Sound Advice In Telecommunications

Application Note No. 5

Switched 56

1. Introduction

This application note describes the technical aspects of Switched 56 service and its deployment in a local exchange area. Switched 56 is an end-to-end digital, 56 kb/s, full-duplex, synchronous, circuit switched service, which is available either directly from a Local Exchange Carrier (LEC) or through an Interexchange Carrier (IXC). Transmission is entirely over digital links.

Switched 56 service is more formally known as Public Switched Digital Service (PSDS), but in this application note it will be called SW56 for clarity. SW56 includes three types of interfaces, Type I, II, and III, which are summarized in Table 1. Type I and III are the most common. More detail is provided later.

Table 1
SW56 Interfaces

Type	Metallic Interface	Signaling	Line Rate	Payload Rate
I	4-wire	In-band	56 kb/s	56 kb/s
II	2-wire	In-band	144 kb/s	56 kb/s
III	2-wire	Out-of-band	160 kb/s	56 kb/s

Table 2 summarizes the types offered with the common end office switching systems. Regular digital carrier facilities may be used to extend the SW56 beyond the transmission limits of the central office line circuit. SW56 requires all digital facilities from end-to-end. Any intervening analog conversion will prevent successful connection and operation. The SW56 is a fully synchronous service with a payload rate of 56 kb/s. However, depending on the capabilities of the user's Data Service Unit (DSU), any asynchronous rate in multiples of 9.6 kb/s up to 57.6 kb/s and any standard synchronous rate up to 56 kb/s can be accommodated.

2. Implementations

Any given central office switching system normally only supports one type of SW56 line circuit. However, when SW56 is provided through a digital trunk interface (DTI) and a channel bank, more than one type may be available depending on the capabilities of the DTI and channel bank.

Fig. 1 shows some typical implementations of SW56. In (a), a SW56-capable digital PBX is connected to a digital trunk interface in the serving central office via a DS1 facility. The DTE shown is a LAN router, which has multiple SW56 connections to the PBX. In (b), the DTE is connected directly to the end office SW56 line circuit via the twisted pair loop. A channel bank with SW56 channel units is used in (c) to provide the SW56 interface, and a DS1 facility connects the channel bank on the customer's premises to the serving central office. In (a) through (c), the serving central office consolidates SW56 traffic and sends it to the interexchange carrier Point-of-Presence via DS1 facilities.

Table 2
End Office Implementation of SW56

Manufacturer	Model	SW56 Type
AT&T	5ESS ❧	Type I or III
Mitel	GX-5000 ❧	Type I
Nortel	DMS-10	Type III
Nortel	DMS-100	Type III
Redcom	MDX-384	Type I
Siemens Stromberg-Carlson	DCO ❧	Type I
Siemens Stromberg-Carlson	EWSD ❧	Type I

❧ The 5ESS, GX-5000, DCO and EWSD provide SW56 through the digital trunk interface, in which case a channel bank or Digital Loop Carrier remote terminal with a SW56 channel unit is required to provide individual SW56 line service.

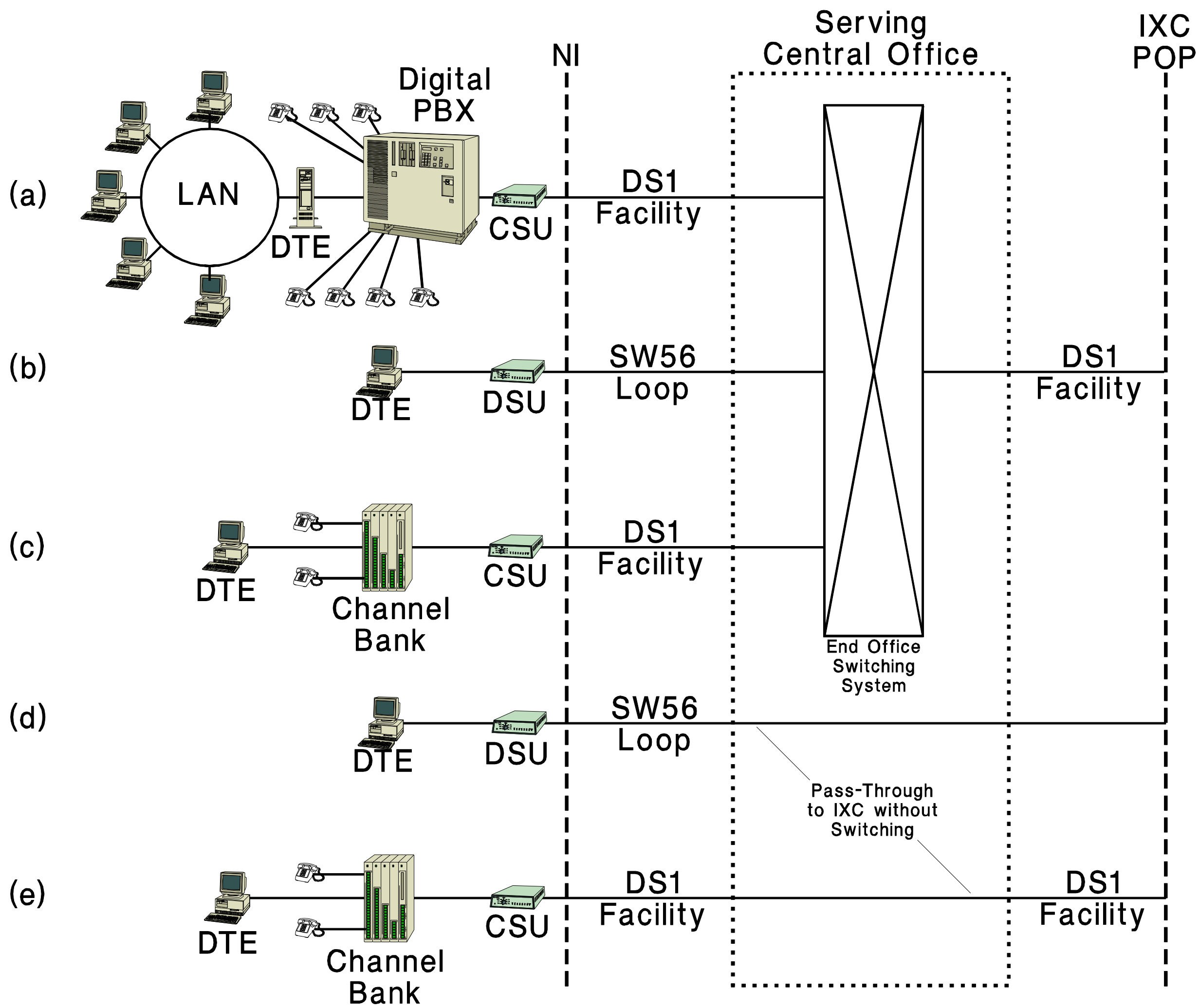
In (d) and (e), which are similar to (b) and (c), the SW56 circuits are sent directly to the POP via LEC facilities and are not locally switched. In (d), twisted pairs are used to transport the SW56 service, and in (e), DS1 facilities transport the service. In the case of (d), the SW56 circuits could be consolidated in a channel bank located in the central office and sent to the POP over DS1 facilities. In all cases, (a) through (e), a CSU or DSU is used on the customer's premises immediately after the network interface (NI). The CSU is used where the service is via DS1 facilities, and a DSU is used where a direct connection to the DTE using standard interfaces (EIA-232, EIA-530, V.35) is required.

3. Industry Standards and Interworking

The applicable industry standards for SW56 are TIA/EIA-596 (Type I, II and III), AT&T PUB 61330 and 41458, and Bellcore TR-880-22135-84-01 (Type II) and TR-EOP-000277 (Type III).[1,2,3,4,5] Bellcore also published TR-NPL-000457 for the Type II interface; however, this TR is proprietary and not available to the public.

Industry standards provide for interworking between the three SW56 interfaces, such that any interface type may call any other type and pass data under most conditions. When a call is established, a handshaking protocol takes place to determine whether a compatible protocol is available at the far-end SCDSU. If a compatible protocol exists, parameters are exchanged to indicate whether the data is to be sent synchronously or asynchronously and the data rate to be used. If the exchanged parameters are incompatible, then a conflict exists and data cannot be transferred. Interworking is also possible between SW56, the ISDN and analog voiceband modems; however, interworking of different services involving subrate multiplexing, rate adaptation, packet switching or the ISDN depends on the end-office switching system feature set and the capabilities of the end-user's DSU.

Fig. 1
SW56 Implementations



4. Data Service Units

SW56 normally is terminated at the customer's premises in a regular modular jack, which serves as the network interface. The types of modular jacks and wiring configurations are discussed later. The customer must connect a Network Channel Terminating Equipment (NCTE) registered under FCC Part 68[6] between the Data Terminal Equipment (DTE) and the network interface. The NCTE is more commonly known as a Data Service Unit, or DSU. The DSU used with Switched 56 service is called a Switched Circuit DSU, or SCDSU, in the rest of this application note to differentiate it from a DSU used for dedicated digital services (DDS). Many vendors provide a DSU that may be used with either DDS or Type I SW56 by simple option settings. Type II and III SW56 normally require a separate single-use SCDSU.

The SCDSU is the interface between the DTE and the loop. It provides signal format conversion and rate adaptation. On the network side, the SCDSU will have a 2-wire or 4-wire interface depending on the SW56 type. On the DTE side, the SCDSU will have an EIA-232, EIA-530 or V.35 interface for data communication.

The DTE will dial the call using one of three methods: EIA-366, V.25bis, or Hayes AT command set. Also, the SCDSU may have dialing capability from the front panel. The EIA-366 method uses a separate physical interface between the DTE and SCDSU. This is an out-of-band dialing method common on video conferencing systems. The V.25bis method is an in-band dialing method that uses the common data communication interface. This method is common on routers and bridges that require a synchronous connection between the DTE and SCDSU. The Hayes AT command set is another in-band method, which is most commonly used when the connection between the DTE and SCDSU operates asynchronously. However, once the SCDSU receives the dialed address from the DTE, the SCDSU converts the address signaling to meet the requirements of the synchronous SW56 interface described previously.

In this situation just described, the SCDSU is usually called on to perform rate adaptation, as well, because of the asynchronous DTE. It is possible to send data from the DTE to SCDSU at asynchronous rates up to 57.6 kb/s. The SCDSU strips the start and stop bits from the data and adapts the remaining payload bits to the 56 kb/s synchronous rate.

5. Overview of SW56 Interface Types

All SW56 interface types provide full-duplex transmission, but the technologies are very different. Type I SW56 uses a 4-wire metallic interface with a separate transmit and receive path, each operating at the 56 kb/s line rate. The line rate equals the payload rate because no out-of-band overhead is required for signaling. Signaling is via in-band bipolar patterns that include intentional bipolar violations. Type I uses a modified Alternate Mark Inversion (AMI) line code with intentional bipolar violations for zero suppression and network control. The line signals are equivalent to the 56 kb/s DDS without secondary channel. However, the path signals are different than DDS because they need to accommodate the in-band supervision and address signaling associated with a Type I SW56 connection.

Type II SW56 uses a 2-wire metallic interface that operates in an analog mode and a digital mode. The analog mode is used for supervisory and address signaling. Once an end-to-end connection is established using the analog mode, the SCDSU is switched to the digital mode. Type II uses Time Compression Multiplexing (TCM), also called “ping-pong.” Bursts of data are sent over the local loop from one end at a 144 kb/s rate using the AMI line code. There is a dead-time between bursts so the other end of the local loop can send a burst of data at 144 kb/s rate. Thus, each end of the local loop alternates between a transmit and receive state to achieve full-duplex transmission. The data sent over the network between line circuits is smoothed and sent at a constant 56 kb/s rate.

Type III SW56 also uses TCM and the AMI line code on a 2-wire metallic interface. However, it only operates in the digital mode and the burst rate is 160 kb/s. Imbedded in each burst are two channels, one for signaling and the other for data. The signaling channel is for supervision and address signaling and operates at a rate of 8 kb/s. It is called an out-of-band channel because the bit positions for the signaling channel are separate from the data channel. The data channel operates at 64 kb/s. Each burst consists of a start and stop bit, 8 signaling bits and 64 data bits, for a total of 74 bits.

Table 3 summarizes the electrical characteristics of each interface type. The following sections discuss each interface type in greater detail.

Table 3
Interface Electrical Characteristics

Parameter	**Type I**	**Type II**	**Type III**
Line rate	56 kb/s	144 kb/s	160 kb/s
Interface	4-wire	2-wire	2-wire
Transmission method	Continuous	TCM	TCM
Line code	AMI (modified)	AMI	AMI
Impedance	135 ohms	120 ohms	135 ohms
Transmitter signal level	1.69 v-p	2.73 v-p	2.55 v-p
Modular connector	8-position (SJA56)	6-position (SJA48)	6-position (SJA48)

6. Line Coding Rules

This section provides a brief overview of the AMI line code and specific modifications to the AMI line code used with the Type I interface. These modifications provide a convenient method of transmitting network control information, and they also are used to ensure that the ones-density requirements are met for clock recovery at the receiver. No modifications are required for the Type II or Type III interface because ones-density is assured by scrambling the data before transmission on the loop and network control is by specific bit sequences.

With AMI, a binary 0 is transmitted as no pulse, or zero volts. A binary 1 is transmitted either as a 50% duty cycle positive or negative pulse, opposite in polarity to the previous binary 1. Two consecutive pulses with the same polarity indicate a line code violation (specifically, bipolar violation). However, with the Type I interface, intentional violations are used to convey network control information and to suppress strings of more than 7 consecutive zeros. Type II or III interfaces do not use intentional bipolar violations. The following notations apply to the Type I interface:

0 Zero volts transmitted, binary 0
B ± 1.69 v-p with polarity determined by normal AMI line code rule, binary 1
V ± 1.69 v-p with polarity in violation of the AMI line code rule, binary 1
X Either 0 or B depending on the need for and the desired polarity of a violation

The AMI line code is used to ensure that the signal carries no undesired dc component. Any intentional violations must also ensure that there is no latent dc component. Therefore, in the line code used with the Type I interface, a timeslot is reserved (designated by the symbol X) prior to any intentional violations for application of a pulse or no pulse in such a way that successive violations (designated by the symbol V) alternate in polarity. The desired polarity of intentional violations (V) is achieved by assigning a value 0 or B to X such that the total number of Bs since the last V is odd. It is not desirable to have adjacent pulses of the same polarity, so the X and V timeslots are separated by a 0, which gives an X0V pattern in each bipolar violation sequence.

As an illustration of how the X0V pattern is used, consider a continuously repeating Control Mode Idle, or CMI, sequence. The basic CMI sequence is BBBBX0V, so a continuous CMI sequence would be as shown in Fig. 2. Table 4 shows the patterns used with the Type I interface for various functions.

Fig. 2
Control Mode Idle Sequence

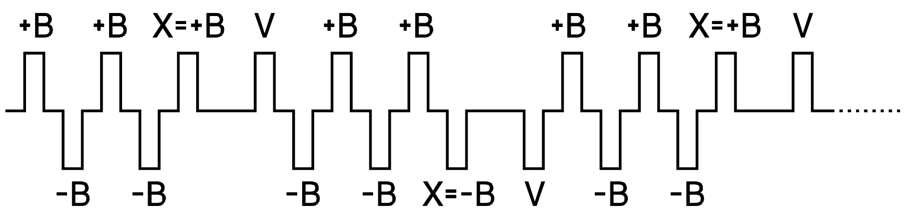


Table 4
Type I Interface Network Control Sequences

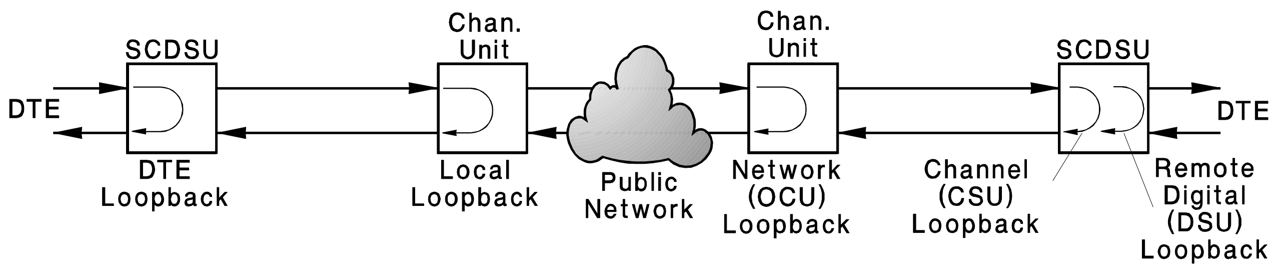
Sequence	Pattern
Customer-to-NI direction	
Control Mode Idle (CMI)	BBBBX0V, repeated
Zero Suppression	0000X0V is substituted for 0000000
Off-Hook (Data Mode)	BBBBBBB
NI-to-Customer direction	
Control Mode Idle (CMI)	BBBBX0V, repeated
Zero Suppression	000X0V is substituted for 000000
Out-Of-Service	000BX0V or B00BX0V, repeated
Out-Of-Frame	00BBX0V or B0BBX0V, repeated
Optional Channel Loopback	00B0X0V, repeated
Off-Hook (Data Mode)	BBBBBBB

7. Maintenance Modes

Each interface type has a maintenance mode, which provides various loopback functions. Loopbacks provide for remote testing and are helpful in isolating problems between the network and customer installation. Fig. 3 shows the location of the various loopbacks that apply to the Type I interface. Type II and Type III are capable of providing similar loopback functions. All modern SCDSUs are capable of providing a local DTE Loopback and initiating a Remote Digital Loopback at a remote SCDSU. In addition, when channel banks are used to provide SW56, the channel units have the Local and Network Loopback functions shown. The Network Loopback is also known as OCU Loopback.

Type I has a mandatory and optional channel loopback. The mandatory loopback uses reversal of the local loop simplex polarity to initiate loopback. This type of loopback is normally called CSU Loopback. The reversal is detected in the local SCDSU, which operates a loopback relay to connect the receive in signal from the network to the transmit out signal toward the network. The reversal is initiated by the central office line circuit or channel bank channel unit serving the local SCDSU. The receive in signal must be equalized and filtered before it is applied to the transmit out line driver circuitry, where it is shaped. This loopback is provided in the SCDSU as close to the network as possible within the constraints of equalizing, filtering and line driving.

Fig. 3
Loopbacks



The DSU loopback code is optionally passed to the SCDSU over the loop. The loopback code 00B0X0V is sent three or four times in succession. During loopback testing (after the loopback has been activated), the signal consists of alternating patterns of the loopback code and test patterns. The loopback is terminated by sending five successive 7 bit pattern intervals without the loopback code.

The Type II interface uses a combination of analog tones and digital data sequences for testing. A 2,713 Hz tone is sent from the central office line circuit over the local loop to the SCDSU for 1 second. The tone is superimposed on analog mode battery (ring negative with respect to tip) provided by the line circuit. The local SCDSU provides an analog mode termination immediately upon detecting the tone, which causes loop current to flow. After the 2,713 Hz tone is sent, the line circuit sends 2,025 Hz tone for 1 second, which should cause the SCDSU to provide a data mode termination after which the line circuit provides data mode battery (tip negative with respect to ring). The SCDSU loop-conditioning circuits are enabled when the SCDSU receives data mode battery. Within 3 seconds after the foregoing sequence is completed, the SCDSU should be in frame-sync and data incoming to the SCDSU from the network should be looped back to the network.

To take the SCDSU out of the maintenance state, the line circuit replaces data mode battery with analog mode battery on the loop. The SCDSU reverts to idle mode within 125 ms. The line circuit then sends a 2713 Hz tone for 1 second. Upon detecting the tone, the SCDSU provides an analog mode termination. After cessation of the tone, the SCDSU reverts once again to the idle mode. The Type II interface has no user-initiated loopback or RDL capability except as provided in the SCDSU.

The Type III interface uses a relatively extensive set of commands to place the SCDSU in various maintenance states, including local loopback, far-end loopback, network initiated loopback, and network initiated loop test. The commands are carried in the signaling channel and are listed in TIA/EIA-596. The Type III interface also has a user-initiated RDL, which is identical to that described for the Type I interface.

All modern SCDSUs used with all interface types also have a user-initiated remote digital loopback (RDL). The RDL uses special data signals and timing sequences to initiate a loopback at the remote SCDSU. The RDL is controlled by transmission of a pseudo-random bit sequences, known as PN127 for loop-up and !PN127 for loop-down. The method of generating and sending this sequence is described in CCITT Recommendation V.54.[7]

To initiate the RDL, the local SCDSU sends PN127 for 2.0 seconds followed by an all-ones pattern for an additional 2.0 seconds. During this time, the local SCDSU configures the DTE interface with DSR, RLSD, and CTS set to Off. This prevents the local DTE from attempting to interchange data. When the RDL sequence ends, the local SCDSU returns to its original operating state (the state it was in prior to starting the loopback sequence). After it has received a minimum of 256 ms of the PN127 pattern, the remote SCDSU enters the RDL state. Once in the RDL state, the remote SCDSU conditions its DTE interface with DSR and CTS set to Off to prevent the remote DTE from attempting data interchange.

To turn-off the RDL, the local SCDSU sends identical sequences except, in this case, the !PN127 pattern is used. After the all-ones pattern sequence, the remote SCDSU returns to its original operating state.

8. Call Progress

SCDSU Originated Call:

Idle - Under idle conditions, the network provides a logic-0 to the SW56 line circuit or channel unit on the A-bit signaling channel. The line circuit (or channel unit) converts this to the CMI code and sends it over the loop to the SCDSU as a pattern of 7 bits with intentional bipolar violations. Likewise, the SCDSU sends the CMI code over the loop to the line circuit. The line circuit converts the CMI code to frames of 7 bits at a logic-1 plus the eighth bit (least significant bit, LSB) set to logic-0; the latter indicates an idle control bit to the network.

SCDSU Call Origination - Upon call origination, the SCDSU sends Data Mode, which is logic-1 in all seven bit positions, over the loop to the line circuit to indicate an off-hook. The line circuit then sends a logic-1 in bit-8 position (along with a logic-1 in the other seven bit positions) toward the network to indicate a service request. When the network is ready to receive address digits, it responds with a wink on the A-bit signaling channel. The wink is a momentary off-hook of normal duration, 140 to 290 ms. During the wink, the network sends frames of 8 bits at logic-1, although the eighth bit is a logic-1 only during the 6th frame. The network wink is translated by the line circuit to an all-ones wink toward the SCDSU. When the wink is completed, the line circuit returns to sending the CMI code to the SCDSU.

Dialing - The SCDSU dials by alternating between the Data Mode and CMI using normal dial-pulse timing protocol. In response, the line circuit alternates between off-hook and on-hook toward the network in cadence with the dial pulses (eighth bit, or control bit, alternating between logic-1 and logic-0, all seven other bits set to logic-1). After dialing, the SCDSU returns to the Data Mode and sends a logic-1 in all 7 bit positions to the line circuit. The line circuit, in turn, sends a logic-1 in all eight bit positions to the network. Until the called station answers, the originating line receives the idle code (seven bits of logic-1 plus bit-8 at logic-0) from the network and any call progress signaling toward the SCDSU is blocked.

Answer - When the called station answers, the network sets the A-bit signaling channel to logic-1, which is a transition from CMI to the Data Mode. The originating line circuit sends this over the loop as 7 bit frames of all-ones. The SCDSU then sends data. Line circuits and channel units do not recognize call progress tones, such as ringback tone or busy tone. Unanswered calls cause the SCDSU to time-out after about 20 seconds.

Terminated Call:

Idle - The idle conditions described above also apply to this sequence.

Alerting - The network alerts the terminating line circuit of a terminating call by going off-hook; that is, sending Data Mode to the line circuit or channel unit. The terminating line circuit passes the Data Mode to the SCDSU as frames of all-ones.

Answer - When the terminating DTE answers the call, the associated SCDSU sends all-ones to the terminating line circuit, which is a transition from CMI to Data Mode. The line circuit passes this to the network as eight ones. The network then sends data to the terminating SCDSU.

9. Loop Design Considerations

The design considerations for each interface type take into account the loop loss at a specific frequency (depending on interface type), bridge tap lengths and gauge and, in the case of the Type III interface, one-way delay. The requirements are summarized in Table 5. Fig. 4, 5 and 6 give the loop loss vs. loop length at 21°C for each of the interfaces assuming a single gauge for the entire loop length and no bridged taps. A more thorough treatment of loop design issues is given in *Subscriber Loop Signaling and Transmission Handbook: Digital* by Reeve.[8]

Table 5
Loop Design Requirements

Parameter	**Type I**	**Type II**	**Type III**
No. Pairs required	2 pairs	1 pair	1 pair
Receiver loss range (including bridged taps)	0 to 34 dB at 28 kHz minimum, 0 to 45 dB typical	0 to 45 dB at 72 kHz	0 to 45 dB at 80 kHz
One-way delay range	N/A	N/A	0 to 31.25 µS
Maximum individual bridged tap length	2000 ft.	Not specified	Not specified ①
Total of all bridged taps	2500 ft.	Depends on loop loss ②	2500 ft ③
Background noise ④	≤ 36 dBrn50kb	Not specified	≤ 32 dBrn50kb
Impulse noise threshold ⑤	50 dBrn50kb	Not specified	49 dBrn50kb

① If all bridged taps are less than 1000 ft. long, then they may be ignored in the loss calculation.
② The total loss added by bridged taps must be less than the value shown in Fig. 1 for a given total loop loss.
③ If at least one bridged tap is more than 1000 ft. long, then the total of all bridged taps must ≤ 2500 ft.
④ Measured with 50 kb noise filter.
⑤ Maximum 7 counts in 15 minutes measured with 50 kb noise filter.

Fig. 4
Type 1 Interface Loop Loss vs. Length at 21°C

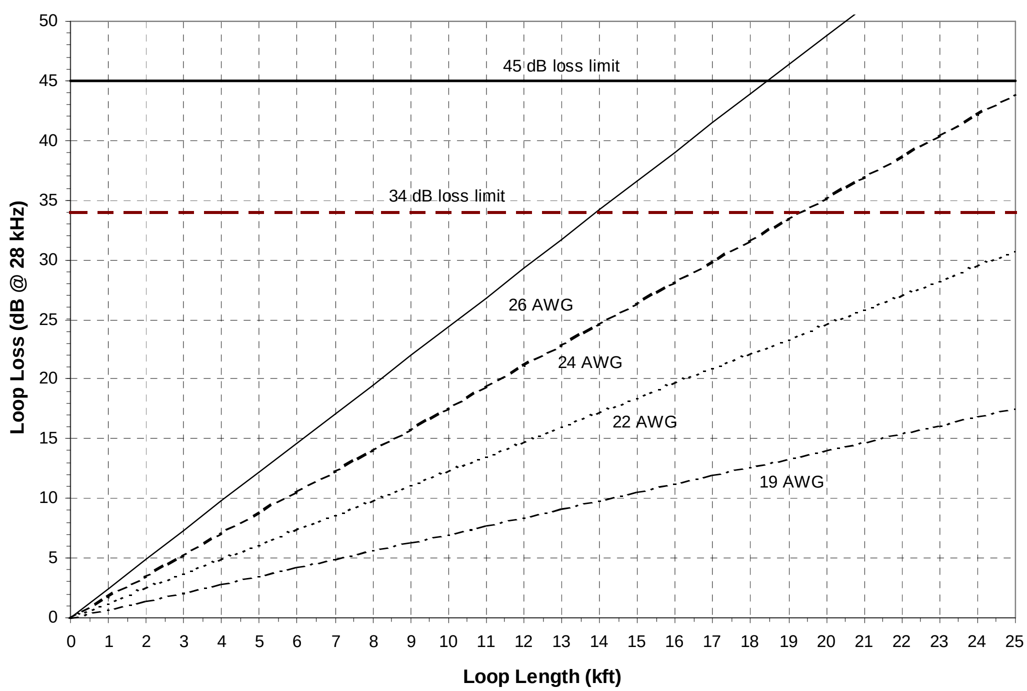


Fig. 5
Type II Interface Loop Loss vs. Length at 21°C

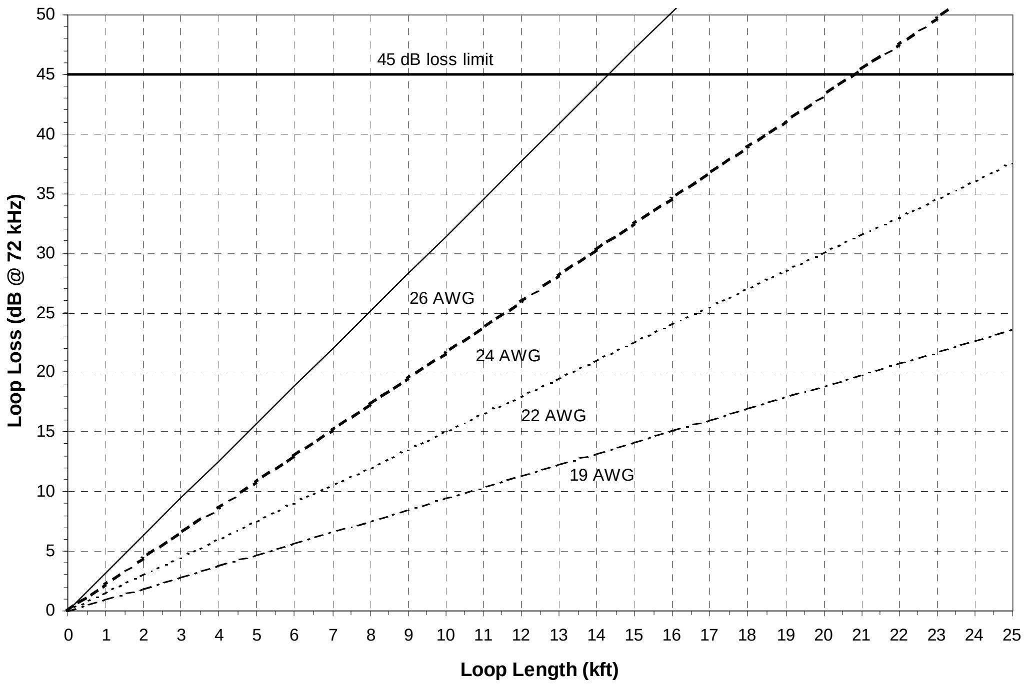
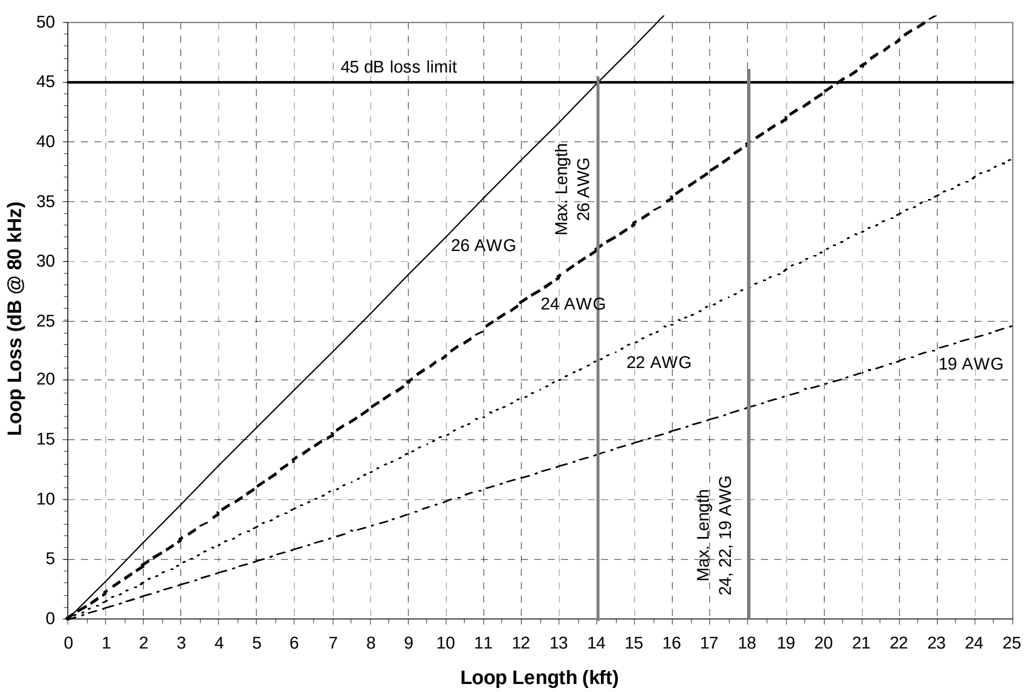


Fig. 6
Type III Interface Loop Loss vs. Length at 21°C



10. Connector Wiring

Two connector configurations are used with the three interface types: SJA56 (Type I) and SJA48 (Type II and III). These are defined in ATIS Report No. 5.[9] Fig. 7 shows the signal directions for the two pairs associated with the Type I interface. The pin assignments are summarized in Table 6.

Fig. 7
Signal Directions for Type I Interface

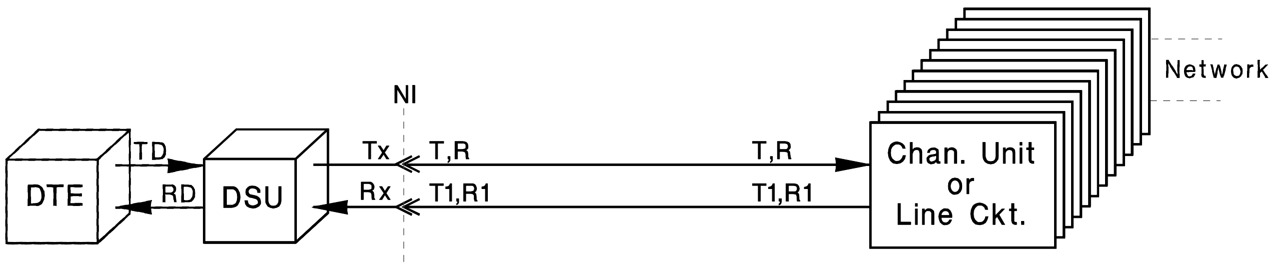


Table 6
Connector Pin Assignments

Pin No.	Type I	Type II	Type III
1	TR (R)	N/C	N/C
2	TT (T)	N/C	N/C
3	N/C	R	R
4	N/C	T	T
5	N/C	N/C	N/C
6	N/C	N/C	N/C
7	RT (T1)	N/A	N/A
8	RR (R1)	N/A	N/A
Configuration	SJA56	SJA48	SJA48

Note: For the Type I interface, the signal direction for T1/R1 is network-to-customer and for T/R is customer-to-network. For the Type II and III interfaces, the leads are bi-directional. N/C indicates No Connection and N/A indicates Not Applicable.

11. Interoffice Facilities

Although this application note focuses on the local loop aspects of SW56, it is necessary to consider the interoffice facilities and their impact on SW56 deployment. Of particular concern are the effect of echo control devices, digital pads, low bit-rate encoding and compression, and signaling.

Echo control devices, such as echo cancellors and echo suppressors, frequently are used in interexchange networks.[1] These devices are required for improved voice transmission when end-to-end delays longer than about 5 ms are involved. However, echo control devices are incompatible with SW56 and must be disabled during the call. Some interexchange carriers use out-of-band signaling (such as an analog tone) as a disabling signal, while other carriers require the calling SCDSU to send a specific data sequence as a disabling signal. CCITT Recommendation G.164[10] for echo suppressors requires that echo *suppressors* be equipped with a tone disabler operating at 2,100 Hz. Echo *cancellors* covered by CCITT Recommendation G.165 also use a 2,100 Hz disabling tone, but this tone has periodic phase reversals.[2][11]

In a connection involving two end offices connected through an interexchange carrier, the receive transmission level point (TLP) in each end office is set to -6 dB to meet the requirements of the digital network loss plan. Depending on the end office type, the 6 dB loss may be provided by analog pads, digital pads or a combination. The 6 dB of loss applies only to connections involving voice or voiceband data. Digital pads, in particular, alter bit values and cannot be used with SW56. Therefore, it is necessary to ensure that no digital padding is inserted in the path between the end office digital trunk interface and the SW56 line circuit.

Low bit-rate encoding and compression systems are designed to increase the efficiency of interexchange transmission facilities that are used for voice. These systems change the bit values in the DS-0 transmission channels and cannot be used with SW56. If fact, any transmission method that alters byte content or does not guarantee bit integrity cannot be used with SW56.

To meet the above requirements, interoffice trunk groups used to carry SW56 should be dedicated to 56 kb/s data and should not carry voice or analog voiceband data traffic.

DS-1 facilities, or broadband facilities with embedded DS-1 channels, normally will be used for interoffice transport of SW56. These facilities may be shared with other communication services. DS-1 facilities used for trunking use either SF (commonly called D3/D4) or ESF frame structure with robbed bit signaling.[3] In some cases, the interoffice signaling is out-of-band, such as through a common channel signaling system like Signaling System No. 7. SW56 is compatible with all of these configurations. However, it is necessary to ensure that the ones-density requirements are met on the DS-1 facilities.

There are several ways of meeting the ones-density requirements. One way is to use the B8ZS line code, which applies in particular to repeatered T1-carrier transmission facilities. Another way is to ensure that the eighth bit of every frame is set to one when transmitting data over the channels

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[1] Echo suppressors reduce transmission impairments due to echo by inserting loss in the transmission path. Echo cancellors reduce impairments due to echo on the send path by subtracting an estimation of that echo from the near-end echo.

[2] Recommendation G.165 is compatible with all V-series modems, while Recommendation G.164 is not.

[3] The frame structure includes two components: Framing and formatting. Framing refers to a synchronous pattern used to establish timeslot boundaries. Formatting refers to the sequencing of the 24 timeslots and the allocation of the timeslots to their respective DS-0 channels. Robbed bit signaling is an in-band signaling technique that preempts (or robs) the least significant bit (bit 8) in a timeslot on selected frames. With D3/D4, frames 6 and 12 are used for the A and B channels, respectively. With ESF, frames 6, 12, 18 and 24 are used for the A, B, C and D channels, respectively. When robbed bit signaling is used with voice transmission, bit-8 is used for encoded voice in all other frames and the voice signal quality is not significantly degraded. However, with SW56, bit-8 is not available for user data.

associated with SW56. At other times, such as idle state or call setup, bit-8 may be equal to one as long as pulse density requirements are met and the A/B signaling bits equal zero to indicate on-hook and one to indicate off-hook.

Table 7
Trunk Group Parameters

Incoming		**Outgoing**	
Address signaling:	MF	Address signaling:	MF
Start-dial signal:	Wink	Start-dial signal:	Wink
Answer supervision provided over trunk:	Yes	Answer supervision provided over trunk:	Yes
Number of digits:	Minimum required	Number of digits:	10
Busy treatment:	Busy tone	Glare resolution:	LEC resolves glare
Ringback tone:	Yes		

In general, trunks may be 1-way incoming, 1-way outgoing, or 2-way (directions refer to the end office). In most situations, 2-way trunks will be used with SW56. Normally, the incoming and outgoing parameters of 2-way trunks are specified independently. Although certain parameter combinations should be avoided, there should be no restrictions with modern switching systems. Table 7 shows the recommended parameter settings for interoffice trunks.

In general, wink start signaling should be used in both directions. Delay dial/start dial (DDSD) is a viable alternative to wink start, but glare resolution with wink start is faster than DDSD. Immediate start signaling should be avoided because it provides neither an integrity check nor a means to detect glare on 2-way trunks. MF signaling in both directions is recommended on interoffice facilities because of its speed advantage over dial-pulse. Note that the SCDSU uses dial-pulse signaling to the end office line circuit. The end office stores and analyzes the digits and outpulses them to the interexchange carrier using MF.

12. References

[1] TIA/EIA-596, Network Channel Terminating Equipment for Public Switched Digital Service, Telecommunications Industry Association, February, 1983.

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Availability: TIA/EIA standards are available from Global Engineering Documents by calling 1+800-854-7179. AT&T documents are available from AT&T Customer Information Center, Order Entry, 2855 North Franklin Road, Indianapolis, IN 46219-1999, tel. 1+800-432-6600, fax 1+317-322-6699. Bellcore documents are available from Bellcore by calling 1+800-521-2673. US Government publications are available from the US Government Printing Office by calling 1+202-. ATIS documents are available by calling the Alliance for Telecommunication Industry Solutions at 1+202-434-8845. IEEE Press books are available from IEEE Press by calling 1+800-678-IEEE. Most CCITT and ITU recommendations through December 1994 are available on CD-ROM at very low cost ($30) from InfoMagic, P.O. Box 30370, Flagstaff, AZ 86003-0370, tel. 1+800-800-6613, fax 1+602-526-9573. Recommendations and standards are also available on CD-ROM or paper directly from ITU, Sales Service, CH-1211, Geneve 20 (Switzerland), fax 41+22-730-5194. The CCITT Blue Book and many individual ITU recommendations are available from NTIS, US Department of Commerce, Springfield, VA 22161, fax 1+703-321-8547.

Note to Readers:

Readers are encouraged to send their opinions, suggestions and comments. Subscribe to application notes or contact the author at any of the following addresses:

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