LOOP SIGNALING EXTENDER (J99343CA, CB, CC, CD, CE)

SD-1C359-01 AND SD-7C050-01

DESCRIPTION

METALLIC FACILITY TERMINAL

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1. GENERAL

1.01 The Metallic Facility Terminal (MFT) is a standardized grouping of modular equipment which supplies the various forms of transmission and/or signaling functions required with metallic facilities. The loop signaling extenders (LSEs) are part of the MFT family of equipment which perform signaling functions.

1.02 This section is reissued to include the J99343CE unit which features cost reduction, reduced dial pulse distortion, and low insertion loss in both the idle and busy states. Table B has been changed into two tables: Tables A and B. Tables A, C, D, and E are changed to D, E, C, and G, respectively. Part 7 Reference has been deleted and the BSPs and drawings are moved to paragraph 1.03. Revision arrows are used to emphasize the more significant changes. Equipment Test Lists are not affected.

1.03 ▶Detailed information on the LSEs can be found in Sections 332-910-100, 332-910-200, and Drawings CD- and SD-1C359-01 and CD- and SD-7C050-01.◀

1.04 The signaling equipment described in this section extends the signaling range of metallic facilities by the following methods:

- Boosts all dc signaling voltages by the insertion of a 12-volt floating dc source in series with each of the tip and ring conductors
- Senses the loop current direction and maintains the polarities of the floating boost voltages so that they always aid the CO battery.

Note: In the following general discussion (Part 1), the use of the term LSE includes the LSE plus toll diversion (TD) and the LSE II except where specifically stated otherwise.

1.05 All LSE units are approximately 1-11/16 inches wide by 7-7/8 inches high by 9 inches deep. They are composed of circuit components mounted on a printed wiring board which is attached to a rigid frame made of polycarbonate or die-cast aluminum. See Fig. 1, 2, and 3 for pictures of the J99343CA LSE (Mfg. Disc.), J99343CB LSE plus TD (Mfg. Disc.), and J99343CD LSE II, respectively.

1.06 The LSE is a nonregenerative signaling range extension device for use on metallic facilities with either loop-start or ground-start circuits. Limits set forth in Tables A, B, and C allow LSEs to be used with any type of central office (CO) and Bell System PBXs except on those circuits of the 770-type PBX that provide series 300 features, such as dial transfer or conference features. (The series 300 features do not comply with the range limits of Tables A and B.) When installed at a PBX location, Packaged Metallic Facility Terminal Assembly (PMFTA) or Customer Premises Facility Terminal (CPFT) arrangements will generally be used to mount the LSE. The LSE does not contain a repeating coil and has negligible effect on voice frequencies.

1.07 When only signaling range extension is desired, the LSE can be used in either of the following ways.

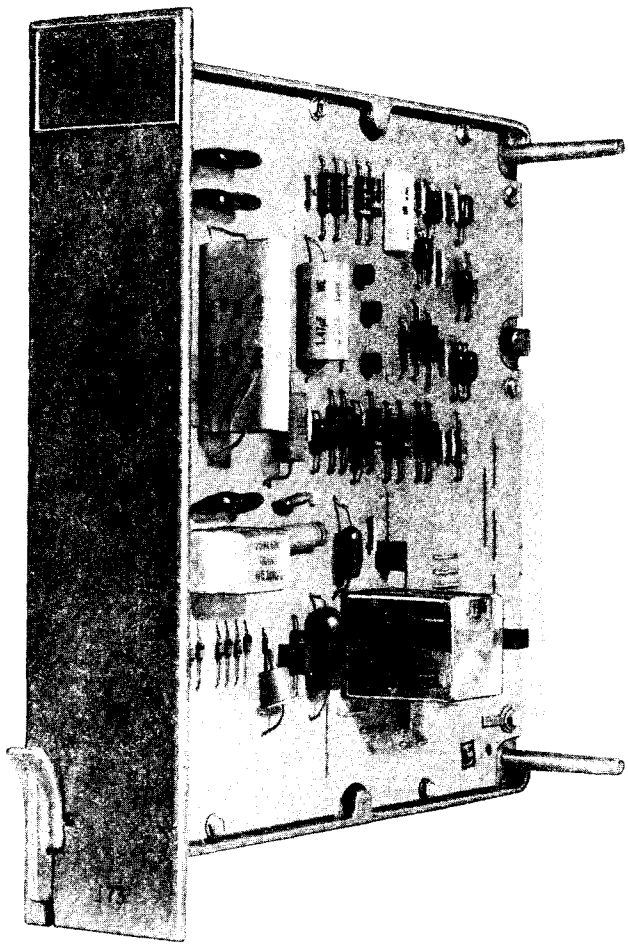


Fig. 1—Loop Signaling Extender J99343CA (Mfg. Disc.)

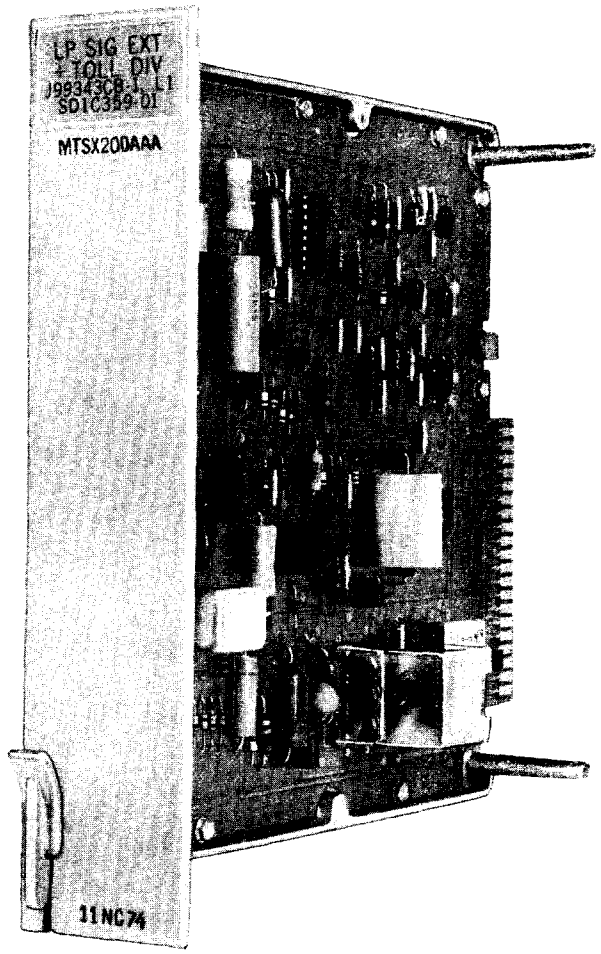


Fig. 2—Loop Signaling Extender Plus Toll Diversion J99343CB (Mfg. Disc.)

- In the transmission unit position of a double-module MFT mounting arrangement. The adjacent space normally occupied by a signaling unit is left vacant.

- In a single-module MFT mounting arrangement. The LSE occupies the single slot associated with each circuit in this equipment arrangement.

1.08 When voice-frequency gain as well as signaling range extension is required, the LSE may be used in a double-module arrangement with any of the MFT repeaters, except the dual 2-wire repeater units (J99343PL). See Parts 2B, 3B, 4D, and 5D for more detailed information concerning the application of the LSE.

1.09 The double-module shelves and frames have two slot positions per circuit and will accommodate any mixture of LSE-only (mounted in the transmission unit [TU] slot) or LSE plus a repeater. The LSE is mounted in the signaling unit (SU) slot when used with a companion MFT repeater. This is the most flexible mounting arrangement for MFT plug-in equipment because any combination of circuits which require signaling and/or transmission enhancement can be accommodated.

1.10 The single-module shelf and frame arrangements are factory wired so each plug-in position serves a separate circuit.

1.11 Table D lists the voice-frequency transmission characteristics which apply to all LSEs.

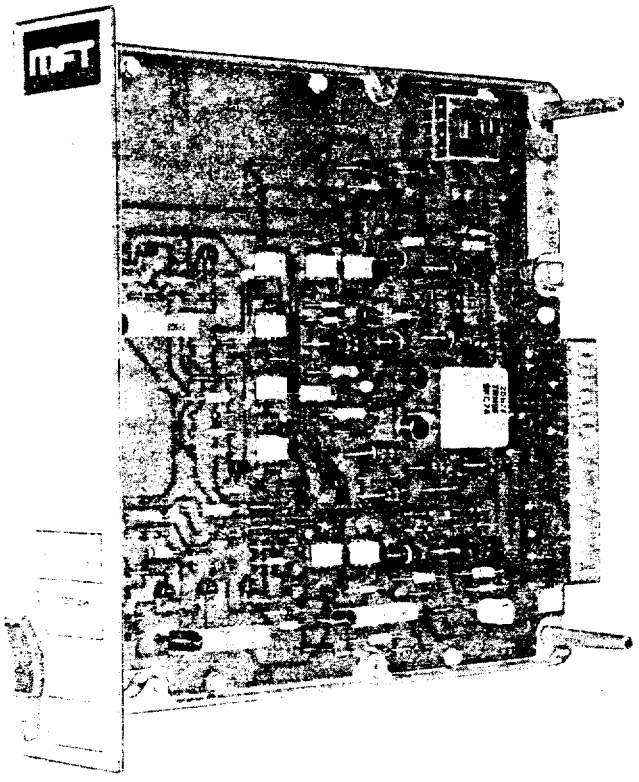


Fig. 3—Loop Signaling Extender II J99343CD (Mfg. Disc.)

Tables A, B, C, E, and F include other engineering parameters such as signaling ranges, ringing capability, reversal time delay intervals, and power consumption which may be useful in establishing circuits that use LSE.

2. LOOP SIGNALING EXTENDER [J99343CA (Mfg. Disc.) AND J99343CC (Mfg. Disc.)]

Note: The J99343CC is functionally identical to the J99343CA, which it replaced, and differs only in the connector terminals being arranged for compatibility with the Switched Maintenance Access System (SMAS). Thus the two codes are interchangeable only in MFT shelves and bays which have SMAS terminal strapping (terminals 37 to 38 and 39 to 40 in all slot locations). Additional information related to connector terminal functions and strapping arrangements can be found in Section G of SD-1C359-01.

A. Circuit Description

2.01 The J99343CA and CC LSEs consist primarily of the following two circuits, shown in the block diagram in Fig. 4:

- A dc-to-dc converter with dual floating 12-volt outputs
- A loop current polarity detecting circuit which controls a reversing relay.

2.02 The LSE supplements the normal -48 volt CO battery with a boost voltage of up to 24 volts, depending on the amount of loop current. Based on a minimum allowable loop current of 23 mA, this increase in effective battery voltage (to -72 volts maximum) permits satisfactory signaling out to a range of approximately 2400 ohms external conductor loop resistance. The LSE can be installed at any location in the loop between the CO battery supply and the terminating equipment.

2.03 The 12-volt dc supplies are derived from a dc to dc converter which is powered by -48 volt battery. Each independent 12-volt supply includes a full-wave rectifier and filter with the current regulation characteristic shown in Fig. 5.

2.04 The current regulation of the supplies is such that if the loop current increases for any reason (eg, a decrease in loop resistance) the boost voltage decreases. This tends to prevent excessive loop currents and helps stabilize the circuit from the effects of external influences. The boost circuit assures that 23 mA of current will flow when the loop resistance is at the upper limit.

2.05 One of the floating dc supplies is in series with the tip and the other in series with the ring. This arrangement helps maintain longitudinal balance and assures a boost voltage for ground-start operation as well as loop-start operation.

2.06 The polarity of the boost supplies is controlled by a relay associated with the current detector. If the loop is open or if normal current flows (ie, negative battery on the ring, ground on the tip), the output of a resistor bridge drives an operational amplifier into positive saturation. The amplifier output operates the reversing relay RV. Thus the relay is operated whenever either of these two loop conditions exists.

2.07 When the CO battery reverses (ie, negative battery on the tip, ground on the ring), the

TABLE A

SIGNALING PERFORMANCE CHARACTERISTICS
J99343CA, CB, CC LSEs

Acceptable Cable Types:		19-, 22-, 24-, 26-Gauge. Loaded or Nonloaded	
Facility Leakage (T to R, T to Ground, R to Ground)		30K Ohms Minimum	
Minimum Conductor Loop Resistance		1000 Ohms	
Maximum Conductor Loop Resistance		*	
CO Ringing Source Required		86 VRM, 20 Hz With −48 Vdc component	
Maximum Ringing Capability:		RANGE:	
Up to 3 ringers		1500 Ohms Maximum	
Up to 2 ringers†		2000 Ohms Maximum	
1 ringer†		2400 Ohms Maximum	
1 ringer plus J28 Bridge		1300 Ohms Maximum	
Dial Source:	Non-SXS	7.5 to 12.5 PPS; 58 to 64% Break	
	SXS	8 to 11 PPS; 58 to 64% Break	
Dial Types:	Non-SXS	2, 4, 5, 6, 7, 8	
	SXS	6, 7, 8	
Max. Ringer Loads For Dialing		NON-SXS	SXS
C4A Ringers		3	3
C4A Ringers + J28 Bridge		1 + 1	Unsatisfactory
Maximum Longitudinal 60 Hz ac:			
Open Circuit, at switch		50V	
Across 500 ohms, at switch		30V	
Boost Battery Reversal Delays:		LSE	LSE (plus TD)
Normal to reverse (R- to R+)		35-60 ms	5-15 ms
Reverse to normal (R+ to R-)		3-10 ms	5-15 ms
Toll Diverting Signal Duration		100 ms Minimum	25 ms Minimum
Pulse Distortion		—	±6 ms
Talking Battery Requirements— Associated Switching Circuit		53 Vdc maximum	
Primary Power Requirements		42.5 — 52 Vdc	
Noise on Battery		56 dBrnc Maximum	
Impulse Noise		84 dBrnc Maximum	
		LSE	LSE (plus TD)
Current Drain:	Idle	125 mA dc	20 mA dc
	Normal Battery	125 mA dc	95 mA dc
	Reverse Battery	125 mA dc	115 mA dc
Boost Current Regulation		Maximum	Minimum
@ 1000 ohms		34.5 Ma	29.5 mA
@ 1700 ohms		28.0 Ma	24.0 mA
@ 2400 ohms		24.0 Ma	20.5 mA

* The LSE maximum range (loop resistance in ohms) will vary with the application of the LSE and the required CO ring trip current and/or talk current.

† One additional ringer may be satisfactory if selected.

TABLE B

LSE MAXIMUM LOOP RESISTANCE (NOTE 1)

LSE USED WITH COMPANION TRANSMISSION UNIT	
CIRCUIT ARRANGEMENT	LOOP RESISTANCE FORMULA (NOTE 2)
*Switch to Switch through LSE	Range = $\frac{100}{I\dagger}$ — (1860 + CO BAT RES + PBX RES)
*Switch to Switch through LSE	Range = $\frac{100}{I\dagger}$ — (1860 + CO BAT RES + STA RES)
LSR to LSR through LSE	Range = 3000
LSR to Station through LSE	Range = 2200 — STA RES
	LSE USED ALONE
*Switch to Switch through LSE	Range = $\frac{100}{I\dagger}$ — (1560 + CO BAT RES + PBX RES)
*Switch to Switch through LSE	Range = $\frac{100}{I\dagger}$ — (1560 + CO BAT RES + STA RES)
LSR to LSR through LSE	Range = 3300
LSR to Station through LSE	Range = 2500 — STA RES

Note 1: Since the LSE is not a terminating device, the range data in this table represents the range between terminal equipment. The LSE can be connected into the circuit at any intermediate point.

Note 2: Range equals loop conductor resistance in ohms.

* Equations applicable only for –48 volt battery supply.

† I equals required trip current for the CO and/or talk current in amperes.

reversing relay is released. This action inserts reverse boost voltages with the CO battery.

2.08 The detector will not respond to battery reversals of less than 60 ms duration. This prevents it from following the 20-Hz ringing voltage. The negative dc component of the superimposed ringing signal will be boosted during the ringing intervals and will assure adequate ring-trip capability out to the maximum range.

2.09 The J99343CA and CC LSEs incorporate a reversing switch mounted on the printed wiring board. The reversing switch, designated NOR/REV, interchanges the T and R with the T1 and R1 connections. The 'Boost Battery Reversal Delays' for the LSE (Table A) are considerably different when going

TABLE C

LSE II APPLICATION DATA

SIGNALING REQUIRE-MENTS	General	Loop resistance	Minimum	600 ohms
			Maximum	See Table G.
		Ground-start features	Boost-tip and ring	12 volts each
			Maximum range	See Table G.
		Reverse battery toll diversion	Minimum signal duration	10 ms
		Facility leakage	T to R, T to Grd, R to Grd.	30,000 ohm min.
		Cable types		All gauges loaded or nonloaded
		Supervisory delay timing boost battery reversal delays	Normal to reverse or reverse to normal	10 ms
	Ringing	Types of CO ringing source		Nominal 86 Vrms 20 Hz with −48 Vdc superimposed (see Table E)
		Ringer capability*	C4A ringers: Loops up to 2400 ohms†	Up to 3 ringers
			1 ringer + J28 bridge‡	Up to 1300 ohms
		Ring Trip	Boost	24 volts
			Maximum range	See Table G
SIGNALING	Dial Pulsing§	Dial source	Speed non-SXS	7.5 to 12.5 PPS
			Speed SXS	8 to 11 PPS
		Dial types	Non-SXS	2, 4, 5, 6, 7 and 8
			SXS	6, 7 and 8
		Dial Percent break		58% to 64%

See footnotes at end of table.

TABLE C (Contd)

LSE II APPLICATION DATA

SIGNALING (Contd)	Dial Pulsing§ (Contd)	Range limits non-SXS	Maximum loop	See Table G
			Minimum loop	600 ohms
			Maximum ringer load	3 — C4A
			J28 Bridge‡	1 — C4A
		Range limits SXS	Maximum loop	See Table G
			Minimum loop	600 ohms
			Maximum ringer load	3 — C4A
			J28 bridge‡	Unsatisfactory
		Range limits when pulsed by a loop signaling repeater (LSR)	All offices	Maximum loop
MISCEL-LANEOUS	Battery requirements	Power for LSE	Supply volage	42.5 — 53
			Steady-state noise	56 dBrnc maximum
			Impulse noise	84 dBrnc maximum
		Talk battery—associated switching circuit		53 volts maximum
		Current Drain	600-ohm loop	85 mA dc
			2400-ohm loop	75 mA dc
		Idle State Current Drain		9 mA dc (nominal)
	Boost Current Regulation	Loop Current For	1000-ohm loop	42 to 46 mA
			1860-ohm loop	28 to 32 mA
			2400-ohm loop	23 to 26 mA

See footnotes at end of table.

TABLE C (Contd)

LSE II APPLICATION DATA

MISCEL-LANEOUS (Contd)	Noise Performance	Maximum longitudinal 60 Hz measured across tip and ring at the switch	Open circuit	40 volts
			Across 500 ohms	20 volts

*Ringer capability does not account for dial pulse restrictions which may limit ringers in some applications.

†For maximum loops of 2400 ohms and 3 ringers, ringers may require selection for satisfactory performance.

‡The J28 bridge is representative of high capacitance bridges. Low capacitance bridges should increase the range capability.

§Dial pulse limits are based on central offices having a range of 1500 ohms external circuit loop resistance. If TOUCH-TONE® is used, these limitations do not apply.

from normal to reverse battery and necessitates that its A side face the switching machine. The reversing switch should be used to establish this orientation at the time of installation when the LSE is used alone (paragraph 1.07). The switch should be set in the NOR position if the CO T and R leads are brought into shelf terminal locations 17 and 19; it should be set in the REV position if the CO T and R leads are brought into terminals 14 and 13. When the LSE is used with a companion transmission unit, the switch should be in the NOR position and the NOR-REV switch of the transmission unit should be set to obtain the correct orientation.

2.10 In addition to the NOR/REV switch, LSE units that have been modified will have screw switches S2, S3, and S4. These switches should be turned out (up) for use in single-module mountings and turned in (down) for use in the transmission unit (TU) slot or signaling unit (SU) slot of double-module mounting. The unit must be removed from its service position for access to these switches.

Note: Option Y of SD-1C359 (CPS 5) adds screw switches S2, S3, and S4. When used in the single-module MFT shelf arrangement, the J99343CA and CC LSEs should be modified with Option Y to eliminate crosstalk problems prevalent in many applications of the LSEs.

B. Applications

2.11 The most common applications for the LSE will be found on special service access lines and trunks, such as foreign exchange services (FX), off-premises stations (OPS), off-premises extensions (OPX), long distance terminal services (LD), wide area telephone services (WATS), and PBX-CO trunks.

2.12 Certain restrictions must be observed when using the LSE in these applications. The LSE, unlike the LSR, only boosts the effective signaling battery. This becomes a limitation in some cases because the LSE does not regenerate dial pulses. For example, the LSE applications are limited when used in an SXS (including the 701 and 740 PBX) environment, since these lines normally require dial pulse correction. The LSE is satisfactory for most PBX arrangements, including the above, as long as the re-

TABLE D

TRANSMISSION PEFORMANCE CHARACTERISTICS
(ALL LSEs)

Nominal Circuit Impedance		Standard Cable Facilities and 600/900 Ohm Switching Equipment
Insertion Loss @ 1000 Hz		0.2 ± .15 dB
Additional Loss 200 to 4000 Hz		0.1 dB maximum
Delay Distortion 400 to 3200 Hz		25 μs nominal
Return Loss (900 ohm + 2.15 μf load):		
Echo	500 to 2500 Hz	30 dB nominal
Singing	300 to 3200 Hz	30 dB nominal
Singing	200 to 3400 Hz	26 dB nominal
Equal Level Crosstalk 200-4000 Hz		More than 80 dB down
Noise Contribution:		
C message		6 dBrnc
Impulse		Negligible
Total Harmonic Distortion @ 0 dBm		More than 60 dB down
@ +10 dBm		More than 60 dB down
Out-of-Band Noise (5 kHz to 100 mHz)		
On −48 Volt battery		Less than −80 dBv above 5 kHz
Across the Unit on Either T or R Conductor		Less than −70 dBv above 5 kHz

TABLE E

RINGING CHARACTERISTICS OF
LOOP SIGNALING EXTENDER II

BRIDGED RINGING	RING TRIP BOOST DURING RINGING	AC BOOST	RING TRIP BOOST DURING SILENT INTERVAL
−48 Volt Superimposed			
On Ring	Yes	8—10 volts	Yes
On Tip	No	16—20 volts	Yes
−48 Volt Superimposed			
Ringing Ring to Gnd	Yes	8—10 volts	Yes
Ringing Tip to Gnd	No	16—20 volts	Yes
+48 Volt Superimposed			
Ringing Ring to Gnd	No	16—20 volts	Yes
Ringing Tip to Gnd	No	16—20 volts	Yes

TABLE F

TRANSMISSION AND SIGNALING PERFORMANCE CHARACTERISTICS
J99343CE LSE

TRANSMISSION:	
LSE Insertion Loss (1000 Hz)	0.2 ± 0.15 dB
Return Loss (900 + 2.15 μfd)	
Echo	25 dB
Singing Low	20 dB
Singing High	20 dB
LSE Longitudinal Balance (200—300 HZ)	58 db Min.
DIAL PULSING:	
Source Speed	7.5 to 12 pps
Source Percent Break	58% to 64%
Distortion	+1% break
RINGING RANGE: *†	
Ringing Source	84-88 RMS Negative Superimposed on Ring Conductor
3 C4A Ringers	2400 ohms
EXTERNAL LEAKAGE REQUIREMENTS:‡	
Tip-Ring	30K ohms Min.
Tip-Ground	30K ohms Min.
Ring-Ground	30K ohms Min.
TOLERABLE AC LONGITUDINAL:§	
60 Hz Potential (Open Circuit)	50V RMS
60 Hz Potential (Across 500 ohms)	10V RMS (10 mA RMS per conductor)
SUPERVISING DELAYS:	
Normal to Reverse	15 ms nominal
Reverse to Normal	15 ms nominal
CURRENT DRAINS (Terminal 11):	
Idle State	25 mA
Busy State (23 mA Loop Current)	40 mA
Busy State (65 mA Loop Current)	65 mA

* Ringing ranges to station sets with C4A ringers assume a series 0.5 microfarad capacitor and weak notch setting. Ringers may require selection for satisfactory performance.

† Ringer capability does not account for dial pulse distortion which may limit ringers in some applications.

‡ The external leakage requirements include the leakage characteristics of both the cable and the terminating equipment.

§ Longitudinal AC potential shall be measured at the switch. Open circuit measurements shall be made between the tip or ring conductor and ground. Induction shall also be measured with tip and ring conductors connected together to a 500 ohm resistor to ground.

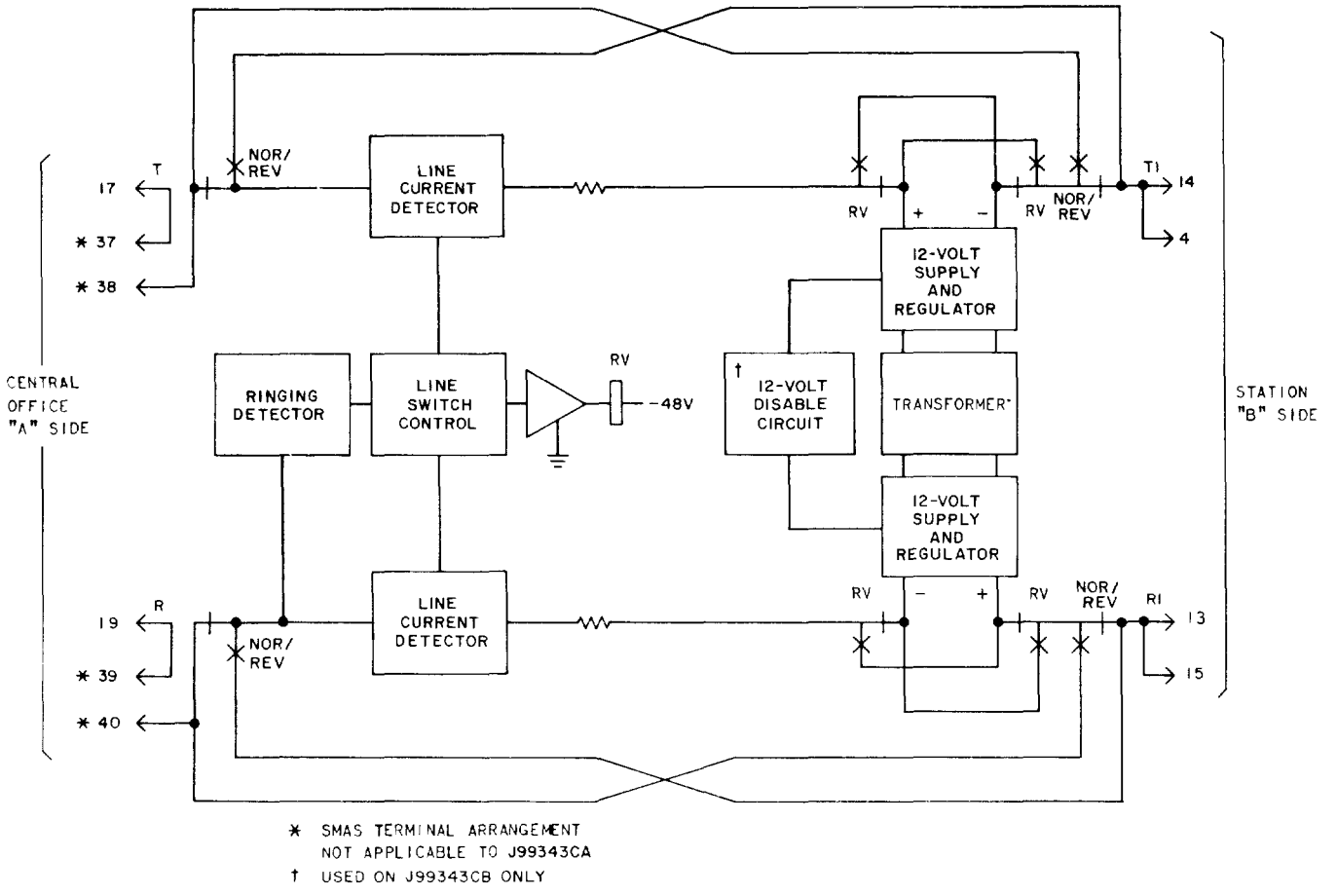


Fig. 4—Block Diagram of the J99343CA, CB, and CC Loop Signaling Extender

quirements listed in Table A are not exceeded. If the LSE is used in tandem with the LSR, F- or G-type signaling unit, which include pulse correction, limitations normally imposed by a terminating SXS machine do not apply. See paragraphs 2.13, 2.14, and 2.15 for additional information concerning tandem use of the LSE with the LSR.

2.13 When the LSE is used in a tandem arrangement with the LSR, the overall circuit noise behavior is difficult to predict. Such installations may be satisfactory, however, and should be carefully engineered and tested prior to use. This is because the LSE does not contain a repeating coil and thus will not block longitudinal currents. The overall circuit noise may become excessive. The LSE could be used with a passive TU in this case. The LSR is superior in this regard and should be used in lieu of the LSE when noise objectives cannot be met with the LSE.

2.14 ***Danger: Under no circumstances should two or more LSEs be used in a tandem arrangement and an LSE must not be used on the station side or B-side of an LSR arrangement for 72-volt operation as discussed in paragraph 2.15.***

2.15 The LSE is intended for use on signaling links requiring only one battery boost range extension device. The LSE principle of operation involves adding dc voltages within the unit to a dc voltage which already exists on the line. These additions are cumulative and could create hazardous line voltage levels if two LSEs are used in tandem. Likewise, care should be observed when placing an LSE in tandem with an LSR.

2.16 Since the LSE supplies battery boost in both the T and R conductors, range extension is also supplied for normal ground-start signals. However, the LSE is not intended for nonspecial service ground-start operation such as coin lines.

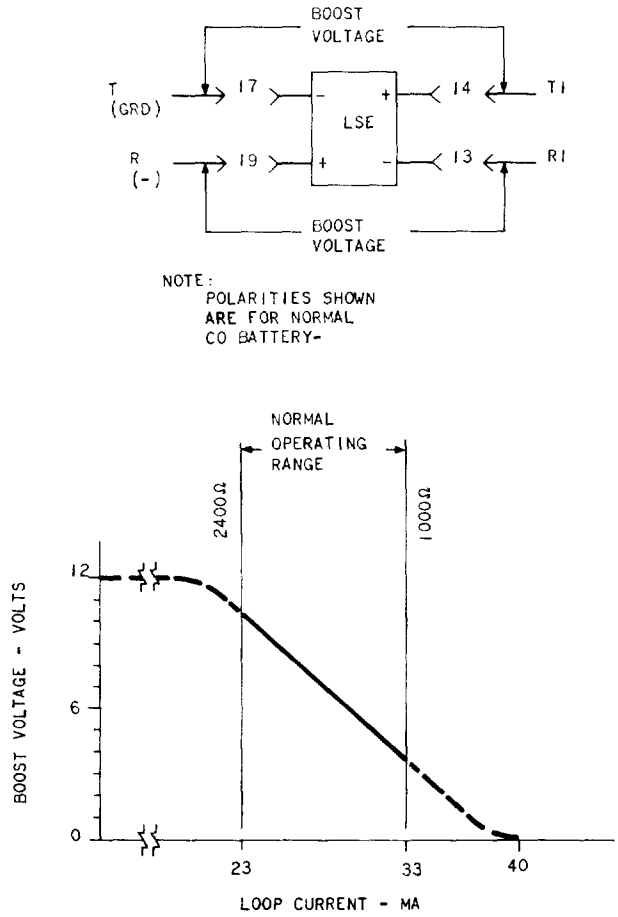


Fig. 5—Output Voltage Characteristics of each Floating Converter Supply of the J99343CA, CB, CC, and CD LSEs

2.17 The LSE may be used with the E6 repeater. The E6 will not block longitudinal currents, and use of this combination should be restricted to environments which are free from serious longitudinal noise problems. When used with the E6, the LSE should be connected on the A or switching side of the E6. Its insertion into the nonloaded station side between the E6 and the cable should be avoided.

2.18 The LSE should not be used with a ringing source which has a positive dc component. Presence of a positive dc component will cause the boost supplies to subtract from the tripping voltage and significantly decrease tripping range.

2.19 Although the LSE is more economical than the LSR from the standpoint of initial cost, its use may prove practical only within the limited field of application described in this section. The LSE can be used alone (ie, without a transmission unit). The LSR must always be used with an MFT transmission unit in a double-module arrangement.

2.20 Figures 6, 7, and 8 are diagrams depicting the LSE in some typical special service applications.

3. LOOP SIGNALING EXTENDER PLUS TOLL DIVERSION [LSE-TD; J99343CB (Mfg. Disc.)]

A. Circuit Description

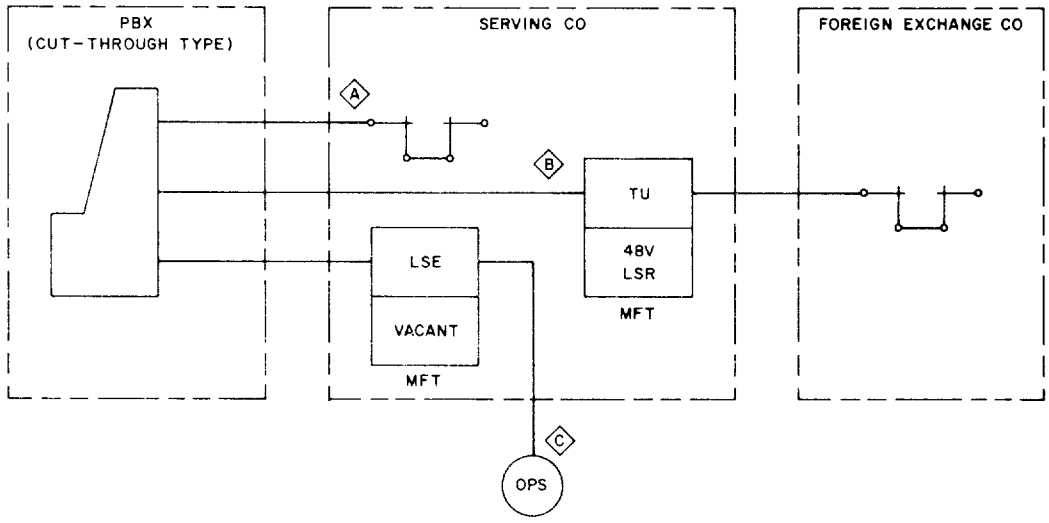
3.01 The LSE plus TD has two main functional differences from the LSE. It can respond more quickly to short duration CO battery reversals (eg, wink-type toll diversion signals) and has lower average power consumption. The LSE plus TD contains the following circuitry:

- A dc-to-dc converter with dual floating 12-volt outputs
- Loop current polarity detecting circuit which controls a reversing relay
- A ringing detector
- A dc-to-dc converter disabling circuit.

3.02 The dc-to-dc converter circuit is similar to the LSE dc to dc converter. See paragraph 2.03 for a description of this circuit.

3.03 The current detecting circuit consists of a resistor bridge and operational amplifier (op-amp) similar to that described in paragraph 2.06. The op-amp in the LSE plus TD, however, is arranged such that the reversing relay RV is released during either normal current or idle conditions (the reversing relay in the LSE is operated during these loop conditions). To minimize dial pulse distortion, the reversing relay is released during dial pulsing.

3.04 The ringing detector circuit consists of a voltage divider, an op-amp, and several transistor stages. The response time of the LSE plus TD is short enough so that the reversing relay RV would normally follow the voltage oscillations of 20-Hz ringing. To prevent this, the ringing detector circuit disables RV whenever ringing occurs. The negative dc component of the ringing signal will, however, be boosted.

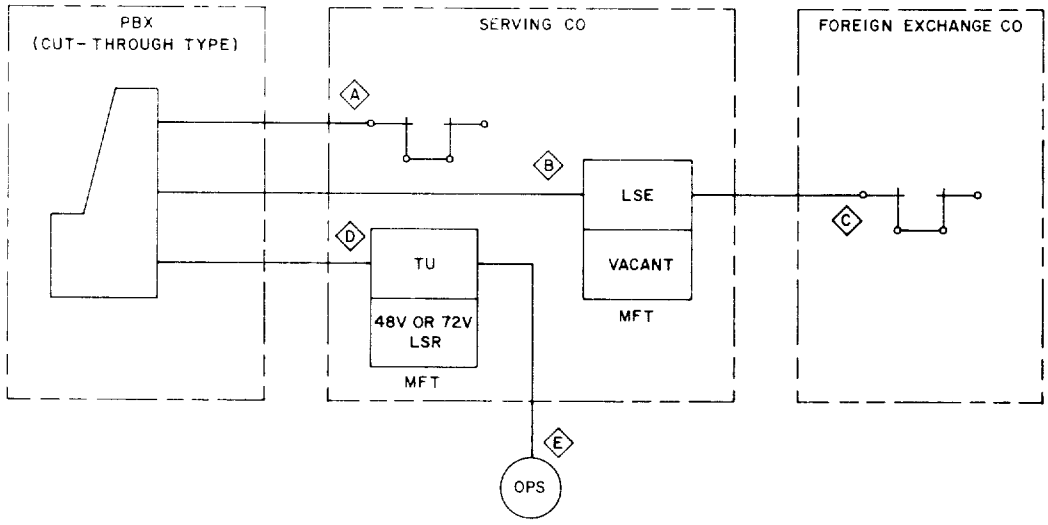


MAXIMUM RANGE

(A) TO (C) = PBX TRUNK PLUS STATION LIMIT (NOT TO EXCEED 2400 OHMS).

(B) TO (C) = LSR RANGE (NOT TO EXCEED 2400 OHMS).

Fig. 6—Typical Application of the LSE on an Off-Premises Station Line



MAXIMUM RANGE

(A) TO (D) = PBX TRUNK PLUS STATION LIMIT

(C) TO (D) = PBX TRUNK PLUS STATION LIMIT (NOT TO EXCEED 2400 OHMS).

(D) TO (E) = LSR RANGE.

Fig. 7—Typical Application of the LSE on a Foreign Exchange Trunk

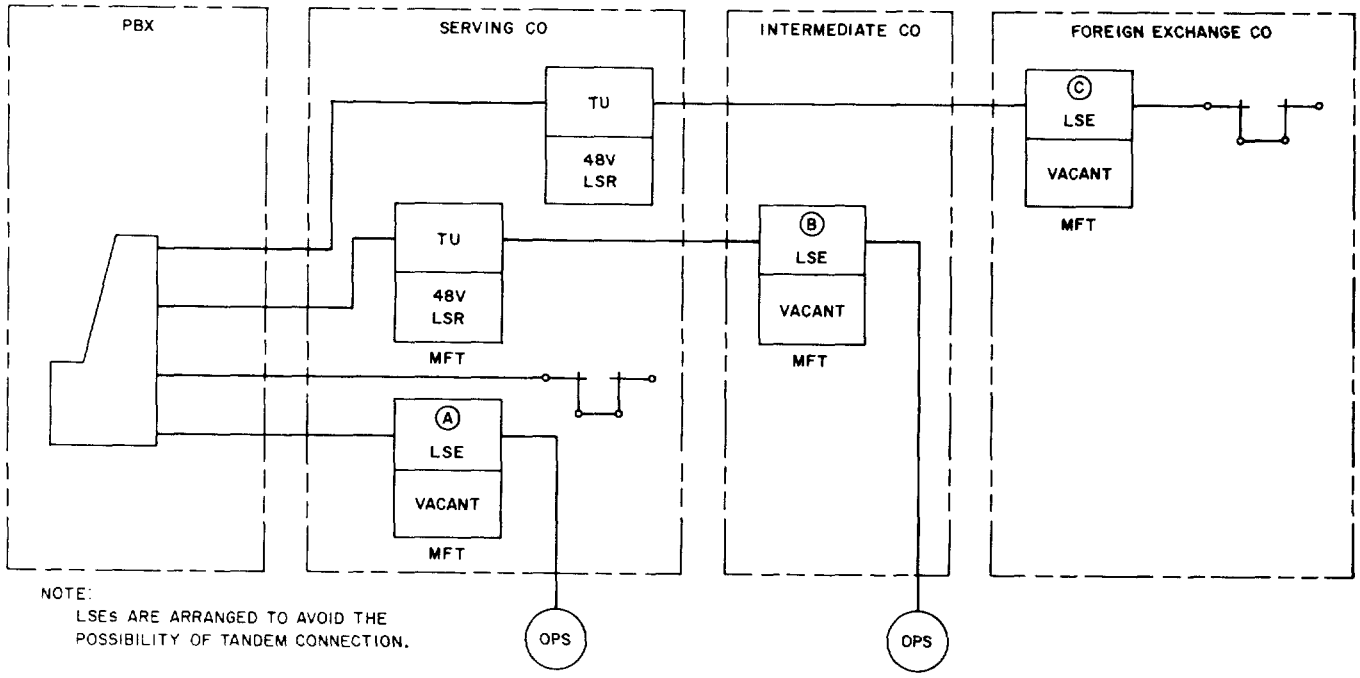


Fig. 8—Typical Application of the LSE in an Off-Premises Station A & B and Foreign Exchange Trunk C

3.05 The function of the converter disabling circuit is to prevent operation of the dc-to-dc converter during idle loop conditions. The disabling circuit uses the outputs of the two operational amplifiers to control a driver transistor stage which is in series with the dc-to-dc converter power source. During idle conditions, the op-amp in the bridge circuit negatively saturates and the op-amp in the ringing detector circuit positively saturates. The disabling circuit uses these outputs to turn off the driver transistor and disable the dc-to-dc converter to significantly reduce the average power consumption.

3.06 A ringing source with a positive dc component will result in a decreased ring-tripping range and should not be used with the LSE plus TD.

3.07 The J99343CB LSE incorporates a reversing switch mounted on the printed wiring board. The reversing switch, designated NOR/REV, interchanges the T and R with the T1 and R1 connections (see paragraph 2.09). In addition to the NOR/REV switch, the J99343CB units that have been modified will have screw switches S2, S3, and S4. These switches should be turned out (up) for use in single-module mountings and turned in (down) for use in the transmission unit (TU) or signaling unit (SU) slots of double-module mountings. The unit must be removed from its service position for access to these switches.

> ***Note:*** Option W of SD-1C359-01 (CPS 6) adds screw switches S2, S3 and S4. When used in the single-module MFT shelf arrangement, the J99343CB LSE should be modified with Option W to eliminate crosstalk problems prevalent in many applications of the LSE.

B. Applications

3.08 The LSE plus TD can be used in all cases where the LSE is used. All application information given in Part 2 applies also to the LSE plus TD. In addition, it can be used in those circuits which require the boosting of short duration wink toll diversion signals.

4. LOOP SIGNALING EXTENDER II [LSE II; J99343CD (Mfg. Disc.)]

A. General

4.01 The LSE II, L1 replaces the J99343CA, J99343CB, and J99343CC LSE units which are rated Mfg. Disc. The LSE II, L2, which replaces the LSE II, L1, incorporates an improved circuitry which is more compatible with the DIMENSION® PBX system. The LSE II, L1 is rated Mfg. Disc.

4.02 The LSE II, L3, which replaces the LSE II, L2, provides all the capabilities of the list 2 plus the following design improvements (see Note):

(a) A bypass circuit has been added, controlled by a switch labeled TEST/NOR, which will effectively switch the LSE II out of the circuit during a dry circuit transmission test (paragraph 4.13).

(b) Several capacitance values have been changed which allow the list 3 greater immunity to high longitudinal voltages.

(c) An indicator lamp labeled BUSY has been added to the front panel. The indicator lamp will conveniently show whether the connecting circuit is idle or busy, ie, lamp is on when the circuit is busy (paragraph 4.15).

Note: Existing LSE II, L2s can be modified to contain the design improvements of the LSE II, L3 by adding options V and X to CP33 of SD 1C359-01. Option V provides for a TEST/NOR switch and a busy lamp (DS1) along with associated circuitry. Option X provides for capacitive changes enabling the LSE II to have greater immunity to high longitudinal voltages.

4.03 Two switch controls (SM/DM and S1 shown in Fig. 9) are located on the component board of the LSE II. The SM/DM slide switch is operated to SM when the LSE II is installed in a single-module mounting arrangement and to DM when installed in a double-module mounting arrangement. The S1 is a 2-position, screw-type switch which varies the sensitivity of the line current detecting circuits (paragraph 4.07).

4.04 The LSE II, L1, L2 and L3 are functionally similar to the previous LSE units, however, operational characteristics and efficiency of the LSE IIs have been improved. Optical isolators are used as current detectors and switches, allowing complete isolation between the tip and ring conductors, the control circuitry, and the power sources. This results in better longitudinal balance and immunity to extraneous voltages than in the previous LSE units.

4.05 Other advantages of the LSE II, L1, L2 and L3 over the previously available LSEs include the following:

(a) Increased current boost capabilities as shown in Fig. 10 (for example, 35 milliamperes as opposed to about 27 milliamperes for a 1500-ohm loop)

(b) Negligible dial pulse distortion with either normal or reversed battery

(c) Total solid-state design; no relays.

B. Circuit Description

4.06 The LSE II, L1, L2 and L3 consist of six principal parts. These parts, shown in Fig. 11, are as follows:

(a) Line current detector circuits

(b) Dc-to-dc converter and current regulator

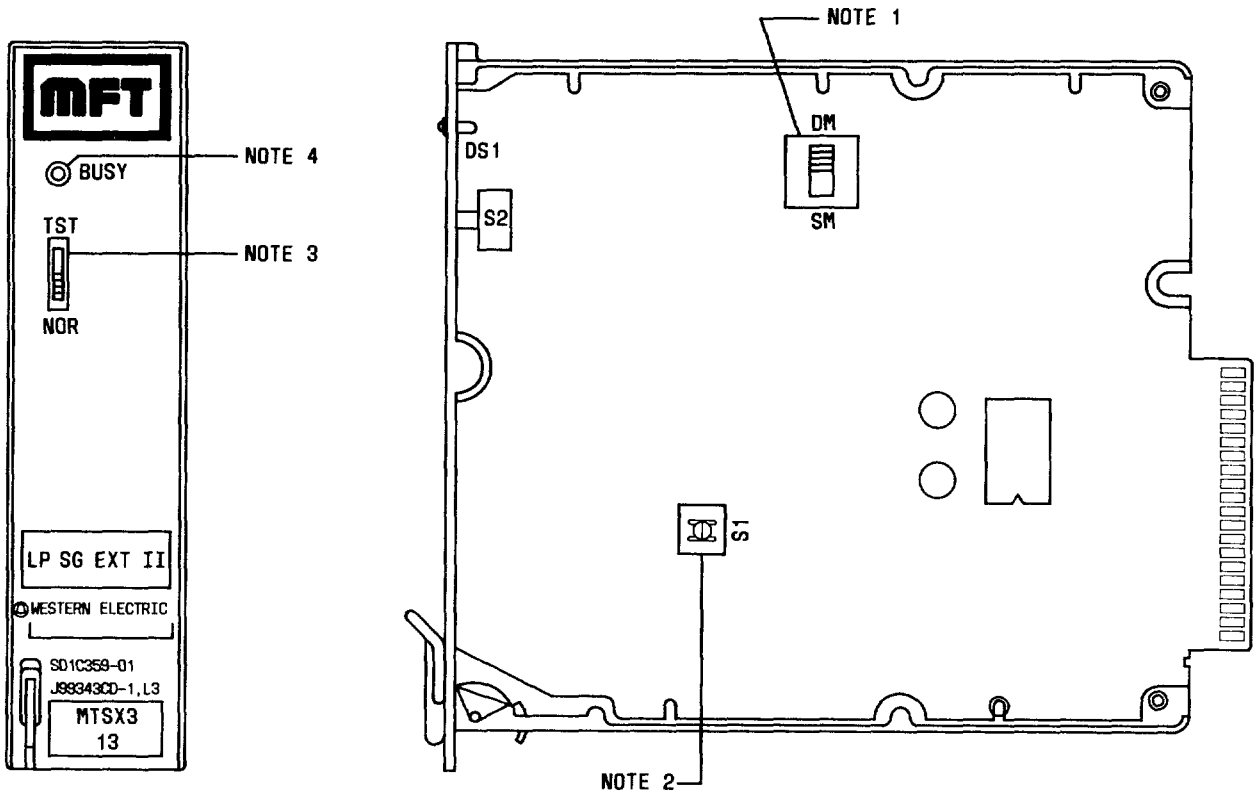
(c) Line switch control circuit

(d) Ringing detector circuit

(e) Dc-to-dc converter enable-disable circuit

(f) Repeater enable circuit.

4.07 Line current detectors (optical isolators) are located in both the tip and ring circuits to detect ground-start or loop-start currents. The threshold current required to activate the line current detectors is determined by the switch position of S1 (Fig. 9) which is set according to office type. Line circuits of the 805 PBX (24V) and other 24V PBXs require that switch S1 be in the turned-up position. In the UP position, a current of 3 mA or more of either polarity in the tip or ring conductors will operate the appropriate line current detector(s). Office arrangements, other than 24V PBX line circuits, require that S1 be in the turned-down position. A current of 5 mA or more of either polarity in the tip or ring circuits



NOTES:
1. THE SM/DM SWITCH MUST BE IN THE SM POSITION WHEN THIS UNIT IS USED IN A SINGLE-MODULE MOUNTING ARRANGEMENT; IN A DOUBLE-MODULE ARRANGEMENT, THE SWITCH MUST BE IN THE DM POSITION
2. THE SENSITIVITY SWITCH SHOULD BE TURNED UP ONLY WHEN THE -24 VOLT LOOPS ARE USED. SWITCH IS UP WHEN SCREW IS TURNED COUNTERCLOCKWISE TWO FULL TURNS
3. THE TEST/NOR SWITCH WHEN IN THE TEST POSITION, ALLOWS TRANSMISSION MEASUREMENTS TO BE MADE WITH THE LSE IN A "DRY LOOP."
4. THE BUSY LAMP (LED) PROVIDES CIRCUIT BUSY INDICATION. THE LED LIGHTS ANY TIME LINE CURRENT IS DETECTED.

Fig. 9—LSE II Switch and Indicator Layout

will operate the appropriate line current detector(s) with S1 in the turned-down position. Operation of a line current detector enables the dc-to-dc converter and the appropriate line switch controls to supply boost voltage of the correct polarity (aiding) to the tip and ring circuits.

Note 1: In the idle state (no loop-start or ground-start current), the line switches (optical isolators) are turned off and the dc-to-dc converter is disabled resulting in an idle current drain of only 9 mA.

Note 2: The J99343CD is normally shipped with switch S1 in the turned-down position.

Note 3: The J99343CD II does not have a reversing switch because the internal sense and boost circuits are independent of orientation. The only exception to this is ring trip boost discussed in paragraph 4.17.

4.08 The dc-to-dc converter supplies the bipolar boost voltages. These boost voltages, plus (+) and minus (-), are both available to the tip and ring circuits. The polarity to be used is controlled by the line switch control circuit which operates the appropriate line switch.

4.09 The magnitude of the boost voltage is controlled by a line current regulation circuit in the dc-to-dc converter. The regulation circuit is bi-

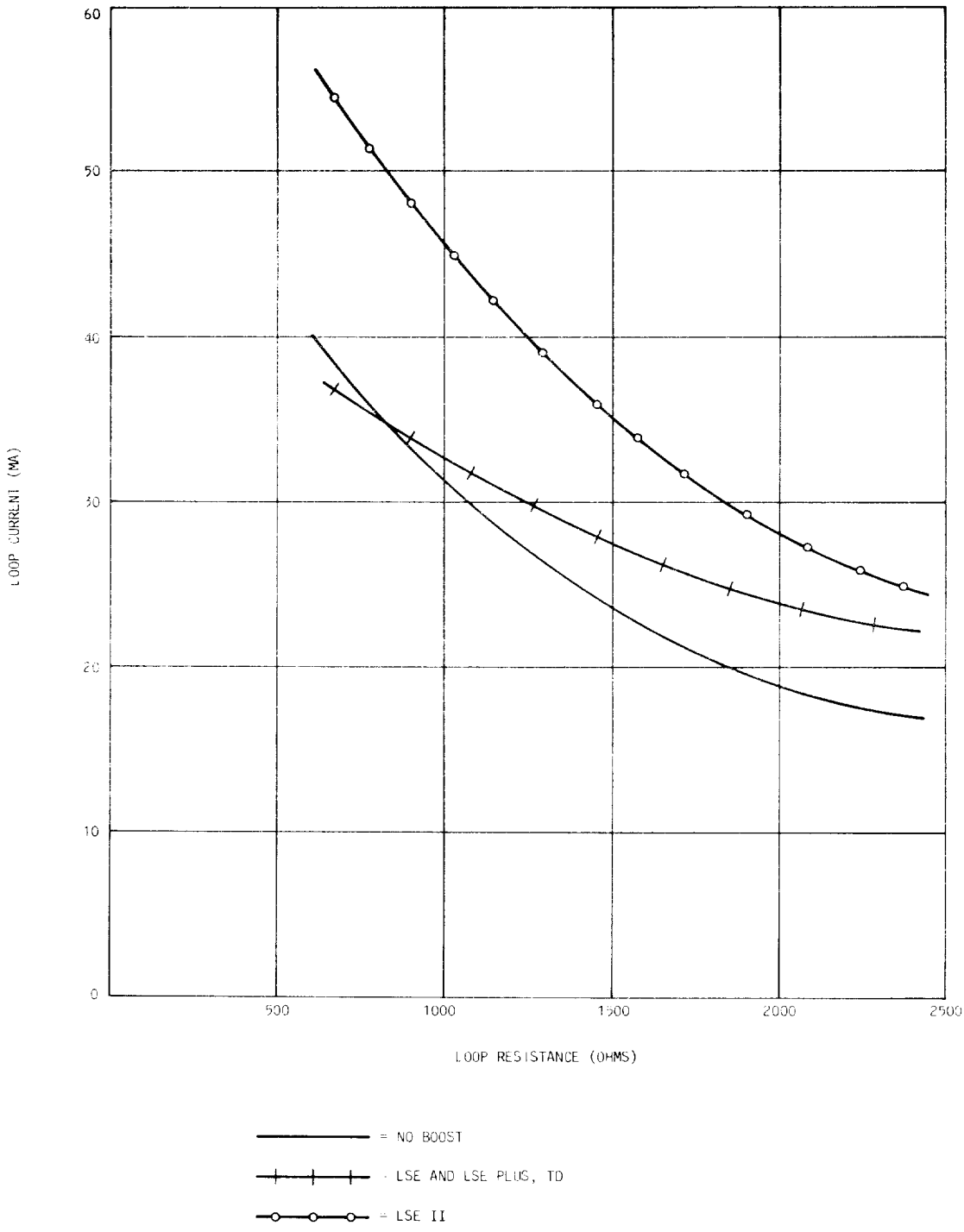


Fig. 10—Representative Loop Current Curves Showing Relative Effect of LSE Application

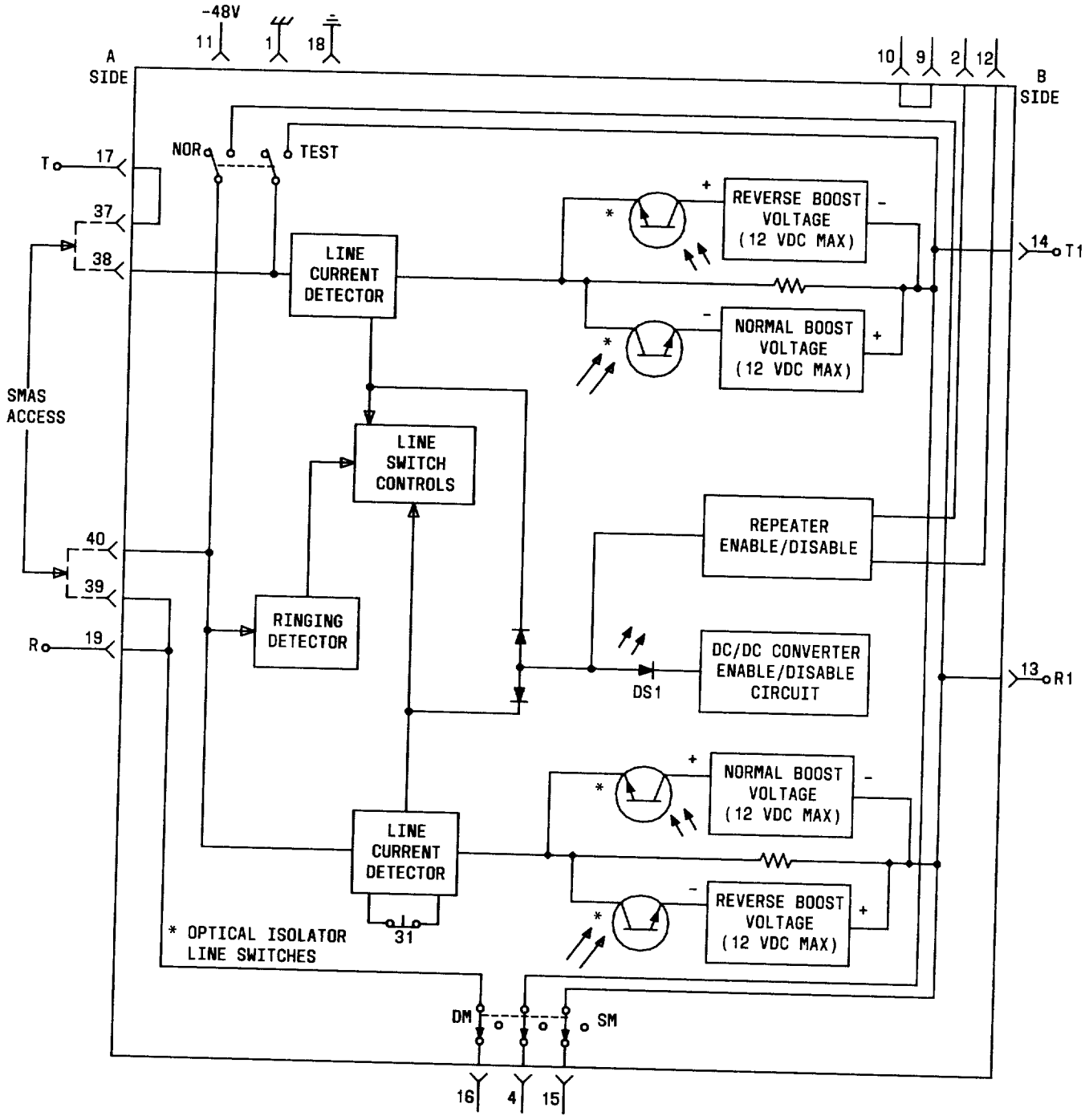


Fig. 11—Block Diagram of the LSE II

ased so that the full boost voltage (12 volts) is in series with each of the tip and ring circuits until the loop current reaches approximately 40 mA. When the loop current reaches 40 mA, the regulation circuit begins to reduce the boost voltage. All boost functions cease when the loop current reaches 65 mA and the LSE II is effectively out of the circuit.

4.10 The line switch control circuit, when enabled by the line current detectors, turns on the appropriate line switches to boost the loop current. Included in the line switch control circuit is a delay circuit which will prevent the LSE from following battery reversals of less than approximately 10 ms.

4.11 The ringing detector senses the presence of instantaneous voltages greater than 100 volts on the ring conductor and in turn prevents the line switches from operating in the reverse direction during this time. Therefore, during a ringing cycle, the boost voltage is applied only in the normal direction. Because the boost supplied by the LSE II during ringing is always in the normal battery direction, the dc component of the superimposed ringing signal is boosted to approximately -72 volts. This action assures sufficient ring trip current during the ringing interval, when the ringing signal is superimposed on -48 Vdc. The ring trip boost action may be affected if other types of ringing signals are used.

4.12 The ringing characteristics of the LSE II as used with various ringing signal sources are shown in Table E.

4.13 The dc-to-dc converter enable/disable circuit turns the converter on and off depending on signals from the line current detectors. This circuit will hold the converter in an on condition during short (300 ms or less) open loop conditions. This is to prevent the dc-to-dc converter from turning off and on during dial pulses, winks, etc.

4.14 The LSE II, when used with a companion MFT repeater, supplies a repeater enable function which enables the repeater when loop current is flowing. When no loop current flows, ie, during idle or open circuit conditions, the repeater is disabled. This decreases power consumption and prohibits repeater singing during idle circuit conditions.

C. TEST/NOR Switch and Busy Indicator (J99343CD, L2 With Option V or J99343CD, L3)

4.15 The TEST/NOR switch located on the LSE II front panel allows the LSE II (L3 or L2 with option V) to be bypassed completely when the switch is operated to the TEST position. Bypassing the LSE II permits dry circuit transmission tests without the LSE II in the circuit (see Note). In addition to the TEST/NOR switch, an indicator lamp labeled BUSY which provides a visible indication of the busy/idle status of the circuit is located on the front panel. The TEST/NOR switch for the LSE II (L3 or L2 with option V) is shown in Fig. 9.

> ***Note:*** When the LSE II (L1, L2 and L3) is active/on (minimum of 5 mA dc current flowing in the circuit), the transmission loss is approximately 0.2 dB. However, in the idle state (no current flowing), the LSE II transmission loss at 1000 Hz is normally approximately 10 dB, which is inherent to the LSE II and not to preceding models. Therefore, when standard transmission measurements are made on a dry circuit containing the LSE II, the 1000-Hz loss will be approximately 10 dB greater if the LSE II is not switched out of the circuit or bypassed.

4.16 The LSE IIs that do not incorporate the TEST/NOR function may be switched out of the connecting circuit during dry circuit tests, if a companion MFT repeater unit is used, by operating the repeater NOR-RV/T switch to the RV/T position, the NOR-RV switch to the NOR position, and the NOR/DISABLE switch to the NOR position. If a companion MFT repeater is not used, transmission measurements should be made with the circuit active. However if measurements cannot be made with the circuit active, the LSE II unit may be bypassed by shorting T to T1 (pins 38 to 14) and R to R1 (pins 40 to 13) on the connector at the rear of the frame or at the distributing frame.

D. Applications

4.17 The LSE II (J99343CD, L1, L2 and L3) may be used in place of any of the previous model LSEs in all applications with the exception of those where ring trip boost (B- to A-side signal direction) is required. The arrangement in Fig. 12 has this problem. The dc signaling comes from the E1R unit on the A and B leads, but the standard MFT distributing frame lead plan does not bring the A and B leads to the distributing frame. The BS1 and BS2 leads (B side) are the only external connections to the signaling path. Ringing is assumed to originate on the A side, thus the boost voltage polarity is preset.

4.18 One of the following alternatives will solve the ring trip boost problem.

- Install option ZQ (SD-1C359-01) in the MFT frame.

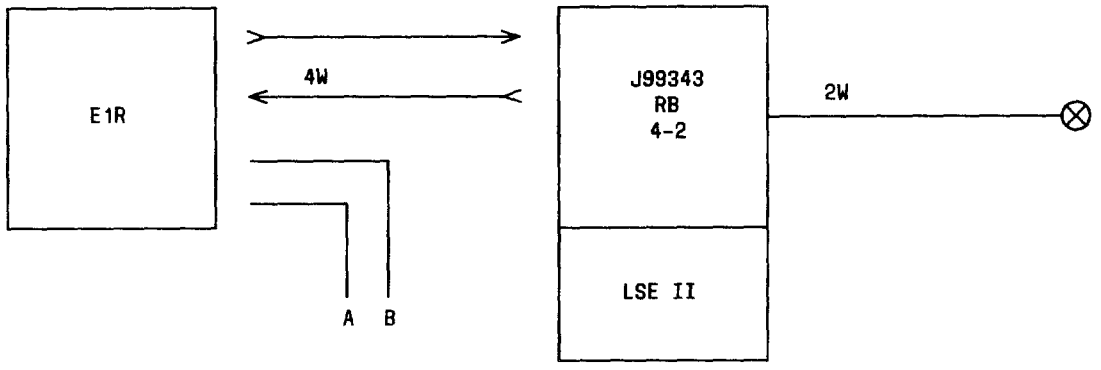


Fig. 12—Typical Application Requiring Ring-Trip boost When Ringing Originates on B-side

- Install a J99343BD between the E1R and the J99343RB. The EXT SX switch on the J99343BD should be operated, and the E1R A and B leads connected to the MFT bay via the BS1 and BS2 leads.

- Substitute a J99343CA, CB, CC, or CE for the J99343CD. Switch REV/NOR on the LSE is set to the REV position. On the J99343RB, set the NOR-RV switch to the RV position and the NOR-RV/T switch to the RV/T position. Leads A and B on the E1R are now connected to the BS1 and BS2 leads from the MFT frame. (BS1 and BS2 leads must be terminated.)

- Install a 4182-type network between the E1R and the J99343RB.

4.19 The transmission characteristics of the LSE II (L1, L2 and L3) are essentially the same as those of the earlier LSEs. These characteristics are given in Table D.

4.20 Tables C and G contain additional information applicable to the LSE II requirements, restrictions, and capabilities which will assist engineering personnel in circuit design.

▶5. LOOP SIGNALING EXTENDER J99343CE

A. Circuit Description

5.01 The J99343CE LSE unit (see Fig. 13) supersedes all of the other LSE units. The CE unit features a cost reduction, reduced dial pulse distortion, and low insertion loss (see Fig. 14) in both idle and busy states. The CE unit performs all the functions necessary for non-regenerative range extension of DC signals in both loop-start and ground-start applications, and with steady-state and wink reverse-battery signaling. The DC signaling range of the CE unit is summarized in Table H. The CE unit also provides loop current regulation to prevent excessive current flow on shorter facilities. The CE LSE is typically used on circuits with conductor loop resistance between 600 and 3000 ohms. The regulating characteristics are illustrated in Fig. 15. The CE unit also provides passive voice frequency coupling on two wire circuits.

5.02 The CE unit may be used in any slot of any MFT mounting arrangement. When the unit is used in the signaling unit slot of a double module bay, a companion transmission unit must be used in the transmission unit slot.

B. Operation

5.03 The J99343CE LSE unit provides:

- A floating 12 volt dc supply in series with both the tip and ring conductors. These supplies operate in series aiding to the CO talk battery to enhance signaling range for both loop- and ground-start signaling.

- Sensing of the loop current direction to maintain the proper polarity of each boost supply so that they are always in series aiding to the CO battery for a loop up to approximately 3000 ohms.

The LSE provides range extension of dc signals, but does not extend 20-Hz ringing ranges.

▶TABLE G◀

LSE II MAXIMUM LOOP RESISTANCE

LSE II USED WITH COMPANION TRANSMISSION UNIT	
CIRCUIT ARRANGEMENT	LOOP RESISTANCE FORMULA (NOTE 1)
Switch to Switch through LSE II	Range = $\frac{72}{I^*}$ — (CO BAT RES + TU RES† + PBX RES)
Switch to Station through LSE II	Range = $\frac{72}{I^*}$ — (CO BAT RES + TU RES† + STA RES)
LSR to LSR through LSE II	Range = 3000
LSR to Station through LSE II	Range = 2200 — STA RES
	LSE II USED ALONE
Switch to Switch through LSE II	Range = $\frac{72}{I^*}$ — (CO BAT RES + PBX RES)
Switch to Station through LSE II	Range = $\frac{72}{I^*}$ — (CO BAT RES + STA RES)
LSR to LSR through LSE II	Range = 3300
LSR to Station through LSE II	Range = 2500 — STA RES

Note 1: Range equals loop conductor resistance in ohms.

* Current (I) equals required ring trip current for the CO or talk current in amperes, whichever is greatest.

† MFT TU resistance may be obtained from SD-1C359-01 Information Notes.

5.04 The six principle parts of the J99343CE unit as shown in Fig. 16 are as follows:

(a) Loop Current Detector Circuits

(b) 12-volt Boost Supplies

(c) Polarity Reversal Relay (RV)

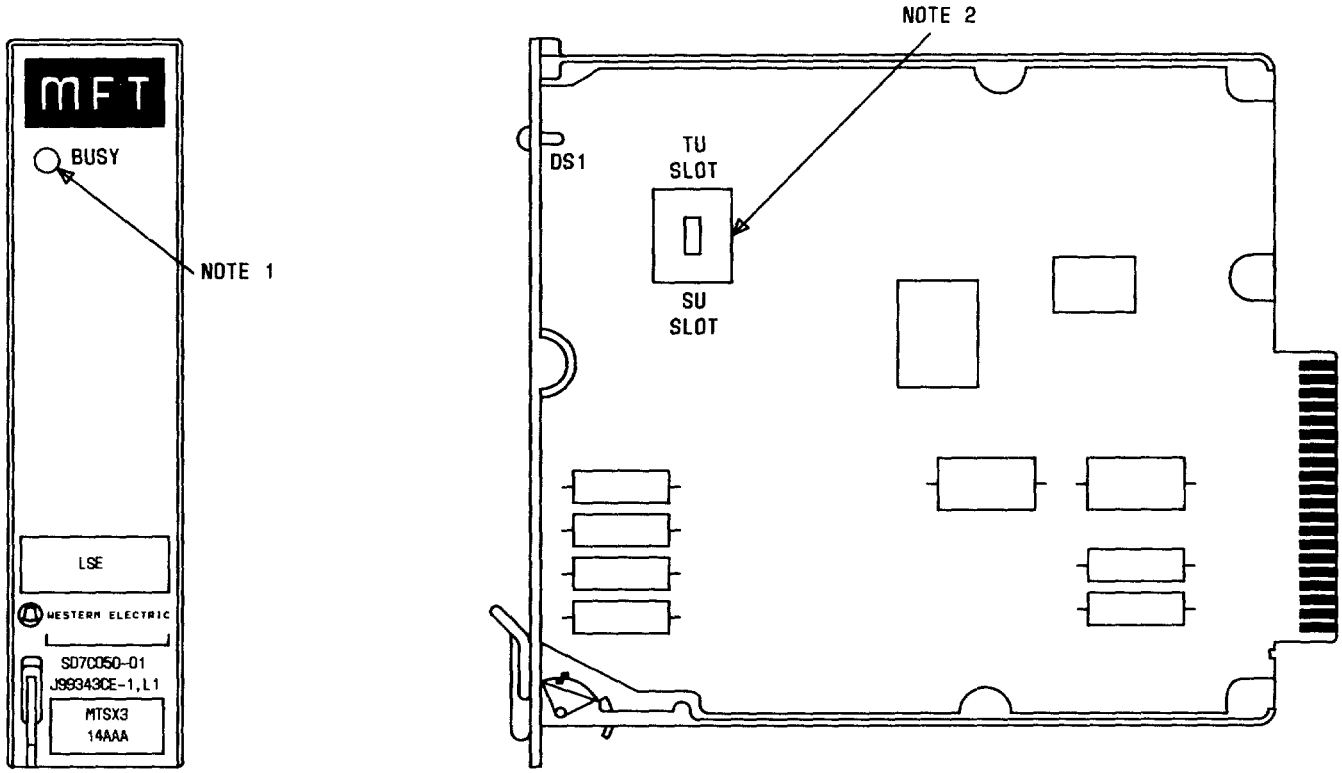
(d) Ringing Detector Circuit

(e) Repeater Enable Circuit.

Loop Current Detector Circuits

5.05 The J99343CE LSE unit uses optical isolators as loop current detectors. These devices allow complete isolation between the tip and ring conductors, the control circuitry, and power sources.

5.06 The loop current detectors are located in both the tip and ring circuits to detect ground-start or loop-start currents. A current flow of either polarity in the tip or ring circuit will activate the loop current detector. An output from the appropriate detector(s) results in boost voltage being supplied in series to the loop in the correct polarity.



NOTES:
1. THE BUSY LAMP (LED) PROVIDES CIRCUIT BUSY INDICATION. THE LED LIGHTS ANY TIME LINE CURRENT IS DETECTED.
2. THE TU SLOT/SU SLOT SWITCH MUST BE OPERATED TO THE TU SLOT POSITION WHEN THE CE UNIT IS PLUGGED INTO A TRANSMISSION SLOT OF A SINGLE MODULE BAY OR A DOUBLE MODULE BAY. IF THE CE UNIT IS USED IN THE SIGNALING SLOT OF A DOUBLE MODULE BAY, THE TU SLOT/SU SLOT SWITCH MUST BE OPERATED TO THE SU SLOT POSITION AND A COMPANION UNIT MUST BE MOUNTED IN THE TRANSMISSION SLOT.

Fig. 13—J99343CE LSE Switch and Indicator Layout

12-volt Supplies

5.07 The two floating 12-volt dc supplies for the boost voltage are derived from a dc-to-dc converter source. The amount of boost voltage inserted by the converter is regulated. As the loop current increases, the amount of boost voltage decreases. The regulating characteristics of the LSE as a function of loop resistance is illustrated in Fig. 15. The LSE may be used in applications where the external dc resistance is greater than 600 ohms.

Polarity Reversal Relay (RV)

5.08 When in the idle state, the RV relay is released. With the RV relay released, a total of 24 volts boost voltage is supplied (series aiding) to extend the range of the normal central office battery (-48V). As long as the switching equipment provides ground on the tip conductor and -48 volts on the ring conductor, the RV relay is disabled. If, during a call sequence, the central office reverses the battery polarity or if there is a tip-ring reversal on the switching side of the unit, the RV relay will operate. Operation of the RV relay will cause a series aiding loop current to be applied to the tip and ring conductors. The reversal occurs when there is current flow in either or both conductors.

Ringing Detector Circuit

5.09 The ringing detector monitors the A-side facility for 20-Hz ringing between the ring con-

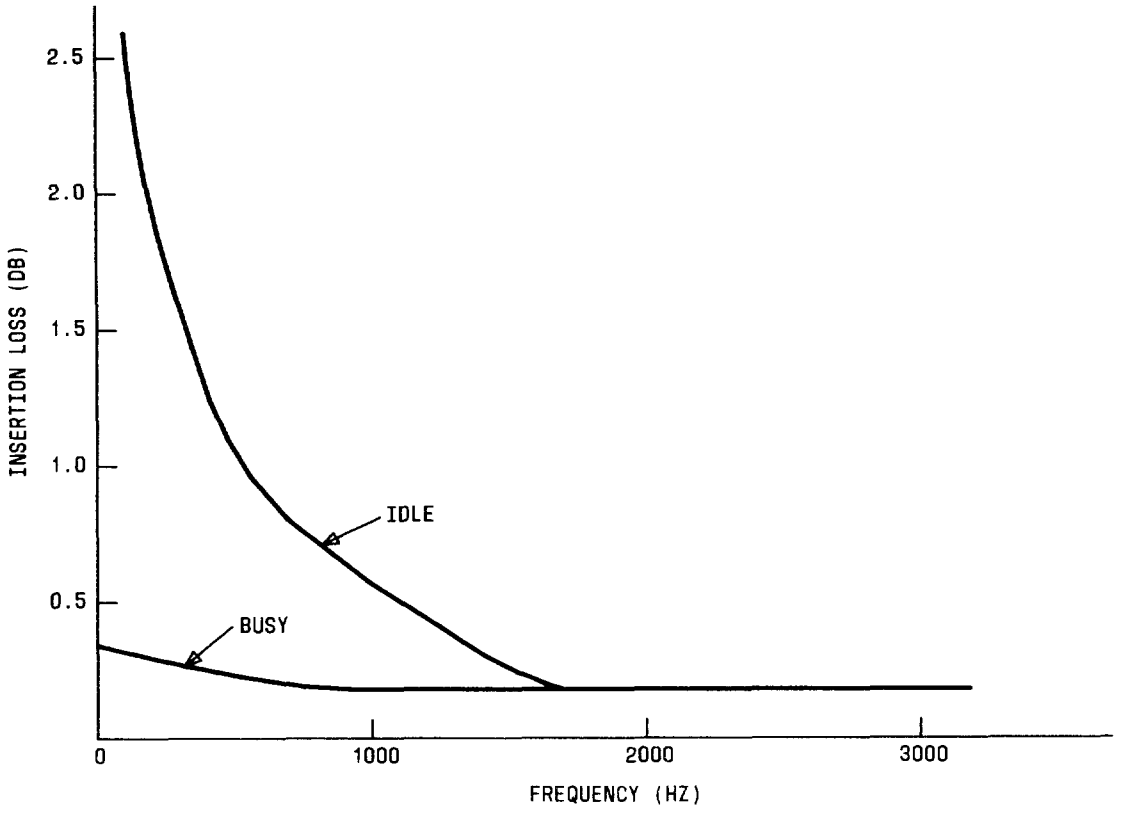


Fig. 14—J99343CE Insertion Loss

TABLE H

J99343CE DC SIGNALING RANGE IN OHMS (NOTE 1)

CO BATTERY	LSE VOLTAGE SUPPLY ON TERMINAL 11			
	42.5V	48V	52.5V	LOOP CURRENT (mA)
42.5V	2800 2400	2900 2500	3100 2600	20 23
48V	3100 2600	3200 2800	3300 2900	20 23
52.5V	3300 2800	3400 3000	3600 3100	20 23

Note 1: The DC signaling range is the total external DC resistance connected to the unit and includes the resistance of the central office battery feed, the cable resistance, the internal resistance of a companion transmission unit, if any, and the resistance of the terminating equipment.

ductor and circuit ground. Once ringing is detected, the RV relay is inhibited to prevent it from following the ringing. Inhibiting the RV relay also enables the LSE to boost the negative ring-trip battery which is superimposed with the ringing voltage. This enhances the ring-trip range.

Repeater Enable Circuit

5.10 When the J99343CE unit is used with a companion MFT repeater, a repeater enable function is supplied. This function enables the repeater when loop current is flowing. When no loop current flows, ie, during idle or open circuit conditions, the repeater is disabled. This decreases power consumption and prohibits repeater singing during idle circuit conditions.

C. Unit Controls

TU SLOT/SU SLOT

5.11 When the CE unit is used in the transmission slot of a single module bay or a double module bay, the TU SLOT/SU SLOT switch must be operated

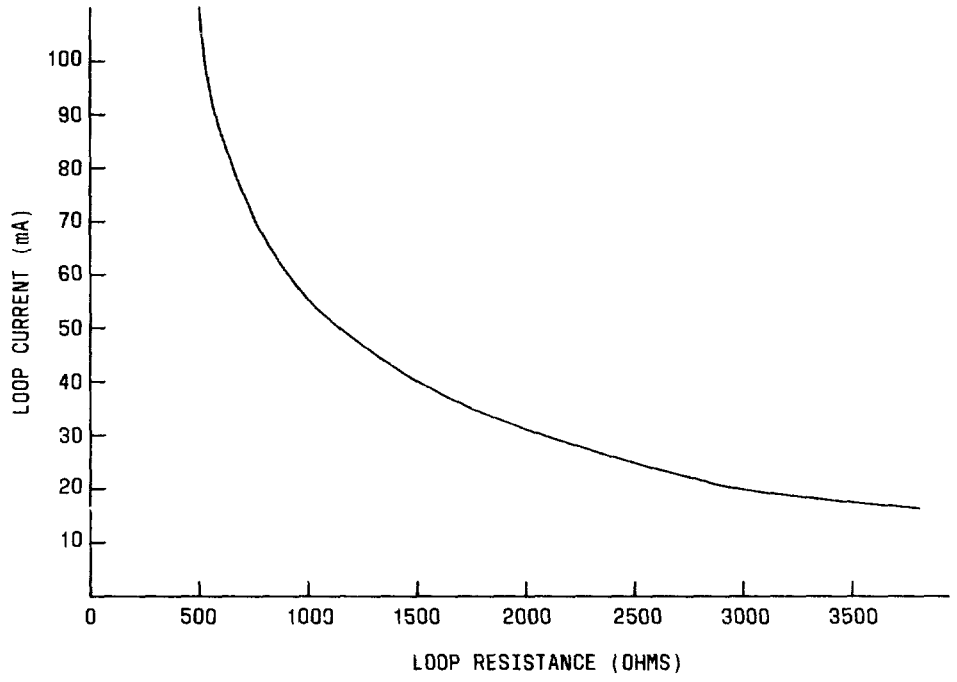


Fig. 15—J99343CE Loop Current Regulating Characteristics

to the TU SLOT position. If the CE unit is used in the signaling slot of a double-module bay, the TU SLOT/SU SLOT switch must be operated to the SU SLOT position and a companion unit must be mounted in the tranmission slot.

D. Applications

5.12 The J99343CE unit may be used in either loop-start or ground-start operation within the limits specified in Table F. Typical applications of the J99343 CE unit are illustrated in Fig. 17.

5.13 The CE unit may be used for metallic range extension from analog and digital carrier systems and may be used at either switching or station end of a carrier channel with the following exceptions:

(a) If additional range extension is required, the CE unit may be placed in tandem on the switching side of MFT loop-signaling repeaters, or in tandem with switching side analog or digital carrier channel units.

(b) The LSE may be placed in tandem on the station side of MFT loop-signaling repeater or carrier channel unit if 48 volts talk battery is used rather than 72 volts.

5.14 The CE unit may be used on direct-inward-dialing (DID) trunk circuits and is compatible with loop and battery-ground outpulsing. The CE is also compatible with immediate-start, delay dial, or wink-start dial pulse supervision.

6. MAINTENANCE

6.01 There is no routine maintenance required for LSE plug-in units.

6.02 Access for switch settings is normally required for initial circuit order work only. There is usually no further requirement for access after the circuit is established.

6.03 If trouble occurs on a circuit, the problem must first be localized. This is made easier in MFT installations because the transmission unit (if used) and signaling unit are located adjacent to each other.

6.04 If an LSE unit is determined to be faulty, it is removed and replaced by a spare. The defective unit should then be returned to the Western Electric Service Center for repair.

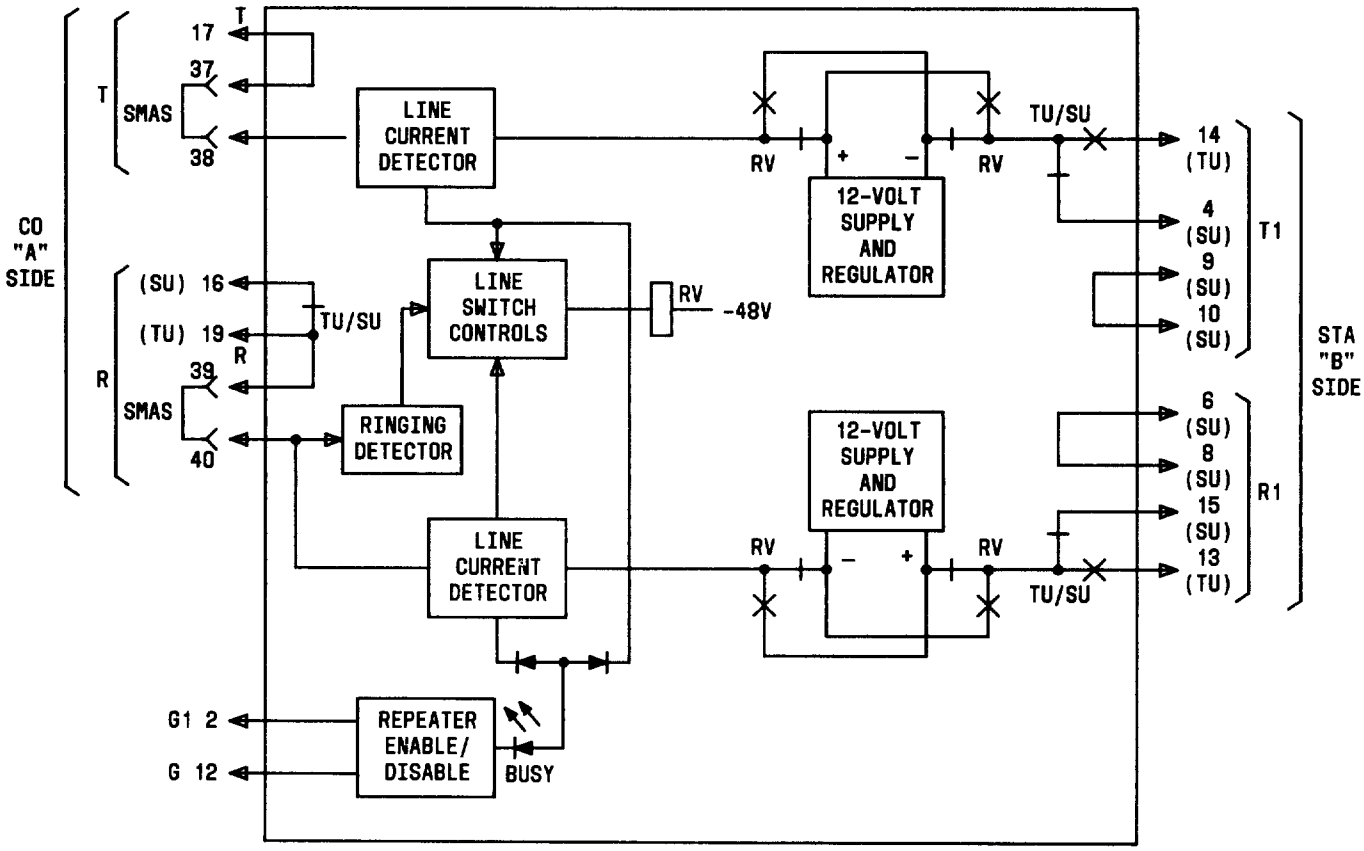
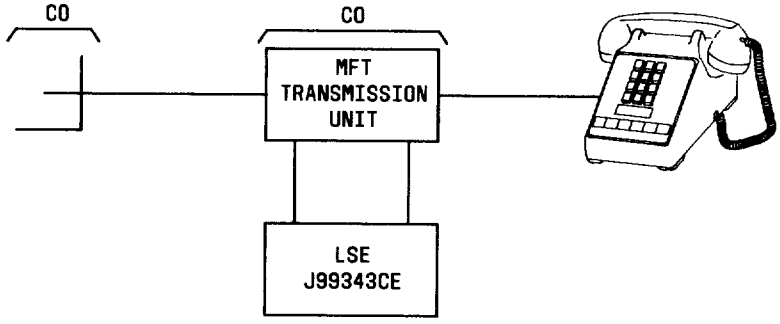
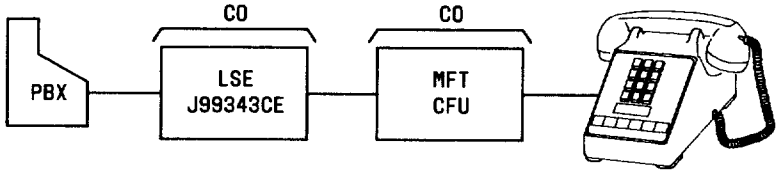


Fig. 16—Block Diagram of J99343CE LSE Unit



FX LINE WITH J99343CE



OPS LINE WITH TANDEM CFU

Fig. 17—Typical Application of J99343CE LSE Unit