Circuit Associated Signaling Trunk Analysis – Part I

1. Introduction

This application note describes the signals, digits and digit sequences used in Circuit Associated Signaling (CAS) trunks and includes end office, interexchange carrier and PBX trunks. CAS trunks are trunks in which the voice frequency channel is used for both signaling (supervision, call setup and call takedown) and speech transmission. Part II of this application note describes detailed test procedures using common DS-1 test sets.

Three components are involved in CAS trunk operation –

- Supervision
- Address Digits
- Signaling Sequence

Supervision: Digital trunks setup for CAS use robbed bit signaling (RBS) to convey supervisory states (on-hook, off-hook and wink status) and multi-frequency tones to convey digits. If a DS1 interface is used for interconnection and is set for SF (D3/D4) framing, then RBS includes A- and B-signaling bits and if set for ESF framing, then RBS includes A-, B-, C- and D-signaling bits.

CAS trunks used in interoffice applications require only the A-bit for operation and the other bits B-, C- and D-bits, as applicable to the type of framing used, follow the A-bit. CAS trunks used in some digital loop carrier applications, such as TR8 interfaces, and in PBX DOD/DID (Direct Outward Dial/Direct Inward Dial) applications, require both A- and B-bits for signaling with SF framing. Where ESF is used, the C- and D-bits follow the A- and B-bits in most cases. GR303 integrated digital loop carrier interfaces always are set for ESF and may also use robbed bit signaling. Tables are provided later that define the signaling states used with common trunking schemes using SF and ESF framing and with GR303.[1]

Analog and digital PBX DOD trunks use Loop-Start or Ground-Start FXO (Foreign Exchange – Office) and FXS (Foreign Exchange – Station) supervision. Analog PBX DID trunks usually use Loop-Reverse Battery (LRB) supervision, and digital PBX DID trunks can use either LRB or E&M supervision (digital supervision of LRB and E&M are identical). It is common for DOD and DID trunks to be combined on the same DS1 interface (with some channels assigned as DOD trunks and other channels as DID trunks), but not all end office switching systems and PBXs support combined DOD/DID.

Address Digits: Trunk addressing methods use multi-frequency schemes in which each digit is represented by two unique frequencies or tones. Interoffice trunks use MF-R1 (also known simply as MF) and PBX DOD/DID trunks usually use DTMF (Dual Tone Multi-Frequency). In some cases, PBX DID trunks may use MF.

MF is a 2-of-6 frequency scheme in which each digit is represented by two of six frequencies (700, 900, 1100, 1300, 1500, and 1700 Hz). In addition to the address numerals 0 – 9, MF includes control digits to indicate the beginning and end of a digit string (KP and ST, respectively) and operator control functions such as coin collect and return. For example, a 7-digit directory number would be transmitted as KP+NXX-XXXX+ST.

[1] This document only lists GR303 RBS states and does not describe the protocol.

DTMF is a 2-of-8 scheme in which each digit is represented by two of eight frequencies (697, 770, 852, 941, 1209, 1336, 1477, and 1633 Hz). There are 16 possible combinations in a 2-of-8 scheme but only 12 are used in most applications (0 – 9, *, and #). The last four digits (A, B, C and D) were used in some military and old PBX applications but current switching systems do not support them. DTMF digit strings do not have start and stop digits as in MF. For example, a 7-digit number would be transmitted as NXX-XXXX. MF and DTMF use similar but not exactly the same transmission levels and timing intervals.

Signaling Sequences: Signaling sequences, or signaling protocols, specify the order of signaling state (supervision) changes and digit transmission. There are four basic signaling sequences used with CAS trunks depending on the application – Interoffice, FGC, FGD, and PBX. PBX signaling sequences vary with the application and include DID and DOD.

GR303 interfaces use an embedded DS0 data link between the Integrated Digital Terminal (IDT) and the Remote Digital Terminal (RDT) called the Embedded Operations Channel (EOC) to transmit operations messages (for example, alarms). GR303 interfaces also use a separate DS0 data link to perform per-call timeslot assignments (Timeslot Management Channel – TMC) in conjunction with the RBS previously described (this is called *hybrid* signaling). This same channel can be used to transmit call processing (call setup and supervisory) messages via a common channel (Common Signaling Channel – CSC), in which case RBS is not required (this is called *inband* signaling). The EOC and TMC/CSC use the Link Access Protocol for the D-Channel (LAPD), and call processing messages are based on ITU-T Recommendation Q.931. Common channel signaling methods are beyond the scope of CAS trunking and are not discussed in this issue.

Table 1-1 summarizes the various application signaling sequences, addressing, supervision and applicable signaling state tables. Table 1-2 shows the tone addressing schemes and Tables 1-3 through 1-14 show on-hook and off-hook signaling states for the A-, B-, C- and D-bits as they are used with various application types. In Tables 1-3 and 1-7, “Office A” is the near-end location and “Office Z” is the far end.

Additional information on signaling sequences is provided in Section 2.

Table 1-1 – Applications

Signaling Sequence	Addressing	Supervision	Tables
Interoffice	MF-R1	Interoffice	1-3 and 1-7
Toll FGC or FGD	MF-R1	Interoffice	1-3 and 1-7
PBX DOD	DTMF	Loop-Start or Ground-Start	1-4, 1-5, 1-8, 1-9
PBX DID	DTMF	Loop-Reverse Battery	1-6 and 1-10
GR303	Transparent	Common Channel & RBS	1-11 to 1-14

Table 1-2 – MF and DTMF Addressing Schemes

MF-R1		DTMF	
Frequency-Pair (Hz)	**Digit**	**Frequency-Pair (Hz)**	**Digit**
700-900	1	697-1209	1
700-1100	2	697-1336	2
900-1100	3	697-1477	3
700-1300	4	770-1209	4
900-1300	5	770-1336	5
1100-1300	6	770-1477	6
700-1500	7	852-1209	7
900-1500	8	852-1336	8
1100-1500	9	852-1477	9
1300-1500	0	941-1209	*
1100-1700	KP	941-1336	0
1500-1700	ST	941-1477	#
900-1700	STP	697-1633	A
1300-1700	ST2P	770-1633	B
700-1700	ST3P	852-1633	C
		941-1633	D
KP signal duration, minimum/nominal	55/110 ms	Cycle time, minimum	93 ms
All other signal duration, minimum/nominal	30/70 ms	Pulse duration, minimum	40 ms
Signal-off time, minimum	25 ms	Signal-off time, minimum	40 ms
Inter-digit interval, minimum/nominal	25/70 ms	Inter-digital interval, minimum	40 ms
Rise time, maximum	10 ms	Rise time, maximum	10 ms
Tone level	–6 to –8 dBm0	Tone level (transmit)	–6 dBm0
Frequency tolerance	±1.5%	Frequency tolerance	±1.5%
Twist	1 dB	Twist	+4 to –8 dB

Table 1-3 – CAS Trunk RBS States – Interoffice (E&M): SF Framing

State	A	B
Office A → Office Z		
On-Hook	0	0
Off-Hook	1	1
Office A ← Office Z		
On-Hook	0	0
Off-Hook	1	1

Table 1-4 – CAS Trunk RBS States – FXO/FXS Loop-Start Signaling: SF Framing

State	A	B
Loop-Start Signaling (FXO)		
Network → Customer		
Loop Current Feed	0	1
Ringing (alternates with Loop Current Feed state)	0	0
Loop-Start Signaling (FXS)		
Network ← Customer		
Loop Open (On-Hook)	0	1
Loop Closed (Off-Hook)	1	1
Loop-Start Signaling with Reversal (FXO)		
Network → Customer		
Loop Current Feed	0	1
Reverse Loop Current Feed[2]	0	1/0
Reverse Loop Current Feed Open	1	1
Ringing (alternates with Loop Current Feed state)	0	0
Loop-Start Signaling with Reversal (FXS)		
Network ← Customer		
Loop Open (On-Hook)	0	1
Loop Closed (Off-Hook)	1	1

[2] B-bit alternates between 1 and 0 in successive superframes.

Table 1-5 – CAS Trunk RBS States – FXO/FXS Ground-Start Signaling: SF Framing

State	A	B
Ground-Start Signaling (FXO)		
Network → Customer		
Loop Current Feed (Tip ground)	0	1
Loop Current Feed Open (Tip open)	1	1
Ringing (alternates with Loop Current Feed state)	0	0
Ground-Start Signaling (FXS)		
Network ← Customer		
Loop Open (On-Hook)	0	1
Loop Closed (Off-Hook)	1	1
Service Request (Ring Ground)	0	0
Ground-Start Signaling with Reversal (FXO)		
Network → Customer		
Loop Current Feed (Tip ground)	0	1
Reverse Loop Current Feed (Ring ground)[3]	0	1/0
Loop Current Feed Open (Tip open)	1	1
Ringing (alternates with Loop Current Feed state)	0	0
Ground-Start Signaling with Reversal (FXS)		
Network ← Customer		
Loop Open (On-Hook)	0	1
Loop Closed (Off-Hook)	1	1
Service Request (Ring Ground)	0	0

Table 1-6 – CAS Trunk RBS States – Loop-Reverse Battery (LRB): SF Framing

State	A	B
Network → Customer		
Loop Open (On-Hook)	0	0
Loop Closed (Off-Hook)	1	1
Network ← Customer		
Loop Current Feed (On-Hook)	0	0
Reverse Loop Current Feed (Off-Hook)	1	1

[3] B-bit alternates between 1 and 0 in successive superframes.

Table 1-7 – CAS Trunk RBS States – Interoffice (E&M): ESF Framing

State	A	B	C	D
Office A → Office Z				
On-Hook	0	0	0	0
Off-Hook	1	1	1	1
Office A ← Office Z				
On-Hook	0	0	0	0
Off-Hook	1	1	1	1

Table 1-8 – CAS Trunk RBS States – FXO/FXS Loop-Start Signaling: ESF Framing

State	A	B	C	D
Loop-Start Signaling (FXO)				
Network → Customer				
Loop Current Feed	0	1	0	1
Ringing (alternates with Loop Current Feed state)	0	0	0	0
Loop-Start Signaling (FXS)				
Network ← Customer				
Loop Open (On-Hook)	0	1	0	1
Loop Closed (Off-Hook)	1	1	1	1
Loop-Start Signaling with Reversal (FXO)				
Network → Customer				
Loop Current Feed	0	1	0	1
Reverse Loop Current Feed	0	1	0	0
Reverse Loop Current Feed Open	1	1	1	1
Ringing (alternates with Loop Current Feed state)	0	0	0	0
Loop-Start Signaling with Reversal (FXS)				
Network ← Customer				
Loop Open (On-Hook)	0	1	0	1
Loop Closed (Off-Hook)	1	1	1	1

Table 1-9 – CAS Trunk RBS States – FXO/FXS Ground-Start Signaling: ESF Framing

State	A	B	C	D
Ground-Start Signaling (FXO)				
Network → Customer				
Loop Current Feed (Tip ground)	0	1	0	1
Loop Current Feed Open (Tip open)	1	1	1	1
Ringing (alternates with Loop Current Feed state)	0	0	0	0
Ground-Start Signaling (FXS)				
Network ← Customer				
Loop Open (On-Hook)	0	1	0	1
Loop Closed (Off-Hook)	1	1	1	1
Service Request (Ring Ground)	0	0	0	0
Ground-Start Signaling with Reversal (FXO)				
Network → Customer				
Loop Current Feed (Tip ground)	0	1	0	1
Reverse Loop Current Feed (Ring ground)	0	1	0	0
Loop Current Feed Open (Tip open)	1	1	1	1
Ringing (alternates with Loop Current Feed state)	0	0	0	0
Ground-Start Signaling with Reversal (FXS)				
Network ← Customer				
Loop Open (On-Hook)	0	1	0	1
Loop Closed (Off-Hook)	1	1	1	1
Service Request (Ring Ground)	0	0	0	0

Table 1-10 – CAS Trunk RBS States – Loop-Reverse Battery (LRB): ESF Framing

State	A	B	C	D
Network → Customer				
Loop Open (On-Hook)	0	1	0	1
Loop Closed (Off-Hook)	1	1	1	1
Network ← Customer				
Loop Current Feed (On-Hook)	0	1	0	1
Reverse Loop Current Feed (Off-Hook)	0	1	0	0

Table 1-11 – GR303 RBS States – Locally Switched – IDT → RDT

A	B	C	D	Loop Start	Ground Start	Loop-Reverse Battery	Coin		
							Coin First (CF)	Dialtone First (DTF)	Multiparty
0	0	0	0	-R Ringing	-R Ringing		-R Ringing	-R Ringing	-R Ringing
0	0	0	1						
0	0	1	0	DS0 AIS	DS0 AIS	DS0 AIS	DS0 AIS	DS0 AIS	DS0 AIS
0	0	1	1						
0	1	0	0	RLCF	RLCF		RLCF	RLCF	
0	1	0	1	LCF	LCF	LO	LCF	LCF	LCF
0	1	1	0						
0	1	1	1	DS0 Yellow	DS0 Yellow	DS0 Yellow	DS0 Yellow	DS0 Yellow	DS0 Yellow
1	0	0	0	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved
1	0	0	1	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved
1	0	1	0				+ Coin Check	+ Coin Check	+R Ringing
1	0	1	1				- Coin Check	- Coin Check	Tip Party Test
1	1	0	0				+ Coin Control	+ Coin Control	+T Ringing
1	1	0	1	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved
1	1	1	0				- Coin Control	- Coin Control	-T Ringing
1	1	1	1	LCFO	LCFO	LC	LCFO	LCFO	LCFO

See key after Table 1-14

Table 1-12 – GR303 RBS States – Locally Switched – RDT → IDT

A	B	C	D	Loop Start	Ground Start	Loop-Reverse Battery	Coin		
							Coin First (CF)	Dialtone First (DTF)	Multiparty
0	0	0	0		Ring Ground				
0	0	0	1						
0	0	1	0	DS0 AIS	DS0 AIS	DS0 AIS	DS0 AIS	DS0 AIS	DS0 AIS
0	0	1	1						
0	1	0	0			RLCF			
0	1	0	1	LO	LO	LO	LO	LO	LO
0	1	1	0						
0	1	1	1	DS0 Yellow	DS0 Yellow	DS0 Yellow	DS0 Yellow	DS0 Yellow	DS0 Yellow
1	0	0	0	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved
1	0	0	1	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved
1	0	1	0						
1	0	1	1						
1	1	0	0						
1	1	0	1	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved
1	1	1	0				Coin Ground	Coin Ground	Tip Party Ground
1	1	1	1	LC	LC		LC	LC	LC

See key after Table 1-14

Table 1-13 – GR303 RBS States – Non-Locally Switched – DNE → RDT

				FXS at RDT		FXO at RDT		
A	**B**	**C**	**D**	**Loop Start**	**Ground Start**	**Loop Start**	**Ground Start**	**All Others**
0	0	0	0	-R Ringing	-R Ringing	LO	Ring Ground	Possible Use
0	0	0	1	-R Ringing	-R Ringing			
0	0	1	0	DS0 AIS	DS0 AIS	DS0 AIS	DS0 AIS	DS0 AIS
0	0	1	1					
0	1	0	0	RLCF	RLCF			
0	1	0	1	LCF	LCF	LO	LO	Possible Use
0	1	1	0					
0	1	1	1	DS0 Yellow	DS0 Yellow	DS0 Yellow	DS0 Yellow	DS0 Yellow
1	0	0	0					
1	0	0	1	Reserved	Reserved	Reserved	Reserved	Reserved
1	0	1	0					Possible Use
1	0	1	1					
1	1	0	0					
1	1	0	1					
1	1	1	0					
1	1	1	1	LCFO	LCFO	LC	LC	Possible Use

See key after Table 1-14

Table 1-14 – GR303 RBS States – Non-Locally Switched – RDT → DNE

				FXS at RDT		FXO at RDT		
A	**B**	**C**	**D**	**Loop Start**	**Ground Start**	**Loop Start**	**Ground Start**	**All Others**
0	0	0	0		Ring Ground	-R Ringing	-R Ringing	Possible Use
0	0	0	1					
0	0	1	0	DS0 AIS	DS0 AIS	DS0 AIS	DS0 AIS	DS0 AIS
0	0	1	1					
0	1	0	0					
0	1	0	1	LO	LO	LCF	LCF	Possible Use
0	1	1	0					
0	1	1	1	DS0 Yellow	DS0 Yellow	DS0 Yellow	DS0 Yellow	DS0 Yellow
1	0	0	0					
1	0	0	1	Reserved	Reserved	Reserved	Reserved	Reserved
1	0	1	0					Possible Use
1	0	1	1					
1	1	0	0					
1	1	0	1					
1	1	1	0					
1	1	1	1	LC	LC	LCFO	LCFO	Possible Use

Key:

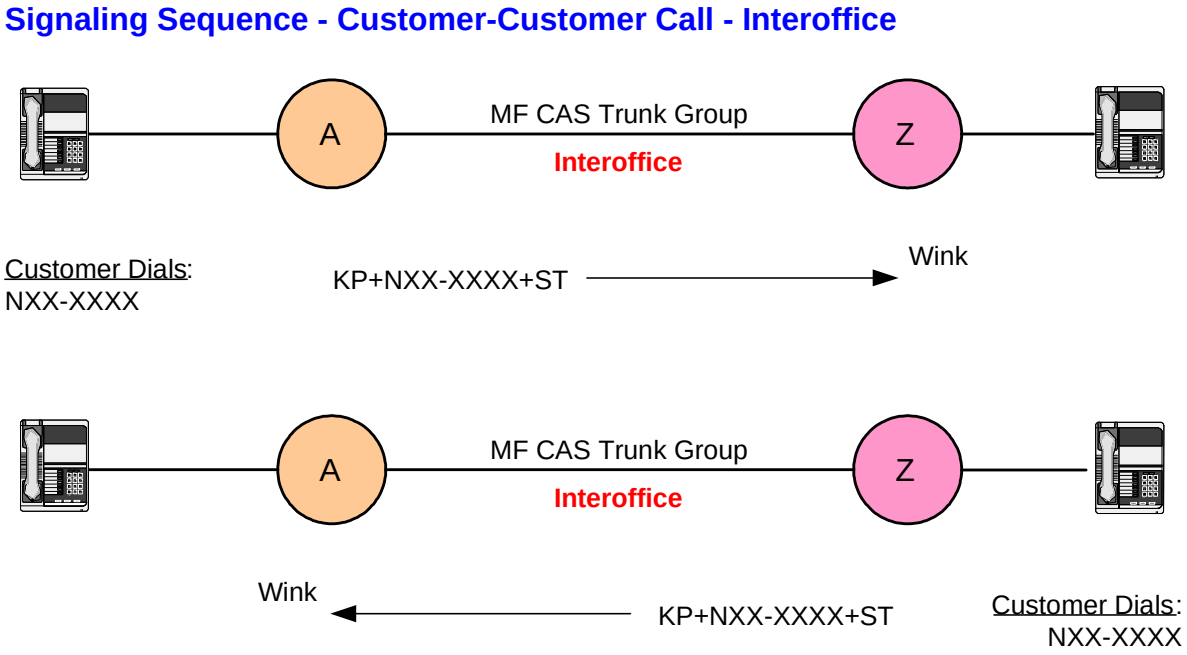
Undefined

LC	Loop closure
LO	Loop open
LCF	Loop current feed
RLCF	Reverse loop current feed
LCFO	Loop current feed open
DNE	Digital network element

2. Signaling Sequences

The signaling sequence depends on the application. The sequences for simple interoffice trunk applications are shown in Fig. 2-1. This sequence is simple wink start in both directions and includes the 4-, 7- or 10-digit called number (7 digits are shown). The sequence has no billing or network control capabilities.

Fig. 2-1 – Interoffice Trunk Signaling Sequences



The sequences for outgoing toll trunk applications are according to one of two basic protocols – Feature Group C and Feature Group D. These sequences include billing and network control features. Feature Group C (FGC) normally is used only in non-equal access end offices and in some equal access end offices on some AT&T operator services trunks and on some AT&T DAMA earth station trunks. Feature Group D (FGD) is the preferred protocol in equal access end offices that do not use SS7 and is used in equal access end offices on trunks to all inter-exchange carriers (including AT&T operator and DAMA trunks in most locations).

FGC (also called FGC CAMA) consists of 2-stage outpulsing from end office to carrier and 1-stage outpulsing from carrier to end office. Both directions use wink start. In the end office to carrier direction, the first stage consists of the called number and is initiated by a wink start. The second stage is initiated by an off-hook from the carrier and consists of an ANI (Automatic Number Identification, or calling number) information digit followed by the ANI itself.[4] KP and ST digits delineate each digit string (called number and calling number with ANI Info). In the outgoing direction, the digit string stop digit (ST) can take on several forms depending on the originating line – ST, STP, ST2P and ST3P (the last three are sometimes pronounced ST-Prime, ST-Double-Prime and ST-Triple-Prime and shown as ST', ST'' and ST''', respectively). On toll completing calls to the end office from the carrier, wink start is used to send the called number only (usually 7 digits but sometimes 4 digits). See Fig. 2-2.

[4] The 2nd stage off-hook may be replaced by a wink in certain carrier interconnections (but not in Alaska).

FGD signaling includes two basic configurations, one without an Access Tandem (direct access) and one with an Access Tandem (tandem access). An Access Tandem is a switching system that collects toll traffic from one or more individual end offices and routes the traffic to the appropriate interexchange carrier. In the other direction, the Access Tandem accepts traffic from the interexchange carrier and routes it to the appropriate end office. The Access Tandem can improve the efficiency of access to and from a local network by an interexchange carrier. There are many factors that affect an interexchange carrier's choice of using direct or tandem trunks, including trunk group efficiency, location of the carrier's Point-of-Presence (POP), technical limitations in the end offices, and others. The signaling from the end office to an Access Tandem differs from the end office direct to an interexchange carrier.

End Office Direct to Interexchange Carrier: Direct access FGD consists of 2-segment, 1-stage outpulsing on domestic calls and 3-segment, 2-stage outpulsing on international calls. On domestic toll calls from the end office to the carrier, the two segments consist of the calling number with ANI Info followed by the called number. Wink start is used to initiate digit outpulsing and an acknowledgement wink is used at the end of the second segment.

On international calls, the sequence is a little more complicated. The first segment consists of a tandem routing code, or 1NX digits (either 138 or 158), followed by the 4-digit carrier identification code and 3 digits to indicate the country code (if necessary, the country code is padded with one or two leading zeros to bring it to 3 digits). After the first segment, the carrier returns another wink to initiate the next two segments, which include the calling number (including ANI Info) and called number, and are similar to domestic calls. The last segment is completed by an acknowledgement wink from the carrier. Incoming toll (toll completing to the end office) always uses wink start and usually are configured for 7 digits. Direct FGD toll trunk signaling sequences are shown in Fig. 2-3.

End Office to Interexchange Carrier via Access Tandem: Tandem access FGD consists of 2-stage, 3-segment outpulsing on both domestic and international calls. The 1st stage provides carrier routing information to the Access Tandem. On domestic calls, this includes a 0ZZ tandem routing code (the digits 0ZZ are specified by the interexchange carrier) and the carrier access code. On international calls, the signaling sequence includes 1NX digits (which replaces the 0ZZ code used in domestic calls) to indicate whether the call is IDDD[5] or operator assisted, carrier access code and country code. The country code (CCC) is sent to allow the Access Tandem to screen or validate the call prior to disposition. The 2nd stage is very similar to the domestic 2nd stage except that the called number includes the country code and the national number (NN). Access Tandem FGD toll trunk signaling sequences are shown in Fig. 2-4(a) for domestic and 2-4(b) for international calls.

MF CAS trunks usually use a wink after seizure to indicate that a digit receiver is connected and ready to collect digits and also to acknowledge digit reception in FGD. A wink is a short off-hook transition (from on-hook to off-hook and back to on-hook) of the signaling bits. Wink duration is at least 140 ms and averages around 240 ms, but longer winks may be observed. A few applications use Immediate-Dial, in which digits are outpulsed almost immediately after seizure (a short delay of 50-70 ms is imposed between seizure and outpulsing), or Delay Dial, in which digits are not outpulsed until the extended wink start signal returns to the on-hook state.

[5] IDDD: International Direct Distance Dialing.

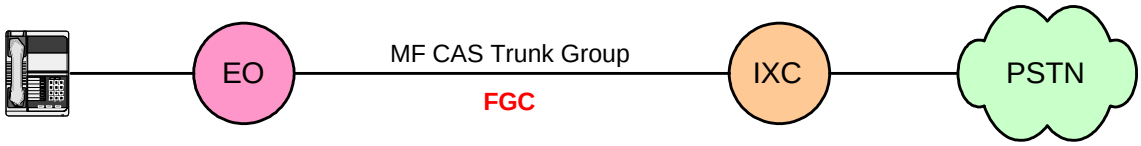
Outgoing toll trunk signaling sequences include ANI (calling number) digits and ANI Information digits. A 1-digit ANI Info digit (sometimes indicated as "ANI I") is used with FGC and a 2-digit ANI Info digit ("ANI II") is used with FGD. Occasionally, trunks with a 2-digit ANI Info will be used with FGC. FlexANI is a term commonly used to indicate ANI II in FGD trunk groups. FlexANI simply is the flexible assignment of specific ANI Info digits to individual subscriber lines or groups of subscriber lines. The default ANI Info digits are 00 for POTS lines. Payphones, special billing lines and hotel/motel lines are examples of line types that use different ANI Info digits. The functions of the ANI Info digits are shown in Table 2-1.

PBX signaling sequences are similar to interoffice trunk applications except that digit string start and stop digits (KP and ST) are not used with DTMF tones. Fig. 2-5 shows typical sequences. The number of DOD digits will depend on the digits dialed by the PBX station user and how the PBX and end office are setup to handle those digits (a 7 digit local number is shown). DOD trunks carry digits only in the PBX to end office direction. DOD includes 2-way operation, while DID is 1-way (outgoing from end office) only. In many applications, DOD is combined on the same digital trunk interface as DID. Where DOD and DID share the same channels, the DOD is setup as 1-way incoming (to end office) and the DID provides 1-way outgoing service. Where DOD and DID are on separate channels, the DOD is setup as 2-way on some channels and DID is setup on other channels of the T1. Where analog DOD and DID interfaces are involved, any given interface either is DOD (usually 2-way) or DID and no combination is possible.

The DID digits sent from the end office to the PBX depend on particular setups but typically are the last 3 or 4 dialed digits of the dialed number and, in most applications, correspond to the PBX station number. Where DID is used on a T1 interface, the RBS states for loop-reverse battery or E&M are used (Tables 1-3, 1-6, 1-7 and 1-10). Where DOD is used on a T1 interface, the RBS states for FXO/FXS loop-start or FXO/FXS ground-start are used (Tables 1-4, 1-5, 1-8 and 1-9). The signaling/supervision states for loop-start and ground-start analog interfaces are shown graphically in Fig. 2-6 and 2-7, respectively. These analog signaling state diagrams also apply to digital trunk interfaces by appropriate substitution of RBS states.

Fig. 2-2 – Feature Group C Toll Trunk Signaling Sequences

Originating Signaling Sequence - Customer-to-IXC Call - FGC



Customer Dials: 1+NPA-NXX-XXXX	KP+NPA-NXX-XXXX-ST( ) →	Wink
	KP+I-7D ANI-ST →	Off-Hook
Customer Dials: 0+NPA-NXX-XXXX	KP+NPA-NXX-XXXX-ST( ) →	Wink
	KP+I-7D ANI-ST →	Off-Hook
Customer Dials: 0-	KP+ST( ) →	Wink
	KP+I-7D ANI-ST →	Off-Hook
Customer Dials: 011+CC-NN	KP+1+CC-NN-ST( ) →	Wink
	KP+I-7D ANI-ST →	Off-Hook
Customer Dials: 01+CC-NN	KP+1+CC-NN-ST( ) →	Wink
	KP+I-7D ANI-ST →	Off-Hook
Customer Dials: 411	KP+907-555-1212-ST( ) →	Wink
	KP+I-7D ANI-ST →	Off-Hook
Customer Dials (Alternate): 411	KP+411-ST( ) →	Wink
	KP+I-7D ANI-ST →	Off-Hook

ST( ) Depends on Originating Line Type

1+ Non-Coin	ST2P
1+ Coin	ST
0+/0- Non-Coin	ST3P
0+/0- Coin	STP

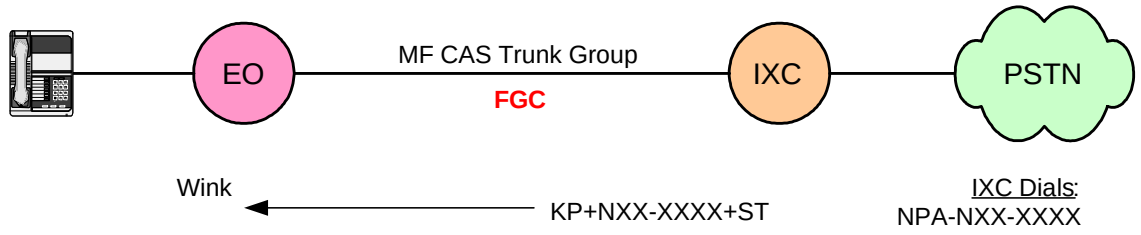


Fig. 2-3 – Feature Group D Toll Trunk Signaling Sequences - Direct

Originating Signaling Sequence - Customer-to-IXC Call - FGD

Customer Dials:
1+NPA-NXX-XXXX
KP+II-10D ANI+ST → Wink
KP+NPA-NXX-XXXX+ST → Acknowledgment Wink

Customer Dials:
0+NPA-NXX-XXXX
KP+II-10D ANI+ST → Wink
KP+0+NPA-NXX-XXXX+ST → Acknowledgment Wink

Customer Dials:
0-
KP+II-10D ANI+ST → Wink
KP+0+ST → Acknowledgment Wink

Customer Dials:
011+CC-NN
KP+1(NX)+XXXX-CCC+ST → Wink (1st Stage)
Wink (2nd Stage)
KP+II-10D ANI+ST →
KP+CC-NN+ST → Acknowledgment Wink

Customer Dials:
01+CC-NN
KP+1(NX)+XXXX-CCC+ST → Wink (1st Stage)
Wink (2nd Stage)
KP+II-10D ANI+ST →
KP+CC-NN+ST → Acknowledgment Wink

1(NX) Depends on Call Type

Int'l 0+/0-	158
Int'l 1+	138

Note: *In the 1st stage of an international call:*

XXXX	Carrier Access Code
CCC	Country Code

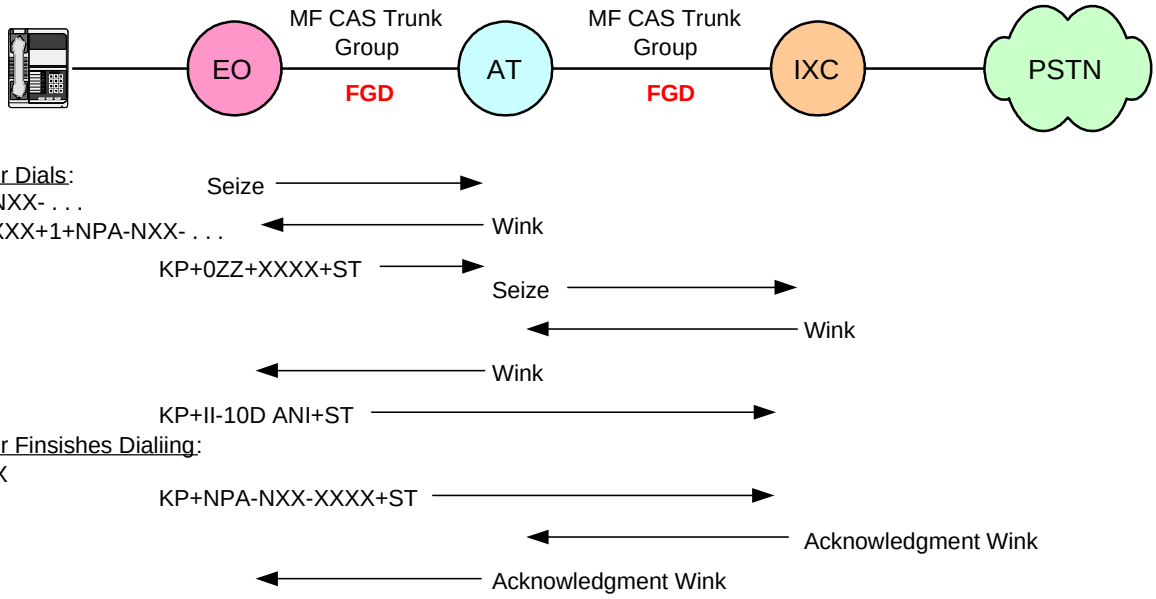
Terminating Signaling Sequence - IXC-to-Customer Call - FGD

Wink ← KP+NXX-XXXX+ST

IXC Dials:
NPA-NXX-XXXX

Fig. 2-4(a) – Feature Group D Toll Trunk Signaling Sequences – via Access Tandem – Domestic Calls

Originating Signaling Sequence - Customer-to-IXC Call via Access Tandem - FGD



Note: *In the 1st stage of a domestic call:*
0ZZ Carrier routing digits (tandem routing code)
XXXX Carrier Access Code

Note:
If Customer Dials: 0+NPA-NXX-XXXX or 101XXXX+0+NPA-NXX-XXXX
Then: 2nd segment of 2nd stage is KP+0+NPA-NXX-XXXX+ST

If Customer Dials: 0- or 00-
Then: 2nd segment of 2nd stage is KP+0+ST

Terminating Signaling Sequence - IXC-to-Customer Call via Access Tandem - FGD

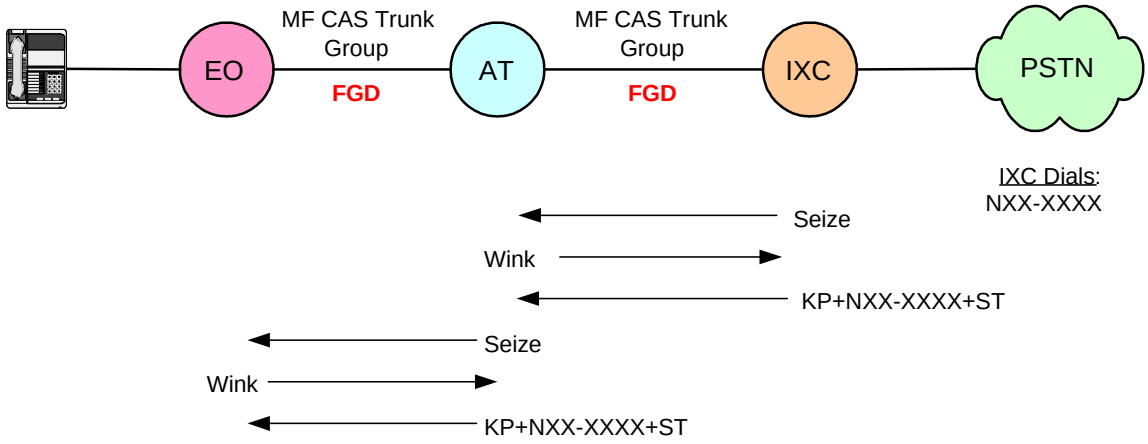
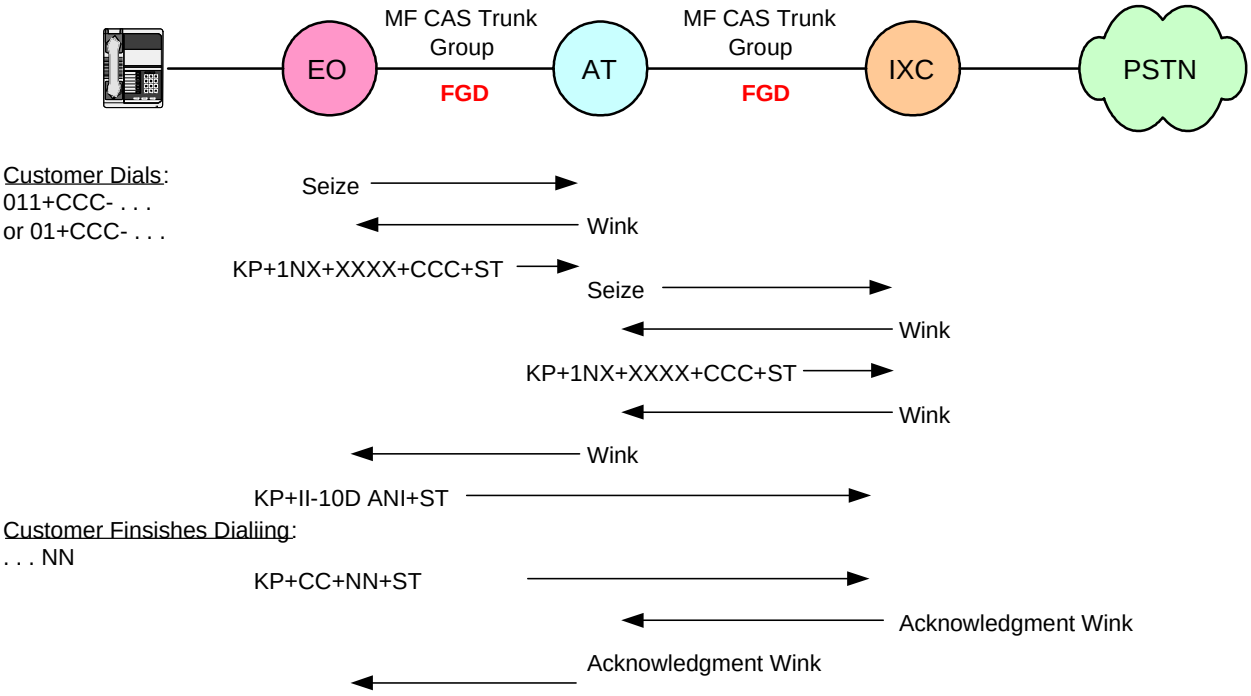


Fig. 2-4(b) – Feature Group D Toll Trunk Signaling Sequences – via Access Tandem – International Calls

Originating Signaling Sequence - Customer-to-IXC Call via Access Tandem - FGD



1NX Depends on Call Type

Int'l 0+/0-	158
Int'l 1+	138

Note: *In the 1st stage of an international call:*

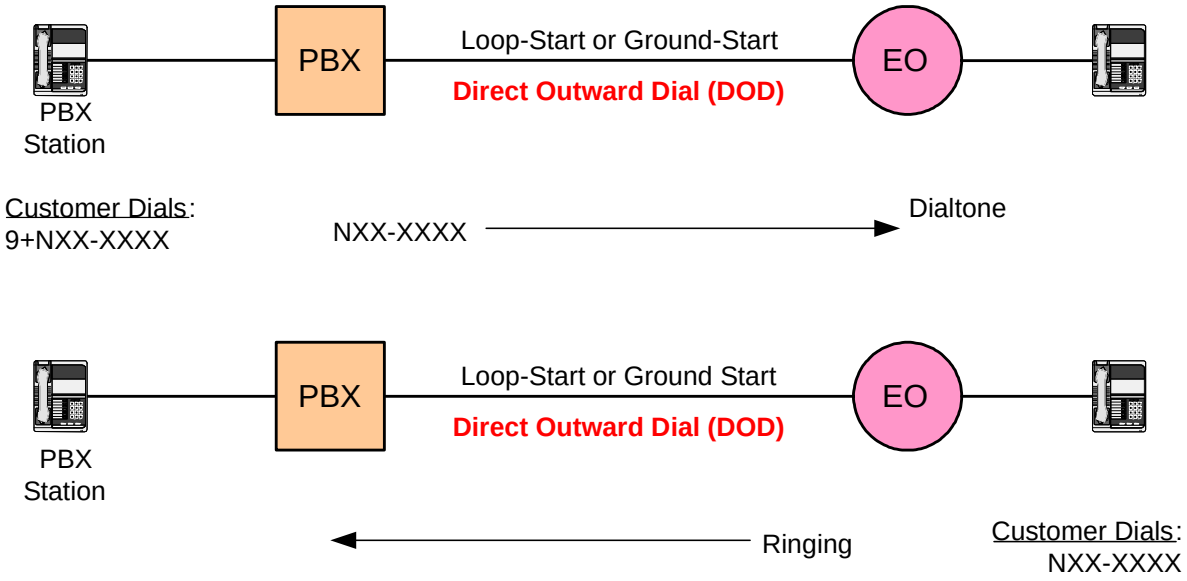
XXXX	Carrier Access Code
CCC	Country Code

Table 2-1 – ANI Info Digits (most common shown in BOLD)

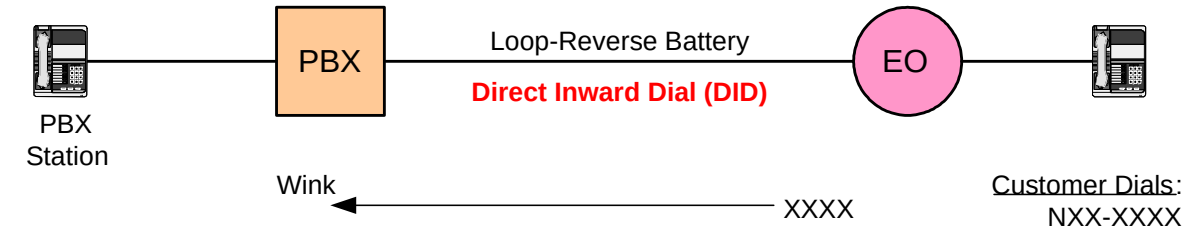
Digit	Function	Remarks
FGC – 1-Digit ANI Info		
0	**POTS**	
1	Operator Identified	
2	ANI Failure	
3-5	Unassigned	
6	**Hotel/Motel**	
7	**Special Operator Handling Required**	
8-9	Unassigned	
FGD – 2-Digit ANI Info		
00	**POTS**	Default
01	Operator Identified	
02	ANI Failure	
03-05	Unassigned	
06	**Hotel/Motel**	
07	**Special Operator Handling Required**	Example: Billing control feature
08-19	Unassigned	
20	Automatic Identified Outward Dialing	AIOD
21-22	Unassigned	
23	Coin/Non-Coin Status In Question	
24	800 Service Call	800 number converted to POTS number
25-26	Unassigned	
27	**Network-Controlled Paystation**	Examples: Semi-Postpay and Full-Prepay
28	Unassigned	
29	Prison/Inmate Service	
30-32	Intercept	
33	Unassigned	
34	Operator Handled Call	
35	Unassigned	
36	Customer Specific	
37-39	Unassigned	
40-49	Carrier Assigned	
50-51	Unassigned	
52	OUTWATS	
53-59	Unassigned	
60	Telecommunications Relay Service (TRS)	
61	Cellular/Wireless Carrier Type 1	
62	Cellular/Wireless Carrier Type 2	
63	Cellular/Wireless Carrier Roaming	
64-65	Unassigned	
66	TRS from Hotel/Motel	
67	TRS from Restricted Line	
68-69	Unassigned	
70	**Non-Network-Controlled Paystation**	Example: Private and “smart” payphones
71-92	Unassigned	
93	Virtual Private Network	
94-99	Unassigned	

Fig. 2-5 – PBX DOD and DID Signaling Sequences

Signaling Sequence - PBX Station-Customer Call - DOD



Signaling Sequence - Customer-PBX Station Call - DID



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