METALLIC FACILITY TERMINAL
LOOP SIGNALING REPEATER (J99343AA, AB, AC, AD, AE, AF, AH)
INSTALLATION AND TESTING
SD-1C359-01

CONTENTS PAGE

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. This section gives installation and testing information for the MFT loop signaling repeaters (LSR) J99343AA, AB, AC, AD, AE, AF, and AH.

1.02 This section is reissued to contain installation and testing information for LSRs only. Previous issues of this section contained information for all MFT signaling units. The installation and testing information for other MFT signaling units can be found in Sections 332-911-202 through -205.

1.03 LSRs provide all the functions required for the regeneration of dc and ac 20-Hz signals as required for either loop-start or ground-start operation. The unit interfaces through A- and B-type leads or SX and SX1 leads to the transmission unit and provides detection and regeneration functions toward the station and switching equipment.

2. CHARACTERISTICS OF LOOP SIGNALING REPEATERS

A. Loop Signaling Repeaters — J99343AA, AB, AC, AD, and AH

2.01 The LSRs regenerate 20-Hz ringing in one direction and dc signals or dial pulses in the opposite direction. Ground-start LSRs repeat dc signals in both directions. Three units (AA, AC, and AH) allow selection of either loop-start or ground-start operation and are designated LSR/LS-GS for the first two units and LSR/DR for the last (DR designates distinctive ringing). A fourth (J99343AF) operates in either loop-start or

ground-start mode without manual selection. The J99343AF unit repeats distinctive ringing and performs toll diversion (battery reversal) and is designated LSR/TD. The AB and AD units are for use on loop-start circuits only and are designated LSR/LSO. The AC, AD, and AH units are shown in Fig. 1, 2, and 3, respectively.

2.02 The AA, AB and AH units are rated manufacture discontinued (MD) and are replaced by the AC, AD and AF units, respectively. Detailed descriptions of the LSR are presented in Section 332-911-101.

2.03 The loop-start/ground-start switch (LS-GS) on the AA, AC and AH units is operated to the appropriate position depending on circuit operation. In the LS position, the circuit is seized by the station side loop closures, while the GS position requires a ground from either direction for circuit seizure. On the AA unit, the LS-GS switch is mounted on the front panel. The switch is mounted on the printed wiring board of the AC and AH units.

2.04 The SX inductor switch on the associated transmission unit should be in the NOR position regardless of the position of the LS-GS switch.

2.05 Two early model transmission units (J99343BA and BB) are equipped with build-out resistors (BORs) to limit the current flow in short loops. When these transmission units are used with BOR equipped LSRs (modified AA and AB units or AC, AD, AH and AF units), the transmission units' BORs should be switched out.

2.06 The minimum DC resistance between LSRs and switching equipment is 300 ohms. This can be provided by the BOR on all units except the unmodified J99343AA or AB. The maximum central office (CO) or PBX to LSR range is limited by the maximum external circuit resistance of the CO or PBX. Table A lists the minimum range restrictions for unmodified LSRs (no BOR) with various MFT transmission units. There are no minimum range restrictions for LSRs equipped with BORs. Table B lists the BOR settings required on the switching side and Table C lists the BOR settings required on the station side of the unit

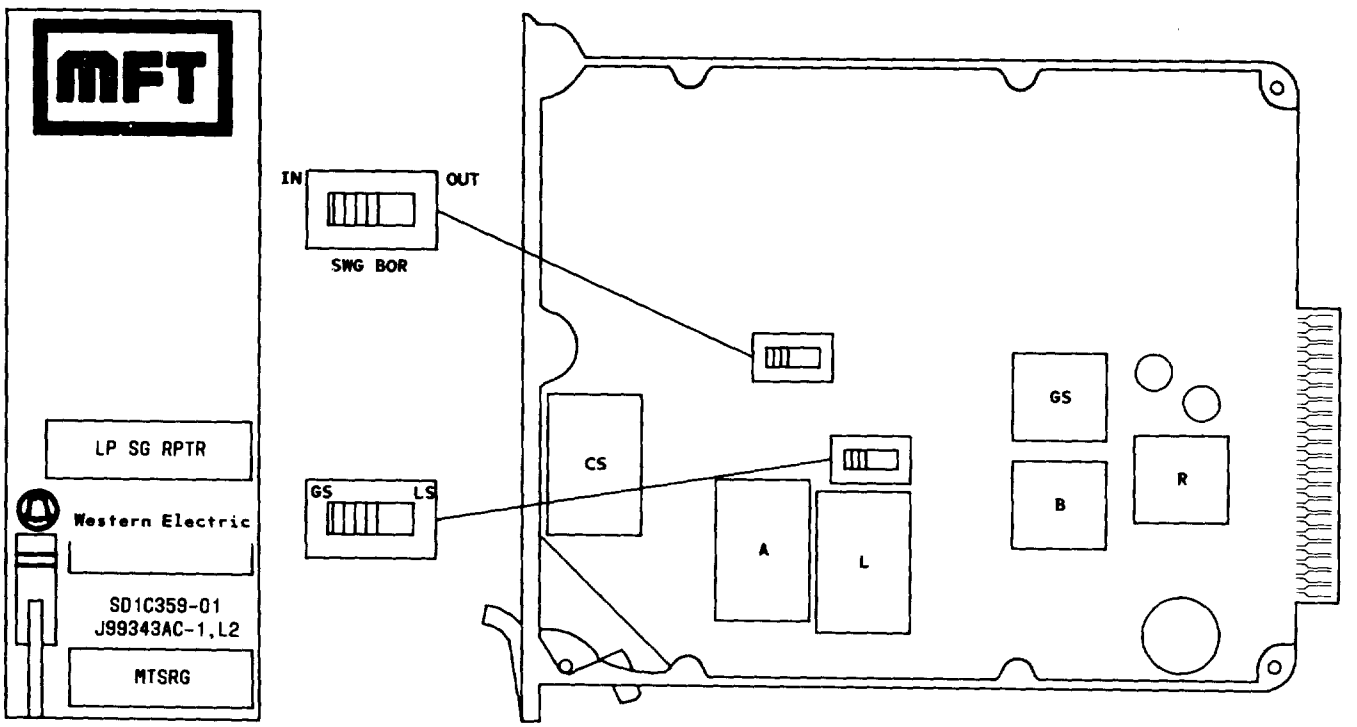

Fig. 1—J99343AC Layout

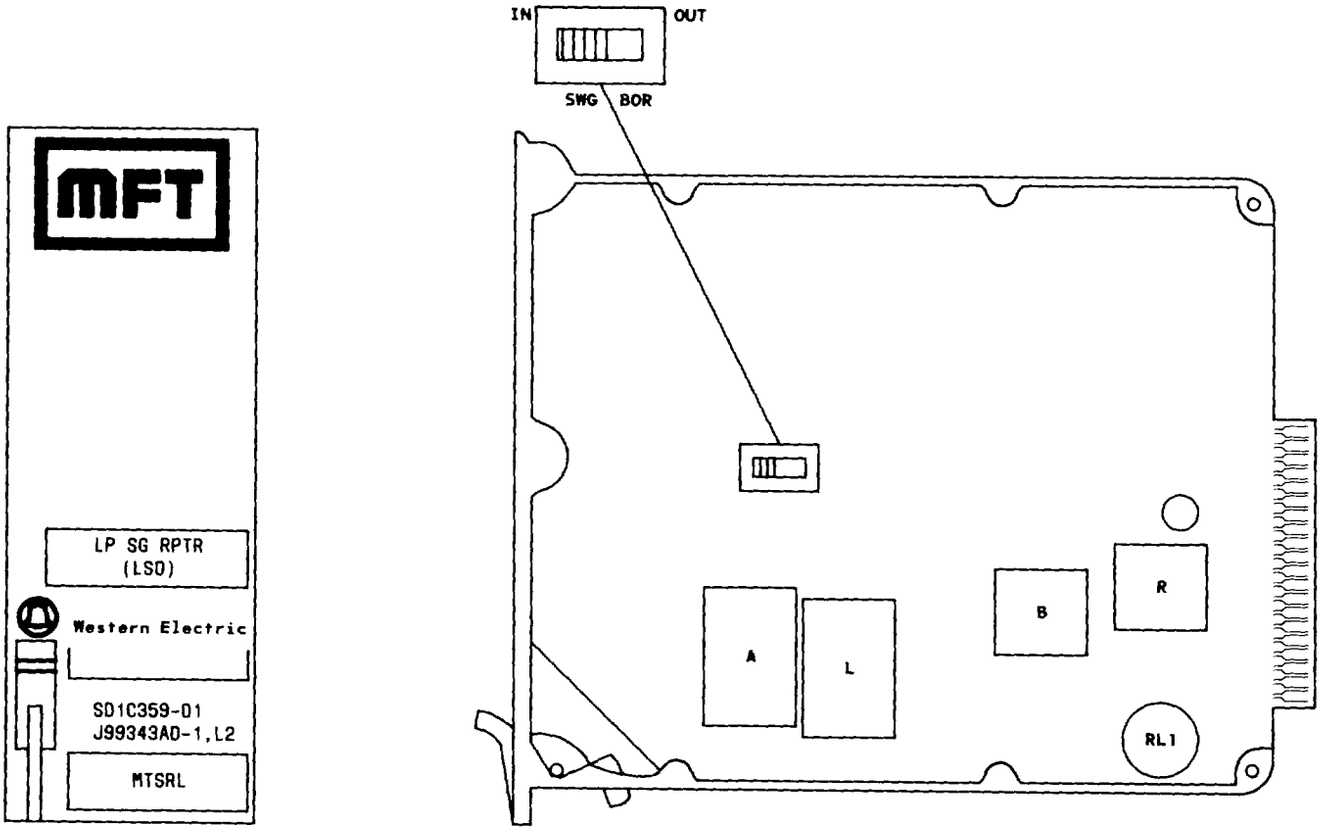

Fig. 2—J99343AD Layout

based on talk battery voltage and conductor loop resistance. Tables D and E list the maximum ringing and signaling ranges. (For further detail see SD-1C359-01.) Signaling range limitation information is found in Section 851-300-170.

2.07 The signaling capabilities of the LSR/LS-GS J99343AC also apply to the LSR/DR J99343AH. The only change in electrical characteristics of the LSR/DR is a reduction of the 150 ms guard band in the ringing detector circuit to 50 ms. This faster response results in the ability to faithfully reproduce all DIMENSION® PBX distinctive ringing modes on circuits containing an LSR/DR.

> ***Note:*** On circuits which require a second LSR/DR to meet end-to-end signaling requirements, a 100 ms ringing pulse which is generated by the DIMENSION equipment ("Ring Ping") may not be transmitted to the terminating equipment. This condition can occur if an improper phase relationship occurs between the 20-Hz generators at the DIMENSION PBX and the first LSR/DR; this results in an input pulse to the second LSR/DR which is less than 50 ms. The second LSR/DR will not respond to this short signal.

2.08 The LSR/DR has the same controls and circuit board arrangement as the LSR/LS-GS J99343AC.

2.09 The LSR/DR has the same signaling range, performance capabilities, and installation and testing requirements as the LSR/LS-GS J99343AC.

B. Loop Signaling Repeater with Toll Diversion (LSR/TD) — J99343AF

2.10 The LSR/TD is a new direct replacement repeater for the loop-start/ground-start LSR J99343AC and AH (see Fig. 4). It embodies the same signaling capabilities described in Part 2A

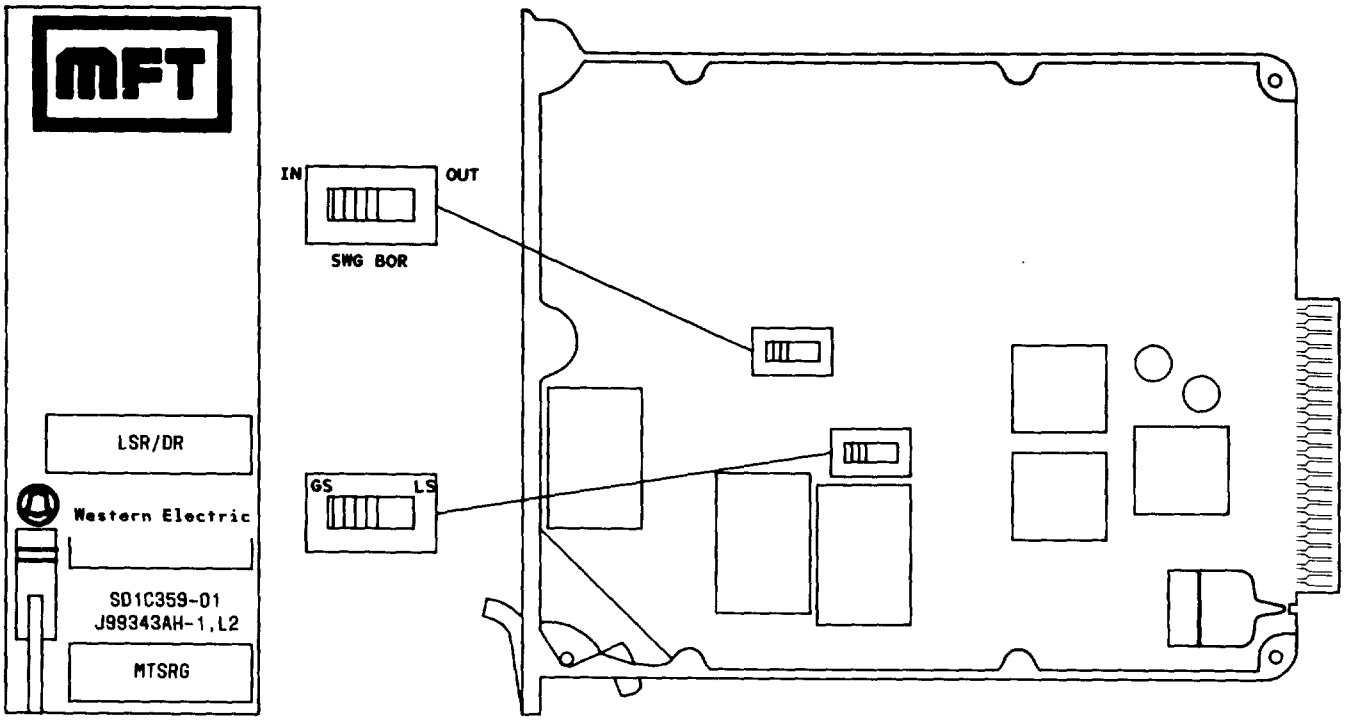

Fig. 3—J99343AH Layout

TABLE A

MINIMUM RANGE* RESTRICTIONS OF UNMODIFIED J99343AA AND AB LSRs
(LSR CONTAINS NO BOR OR RESISTANCE LAMP)

MFT TRANSMISSION UNIT	TO CENTRAL OFFICE (OHMS)		TO STATION (OHMS) J99343AA, AB	
	J99343AA	J99343AB	—48 VOLTS	—72 VOLTS
J99343BA 2-Wire Transmission Unit (BORs IN) J99343BB bypass Transmission Unit	0	0	0	0
J99343BC 2-Wire Transmission Unit J99343PA and PF 2-2 Repeaters	0	185	395	795
J99343RA, RD, RE, and RF 2-4 Repeaters	0	185	490	890
J99343RB and RC 4-2 Repeaters	115	280	395	795
J99343SA and SB 4-4 Repeaters	115	280	490	890

* The minimum range between a CO and an LSR is based on a 300-ohm minimum requirement between a CO and a Dial Long Line (DLL) circuit.

TABLE B

LSR BUILD-OUT RESISTOR (BOR) REQUIREMENTS (SWITCHING SIDE BORs IN J99343AA, AB, AC, AD, AH, AF, BA, BB AND GA)

TALK BATTERY FROM SWITCH MACHINE (VOLTS)	CONDUCTOR LOOP RESISTANCE (OHMS)	BOR IN BA OR BB WHEN USED WITH AA OR AB WITHOUT BOR MOD*	BOR IN AA OR AB (WITH BOR MOD*) OR IN AC, AD, AF OR AG, AND AH WHEN USED WITH ANY TRANSMISSION UNIT	BOR IN BA OR BB WHEN USED WITH AA OR AB WITH BOR MOD*
−24	Less than 300 Greater than 300	DOWN UP	DOWN UP	UP UP
−48	Less than 600 Greater than 600	DOWN UP	DOWN UP	UP UP
−72	Less than 900 Greater than 900	DOWN UP	DOWN UP	UP UP

* BOR MOD is the addition of a resistance lamp on the station side and the addition of a resistor and associated switch on the switching side of the unit. This addition is shown as options F, G, V, and W of SD-1C359-01 for the AA unit and options Y, Z, and U of SD-1C359-01 for the AB unit.

TABLE C

LSR BUILD-OUT RESISTOR (BOR) REQUIREMENTS (STATION SIDE BORs IN J99343BA AND BB WHEN USED WITH J99343AA OR AB WITHOUT BOR MOD*)

LSR TALK BATTERY (VOLTS)	EXTERNAL CIRCUIT RESISTANCE (OHMS)	BOR IN BA OR BB
−48	Less than 500 Greater than 500	DOWN UP
−72	Less than 960 Greater than 960	DOWN UP

*BOR MOD is the addition of a resistance lamp on the station side and the addition of a resistor and associated switch on the switching side of the units. This addition is shown as options F, G, V, and W of SD-1C359-01 for the AA unit and options Y, Z, and U of SD-1C359-01 for the AB unit.

plus the addition of a reverse battery supervision feature needed for such applications as a wink or continuous battery reversal toll diversion signal. This feature (TD) is provided as a switch-selectable option.

2.11 The outstanding feature of this unit is the improved design. The latest in modern hybrid integrated and optically coupled circuit techniques are used to improve performance and reliability and to reduce power consumption. Whenever possible, functional circuits which used discrete components in previous LSR designs have been replaced with integrated circuit equivalents.

2.12 Installation and testing information for the LSR/TD is the same as listed for other LSR units. Refer to Table F for signaling ranges. Table G gives internal resistance of the LSR/TD. Ringing information is contained in Table H. Table I lists tolerable longitudinal ac voltages. Table J contains LSR power information.

C. Loop-Start/Ground-Start Converter — J99343AE

2.13 The loop-start to ground-start converter (LS-GS CONV) is used at the CO end of

TABLE D

RINGING RANGE TO STATION SET OR PBX

RINGING RANGE TO STATION SET WITH C4A RINGERS AND 0.5 μF SERIES CAPACITOR (NOTE 1)		
NUMBER OF C4A RINGERS	MAXIMUM CONDUCTOR LOOP RESISTANCE IN OHMS BETWEEN LSR OR LS-GS CONV AND STATION SET (NOTE 2)	
	STIFF NOTCH BIAS SPRING SETTING 50V RMS AT RINGER	WEAK NOTCH BIAS SPRING SETTING 43V RMS AT RINGER
1	5220 Ohms max	6540 Ohms max
2	2880 Ohms max	4050 Ohms max
3	1820 Ohms max	2650 Ohms max
RINGING RANGE TO PBX WITH TYPICAL RINGING RELAY TYPE OF RINGING DETECTION CIRCUIT (NOTES 1 AND 3)		
RINGING LOAD	MAXIMUM CONDUCTOR LOOP RESISTANCE IN OHMS BETWEEN LSR OR LS-GS CONV AND PBX (NOTE 2)	
	STIFF NOTCH BIAS SPRING SETTING ON C4A RINGER 50V RMS AT RINGER	WEAK NOTCH BIAS SPRING SETTING ON C4A RINGER 43V RMS AT RINGER
PBX Ringing Detector Only	3600 Ohms max	
PBX Ringing Detector and 1 C4A Ringer	2300 Ohms max	3300 ohms max
PBX Ringing Detector and 2 C4A Ringers	1750 Ohms max	2450 Ohms max

Note 1: Regenerated ringing ranges given in these tables assume a ringing supply of 84 to 86 volts rms 20 Hz and a series 13L or 21A resistance lamp. Ringing trip range and ringing detection range both exceed 3650 ohms and are not considered as limiting factors in circuit design.

Note 2: The average voltage required to operate a C4A ringer with bias spring set in the stiff notch is 50 volts ac rms. The maximum voltage required to operate a C4A ringer with the bias spring set in the weak notch is 40 volts ac rms. To ensure adequate operating margin in most circuit designs, the maximum ranges listed for 50-volt operation are recommended as design limits. When operating at the extremes of these ranges, ringers may have to be selected or set in the weak bias spring notch to obtain satisfactory operation.

Note 3: These ranges are based on measurements made on a typical PBX relay ringing detector circuit, such as the circuits used in SD-5E001, SD-69566, SD-5E016, and SD-1E340. The PBX ringing detector and C4A ringer combinations are typical of night connections.

TABLE E

LSR AND LS-GS SIGNALING RANGE

TALK BATTERY	RANGES BASED ON LOW/NOMINAL BATTERY VOLTAGES	RANGE BETWEEN			
		SWITCHING MACHINE AND LSR (NOTE)	TWO LSRs OR LS-GS CONV & LSR BASED ON 16mA LOOP CURRENT	LSR OR LS-GS CONV AND STATION BASED ON	
				23mA LOOP CURRENT	36mA LOOP CURRENT
−24V (−22.5V To −26V)	Low	The lesser of: (1) CO or PBX limit minus 320 ohms or (2) 1080 minus CO or PBX battery feed resistance.	—	—	—
	Nominal	The lesser of: (1) CO or PBX limit minus 320 ohms or (2) 1180 minus CO or PBX battery feed resistance	—	—	—
−48V (−42.5A To −52V)	Low	The lesser of: (1) CO or PBX limit minus 320 ohms or (2) 2330 minus CO or PBX battery feed resistance.	1950 Ohms maximum	1430 minus station resistance	515 minus station resistance
	Nominal	The lesser of: (1) CO or PBX limit minus 320 ohms or (2) 2680 minus CO or PBX battery feed resistance.	2290 Ohms maximum	1670 minus station resistance	690 minus station resistance
−72V (−67.5V To −78V)	Low	The lesser of: (1) CO or PBX limit minus 320 ohms or (2) 3990 minus CO or PBX battery feed resistance.	3500 Ohms maximum	2520 minus station resistance	1210 minus station resistance
	Nominal	The lesser of: (1) CO or PBX limit minus 320 ohms or (2) 4180 minus CO or PBX battery feed resistance.	3790 Ohms maximum	2710 minus station resistance	1360 minus station resistance

Note: The CO or PBX limit referenced in this table is the maximum external circuit resistance limit specified for the CO or PBX.

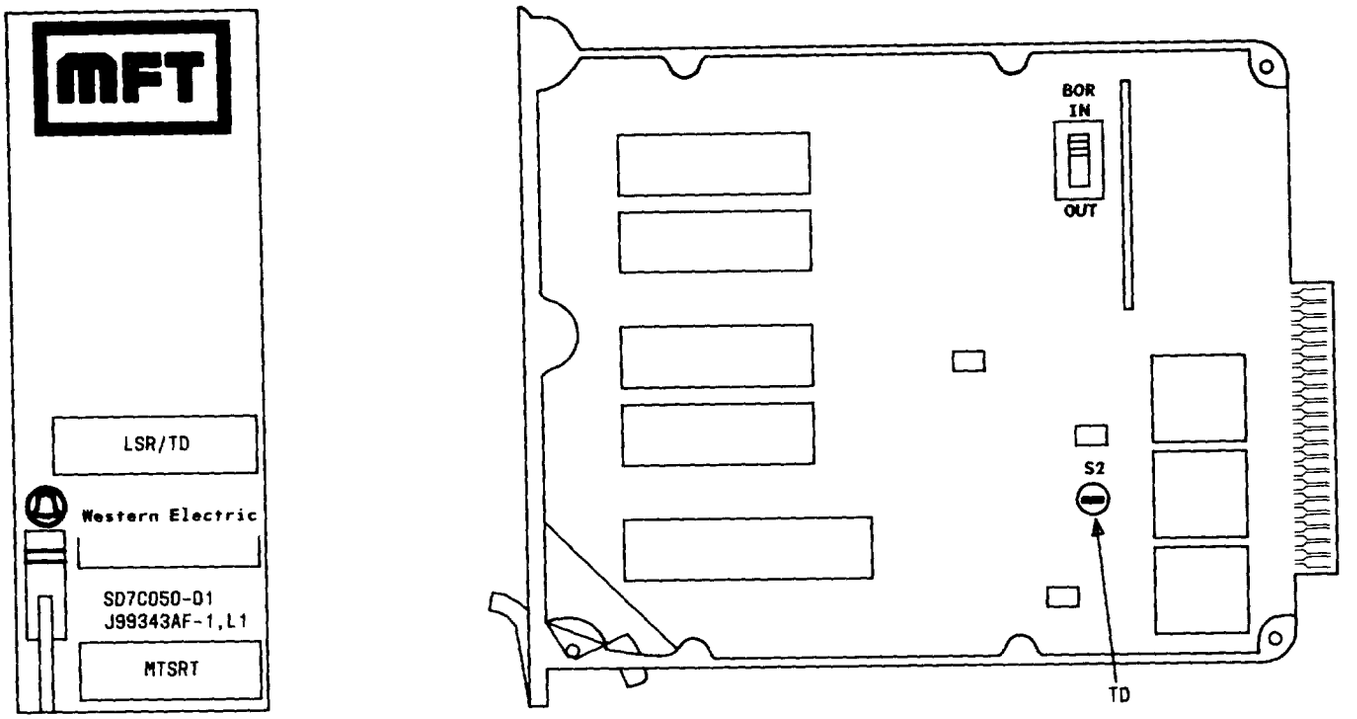

Fig. 4—J99343AF Layout

CO-PBX trunks. It regenerates dc signals and 20-Hz ringing from the CO (A-side) toward the station (B-side) and regnerates DC signals, including correction of dial pulses from the station toward the CO. It operates loop-start with a sleeve lead control on the CO side and ground-start on the station side (the station side is identical to the LSR in the ground start configuration). The sleeve lead control on the CO side makes the LS-GS CONV immune to open switching intervals which can occur in certain CO arrangements and causes the disconnection of some PBX equipment. The LS-GS CONV is shown in Fig. 5. Detailed information is contained in Section 332-911-101.

2.14 The adjacent transmission unit SX inductor switch should be in the NOR position. When the LS-GS CONV is used with BOR equipped transmission units (J99343BA and BB), the BOR switches in the transmission unit should be in the up position. Both BOR switches should never be in the down position at the same time.

2.15 To configure the LS-GS CONV to operate with a particular type of central office, 12 screw switches mounted on the printed wiring board must be set as indicated in Table K.

3. SWITCH FUNCTIONS AND SETTINGS

A. Build-out Resistor Switch (SWG BOR)

3.01 The BOR switches are found on all LSRs except the J99343AE. The SWG BOR switch,

TABLE F

SIGNALING RANGES (GS or LS) FROM SWITCHING MACHINE (NOTE 1)

TALK BATTERY	RANGES BASED ON LOW/NOMINAL BATTERY VOLTAGES	RANGE BETWEEN			
		SWITCHING MACHINE AND LSR (NOTE 2)	TWO LSRs OR LS-GS CONV & LSR BASED ON 16mA LOOP CURRENT	LSR OR LS-GS CONV AND STATION BASED ON	
				23mA LOOP CURRENT	36mA LOOP CURRENT
−24V (−22.5V To −26V)	Low	The lesser of: (1) CO or PBX limit minus 255 ohms or (2) 1143 minus CO or PBX battery feed resistance.	—	—	—
	Nominal	The lesser of: (1) CO or PBX limit minus 255 ohms or (2) 1245 minus CO or PBX battery feed resistance	—	—	—
−48V (−42.5V To −52V)	Low	The lesser of: (1) CO or PBX limit minus 255 ohms or (2) 2400 minus CO or PBX battery feed resistance.	2355 Ohms maximum	1430 minus station resistance	515 minus station resistance
	Nominal	The lesser of: (1) CO or PBX limit minus 255 ohms or (2) 2745 minus CO or PBX battery feed resistance.	2355 Ohms maximum	1670 minus station resistance	690 minus station resistance
−72V (−67.5V To −78V)	Low	The lesser of: (1) CO or PBX limit minus 255 ohms or (2) 3965 minus CO or PBX battery feed resistance.	3565 Ohms maximum	2520 minus station resistance	1210 minus station resistance
	Nominal	The lesser of: (1) CO or PBX limit minus 255 ohms or (2) 4245 minus CO or PBX battery feed resistance.	3855 Ohms maximum	2710 minus station resistance	1360 minus station resistance

Note 1: These ranges apply to all standard types of CO or PBX switching machines (SXS, No. 5 Crossbar, No. 1 ESS, etc.) for supervision, dialing and ringing, assuming conventional 84 to 100 volts 20 Hertz CO ringing potential. The ranges are based on the internal resistance of the LSR/TD and internal resistance of the MFT 2-wire passive transmission unit (CPS 1 of SD-1C359-01) and are a worst case limit for the voltages specified. If a more exact limit is required, see SD-7C050-01.

Note 2: The CO or PBX limit referenced in this table is the maximum external circuit resistance limit specified for the CO or PBX.

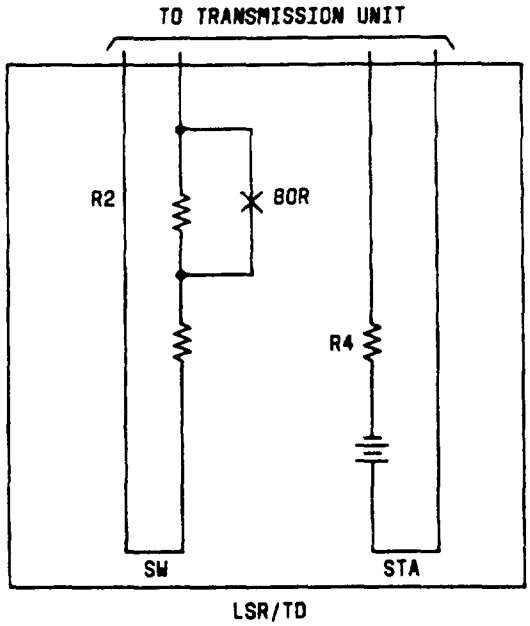

TABLE G

INTERNAL RESISTANCE OF THE LSR/TD*

BOR SW OUT R2 (OHMS)	R4 16 MA (OHMS)	BOR SW IN R2 (OHMS)	R4 23 MA (OHMS)	R4 35 MA (OHMS)
100	230	611	260	480

*The LSR/TD, as well as the existing LSRs, limits station current with a resistance lamp. The internal resistance of the unit thus depends on loop current. If range is to be based on a loop current value other than those given above, SD-7C050-01 provides additional details.

TABLE H

LSR RINGING INFORMATION

TIMER		RINGING DETECTABLE
Ringing Delay	50 ms nominal	16 to 40 Hz AC/DC, negative superimposed or clamped to —48 volts as provided by some PBXs (eg, 801)
Ring Trip Delay	60 ms nominal	
Ringing Distortion	less than 10 ms	

TABLE I

LSR TOLERABLE LONGITUDINAL AC (NOTE)

Switching side at 25 or 60 Hz	100 volts rms
Station side at 25 or 60 Hz	40 volts rms

Note: To measure these voltages, the trip and ring should be connected together and to 500 ohms to ground. The AC is measured across the 500 ohms.

TABLE J

LSR POWER (NOTE)

	IDLE (MA)	BUSY (MA)	RINGING (MA)
Ground start circuit	52	95	103
Loop Start Circuit	79	95	103

Note: These current values ***do not*** include talk battery current drains. Power from the talk battery source is dissipated in the resistance lamp and interval circuitry of the LSR/TD (also the LSR and LSR/TD) as follows:

Loop Current (MA)	Power (Watts)
23	0.14
35	0.59
65	3.8

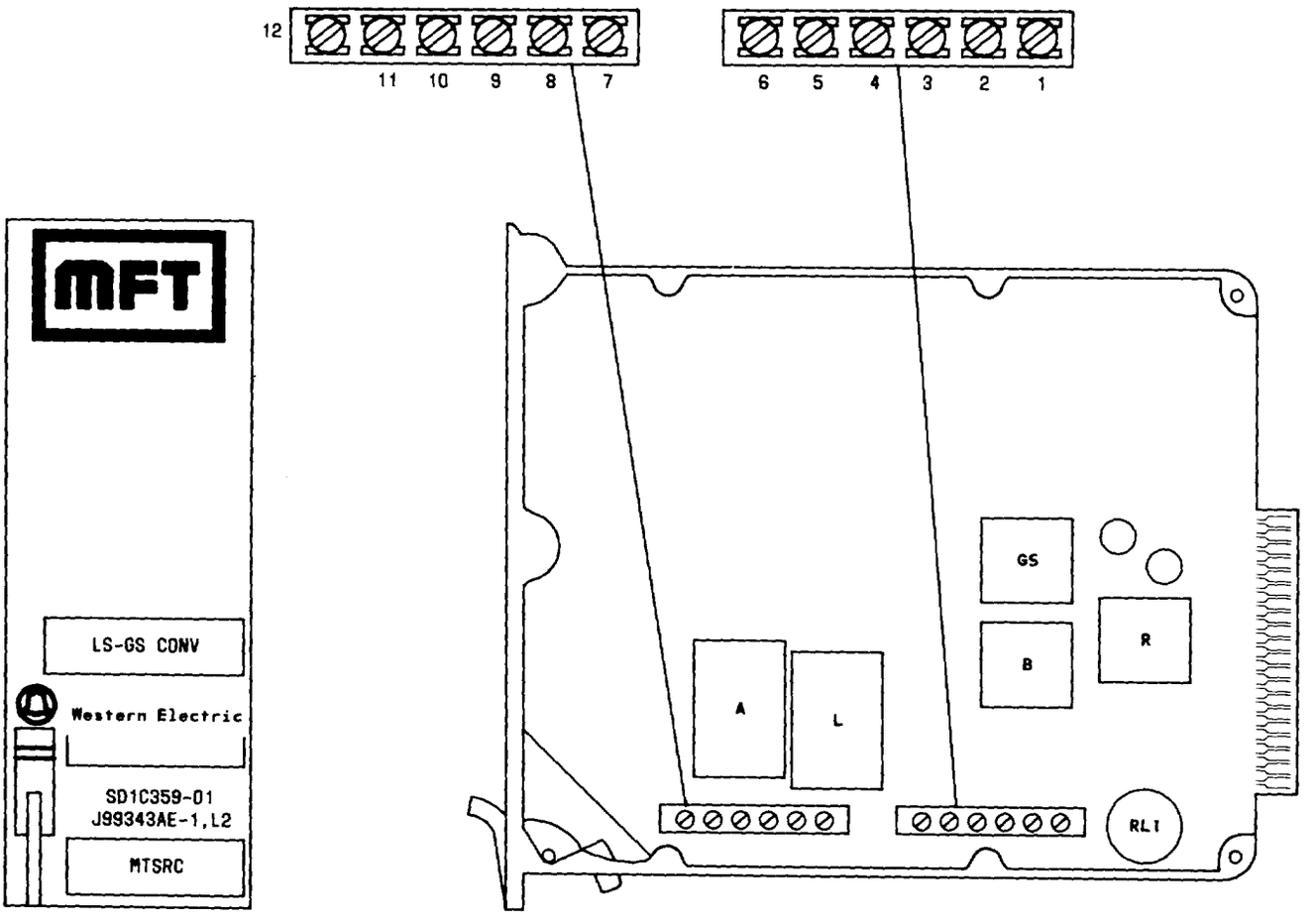

Fig. 5—J99343AE Layout

located on the printed wiring board (PWB) gives access to a current limiting resistor for use on short loops. It adds, or removes by shorting, the current limiting resistor in series with the switching side signaling leads. The resistor is either put into or taken out of the circuit by pushing the switch in the direction of the desired marking stamped on the PWB. Table B lists BOR requirements for switching side BORs.

B. Loop-Start/Ground-Start Switch (LS-GS)

3.02 The LS-GS switch, located on the PWB, selects either the loop-start or ground-start mode of operation. Proper switch setting selection is made by pushing the switch in the direction of the desired marking. The LS-GS signaling information is given in Tables E and F. The LSR/LS-GS J99343AC and the LSR/DR J99343AH contain an LS-GS switch.

C. Toll Diversion Screw Switch (TD)

3.03 The toll diversion screw switch, located on the PWB, selects or rejects the toll diversion mode. It must be closed (down) to operate in the TD mode. Opening the switch (up) inhibits the toll diversion. The switch is open when the screw is turned counterclockwise two full turns. The TD switch is contained in the LSR/TD J99343AF, L1 and L2.

TABLE K

LS-GS CONV SWITCH SETTINGS FOR DIFFERENT CENTRAL OFFICES

SCREW SWITCH / CO TYPE	1	2	3	4	5	6	7	8	9	10	11	12
SXS	DOWN	UP	DOWN	DOWN	UP	UP	UP	DOWN	DOWN	UP	UP	UP
No. 1 Crossbar	UP	UP	DOWN	DOWN	UP	UP	DOWN	DOWN	DOWN	UP	UP	UP
No. 5 Crossbar	DOWN	UP	UP	UP	DOWN	DOWN	DOWN	DOWN	DOWN	UP	UP	DOWN
ESS No. 1 & 2	DOWN	DOWN	UP	UP	UP	UP	UP	DOWN	DOWN	UP	UP	UP
PANEL BCO	DOWN	UP	UP	UP	UP	UP	UP	DOWN	DOWN	UP	UP	UP
PANEL GCO	DOWN	UP	UP	UP	UP	UP	UP	UP	UP	DOWN	DOWN	UP

D. Loop-Start to Ground-Start Converter Switches

3.04 The LS-GS CONV J99343AE has twelve screw switches on the PWB. They are numbered 1 through 12 and are set to achieve compatibility with central office switching equipment. Table K contains switch settings for different type offices.

4. APPLICATIONS

4.01 The LSRs are a series of signaling units (SUs) which provide regenerative range extension for 2-way loop signaling circuits. Loop signaling-type circuits can be either ground-start (GS) or loop-start (LS) in operation, depending on the application. Some of the LSRs, AA, AC, AH and the new AF units, are compatible with both GS and LS circuits. The new AF unit has, in addition to the standard LSR features, the capability of regenerating reverse battery signals as well as distinctive ringing signals of the DIMENSION PBX. The AA and AH units are MD while AC and AF are standard. The AB and AD units are specialized LSRs because they operate loop-start-only (LSO) and are less expensive than the LS or GS units. All the LSRs are described in Section 332-911-101. Functionally, these LSRs replace the older ground-start dial long-line and long-trunk circuits including SD-66192-01 and SD-66474-01. They also replace the loop-start dial long-line circuit SD-96555-01.

4.02 The LS-GS CONV is a specialized unit for a unique loop-signaling application. The AE provides dc signal conversions between loop-start plus sleeve lead central office equipment and a ground-start circuit, such as to a PBX or ACD. The AE can be conditioned to be compatible with various types of switching equipment. See descriptive Section 332-911-101. Functionally, the AE unit replaces the SD-96371-01 DLL circuit.

5. MAINTENANCE AND TESTS

A. Maintenance

5.01 When it is determined that an LSR unit is defective, it must be replaced with a spare unit. Signaling options and/or switch settings for the replacement unit should be set the same as the defective unit. The defective unit should be returned to the nearest Western Electric Service Center for repair.

B. Tests

5.02 An end-to-end test may be used to locate defective LSRs; but when a loop contains more than one type signaling, an end-to-end test may not locate the defective unit. Further testing may be necessary to locate the trouble.

5.03 LSRs cannot be tested individually. They must be tested through a companion MFT transmission unit using the J99343TB test extender (Section 332-910-102). The test extender provides access to A and B or SX/SX1 leads. Tests through the companion transmission unit should use the procedures listed in the installation and testing section for the particular transmission unit used.

6. REFERENCES

6.01 The following references provide additional information for LSRs.

NUMBER	TITLE
332-910-100	MFT—Description (J99343)
332-910-180	MFT—General Application Information
332-911-101	Loop Signaling Repeater (J99343AA, AB, AC, AD, AE, AF, AH)—Description
SD-1C359-01	Metallic Facility Terminal Circuit—Schematic Drawing
CD-1C359-01	Metallic Facility Terminal Circuit—Circuit Description.

The appropriate Numerical Index section should be consulted to find the current issue to the references listed and any addendum that may have been issued. The pertinent numerical index for the references listed is 332-000-000.