means of the ESF data−link messages specified for that purpose in ANSI T1.403.[6] Line loopback activate codes shall not be returned to the NI in response to line loopback activation signaling (e.g., by the requested loopback).[7] Accordingly, signaling for line loopback activation shall be a two step process as follows:

Activation Signal: The line loopback activation code shall be sent as a preamble to line loopback request. The end of the transmission of the preamble shall constitute a request for line loopback activation. The activation signal for a payload loopback shall be by means of the ESF data−link message specified in ANSI T1.403.

Deactivation Signal: Signaling for line loopback deactivation and payload loopback deactivation may be accomplished in several ways. First, deactivation shall be signaled by the use of the deactivation codes specified in ANSI T1.403. In addition, deactivation of both line loopback and payload loopback shall be signaled by any of the following:Activation Signal: The line loopback activation code shall be sent as a preamble to line loopback request. The end of the transmission of the preamble shall constitute a request for line loopback activation. The activation signal for a payload loopback shall be by means of the ESF data−link message specified in ANSI T1.403.

- Universal loopback deactivate codeword defined in ANSI T1.403
- AIS
- A data−link signal consisting of two occurrences of the one per second
- RM separated by uninterrupted idle code

9.5 DS1 Idle Signal

Generation and detection of the DS1 Idle Signal is optional. If provided, the DS1 Idle Signal shall meet the requirements defined in Annex C of ANSI T1.403. The Idle Signal indicates that the normal signal source is not present. The DS1 Idle Signal is not to be confused with the ESF data link idle code.

---

[6] Some embedded CI equipment uses either framed or unframed in−band codes to activate and de−activate ESF line loopbacks.

[7] Some embedded CI equipment for ESF operation activates loopback immediately upon identification of the loopback activation codeword and does not delay actual loopback until either transmission of the loopback activation codeword ceases, or is replaced by the loopback retention codeword.

10. References

ANSI T1.101−1994, Synchronization Interface Standards for Digital Networks.

ANSI T1.102−1993, Digital Hierarchy − Electrical Interfaces.

ANSI T1.107−1995, Digital Hierarchy − Formats Specifications.

ANSI T1.401−1993, Interface between Carriers and Customer Installations − Analog Voicegrade Switched Access Lines Using Loop−Start and Ground−Start Signaling.

ANSI T1.403−1999, Network and Customer Installation − DS1 Metallic Interface.

ANSI T1. 403.01−1999, Network and Customer Installation Interfaces−Intergrated Services Digital Network (ISDN) Primary Rate Layer 1 Electrical Interface Specification.

ANSI T1.403.02−1999. DS1 Robbed−bit Signaling State Definitions.

ANSI T1.510−1994, Network Performance Parameters for Dedicated Digital Services − Specifications.

T1 Technical Report No.5, Carrier to Customer Installation Interface Connector Wiring Configuration Catalog, 1990.

Code of Federal Regulations, Title 47, FCC Rules and Regulations, Part 68, Revised December, 1987.

CCITT, Red Book, Fascicle VI Recommendation Q.921, ISDN User−Network Interface Data Link Layer Specification.

Rules and Regulations, Part 68, Federal Communications Commission.

TR 53545, SynchroNet® Service Network Interface Specifications, Issue D, September, 1994.

TR 73590, Broadband Exchange Line Service Interface & Performance Specifications, Issue C, June 1999.

GR−436−CORE, Digital Network Synchronization Plan, Issue 1, June 1994.

GR−342−CORE, High−Capacity Digital Special Access Service Transmission Parameter Limits and Interface Combinations, Issue 1, December 1995.

TA−TSY −000077, Digital Channel Bank Requirements for Dataport Channel Unit Functions, Issue 3, April 1986.

ANSI documents can be ordered from:

Global Engineering Documents
15 Inverness Way East
Englewood, CO 80112−5702
(800) 854−7179

Telcordia (formerly Bellcore) documents can be ordered from:

Telcordia Customer Relations
8 Corporate Place–Room 3A–184
Piscataway, NJ 08854–4156
(800) 521–2673

11. Definitions

Alarm Indication Signal (AIS)

A signal transmitted in lieu of the normal signal to maintain transmission continuity, and indicate to the receiving terminal that there is a transmission fault which is located either at the transmitting terminal or upstream of the transmitting terminal.

American National Standards Institute (ANSI)

An organization that has accredited projects undertaken by the telecommunications independent standards committee T1.

Bipolar (Alternate Mark Inversion) Signal

A pseudo–ternary signal, conveying binary digits, in which successive "ones" (marks, pulses) are of alternating, positive (+) and negative (–) polarity, equal in amplitude, and in which a "zero" (space, no pulse) is of zero amplitude.

B8ZS (Bipolar with 8–Zero Substitution)

A code in which eight consecutive "zeros" are replaced with the sequence 000VB0VB, where V is a binary one in which the polarity is in violation of the bipolar rule and B is a binary one in which the polarity is in conformance with the bipolar rule.

Bipolar Violation

In a bipolar signal, a one (mark, pulse) which has the same polarity as its predecessor.

Carrier

An organization that provides telecommunications service to the public.

Clear Channel Capability

A characteristic of a DS1 transmission path in which the 192 "information" bits in a frame can represent any combination of zeros and ones.

Customer Installation (CI)

Equipment and wiring at the customer's location on the customer side of the NI.

Cyclic Redundancy Check (CRC)

A method of checking the integrity of received data, where the check uses a polynomial algorithm based on the content of the data.

DS1 (Digital Signal Level 1)

A digital signal transmitted at the nominal rate of 1.544 Mbit/s.

In–Band

Using or involving the information digit time slots of a DS1 frame; i.e., bit assignments of a frame exclusive of the framing bit.

Isolated Pulse

A pulse free from the effects of the other pulses in the same signal. (A suitable testing signal is a repetitive pattern of one "one" and seven "zeros.")

Jitter

Short–term variation of the significant instants of a digital signal from their ideal positions in time. Short–term implies that these variations are high frequency (greater than 10 Hz).

LAPD

Link Access Procedure for the D Channel.

Line Loopback

A loopback in which the signal transmitted beyond the loopback point (the forward signal), when the loopback is activated, is the same as the received signal at the loopback point.

Loopback

A state of a transmission facility in which the received signal is returned towards the sender.

Mbit/s

Megabits per second.

MegaLink Channel Service (MCS)

The DS1 bit stream channelized to the DS0 level.

Network

A collection of transmission and switching facilities used to establish communications channels.

Network Interface (NI)

The point of demarcation between the Network and the CI.

Payload

The 192 information bits of a DS1 frame.

Pulse Density

A measure of the number of "ones" (marks, pulses) in relation to the total number of digit time slots transmitted.

Quasi–Random Signal (QRS)

A signal consisting of a bit sequence which approximates a random signal.

Regenerator

Equipment that reconstructs and retransmits a received pulse train.

Terminal Equipment (TE)

Equipment which originates or terminates signals at the specified rate.

T1 Line

A full duplex digital transmission facility that is composed of two twisted metallic pairs and regenerators that carry one DS1 signal.

Unit Interval

The nominal difference in time between consecutive significant instants of an isochronous signal.

Wander

Long−term variations of the significant instants of a digital signal from their ideal positions in time. Long−term implies that these variations are low frequency (less than 10 Hz).

ZBTSI (Zero−Byte Time Slot Interchange)

A technique used on a DS1 signal to ensure that pulse density requirements are met, where zero octets are replaced by an address chain which is decoded by the receiving terminal.

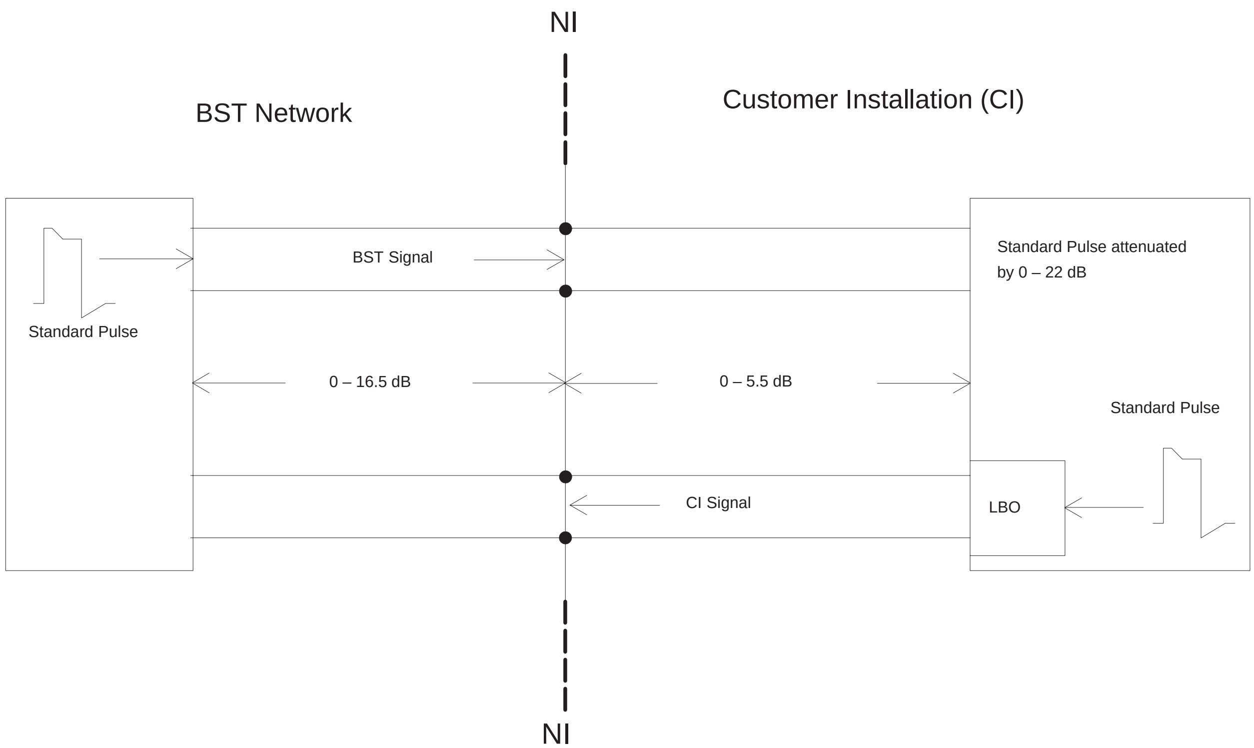
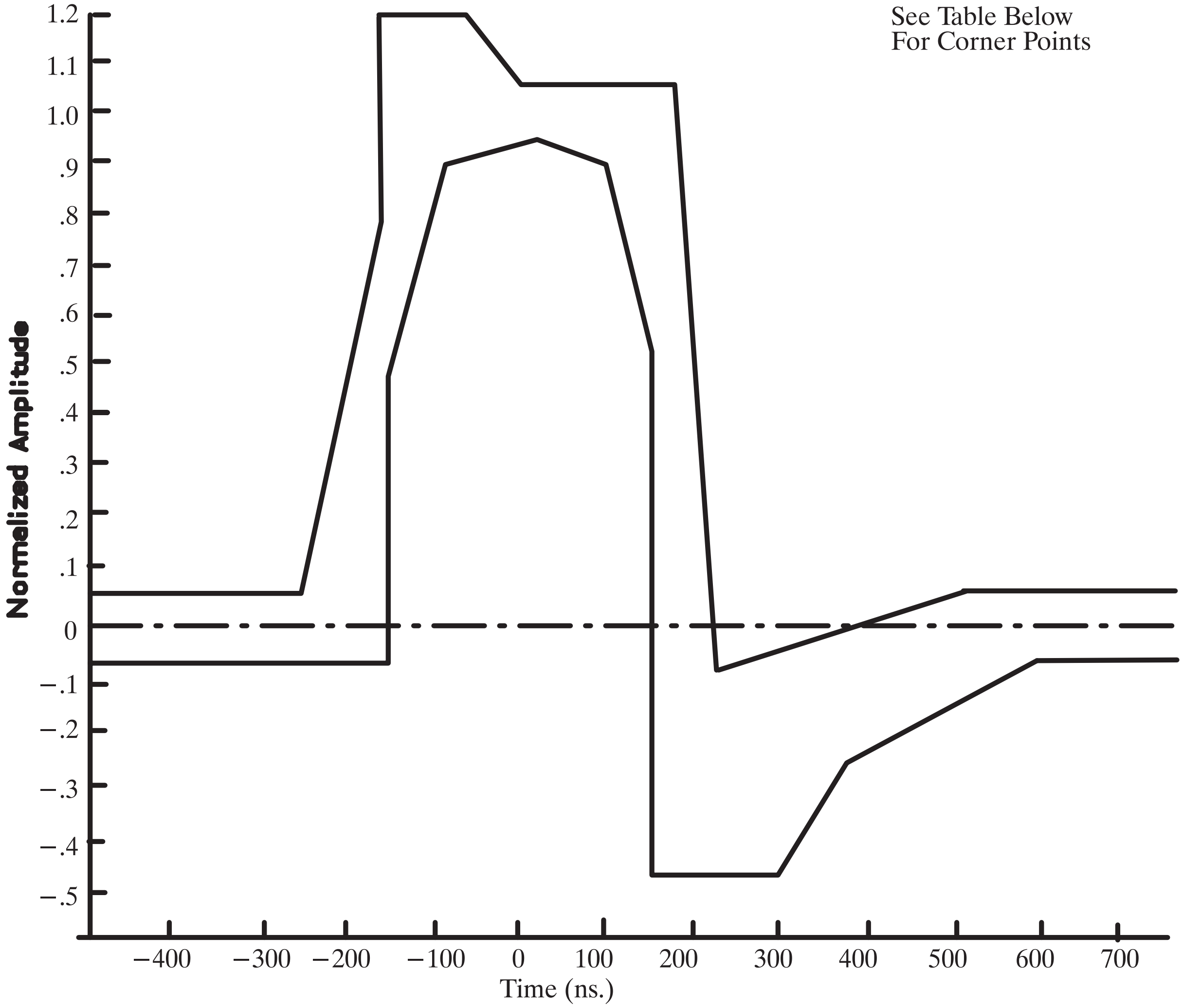


Figure 1 − DS1 Network Interface



Maximum Curve

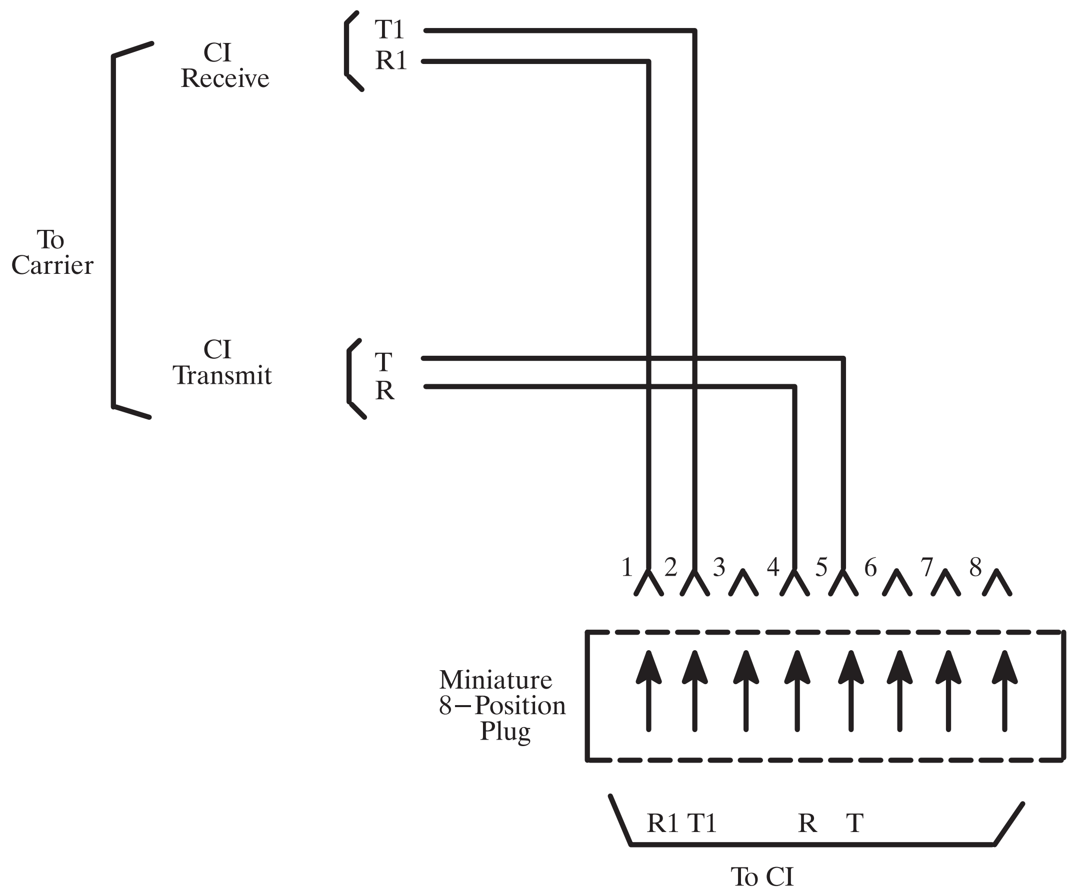
TIME	Nanoseconds	−500	−250	−175	−175	−75	0	175	220	500	750	−	−
	Unit Intervals	−.77	−.39	−.27	−.27	−.12	0	.27	.34	.77	1.16	−	−
NORMALIZED AMPLITUDE		.05	.05	.80	1.20	1.20	1.05	1.05	−.05	.05	.05	−	−

Minimum Curve

TIME	Nanoseconds	−500	−150	−150	−100	0	100	150	150	300	396	600	750
	Unit Intervals	−.77	−.23	−.23	−.15	0	.15	.23	.23	.46	.61	.93	1.16
NORMALIZED AMPLITUDE		−.05	−.05	.5	.9	.95	.9	.5	−.45	−.45	−.26	−.05	−.05

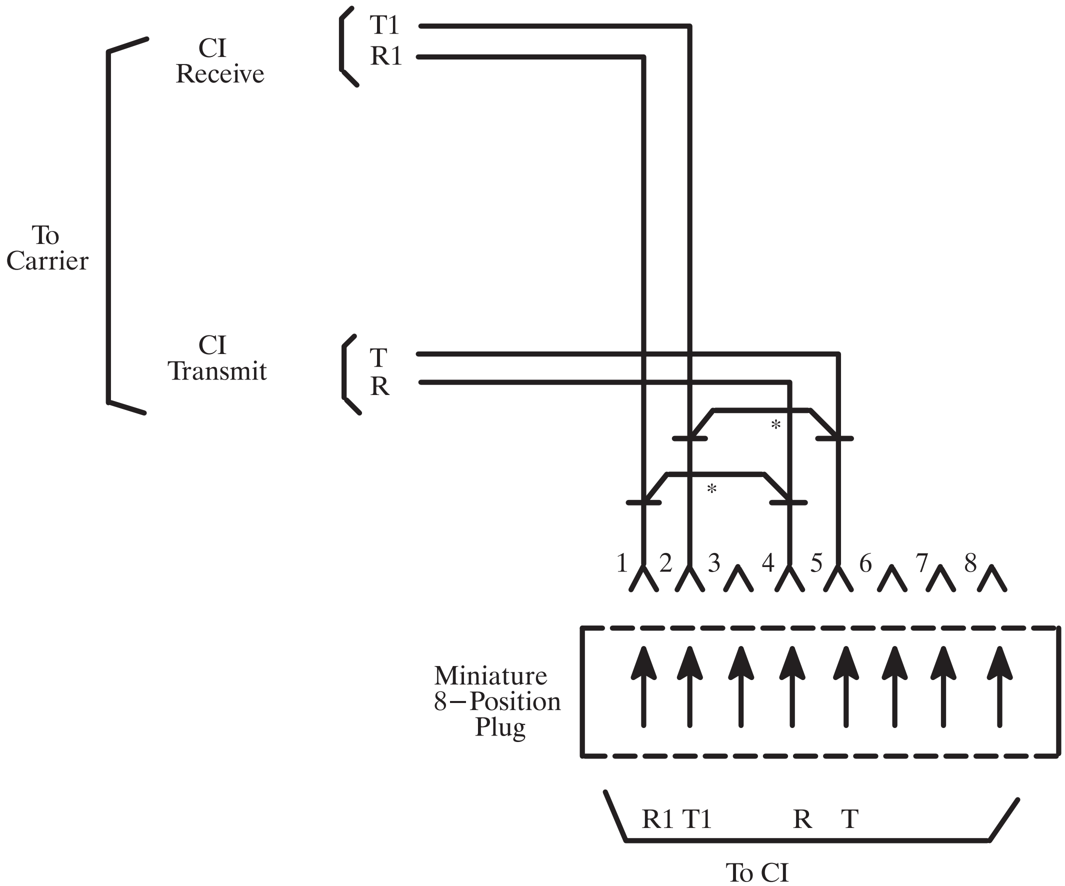
Note: 1 Unit Interval = 648 Nanoseconds

Figure 2 − Isolated Pulse Template and Corner Points



Do not connect cable shield to pins of this connector.

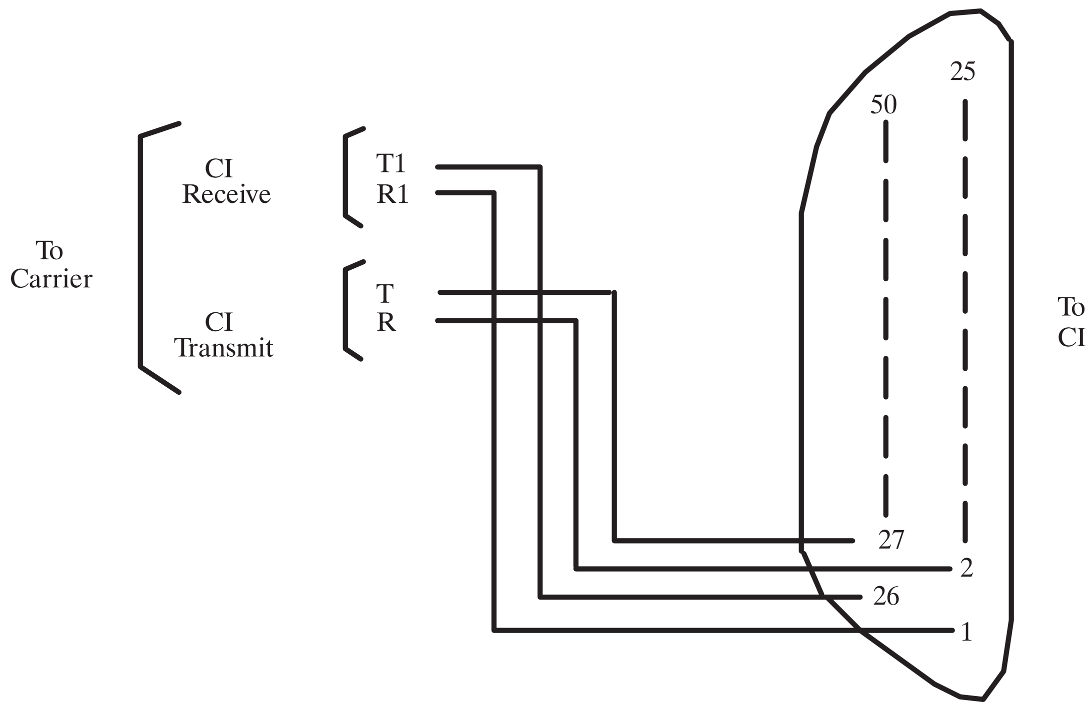
Figure 3 − Connector Pin Assignments (8 Position/RJ48C)



Do not connect cable shield to pins of this connector.

NOTE: *Short removed on insertion of plug.

Figure 4 − Connector Pin Assignments (8 Position/RJ48X)

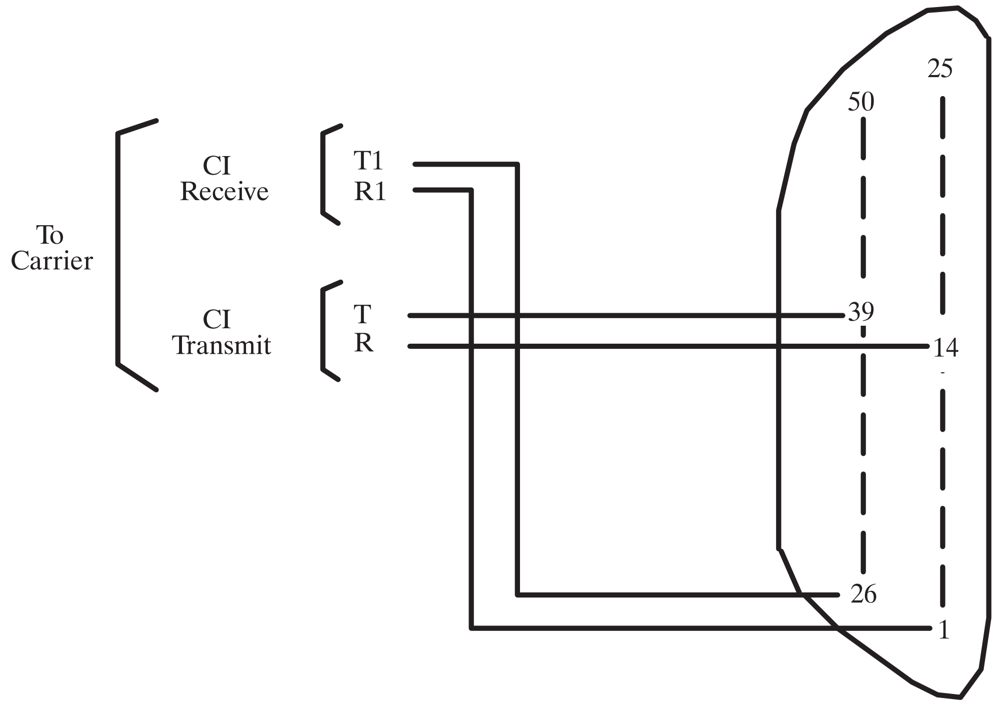


POSITION

LINE	T1	R1	T	R
1	26	1	27	2
2	29	4	30	5
3	32	7	33	8
4	35	10	36	11
5	38	13	39	14
6	41	16	42	17
7	44	19	45	20
8	47	22	48	23

Do not connect cable shield to pins of this connector.

Figure 5 − Connector Pin Assignments (50 Position/RJ48M)



POSITION

LINE	T1	R1	T	R
1	26	1	39	14
2	27	2	40	15
3	28	3	41	16
4	29	4	42	17
5	30	5	43	18
6	31	6	44	19
7	32	7	45	20
8	33	8	46	21
9	34	9	47	22
10	35	10	48	23
11	36	11	49	24
12	37	12	50	25

Do not connect cable shield to pins of this connector.

This is the preferred multi−circuit connector.

Figure 6 − Connector Pin Assignments (50 Position/RJ48H)

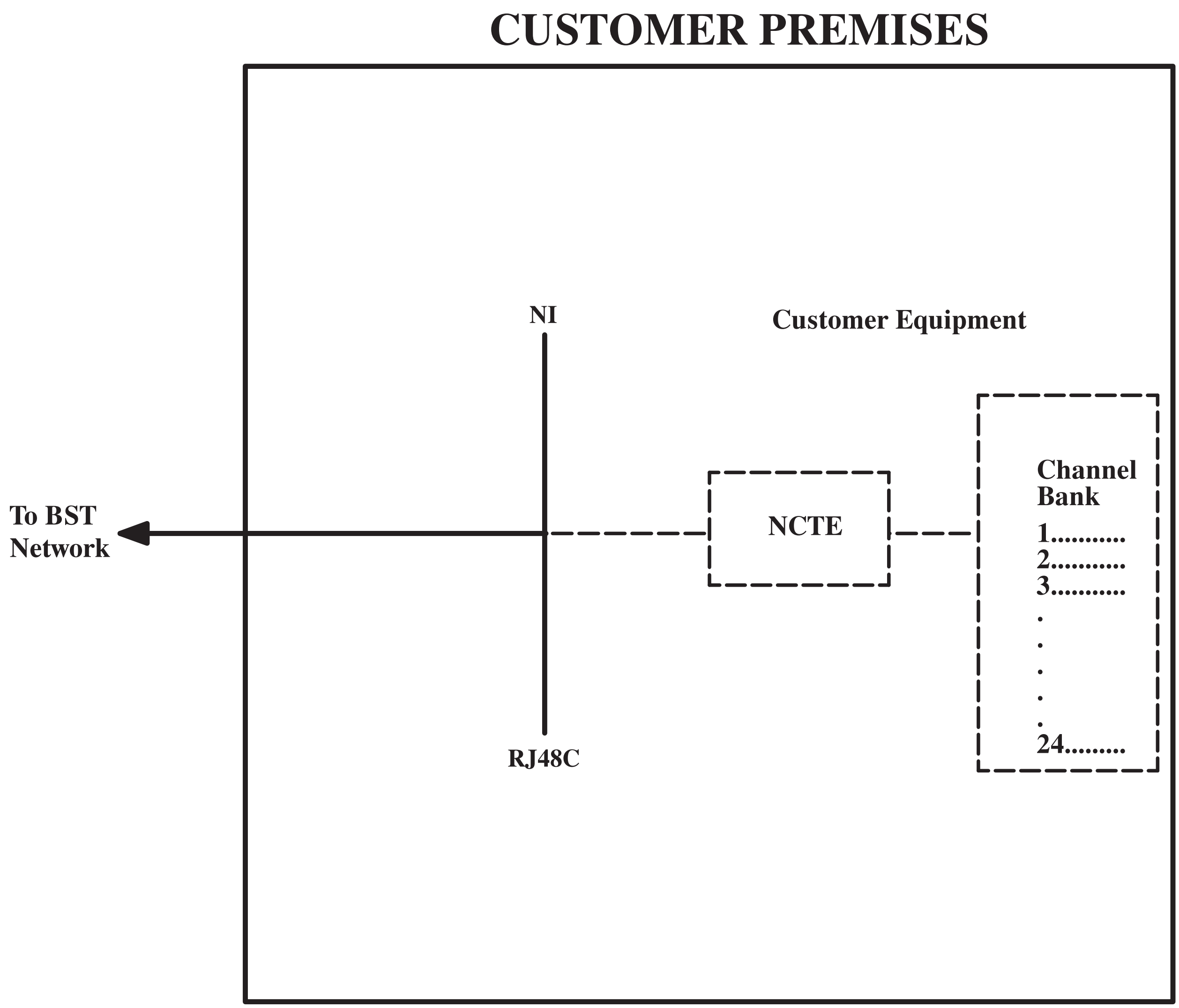
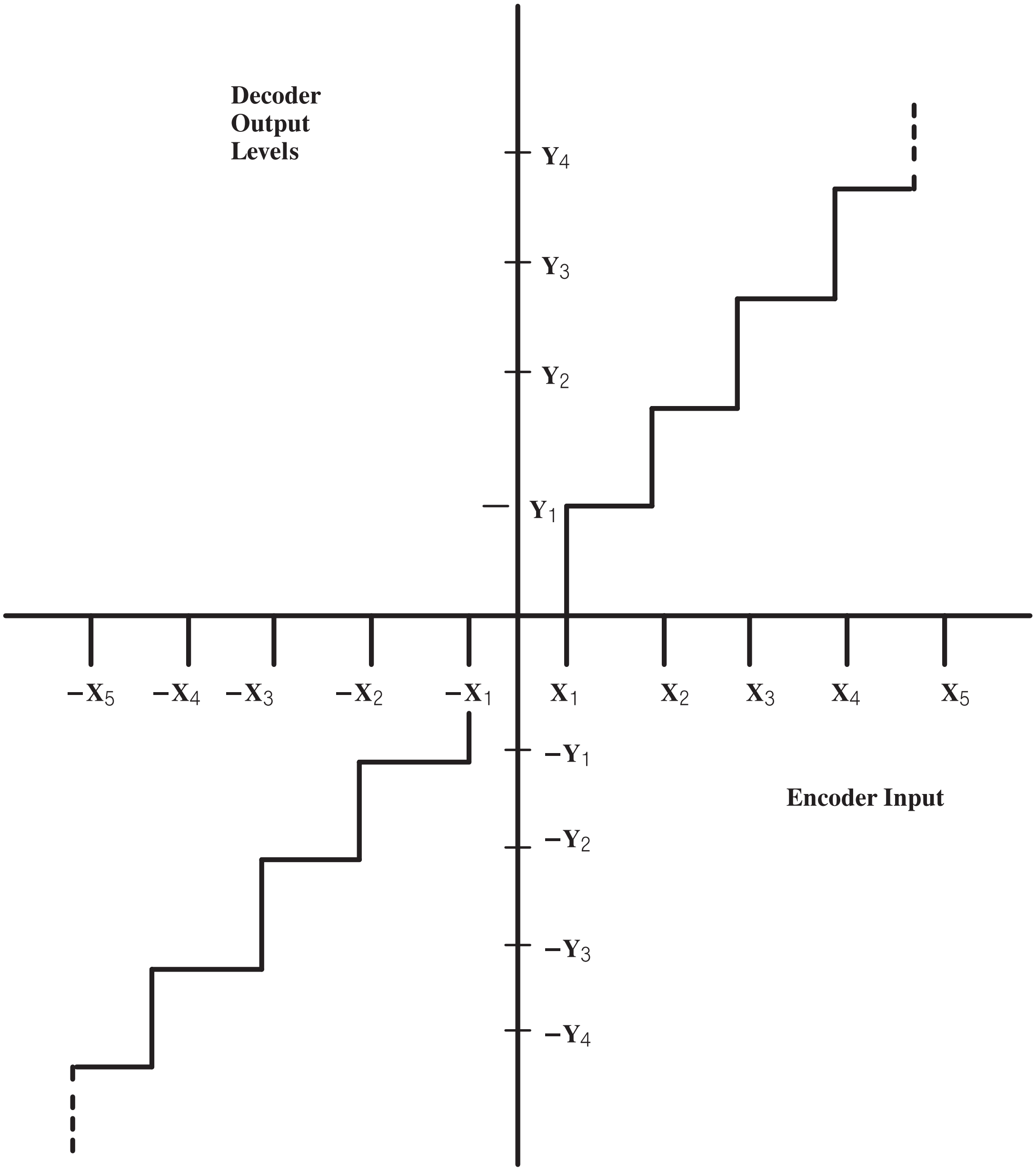


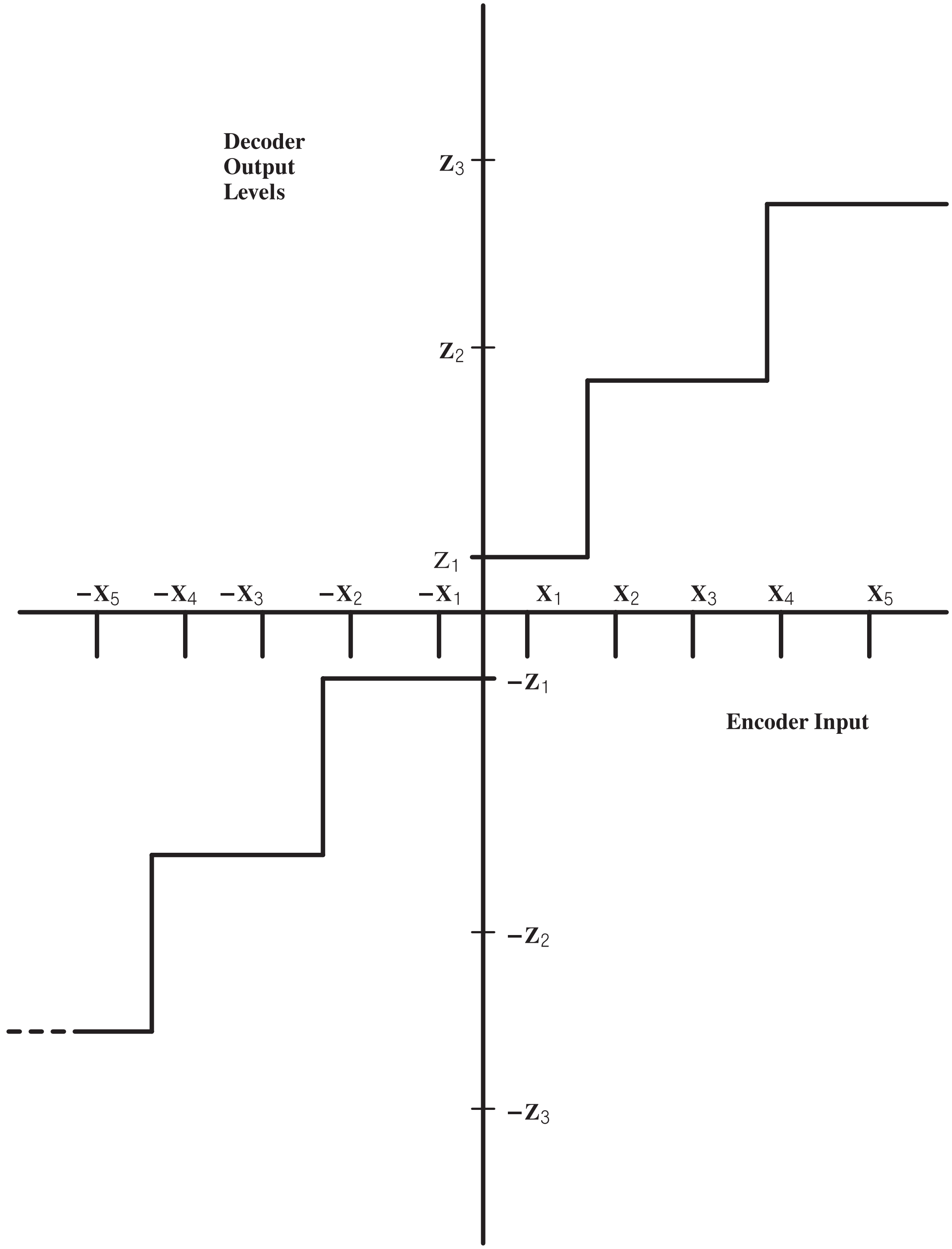
Figure 7 − MCS With Channelization Equipment Provided By Customer



$$Y_0 = X_0 = 0$$

$$Y_n = \frac{X_n + X_{m+1}}{2}, \text{ n} = 1,2,3,...,127$$

Figure 8 − CODEC Transfer Characteristic − Information Frame



$Z_n = X_{2n-1}$; n = 1,2,3,....64

Figure 9 − CODEC Transfer Characteristic − Signaling Frame

LEVEL NUMBER n	LEVEL MAGNITUDE* $\|X_n\|$
0	0
$1 \leq n \leq 16$	$2n - 1$
$17 \leq n \leq 32$	$4n - 33$
$33 \leq n \leq 48$	$8n - 161$
$49 \leq n \leq 64$	$16n - 545$
$65 \leq n \leq 80$	$32n - 1569$
$81 \leq n \leq 96$	$64n - 4129$
$97 \leq n \leq 112$	$128n - 10273$
$113 \leq n \leq 128$	$256n - 24609$

*Normalized to lie in range of 0 to 8159 units

Figure 10 − Code Decision Levels

CODING RANGES	PCM WORDS** 1 2 3 4 5 6 7 8	DECODER LEVELS	
		INFORMATION FRAME	SIGNALING FRAME
X_{127}, X_{128}	1 0 0 0 0 0 0 0	Y_{127}	
X_{126}, X_{127}	1 0 0 0 0 0 0 1	Y_{126}	Z_{64}
...	...*	...	...
X_{n+1}, X_{n+2}	(255−(n−1)) Modulo 2	Y_{n+1}	
X_n, X_{n+1}	(255−n) Modulo 2	Y_n	$Z_{(n+2)/2}$
...	...*	...	...
X_3, X_4	1 1 1 1 1 1 0 0	Y_3	
X_2, X_3	1 1 1 1 1 1 0 1	Y_2	Z_2
X_1, X_2	1 1 1 1 1 1 1 0	Y_1	
X_0, X_1	1 1 1 1 1 1 1 1	Y_0	Z_1
$X_0, -X_1$	0 1 1 1 1 1 1 1	Y_0	
$-X_1, -X_2$	0 1 1 1 1 1 1 0	$-Y_1$	$-Z_1$
$-X_2, -X_3$	0 1 1 1 1 1 0 1	$-Y_2$	
$-X_3, -X_4$	0 1 1 1 1 1 0 0	$-Y_3$	$-Z_2$
...	...*	...	...
$-X_n, -X_{n+1}$	(127−n) Modulo 2	$-Y_n$	
$-X_{n+1}, -X_{n+2}$	(127−(n+1)) Modulo 2	$-Y_{n+1}$	$-Z_{(n+2)/2}$
...	...*	...	...
$-X_{124}, -X_{125}$	0 0 0 0 0 0 1 1	$-Y_{124}$	
$-X_{125}, -X_{126}$	0 0 0 0 0 0 1 0	$-Y_{125}$	$-Z_{63}$
$-X_{126}, -X_{127}$	0 0 0 0 0 0 W_1 1	$-Y_{126}$	
$-X_{127}, -X_{128}$	0 0 0 0 0 0 W_2 0	$-Y_{125}$	$-Z_{64}$ OR $-Z_{63}$

DEFINITION OF W−BITS					
INFORMATION FRAME		SIGNALING FRAME			
W_1	W_2	SIG. BIT	W_1	W_2	DECODER LEVEL
0	1	1	0	0	Z_{64}
		0	1	1	Z_{63}

***Codes Change In Normal Binary Sequence.**
****During Signaling Frame, The Eighth Bit Carries Signaling Information And The PCM Word Consists of Bits 1 to 7.**

Figure 11 − Assignment of Transmitted Codes and Decoded Levels

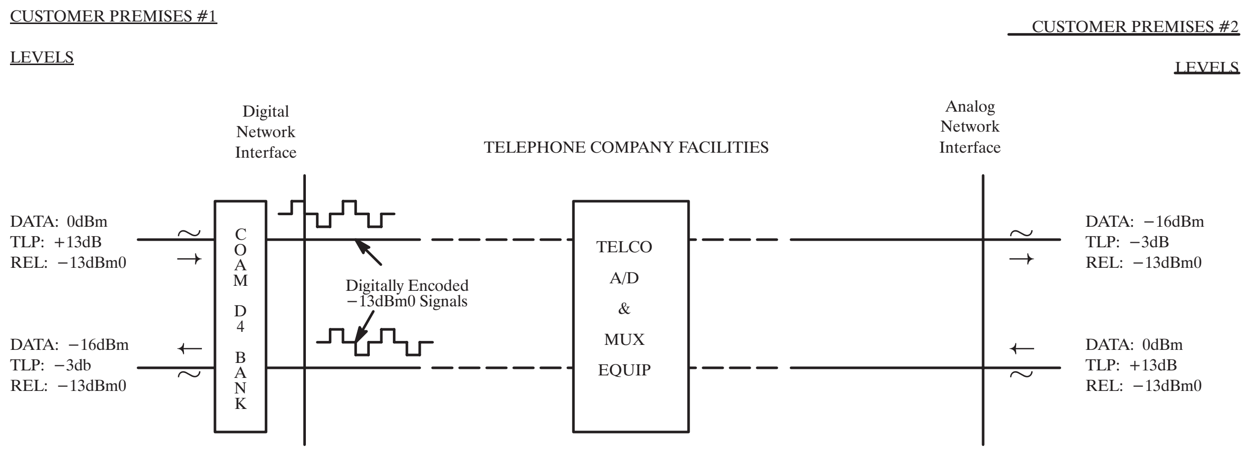


Figure 12 − Analog and Digital Signal Relationships for 4 Wire Private Line Voicegrade Data Channel With Digital Interface at Premises #1 and Analog Interface at Premises #2

Service	Transmit TLP	Receive TLP
Exchange Network Access	0	−4.0
Foreign Exchange Access	0	−4.0
Off Premises Extension		
Station End	0	−4.0
System End	0	−4.0
Tie−Line Like Channels		
TL11E/TL11M/TL12E/TL12M	−2	−(VNL+2)
TL31E/TL31M/TL32E/TL32M	−2	−(VNL+2)
TC31E/TC31M/TC32E/TC32M	−6	−(VNL−2)
Private Line Voicegrade Data Channels		
2−wire interfaces	+13	−3
4−wire interfaces	+13	−3

Figure 13 − Interface Transmission Level Points (TLP's)

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