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VOICEBAND LOCAL ACCESS AND TRANSPORT AREA SPECIAL ACCESS CHANNELS PRESERVICE TRANSMISSION TEST REQUIREMENTS AND LIMITS

Prepared by the Information Management Services Division
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1. GENERAL

1.1 Purpose and Scope

This practice is reissued to reflect present-day transmission limits contained in the latest Technical References and to emphasize current-vintage transmission facilities. It suggests preservice transmission tests and limits for voice grade special-access channels (VG1-VG12), the Wide Area Telecommunications Service (WATS) access line, and the Feature Group A switched-access service. For purposes of this practice, these circuits are referred to as channels. Although they are tariffed as switched-access services, WATS access line and Feature Group A channels are included because they are used to furnish services that have traditionally been considered special services.

The preservice tests and limits given in this document have been determined by the performance required for the type of service each channel will provide. The preservice tests and limits include both voice and voiceband data parameters that should be tested for each channel.

This document also provides the preservice tests and limits that apply to the optional C, DA, and T-conditioning offered with certain channels. Acceptance and immediate action limits are contained in Bellcore Technical Reference BR 313-220-101, *Voice Grade Special Access Service Feature Group A and WATS Access Lines Transmission Tests and Limits,* Issue 1, December 1986.

1.2 Application

Special-access channels are provided by the Bellcore Client Companies (BCCs) to provide the interexchange carriers (ICs) access to their customers (the end users) in the local access and transport area (LATA). Voice Grade channels (VG1-VG12) are provided between the IC point-of-termination (POT) within the LATA and a POT on a customer's premises, between the IC POT and a telephone company central office (CO), or between two IC POTs.

WATS access line channels extend from a POT on a customer's premises to a telephone company's CO that is equipped to provide WATS or 800 Service screening functions and that terminates Feature Group C or D switched-access service to an IC.

Feature Group A channels extend from an IC POT to a line-side termination at a telephone company end office.

1.3 Preservice Test Requirements and Limits

Preservice tests are performed by the BCC to ensure that the quality of a channel meets the acceptance limits of an IC when turned up for service (i.e., installed, rearranged, or repaired). The preservice limits are selected to ensure that normal variations will not cause a parameter to exceed the tariffed Immediate Action Limits (IALs).

Benchmark measurements are preservice test results that are recorded for use as an aid in localizing future troubles. (Any impairment to normal transmission is classified as a trouble.) Loss and three-tone slope are suggested as benchmark measurements on all channels.

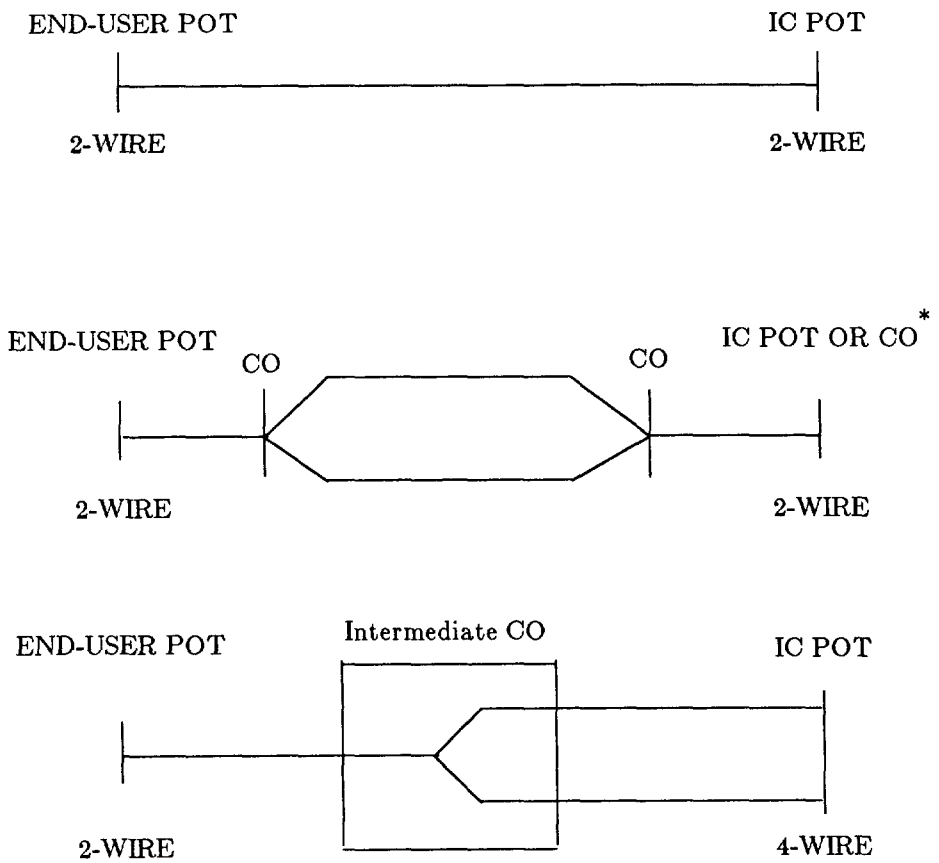
1.4 Channel Configurations

Technical specifications refer to "effective 2-wire" and "effective 4-wire" transmission capability. The channels provided by the BCC typically use a mix of facilities:

- analog carrier
- digital carrier

- single-gauge cable
- mixed-gauge cable
- digital loop carrier.

An effective 2-wire channel may terminate in either a 2-wire or a 4-wire interface (**Figure 1**). It may be wholly 2-wire, such as a channel made up entirely of metallic cable, or may contain a 4-wire section such as a carrier facility with a 2-wire cable extension. An effective 2-wire channel will contain at least one 2-wire segment and its transmission performance is that of a 2-wire channel. With effective 2-wire transmission, simultaneous transmission in both directions may be possible but is not ensured.



* Central Office used with WATS access line or Feature Group A.

Figure 1. Typical Effective 2-Wire Channel Configurations

An effective 4-wire channel may terminate in a 2-wire interface at the end user's premises or CO end but the IC interface must be 4-wire (**Figure 2**). An effective 4-wire channel is entirely 4-wire with no intermediate 2-wire segment. Its transmission performance is that of a 4-wire channel. Effective 4-wire channels ensure simultaneous transmission in both directions except when the channel is terminated in a 2-wire interface. When terminated in a 2-wire, an effective 4-wire channel may allow simultaneous bi-directional transmission, but there is no guarantee.

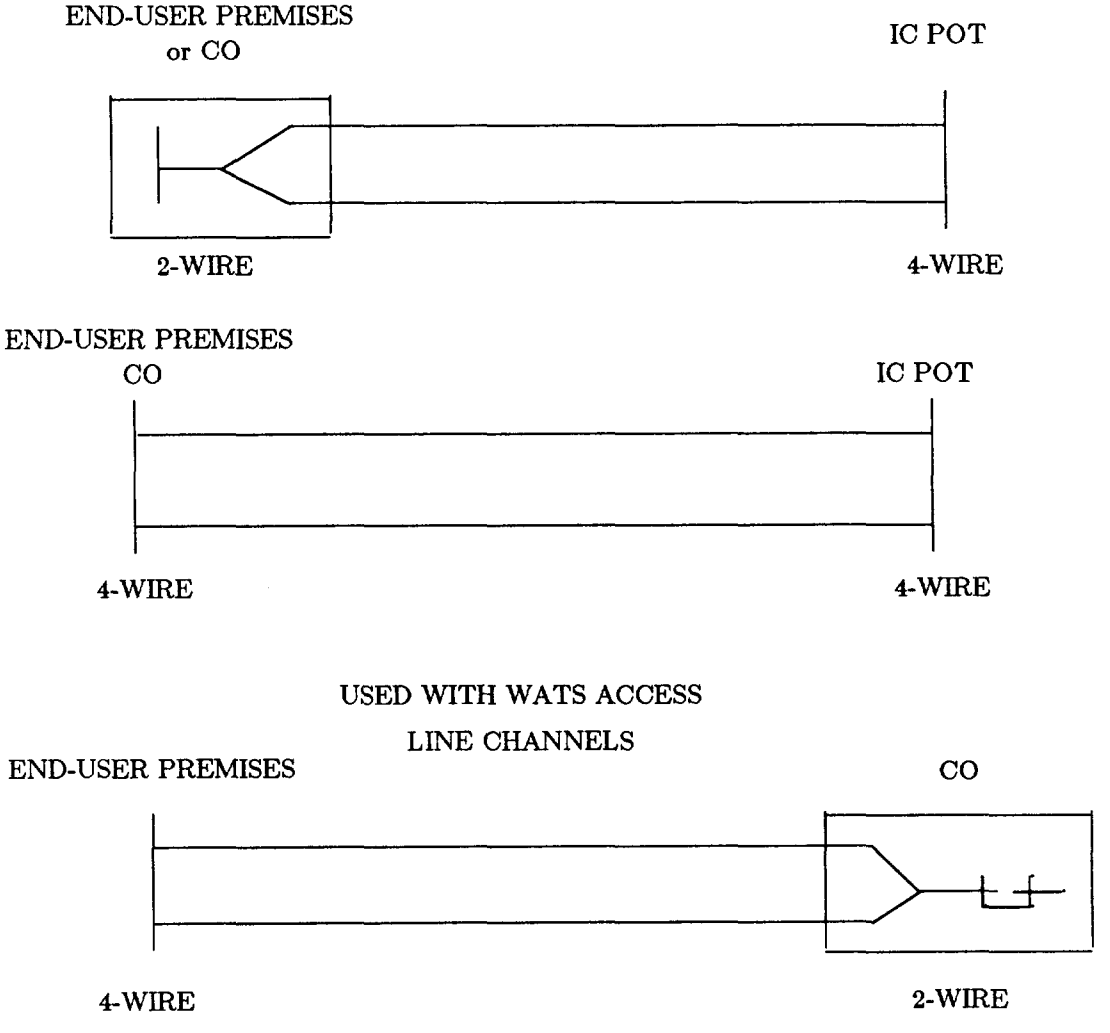


Figure 2. Typical Effective 4-Wire Channel Configurations

The method of implementing effective 4-wire transmission on a channel (whether the separation is physical, time-domain, or frequency-domain) is at the discretion of the BCC. This is subject, of course, to the growing use of high-capacity 4-wire carrier facilities, paid for by the IC, between the IC POT and a BCC "hub" office.

Analog or digital multiplexing at the IC end is an option available with these channels. At the IC end, the channel is part of a Digital Signal Level 1 (DS-1) or higher-rate digital signal or part of a group (or higher-capacity) analog system. With this option, the stated limits apply to the derived voice-frequency (VF) channel as measured between the customer premises and the IC POT or between the CO and the IC POT. Parameters such as loss and noise can be measured at a digital multiplexed interface with digital time-slot test equipment; an analog multiplexed signal can be tested with a selective level meter and similar equipment.

Table 1 gives the tariffed parameters. Although frequency response is a tariffed parameter, slope and attenuation distortion are two ways of measuring it. Usually a slope measurement is made using three test frequencies (404, 1004, and 2804 Hz) for a quick test of the channel frequency response. An attenuation distortion measurement uses frequencies spaced every 200 Hz apart throughout the frequency band. This provides a more accurate picture of the channel frequency response, but is more expensive. Attenuation distortion measurements are necessary on most of the conditioned channels. These tests should be made in both directions of transmission. The test requirements specify whether a slope or an attenuation distortion measurement should be made. The channel must be within the stated limits at all test frequencies.

Although not all tariffed parameters are designated for preservice testing, all listed parameters should be supported. A tariffed parameter that is out of limits requires corrective action when IAL values are not met.

Usually the transmit and receive levels are specified by the type of service, but several sets of transmission levels are offered as an option. The exact levels are stipulated on the Circuit Layout Record (CLR) card or Work Order Record and Details (WORD) document and on the Design Layout Record (DLR) offered to the IC. The usable frequency range for the channels discussed in this practice is nominally 300 to 3000 Hz.

The access tariffs offer the customer the option of requesting "customized" performance parameters via a VG13 channel, service code LQ, subject to acceptance by the BCC. Since these parameters are unique, they are not included in this practice.

Table 1. Tariffed Parameters—Conditioned and Non-Conditioned Channels

Parameter	Channel
Loss	All
Frequency Response (3-Tone Slope or Attenuation Distortion)	All
C-Message Noise	All
C-Notched Noise	VG5-12, WATS Access Lines
Impulse Noise	VG5-12, WATS Access Lines
Echo Control (Impedance Balance)	All
Envelope Delay Distortion	VG6-12, WATS Access Lines
Intermodulation Distortion	VG6-11, WATS Access Lines
Phase Jitter	VG6-11
Frequency Shift	VG6-12, WATS Access Lines
Resistance Unbalance	VG12
Signal-to-C-Message Noise	VG4

2. SPECIAL ACCESS — CHANNEL DESCRIPTIONS

2.1 Service Code LB (Voice Grade 1)

Voice Grade 1 (VG1) channels are suitable for the access segments of basic two-point nonswitched-voice circuits when the better transmission quality of other channels is not required. Typical configurations for a VG1 channel are shown in **Figure 3**.

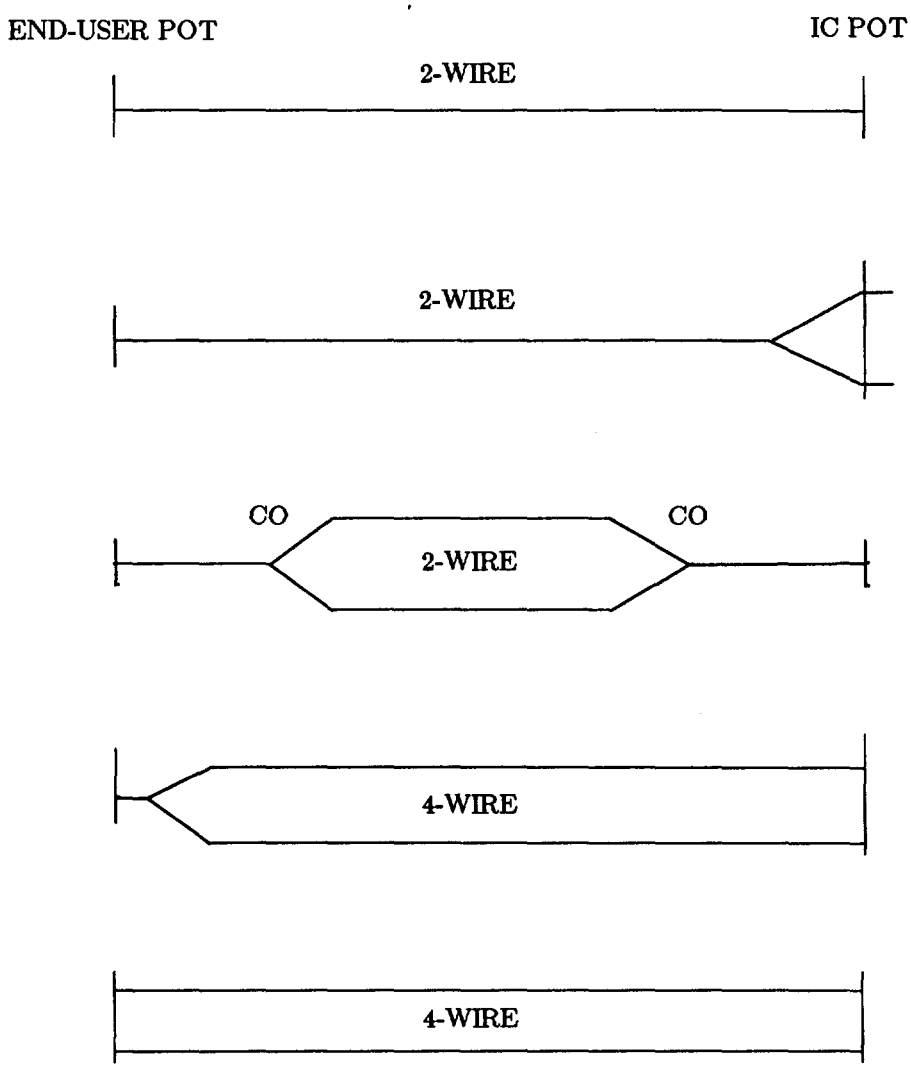


Figure 3. Typical VG1 Channel Configurations

A VG1 channel extends from the customer premises POT to an IC POT. The transmission interfaces are 2- or 4-wire at each end. This channel supports effective 2-wire or effective 4-wire transmission.

Voice Grade 1 (VG1) is suitable for application such as voice grade facility, access facility, or voice grade alarm circuit.

Table 2 gives the preservice tests along with description and limits for VG1 channels.

Table 2. Preservice Tests—Voice Grade 1

Parameter	Description/Limits
Loss	Measure (and record) 1004-Hz loss Limit: ±.8 dB of EML Note: ±1 dB non-repeatered cable.
Slope	Measure (and record) 404 Hz and 2804 Hz. Limit: Within -1.5 to +9.0 dB of 1004-Hz measurement.
C-Message Noise	See **Table 15** for limits.
Echo Control (Impedance Balance)	Required when POT is 4-wire and other end is 2-wire. See **Table 19** for limits.
DC Continuity	Measure (and record) DC resistance as appropriate for all cable facilities serving customer premises.

2.2 Service Code LC (Voice Grade 2)

Voice Grade 2 (VG2) channels are suitable for the access segments of two-point voice private lines and switched-special-service circuits. For services such as Foreign Exchange (FX) that are switched at a BCC CO, this channel is suitable for the station or "closed end" only. The "open end" of an FX service is provided by a switched-access Feature Group A channel. Typical configurations for a VG2 channel are shown in **Figure 4**.

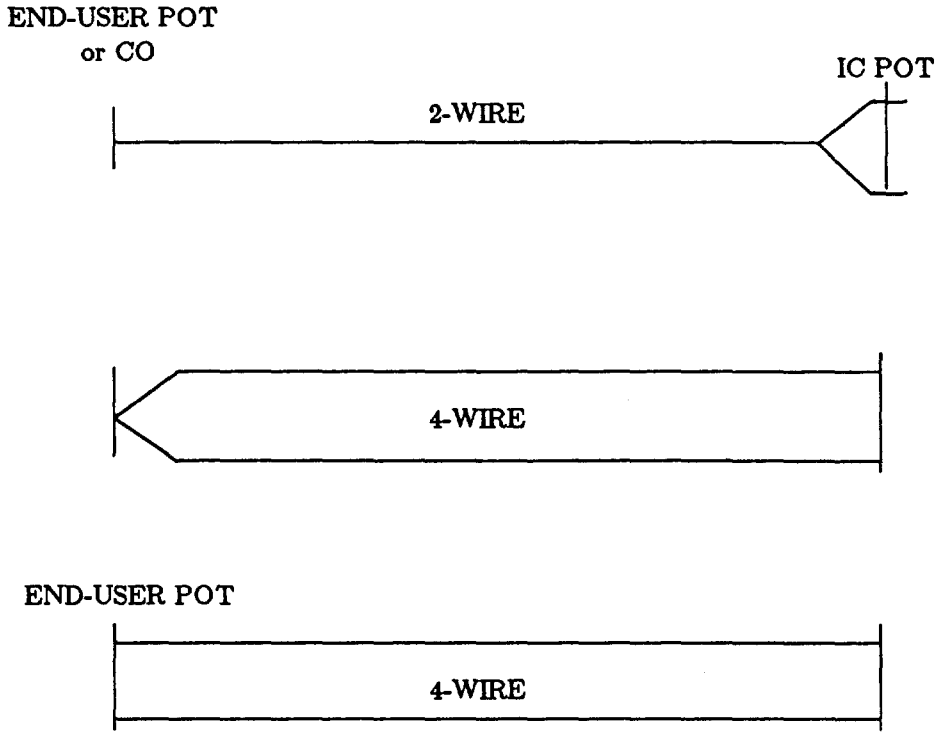


Figure 4. Typical VG2 Channel Configurations

A VG2 channel extends from the end-user premises POT or BCC CO, where a Centrex switch is located, to the IC POT. The transmission interface is 2- or 4-wire at the end-user premises POT, 2-wire at the BCC CO, and 4-wire at the IC end. This channel supports effective 2-wire or effective 4-wire transmission.

VG2 is suitable for applications such as FX line (closed end), extension service, intercommunication off-premises station line, off-premises PBX station line, off-premises extension, private-line voice circuit, paging circuit, radio landline, secretarial line, and turret or automatic call distributor (ACD) line.

Table 3 gives the preservice limits along with description and limits for VG2.

Table 3. Preservice Tests—Voice Grade 2

Parameter	Description/Limits
Loss	Measure (and record) 1004-Hz loss. Limit: Within ±0.8 dB of EML (±1.0 dB if channel consists entirely of non-repeatered cable).
Slope	Measure (and record) 404 Hz and 2804 Hz. Limit: Within -0.5 to +3.0 dB of 1004-Hz measurement.
C-Message Noise	See **Table 15** for limits.
Echo Control (Impedance Balance)	Required when IC interface is 4-wire and other end is 2-wire. See **Table 19** for limits.
DC Continuity	Measure (and record) DC resistance as appropriate.

2.3 Service Code LD (Voice Grade 3)

Voice Grade 3 (VG3) channels are suitable for the access segments of voice trunk-type circuits. Typical configurations for a VG3 channel are shown in **Figure 5**.

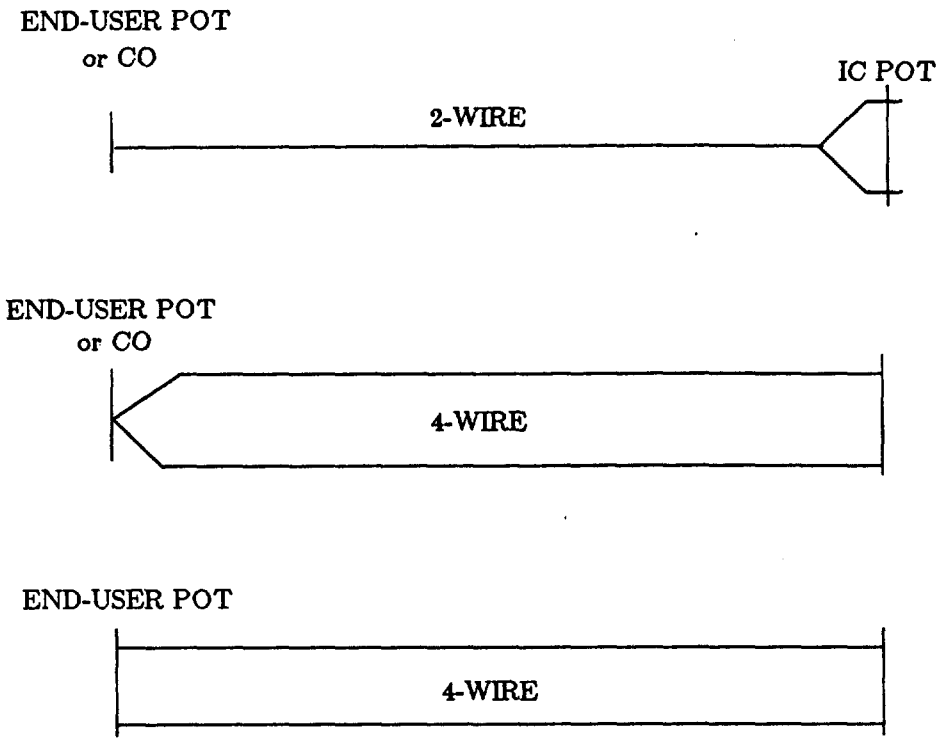


Figure 5. Typical VG3 Channel Configurations

A VG3 channel extends from the end-user premises POT, or BCC CO where a Centrex switch is located, to the IC POT. The transmission interface is 2- or 4-wire at the end-user premises POT, 2-wire at the CO, and 4-wire at the IC end. This channel supports effective 2-wire or effective 4-wire transmission.

Voice Grade 3 is suitable for applications such as:

- foreign exchange trunk (closed end)
- remote attendant trunk
- alternate service
- tie trunk
- Switched Services Network (SSN) access line
- SSN station line
- local off-network access line
- SSN tie trunk
- turret or ACD trunk.

Table 4 gives the preservice tests for Voice Grade 3 along with description and limits for VG3 channels.

Table 4. Preservice Tests—Voice Grade 3

Parameter	Description/Limits
Loss	Measure (and record) 1004-Hz loss. Limit: Within ±0.8 dB of EML (±1.0 dB if channel consists entirely of non-repeatered cable).
Slope	Measure (and record) 404 Hz and 2804 Hz. Limit: Within -0.5 to +2.0 dB of 1004-Hz measurement.
C-Message Noise	See **Table 15** for limits.
Echo Control (Impedance Balance)	Required when IC interface is 4-wire and other end is 2-wire. See **Table 19** for limits.
DC Continuity	Measure (and record) DC resistance as appropriate.

2.4 Service Code LE (Voice Grade 4)

Voice Grade 4 (VG4) is suitable for the access segments of specialized voice/tone circuits for the Federal Aviation Administration per FAA specification S-1142a. This channel provides two-way voice transmission and also one-way or two-way transmission of tones that control radio transceivers. **Figure 6** shows a typical configuration of a Voice Grade 4 channel.

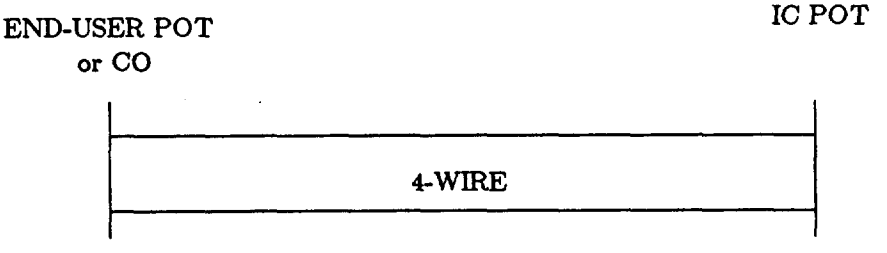


Figure 6. Typical VG4 Channel Configuration

A VG4 channel extends from the end-user premises POT to the IC POT. The transmission interfaces are 4-wire at both ends. This channel supports effective 4-wire transmission.

Table 5 gives the preservice tests along with the description and limits for VG4 channels.

Table 5. Preservice Tests—Voice Grade 4

Parameter	Description/Limits
Loss	Measure (and record) 1004-Hz loss. Limit: Within ±0.5 dB of EML (±1.0 dB if channel consists entirely of non-repeatered cable).
Slope	Measure 304, 504, 2504, 2804 and 3004 Hz. Limits compared to 1004-Hz measurement: 304 and 504 Hz: -0.5 to +2.5 dB 2504 Hz: -0.5 to +1.0 dB 2804 Hz: -0.5 to +2.0 dB 3004 Hz: -0.5 to +3.0 dB
C-Message Noise	See **Table 15** for limits.

2.5 Service Code LF (Voice Grade 5)

Voice Grade 5 (VG5) channels are suitable for the access segments of low-speed voice grade data circuits. Typical configurations for VG5 channels are shown in **Figure 7**.

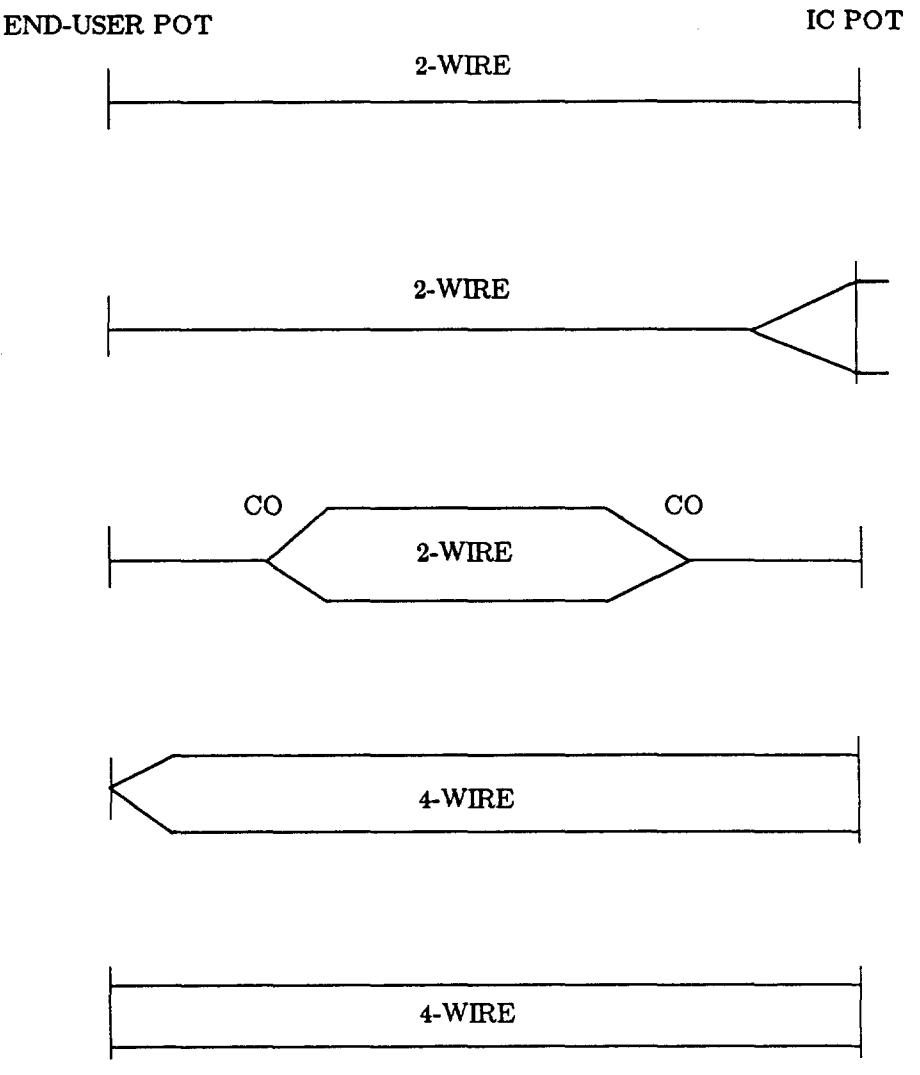


Figure 7. Typical VG5 Channel Configurations

A VG5 channel extends from the end-user premises POT to the IC POT. The transmission interfaces are 2- or 4-wire at the customer premises and at the IC end. This channel supports effective 2- or 4-wire transmission. The customer may order C-conditioning for this channel.

VG5 channels are suitable for services such as protective alarm or DATAPHONE* Select-A-Station service.

Table 6 gives the preservice tests along with descriptions and limits for VG5 channels.

Table 6. Preservice Tests—Voice Grade 5

Parameter	Description/Limits
Loss	Measure (and record) 1004-Hz loss. Limit: Within ±0.8 dB of EML (±1.0 dB if channel consists entirely on non-repeatered cable).
Slope	Measure (and record) 404 Hz and 2804 Hz. Limit: Within -0.5 to +4.0 dB of 1004-Hz measurement.
C-Notched Noise (S/C-NN ratio)	See **Table 16** for limits.
Echo Control (Impedance Balance)	Required when IC interface is 4-wire and other end is 2-wire. See **Table 19** for limits.
DC Continuity	Measure (and record) DC resistance as appropriate.
C-Conditioning	See **Table 23**.

2.6 Service Code LG (Voice Grade 6)

Voice Grade 6 (VG6) channels are suitable for the access segments of most two-point voice grade data circuits. **Figure 8** shows a typical configuration of a VG6 channel.

* Trademark of AT&T Co.

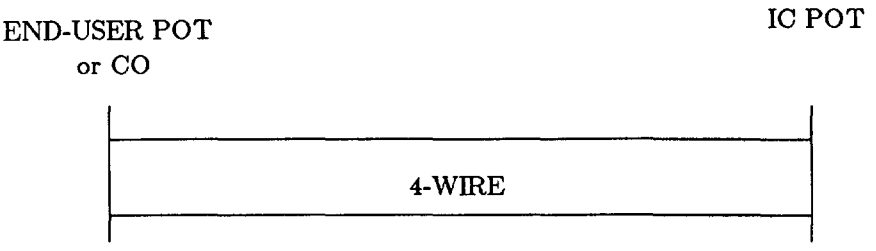


Figure 8. Typical VG6 Channel Configurations

A VG6 channel extends from the end-user premises POT to the IC POT. The transmission interfaces are 4-wire at both ends. This channel supports effective 4-wire transmission. The customer may order C- and/or DA-conditioning.

Voice Grade 6 is suitable for services such as:

- two-point private circuits
- multiplex lines
- data/control links for Enhanced Private Switched Communications Service (EPSCS)
- digital data—off-net extension
- control/remote metering.

Table 7 gives the preservice tests along with description and limits for a VG6 channel.

Table 7. Preservice Tests—Voice Grade 6

Parameter	Description/Limits
Loss	Measure (and record) 1004-Hz loss. Limit: Within ±0.8 dB of EML (±1.0 dB if channel consists entirely of non-repeatered cable).
Slope	Measure (and record) 404 Hz and 2804 Hz. Limit: Within -0.5 to +3.0 dB of 1004-Hz measurement.
C-Notched Noise (S/C-NN ratio)	See **Table 16** for limits.
Envelope Delay Distortion (EDD)	Envelope delay distortion and phase-jitter tests are required when the channel includes an N3, N4, or A carrier facility. See **Table 20** for EDD limits.
Phase Jitter	See **Table 22** for phase-jitter limits.
DC Continuity	Measure (and record) DC resistance, as appropriate.
Conditioning - C and/or DA	See **Table 23**.

2.7 Service Code LH (Voice Grade 7)

Voice Grade 7 (VG7) channels are suitable for the access segments of medium-speed voice grade data circuits. Typical configurations for VG7 channels are shown in **Figure 9**.

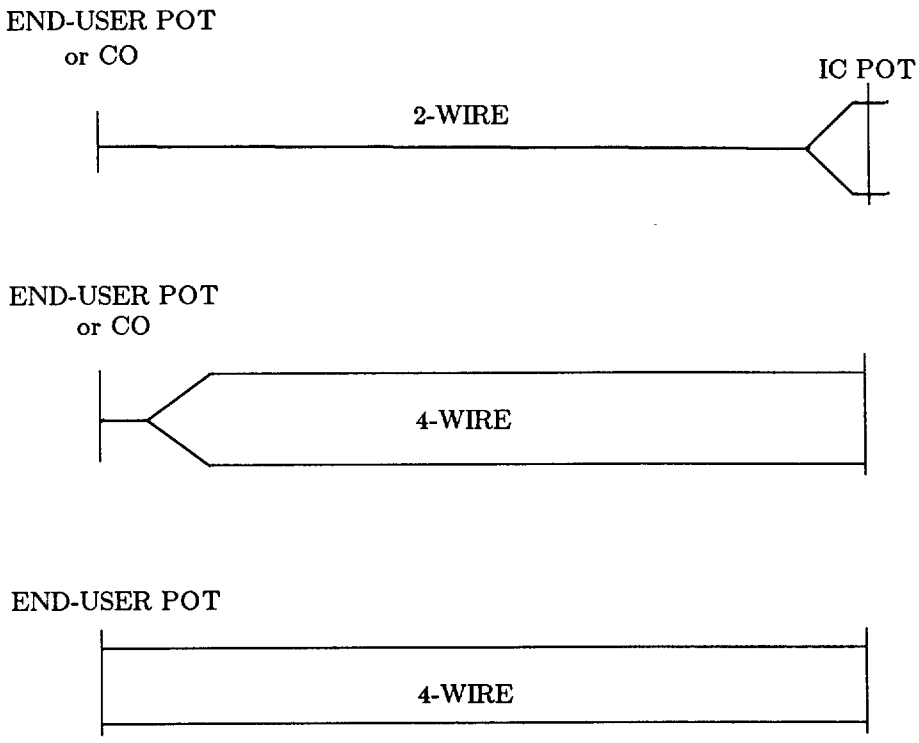


Figure 9. Typical VG7 Channel Configurations

A VG7 channel extends from the end-user premises POT or from a BCC CO, where a Centrex switch is located, to the IC POT. The transmission interface is 2- or 4-wire at the end-user premises, 2-wire at the CO, and 4-wire at the IC end. This channel supports effective 2- or 4-wire transmission. C- and/or DA-conditioning are orderable with this channel.

Voice Grade 7 is suitable for services such as:

- Centrex off-premises station line
- Private Branch Exchange (PBX) off-premises station line
- tie trunk
- foreign exchange line or trunk (closed end)
- voice grade data connecting facility.

Table 8 gives preservice tests along with description and limits for VG7 channels.

Table 8. Preservice Tests—Voice Grade 7

Parameter	Description/Limits
Loss	Measure (and record) 1004-Hz loss. Limit: Within ±0.8 dB of EML (±1.0 dB if channel consists entirely of non-repeatered cable).
Slope	Measure (and record) 404 Hz and 2804 Hz. Limit: Within -0.5 to +1.0 dB of 1004 Hz measurement.
C-Notched Noise (S/C-NN ratio)	See **Table 16** for limits.
Echo Control (Impedance Balance)	Required when the IC POT is 4-wire and the other end is 2-wire. See **Table 19** for limits.
Envelope Delay Distortion (EDD)	Envelope delay distortion and phase-jitter tests are required when the channel includes an N3, N4, or A carrier facility. See **Table 20** for EDD limits.
Phase Jitter	See **Table 22** for phase-jitter limits.
DC Continuity	Measure (and record) DC resistance, as appropriate.
Conditioning - C and/or DA	See **Table 23**.

2.8 Service Code LJ (Voice Grade 8)

Voice Grade 8 (VG8) channels are suitable for the access segments of trunk-type voice grade data circuits. **Figure 10** contains typical configurations of VG8 channels.

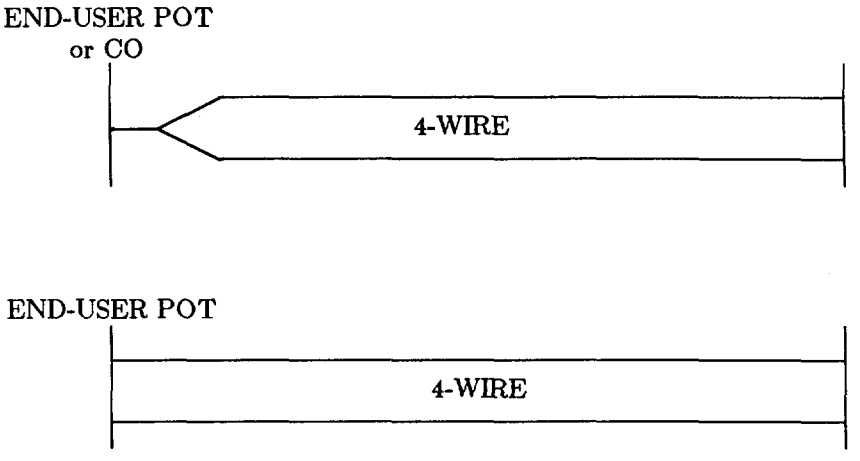


Figure 10. Typical VG8 Channel Configurations

A VG8 channel extends from the end-user premises POT or from a BCC CO office to the IC POT. The transmission interface is 2- or 4-wire at the customer premises, 2-wire at the CO, and 4-wire at the IC end. This channel supports effective 4-wire transmission. C-conditioning may be ordered for this channel.

A VG8 is suitable for services such as SSN access line or station line.

Table 9 gives preservice tests along with description and limits for VG8 channels.

Table 9. Preservice Tests—Voice Grade 8 Without C-Conditioning

Parameter	Description/Limits
Loss	Measure (and record) 1004-Hz loss. Limit: Within ±0.8 dB of EML (±1.0 dB if channel consists entirely of non-repeatered cable).
Slope	Measure (and record) 404 Hz and 2804 Hz. Limit: Within -0.5 to +1.0 dB of 1004-Hz measurement.
C-Notched Noise (S/C-NN ratio)	See **Table 16** for limits.
Echo Control (Impedance Balance)	Required when the IC interface is 4-wire and the other end is 2-wire. See **Table 19** for limits.
DC Continuity	Measure (and record) DC resistance as appropriate.
C-Conditioning	See **Table 23**.

2.9 Service Code LK (Voice Grade 9)

Voice Grade 9 (VG9) channels are suitable for the access segments of two-way simultaneous (duplex) voice grade data circuits. **Figure 11** shows a typical configuration for a VG9 channel.

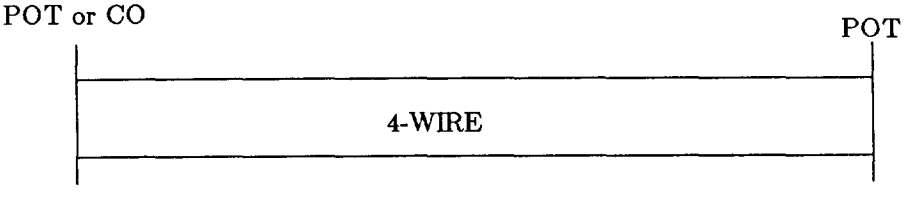


Figure 11. Typical VG9 Channel Configuration

A VG9 channel extends from the IC POT to another IC POT in the same LATA or between the IC POT and a BCC CO that serves as a SSN switch. The transmission interfaces are 4-wire. This channel supports effective 4-wire transmission. It may be ordered with C-conditioning.

Voice Grade 9 is suitable for use as part of SSN intermachine trunks.

Table 10 gives preservice tests along with description and limits for VG9 channels.

Table 10. Preservice Tests—Voice Grade 9

Parameter	Description/Limits
Loss	Measure (and record) 1004-Hz loss. Limit: Within ±0.8 dB of EML (±1.0 dB if channel consists entirely of non-repeatered cable).
Slope	Measure (and record) 404 Hz and 2804 Hz. Limit: Within -0.5 to +1.0 dB of 1004-Hz measurement.
C-Notched Noise (S/C-NN ratio)	See **Table 16** for limits.
DC Continuity	Measure (and record) DC resistance as appropriate.
C-Conditioning	See **Table 23**.

2.10 Service Code LN (Voice Grade 10)

Voice Grade 10 (VG10) channels are suitable for specialized 2-way simultaneous voice grade analog data circuits that extend digital data access service into areas that do not have digital line facilities. **Figure 12** shows a typical configuration of a VG10 channel.

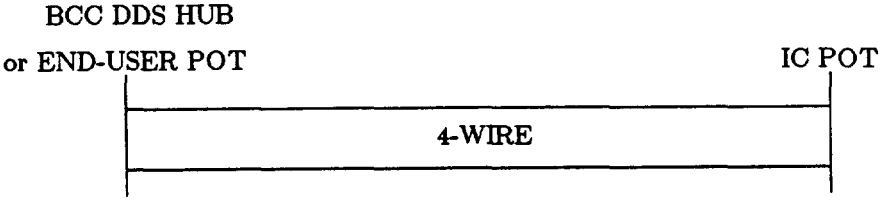


Figure 12. Typical VG10 Channel Configurations

A VG10 channel extends from the end-user premises POT to the IC POT or from the IC or end-user POT to a BCC Digital Data System (DDS) hub office for connection to digital data service. The

transmission interfaces are 4-wire. This channel supports effective 4-wire transmission. Conditioning, either C, DB, or both, may be ordered for this offering.

Table 11 gives preservice test parameters along with description and limits for VG10 channels.

Table 11. Preservice Tests—Voice Grade 10

Parameter	Description/Limits
Loss	Measure (and record) 1004-Hz loss. Limit: Within ±0.8 dB of EML (±1.0 dB if channel consists entirely of non-repeatered cable).
Slope	Measure (and record) 404 Hz and 2804 Hz. Limit: Within -1.5 to +9.0 dB of 1004-Hz measurement.
C-Notched Noise (S/C-NN ratio)	See **Table 16** for limits.
Phase Jitter	Required when the channel includes N3, N4, or A carrier facilities. See **Table 21** for limits.
DC Continuity	Measure (and record) DC resistance as appropriate.
Conditioning - C and/or DA	See **Table 23**.

2.11 Service Code LP (Voice Grade 11)

Voice Grade 11 (VG11) channels are suitable for the access segments of specialized voice grade telephoto/facsimile circuits. **Figure 13** show typical configurations for VG11 channels.

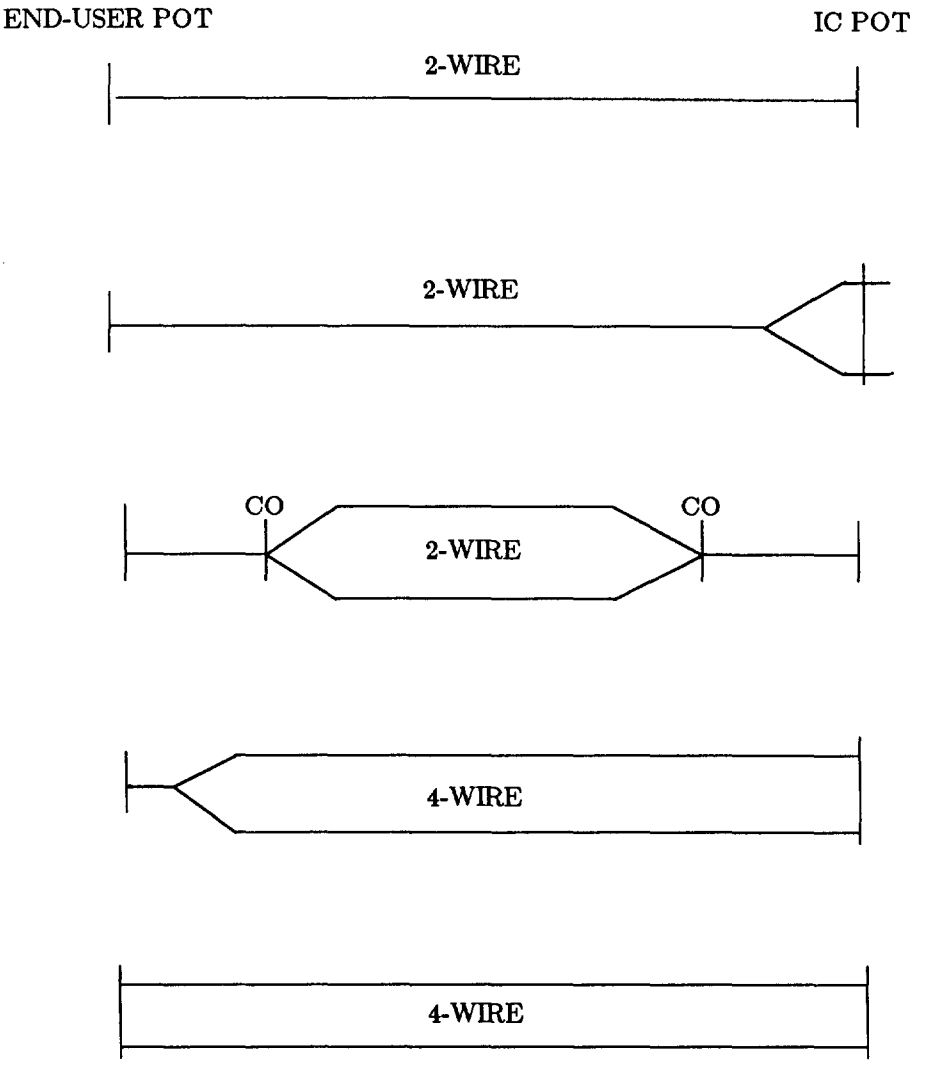


Figure 13. Typical VG11 Channel Configurations

A VG11 channel extends from the customer premises POT to the IC POT. The transmission interfaces may be 2- or 4-wire at either end. This channel supports effective 2- or 4-wire transmission. Special "T" conditioning may be ordered for a VG11.

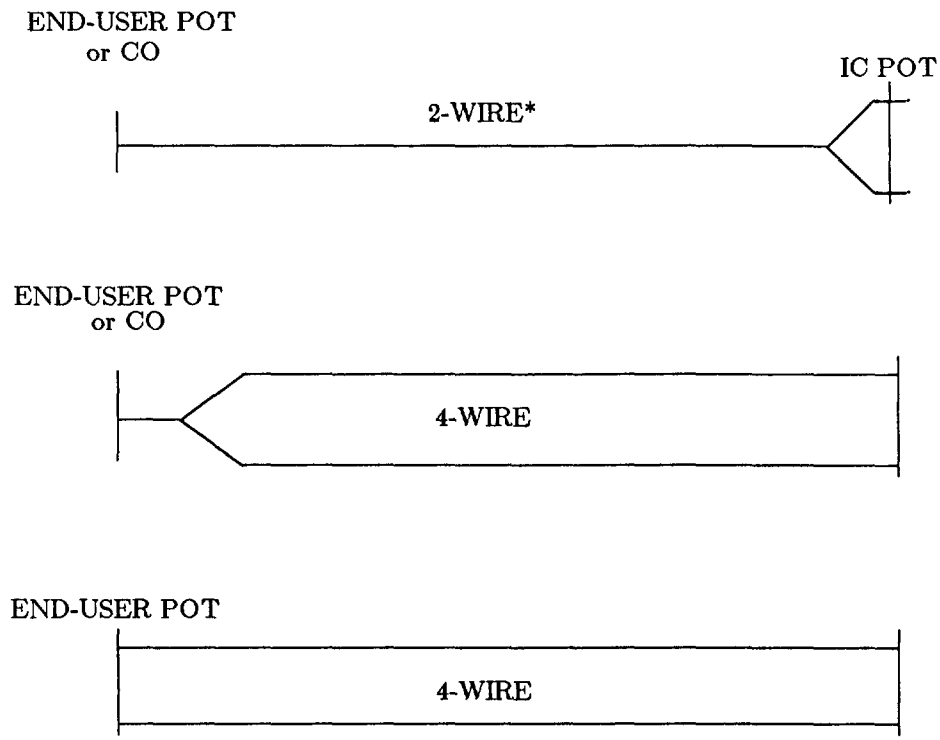
Table 12 gives the preservice tests along with description and limits for VG11 channels.

Table 12. Preservice Tests—Voice Grade 11 Without T-Conditioning

Parameter	Description/Limits
Loss	Measure (and record) 2204-Hz loss. Limit: Within ±0.8 dB of EML
Slope	Measure (and record) 1204 Hz and 2604 Hz. Limit: Within -0.5 dB of 2204-Hz measurement.
C-Notched Noise (S/C-NN ratio)	See **Table 16** for limits.
Echo Control (Impedance Balance)	Required when the IC POT is 4-wire and the other end is 2-wire. See **Table 18** for limits.
Envelope Delay Distortion (EDD)	See **Table 20** for limits.
Phase Jitter	Required when the channel includes an N3, N4, or A carrier facility. See **Table 21** for limits.
DC Continuity	Measure (and record) DC resistance as appropriate.
T-conditioning	See **Table 23**.

2.12 Service Code LR (Voice Grade 12)

Voice Grade 12 (VG12) channels are suitable for the access segments of specialized voice grade private-line audio-tone protective-relaying circuits as used by the electric power industry. **Figure 14** shows three typical configurations of VG12 channels.



* One-way transmission only.

Figure 14. Typical VG12 Channel Configurations

A VG12 channel extends from the customer premises POT to the IC POT. The transmission interface may be 2- or 4-wire at either end. This channel can provide one-way effective 2-wire transmission or effective 4-wire transmission.

Table 13 gives the preservice test along with description and limits for VG12 channels.

Table 13. Preservice Tests—Voice Grade 12

Parameter	Description/Limits
Loss	Measure (and record) 1004-Hz loss. Limit: Within ±0.8 dB of EML
Slope	Measure 304, 504, 2504, 2804, and 3004 Hz. Limits, referred to 1004-Hz measurement: 304 Hz: -0.5 to +1.5 dB 504 and 2804 Hz: -0.25 to +0.25 dB 3004 Hz: -0.5 to +1.5 dB
C-Notched Noise	See **Table 16** for limits.
Echo Control (Impedance Balance)	Required when the IC interface is 4-wire and the other end is 2-wire. See **Table 19** for limits.
Resistance Unbalance	Unbalance between wires of local cable may not exceed ±1%.
DC Continuity	Measure (and record) DC resistance.

3. SPECIAL ACCESS - Preservice Limits

3.1 General

This section describes special access channels. **Tables 14 through 23** give preservice test limits on parameters for special-access channels.

Table 14 gives the preservice limits and the frequencies that should be measured to determine the frequency response of a channel. When this test is specified, the measurements must be within the stated limits at all frequencies in the indicated band. All limits are the variation from the 1004-Hz loss (2204-Hz loss for a non-conditioned VG11 channel).

Table 15 gives the C-message noise limits for channels of various lengths and facilities. An example of how to determine a limit for a channel with a mix of facilities is given in the notes that accompany **Table 15**.

Tables 14 and 15 apply to all channels.

Table 16 gives the signal-to-C-notched-noise ratio limits listed according to mileage and facility type.

Table 17 gives special limits for signal to C-message noise that apply only to VG4 channels.

Impulse noise limits are given in **Table 14**. **Tables 14 and 16** apply to all channels except VG1-VG4.

Echo control (impedance balance) limits are given in **Table 19**. The appropriate terminating network must be in place for an echo control measurement. Refer to the table notes for details. This table applies to all channels involving a 2-wire interface.

Envelope delay distortion limits are given in **Table 20**. These limits are given in microseconds (s) and apply to all channels except VG1 through VG5.

Table 21 contains the limits for intermodulation distortion. These limits apply to channels VG6-VG11 and WATS access lines.

Phase-jitter limits are given in **Table 22**. They apply to VG6-VG12 channels. Frequency shift limits are discussed in Section 3.2.

Table 14. Attenuation Distortion—Preservice Limits

The +limit means more loss; the -limit means less loss with respect to 1004 Hz.

Do not attempt to measure 2604 Hz directly.

CHANNEL	FREQUENCY BAND (Hz)	LIMITS (see Note A)	TEST FREQUENCIES (Hz)
Voice Grade 1	500-2500	-1.5 to + 7.0	304
Voice Grade 10	400-2800	-1.5 to + 9.0	404
	300-3000	-2.5 to +11.0	504
			604
Voice Grade 2	400-2800	-0.5 to + 3.0	804
	300-3000	-0.5 to + 4.0	1004
			1204
Voice Grade 3	400-2800	-0.5 to + 2.0	1404
	300-3000	-0.5 to + 4.0	1604
			1804
Voice Grade 4	300-499	-0.5 to + 2.5	2004
	500-2500	-0.5 to + 1.0	2204
	2501-2800	-0.5 to + 2.0	2404
	2801-3000	-0.5 to + 3.0	2604 (see Note B)
			2804
Voice Grade 5	400-2800	-0.5 to + 4.0	3004
Voice Grade 6	500-2500	-0.5 to + 2.0	
	400-2800	-0.5 to + 3.0	
	300-3000	-0.5 to + 4.0	
Voice Grade 7	400-2800	-0.5 to +1.0	
	300-3000	-0.5 to + 4.0	
Voice Grades 8 and 9	400-2800	-0.5 to + 0.5	
	300-3000	-0.5 to + 4.0	
Voice Grade 11	1200-2600	±0.5	
(see Note A)	300-3000	-0.5 to + 1.5	
C-Conditioning	400-2800	-1.0 to + 1.5	Those above,
(Limited to VG5 through VG10)	300-3000	-1.0 to + 2.0	plus 3204 Hz
	300-3200	-1.5 to + 5.0	
T-Conditioning	500-3000	-0.5 to + 1.0	
(VG11 only)	300-3200	-1.0 to + 2.0	
WATS Access Lines			Those above, less
2-Wire Standard	400-2800	-2.5 to + 8.0	304 and 3004 Hz
2-Wire Improved	400-2800	-1.5 to + 5.0	
4-Wire	400-2800	-1.5 to + 4.0	

NOTE A: For VG11 channels, use 2204 Hz as the reference frequency; use 1004 Hz as reference for all other channels.

NOTE B: If the channel uses SF signaling, measure 2504 Hz and 2704 Hz and average the two results.

Table 15. C-Message Noise Preservice Limits
(In dBrnc0)

Channels containing multiple facilities (other than cable) require that the individual facility limits be added on a power basis and the results used as the preservice limit. Example: Facility length = 75 route miles; facility consists of T1/D1 B digital carrier and N3 carrier channel, and a short length of connecting cable.

Step 1. Use values from the table as follows:

Column D1 at 51-100 miles = 28
Column CAC/N3 at 0-50 miles = 23
Column C at 0-50 miles = 25

Step 2. Combine the Step 1 values using rules in **Chart A** below.

28 and 23 = 29
29 and 25 = 30

Result: C-message noise limit for this example is 30 dBrnc0. If the channel in this example contained the same facilities but terminated in a CO switch, the C-message noise limit would be 31 dBrnc0 (30 combined with 22 taken from CO switch column = 31). Where two T1 facilities are connected together through a DCS, the applicable noise limit is for a single facility.

Chart A

To add two noise limits on a power basis, the following rules apply:

DIFFERENCE BETWEEN LIMITS	ACTION
0 dB	Add 3 dB to one of them
1-3 dB	Add 2 dB to the larger
4-8 dB	Add 1 dB to the larger
9 or more	Use the larger

If channels containing both carrier and cable facilities are designed for nominal levels (0 to -6) at a CO switch, the cable limit can be considered to be in dBrnc0; otherwise, these channels must have the carrier limit converted to dBrnc by adding the TLP at the point of measurement to the cable limit.

FACILITY LENGTH (ROUTE MILES)	VF CABLE OR INTRABUILDING CABLE WITH GAIN (see Note)	COMPANDORED ANALOG CARRIER			NON-COMPANDORED ANALOG CARRIER
		CAC1	CAC		
	C	N1	N2, N3	N4	NCAC
0-50	25	26	23	18	31
51-100		28	26	20	33
101-200		30	28	23	34
201-400					36
401-1000					39

NOTE: Multiple cable facilities connected in tandem are treated as a single facility.

FACILITY LENGTH (ROUTE MILES)	DIGITAL CARRIER (see Note A)		COMBINATION ANALOG/DIGITAL FACILITY (see Note B)	CENTRAL OFFICE SWITCH
	D1	D	AT	SW
0-50			33	
51-100			34	
101-200	28	23	35	22
201-400			37	
401-1000			39	

NOTE A: "D" includes DID through D5 channel banks, DLC, etc. Includes digital radio facilities.

NOTE B: Use this column when facility includes LT1-type analog-to-digital converter (i.e., combined "A" and "T1" facilities).

Table 16. Signal to C-Notched Noise Ratio

PRESERVICE LIMITS (In dB) USING -16 dBm0 TEST TONE

FACILITY TYPE	ROUTE MILEAGE				
(See Note)	0-50	51-100	101-200	201-400	401-1000
Compandored N/ON Carrier	36	35	32	NA	NA
Non-Compandored Analog Carrier	46	44	43	41	38
Digital Carrier (Includes DLC)	34				
Combination Digital and Analog Carrier	34	34	34	33	33
N/ON Carrier, Compandors Disabled	30	29	26		
VF Cable	52				

PRESERVICE LIMITS (In dB) USING -13 dBm0 TEST TONE

FACILITY TYPE	ROUTE MILEAGE				
(See Note)	0-50	51-100	101-200	201-400	401-1000
Compandored N/ON Carrier,	37	36	33		
Non-Compandored Analog Carrier	49	47	46	44	41
Digital Carrier (Includes DLC)			34		
Combination Digital & Analog Carrier	34	34	34	33	33
N/ON Carrier, Compandors Disabled	33	32	29		
VF Cable	52				

NOTE: Application: The difference in dB between the signal level and the C-notched noise level must equal or exceed the value from the chart. This difference must also include the value derived from the use of multiple facilities.

If a channel consists of multiple facilities, the preservice limit is calculated as follows: If the limits are equal, subtract 3 dB from one of them; if the limits differ by 1 to 3 dB, subtract 2 dB from the lower one; if the limits differ by 4 to 8 dB, subtract 1 dB from the lower one; if the limits differ by more than 8 dB, use the lower one. Combine three or more limits by pairing.

Table 17. Signal to C-Message Noise—Preservice Limits

Application: For the 300 to 3000-Hz band, the difference in dB between a 1004-Hz signal at -8 dBm0 (82 dBrnC) and C-message noise must equal or exceed 44 dB. For the 2600 to 3000-Hz band, the difference in dB between any signal in the band at -15 dBm0 (75 dBrnC) and C-message noise must equal or exceed 24 dB.

CHANNEL	FREQUENCY BAND (HZ)	LIMIT (dB)
VG4	300-3000	44
	2600-3000	24

Table 18. Impulse Noise—Preservice Limits

Application: Counts not to exceed 15 in 15 minutes at threshold settings.

CHANNEL (see Note)	**THRESHOLD SETTING (dBrnc0)**
VG5, 6, 7, 8, 9, 11 and 12	65
VG10	67

NOTE: If the channel consists of only A or cable facilities, a 5-dB lower threshold setting applies. If the channel consists of N carrier with companders disabled, careful facility selection may be necessary to meet limits, since noncompandored limits are 6-dB higher than compandored limits.

Table 19. Echo Control (Impedance Balance)—Preservice Limits

INTERFACE BEING MEASURED - ALL VGs (see Note)	TYPE OF MEASUREMENT	ERL LIMIT	
Effective 2-wire Facility 2-wire at both ends	Return Loss	5.5	3
2-wire Network Interface (with 4-wire IC Interface			
-Standard		5.5	3
-Improved		16	10
4-wire IC Interface (2-wire Network Interface)	Equal Level Echo Path Loss	19	12
Effective 4-wire Facility 2-wire Network Interface (4-wire IC Interface)	Echo Return Loss	28	21
4-wire IC Interface 2-wire Network Interface	Equal Level Echo Path Loss	25	17
Both 4-wire		Not Specified	
WATS Access Line Effective 2-wire Facility 2-wire Network Interface and CO	Echo Return Loss		
-Standard		7	4
-Improved		16	8
Effective 4-wire Facility 4-wire Interface and 2-wire CO	Equal Level Echo Path Loss	21	14

NOTE: Network interface is the interface at the end-user POT or the equivalent point in a BCC CO. Interface combinations not shown are not offered.

Table 20. Envelope Delay Distortion—Preservice Limits

The absolute difference in delay between the frequency with the least delay and the frequency with the most delay, within the applicable frequency band, may not exceed the limit shown.

Where two T1 channels are tied back-to-back through a DCS, the connection is electrically transparent. The resulting EDD is that of a single channel.

CHANNEL	LIMIT μ s	FREQUENCY BAND, Hz
VG6, 7, 8 & 9	600*	800-2600
VG10	1650	800-2600
VG11	600	1200-2600
VG12	600*	800-2600
C-Cond (VG5 - VG10)	75	1000-2600
	100	800-2600
	200	600-2600
	500	500-2800
	2900	300-3000
T-Cond (VG11 Only)	75	1000-2600
	80	800-2800

* 650 μ s if the channel design includes two analog carrier facilities in tandem.

Table 21. Intermodulation Distortion (IMB)—Preservice Limit

USING FOUR-TONE MEASUREMENT METHOD

Application: The difference in dB between the fundamental and the intermodulation distortion products (R2 and R3) must equal or exceed the values shown.

CHANNEL	IMD PRODUCT (see Note)	LIMIT (dB)
VG6, 7, and 11	R2	36
	R3	43
VG8	R2	47
	R3	50
VG9	R2	51
	R3	55
VG10	R2	30
	R3	35
VG6, 7, and 10 with DA cond.	R2	41
	R3	45

NOTE: R2 is the ratio of fundamental to second-order products; R3 is the ratio of fundamental to third-order products.

Table 22. Phase Jitter Preservice Limits*

* Accurate phase jitter measurements are required for adequate signal to C-notched noise margins.

Phase jitter within the applicable frequency band may equal but not exceed the limit shown.

CHANNEL	FREQUENCY BAND (HZ) (see Note A)	LIMIT (DEGREES PEAK-TO-PEAK) (see Note B)	
		ROUTE MILEAGE	
		0-250	251-500
VG6, 7 and 11	200-300 4-300	2 7	4 9
VG8	20-300 4-300	2 7	3 8
VG9	20-300 4-300	2 7	2.5 7
VG10	20-300 4-300	2 7	4 9

NOTE A: If the channel makeup (except VG10 channels) contains A, N3, or N4 carrier, use the maximum limit (the 251-500 route mileage figure) regardless of channel length. VG10 limits become 8 and 13. Facility selection may be required to meet the limit.

NOTE B: The 20 to 300-Hz band is sometimes referred to as "Bell"; the 4 to 300-Hz band as "Bell plus LF (low frequency)."

3.2 Frequency Shift

The frequency shift on VG6 through VG12 channels carries a preservice test limit of ± 1 Hz. However, since frequency shift is generated solely in certain types of analog carrier, no preservice test is necessary if the facilities are digital carrier, wire, N1 carrier, or N2 carrier.

4. TESTS REQUIRED FOR CONDITIONING

Table 23 shows the preservice tests required when optional conditioning of several types is ordered for a channel:

- C-conditioning (VG5 - VG10)
- T-conditioning (VG11 only)
- DA-conditioning (VG6, VG7, and VG10)
- Both C- and DA-conditioning (VG6, VG7, and VG10)

Table 23. Optional Conditioning—Preservice Tests Required

PARAMETER	TESTS REQUIRED WITH CONDITIONING		
	C or T	DA	C and DA
Loss	Yes	Yes	Yes
Attenuation Distortion (Frequency Response)	Yes	No	Yes
Slope (Frequency Response	No	Yes	No
Envelope Delay Distortion	Yes	see Note A	Yes
Phase Jitter	see Note A	see Note A	see Note A
Echo Control (Impedance Balance)	see Note B	see Note B	see Note B
C-Notched Noise (S/C-NN)	Yes	Yes	Yes
Intermodulation Distortion	No	Yes	Yes

NOTE A: Required only when the channel uses an "A", N3, or N4 carrier facility.

NOTE B: Required only with a 4-wire IC interface and a 2-wire interface at the other end.

5. SWITCHED ACCESS CHANNELS—DESCRIPTIONS AND PRESERVICE LIMITS

5.1 Service Codes SE and SF (WATS Access Line)

A WATS access line provides a connection between an end-user premises POT or a Centrex CO switch to a CO switch capable of performing screening functions for 800 Service, WATS, or other similar services. The WATS access line is provided only with Feature Groups C or D switched-access services. **Figure 15** shows typical configurations for WATS access lines. WATS access lines are orderable as "standard" (service code SE) and "improved" (code SF), with performance as shown in **Table 24**.

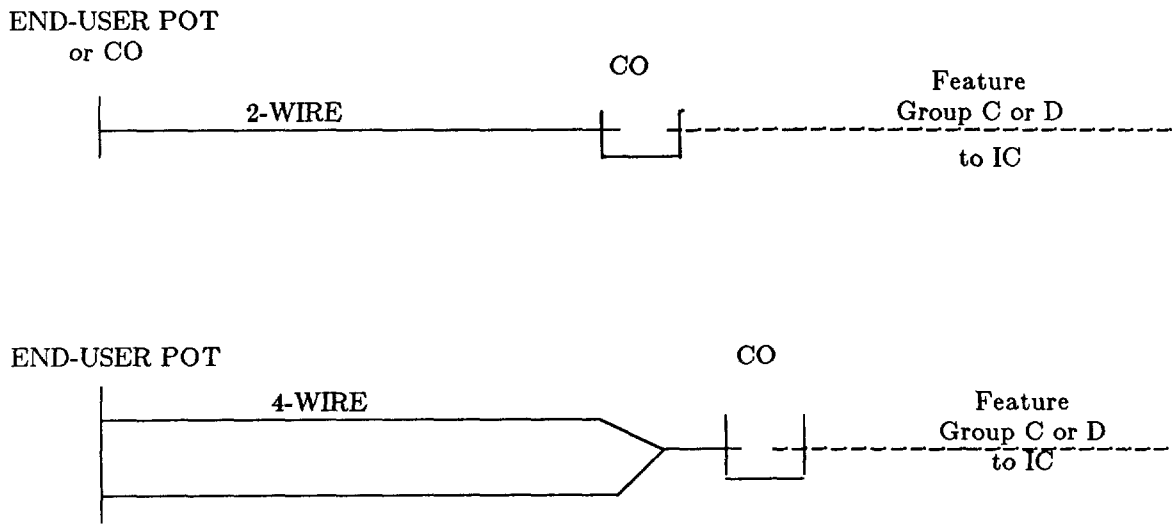


Figure 15. Typical WATS Access Line Configurations

The line extends from the end-user POT or a Centrex CO switch to a line-side (or trunk-side) termination at the WATS/800 Service switch. The transmission interface may be 2- or 4-wire at either end. This channel will support effective 2- or 4-wire transmission.

WATS access lines provide the closed end of an 800 Service or other WATS-type service.

Table 24 lists preservice tests, test descriptions, and limits for WATS access lines.

Table 24. Preservice Tests—WATS Access Line

Parameter	Description/Limits
Loss	Measure (and record) 1004-Hz loss. Limit: Within ±0.8 dB of EML
Slope	Measure (and record) 404 Hz and 2804 Hz. Limit referred to 1004-Hz measurement: 2-W Standard: -2.5 to +7.5 dB 2-W Improved and 4-W WATS access lines: -1.5 to +4.5 dB
C-Message Noise	See **Table 15** for limits.
Echo Control (Impedance Balance)	See **Table 18** for limits.
DC Continuity	Measure (and record) DC resistance as appropriate.

5.2 Service Codes SB and SD (Feature Group A)

Feature Group A channels provide a connection between an IC POT and an IC-specified point of switching within a LATA. The first switch provides a line-side termination that is assigned a seven-digit telephone number. Typical configurations of Feature Group A channels are shown in **Figure 16**. These channels are offered with "standard" transmission (service code SB) and "improved" performance (code SD).

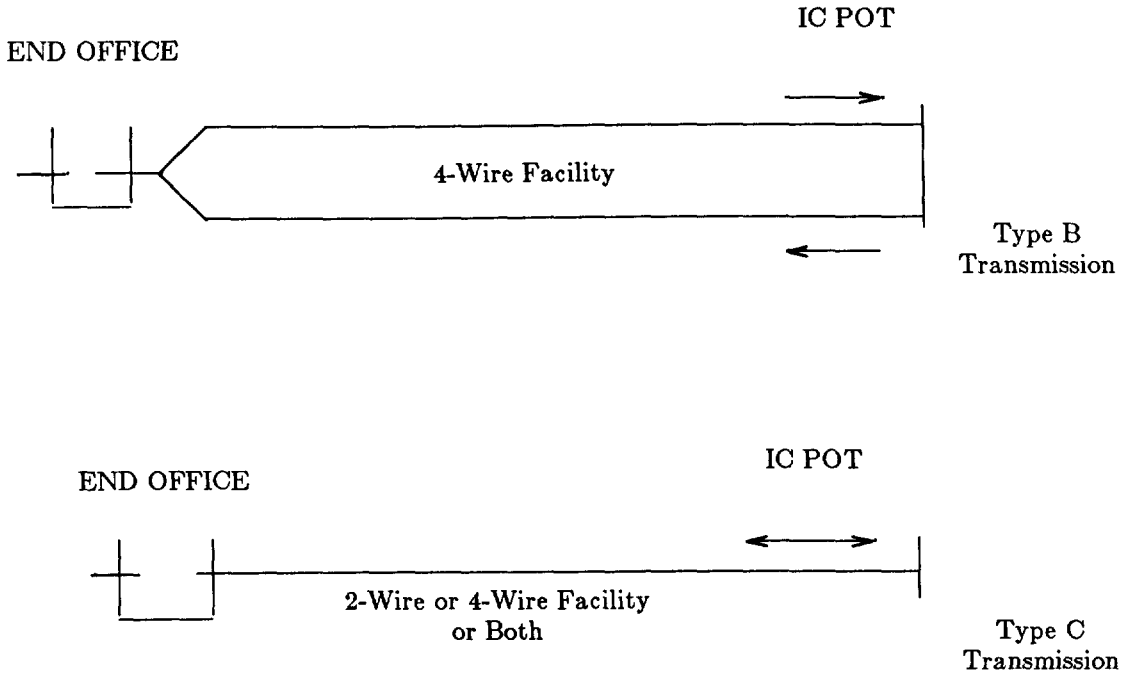


Figure 16. Typical Feature Group A Configurations

The transmission interfaces are 2-wire at the CO and either 2- or 4-wire at the IC POT. Transmission type B offers a 4-wire interface at the IC end and effective 4-wire at BCC facilities. Transmission type C offers a 2-wire interface at each end, while BCC facilities may be 2-wire, 4-wire, or both. Transmission parameters apply only between the IC POT and the point of switching.

Feature Group A channels are suitable for FX service, off-net access lines, and as replacements for the former ENFIA-A facility.

Table 25 contains the preservice test parameters, test descriptions, and limits for FG A channels.

Table 25. Preservice Tests—Feature-Group A Channels

These channels should be measured at the IC POT with a termination at the end office. Measurement is not required on 4-wire channels with 4-wire IC POT and 4-wire switch or on channels with digital switch terminations.

Parameter	Description/Limits
Loss	Measure (and record) 1004-Hz loss. Limit: Within ±0.5 dB of EML (±1.0 dB if channel consists entirely of cable without gain).
Slope	Measure (and record) 404 Hz and 2804 Hz. Limits referred to 1004 Hz: −1.5 to +3.0 dB (type B) Limit: −1.5 to +4.5 dB (type C)
C-Message Noise	See **Table 15** for limits.
Echo Control (See Note)	Limit, type B: ERL, 20 dB; SRL, 13 dB Limits, type C: RL, 16 dB; SP, 9 dB

NOTE: If one or more of the facilities listed in **Table 25** are used on a Feature Group A channel, the parameters listed should be preservice tested. There is a probability that these facilities will not meet the assigned limits. Refer to Bellcore Technical Reference BR 313-320-100, *Voice Grade Switched Access Service Preservice Tests and Limits*, Issue 1, March 1986, for preservice test limits.

Table 26. Facility-Related Parameters Requiring Preservice Tests

FACILITY TYPE	PARAMETERS THAT REQUIRE PRESERVICE TESTS
T1/D1A T1/D1B	Intermodulation distortion (second order) and C-Notched noise.
N1	C-Notched noise, envelope delay distortion, intermodulation distortion (2nd and 3rd order), attenuation distortion, and impulse noise.
ON2	Same as N1 plus phase jitter measurement.
A, N3	Envelope delay distortion and phase jitter.
N2	C-Notched noise and impulse noise.
N4	Envelope delay distortion

Acronyms

ACD	—	Automatic Call Distributor
BCC	—	Bellcore Client Company
CLR	—	Circuit Layout Record
CO	—	Central Office
DCS	—	Digital Cross-Connect System
DDS	—	Digital Data System or Service
DLR	—	Design Layout Record
DS	—	Digital Signal
DS-1	—	Digital Signal Level 1
EDD	—	Envelope Delay Distortion
EPSCS	—	Enhanced Private-Switched Communications Service
FAA	—	Federal Aviation Administration
FX	—	Foreign Exchange
IAL	—	Immediate Action Limit
IC	—	Interexchange Carrier
LATA	—	Local Access and Transport Area
PBX	—	Private Branch Exchange
POT	—	Point of Termination
PSCS	—	Enhanced Private Switched Communications Service
SSN	—	Switched Services Network
VF	—	Voice Frequency
VG	—	Voice Grade
WATS	—	Wide Area Telecommunications Service
WORD	—	Work Order Record and Details

References

[1] Bellcore Technical Reference BR 313-220-101, *Voice Grade Special Access Service Feature Group A and WATS Access Lines Acceptance and Immediate Action Transmission Tests and Limits,* Issue 1, December 1986.

[2] Bellcore Technical Reference BR 313-320-100, *Voice Grade Switched Access Service Preservice Tests and Limits,* Issue 1, March 1986.