BUSINESS COMMUNICATIONS SYSTEM

SL-1*

Pulsed E&M Signaling Trunk Circuit Description

Publication number: Practice 553-2711-190
Document status: Standard
Document release: 1.0
Date: July 30, 1982

Contents

General information

1.01 This practice outlines the functions, interconnections, characteristics and operation of the 4-wire Pulsed E&M signaling trunk circuit. The information is intended to be used as a guide when selecting or engineering the connection of customer provided apparatus to the trunk circuit.

Functions

2.01 The 4-Wire Pulsed E&M trunk circuit provides the appropriate interface of the SL-1 to switches which use timed pulses for trunk signaling. The Pulsed E&M trunk circuit packs (QPC390, A-law; QPC391 mu-law) are similar to the basic 4-wire E&M trunk (QPC237) with the addition of Periodic Pulse Metering (PPM) for CO trunk applications.

2.02 Two 4-wire Pulsed E&M trunk circuits are located on the circuit pack. Each trunk circuit may be used as a 2-way, dial repeating trunk in one of the following modes of operation:

(a) Pulsed E&M Signaling, Type I with M-lead connections for the Norwegian Telecommunications Administration (NTA);

(b) Pulsed E&M Signaling, Type I with M-lead connections for British Post Office (BPO);

(c) Pulsed E&M Signaling, Type II (NTA and BPO);

(d) North American E&M Signaling, Type I and II;

(e) DX 4-wire Signaling (NTA);

(f) DX 4-wire Signaling (BPO).

2.03 For the operation of North American E&M Signaling and 4-wire DX Signaling refer to 553-2001-190.

2.04 The pulsed E&M trunk is also capable of DIGITONE* sending and receiving without any hardware modification required.

* DIGITONE is a trademark of Northern Telecom Limited.

Applications

2.05 The pulsed E&M trunk signaling may be used for the following trunk applications:

(a) CO, FX, or WATS trunks

(b) DID trunks

(c) Tie trunks.

Capabilities

2.06 The pulsed E&M trunk circuit has the following capabilities:

(a) E&M signaling

(b) Periodic Pulse Metering (PPM)

(c) supervision of far-end, off-hook dial pulsing

(d) isolation of foreign potentials on the loop from portions of the transmission and signaling circuit

(e) controlled false detection compensation on outpulsing

(f) switchable 2-dB pad for controlling gain between line-to-trunk and trunk-to-trunk on normal non-VNL (Via Net Loss) connections, and gain and echo protection on VNL through balance and terminal balance connections; choice of internal pad switching or control of an external echo suppressor (Type I interface only)

(g) switchable 7-dB and 16-dB pads for attenuation to accommodate carrier facilities

(h) carrier failure alarm.

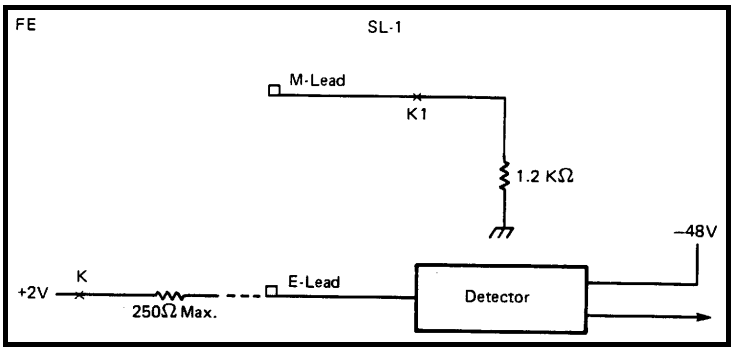


Figure 2-1
Pulsed E&M Trunk Signaling, Type I (NTA)

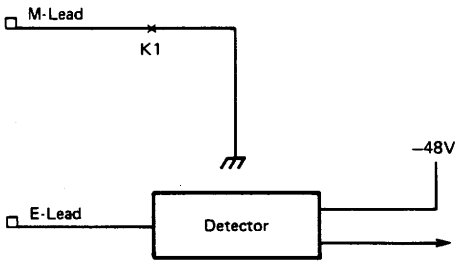


Figure 2-2
Pulsed E&M Trunk Signaling, Type I (BPO)

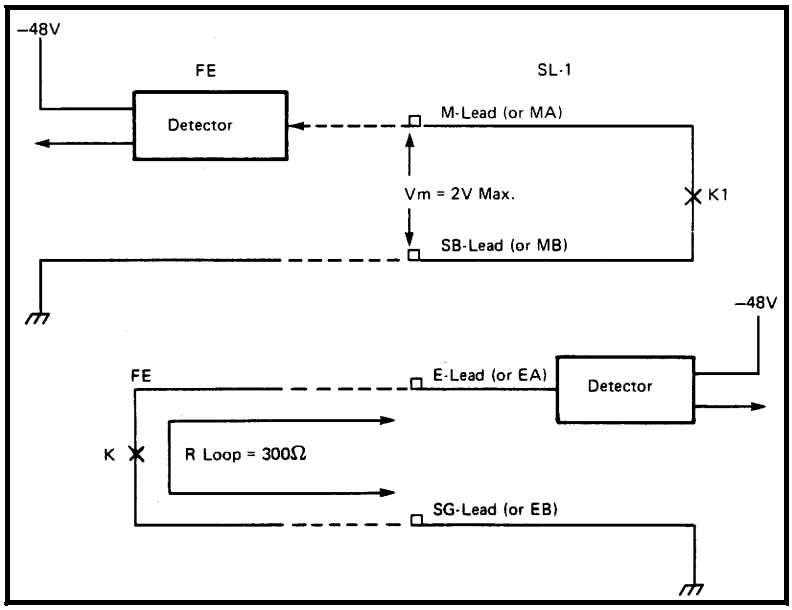


Figure 2-3
Pulsed E&M Trunk Signaling, Type I I

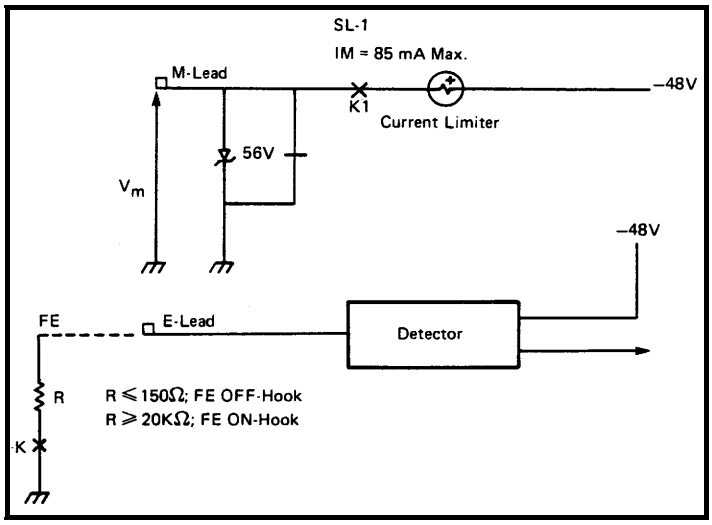


Figure 2-4
North American E&M Trunk Signaling, Type I

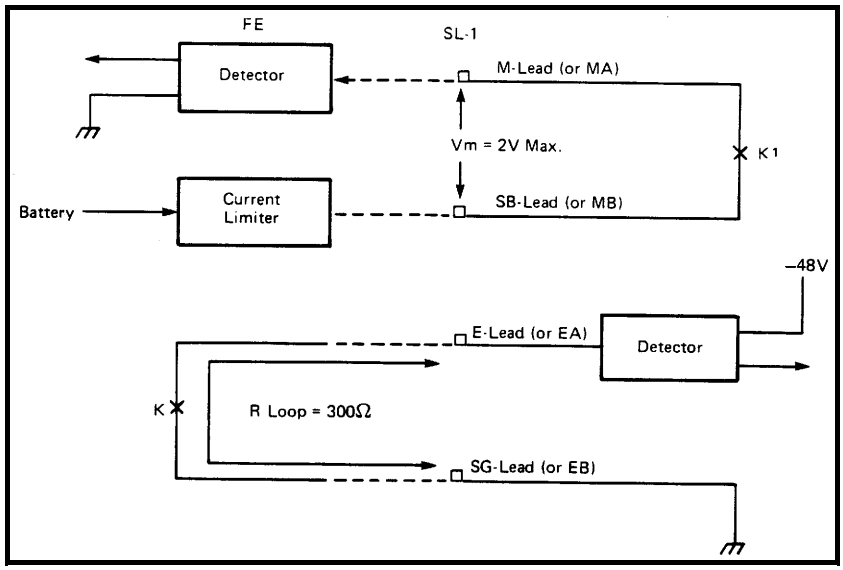


Figure 2-5
North American E&M Signaling, Type I I

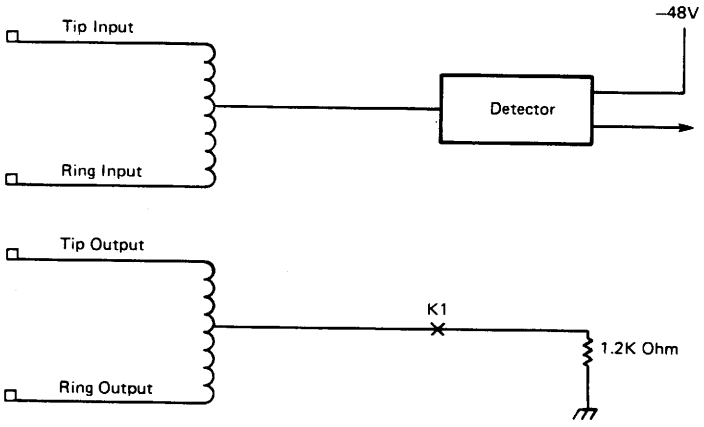


Figure 2-6
DX 4-wire Signaling (NTA)

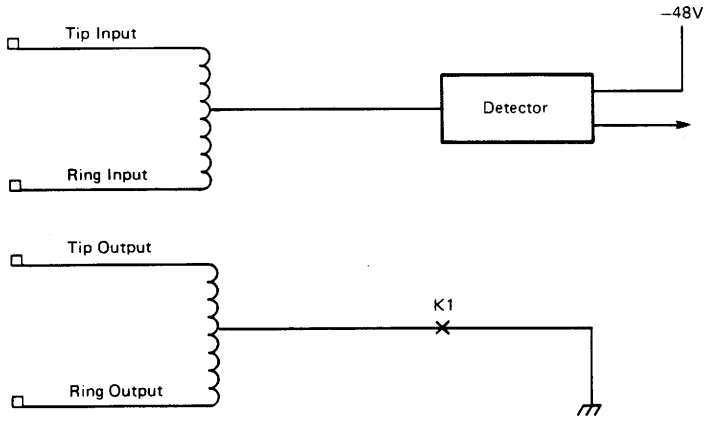


Figure 2-7
DX 4-wire Signaling (BPO)

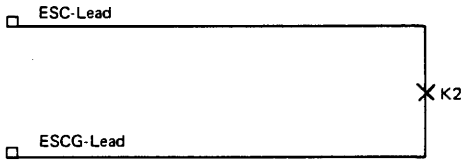


Figure 2-8
Echo Suppressor
(Type I interface only)

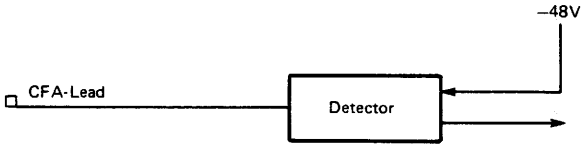


Figure 2-9
Carrier Failure Alarm

Circuit Description

3.01 The two trunk circuits and common multiplexing circuitry are mounted in a 12.5 in (32.8 cm) by 10 in (25.4 cm) printed circuit board which, along with nine others, slides into the Peripheral Equipment (PE) shelf. The trunk card connects with the switching system and the outside trunk circuits via an 80-pin connector at the back of the board. (Fig. 3-1).

3.02 Figure 3-2 provides a simplified block diagram of the Pulsed E&M trunk circuit pack.

Transmission

3.03 Each trunk circuit on the trunk card has four leads for communication of voice signals: TO and RO for output, and TI and RI for input, E&M signaling is accomplished by using the E lead and M lead in the case of Type-I signaling, or EA & EB and MA & MB in the case of Type-II signaling. For Type-I signaling, two leads, ESC and ESCG, control the external echo suppressor, if one is provided.

3.04 Audio signals received from the tip and ring input (TI and RI) are passed via the T1 transformer to the low-pass hybrid analog-to-digital filter, then through the PCM codec to the Common Equipment (CE) for switching.

3.05 The returning speech signals from the CE, pass through the codec to the low-pass analog-to-digital filter. This filter integrates the amplitude modulated pulses from the codec, filters the result, and amplifies the analog signal for connection to the T2 transformer. The signals pass through the T2 transformer to the tip and ring output (TO and RO) leads.

Common Circuitry

3.06 The pulsed E&M trunk circuit pack contains a microprecessor to control most of the timing functions required for pulsed signaling. The processor also decodes the incoming digits received in the form of decadic pulses and sends the corresponding digit to the CE.

3.07 Two Scan and signal Distributers (SSD) are located on the trunk circuit pack to detect and control the state of each trunk, and to communicate with the Central Processing Unit (CPU). SSD messages to and from the CPU are relayed in serial form.

3.08 The trunk circuit operation can be tested by sending special SSD messages to the trunk card. This causes the micro-processor to test the hardware on the trunk card. The result of this test is reported to the CPU by SSD messages. The software will automatically lockout a faulty trunk and report it in a TTY message.

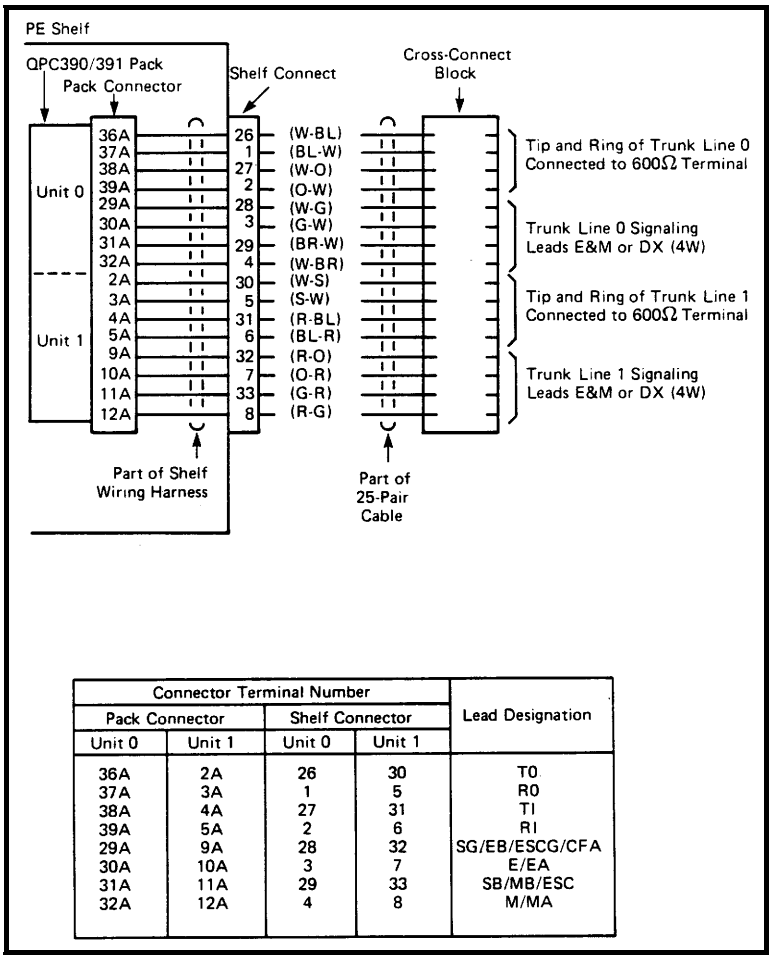
Periodic Pulse Metering (PPM)

3.09 Each of the two trunks on the trunk card has a seven-bit counter to accumulate metering pulses received on the E-lead. A short signal (40-400 ms duration) received after an answer signal on an outgoing call is considered to be a meter pulse and is accumulated in the trunk counter.When the counter overflows, the trunk card resets the counter and sends an SDD message to the CE to indicate that overflow has occurred.

3.10 A temporary buffer in the system memory is used to store the total number of received meter pulses. This buffer is incremented by 127 for every overflow message. Upon call termination or call modification (e.g., Call Transfer), the system software adds the residual count in the trunk counter to the temporary buffer. This total is then added to the contents of the terminal meter in system memory that is associated with the originating party.

Option Switches

3.11 The available trunk options are selected manually by setting six option pads on the trunk card. There are three pads per trunk circuit, and each pad contains six switches. The switch settings are given in Fig. 3-3.



Connector Terminal Number				Lead Designation
Pack Connector		Shelf Connector		
Unit 0	Unit 1	Unit 0	Unit 1	
36A	2A	26	30	T0
37A	3A	1	5	R0
38A	4A	27	31	TI
39A	5A	2	6	RI
29A	9A	28	32	SG/EB/ESCG/CFA
30A	10A	3	7	E/EA
31A	11A	29	33	SB/MB/ESC
32A	12A	4	8	M/MA

Figure 3-1
Pulsed E&M Trunk Connection with Circuit Pack, Shelf and Cross-Connect Block

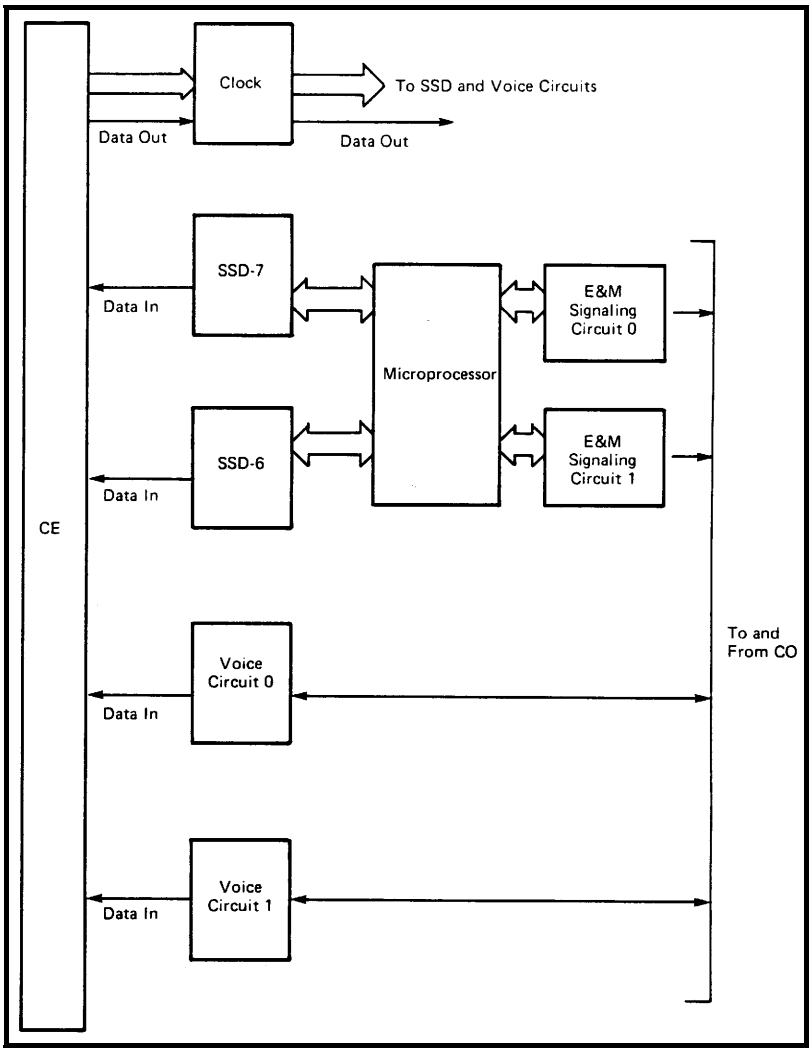
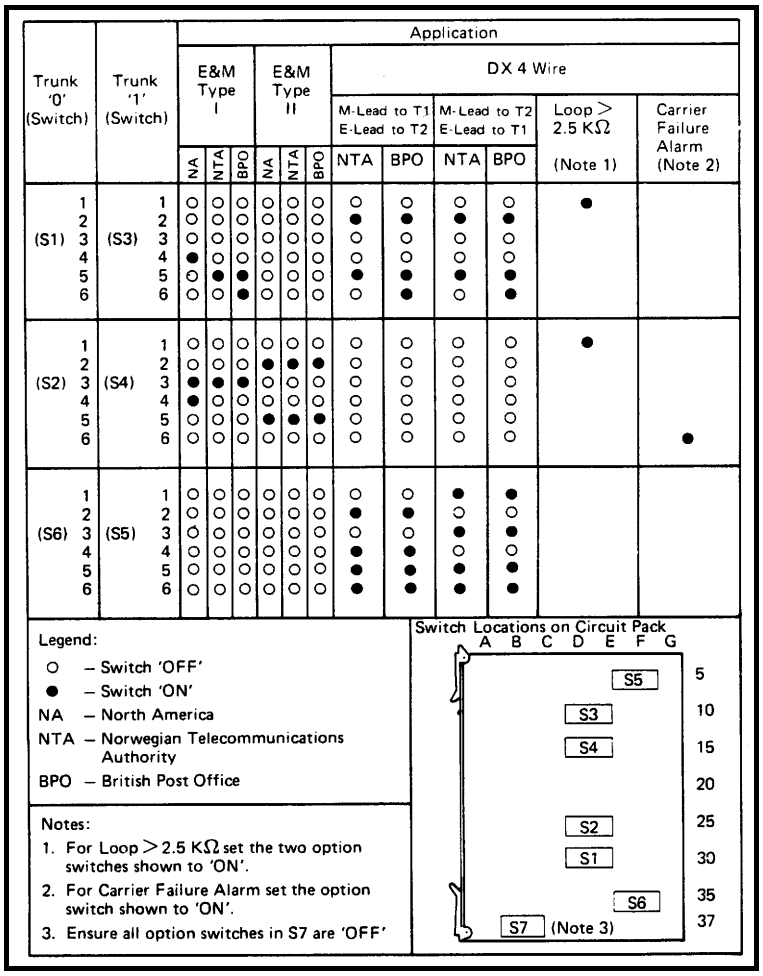


Figure 3-2
Block Diagram of Pulsed E&M Trunk Circuit Pack



Trunk '0' (Switch)	Trunk '1' (Switch)	Application: E&M Type I NA	E&M Type I NTA	E&M Type I BPO	E&M Type II NA	E&M Type II NTA	E&M Type II BPO	DX 4 Wire: M-Lead to T1 E-Lead to T2 NTA	M-Lead to T1 E-Lead to T2 BPO	M-Lead to T2 E-Lead to T1 NTA	M-Lead to T2 E-Lead to T1 BPO	Loop > 2.5 KΩ (Note 1)	Carrier Failure Alarm (Note 2)
1	1	○	○	○	○	○	○	○	○	○	○		
2	2	○	○	○	○	○	○	●	●	●	●		
(S1) 3	(S3) 3	○	○	○	○	○	○	○	○	○	○		
4	4	●	○	○	○	○	○	○	○	○	○		
5	5	○	●	●	○	○	○	●	●	●	●		
6	6	○	○	●	○	○	○	○	●	○	●		
1	1	○	○	○	○	○	○	○	○	○	○	●	
2	2	○	○	○	●	●	●	○	○	○	○		
(S2) 3	(S4) 3	●	●	●	○	○	○	○	○	○	○		
4	4	●	○	○	○	○	○	○	○	○	○		
5	5	○	○	○	●	●	●	○	○	○	○		
6	6	○	○	○	○	○	○	○	○	○	○		●
1	1	○	○	○	○	○	○	○	○	●	●		
2	2	○	○	○	○	○	○	●	●	○	○		
(S6) 3	(S5) 3	○	○	○	○	○	○	○	○	●	●		
4	4	○	○	○	○	○	○	●	●	○	○		
5	5	○	○	○	○	○	○	●	●	●	●		
6	6	○	○	○	○	○	○	●	●	●	●		

Legend:

○ – Switch 'OFF'

● – Switch 'ON'

NA – North America

NTA – Norwegian Telecommunications Authority

BPO – British Post Office

Notes:

1. For Loop > 2.5 KΩ set the two option switches shown to 'ON'.
2. For Carrier Failure Alarm set the option switch shown to 'ON'.
3. Ensure all option switches in S7 are 'OFF'

Figure 3-3
Pulsed E&M Trunk Switch Settings

Carrier Facilities

3.12 To accommodate the input and output levels required for operation with carrier facilities, switchable 7 dB and 16 dB pads are included in each trunk circuit. The 7dB pad attenuates the input to the trunk (TI/RI) leads, and the 16 dB pads attenuate the output (TO/RO) leads. The pads are controlled on switches S5 and S6 as shown in Table 3-A.

Table 3-A
Switchable Pads

TRUNK 0 (Switch 6)	TRUNK 1 (switch 5)	PAD
S6.5	S5.5	7dB
S6.6	S5.6	16 dB

3.13 If no pads are required, the switches are off (open). If a pad is required, the appropriate switch is turned on (closed).

Pulsed E&M Signaling Formats

4.01 The call processing sequence in pulsed E&M signaling is dependent on ground pulses applied on the 'M' lead and received on the 'E' lead. These signals consist of long pulses (600 ms), short pulses (150 ms), and decadic dial pulses (50 ms).

4.02 Tables 4-A and 4-B provide the meaning of the timed pulses used in pulses E&M signaling.

Address signals

4.03 Receiving Decadic Dial Pulses. If the decadic pulse signaling is used for transferring address information, then the received pulses associated with each digit are collected at the trunk card, decoded, and the corresponding digit is sent to the CPU in a single SSD message. This process is repeated for each received digit until all the digits are received. The software then routes the call to the proper destination.

4.04 Sending Decadic Dial Pulses. The Tone and Digit Switch (TDS) controls the sending of dial pulses by sending a sequence of SSD messages to the trunk card. Timing for the pulses and interpulse breaks are controlled by the TDS as for other trunk signaling types.

4.05 Digitone Address Signals. Digitone address signals are sent and received over the voice path and are not detected by the trunk card. These signals are treated as for other trunk types.

Table 4-A
Reception of Signals

SIGNAL TYPE	POSSIBLE MEANING	PULSE DURATION (ms)
Short (Note 1)	Seizure B-Answer Meter Pulse	40-400
Long/ Continuous (Note 2)	Clear Forward Forced Release Release Guard Manual blocking	400-2000
Continuous	Manual Blocking	>2000
Address	Decadic Pulses	40-70 ms make 40-70 ms break
Interdigit Pause		600 ± 100

Note 1: The meaning of a signal is determined by the context in which it occurs. For example, A short signal received by the SL-1 after the answer signal would have to represent a meter pulse. A short signal is not recognized until the end of the signal is detected. The following criteria are used to determine the end of the signal:

E-lead open less than 30 ms – No break in signal
E-lead open 30-50 ms – May be accepted as end of signal
E-lead open greater than 50 ms – Accepted as end of signal

Note 2: A long signal is recognized whenever the signal is expected and the E-lead ground condition is timed for 400 ms. A signal exceeding 400 ms which is received when the trunk is idle is an indication that manual

blocking has been imposed at the Public Exchange. When the trunk is not idle, a 2 second pulse is required to indicate manual blocking. An end of signal detection is required for any long pulse except manual blocking.

Table 4-B
Sending of Signals

SIGNAL TYPE	POSSIBLE MEANING	DURATION (ms)
Short (Notes 1 and 2)	Seizure B-Answer	150 ± 30
Long (Notes 3 and 4)	Clear Forward Release Guard Forced Release	600 ± 120
Continuous	Manual Blocking	>2000
Address	Decadic Pulses	10 pps 40-70 ms break
Interdigit Pause		600 ± 100

Note 1: The interval between two consecutive nonaddress signals must be 240 ms or greater.

Note 2: In a glare situation (incoming seizure signal is reported while the trunk is being seized for an outgoing call), priority is given to the incoming call.

Note 3: After recognizing an incoming Forced Release Signal, the SL-1 sends a Clear Forward signal within 100 ms of the end of the Forced Release signal.

Note 4: After recognizing an incoming Clear Forward signal, the SL-1 sends a Release Guard signal within 55 ms of the end of the Clear Forward signal.

Public exchange trunk operation

4.06 The Pulsed E&M Trunk operation as a Public exchange trunk allows for two way operation similar to the existing CO trunk operation except that the Pulsed E&M signaling is supported. The following information is a summary of the Public Exchange trunk operation in both the incoming and out outgoing directions.

Outgoing public exchange operation

4.07 Idle Condition. The trunk is considered idle and available for outgoing calls if the E-lead is open and if the software condition of the trunk is ‘idle’.

4.08 Manual Blocking. When the trunk is blocked from the far end by a continuous ground on the E-lead, the trunk card sends a message to the CPU to report the blocking condition. When this message is received, the software marks the trunk as ‘blocked’ and makes it busy for outgoing calls.

4.09 When the far end removes the blocking condition (E-lead appears open), the trunk card sends a message to the CPU to unblock the trunk, and the software marks the trunk as idle and available for outgoing calls.

4.10 Trunk seizure. When the access code for the trunk route is dialed, an idle trunk associated with this route is selected and a seizure message is sent to the trunk card. Upon receiving the seizure message, the trunk card sends a seizure signal to the distant Public Exchange.

4.11 If the outgoing call is placed through a metered Public Exchange trunk, then the temporary meter associated with the trunk is reset to zero to allow for the accumulation of meter pulses.

4.12 Outpulsing. The Public Exchange will return Dial Tone when the seizure signal is received and the exchange is ready to receive the address signals. The calling party (connected to SL-1) then dials the digits of the desired destination. These digits are sent in the proper form (decadic or Digitone signals) to the exchange.

4.13 Glare Condition. A glare condition occurs when both ends of the trunk attempt to seize the trunk at the same time. In general, priority is given to the incoming call.

4.14 If a glare occurs, the trunk card aborts the seizure signal to the far end immediately upon receiving a valid signal (40 ms or greater) from the exchange. The trunk card sends a forced release message to the CPU followed by a message reporting the received signal.

4.15 When the software receives these signals, it performs one of the following operations:

- If the trunk card reports the reception of a seizure signal, the software honors the incoming call on that trunk and hunts for another trunk for the outgoing call.

- If the trunk card reports the reception of a blocking signal, the software puts the trunk in the blocking state and hunts for another trunk for the outgoing call.

4.16 Answer signal. When the Public Exchange receives the address signals from the SL-1, the call is routed to the dialed destination. If the call is answered, the Public Exchange sends an answer signal (a short pulse) to the SL-1. The answer signal is detected by the trunk card, which then reports this to the CPU.

4.17 Metering Pulses. short pulses received after the answer signal are considered as metering pulses by the trunk card. These pulses are accumulated in the trunk card counter.

4.18 When a counter overflow occurs (i.e. when 127 pulses are received), the trunk card sends an overflow message to the CPU and resets the counter. The software then increments a temporary meter in system memory by 127.

4.19 When the call is modified by the calling party (e.g., the calling party transfers the call to another station), the CPU sends a message to the trunk card to read and clear the counter. The trunk card responds to the CPU with the residual count which is added to the temporary meter.

4.20 If the residual count is not received from the trunk card within one second, then another read and clear message is sent. If the residual count is not received within one second after the second attempt, then a zero residual count is assumed and a TTY error message is printed.

4.21 When the residual count is received, the following events occur:

(1) The software adds the residual count to the contents of the temporary meter.

(2) The final total in the temporary meter is added to the contents of the terminal meter associated with the originating party, and the temporary meter is cleared.

(3) A message is sent to the trunk card to continue counting incoming meter pulses.

4.22 After the call is modified, pulse accumulation continues as normal. Refer to 553-2711-105 for details about interactions of PPM with call modification.

4.23 Release: Near End First. If the calling party disconnects first, then the CPU releases the calling party and instructs the trunk card to do the following:

(1) Send a ‘clear forward’ signal to the Public Exchange.

(2) Send the residual pulse count to the CPU.

(3) Start a timer ‘T3’ (120 s) for receiving a ‘release guard’ signal from the far end.

(4) If a release guard signal is received within the time T3, then the trunk card sends a ‘release guard received’ message to the CPU. The software then makes the trunk busy for outgoing calls for 240 ms and makes it available for incoming calls immediately.

(5) If the ‘release guard’ signal is not received within the time T3, then the following events occur:

   (a) The trunk card sends a seizure signal to the far end,

   (b) Timer T2 starts (300 ± 60 ms).

   (c) When T2 times out, increment a counter T1 and send a ‘clear forward’ signal to the far end.

(6) Repeat steps (3) through (5) above until one of the following events occur:

(a) A ‘release guard’ is received, which causes the trunk card to send a ‘release guard received’ message to the CPU. The software then makes the trunk busy for outgoing calls for 240 ms, and makes it available for incoming calls immediately.

(b) The counter T1 counts three (i.e., the trunk repeats this attempt three times), which causes the trunk card to send a ‘trouble release’ message to the CPU. The software then puts the trunk into the lockout state and prints a diagnostic message on the maintenance TTY. The trunk stays in the lockout state until an incoming call is received on this trunk, or until trunk is enabled again by a maintenance command at a TTY.

4.24 Release: Far End First. When the far end disconnects first, a ‘forced release’ saignal is sent to the SL-1. The trunk then does the following:

(1) Sends a ‘clear forward’ signal (long signal) to the far end.

(2) Sends a ‘clear forward sent’ message to the CPU. This causes the software to connect a Busy Tone to the calling station followed by placing the station in line lockout (if it is a PBX set), or releasing it (if it is an SL-1 set).

(3) Starts Timer ‘T3’ (120 s) for receiving a “release guard’ signal from the far end.

(4) If a ‘release guard’ is received within the time T3, then the trunk card sends a ‘release guard received’ message to the CPU. The software then makes the trunk busy for outgoing calls for 240 ms and makes it available for incoming calls immediately.

(5) If the ‘release guard’ signal is not received in the time T3, then the following events occur:

(a) The trunk card sends a seizure signal to the far end,

(b) Timer T2 starts (300 $\pm$ 60 ms).

(c) When T2 times out, increment a counter T1 and send a 'clear forward' signal to the far end.

(6) Repeat steps (3) through (5) above until one of the following events occurs:

(a) A 'release guard' is received, which causes the trunk card to send a 'release guard received' message to the CPU. The software then makes the trunk busy for outgoing calls for 240 ms, and makes it available for incoming calls immediately.

(b) The counter T1 counts three which causes the trunk card to send a 'trouble release' message to the CPU. The software then puts the trunk into line lockout state and prints a diagnostic message on the maintenance TTY. A trunk remains in line lockout until an incoming call is received or until the trunk is enabled again by a maintenance command at the TTY.

Incoming public exchange operation

4.25 Idle Condition. When the Public Exchange trunk is idle and available for incoming calls, the M-lead to the far end is open. From the SL-1 point of view, incoming calls can be received on the trunk if the trunk is idle, or if the trunk is in the lockout state.

4.26 Blocking. A trunk is blocked from receiving incoming calls by entering the appropriate disable command via overlay 32, 36 or 41. This causes the software to send a blocking message to the trunk card which, in turn, sends a blocking signal (continuous ground on the E-lead) to the far end to block incoming calls. The software also makes the blocked trunk busy for outgoing calls.

4.27 To remove a trunk from the blocking state, the appropriate enable command is entered via overlay 32, 26 or 41. The software then sends a message to the trunk card to unblock the trunk (M-lead open). The trunk is also marked 'idle' and made available for outgoing calls.

4.28 When the trunk card receives an enable signal while there is a blocking signal from the far end, then the trunk card sends a new blocking signal to the CPU even though the signal was sent when the far end blocking was first applied. This is required in order to avoid the case where the first blocking message to the CPU was lost because the trunk was disabled.

4.29 Trunk Seizure. When a seizure signal is received on the E-lead, the trunk card sends a seizure message to the CPU and the attendant (or night station) is alerted.

4.30 Answer. When the incoming call is answered, the software will send a message to the trunk card instructing it to send an 'answer signal' to the far end.

4.31 Release: Near End First. If the near end releases first, the software will send a message to the trunk card reporting the disconnection. The trunk card then sends a "clear back' signal to the far end, which responds with a 'clear forward' signal.

4.32 The trunk card then sends both a 'release guard' signal to the far end and a 'release guard sent' message to the CPU. The Software makes the trunk busy for outgoing calls for 240 ms, and makes the trunk available for incoming calls immediately.

4.33 Release: Far End First. When the far end disconnects first, it sends a 'clear forward' signal to the trunk card, which reports the signal to the CPU. The software drops the trunk connection, and connects an immediate Busy Tone to the terminating party for 15 s, followed by placing the station in line lockout (if it is a PBX station), or releasing it (if it is an SL-1 station). The software also instructs the trunk card to send a 'release guard' signal to the far end.

4.34 After sending the release guard signal, the trunk sends a 'release guard sent' to the CPU. The trunk is kept busy for outgoing calls for 240 ms, and made available for incoming calls immediately.

Direct inward dial (DID) operation

4.35 Operation. The DID operation of the pulsed E&M trunk is similar to the operation of the Public Exchange trunk in the incoming direction. For DID operation, the trunk card receives the address signals from the far end and sends a single message to the CPU for each digit. The software translates the received digits and routes the call to the dialed destination. The call is then treated as for normal DID calls.

Tie trunk operation

4.36 Outgoing Operation The Outgoing tie trunk operation of the Pulsed E&M Trunk is similar to the operation of the Public Exchange trunk in the outgoing direction, except that there is no metering pulses expected on outgoing tie trunks. However, if a sequence of short signals are received after an answer signal on an outgoing tie trunk call, then the trunk hardware accepts them as metered pulses and accumulates them in the buffer. The CPU ignores any subsequent overflow and residual count messages sent from the trunk card.

4.37 Incoming Operation . The incoming tie trunk operation of the Pulsed E&M Trunk is similar to the operation of the Public Exchange trunk in the incoming direction, except that the trunk card receives the address signals from the originating switch and passes the decoded digits to the CPU. The software translates the digits and routes the call to the dialed destination as normal, and the call is then treated as for normal tie trunk calls.

Design Considerations

Foreign and surge voltage protection

5.01 When telephone lines connected to the trunk circuit are exposed to foreign voltages by direct contact or induction (e.g., power line crosses or lightning), protection devices must be installed on the customer's premises. These devices must be capable of providing a path to ground from tip to ring for foreign voltages that exceed 600 V peak.

Pad switching

5.02 The transmission properties of each trunk are characterized by Class Of Service (COS) assignments included in the trunk data block (553-2711-220). The options are as follows:

(a) Via Net loss (VNL),

(b) Non-VNL, either transmission compensated (TRC) or nontransmission compensated (NTC).

5.03 To ensure stability and minimize echo on long haul connections, 4-wire tie and CCSA are assigned either VNL or non-VNL. Similarly 2-wire tie, CO, FX, WATS, CCSA, and 4-wire non-VNL facilities are assigned with one of the non-VNL options.

5.04 The TRC and NTC class options for non-VNL determine the operation of the switchable pads contained in the trunk circuit packs. They are assigned as follows:

- TRC – For a 2-wire non-VNL trunk facility with a loss greater than 2 dB, or for which impendance compensation is provided; or for a 4-wire non-VNL facility.
- NTC – For a 2-wire, non-VNL trunk facility with a loss less than 2 dB or when impedance compensation is not provided.

Insertion loss

5.05 The standard insertion loss of 1 $\pm$ 1 dB is maintained for the various trunk connections by the use of software controlled pads. A Pad In (PI) condition provides an insertion of 2 dB, and a Pad Out (PO) is 0 dB. The pads are selected as follows:

- Line to Pulsed E&M (PO).
- Pulsed E&M (PI) to Pulse E&M (PI).
- Pulsed E&M (PO) to CO Trunk (4 dB PI).

Return loss

5.06 The return loss into 600Ω with a 1 dB insertion loss is given in Table 5-A.

Table 5-A
Return Loss

TYPE OF RETURN LOSS	FREQUENCY LOSS (K Hz)	(dB)
Echo Return Loss	0.5 to 2.5	27 dB
Singing Return Loss Low	0.26 to 0.5	20 dB
Singing Return Loss High	2.2 to 3.4	20 dB

Overload levels

5.07 The 2 dB software controlled pad provides attenuation in the transmit and receive paths simultaneously. The overload levels for the pad-in and pad-out conditions are given in Table 5-B. Signals exceeding these levels result in distortion.

Table 5-B
Overload Levels

CONDITION	TRANSMIT	RECEIVE	ATTENUATION
Pad-in	+ 4 dB	+ 5 dB	1 dB gain
Pad-out	+ 6 dB	+ 3 dB	3 dB gain

Electrical characteristics

5.08 The electrical characteristics of the signaling leads are given in Table 5-C.

Table 5-C
Pulsed E&M Electrical Characteristics

LEAD	CONDITION	VALUE
M-Lead Output	active/on state resistance to ground	1.2 KΩ
	Inactive/off state resistance to ground	≥ 100 KΩ
	Maximum active/on state current	130 mA
M-lead Input	Maximum positive transients	≤ + 100 V or 100 mA for 5 ms
	Maximum negative transients	≤ - 300 V or 250 mA for 5 ms
E-lead Output	Maximum voltage transients applied by the detector	- 150 V, ± 100 V
	Maximum current transients applied by the detector	± 100 mA
E-Lead Input	Resistance to ground for the detection of ‘ground not present’, (E-lead open)	≥ 100 KΩ
	Resistance to ground for the detection of ‘ground present’, (E-lead grounded)	≤ 250Ω
	Signal potential to ground for E-lead grounded	2V

BUSINESS COMMUNICATIONS SYSTEM

SL-1*

Pulsed E&M signaling trunk circuit description

Manual release 1.0
Standard
July 1982
Printed in Canada.