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SynchroNet® Service
Network Interface Specifications

Technical
Reference

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SYNCHRONET® SERVICE NETWORK INTERFACE SPECIFICATIONS

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SYNCHRONET® SERVICE NETWORK INTERFACE SPECIFICATIONS

1. General

This document describes the Network Interface specifications for SynchroNet®service. SynchroNet service is a dedicated IntraLATA digital service offered by the BellSouth Operating Telephone Companies. SynchroNet service currently provides for the synchronous full−duplex (simultaneous two−way), four−wire, digital transmission of data between customer locations at service speeds of 2.4, 4.8, 9.6, 19.2, 56, and 64 kilobits per second (kbit/s) over non−loaded local loop facilities.

The SynchroNet service architecture consists of one or more Node Central Offices per LATA, linked with digital facilities to each serving wire center in which SynchroNet service is available. The Node Central Office serves as a hub for SynchroNet service testing, the cross−connection of multipoint service, and synchronization. No alternate voice or voice coordination is provided with SynchroNet service.

The Network Interface (NI) specifications are generally the same as those for Dataphone® Digital Service (DDS). The network interface specifications contained in this document are consistent with Bellcore PUB 62310, “Digital Data System Channel Interface Specification” (see Section 9).

This technical reference is being reissued to provide a new Section 6 defining the performance objectives for SynchroNet service.

2. Types of SynchroNet Access

SynchroNet service access is available at six different line rates. The highest line rate available is 64 kbit/s. In addition to 64 kbit/s, 56 kbit/s service is available, as are four “subrate” speeds: 2.4 kbit/s, 4.8 kbit/s, 9.6 kbit/s and 19.2 kbit/s. These six speeds comprise the primary SynchroNet service offerings.

In many areas, SynchroNet service is available with Secondary Channel capability. This capability provides a separate, lower speed data channel in addition to (and in the same circuit as) the primary channel. Multipoint service is also offered in many SynchroNet service locations. Multipoint service allows for the connection of three or more customer stations onto a single circuit. Neither Secondary Channel capability nor multipoint service is available with 64 kbit/s SynchroNet service. Multipoint operation and/or Secondary Channel capability may not be available in all SynchroNet service locations.

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3. Physical Interface Specifications

The NI is located at the customer's (or user's) location. Figure 1 illustrates the typical point–to–point SynchroNet service local loop architecture. A four–wire, non–loaded, direct access (metallic) facility, or its equivalent, is provided from the network. The customer is required to provide network protection, signal recovery, and test access functionality. These are normally included in a device called a Channel Service Unit (CSU). The typical customer equipment configuration also includes Data Service Unit (DSU) functionality, including timing recovery, zero code suppression, and the Data Circuit–Terminating Equipment/Data Terminal Equipment (DCE/DTE) interface.

Network access at the interface is provided by one of two telephone company provided jacks. The first jack is used for single circuit installation, and is a miniature 8–position series jack without a shorting bar, as specified in the Federal Communications Commission (FCC) Code of Federal Regulations (CFR) 47 CFR 68.500 (see Section 8). Part 68, Subpart F, Figures 68.500 (d)(1) and (d)(2(i) illustrate the physical specifications of the jack. This jack is identified as a RJ48S Universal Service Order Code. Only four of the eight pins are connected. The following are the pin assignments for the jack:

Pin Number	Description
1	Transmit Data (R); From Customer to NI
2	Transmit Data (T); From Customer to NI
7	Receive Data (T1); From NI to Customer
8	Receive Data (R1); From NI to Customer

Multiple circuit installations may attain network access through the second jack, a miniature ribbon jack, as specified in FCC 47 CFR 68.500, Subpart F, Figures 68.500 (f)(1), (f)(2), and (f)(3). This jack is identified as a RJ48T Universal Service Order Code.

4. Electrical Requirements

This sections provides the electrical specifications for the NI. These specifications are applicable to both Basic and Secondary Channel SynchroNet service.

4.1 Transmitted Signal Requirements

The requirements in this section are applicable to signals across the NI transmitted from the customer location toward the network. **To insure compatibility, transmit signal specifications other than those addressed in this document are covered in Bellcore PUB 62310 and Bellcore TR–NPL–000157.**

4.1.1 Bit Rates

The signal at the NI for all types of SynchroNet service access is a 50% duty cycle, bipolar, return−to−zero (RZ) signal.

The service rates and the line bit rates (local loop speed) for Basic SynchroNet service are listed below:

Primary Channel Speed	Local Loop Speed
2400 b/s	2400 b/s
4800	4800
9600	9600
19200	19200
56000	56000
64000	72000

The following rates apply for SynchroNet Secondary Channel service:

Primary Channel Speed	Secondary Channel Speed	Local Loop Speed
2400 b/s	133 1/2 b/s	3200 b/s
4800	266 1/3	6400
9600	533 1/3	12800
19200	1066 2/3	25600
56000	2666 2/3	72000

4.1.2 Driving Pulse Amplitude

The transmit section of the CSU should present a 135 ohm source impedance to the network. The network will present an approximate 135 ohm termination. The CSU should generate signals as follows into that system of 135 ohm matching driving and terminating resistances:

Local Loop Rate	Amplitude (0 to Peak)
2.4 kbit/s (and 3.2 kbit/s)	1.66 volts
4.8 (and 6.4)	1.66
9.6 (and 12.8)	8.83
19.2 (and 25.6)	1.66
56.0	1.66
72.0	1.66

4.1.3 Maximum Power Spectral Density

The transmitted signal at the NI must conform to PUB 62310, Section 3. Figure 2 − Figure 6 are plots of the maximum allowable power spectral density of the transmitted signal across the NI (from the customer to the network) for the SynchroNet service access rates. The plots are derived from the signal shaping and filtering requirements in Section 3 of Bellcore PUB 62310.

There are also minimum additional attenuation requirements not shown on the spectral density plots for the local loop rates of 2.4, 4.8, and 9.6 kbit/s (Figure 2, Figure 3 and Figure 4). These requirements are as follows.

Local Loop Rate		Frequency band 24 to 32 kHz	Frequency Band 72 to 80 kHz
2.4 kbit/s	(and 3.2 kbit/s)	5 db	1 db
4.8	(and 6.5)	13	9
9.6	(and 12.8)	17	8

4.1.4 Longitudinal Balance

The customer premises equipment (CPE) must meet the longitudinal balance requirements shown by the mask in Figure 6. This mask conforms to 47 CFR 68.310 (see Section 8) and Bellcore PUB 62310, Section 3.1.8. The longitudinal balance requirements conform to the description in Part 68, Section 68.310(l), and the plot of Figure 68.310(k).

The requirements are applicable to CPE in both the transmitting and receiving ports independent of the terminal state (e.g., transmitting, receiving, quiescent, power off, etc.). The metallic impedance for longitudinal balance measurements must be 135 ohms, plus or minus one percent.

4.2 Received Signal Characteristics

The received signal across the NI (from the network towards the customer location) is generated by a signal driver in the network which meets the requirements of Section 4.1 above. The CPE must provide an approximate 135 ohm impedance to the line from 100 Hz to an upper frequency equal to twice the local loop rate (including the overspeeds attributable to secondary channel).

4.2.1 Loop Loss

The deployment range of SynchroNet service in the local loop is limited by the one−way, two−wire local loop insertion loss. Insertion loss limits are specified for a particular frequency for each local line rate, terminated into 135 ohms. This frequency is one−half the line rate (sometimes referred to as the Nyquist frequency). The insertion loss frequency associated with each of the SynchroNet service local loop speeds is listed in the following table:

Local Loop Rate (kbit/s)		Specified Insertion Loss Frequency (kHz)
2.4		1.2
3.2	(2.4 w/Secondary Channel)	1.6
4.8		2.4
6.4	(4.8 w/Secondary Channel)	3.2
9.6		4.8
12.8	(9.6 w/Secondary Channel)	6.4
19.2		9.6
25.6	(19.2 w/Secondary Channel)	12.8
56.0		28.0
72.0	(64 and 56.0 w/Secondary Channel)	36.0

The maximum allowable SynchroNet service insertion loss for the subrate access rates of 2.4, 4.8, and 9.6 is 34 dB. The maximum allowable insertion loss for the 19.2, 56 and 64 kbit/s access rates is 40 dB.

4.2.2 Isolation From Ground

Both transmit and receive pairs across the NI must be isolated from the local ground reference. Resistance from any lead to ground should exceed 300 kohms. Stray capacitance of any lead should not exceed 500 pF to ground, and the difference between the capacitance to ground of the two leads of any pair should not exceed 100 pF.

4.2.3 Simplex Path

A dc path must be provided on a balanced basis between transmit and receive pairs. The balance, which may be established in terminating resistances or coupling transformers, should be held to a maximum difference of plus or minus 5 percent, in resistance value or self−inductance as appropriate. The simplex termination shall be such that if a dc simplex voltage of either polarity is imposed between the receive pair and the transmit pair, the following current limitations will be satisfied:

(1) For the minimum simplex voltage of 7 volts, the magnitude of the current through the simplex termination will be at least 4 mA.

(2) For the maximum simplex voltage of 28 volts, the simplex current will not exceed 20 mA.

(3) For equal voltage on both wires of a pair, the current difference between the wires of the pair will not exceed 1 mA.

The presence of simplex current between 4 to 20 mA is ensured by a source in the network. Temporary absence of the current should not affect loop transmission. This dc path is necessary to provide sealing current for the loop, and provide a signaling path for the mandatory channel loopback discussed in Section 6[1].

4.2.4 Background Noise

CPE must be able to accommodate the maximum amount of local loop background noise shown in the table below, as measured through a 50 kb/sec (40 Hz − 30 kHz) weighting network and 135 ohm impedance. The maximum background noise levels apply to both basic SynchroNet service and Secondary Channel service for the bit rates indicated in the table, except for 64 kbit/s service (for which Secondary Channel Capability is not available).

Bit Rate (kbit/s)	Maximum Background Noise Level (dBrn)
2.4	48
4.8	45
9.6	37
19.2	35
56.0	34
64.0	34

1. BellSouth background noise tests are made on the T1 and R1 pairs at the NI, with the T and R pairs terminated with a 135 ohm resistor.

4.2.5 Impulse Noise

CPE must be able to accommodate impulse noise levels shown in the table below. This table indicates the local loop testing limits for impulse noise. The 50 kbit/s weighted noise threshold for the SynchroNet service bit rates are shown in the table. No more than seven impulse events can occur during a 15 minute test at the impulse noise threshold associated with a particular bit rate. Following any crossing of the threshold, additional crossings are ignored for a 200 ms period. The impulse noise thresholds apply to both basic SynchroNet service and Secondary Channel service for the bit rates indicated in the table, except for 64 kbit/s service (for which Secondary Channel Capability is not available). The BellSouth test configuration for impulse noise is the same as that described for background noise testing in Section 4.2.4 above.

Bit Rate (kbit/s)	Maximum Background Noise Level (dBrn)
2.4	65
4.8	61
9.6	53
19.2	52
56.0	50
64.0	50

4.2.6 Bridged Tap Limits

The local loop facility used to deliver Synchronet service is non−loaded, and has maximum acceptable bridged tap lengths. CPE is required to accommodate these maximum bridged tap lengths.

The maximum acceptable cumulative bridged tap for the 2.4, 4.8, 9.6 and 19.2 bit/s bit rates (including Secondary Channel service) is 6000 feet. The maximum single tap length for these speeds is also 6000 feet.

The maximum acceptable cumulative bridged tap for 56 kbit/s, 56 kbit/s with Secondary Channel and 64 kbit/s is 1000 feet, with a maximum single tap length for these speeds of 750 feet. However, if the facility meets the BellSouth Carrier Serving Area (CSA) guidelines, the maximum cumulative bridged tap for these three speeds is 2500 feet, with a maximum single tap of 2000 feet. Information regarding CSA design is contained in Chapter 7 of SR−TSV−002275, “BOC Notes on the LEC Networks − 1990” (see Section 9).

There are no restrictions concerning the location of bridged taps on a facility.

5. Signal Format

5.1 Bipolar Format

Both Basic SynchroNet service access and SynchroNet service Secondary Channel access utilize the bipolar, RZ signal in the local loop, described in PUB 62310, Section 3. A binary 1 is transmitted as either a positive or negative pulse, opposite in polarity to the previous 1. A binary 0 is transmitted as zero volts.

5.1.1 Basic Service Format

Except for 64 kbit/s access, the local loop line rate for Basic SynchroNet service is exactly the same as the customer data rate. The local loop signal for 4800 bps basic access is, for example, a 4800 bps unstructured signal. Unlike Secondary Channel access and 64 kbit/s access described in Sections 5.1.2 below and 5.1.3, respectively, there are no overhead bits for byte alignment, network codes, etc. For Basic SynchroNet service access, bipolar violations should not occur in the transport of customer data in the network. However, intentional bipolar violations are used to pass certain network codes across the NI. These network codes are described in Section 7.1.

5.1.2 Secondary Channel Capability

The local loop line rate for Secondary Channel capability is higher than that of the customer data rate. The signal is formatted in 8−bit bytes containing six primary channel data (D) bits for subrate data channels, or nine bit bytes containing seven D−bits for 56 kbit/s primary channel data (See Figure 1). Each byte contains one F−bit, and a C′−bit.

The F−bits are used for framing, so that the customer primary data bytes and secondary channel bytes can be identified in the local loop signal. The framing bit structure consists of the following repeated F−bit pattern:

101100...

This framing pattern does not propagate throughout the network, but is inserted and removed at the end office such that it occurs only in the local loop.

The C′ bit stream is comprised of C−bits, allocated for network use (not used for customer data), and B−bits, which are the modulated Secondary Channel customer data bits. The C bit stream sequence is:

C C B C C B C C B...

Since every third bit C−bit is replaced by a B−bit, the Secondary Channel rate is one−third the C′ bit stream rate.

5.1.3 64 kbps Format

The local loop format for 64 kbit/s SynchroNet service is similar to that of 56 kbit/s with Secondary Channel capability. The local loop line rate is 72 kbit/s, composed of a nine−bit byte structure transmitted at a rate of 8000 bytes per second. The nine−bit byte consists of eight customer data bits (D bits) and one local loop framing (F) bit. The same framing bit structure used for 56 kbit/s with Secondary Channel is used for 64 kbit/s. The framing bit pattern is the repeated sequence of:

101100....

The F−bits do not propagate throughout the network, but only appear in the local loop.

Whereas the C’ sequence used for 56 kbit/s with Secondary Channel capability is a shared sequence containing both customer and network information (contains both B and C bits as described in Section 5.1.2), the C’ sequence is eliminated and replaced with an eighth customer data (D) bit for 64 kbit/s service. The bit structure for 64 kbit/s service is shown in Figure 1.

5.2 Coding Rules

5.2.1 Basic Access Coding Rules

Bipolar violations are used to transmit control information and for zero suppression across the NI, for both point–to–point and multipoint Basic SynchroNet service access.

5.2.1.1 Point–To–Point Operation

Unrestricted insertion of bipolar violations of the same polarity could generate an undesirable dc component on the facility. The bipolar violation scheme used for SynchroNet service was designed to avoid this situation by alternating the polarity of the bipolar violations. This scheme utilizes the "X0V" pattern, where:

0	=	a zero level pulse
B	=	a "one" pulse with normal polarity, under the bipolar (polarity alternation) rule
X	=	a system–determined pulse with normal polarity, or zero, which forces the number of pulses (B's) between violations to be odd.
V	=	a "one" pulse with a polarity that is a violation of the normal bipolar rule

At the customer location, there are two transmitting sequences and five receiving sequences across the NI which contain bipolar violations:

(a) **Transmitting Sequences Containing Bipolar Violations**

(1) Idle Sequence – The Idle sequence consists of one or more repetitions of the sequence BBBX0V for the subrate speeds, or BBBBX0V for 56 kbit/s. This sequence may be used as a supervisory signal. For example, it could indicate that the terminal does not have data to transmit. If the customer uses the sequence for supervision, he should realize that the transmission delay through the network will not necessarily be the same for the Idle sequence as for data. The transition from data to Idle adds a number of pulses between the last data bit and the first pulse of the Idle sequence. The transition from Idle to data will replace the same number of the initial data bits with the bits of the Idle sequence. The additional delay for Idle sequences will be less than six bits at the subrates, and less than seven bits at 56 kbit/s.

(2) Zero Suppression – At the subrates, any sequence of six consecutive zeros must be encoded as 000X0V; at 56 kbit/s, any sequence of seven consecutive 0's must be encoded as 0000X0V. It should be realized that for both directions of transmission, a Zero Suppression sequence may not be received when one was transmitted.

(b) **Receiving Sequences Containing Bipolar Violations**

(1) Idle Sequence − Same as the transmitting Idle Sequence described above.

(2) Zero Suppression Sequence − The reception of 000X0V for any speed must be decoded as six 0's.

(3) Out−of−Service Sequence − This sequence is an indication of trouble in the network. It consists of one or more repetitions of the sequence 00BX0V at the subrates, or 000BX0V at 56 kbit/s.

(4) Out−of−Frame Sequence − This sequence is an indication of trouble in the network. It consists of one or more repetitions of the sequence 0BBX0V at the subrates, or 00BBX0V at 56 kbit/s.

(5) Loopback Sequence − This sequence requests the loopback of the received signal onto the transmit circuit. It consists of three successive repetitions of the sequence 0B0X0V at the subrates, or 00B0X0V at 56 kbit/s. This is the non−latching DSU channel loopback request code.

5.2.1.2 Multipoint Operation

Multipoint Basic SynchroNet service allows the connection of three or more customer stations onto a single SynchroNet circuit. One station is designated as the control (master) station. The Node Central Office serves as the hub location at which the outlying stations are cross−connected to the control station (see Figure 7).

Multipoint basic SynchroNet service is provided in the same manner as for DDS multipoint service. This is described below and in Bellcore PUB 62310. All stations in a multipoint circuit must operate at the same rate. Communication always takes place between the control station and the outlying stations. No communication between outlying stations is possible, except through the control station. The customer is responsible for the insertion and detection of addressing information, and for information flow control in SynchroNet service multipoint configurations.

Multipoint service is provided through active devices, known as Multipoint Junction Units (MJU's)*, located in telephone company central offices. Logic in the MJUs located at the telephone central offices allows two different polling disciplines. Properly utilized, a MJU can block erroneous bits (impulse noise misread by the receivers as valid bits) received from branches that are not in use, so that the performance quality for data transmitted from each remote station to the control station can be about as high as that for point−to−point service. Therefore, the customer should consider the manner in which a MJU combines data from its branches into a single data stream for transmission to the control station. When all stations have permanent Request to Send with idle stations in a MARK hold condition (transmitting continuous 1's), performance is described in paragraph (1) below. When idle stations turn OFF their Request to Send (transmitting the idle sequence BBBBX0V), performance is described in paragraph (2) following.

* This term is used generically to describe a functionality, and is applicable to any hardware or software performing the MJU function.

(1) Data bits received by a MJU from its branches are combined, such that a SPACE (0) bit is transmitted toward the control station whenever a SPACE (0) bit is received by the MJU from any one or more of its branches. If all branches transmit MARK (1) bits to the MJU, then the MJU transmits MARK (1) bits toward the control station. Thus, if one remote station transmits data (0 and 1 bits), and all of the other remote stations transmit only MARK (1) bits, only the data from the one active remote station is transmitted to the control station. With this arrangement, however, all bit errors received by a MJU from branches not carrying the data would be combined with the data, thus degrading the performance quality for all data received at the control station.

(2) Many errors of the type described in paragraph (1) above will be blocked by protective circuits in the MJUs if each remote station not transmitting data to the control station is held in the idle mode. This is accomplished by transmitting the idle sequence from the station. If one remote station transmits data, and all other remote stations remain in the idle mode, the data will be transmitted through the MJUs to the control station. Thus, to minimize the number of errors in the data received at the control station, it is recommended that each remote station be held in the idle mode, except while it is transmitting data to the control station.

When all of the remote stations on a multipoint circuit are in the idle mode, the idle sequence is transmitted to the control station.

5.2.2 Secondary Channel Capability Coding Rules

Secondary Channel Capability provides an additional, lower speed channel to the customer on the same circuit as the primary SynchroNet 56 kbit/s or subrate channel. Secondary Channel Capability is possible for both point–to–point and multipoint circuits. The additional bandwidth required for Secondary Channel Capability is provided in the local loop by use of a higher line rate between the customer and the serving wire center. The higher line rate in the local loop is such that a portion of the additional bandwidth is allocated for customer use as a secondary data channel, and the rest is reserved for network use. Secondary channel capability is not available for 64 kbit/s service

The network control codes used in Basic SynchroNet service are provided in–band by use of bipolar violation codes and line polarity reversals. Secondary Channel Capability does not utilize the bipolar violation technique to pass network control codes across the NI. For Secondary Channel Capability, network control codes are provided by specific byte codes with the C–bit in the C′ bit stream set to 0, polarity reversals, and (optionally) in–band latching loopback sequences. The increased line rate required for Secondary Channel Capability and the use of different network control codes require that a special DSU/CSU be used for this type of SynchroNet service access. There are also restrictions on the number of consecutive zeros that can be transmitted by the customer on a 56 kbit/s SynchroNet service circuit with Secondary Channel Capability.

SynchroNet service Secondary Channel Capability network interface requirements conform to Bellcore TR–NPL–000157, “Secondary Channel in the Digital Data System: Channel Interface Requirements” (see Section 9).

5.2.2.1 Point–To–Point Operation

When transmitting customer data, the C–bit must be set to 1. Setting the C–bit to 0 when transmitting customer data will result in interfering network interactions and unsatisfactory transmission. When no primary channel data is being transmitted, the customer station may set the C–bit to 0 to transmit the Control Mode Idle (CMI) sequence, which is 111111F0 at the subrate speeds and 1111111F0 at 56 kbit/s.

A customer station is defined to be in the data mode when the C–bit is set to 1, and in the control mode when the C–bit is set to 0. A station must remain in the data mode for a minimum of four bytes to conform with network operation requirements.

At the subrate speeds, there is no restriction on the content of the D–bits for point–to–point operation. Transmission on 56 kbit/s point–to–point circuits is subject to coding restriction B (below):

Coding restriction B:

> A station cannot transmit binary 0s in all seven D–bits while transmitting a C′=0 bit within the same byte.

The rationale for coding restrictions B is to ensure that an all–zeros byte does not arise in the network, because it may be overwritten by the Unassigned Multiplex Code (UMC) code, corrupting the customer data.

Secondary channel information is transmitted through the network on the B–bit (encoded secondary channel information) in the C′ bit stream. Every third C–bit is replaced with a B–bit to form the C bit stream.

5.2.2.2 Multipoint Secondary Channel Capability Coding

The coding for Secondary Channel multipoint access is the same as Secondary Channel point–to–point service, except as listed in this section. Transmission of the primary channel and secondary channel are independent of each other, in that a remote station may communicate with the control station on the primary channel while another remote station is communicating with the control station on the Secondary Channel.

Transmission of the repetitive sequence of CMI code is required for proper operation upstream on multipoint circuits for stations that are inactive on the primary channel. There is no restriction on the content of the D–bits for the subrate speeds. However, coding restriction A (below) must be implemented when the 56 kbit/s multipoint configuration is used.

Coding restriction A

> A station cannot transmit binary zeros in all seven D–bits of a byte.

Upstream on multipoint circuits, the C bit stream must be structured in the format:

$$C_1\ C_2\ B\ C_1\ C_2\ \ldots \qquad , \text{where } C1 = C2$$

The secondary channel information (SC–bit) is encoded, by performing a logical exclusive NOR with the preceding (C2) bit, as:

B = SC XNOR C2, and can be decoded as: SC = B XNOR C2.

Thus, a SC = 0 bit causes a C−bit transition, and a SC = 1 bit does not cause a C−bit transition.

Only one remote station can be active on the upstream secondary channel at any time. Two or more remote stations attempting to transmit on the upstream secondary channel will result in collisions in the network and unsatisfactory transmission. The nonzero differential delay between the primary and secondary channel upstream on a multipoint circuit should be taken into account in polling procedures on the secondary channel.

Secondary channel messages in the upstream channel on a multipoint circuit shall consist of a training sequence, the secondary channel information, and an idle sequence. Upon going active, the remote station transmits six SC = 0 bits (i.e., six B−bits that are C−bit transitions. To deactivate the upstream secondary channel, the remote station transmits 12 SC = 1 bits (12 B−bits that are not C−bit transitions). It therefore follows that the secondary channel data cannot contain more than 11 consecutive SC = 1 bits.

The control station will always receive the complete training sequence, and may receive a longer sequence of C−bit transitions. The training sequence will include one of the following four training patterns, which allows the control station to synchronize on the B−bit in the C bit stream:

PATTERN	C1	C2	B	C1	C2	B
#1	0	0	1	0	0	1
#2	0	0	1	1	1	0
#3	1	1	0	1	1	0
#4	1	1	0	0	0	1

Pattern #4 is not a valid framing pattern when transmitting the two initial SC=0 bits of the six SC = 0 bit string which is needed to seize the secondary channel in the upstream direction from the remote station to the control station.

Further information regarding Secondary Channel multipoint operation can be found in Bellcore TR−NPL−000157, “Secondary Channel in the Digital Data System: Channel Interface Requirements”, and in Bellcore TA−TSY−000192, “Digital Data System (DDS) Multipoint Junction Unit (MJU) Requirements” (see Section 9).

5.2.3 64 kbit/s Coding Rules

Neither Secondary Channel capability, nor multipoint service is available with 64 kbit/s SynchroNet Service. However, SynchroNet service 64 kbit/s access utilizes the network coding rules described for Secondary Channel capability in Section 5.2.2, except the Coding Restriction B does not apply for 64 kbit/s service. The deployment of 64 kbit/s−compatible network equipment, including 64 kbit/s office channel units and clear channel capability equipment, allows the transmission of all−zeros bytes.

For 64 kbit/s service, the customer’s CSU/DSU should not perform zero code suppression, and should not respond to the non−latching DSU loopback code. It is desirable for the CSU/DSU to respond to the latching loopback code sequence described in Section 7.3.2.

6. Performance

The performance of SynchroNet service is specified in terms of three parameters, errored seconds, percent error−free seconds and severely errored seconds.

> An errored second (ES) is defined as a one−second interval during which one or more bit errors has occurred.
>
> Percent Error−Free Seconds (%EFS) is defined as the ratio, expressed as a percentage, of seconds without the occurrence of a bit error to the total number of in−service seconds.
>
> A severely errored second (SES) is defined as a one−second interval during which the bit error rate was worse than 1×10^{-3}.

SynchroNet service, under normal conditions, will perform at an average level equal to or greater than 99.8 %EFS; which is equivalent to an average level equal to or less than 173 ES per day. Additionally, SynchroNet service, under normal conditions, will perform at an average level equal to or less than 17 SES per day.

7. Maintenance

7.1 Mandatory Channel Loopback

The customer equipment must respond to the mandatory channel loopback test signal, when received across the NI. This loopback test signal consists of a reversal of the local cable simplex dc polarity. In the normal polarity, the line driver pair (T1, R1) is kept positive with respect to the line receiver pair (T, R). Reversal of this polarity must be sensed in the simplex CPE termination to control the channel loopback. The sensing circuit must respond to the minimum 4 mA current described in Section 4.2.2. To accomplish this channel loopback, the station apparatus must perform full equalization and filtering of the received signal. The loopback path should return this signal to the line driving circuitry of the transmitter for shaping consistent with the requirements of Section 4.1. CPE response to this loopback signal is necessary to provide for remote testing and speed the isolation of trouble conditions between the telephone company and the CPE.

7.2 Basic SynchroNet Service Codes

The two transmitting sequences and five receiving sequences described in Section 5.2.1.1, utilizing bipolar violations, are used to pass network control information across the NI.

7.3 Secondary Channel Capability Maintenance Codes

7.3.1 Network Codes

Under conditions of network failure, the network will generate one of the following repeated byte sequences to the customer:

TYPE	SUBRATE CODE	56 KB/S
Abnormal Station Code (ASC)	S01111F0	X001111F0
Unassigned Multiplex Code (UMC)	S01100F0	X001100F0
All Zeros	S00000F0	X000000F0
Multiplexer Out Of Sync (OOS)	S01101F0	X001101F0
Idle Code	S11111F0	X111111F0
Non−latching DSU Loopback	S10110F1	X010110F0

Where: F is the Frame bit
X = 1 or 0
S = 1 or 0

The ASC code indicates a failure in the user's equipment or in equipment between the NI and the end office Office Channel Unit (OCU) in the direction of transmission toward the telephone company office. It will occur on total loss of signal or loss of framing at that office. Reception of this signal can also indicate removal of the user equipment at the far end of the circuit.

One of these repeated byte sequences will be received by a remote station on a multipoint circuit, or a station on a two−point circuit. The repeated byte sequence will also be received by a control station on a multipoint circuit if the trouble occurs between the serving SynchroNet office and the office containing the first MJU in the downstream path. The nature of this repeated byte sequence should be included in the trouble report to the telephone company.

A MJU will block this repeated byte sequence from propagating upstream to the control station on a multipoint circuit. Under these circumstances, the control station will not be able to communicate with a subset of the remote stations. The customer should identify this subset of remote stations in the trouble report to the telephone company.

7.3.2 Secondary Channel Loopback Codes

An optional DSU latching loopback sequence may be available in some areas. This sequence is described below, and allows a customer's DSU to respond through a remote test to speed trouble isolation. The DSU loopback sequence is the same as that described in Bellcore TA−TSY−000077, "Digital Channel Banks − Requirements For Dataport Channel Unit Functions", Section 5.1.3 (see Section 9). This loopback sequence causes the loopback condition to occur and to remain in operation until the correct loopback release code sequence has been detected. The optional loopback sequence is as follows:

The test center will send the following sequence of control codes to effect a latching loopback. The maximum values listed may be exceeded in cases of manual testing.

(1) Minimum of 35 (maximum of 40) Transition in Progress (TIP) bytes (S011101F0).

(2) Minimum of 35 (maximum of 40) Loopback Select Code (LSC) bytes (SDDDDDDF1). For the optional DSU loopback, SDDDDDDF1 equals S111011F1.

(3) Minimum of 100 (maximum of 120) Loopback Enable (LBE) bytes (S101011F0).

(4) Minimum of 32 Far End Voice (FEV) bytes (S101101F0). The test center will continue to send FEV bytes until approximately two seconds have elapsed. It is recommended that the loopback be initiated after no more than 40 bytes.

Where:

- F is 1 or 0, as described in Section 5.1.2, and
- S = 0 for 56 kbit/s (and 64 kbit/s basic SynchroNet service), but is not present for the sub-rate access rates.

The optional DSU loopback is latching, and will remain operational until the test center transmits a minimum of 35 TIP (maximum of 40) bytes.

7.3.3 64 kbit/s Maintenance Codes

The CPE must respond to the mandatory simplex polarity reversal channel loopback code described in Section 7.1. It is desirable for the CPE to respond to the optional latching loopback sequence described in Section 7.3.2.

The format of the signal transmitted between telephone company central offices differs from that in the local loop for SynchroNet service. The interoffice (and intraoffice) signal is composed of eight−bit bytes. In the case of all other basic SynchroNet service rates the eighth bit is set to 0 to indicate a network code byte, and set to 1 to a indicate customer data byte. Similarly, with Secondary Channel capability for rates other than 64 kbit/s, the C bit of the C' bit scheme is set to 0 as an indication of it being a network code byte, and a 1 for customer data bytes. However, the eighth bit of a SynchroNet service 64 kbit/s byte in the interoffice network is customer data, and therefore cannot be used to determine whether the byte is a network code or a customer data byte.

It is therefore possible with 64 kbit/s service to have customer data transmitted in the interoffice network that appears to be one of the legitimate network codes specified in Section 7.3.1. The transmittal of these network codes by customer equipment is undesirable, but unavoidable for unrestricted customer data transmission. The transmission of any of the network code bytes by a customer as part of normal data should not cause the network significant problems. However, the transmission of repetitive patterns of any of these network code bytes by the customer complicates network maintenance and operations procedures, and may adversely impact service restoral and availability. The customer and CPE shall therefore avoid using any of the network code bytes listed in Section 7.3.1 in a manner that would allow transmission of repetitive patterns of these bytes across the network interface (e.g., customer idle codes, "keep−alive" signals, etc.).

The CPE used for 64 kbit/s SynchroNet service should not perform zero code suppression. The CPE should respond to the CSU loopback and to the DSU latching loopback sequence described in Section 7.2.2. The CPE should not respond to the non–latching DSU loopback code described in Section 5.2.2.1. If the CSU/DSU implements an idle code transmission state, the all ones code (1111111F1) should be used.

7.4 Synchronization

SynchroNet service is a synchronous digital service, and requires that the customer–transmitted signals across the NI be synchronized in frequency with the network. It is recommended that the customer equipment be loop–timed (slaved) to the incoming bit stream from the network to achieve this frequency synchronization.

The SynchroNet service network complies with Bellcore TA–NPL–000436, "Digital Synchronization Network Plan", and ANSI T1.101 – 1986, "Synchronization Standards For Digital Networks" (see Section 9).

8. Synchronet Service Access to Derived Data Channel Service

8.1 Description of Service

Derived Data Channel Service (DDCS) is a BellSouth service which provides the customer a two–wire simultaneous voice and data access to the network. The network interface specifications for the two–wire access to DDCS is described in BellSouth TR 73548, "Derived Channel Access Service Digital Data Over Voice Network Interface Specification".

Up to 20 two–wire DDCS data circuits can be multiplexed into one DS0B signal within the network. This section describes the network interface specifications for SynchroNet service access to this DS0B network signal (see Figure 9).

Access to the DDCS DS0B signal requires a 64 kbit/s SynchroNet service facility. There are additional requirements at the network interface for this access. Also, the performance objectives that apply to SynchroNet service circuits are not extended to the DDCS facility.

8.2 Signal Specifications

The DS0B signal is a standard DDS signal used within the network. It is a 64 kbit/s signal comprised of several multiplexed subrate circuits. The DS0B signal can contain one of the following:

Up to twenty 2.4 kbit/s circuits
Up to ten 4.8 kbit/s circuits
Up to five 9.6 kbit/s circuits
Two 19.2 kbit/s circuits

The mixing of different types of subrates within an individual DS0B is not permitted. Currently, only the multiplexing of 2.4 kbit/s DCAS service is offered.

The specifications for a standard DS0B signal is contained in ANSI T1.107b–1991 (see Section 9).

8.2.1 DS0B Structure

The DS0B signal comprises eight−bit bytes transmitted at 8000 times per second. The format is as follows:

```
S D D D D D D C S D D D D D D C ..... S D D D D D D C
└── byte 1 ───┘ └── byte 2 ───┘       └── byte n ───┘
```

Where:
D = Customer data bit
S = DS0B subrate framing pattern bit
n = 5 for 9.6 kbit/s
10 for 4.8 kbit/s
20 for 2.4 kbit/s
C = 1 for customer data
= 0 for network codes and idle code (S1111110)

The subrate framing bit (S−bit) patterns for 2.4, 4.8 and 9.6 kbit/s are:

SUBRATE	S−BIT PATTERN
9.6 kbit/s	01100
4.8	0110010100
2.4	01100101001110000100

8.3 Special Requirements for DDCS Access

The signal passed across the Network Interface must have a format and structure such that it conforms to DS0B specifications at the DS0−level crossconnect point in the network. The circuit used for DDCS access must be a SynchroNet service 64 kbit/s circuit, with additional requirements beyond those of the normal SynchroNet 64 kbit/s circuit.

The SynchroNet service DDCS access must conform to the physical, electrical, signal format, and maintenance requirements for 64 kbit/s point−to−point service described in Sections 2 through 6 of this document. The local loop signal for 64 kbit/s consists of a nine−bit byte, comprising eight customer data bits and one F bit (see Section 5.1.3). The F bit is only used in the local loop, and for normal 64 kbit/s access, its placement by the network OCU and customer equipment is arbitrary.

For 64 kbit/s access to DDCS, the bit structure of the customer data bits in the signal across the interface must conform to the DS0B bit structure described in Section 8.2.1 and TA−TSY−000280. Further, the F bits transmitted by the CPE across the network interface must be byte aligned with the eight−bit DS0B bit structure. That is, the DS0B bytes must be transmitted as discrete units with the F bit inserted in bit position 8 of each 9−bit local loop 64 kbit/s byte (S D D D D D D F 1 or S 1 1 1 1 1 1 F 0). This is required to maintain DS0B subrate byte alignment within the network.

The local loop signal across the network interface from the network towards the customer will contain an F−bit in bit position 8 of the 9−bit byte. However, there is no correlation between the beginning of the F−bit pattern and any particular subrate channel within the DS0B signal, since the F−bit pattern is arbitrarily inserted in the signal by the OCU at the end office.

9. Related Documents

The following are documents referenced in this reference:

PUB 62310	"Digital Data System Channel Interface Specification", Bellcore[1].
SR−TSV−002275	"BOC Notes on the LEC Networks−1990", Bellcore.[1]
TA−TSY−000077	"Digital Channel Banks − Requirements For Dataport Channel Unit Functions", Bellcore[1].
TR−NPL−000157	"Secondary Channel in the Digital Data System: Channel Interface Requirements", Bellcore[1].
TA−TSY−000192	"Digital Data System (DDS) Multipoint Junction Unit (MJU) Requirements", Bellcore[1].
TA−TSY−000280	"Digital Cross−Connect System (DCS) Requirements and Objectives for the Sub−Rate Data Cross−Connect (SRDC) Feature", Bellcore[1].
TA−NPL−000436	"Digital Synchronization Network Plan", Bellcore[1].
T1.101 − 1986	"Synchronization Standards For Digital Networks", ANSI[2].
T1.107b−1991	"Digital Hierarchy − Supplement to Formats Specifications (Synchronous Digital Data Format)"[2].
47 CFR 68	"Code of Federal Regulations, Title 47, Parts 40 to 69, Revised as of October 1, 1987", Office of the Federal Register, National Archives and Records Administration[3].

Footnotes

1. This document can be ordered through Bell Communications Research (Bellcore), Customer Service, 60 New England Avenue, Piscataway, NJ, 08854−4196. Telephone orders can be made by calling 1−800−521−CORE, or (201) 699−5800. Pricing and availability information is also available at this number.

2. This document can be ordered through the American National Standards Institute, Inc., (ANSI), 1430 Broadway, New York, NY, 10018, telephone (212) 642−4900.

3. This document is available through the Superintendent of Documents, Government Printing Office, Washington, D.C., 20402, telephone (202) 783−3238.

Appendix

This appendix contains the recommended SynchroNet service customer DSU option settings. It is intended to serve only as a guide to the customer for setting DSU options to be compatible with the network. The recommended customer options are not the only options compatible with SynchroNet service in all cases.

The appendix is not intended as an all−inclusive listing of options for any make of DSU, or to insure compatibility with the far−end customer−owned DSU. The recommended option settings are:

500A operation (assumes no external CSU)

DDS−type DSU operation

Slave timing (from receiver clock) for transmitter

Request−to−send (CA) operation is synthesized continuously by DSU

Data set ready (CC) operates normally during no signal or out−of−service code reception

Data set ready (CC) is forced on during line loopback test mode

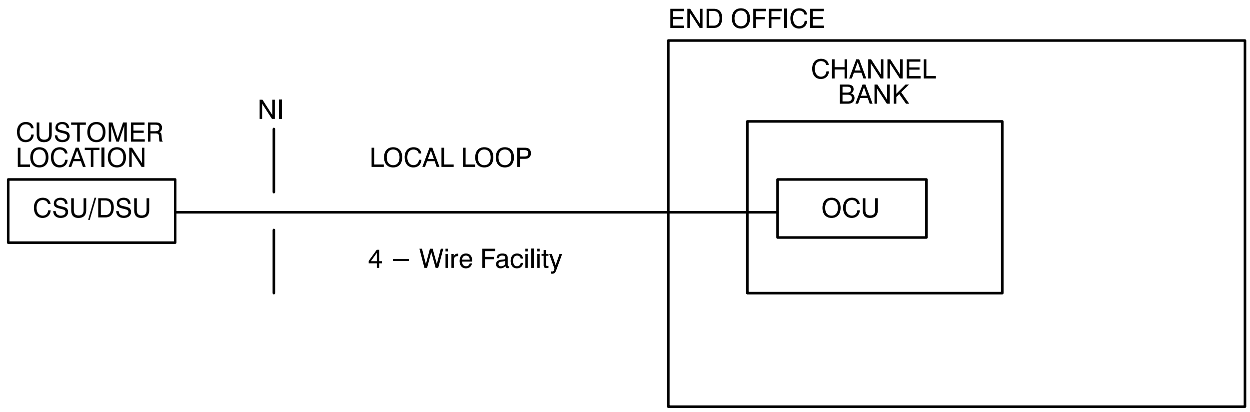
511−bit self−test pattern

Bilateral digital loopback

Enable remote digital loopback test

The above list does not include some customer−specific options that have no effect on network interoperation, and may include options not found on all DSUs.

BASIC SYNCHRONET SERVICE



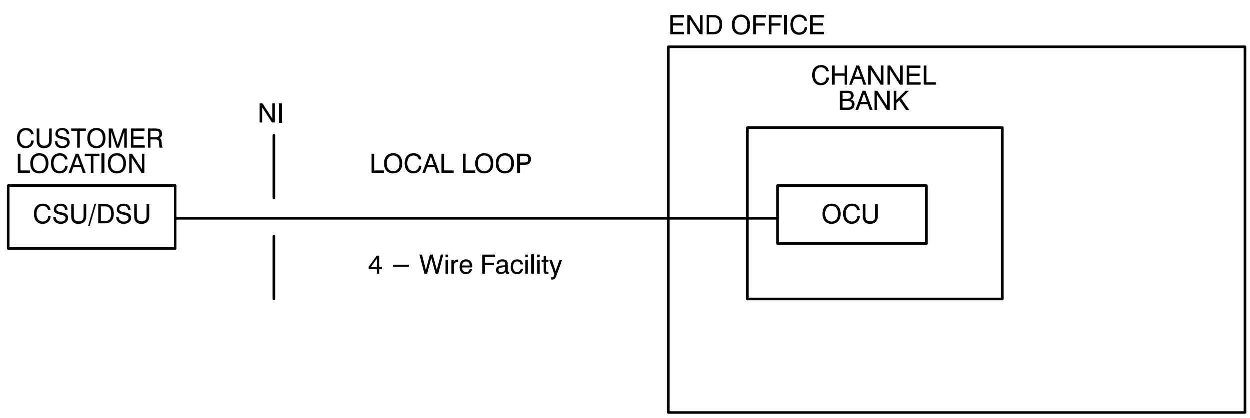
Coding of Signal in Local Loop (Both Directions):

Subrate Speeds: $D_1 D_2 D_3 D_4 D_5\ D_6$ ...

56 kbit/s: $D_1 D_2 D_3 D_4 D_5 D_6\ D_7$ ...

64 kbit/s: $D_1 D_2 D_3 D_4 D_5 D_6 D_7 F_1\ D_8$ ...

SECONDARY CHANNEL CAPABILITY



Coding of Signal in Local Loop (Both Directions):

Subrate Speeds: $D_1 D_2 D_3 D_4 D_5 D_6 F_1 C'$

56 kbit/s: $D_1 D_2 D_3 D_4 D_5 D_6 D_7 F_1 C'$

Figure 1 – Typical Synchronet Service Point–To–Point Configuration

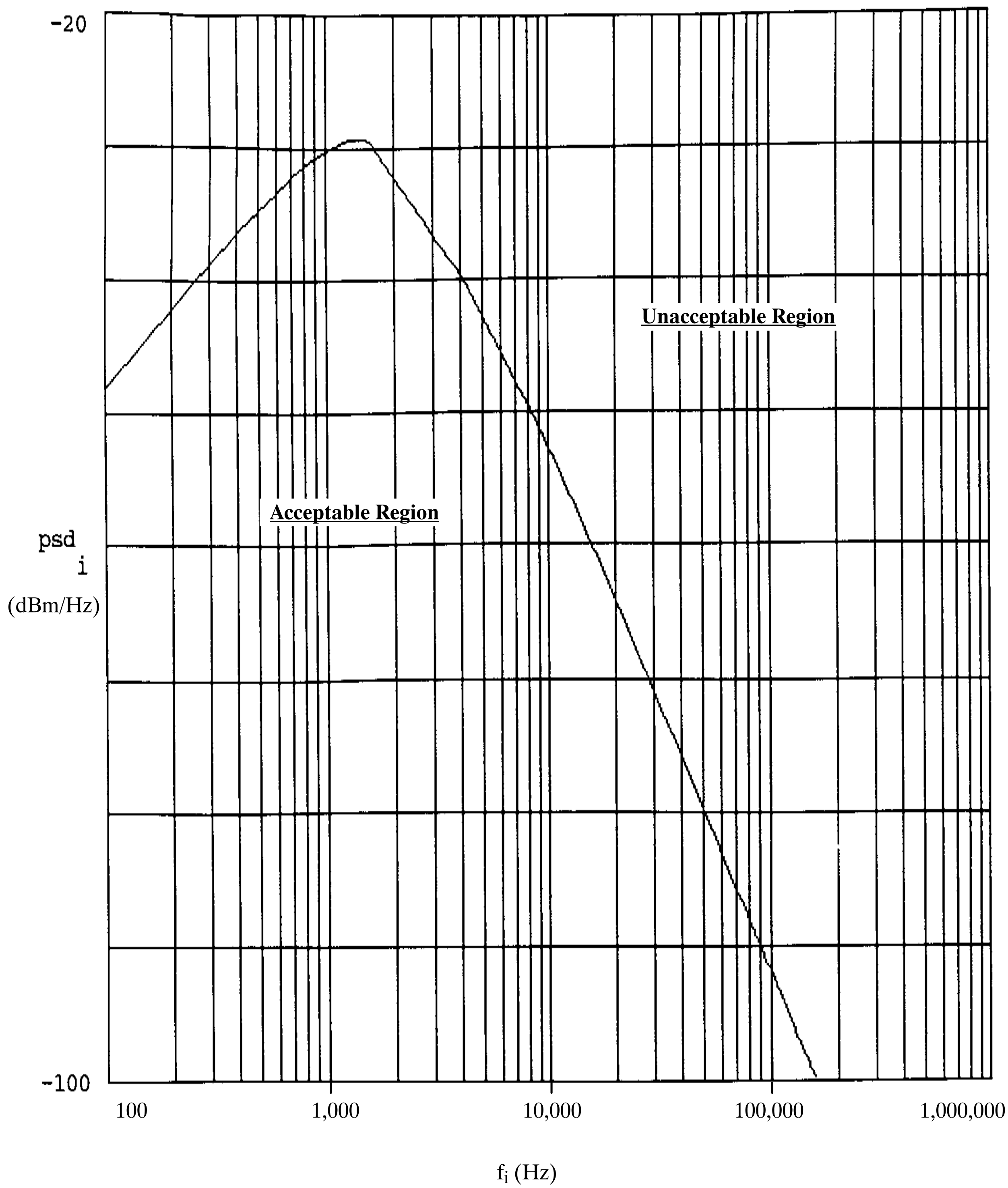


**Figure 2 − Transmit Signal Power Spectral Density Template −
2.4 kbit/s Secondary Channel (3.2 kbit/s) Rate**

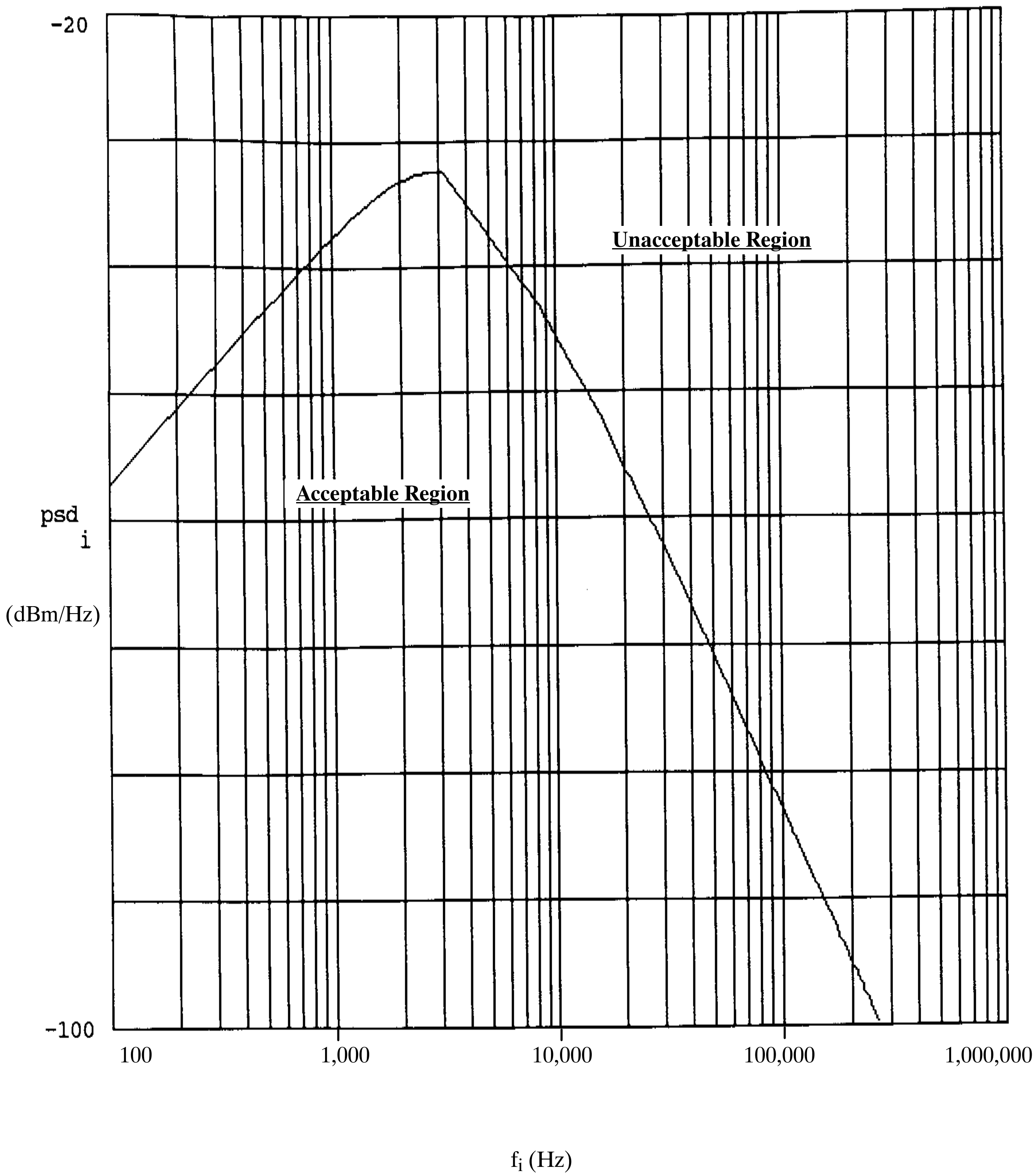


Figure 3 − Transmit Signal Power Spectral Density Template − 4.8 kbit/s Secondary Channel (6.4 kbit/s) Rate

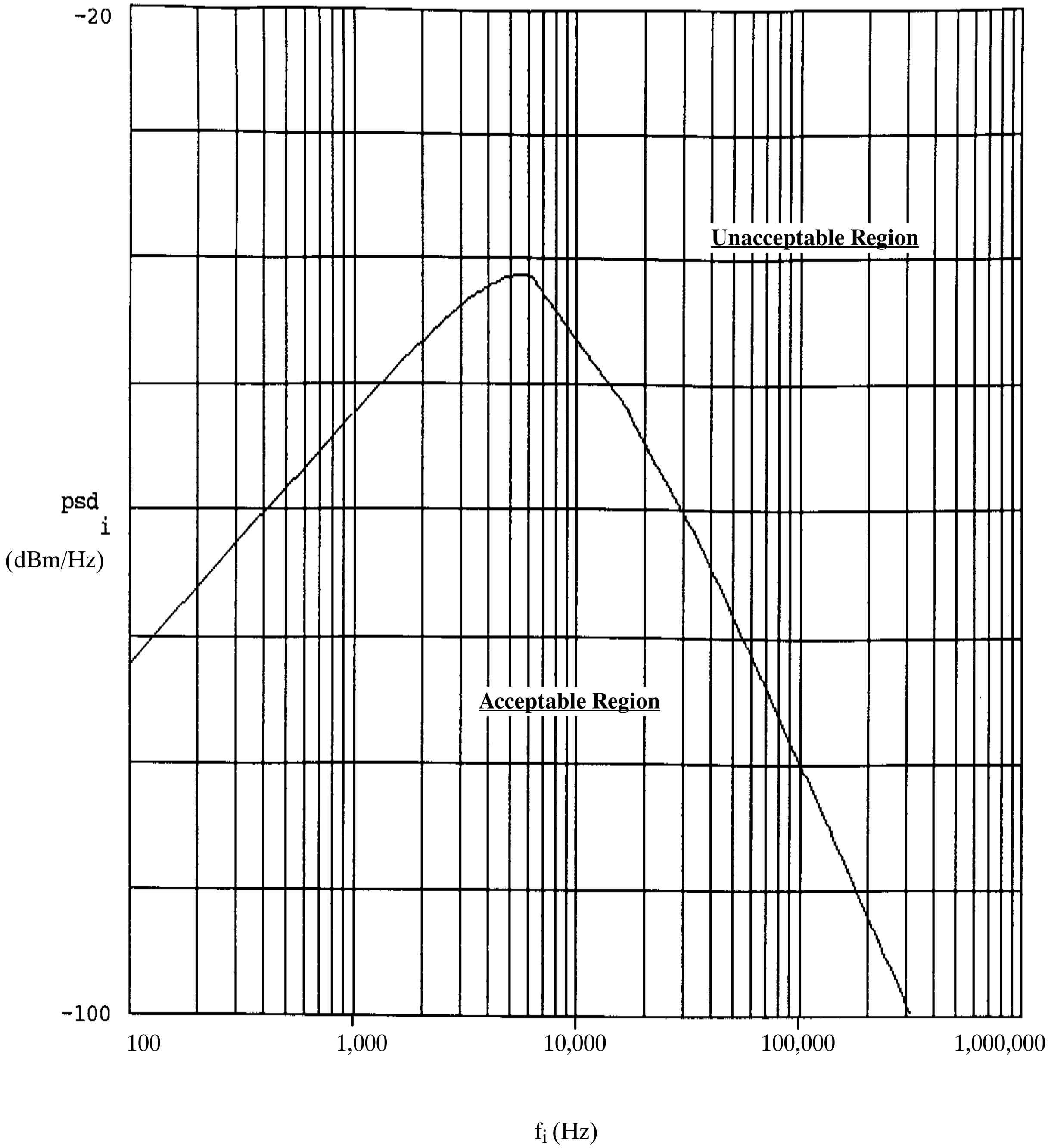


Figure 4 − Transmit Signal Power Spectral Density Template − 9.6 kbit/s Secondary Channel (12.8 kbit/s) Rate

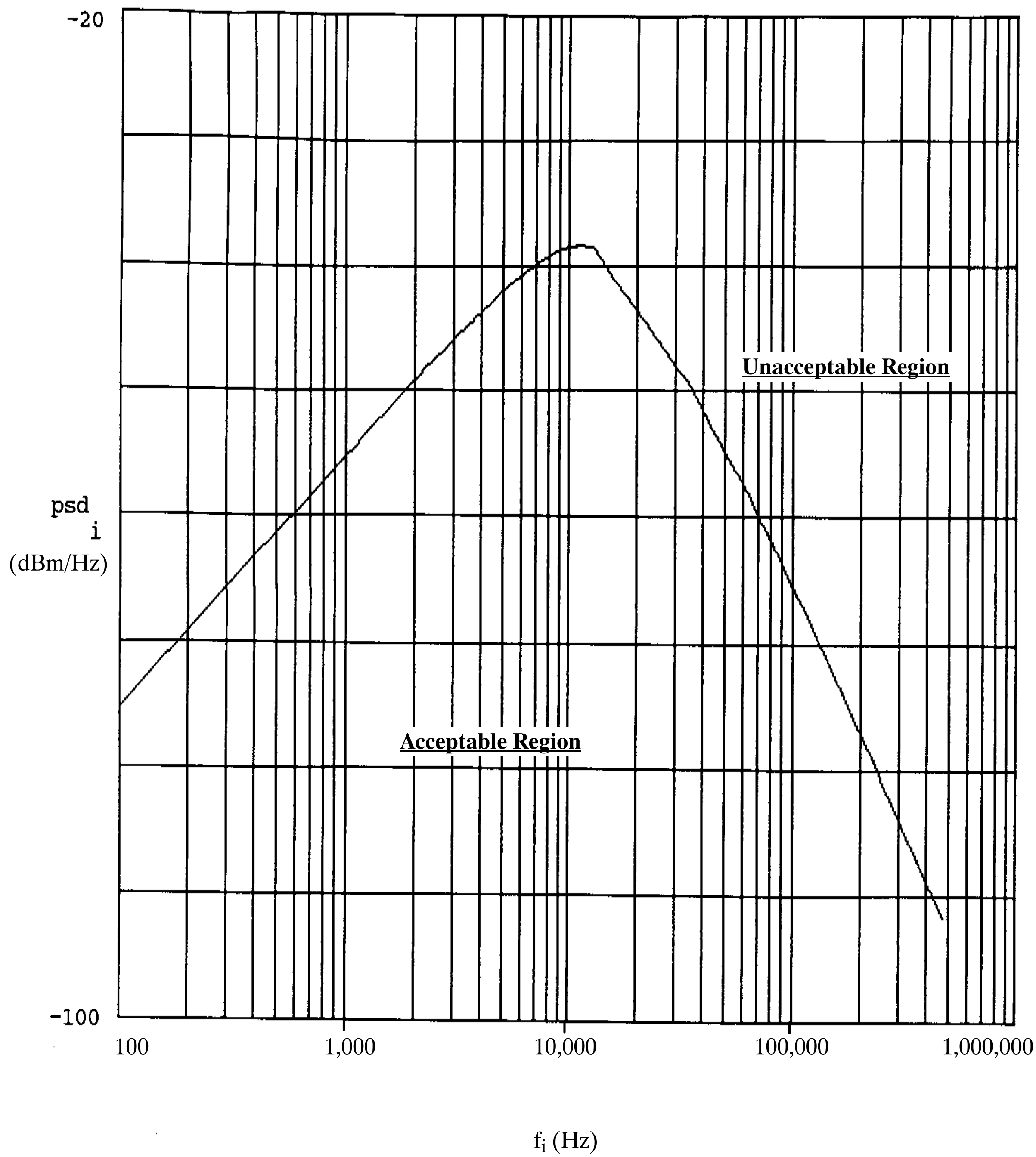


**Figure 5 − Transmit Signal Power Spectral Density Plot −
19.2 kbit/s Secondary Channel (25.6 kbit/s) Rate**

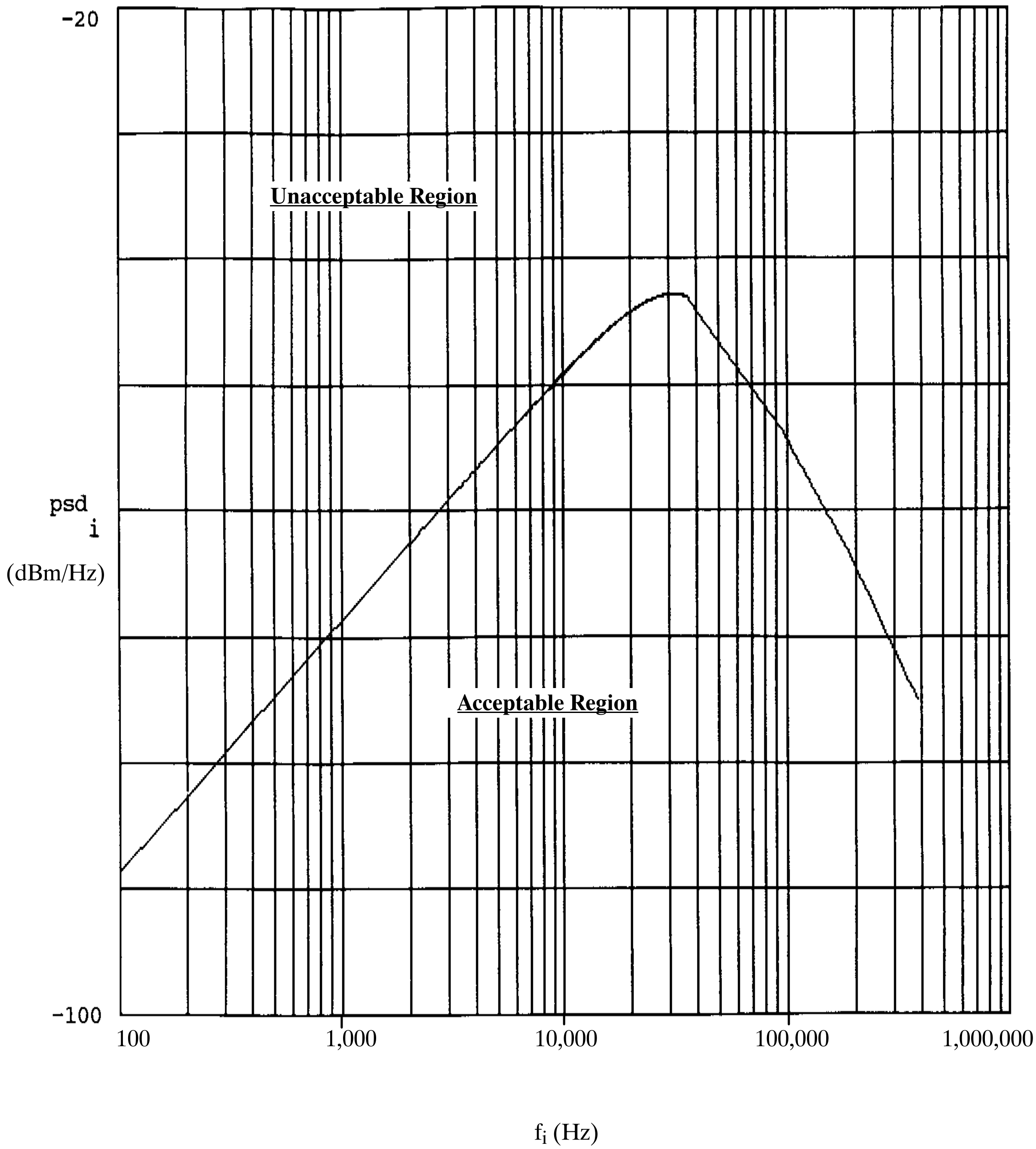


Figure 6 − Transmit Signal Power Spectral Density Template − 56.0 kbit/s Secondary Channel (72.0 kbit/s) Rate

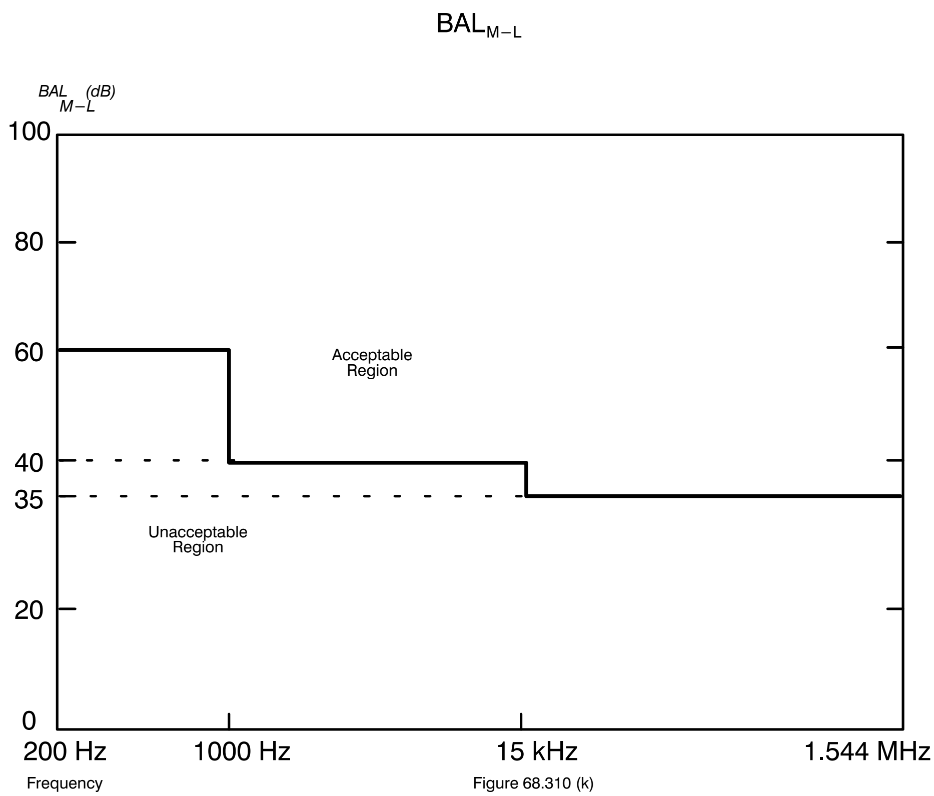


Figure 7 − Longitudinal Balance Requirement

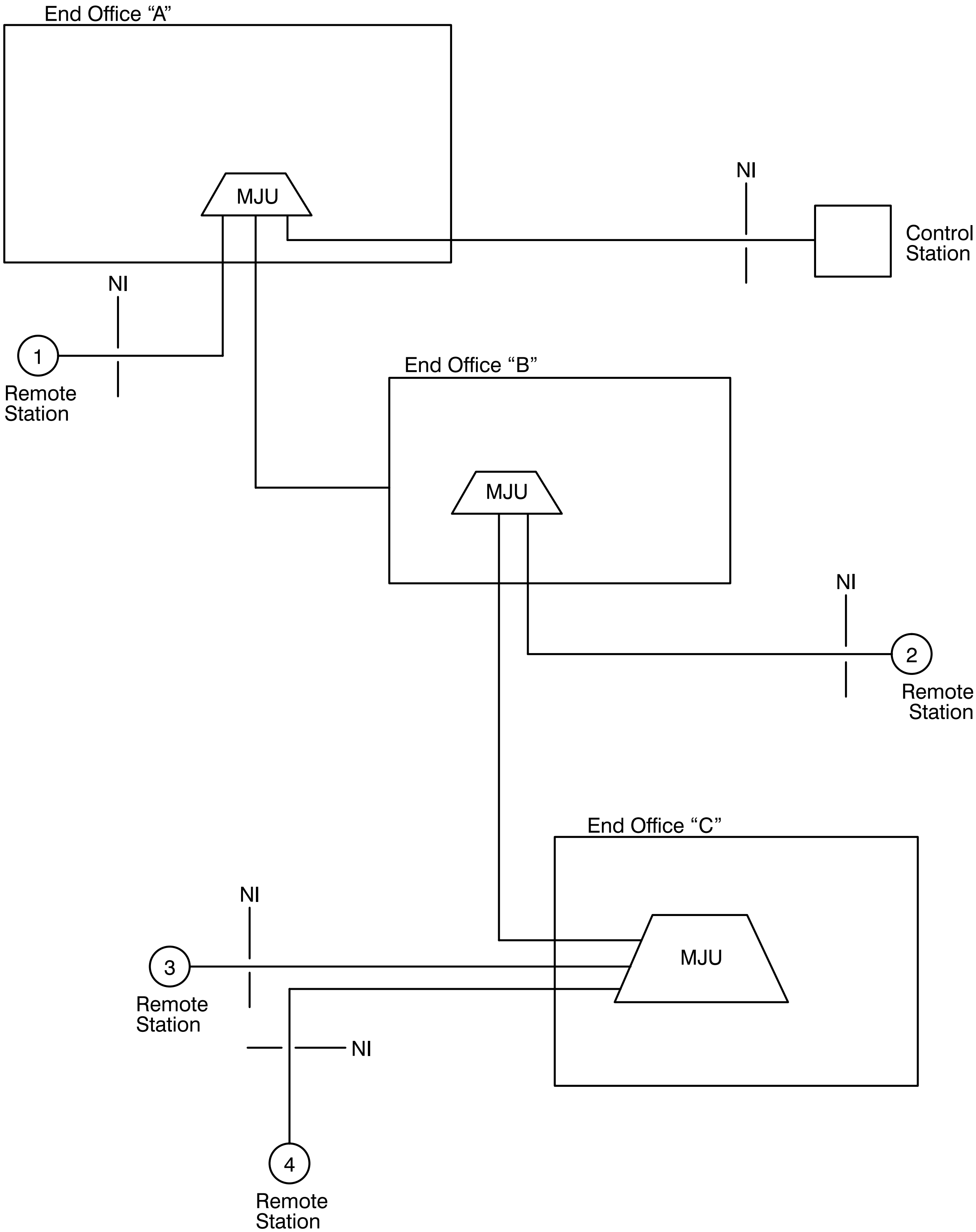


Figure 8 − Multipoint Configuration Example

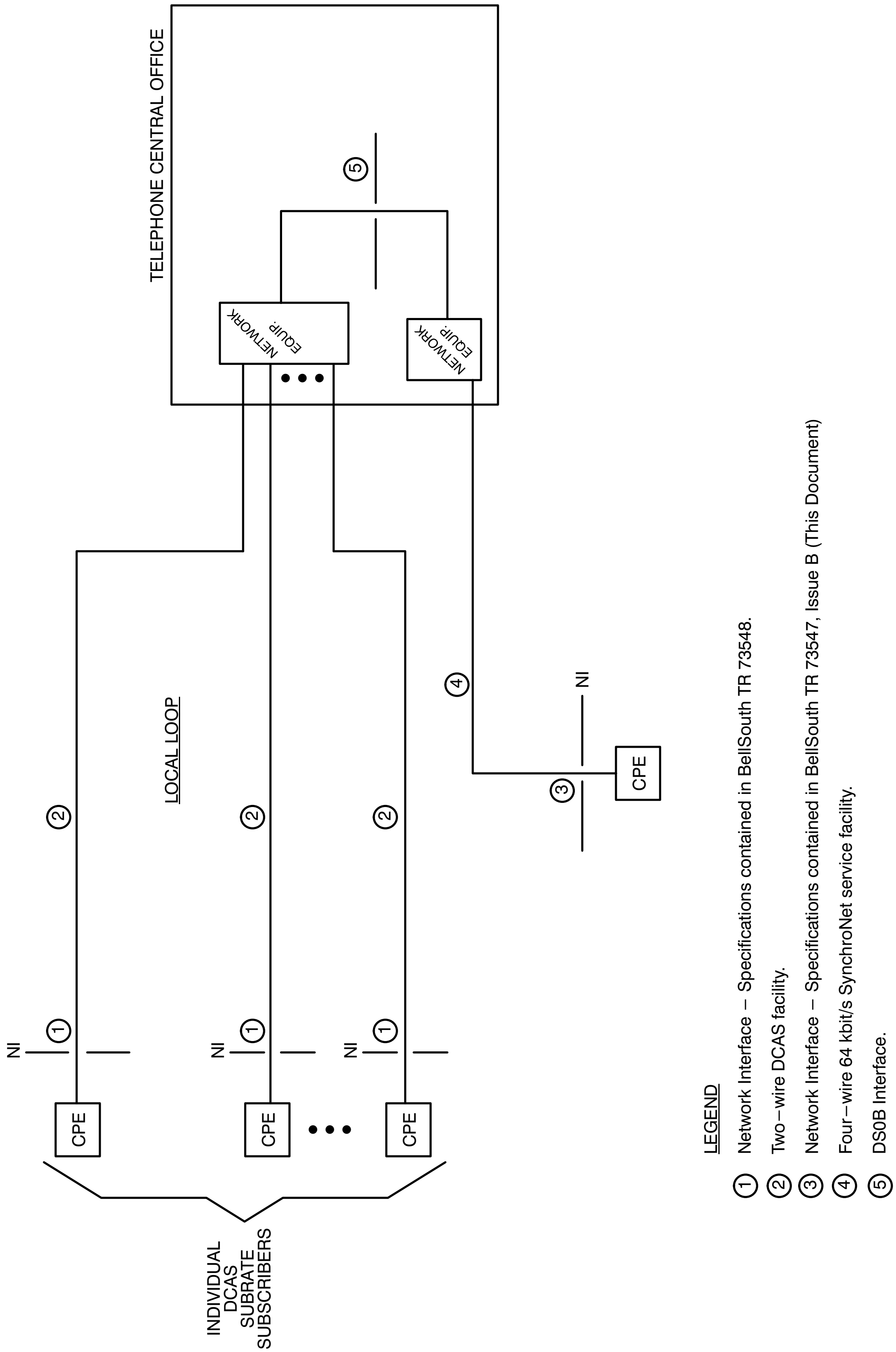


Figure 9 − Illustration of Synchronet Service Access to Network DS0B Signal