

## SPECIAL SERVICES CONSULTING GUIDE

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<b>TRANSMISSION</b> . . . . .	18	1. <b>INTRODUCTION</b>	
<b>SIGNALING</b> . . . . .	25	1.01 The objective of the Special Services Consulting Guide (SSCG) is to be a reference source and training aid to those involved in maintenance testing of basic voice-grade special service circuits. It is directed to the specific needs of the tester so as to aid in returning an out-of-service circuit to in-service status as quickly as possible. It is assumed that these special service circuits are tested initially from a testboard or test desk location. It is also assumed that access to the circuits is by jacks, Switched Maintenance Access System (SMAS), or "shoes" that give a test desk access to metallic facilities at the main distributing frame (MDF). Although the section is oriented in this manner, much of the information should prove useful to others involved in testing and locating troubles on special service circuits.	
<b>METALLIC FACILITY TERMINAL</b> . . . . .	30	1.02 If this section is reissued the reason for reissue will be listed in this paragraph.	
<b>TEST REQUIREMENTS AND CIRCUIT ACCESS</b> . . . . .	30	1.03 The material contained in this section generally falls into three categories: access, background, and reference. The access material, found in the table of contents and the index, allows the tester to locate specific information within the other parts of the SSCG. The background material, which	
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gives the tester a good understanding of special services testing, is found in Parts 2, 3, 4, 5, and 7. The reference material generally found in Parts 4, 5, and 6 is more detailed and related to testing of specific troubles and equipment. The main body of testing information in the SSCG is found in these parts. The following paragraphs further describe each part of the SSCG.

**1.04** Part 2, TESTING FUNDAMENTALS, describes commonly reported symptoms, common tests, and common causes of trouble. Along with the description of tests is a general discussion of transmission level point (TLP).

**1.05** Part 3, SPECIAL SERVICE CIRCUIT FUNDAMENTALS, describes typical special service circuits, their use and their operation. Also, Part 3 contains information on the transmission and signaling facilities and equipment that make up special service circuits. Circuit test requirements and access information is also given for each type of circuit.

**1.06** Part 4, TEST EQUIPMENT, briefly describes the test equipment commonly used to test special services. This part also contains calibration procedures (when applicable) and operational procedures (for typical tests) for each test set.

**1.07** Part 5, TROUBLE CLEARING, and Part 6, CIRCUIT COMPONENTS—FUNCTIONS AND TESTING, represent the bulk of material concerning testing of special service circuits.

**1.08** Information in Part 5 consists of symptom analysis, sectionalization, and a description of the circuit layout record (CLR). Symptom analysis is discussed in terms of a logical sequence for identifying the cause of trouble. Sectionalization aids in locating the trouble within certain sections of the circuit.

**1.09** Each circuit component covered in Part 6 is identified in at least three ways: (1) Common Name, (2) Common Language Equipment Code, (3) SD number and/or J-code. Other information in Part 6 offers the tester a quick test for each circuit component. In addition, Part 6 gives the tester a functional block diagram showing the relationship of associated equipment. A description of the options commonly available on the circuit component and the operational tolerances for the component are also included. For signaling circuit components,

the normal-circuit conditions of the signaling leads are given for basic circuit functions such as idle, busy, dialing, and ringing. Line and Drop lamp indications are also given for circuit components using E & M lead signaling. A simplified schematic and a sequence chart of the operational status of relays are given to aid in circuit analysis. References to BSPs containing more detailed test information are also given.

**1.10** Part 7, GLOSSARY, is available to define a term, which if left undefined, might create confusion or inhibit understanding of other information in the SSCG.

**1.11** The index located at the back of the section permits alphabetized entries to all the material in the SSCG in three main ways:

- According to the first letter of the word or term
- According to the word in the term that names the function
- Often as a subheading to an overall functional type.

**1.12** The following two examples demonstrate these three methods of indexing.

(a) E & M Signaling: The “E” will occur in alphabetical order in the index as the first letter of the term, “E & M signaling.” Within the alphabetized “S” portion of the index the tester should find “signaling, E & M”. This entry keys on the word in the term that names the function—signaling.

(b) “Echo return loss” is indexed by the “E” in “Echo return loss”, by the “R” in “Return loss, echo” and by the “L” in “Loss, echo return”.

**1.13** Equipment or terms having a number in the first position of the term, such as “24V4 repeater,” are indexed by the first letter of the word in the term that names the function; for this example the index would show “repeater, 24V4” or by the term “V4”-type repeater.

**1.14** The organizational chart in Fig. 1-1 serves as a quick explanation of the organization and contents of the SSCG. Note that Parts 5 and

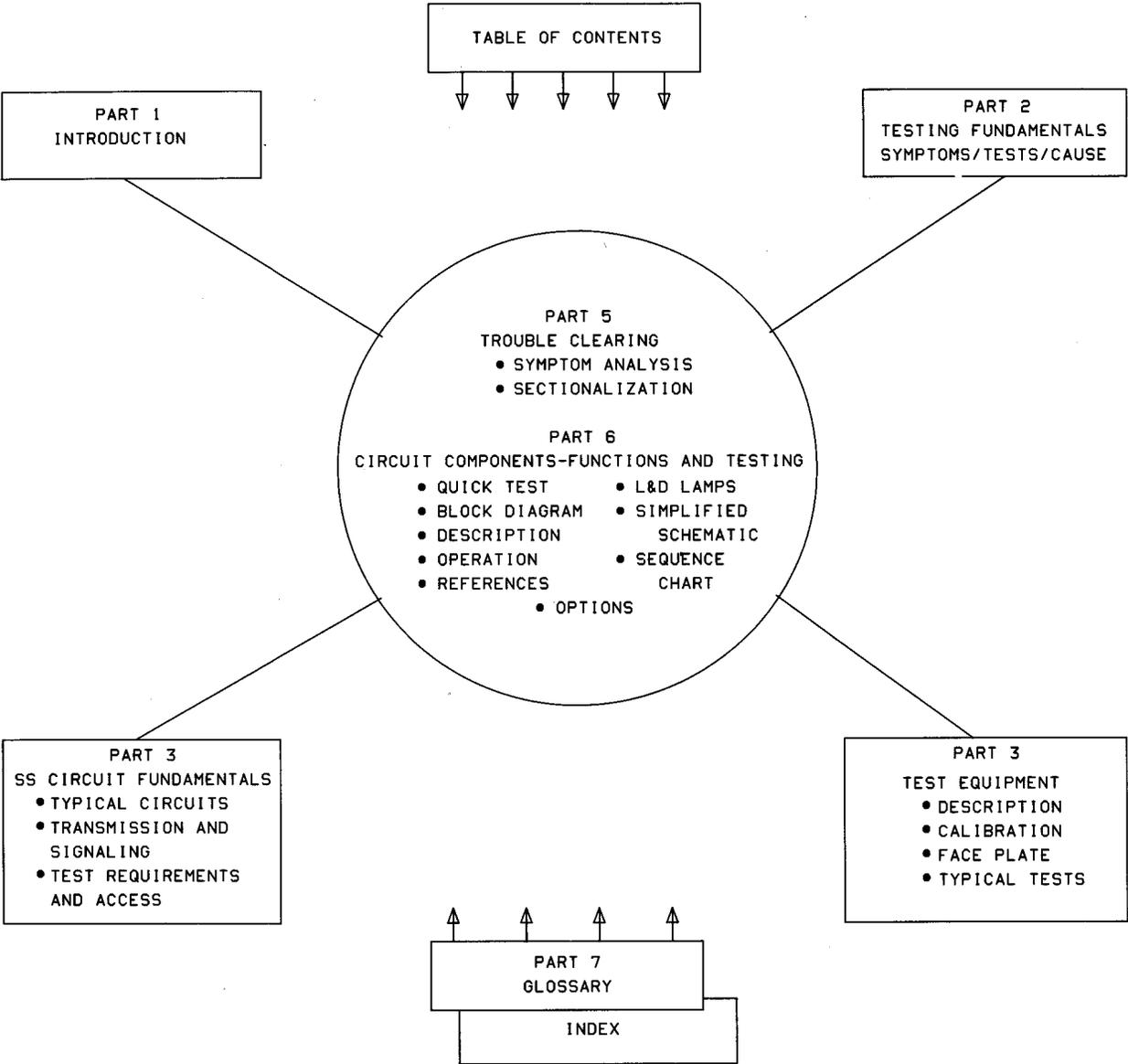


Fig. 1-1—Organization Chart

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6 are depicted as the main body of material intended for testing special service circuits.

### 2. TESTING FUNDAMENTALS

#### COMMON SYMPTOMS

**2.01** The decision making process that leads up to circuit testing activities begins with a trouble symptom. This symptom is usually customer reported and may only vaguely identify the specific problem. Since the symptom may not conform exactly to the list given below, the tester must interpret the report, keeping the actual circuit in mind, and by this translation process select either a transmission or signaling symptom. Dividing the symptoms into transmission or signaling gives the tester a starting point for testing and may enable him to eliminate some circuit components. Also, the circuit layout record (CLR) usually divides the circuit components into signaling and transmission components (see Part 5-CLR). Although this list of symptoms could be made much longer, it is considered to be sufficient to cover most reports. Also, it is general enough in its eventual identification of trouble causes (see Table B in TROUBLE CLEARING—Part 5) that any customer reported symptom, after translation, should lead to the general area of trouble.

**2.02** The following is a list of common symptoms:

#### (a) Transmission Symptoms

- (1) Static or hum on the line
- (2) Crosstalk (any interference from other transmission channels producing intelligible or unintelligible noise)
- (3) Hollow sounding (like in a barrel or tunnel)
- (4) Howling or singing
- (5) Fading (weakening of volume level often accompanied by a rushing sound)
- (6) Can't hear or can't be heard
- (7) Weak or Dead

#### (b) Signaling Symptoms

- (1) No dial tone

- (2) Doesn't answer
- (3) Can't receive and/or transmit ringing (phone doesn't ring at either end)
- (4) Can't trip ringing (continuous ringing)
- (5) Wrong numbers
- (6) Can't break dial tone

#### COMMON TESTS

**2.03** Certain tests are often required in response to these symptoms. The following tests are typical for special service circuits. Again, the tests are divided into groups according to transmission and signaling applicability.

#### Transmission Tests:

- (1) Listening Tests
- (2) 1000-Hz Loss Test
- (3) Frequency Response Test
- (4) Return Loss Tests (Echo and Singing Return Loss)
- (5) Singing Point Test
- (6) Message Circuit Noise Test
- (7) Voltmeter Tests

#### Signaling Tests:

- (1) Listening or Operational Tests
- (2) Pulsing Tests
- (3) E & M Lead Signaling Tests
- (4) Voltmeter Tests

**2.04** The individual *transmission* tests for special service circuits are described in the following paragraphs.

#### A. Listening Tests

**2.05** In listening tests, the ear of the tester becomes the discriminating device for

sectionalizing trouble in a circuit. Listening tests may be used, also, in the initial verification of the symptom itself.

**CAUTION:** *The human ear may be damaged by certain high level tones which can occur during listening tests. For example, high level tones occurring during the Singing Point Test (see 2.17) can damage the ear.*

If the trouble is distinctly audible where it is possible to distinguish good circuit operation from improper circuit operation, then the human ear is the ideal trouble detector when aided by the headset or loudspeaker at the test board.

#### B. 1000-Hz Loss Test

**2.06** The 1000-Hz loss test determines that the circuit will provide the correct talking volume. The other frequencies in the voice band are "set" according to the level established for the 1000-Hz frequency. In other words the 1000-Hz point in the voice band of frequencies is selected as the reference point for the circuit. The transmission level of the entire circuit is referenced to the 1000-Hz level. All the transmission level points (TLPs) of the circuit are measured at the 1000-Hz frequency. Since the 1000-Hz loss test establishes the actual measured loss (AML) of the circuit, no other tests should be performed until the 1000-Hz loss test has been performed. All other tests are **level sensitive**.

**2.07** Two functions of the 1000-Hz loss test are (1) continuity check of the circuit (losing the 1000-Hz signal constitutes a loss of continuity, when it occurs in the transmission facility), and (2) deviations from the expected measured loss (EML) or TLP given on the CLR must be within prescribed limits, depending on the circuit type. Excessive deviations probably indicate that a problem exists in the gain- or loss-producing elements of the circuit.

**2.08** Sectionalization of the circuit is possible by locating the excessive deviation between the EML values and the AML values for the overall circuit. By using the "half-split" method (cutting the circuit in half several times), the exact location and the direction of the malfunction in the circuit can be determined.

**C. Frequency Response Test** (Other names for frequency response are attenuation distortion, frequency attenuation, and slope.)

**2.09** Frequency response tests are made for at least two frequencies other than 1000 Hz. The lower test frequency (LTF) is 400 Hz and the upper test frequency (UTF) is 2800 Hz. Ideally, the frequency response test will cover all the frequencies from 400 to 2800 Hz at 200-Hz intervals. Frequency response requirements determine how much deviation from the measured 1000-Hz loss level is allowed for the whole voice frequency spectrum. The measured levels for each of the test frequencies are said to deviate from the measured 1000-Hz level by having more or less loss in dB. Normally, in designing the circuit, consideration is given to the fact that higher frequencies suffer greater loss in cable pairs than do the lower frequencies; thus lower frequencies often have less loss in the circuit than does the 1000-Hz frequency used as the reference point. Equalization networks usually compensate the frequency response of the circuit by adding sufficient loss to the lower frequencies, bringing their levels into the required limits. In order that the volume level of the circuit remains high enough when this loss is added, the original circuit design increases the gain proportionately.

**2.10** Poor frequency response degrades the voice frequency transmission. If the deviations from the 1000-Hz level are great enough at the other frequencies in the voice band, then the volume levels can become too high, too low, or even absent altogether.

**2.11** The 21A Transmission Measuring Set contains the oscillator and the detection device necessary to perform the frequency response test. The oscillator provides the whole range of voice-band test frequencies with a virtually flat output level for all frequencies. Because the range of frequencies are introduced into the circuit at nearly identical levels, the levels of the same frequencies upon detection describe the frequency response of the circuit. Other applicable test equipment is listed in Table 4-A, Part 4.

#### D. Return Loss Tests (Echo and Singing Return Loss)

**2.12** There are many instances where return loss (RL) measurements should be made to insure circuit stability. The RL tests should usually be

made when 2-wire equipment terminates circuits that consist partly of 4-wire facilities. (At the junction of these dissimilar facilities, any impedance mismatch results in energy reflected back to the loop.) The conversion from 2-wire to 4-wire is usually accomplished with a 4-wire terminating set (4WTS) or a hybrid of some type. The 4WTS, or hybrid, permits transfer of voice frequencies from the 4-wire facility receive path into the 2-wire facility and from the 2-wire facility into the 4-wire facility transmit path. Because of the transformer type hybrid in the 4WTS, and the fact that power reflections will occur whenever impedance irregularities exist at interconnections of 2-wire circuits with 4-wire circuits, control of impedance at the interconnection point is necessary.

**2.13** A portion of the power that is reflected within the 4WTS is returned to the transmit path of the 4-wire facility. This power is then amplified and returned to the distant end. If this returned power is received at the distant end with sufficient magnitude, impairments to transmission will occur.

**2.14** When return losses are small and power is returned in the frequency band between 500 to 2500 Hz, the transmission impairment known as echo return loss (ERL) occurs. When return losses are small and power is returned at a single frequency with sufficient magnitude to start self-sustained oscillations, the RL impairment known as singing or near-singing, occurs. A singing condition often occurs when the gains exceed the losses in a circuit from termination to termination.

**2.15** Although singing can occur at any frequency in the voice band, it generally occurs in the frequency ranges from 200 to 500 Hz and 2500 to 3200 Hz.

**2.16** Since some confusion may exist concerning definitions of RL, the following definitions are given:

Return Loss—The RL is the measure of an impedance match between circuits at the point of their interconnection. If, *at a given frequency*, the impedances exactly match one another, the RL is infinite. Stated another way, no transmitted energy is reflected, or returned, as echo or singing.

Of course, the path followed by this reflected energy is typically from the 4-wire receive side of the facility through the term set and back through the transmit side of the 4-wire facility (arriving finally at the originating telephone set). A complete mismatch or imbalance will cause the RL to be zero (for example, if one impedance is zero due to a short circuit).

Echo Return Loss—The ERL is a weighted average of the RLs for all the frequencies in the echo range (500 to 2500 Hz). This measurement is made at the 4-wire side of the 4WTS where the 4-wire and 2-wire portions of a circuit interconnect. This measurement does not necessarily indicate the RL at an individual frequency. However, if ERL is maximized by adjusting the network building-out capacitance (NBOC), or a precision balancing network in the 4WTS, the average impedance of the 4WTS over the echo range will more closely approach the average impedance of the 2-wire circuit over the echo range. The ERL is measured with a KS-20501 return loss measuring set (RLMS), or equivalent.

Singing Point (SP)—The SP is a measure of the RL for a single frequency in the entire voice band (200 to 3200 Hz). This single frequency is often called the critical frequency. When singing or near-singing conditions exist, it may occur at any frequency in the voice band; however, since impedances are better controlled in the 500 to 2500 Hz band, the critical frequency usually occurs in the upper and/or lower ends of the voice band. The SP is measured with a 2D or 2E Singing Point Test Set, or equivalent.

Singing Return Loss (SRL)—The SRL is the weighted average of the RL in the singing bands (200 to 500 Hz and 2500 to 3200 Hz) and is measured with a KS-20501 RLMS, or equivalent. Switch settings on the KS-20501 RLMS determine the frequency band in which SRL is measured. The SRL switch position measures singing in the low portion of the band (200 to 500 Hz) and the SRL-HI switch position measures singing in the upper portion of the band (2500 to

3200 Hz). The SRL readings correspond closely with SP measurements and, for a given circuit, may be considered equivalent.

#### E. Singing Point Test

**2.17** The primary difference between the SRL test and the singing point (SP) test is in the way the singing point is detected. The SRL test is described above. The SP test does not use an oscillator to introduce voice frequency energy into the circuit. This test, using the 2D or 2E Singing Point Test Set, adds gain to the circuit until the circuit sings at some frequency. The test set is placed in the circuit and functions as an amplifier increasing the gain sufficiently to cause singing at the critical frequency of the circuit being tested.

**2.18** The relationship between the singing point and the gain of the circuit should be apparent from this procedure. The gain introduced during singing point testing may create high levels in the circuit, which, when transmitted into a carrier system, may disable the carrier. An excessively high level in a circuit can cause crosstalk in adjacent channels.

#### F. Message Circuit Noise Test

**2.19** Message circuit noise disturbs the normal operation of the circuit. (Impulse noise, with durations less than 200 ms, is not covered in this section.) The primary types and causes of message circuit noise are listed as follows:

- Normal facility background noise or “white” noise (partly produced as thermal noise from environmental causes and from heated components)
  - “Frying”, “crackle” produced by wet cable
  - Crosstalk (produced by excessive carrier or repeater gain or by misalignment of carrier facility—usually intelligible)
  - Cross modulation (produced by carrier misalignment or malfunction—distorted, “Donald Duck” noise)
  - Power hum (induced due to proximity with AC power lines—60 Hz or odd harmonic—180 Hz, 300 Hz, 420 Hz)
- Telegraph VF carrier (produces a whine in adjacent voice channels due to cross modulation)
  - Working data (produced by various data sets, the sound varying according to the type and bit rate—sounds something like an idling diesel engine)
  - Data polling (morse code sounds, in bursts)
  - Microphonics (caused by contacts reproducing vibrations).

**2.20** The end objective of the message circuit noise tests is to remove, or to reduce to acceptable levels, the noise components degrading the voice frequency transmission. The tests accomplish this by first verifying that the noise exists and is above acceptable levels; and, secondly, the tests can sectionalize the circuit by isolating the noise to a particular section of the circuit. Sectionalization is accomplished by repeating the noise tests, if necessary, at different test access positions for the same circuit.

**2.21** The individual *signaling* tests for special service circuits are described in the following paragraphs.

#### G. Listening and Operational Tests

**2.22** When signaling failure is due to marginal condition or mutilation of signaling pulses, the human ear may not be able to determine at which point the distortion of signals occurs. In these cases signaling test equipment must be used. But if the signaling problem is something like loss of ringing or dial tone, then listening tests at different points in the circuit constitute the simplest method of sectionalizing the trouble. “Operational tests” attempt to reproduce the circumstances of the original signaling failure by dialing the same number from the test board position, or by connecting the headset to the tip and ring of the station set having difficulty and having the distant end attempt to dial; connected to the station set it is a simple matter to try to receive dial tone, for example.

#### H. Pulsing Tests

**2.23** Pulsing tests in effect simulate dialing, in either direction, on a circuit reporting signaling difficulties. The signaling test equipment measures

the circuit's response to these pulses. By transmitting idealized dial pulses at an appropriate rate, the condition of the pulses can be measured after traveling through the circuit. If the timing of the pulses or the percent break is not acceptable, then the pulsing tests can be repeated at enough locations (including different test board locations) to sectionalize the difficulty. For example, the pulse timing is often affected by the pulse repeating relays in the signaling path. On the other hand, cable pair capacitance is typically a cause of percent break deviations. Percent break, which in the simplest sense has to do with the rounding off of the signaling pulses, is easily affected by excessive cable capacitance which tends to delay, widen, and generally distort signaling pulses. The effect of this signaling malfunction is usually wrong numbers or the complete failure to get the call to go through.

#### I. E & M Signaling Tests

**2.24** These tests analyze signaling systems which use E & M lead signaling. By monitoring the conditions, electrically speaking, of the E & M leads which tie two or more signaling systems together, the presence or absence of proper signals can be determined. The 2B, 1A, 4A, or 26B Signaling Test Sets are used to detect the E & M conditions, and to visually display that condition with "line and drop" lamps, which are either on or off, corresponding directly to on-hook and off-hook conditions in the circuit. (For detailed descriptions of these and other test sets refer to TEST EQUIPMENT, Part 4, of this section.) Line and drop lamp status is provided in CIRCUIT COMPONENTS- FUNCTIONS AND TESTING, Part 6. Most E & M type signaling components commonly found in special service circuits is covered in Part 6. The line and drop lamp indications are given for typical modes of operation, such as idle, busy, ringing, dialing, incoming calls, and outgoing ring. With these indications the circuit operation in any of these modes can be tested.

#### J. Voltmeter Tests (Transmission or Signaling)

**2.25** The voltmeter at the test board enables the test board operator to observe the electrical status of the tip and ring at the station end of the loop. Voltmeter tests yield the following information concerning the loop or local channel (experienced test board operators might add other uses for the voltmeter to this fundamental list).

- (1) Voltage on tip or ring (Battery condition)
- (2) Ground on tip or ring
- (3) Open between tip and ring
- (4) Short between tip and ring
- (5) Tip and ring shorted to ground
- (6) High and low resistance ground on tip or ring (tested by shunt key operation)
- (7) Open in tip side of loop
- (8) Open in ring side of loop
- (9) False short—estimation of distance from CA (tested by shunt key operation)
- (10) Loop capacitance as an indication of loop length
- (11) Reversal (turnover) of tip and ring, T1 & R1, and A & B leads (Example: B-lead reflecting A-lead status due to improper wiring)
- (12) Simplex continuity check.

**2.26** The following paragraphs compose a general description of when to test, where to test, and how the tests may be useful. No attempt is made here to explain the testing procedures themselves. Part 4, TEST EQUIPMENT, describes in greater detail the use of different test equipment and their application for typical tests. Table 4-A in Part 4 is a list of test equipment appropriate for use in performing the tests described in this part. Part 5, TROUBLE CLEARING, contains reference to BSPs covering testing procedures.

**2.27** Before any testing is pursued, the tester must decide that the symptom itself is valid. Once the symptom is clearly understood and "fits" one of the symptoms listed in 2.03 (or in Table 5-B in Part 5), then the following three questions, at least, should be answered:

- (1) Is it logical that this symptom was reported for this circuit as shown on the CLR?
- (2) Does the symptom exist when the tester monitors the circuit or can the symptom be repeated by the tester?

- (3) When the symptom cannot be detected by the tester, does the circuit history indicate frequent reports of the same symptom?

The answers to these questions can lead the tester to isolate the trouble.

**2.28** Confirmation of the symptom does not, by itself, lead to circuit testing. Before performing either transmission or signaling tests, the tester must decide on the best procedure to put the circuit back into operation. If the trouble can be analyzed and/or sectionalized to a distant office, then the tester should REFER the trouble to that office. If it is possible to replace the faulty circuit component with a spare unit, or to patch around the trouble by switching to an auxiliary circuit, then SELF-RESTORAL by tester is the proper course of immediate action. If the tester needs assistance or if the trouble is isolated to the station, a DISPATCH may be required. When none of these approaches are valid, the tester should continue to test the circuit until the defective equipment is found. This entire decision-making process may require some "sectionalization." But any analysis or sectionalization that takes place during this phase should be aimed toward selecting the proper course of action from one of the four listed as follows: REFERRAL, DISPATCHING, SELF-RESTORAL, or CIRCUIT TESTING. These four are explained further in TROUBLE CLEARING, Part 5.

**2.29** Test access for transmission tests can be found at amplifiers, equalizers, 4-wire term set inputs and outputs, carrier terminals, and test board locations. At these access locations impedance matching of the test equipment is often not required since the nominal input impedance of the test equipment is normally 600 ohms. Impedance matching is usually required when testing at the following circuit access locations: cable pair appearances, station sets, telephone sets, key telephone set (KTS) terminals, demarcation strips or terminals, and at most distributing frame appearances.

**2.30** Transmission objectives or TLPs given on CLRs assume that the measurements are made from specific points in a circuit. (See paragraph 2.31 for more on TLPs.) The test equipment used to make the measurements is also assumed to have a specific impedance. For example, in the calculations of EML the test set impedance is assumed to be 600 ohms; and the

terminating impedance of the circuit is usually assumed to be 600 or 900 ohms. In a few instances the circuit impedance may be assumed as 1200 ohms; for example, when measuring at the AMPL IN or AMPL OUT jacks of a V4 Repeater on the 359A or 359D equalizer side of the repeater. The impedance on the 4-wire side of MFT repeaters may also be 1200 ohms. When the impedance of the test equipment and/or the circuit impedance differs from 600 ohms, correction factors should be applied to take into account reflection losses.

#### K. Transmission Level Point (TLP)

**2.31** When testing a circuit, it is sometimes necessary to describe the power present at a particular point in the circuit and to compare this power to the power present at other points in the circuit. The power present at a particular point in a circuit is dependent upon the power at the source, and the loss or gain between the source and that point. Since this information is not always available, it is convenient to describe the power present in the circuit by comparing it to some standard reference point.

**2.32** Describing this power is similar to the problem of trying to describe the height of a mountain. To measure the height of a mountain, it is necessary to pick a reference height from which to measure. If the reference height is standardized, then comparison of two mountains can be made even though they are thousands of miles apart. The widely accepted standard reference height for measuring mountains is mean sea level.

**2.33** The reference point for measuring power in the Bell System is called the zero transmission level point or 0 TLP. This reference point makes it possible to compare the signal power at two points in a circuit even though the points are many miles apart.

**2.34** With the establishing of the 0 TLP concept, the power present in a circuit is described by stating what this power would be if it were measured at the 0 TLP. The standard notation used to describe the power in this case is dBm<sub>0</sub>. For example, the term "-5 dBm<sub>0</sub>"; ie, if a -5 dBm signal were measured at the 0 TLP the meter would indicate -5 dBm.

**2.35** After the power at the 0 TLP is described, the power at any point of the circuit can

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be determined. For example, if the signal power is -5 dBm when measured at the 0 TLP, it will be 5 dB below the value of any TLP on the circuit when measured at that TLP. If the signal power is -5 dBm at the 0 TLP, then the power at the -3 TLP would be -8 dBm  $[-3 + (-5) = -8]$ . Similarly, if a -5 dBmO signal were measured at the -16 TLP, the meter would indicate -21 dBm  $[-16 + (-5) = -21]$ .

**Note:** The numeric value of the TLP does not describe the power to be measured at that point any more than the elevation of a mountain top above sea level describes how high the mountain rises above the plains that surround it. To know how high the mountain rises above the plains, it is necessary to know the elevation of the plains above sea level as well as the elevation above sea level of the mountain itself. To know the power expected at any given TLP, it is necessary to know the power at another TLP on the circuit. For example, if a -10 dBm signal is applied to a circuit at the -7 TLP, the signal is -3 dBm at the 0 TLP  $[-10 - (-7) = -3]$ . The power at the -7 TLP is 7 dB lower than the power at the 0 TLP.

### COMMON CAUSES

**2.36** The following paragraphs discuss some of the common causes for the common symptoms listed in 2.02.

#### A. Static or Hum

**2.37** A report of static or hum is usually the result of 60 Hz (or the odd harmonics of 60 Hz) interfering with the voice frequencies in the transmission path. Also, hum may be caused by an improper ground or short. Possible excessive gain can also cause this symptom.

#### B. Crosstalk

**2.38** Crosstalk (from adjacent circuits) is probably the source of most reports of a "noisy" circuit. Crosstalk is probably caused by excessive gain all across the voice spectrum or at some portion of the frequency spectrum, in an adjacent circuit (or channel).

#### C. Hollow Sounding

**2.39** The hollow sound in the voice circuit, often resembling the sound in a tunnel or barrel, indicates a near-singing condition in the circuit. This can be due to impedance mismatch at the interface of the 2-wire to 4-wire facility, excessive gain or poor balance. This near-singing condition requires analysis by the return loss test from the 4-wire side of the facilities in order to determine the location of the mismatch.

#### D. Howling or Singing

**2.40** Carrier or repeater levels that are too high are usually the cause of this circuit condition. It is possible also that there is an impedance mismatch at the 2- to 4-wire junction. If the circuit design and prescription settings of the balance network are correct, the network should not need adjustment. However, errors in design or installation, mistakes in subsequent adjustments, or a change in facilities, may require that the balance network be adjusted.

#### E. Fading

**2.41** Fading is probably symptomatic of carrier power level variations. Fading may occur at a specific frequency, but it is more likely that the decrease in volume will occur across the entire voice band. Carrier level deviations causing fading probably affect the entire carrier channel group. A rushing sound usually accompanies fading of this type, since the lower level of the voice transmission creates a worse signal-to-noise (S/N) ratio. (The effect of the noise component is greater.) Fading can be caused by the effects of weather, especially when a microwave facility is involved. Another possible cause of fading is a defective power supply at the customer location.

#### F. Can't Hear or Can't Be Heard or Weak

**2.42** The probable cause is in the gain or loss producing components of the circuit such as pads, repeaters, or carrier facilities. This symptom can be caused by shorts, high resistance shorts, open on one side of the loop, bad splices, open coil, and many other primarily mechanical defects. These causes are less likely, however, if the signal is weak. This condition may indicate that an SF unit, if one is used in the circuit, may not be cutting off the SF tone when the called party

answers. If the near end "can't be heard" the SF unit in the near end office may be sending SF tone to the far end preventing voice transmission in that direction. But if the far end can hear the voice transmission, even weakly, then the problem implies that the circuit power level is too low.

#### **G. No Dial Tone**

**2.43** This symptom indicates that the customer does not hear dial tone when the receiver is picked up (off-hook). Ruling out the dial tone supply, the loop and station equipment are left as primary possibilities (unless dial tone is supplied from a distant CO, such as in the case of some foreign exchange circuits). The most probable cause for this symptom is a defective loop, improper short, open or ground.

#### **H. Doesn't Answer**

**2.44** This symptom implies that the called end does not hear ringing. In most cases signaling equipment is at fault, however, the transmission path may be the cause.

#### **I. Can't Receive or Send Ringing**

**2.45** In this case the calling party fails to put ringing tone onto the pair when calling out, and cannot be signaled of an incoming call, because ringing is not activated at his station equipment. Again, the signaling equipment is probably the cause, but note that since one customer has two problems, the trouble is probably on the near end. Another point is that this symptom is unique to ringdown type circuit, where the station equipment puts ringing onto the pair. One typical cause of this symptom is that for some reason the loop resistance has become too high and exceeded the ringing range.

#### **J. Can't Trip Ringing**

**2.46** This symptom can be caused by loop resistance being too high which extends the ringing current range. Malfunction of relays in the ringing circuitry is indicated as a probable cause. Another possible cause is that high carrier facility noise may be sufficient to mimic the ringing signal. If DX signaling equipment is used in the circuit, the adjustment may be improper.

#### **K. Wrong Numbers**

**2.47** Wrong numbers usually result when dialing information is distorted, mutilated, or when the sequence is altered. Distortion of dial pulses, measured in terms of percent break can be verified if this is the problem. Poor timing of pulses may be more difficult to detect since this can be caused by carrier hits (interruptions of transmission for very short intervals) which may be impossible to trace. Bad DX signaling balance, if used in the circuit, is another typical cause.

#### **L. Can't Break Dial Tone**

**2.48** When dial tone is continuous, and does not drop out during dialing, a marginal pulse repeating relay can be the cause. Also, the cable capacitance can be too high, causing pulse distortion. The dial pulses can also be out of tolerance. Finally, the failure to cut dial tone may be related to problems existing in CO equipment such as automatic registers.

### **3. SPECIAL SERVICE CIRCUIT FUNDAMENTALS**

**3.01** This part of the Special Services Consulting Guide (SSCG) covers the fundamentals of those services that are basic voicegrade, therefore, some special services such as data are not covered here. The facilities used to provide special services and the transmission and signaling components required to meet the needs of special service circuits are also covered. Finally, the transmission test requirements and the recommended test access points are described.

#### **TYPICAL SPECIAL SERVICE CIRCUITS**

**3.02** The following is a list of the typical special service circuits which are covered in this section:

- Private Line
- Foreign Exchange Line
- WATS Line
- Off-Premises Extension Line
- Secretarial Line
- PBX Services

**A. Private Lines**

**3.03** Private lines are non-switched facilities which have no access to the direct distance dialing (DDD) network. Private lines are either two-point or multipoint. Two-point private lines (Fig. 3-1) involve the facilities and equipment between two terminal locations. The circuit may be made up of metallic facilities entirely or a combination of metallic and carrier. A multipoint private line (Fig. 3-2) involves circuits to several customer locations which are bridged together at a central office.

**Note:** Switched services networks (SSNs) use private line type circuits, however, since these networks usually interconnect PBXs which allow access to the DDD network, SSNs will not be considered private lines in this section. The description and testing requirements for SSNs are completely documented in the 309 division and, therefore, will not be discussed here.

**3.04** Some typical voice-only applications of private lines are order wires, loudspeaker circuits and channels connecting station equipment. Terminal equipment at the customer location may be furnished by either the telephone company or the customer, and may use either 2-wire or 4-wire voice transmission facilities.

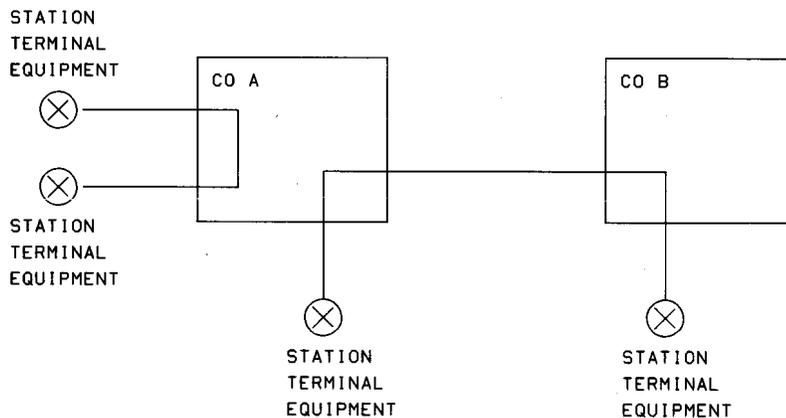
**3.05** The facilities and equipment that are used to meet the transmission requirements of a private line are covered in Transmission 3.21.

**3.06** Signaling on private line circuits may be accomplished in several ways. The stations on a two-point private lines generally signal one another in one of four ways:

- Manual ringdown in both directions
- Automatic ringdown in both directions
- One-way manual and one-way automatic
- Voice-call signaling using a loudspeaker.

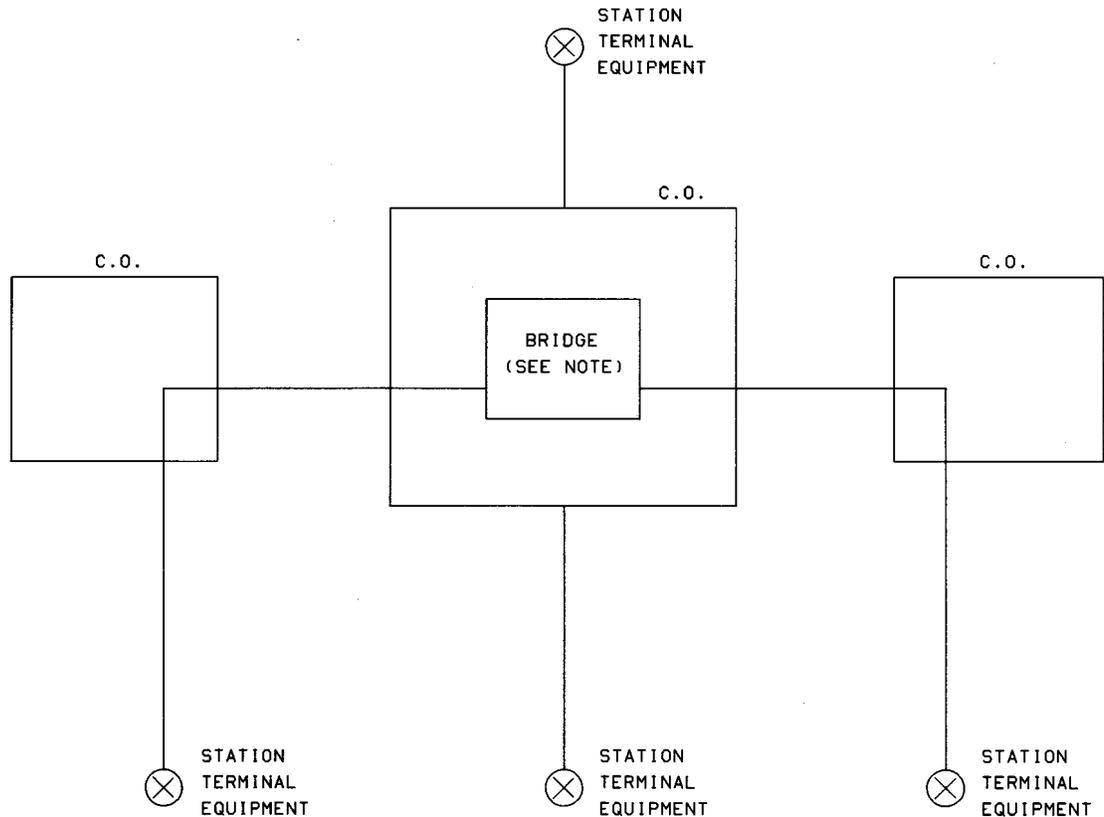
Multipoint private lines may use any of these signaling arrangements as well as selective signaling in which any one, or more, of the several customer locations may be signaled individually as desired. These categories of signaling and the equipment required are discussed in more detail in Signaling — A, Private Line Signaling Arrangements — 3.72.

**3.07** Test requirements and access points for private lines are covered in 3.106. For more detailed information concerning the description



NOTE: TERMINAL EQUIPMENT MAY BE FURNISHED BY EITHER THE TELEPHONE COMPANY OR THE CUSTOMER. FACILITIES MAY BE 2-WIRE OR 4-WIRE. THERE IS NO CONNECTION TO THE SWITCHING MACHINE IN THE COS

**Fig. 3-1—Typical 2-Point Private Line**



NOTE: BRIDGE MAY BE 2-WIRE OR 4-WIRE DEPENDING ON CIRCUIT REQUIREMENTS AND FACILITIES USED. BECAUSE OF TRANSMISSION CONSIDERATIONS, IT IS RECOMMENDED THAT MULTIPOINT PRIVATE LINES USE 4-WIRE CIRCUITS

**Fig. 3-2—Typical Multipoint Private Line Circuit**

and testing of private line circuits, see the following BSPs:

2-Point Private Lines — 310-300-100

2-Point Private Lines — 310-300-300

2-Point Private Lines — 310-300-500

Multipoint Private Lines — 310-405-100

Multipoint Private Lines — 310-405-500

#### **B. Foreign Exchange (FX) Line**

**3.08** A foreign exchange (FX) line (Fig. 3-3) permits a customer to appear as a local

customer in an exchange area other than that normally serving the geographical area in which the customer is located. Since the FX CO can be located anywhere in the nation, several interoffice facilities may be required to supply service. A customer subscribing to FX service is interested in calling (or receiving calls from) the distant exchange area without involving toll charges.

**3.09** Signaling on FX circuits can be accomplished by a variety of methods which are discussed in Signaling — B, Special Access Signaling Arrangements, 3.85. Test requirements and test access information is covered in 3.106. (For more detailed information on FX circuits, see BSP 311-200-180.)

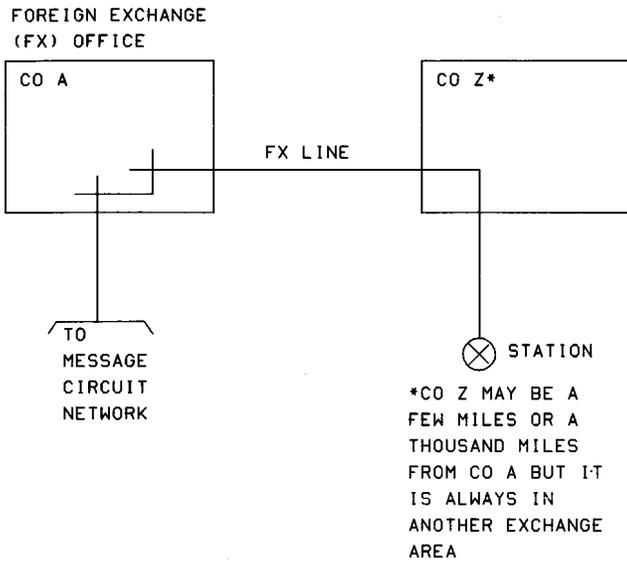


Fig. 3-3—Typical Foreign Exchange (FX) Line

**C. Wide Area Telecommunications Service (WATS) Lines**

**3.10** A wide area telecommunications service (WATS) line (Fig. 3-4) permits a station to make calls to (or receive calls from) selected wide interstate or intrastate geographical regions called bands or service areas for a fixed monthly charge. WATS lines are available for the customer to call out (OUTWATS) or for the customer to receive calls (INWATS) but not both with the same CO appearance. The service may be unlimited or it may be restricted to a specific band or group of bands. Some customers are charged for the service only during certain hours of the day. Since not all COs are equipped for WATS, the access line connects the customer to the nearest WATS CO. This appears very similar to an FX line. When the serving CO is equipped for WATS the WATS line appears very similar to regular telephone service.

**3.11** Signaling on WATS circuits can be accomplished in several ways as discussed in Signaling — B, Special Access Signaling Arrangements 3.85. Test requirements and test access information for WATS lines is covered in 3.106. (For more detailed information on WATS lines, see BSP 311-200-180 or Section 9 of BSP 781-030-100.)

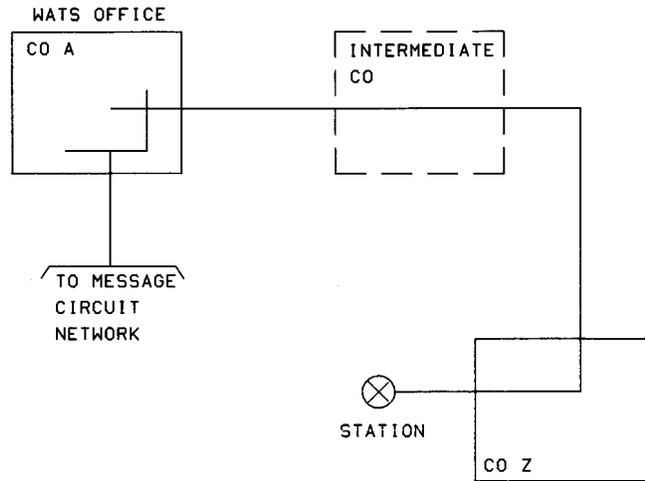


Fig. 3-4—Typical WATS Line

**D. Off-Premises Extension (OPX) Line**

**3.12** An off-premises extension (OPX) line, (Fig. 3-5) connects an extension telephone station to a main station line. The extension telephone station is located remotely from the main station. The extension line can be bridged at the main station location but more often the main station line and the extension line are bridged at the CO serving the main station. Bridge lifters are often required to reduce losses.

**3.13** Signaling on OPX lines can be accomplished in several ways as discussed in Signaling — B, Special Access Signaling Arrangements 3.85. Test requirements and test access information for OPX lines is covered in 3.106. (For more detailed information on OPX lines, see BSP 311-200-180.)

**E. Secretarial Line**

**3.14** A secretarial line (Fig. 3-6) extends a customer's telephone line to an answering service switchboard or its equivalent. This service allows the customer's telephone to be answered at the answering service location when the customer is not available to answer the calls. Bridge lifters are usually used on the main station circuit to reduce loss. Sometimes a concentrator is used at the main station CO to reduce the number of pairs required between the CO and answering service switchboard.

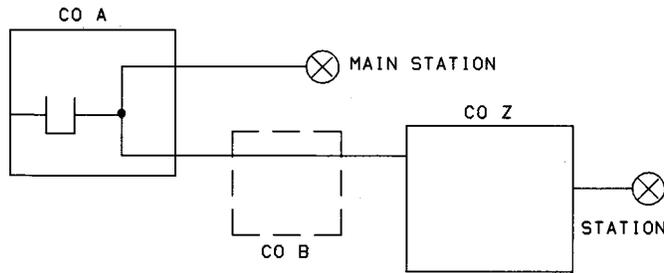


Fig. 3-5—Typical OFF Premises Extension (OPX) Line

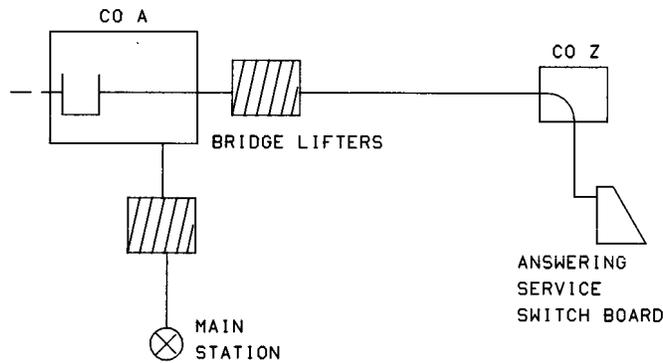


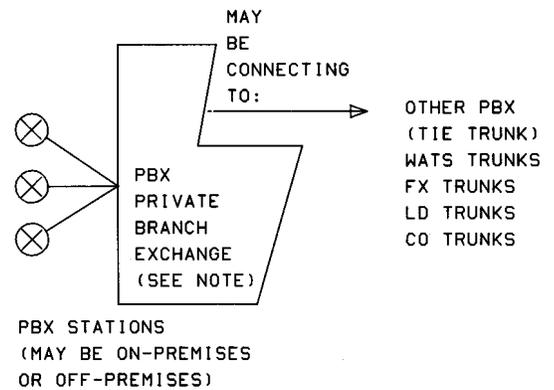
Fig. 3-6—Typical Secretarial Line

**F. Private Branch Exchange (PBX)**

**3.15** A private branch exchange (PBX) (Fig. 3-7) is basically a switching system for interconnecting telephone station sets located on the customer's premises. Connections can also be made from a PBX station to the DDD network or to other lines and trunks which terminate in the PBX. The lines or trunks can connect to other PBX's or to other switching networks. The PBX may be provided by the telephone company or by the customer under interconnecting arrangements. While a PBX can be either manually or dial-operated, it generally has a customer-employed attendant to assist in placing calls, if necessary, or to exercise control and administrative functions.

**3.16** A PBX can be one of the following:

A **main** PBX which has a directory number and can connect PBX stations to the DDD network for both incoming and outgoing calls. Tie trunks, FX trunks, and WATS trunks



NOTE - PBX CONTAINS SWITCHING EQUIPMENT, SPECIAL FEATURES, AND TEST ACCESS JACKS. PBX IS AUTOMATIC DIAL, OR MANUAL WITH ATTENDANT, DEPENDING UPON TYPE INVOLVED

Fig. 3-7—Typical Private Branch Exchange (PBX)

can also be terminated in a main PBX but the PBX does not switch tie trunks together in tandem.

A **satellite** PBX which does *not* have a directory number and whose incoming calls are routed from the main PBX via tie trunks. For outgoing service, calls may be routed directly over CO trunks, if provided, or over tie trunks through the main PBX and CO trunks. The satellite PBX is usually located in the same local area as its main PBX.

A **tandem** PBX which performs the same functions as a main PBX but is also used as an intermediate switching point to connect tie trunks to two or more main PBXs.

A **tributary** PBX which has tie trunks to a main or a tandem PBX and has inward and outward CO trunks and its own directory number.

- 3.17 The trunks, lines, and tie trunks (Fig. 3-7) that can be associated with a PBX are:

**PBX central office (CO) trunks** which connect the PBX to the CO normally serving the PBX location. These trunks appear as station lines at the CO equipment.

**PBX Foreign Exchange (FX) Trunks** which are the same as PBX CO trunks except that they terminate in a remote exchange office rather than the one normally serving the PBX location. (See 3.08 for more information on FX service.)

**PBX WATS trunks** which are similar to WATS lines except that they connect a PBX instead of a station set to a WATS CO. These trunks are used exclusively for outgoing calls from the PBX to the toll network. (See 3.10 for more information on WATS.)

**PBX station lines** (usually called PBX extensions) which connect the telephone stations, that are on the same premises as the PBX, to the PBX. The station lines can be connected through the PBX to other station lines, PBX tie trunks, CO trunks, FX trunks, or WATS trunks.

**PBX off-premises station (OPS) lines** (Fig. 3-8) which give the same services as on-premises station lines except that the station equipment is located remotely from the PBX location.

- 3.18 A tie trunk is used to interconnect two PBXs (Fig. 3-9) and may be of the following types.

**Satellite tie trunks** which connect a satellite PBX to its main PBX.

**Nontandem tie trunks** which are used between two main PBXs which do not have tie trunks to other PBXs. These trunks are primarily intended for connection to PBX stations at both ends but can also be connected to CO trunks and WATS trunks.

**Tandem tie trunks** which are used between main PBXs and tandem PBXs which may be connected together in a customer's PBX tie trunk network.

**Intertandem tie trunks** which connect tandem tie trunks to other tie trunks at both ends in larger PBX tie trunk networks.

- 3.19 Another PBX-related service offering is **Centrex**, which basically gives the PBX customer additional features such as direct inward dialing to a centrex station from the DDD network without attendant assistance. Another feature is detailed billing of outgoing toll calls listed according to specific centrex station. Additional features can be provided at the option of the customer. The dial switching equipment used to give centrex service can be located either on telephone company owned or leased premises (Centrex-CO) or on the customer premises (Centrex-CU). With Centrex-CO service each centrex station is served by a direct line to the CO location. With Centrex-CU service, connections to the DDD network are made over Centrex-CU trunks to a serving CO.

- 3.20 Signaling on PBX circuits is covered in Signaling — B, Special Access Signaling Arrangements 3.85. Test requirements and test access information for PBX circuits is covered in 3.106.

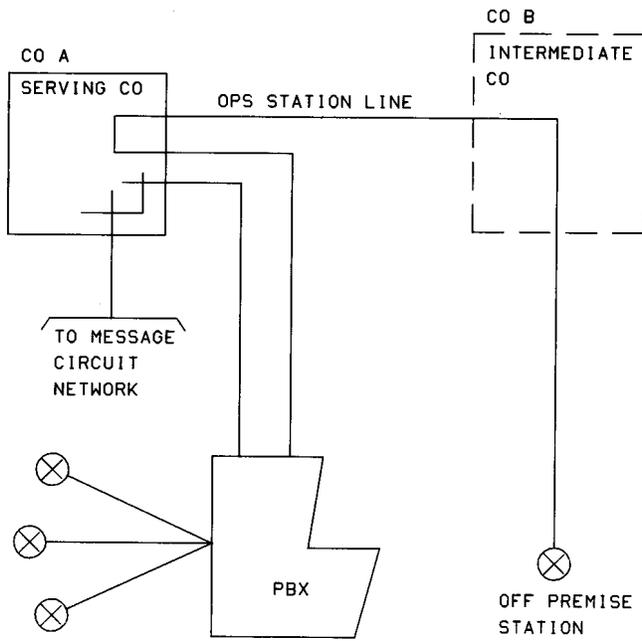


Fig. 3-8—Typical PBX OFF Premises Station Line

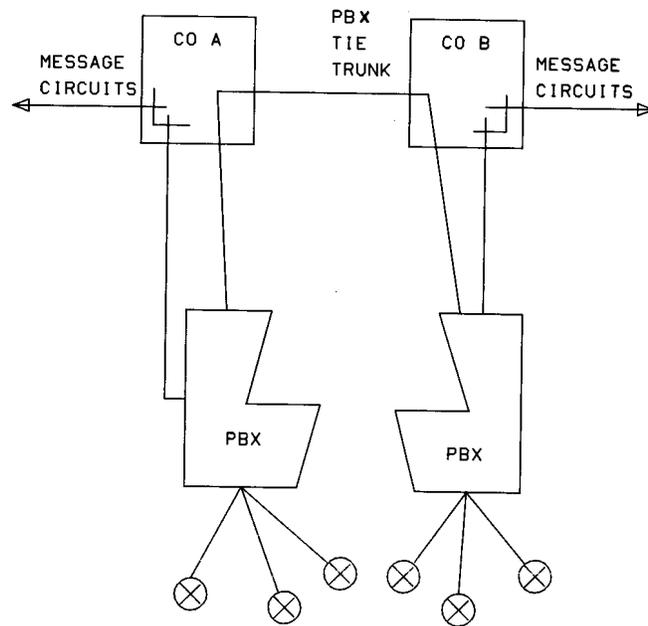


Fig. 3-9—Typical PBX Tie Trunks

## TRANSMISSION

**3.21** The transmission facilities used in special services are made up of existing and available facilities used in the DDD network. The facilities can be either completely metallic or a combination of metallic and carrier. The following paragraphs describe facilities in terms of metallic (two-wire and four-wire) and carrier. The specific transmission components or devices used in metallic facilities to assure proper gain, impedance matching and balancing are described in Part C and D. Bridging devices and special switching components or arrangements are covered in Part E and F, respectively.

## A. Metallic Facilities

**3.22** Metallic facilities consist of wire conductors usually made of copper and, if required, the devices that assure proper gain, equalization and balance. Two wire conductors are insulated with either paper or plastic and twisted together to form a cable pair. Several of these cable pairs, up to 2700 pairs in some cases, are then stranded together to form cables. Neighboring pairs within the cable are twisted with different pitch (twist length) in order to limit electrical interference (crosstalk) between them. Common wire sizes used are 19, 22, 24, and 26 gauge.

**3.23** Several factors interact to cause wire conductors to be less than perfect as a transmission medium. Wire has a number of physical characteristics which attenuate current flow such as **resistance, inductance** and **capacitance**. These characteristics vary according to length of wire, changes in temperature, moisture and mechanical stress on the wire. Also, the smaller the cross-sectional area of wire, the higher the attenuation. For example, 26-gauge wire has about twice the loss at 1000 Hz that 19-gauge wire has and about five times the dc resistance per unit length. As frequencies in the voice range increase, the **attenuation** of the wire also increases due to the effect of **capacitance**. The effect of capacitance is further aggravated by the closeness of wire pairs within a cable sheath. The transmission characteristics of metallic facilities are such that by adding inductance at regular intervals a substantial reduction of attenuation could be achieved. The addition of inductance at regular intervals is called **loading**.

**3.24** Loading arrangements are specified by a code letter designating the distance between load coils and by numbers which indicate the wire gauge and the inductance of each coil. An example is 26H88 where the number 26 specifies 26-gauge wire; H indicates spacing between load coils; and 88 refers to the inductance, in millihenries, of the load coil. Other loading arrangements that may be found in use include H44, D88, and B22, where H is the designation for 6000-foot, D for 4500-foot, and B for 3000-foot spacings.

**3.25** An irregularity often found in cables serving customer locations is **bridged tap**. This consists of another pair of wires connected in shunt (bridged) to the main cable pair at any point along its length. The bridged pair hanging across the main cable pair introduces **bridging loss**. In order to limit this transmission impairment, there are rigid rules concerning the number, length and location of bridged taps allowable. One such rule is that there should never be bridged taps between load coils on a loaded cable.

**3.26** Terminal equipment, and the metallic voice frequency facilities to which it connects, may be either 2-wire or 4-wire. Transmission and signaling considerations normally dictate whether a special service circuit is 2-wire or 4-wire. If transmission and signaling objectives can be met using only 2-wire, then the economic advantage of using only half as much copper is obvious. Two-wire gain devices, discussed in Part C, are often used to meet transmission objectives and still retain 2-wire facilities. In some instances, objectives cannot be met unless a 4-wire facility is used; in other cases, certain special service circuits require the use of 4-wire facilities regardless of loop length.

**3.27** When 2-wire facilities become too long, and a number of gain devices are employed to reduce the attenuation, the 2-wire circuit has a tendency to become unstable. As a result, singing and echo performance are the controlling factors in setting repeater gains. To achieve reasonably high gains in the repeaters used on a 2-wire circuit, careful attention must be paid to the installation and maintenance of the circuit, particularly with regard to the uniformity of loading and to the balancing or line building-out networks that may be on the circuit.

**3.28** Practical considerations such as the foregoing often dictate the use of 4-wire facilities equipped with 4-wire repeaters and equipment.

#### **B. Carrier Facilities**

**3.29** Carrier facilities transmit more than one conversation over a single transmission path by use of various types of modulation. At one end or terminal of the carrier, the voice frequencies of a number of circuits or channels are modulated and then transmitted to the distant end in a different format. At the distant terminal the channels are demodulated to restore the conversations to voice frequencies. The three types of modulation used by the various carrier system are: amplitude modulation, frequency modulation, and pulse code modulation. A block diagram of a typical carrier terminal is shown in Fig. 3-10. Table 3A gives more detailed information concerning each carrier system.

#### **C. Gain Devices**

**3.30** Losses in every transmission facility must be offset sufficiently to ensure satisfactory minimum volume levels at any potential station receiver. Losses in metallic facilities are offset by locating gain devices in the circuit to achieve proper levels at all points in the circuits. Every circuit is unique, and each circuit must be adjusted according to its individual requirements. When gain is required in metallic facilities, the gain devices covered in the following paragraphs are normally used.

#### **E6 Repeater**

**3.31** The E6 repeater is a voice-frequency repeater designed to add gain to 2-wire, loaded or nonloaded circuits in either a terminal or intermediate repeater application.

**3.32** The gain unit of the E6 repeater is bidirectional in that gain is available in both the transmit and receive paths from the single gain unit. The available gain of the E6 repeater gain unit is 13.3 dB. However, crosstalk limitations, especially when the repeater is used as a terminal repeater, may limit the allowable gain. The probability of crosstalk is most severe at the CO end of a circuit where connections are made to subscriber loops. To maintain a crosstalk index of "GOOD," the gain of a terminal repeater should not exceed 7 dB.

However, the 7 dB figure assumes that the 1000-Hz loss of the average loop is 5 to 6 dB. The output of the gain unit may be increased or decreased from 7 dB by the amount that the 1000-Hz loss of the loop deviates from the 6 dB nominal value.

**3.33** In the E6 repeater the impedance matching function is performed by a passive network separate from the gain unit. Once the passive line building-out (LBO) network has been adjusted, the gain can be varied in small steps without readjustment of the matching network. All adjustments are made by tightening or loosening screws to close or open electrical contacts. No strapping or soldering is required.

**3.34** The superior performance of the E6 LBO network is achieved by precisely adjusting the network to fit the cable pair associated with that repeater installation.

**3.35** Repeater inputs or outputs may be monitored with a 419D disabling plug and KS-14418 headset combination inserted in the TST2 jack (located on the front panel of the repeater).

**3.36** When installing the E6 repeater in a new circuit, or when checking the adjustment, the 54B test stand with the 54A and 54C test sets are used for accurate test evaluation and fast screw adjustment.

**3.37** Refer to Part 6 for more specific information on the E6 Repeater.

#### **V4 Repeaters**

**3.38** The 24V4 and 44V4 repeaters were developed to permit grouping together all the voice frequency transmission equipment needed for each circuit in a given office. In general, V4 repeaters consist of a mounting shelf, jack field, and plug-in components. The plug-in components include a 1-type term set, 227-type amplifiers or 849-type networks, a 359-type equalizer, and various auxiliary components, such as filters, balance networks, plugs, relays, and networks.

**3.39** The 24V4 is used at a 2-wire terminal of a 4-wire circuit, or at a junction of the 2-wire and 4-wire portions of a circuit. The 4-wire portion may be a voice frequency metallic facility or a carrier channel.

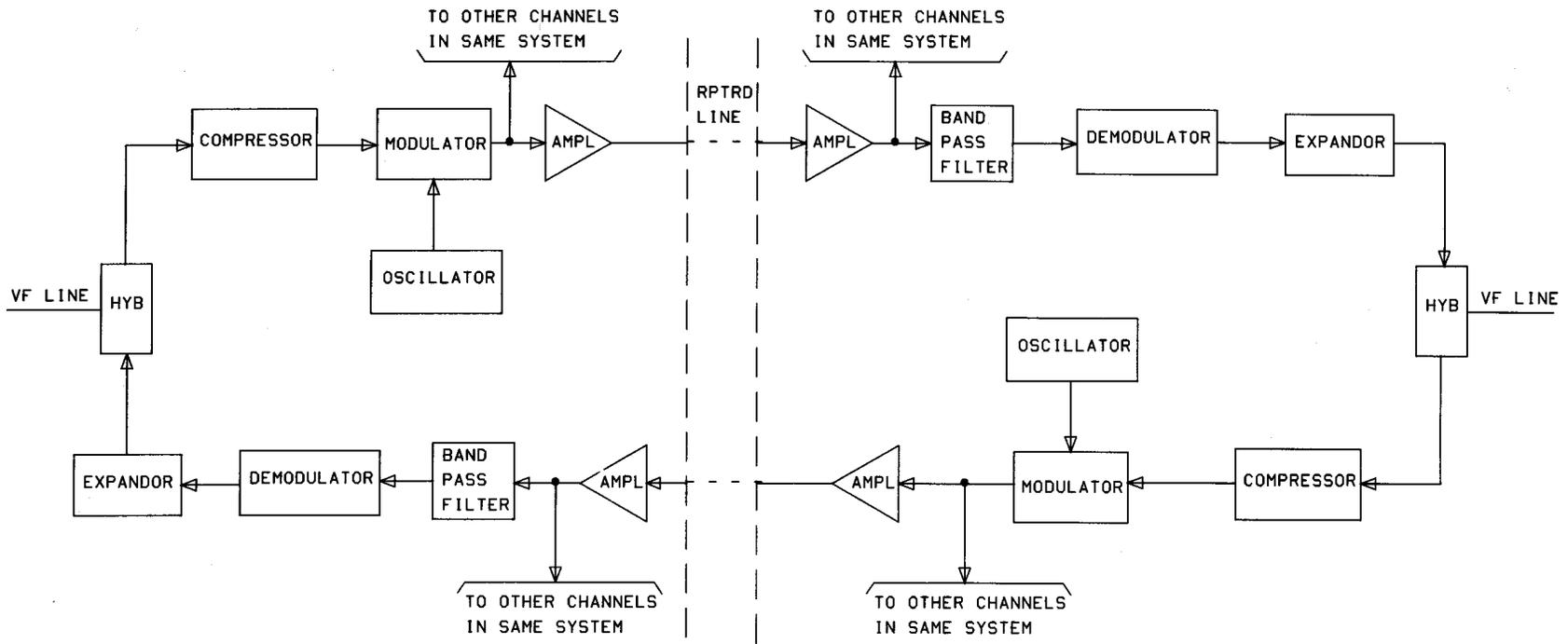


Fig. 3-10—Block Diagram of Typical Carrier System

TABLE 3-A  
CARRIER CHARACTERISTICS

TYPE CARRIER	TYPE MODULATION					TYPE FACILITY				REPEATER SPACING	BUILT-IN SIGNALING	NUMBER OF CHANNELS	COMPANDORED	TUBE OR TRANS.	DESCRIPTIVE BSP REFERENCE	COMMENTS
	AM	FM	PULSE CODE	SSB	DSB	OPEN WIRE	CABLE	COAX	RADIO							
C5	✓			✓		✓				150 mi.	No	3	No	Tube	DIV. 352	Long haul, from 75 to 4000 miles
K2	✓			✓			✓			17 mi.	No	12	No	Tube	355-050-100	Long haul, from 75 to 4000 miles
L1	✓			✓				✓		8 mi.	No	600	No	Trans.	358-010-300	Long haul, from 75 to 4000 miles
L3	✓			✓				✓		4 mi.	No	1860	No	Trans.	359-010-100	Long haul, from 75 to 4000 miles
L4	✓			✓				✓		2 mi.	No	3600	No	Trans.	359-200-100	Long haul, from 75 to 4000 miles
L5	✓			✓				✓		1 mi.	No	9000	No	Trans.	359-300-500	Long haul, from 75 to 4000 miles
R		✓							✓	20 mi.	No	1200	No	Both	DIV. 410, 411	Intra-city or nation-wide
N1	✓				✓		✓			5 mi.	Yes	12	Yes	Tube	362-010-100	Short haul, 15 to 200 miles
N2	✓				✓		✓			5 mi.	No	12	Yes	Trans.	362-800-100	Short haul, 15 to 200 miles
N3	✓			✓			✓			5 mi.	Yes	24	Yes	Trans.	362-900-100	Short haul, 35 to 200 miles
0	✓				✓		✓				Yes	16	Yes	Trans.	362-100-100	Short haul, 15 to 150 miles
ON1	✓				✓		✓			5 mi.	Yes	20	Yes	Trans.	362-100-150	Short haul, 15 to 200 miles
ON2	✓				✓		✓			5 mi.	Yes	24	Yes	Trans.	362-100-150	Short haul, 15 to 200 miles
T1 D1			✓				✓			6000 ft.	Yes	24	Yes	Trans.	365-010-100 365-115-500	Short haul, 10 to 50 miles
T1 D2			✓				✓			6000 ft.	Yes	24	Yes	Trans.	365-010-100	Short haul, 10 to 50 miles
T1 D3			✓				✓			6000 ft.	Yes	24	Yes	Trans.	365-010-100	Short haul, 10 to 50 miles

**3.40** The **44V4** is used at a 4-wire terminal or at an intermediate point in a 4-wire circuit. This may be at a junction between the voice frequency portion of the facility and the carrier facility.

**3.41** For more detailed information on the V4 repeaters, see Part 6.

**3.42** The Metallic Facility Terminal (MFT) contains gain devices that perform similar functions as the E6 and V4 repeaters, however, because it is unique, MFT is covered separately following signaling.

#### **D. Impedance Matching and Balancing Devices**

**3.43** The combined effect of the resistance, capacitance and inductance in a circuit is called the impedance ( $Z$ ) of the circuit. The impedance affects the way a circuit conducts electrical energy in the voice frequency range. When two different impedances are connected together, "reflection losses" occur in the circuit. By using impedance matching devices and balancing networks, reflection losses can be reduced greatly.

**3.44** Transmission facilities usually have greater losses at the higher frequencies. Equalizers add loss at all other frequencies so that the loss becomes more nearly even for the entire spectrum.

**3.45** The devices mentioned above are discussed in the following paragraphs.

#### **Repeating Coils**

**3.46** Repeating coils are primarily used for one or more of the following:

- To match impedances of facilities and equipment.
- To superimpose DC or low frequency (20 Hz) on to AC voice circuits by simplex or composite methods.
- For isolation.

#### **1-Type Terminating Sets**

**3.47** Most 1-type terminating sets consist of a 2-transformer hybrid, compromise network, adjustable building-out capacitor networks, pads

and simplex leads. (See Table 6-F for more detailed information on each terminating set.)

**3.48** Terminating sets are used at the junction of 2-wire and 4-wire facilities. The 2-transformer hybrid is basically two ordinary repeating coils connected with one winding of one coil reversed. A balancing network, composed of the compromise network and building-out capacitors, is adjusted so that electrically, it "looks" like the 2-wire loop. The balancing network should absorb one-half of the energy arriving from the 4-wire side of the facility. The other half is then transmitted into the 2-wire loop. When this energy is not divided between the balancing network and the loop, the difference in energy is reflected back into the 4-wire side. If of sufficient magnitude, this reflected energy could cause singing or echo effects.

#### **Echo Suppressors**

**3.49** Echo suppressors do not really belong in a balance-equalization discussion, but the function of the echo suppressor is similar in the end result. The echo suppressor prohibits the reflection of energy which results from imperfect balance.

**3.50** The length of a circuit in circuit miles, and the make-up of the overall facilities, are the governing factors in the application of an echo suppressor to a circuit. The use, or non-use, is determined by engineering at the time the circuit is designed.

**3.51** The echo suppressor is a voice-sensing device which controls the two paths in a 4-wire facility. The basic purpose of an echo suppressor is to provide a clear voice path for the speaker to the listener while blocking the voice path from the listener to the speaker. This eliminates a feedback to the speaker which would be represented as an echo to the speaker.

**3.52** The echo suppressor units are adjustable for sensitivity to voice and noise and have an adjustment to control release time. All tests and adjustments are normally made at the time the echo suppressor is placed in the circuit for service.

**3.53** Disabler circuits may be added to echo suppressors which respond to a narrow band

tone. When the echo suppressor receives this tone it is taken out of operation (important during testing).

#### Attenuation Equalizers

**3.54** One factor degrading intelligibility of telephone conversations is unequal attenuation of the currents of different frequencies as they pass over the circuits. Therefore, particularly on long circuits where high frequency losses can be great, attenuation equalizers are used to correct for the unequal attenuation of the line.

**3.55** Attenuation equalizers are networks consisting of inductors, capacitors, and resistors. The equalizer increases the losses at lower frequencies in such a way that the resulting frequency response of the line is nearly "flat."

**3.56** A common attenuation equalizer is the 359-type used with the V4 repeater, which is covered in Part 6.

#### E. Bridging Devices

**3.57** The following paragraphs cover the bridging devices commonly used in special services.

##### Bridge Lifters

**3.58** Bridge lifters are devices which remove either electrically or mechanically, bridged telephone pairs to reduce the transmission losses those pairs create. As the current in the bridge lifter circuit decreases the impedance of that bridge lifter increases, therefore, appearing to the bridge circuit as a high impedance. More information on bridge lifters is given in Part 6.

#### 4-Wire Bridges

**3.59** The 4-wire bridge is used to interconnect four individual legs together. The legs may be interoffice facilities, either carrier or metallic, or subscriber's loops. They are used in multipoint circuits. The 4-wire bridge has transmit and receive legs connected through a resistance network to provide a transmission path from each receive leg to all other transmit legs. There are 4-way and 6-way, 4-wire bridges. These may be used individually, or in combinations, to provide the required number of legs for a multipoint circuit.

**3.60** A full duplex (simultaneous transmit and receive) arrangement (commonly called a split bridge) may be provided by utilizing two bridges, one a transmit bridge, with a single input and multiple outputs; the other bridge is a receive bridge, with multiple inputs and one output.

#### 2-Wire Bridges

**3.61** This type of bridge provides a configuration of a 2-wire input with multiple 2-wire outputs.

**3.62** This type of bridge is most commonly used on telephone/data and telephoto services provided for the press and news services, but it may be used on any multiple-receive-only type of voice service.

*Note:* To provide a balance between all legs of any bridge, all legs must terminate into the same impedance (balanced bridge). This requires unused legs to be terminated by means of a resistor in the impedance of the legs used (this is normally 600 ohms).

#### F. Special Switching Arrangements

**3.63** The special switching arrangements discussed here are miscellaneous and practically unrelated to each other, but they do satisfy various special needs in special service circuits.

##### Loop Back Arrangement

**3.64** With the greater usage of 4-wire local loops, and the need of faster trouble isolation, loop back devices are being installed on many new services of this type.

**3.65** The purpose of a loopback device is to connect the receive side of a circuit to the transmit side at the customer location. Continuity, level, noise and many other tests can be made to the customer end of the circuit without dispatching repair personnel.

**3.66** There are three common types of loopbacks in widespread use today. The first is the 6017 key which requires the cooperation of the customer to operate the key to the test position. The other two loopback devices are remotely operated by the CO personnel. The 229B KTU is used predominantly in metropolitan areas and is

operated by applying battery to one side of the simplex and ground to the other side. The last category of loopback arrangements includes the 806A, 828A, and 829A Data Auxiliary Sets (DAS).

The method of loopback is dependent on the operation of the module option selected. Table 3-B below shows the five options available and what is required to operate the loopback.

**TABLE 3-B**  
**LOOP BACK OPERATION**

MODEL	ACTUATING SIGNAL	RELEASE SIGNAL
806A1	48 Volts dc	Removal of 48-Volt Signal
806A2 (Without A Option)	2800 Hz (Continuously Applied)	Removal of 2800-Hz Signal
806A2 (With A Option)	5- to 10-Second Burst of 2800-Hz Tone	5- to 10-Second Burst of 2800-Hz Tone
806A3 (Without A Option)	2400 Hz (Continuously Applied)	Removal of 2400-Hz Signal
806A3 (With A Option)	5- to 10-Second Burst of 2400-Hz Tone	5- to 10-Second Burst of 2400-Hz Tone
828A-L1	48 Volts dc	Removal of 48 Volts
828A-L1 With 44A1 Data Unit Installed	5-Second Burst of 2713-Hz Tone From A406 Generator	5-Second Burst of 2713-Hz Tone
829A-L1	5-Second Burst of 2713-Hz Tone From A406 Generator	5-Second Burst of 2713-Hz Tone

*Note:* All tones applied 10 dB below TLP.

**3.67** When making a loopback test, it is important to know at what transmission level points the loopback device is installed. Most new loopbacks are connected at a point where the receive and transmit sides are at an equal level. This makes testing relatively simple. Some loopback devices are installed at a point where the levels between receive and transmit are different. It is necessary to allow for this difference when making test measurements.

**Multistation Special Switching Arrangements (for control switching)**

**3.68** Multistation private line circuits terminated at the same location are switched by 4-wire switching relays using 4-wire bridges as interconnecting devices. Control of the switching relays is accomplished from the CO or from the customer location. The switches are operated by dc channels

between the CO and stations, or by use of a selective signaling system. A description of each arrangement is not given here. But the result of the special switching relays is that loop circuits and line circuits on a common 44- or 46-type bridge may be switched to produce a variety of combinations. The selection of switching combinations is dependent, therefore, upon customer requirements.

**Special Switching Relay**

**3.69** A special switching relay, the 332A, in the 24V4D repeater, switches the transmission path around the repeater, without gain, whenever the power supply to the repeater is interrupted.

**SIGNALING**

**3.70** Signaling, as discussed in this section, is the communication between the customer

and the telephone equipment. In ordinary telephone service the customer notifies the equipment that service is desired by removing the handset from the cradle or switchhook. This action is called "going off-hook." The equipment at the CO tells the customer that it is ready to receive further information to process the call by giving the customer dial tone. The customer sends dial pulses or TOUCH-TONE® signals to the CO equipment to identify the telephone number being called. The CO equipment responds by causing the distant (called) telephone to ring (provided the telephone is not off-hook) and by applying ringback frequencies to the originating customer's line. When the distant customer tells the CO equipment that the call is received (by going off-hook), the ringing is stopped and the voice path completed.

**3.71** Of course the above operational description is oversimplified, but the information communicated by signaling between the customer and equipment is usually required. The signaling requirements for special service circuits are dependent on the individual needs of the customer and may be different from ordinary telephone service requirements. The signaling arrangements depend on the signaling requirements and the availability of equipment. Signaling arrangements are generally divided according to the two basic types of circuit categories, private line circuits and special access circuits. (Special access circuits are FX lines, WATS lines, OPX lines, secretarial lines, and PBX lines.) The methods used to accomplish signaling of any type are basically divided into two types; DC signaling and AC signaling. The following paragraphs discuss the commonly used signaling arrangements and the methods used to accomplish them.

**A. Private Line Circuit Signaling Arrangements**

**3.72** Private line circuits are divided into two types: 2-point private lines, and multipoint private lines. Since 2-point private lines tend to be the simplest, the signaling arrangements for this type are discussed first. The signaling arrangements for multipoint private line circuits are discussed in 3.74.

**3.73** Since 2-point private lines use dedicated facilities and are not switched to any other telephone, there is no reason for address (telephone number) information to be signaled anywhere. The only signaling that is required is for the telephone

at the distant end to notify the customer that a call is incoming. This can be done by ringing a bell or voice calling. The four types of signaling most commonly used on 2-point private line circuits are:

- (1) Manual ringdown in both directions
- (2) Automatic ringdown in both directions
- (3) Manual ringdown in one direction and automatic ringdown in the other direction
- (4) Voice-call signaling using a loudspeaker.

**3.74** Multipoint private line circuits can have a variety of signaling requirements depending on the customer's needs. The requirements can vary from no signaling or perhaps signaling in one direction only between a few stations to the extreme case in which a large number of stations can signal any of the other stations individually, all of them at one time, or certain pre-selected groups. The five types of signaling most commonly used on multipoint private line circuits are:

- (1) Manual ringdown to and from all stations
- (2) Automatic ringdown to and from all stations
- (3) Voice-call signaling using a loudspeaker
- (4) Code selective ringdown
- (5) SS-1A selective signaling system.

**3.75** Manual ringdown signaling arrangements normally have a button or key arrangement at the station which, when operated, causes a 20-Hz ringing signal to be applied to the telephone at the distant end. (On multistation private lines, 20 Hz is applied to each station set.) The 20-Hz causes the bell in the telephone to ring, notifying the customer(s) of an incoming call. The 20 Hz can be generated from either CO equipment or equipment located on the called customer's premises. At the originating end it is not necessary that the 20 Hz form of signaling be used between the station and CO, however, some station arrangements are equipped with a 20 Hz generator source.

**3.76** Automatic ringdown signaling eliminates the necessity of operating a button or key. When the telephone at the calling station is placed

in an off-hook condition, a 2-second spurt of 20 Hz ringing is applied to the called station(s). A signal control arrangement at the station(s) will lock upon receiving the 2-second signal and supply ringing current to the telephone set until it is answered or times out.

**3.77** Voice-call signaling using a loudspeaker, or loudspeaker signaling, has limited application because of room noise limitations at the customer location. (Loudspeaker circuits are used extensively by "Junk Yards".) With this arrangement; the called party is summoned to the telephone by means of a loudspeaker. In the multistation application, the loudspeakers are bridged on the circuit so all stations can hear the calling party. When the summoned party lifts the handset off-hook, operates the push-to-talk button, or plugs into jacks, the loudspeaker is removed from the circuit allowing normal conversation. The private line terminating circuit SD-69566-01 (FS 11) provides the loudspeaker cutoff function. A talk-back arrangement is necessary with loudspeaker signaling and should be located at the customer location if SD-69566-01 is used; otherwise, it may be located at the CO.

**3.78** Code selective ringdown signaling permits stations on the circuit to selectively signal any other station or group of stations on the circuit by operating the signal button or key a predetermined number of times. With this type of signaling, each loop (or station) to be signaled requires equipment which counts the ringing bursts, and responds (by applying 20-Hz ringing to the telephone set) when the correct code is received.

**3.79** The SS-1A Selective Signaling System (SD-69594-01) replaces the SS-1 system which has been rated Mfr. Disc. The SS-1A system is designed to be installed at the customer premises.

**3.80** The standard station termination to be used with the SS-1A is the 4-wire private line termination SD-69566-01. The SS-1A equipment is inserted between the line termination circuit and the station circuit or pickup relays of the 4-wire termination. This permits stations at the same location to signal each other as well as distant points on the circuit.

**3.81** The SS-1A systems use two-digit codes with a possibility of 81 codes. The digit one is not assigned in any combination, but is reserved as a first digit cancellation code. If an erroneous

first digit is dialed, the digit one may be dialed to cancel the first digit.

**3.82** Dial pulses are converted to 2600- and 2400-Hz frequency shift pulses by the keyer circuit of the SS-1A for transmission over the 4-wire line facility.

**3.83** Upon receipt of the first pulse of any code, the SS-1A system applies a busy signal to all stations until the second digit has been received or until a 6-second time out interval has occurred. Failure to dial the second digit within 6 seconds of the first is recognized as call abandonment and the calling station is released from the keyer circuit.

**3.84** Detailed descriptions of the SS-1 and SS-1A systems are contained in Sections 982-325-100 and 982-326-100, respectively.

#### **B. Special Access Circuit Signaling Arrangements**

**3.85** Signaling on special access circuits is very similar to that used in ordinary telephone service. Generally the same information is required since special access circuits connect a station to some type of switching system. However, special access circuits can provide any one or more of the following additional features:

- Additional signaling states (ground-start)
- Like signaling functions over greater distances than the ordinary subscriber line (FX line)
- Special rate treatment (WATS)
- Remote and/or alternate answering of incoming calls to a main telephone (OPX, OPS, or secretarial service).

**3.86** One end of the special access circuit terminates at the customer's location (station end) and receives 20-Hz ringing as a signal for an incoming call. This end transmits rotary dial pulses or TOUCH-TONE® calling signals for an outgoing call, if dial outgoing service is provided. The rotary dial pulses are transmitted from the station as a rapid succession of "on-hook" and "off-hook" signals. With TOUCH-TONE pulses, combinations of tones are used.

**3.87** The other end of the special access circuit, called the switching end, receives the rotary

dial pulses or TOUCH-TONE calling signals from the station end. In turn it transmits 20-Hz ringing signals toward the station. This end of the circuit may be located at a serving toll center, a local central office, or a PBX.

### C. Methods of Signaling

**3.88** The signaling arrangements covered above are accomplished by a variety of signaling methods which are discussed in the following paragraphs. Basically these methods are divided into two types: DC signaling methods and AC signaling methods. DC signaling methods include loop, E & M lead, composite (CX), simplex (SX), and duplex (DX) signaling, which are used on 2- or 4-wire metallic facilities. AC signaling methods use tones for signaling and are required on carrier or nonmetallic facilities. However, this type of signaling may also be used in wire facilities.

**3.89** AC signaling tones are classified as being in the voiceband of frequencies, or out of the voiceband of frequencies ("inband" or "out-of-band" signaling). Pulse code modulation signaling which is used on T1 Carrier Systems is considered to be in the "out-of-band" category.

### DC Signaling

**3.90** The most basic DC signaling form is loop signaling. Loop signaling as discussed in this section is divided into two types: loop start and ground start. Loop start signaling is the normal type of DC signaling between a subscriber station and a CO or between a PBX and a PBX station. When the handset is removed from its cradle at the station end, a resistance of approximately 200Ω is placed across the tip and ring conductors. Since the tip and ring conductors have battery and ground on them from the CO, the resistance effectively closes the loop. This signal is recognized by the CO equipment as an "off hook" or seizure. Loop start signaling is required when providing service to an OPX, FX or a manual PBX.

**3.91** An incoming call to the station end is recognized by the receipt of the 20-Hz ringing signal only. The usual ringing signal consists of a 2-second ringing period followed by a 4-second silent period. During this silent interval (before the first incoming ring) the customer being called could attempt to seize the circuit to originate a call. In those instances where an individual is

called, this is not considered a problem since the called party would normally answer the incoming call. However, in circuits terminating in a dial PBX, for example, this creates a problem; the customer at the PBX that may attempt to originate a call during the silent interval may not be the customer the call was intended for. Therefore another form of dc signaling is used.

**3.92** Ground start is the signaling operation required on circuits that terminate in a dial PBX or an automatic call distributor (ACD). Typical dial PBXs include the 701, 740, 756, 757, and 800A. Typical ACD's include the 2A and 3A.

**3.93** In many ways a dial PBX is similar to a dial central office in that any one of the dial PBX stations can dial other telephones, and also originate and receive calls over the same trunk between the serving central office and the dial PBX. Since this trunk can be seized at either end, it is apparent that special means must be taken to transmit seizure signals in each direction as quickly as possible. In the description of loop-start signaling, it is noted that four seconds could elapse before the station end of the circuit recognized a seizure by the switching end. ***Ground-start signaling eliminates the four-second seizure delay.*** When ground-start signaling is employed, the subscriber line circuit at the central office is modified by removing the ground which is normally connected to the tip conductor of the line in the idle or on-hook state. This standard modification is used to prevent double seizure.

**3.94** When the central office switching equipment seizes the trunk for a call toward the dial PBX, it immediately places a ground on the tip conductor. The trunk circuit at the PBX recognizes the presence of ground on the tip as a seizure signal and immediately makes itself unavailable to outgoing calls from the PBX. When the 20-Hz signal is received, a signal is given to the PBX attendant to indicate an incoming call.

**3.95** An outgoing call from the PBX toward the central office causes a ground to be placed on the ring conductor toward the central office. The central office equipment recognizes this as a seizure signal and prepares itself to receive dialing. When it is prepared, it places a ground on the tip conductor toward the PBX and applies dial tone. The PBX trunk circuit in turn, recognizing the tip ground as a start-dial signal, closes the line through

for dialing and removes the ground which it had placed on the ring conductor earlier. After dialing, the call is completed in the usual way.

**3.96** To repeat, the dial PBX recognizes ground on the tip conductor from the central office equipment as a seizure signal, the central office equipment recognizes ground on the ring conductor from the dial PBX as a seizure signal. Similarly, the dial PBX recognizes the removal of ground from the tip conductor as a disconnect signal, and the central office switching equipment recognizes the opening of the loop as a disconnect signal.

**3.97** When it becomes necessary to extend the loop signaling range beyond the normal limits of central office or PBX equipment, a dial long line circuit such as a DLL03 (SD-96555-01) is used. A sensitive relay repeats the dial pulses toward the switching end and provides battery toward the station. This circuit also supplies a fresh supply of 20-Hz ringing current toward the station. Not more than three of the circuits may be used in tandem unless dial pulse connection is provided.

**3.98** Another means of extending the loop signaling range is by using other types of signaling arrangements such as CX, DX, or SX signaling (Fig. 3-11). But since these types are not directly compatible to loop signaling, some type of interface must be used. E & M lead signaling performs a universal interfacing function between dissimilar formats of signaling, such as DX to loop signaling (Fig. 3.12). In addition to connecting two DC signaling systems, E & M lead signaling functions equally well connecting a DC signaling system to an AC signaling system (Fig. 3-13). DLL circuits such as DLL01 (SD-96251) and DLL02 (SD-96252) are used to convert loop signals to E & M lead signals.

### AC Signaling

**3.99** The foregoing circuit arrangements are normally limited to relatively short-haul facilities because of signaling and transmission requirements. When longer distances are required other signaling arrangements are used such as Single Frequency (SF) signaling. SF circuits use 2600-Hz tone for signaling which is "in band" and readily passed through the voice path. The range of this method of signaling is limited only by the

transmission capabilities of the entire circuit at that frequency.

**3.100** The SF signaling format consists of 2600-Hz tones at low levels transmitted over a 4-wire facility. Since a 4-wire facility is used SF signaling is bidirectional. The normal tone conditions on an idle circuit are tones on (being transmitted) in both directions. On loop-start circuits, on which the SF tone is transmitted over carrier, the tone toward the station is off in the idle circuit condition and on for ringing. This prevents false ringing when the carrier fails or fades.

**3.101** Basically there are two families of SF signaling units: E-type and F-type. Some of the earlier E-type SF units use E & M lead signaling on one side of the units. Some form of converter circuit is used to convert the loop signaling to E & M lead signaling. Later versions of the E-type SF unit are capable of converting loop-signaling directly to SF signaling and SF to loop.

**3.102** The F-type SF units supersede the E-type in all applications except revertive pulsing, however, the F-type does not directly replace the E-type because of differences in physical design. More detailed information on SF signaling units is given in Part 6.

**3.103** Yet another form of AC signaling is used by some carrier system and is commonly called "built-in" signaling. Carrier systems such as N, O, and ON have an upper speech band limit of 3100 Hz in a 4000 Hz channel space. This vacant gap from 3100 to 4000 makes it possible to build a signaling system into each carrier channel terminal unit. Since the 3700-Hz tone used in N, O, and ON carrier systems (Fig. 3-14) is outside the speech band the elaborate guard arrangements, needed for in-band signaling to avoid interference from speech, are eliminated.

**3.104** Signaling is accomplished in the digital T-type carrier systems by another type of built-in signaling. Since the transmission in T-carrier is a sequence of binary bits (in an 8-bit word format), the signaling is translated in the binary word. Generally, the 7th and 8th bit of a word is used for signaling. Typically, the PCM signaling of a T-carrier system interfaces with some configuration of loop or E & M lead signaling.

**METALLIC FACILITY TERMINAL (MFT)**

**3.105** The metallic facility terminal (MFT) (SD-1C359-01) is a standard arrangement of plug-in equipment which furnishes transmission and/or signaling functions on metallic facilities. The MFT equipment consists of two groups of plug-in modules; transmission modules and signaling modules. The transmission and signaling modules are used in various combinations to perform the functions discussed in previous paragraphs for transmission and signaling on metallic facilities. Normally, an MFT consists of one transmission unit and one signaling unit mounted in adjacent slots in a double module shelf or bay mounting arrangement. This pair of units is associated with one circuit only. The double module shelf accommodates 24 plug-in units or 12 pairs (12 circuits). Other arrangements of MFT units are

available such as the single module shelf or bay arrangement. (See Part 6 for more detailed information on MFT.)

**TEST REQUIREMENTS AND TEST ACCESS INFORMATION**

**3.106** Test requirements and test access information for the special service circuits discussed in this part are given in the following tables and figures. Table 3-C should be used to locate the proper tables and figures for the circuit type required.

**Note:** The figures show typical access points for typical circuits. Obviously many different access arrangements exist, however, these should help in understanding where test access may be found.

TABLE 3-C

**TEST REQUIREMENT REFERENCES**

TYPE OF CIRCUIT	1000-HZ LOSS OBJECTIVE	FREQUENCY RESPONSE OBJECTIVE	C-MESSAGE NOISE LIMITS	TEST ACCESS INFORMATION
2-Point Private Line	Table 3-D	Table 3-E	Table 3-F	Figures 3-15, 3-16, 3-17
Multipoint Private Line	Table 3-G	Table 3-H	Table 3-I	Figures 3-18, 3-19
FX Line	Note 1	Table 3-J	Table 3-K	Figure 3-20
WATS Line	Note 1	Table 3-J	Table 3-K	Figure 3-20
OPX Line	Note 1	Table 3-J	Table 3-K	Figure 3-21
Secretarial Line	Note 1	Table 3-J	Table 3-K	Figures 3-22, 3-23
PBX-CO Trunk	Note 1	Table 3-J	Table 3-K	Figures 3-24, 3-25
PBX Station Lines (On Premises)	Note 1	Table 3-J	Table 3-K	Figure 3-26
PBX-OPS Line (Off-Premises Station)	Note 1	Table 3-J	Table 3-K	Figure 3-27

**Note:**  $\pm 1.0$  dB of EML on CLR

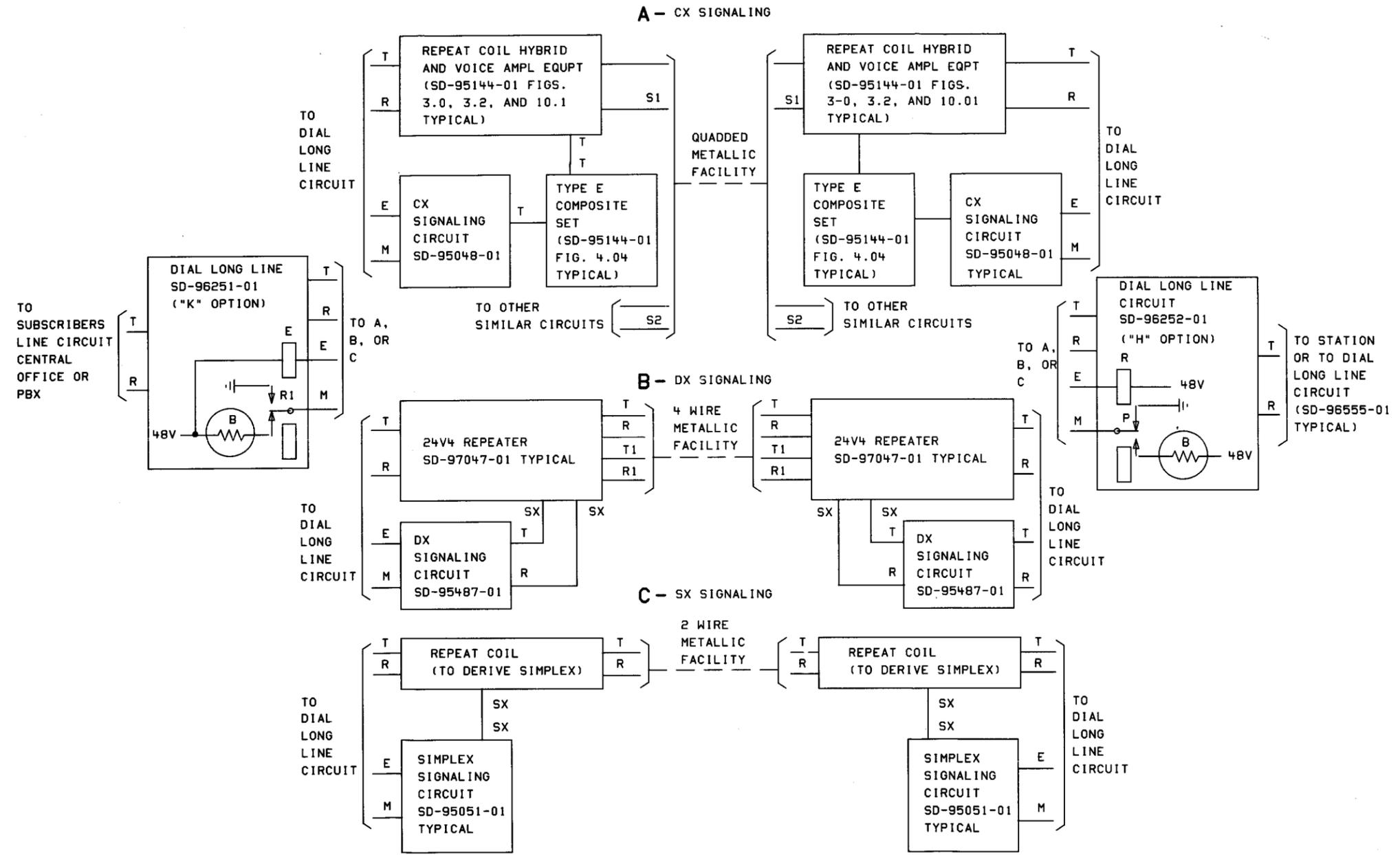


Fig. 3-11—CX, DX, and SX Signaling on Metallic Facilities Loop Start

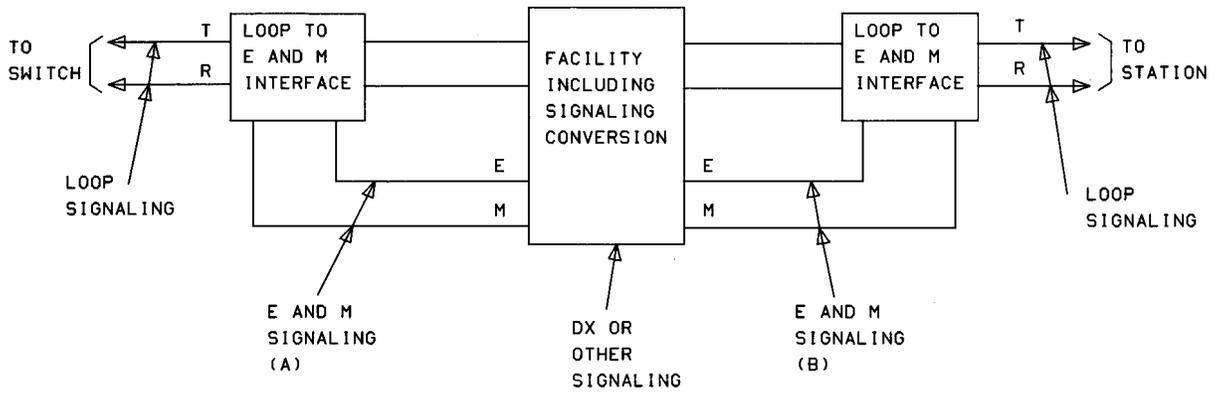


Fig. 3-12—E & M Interface Between Two Dissimilar Formats (Loop and DX, or Similar)

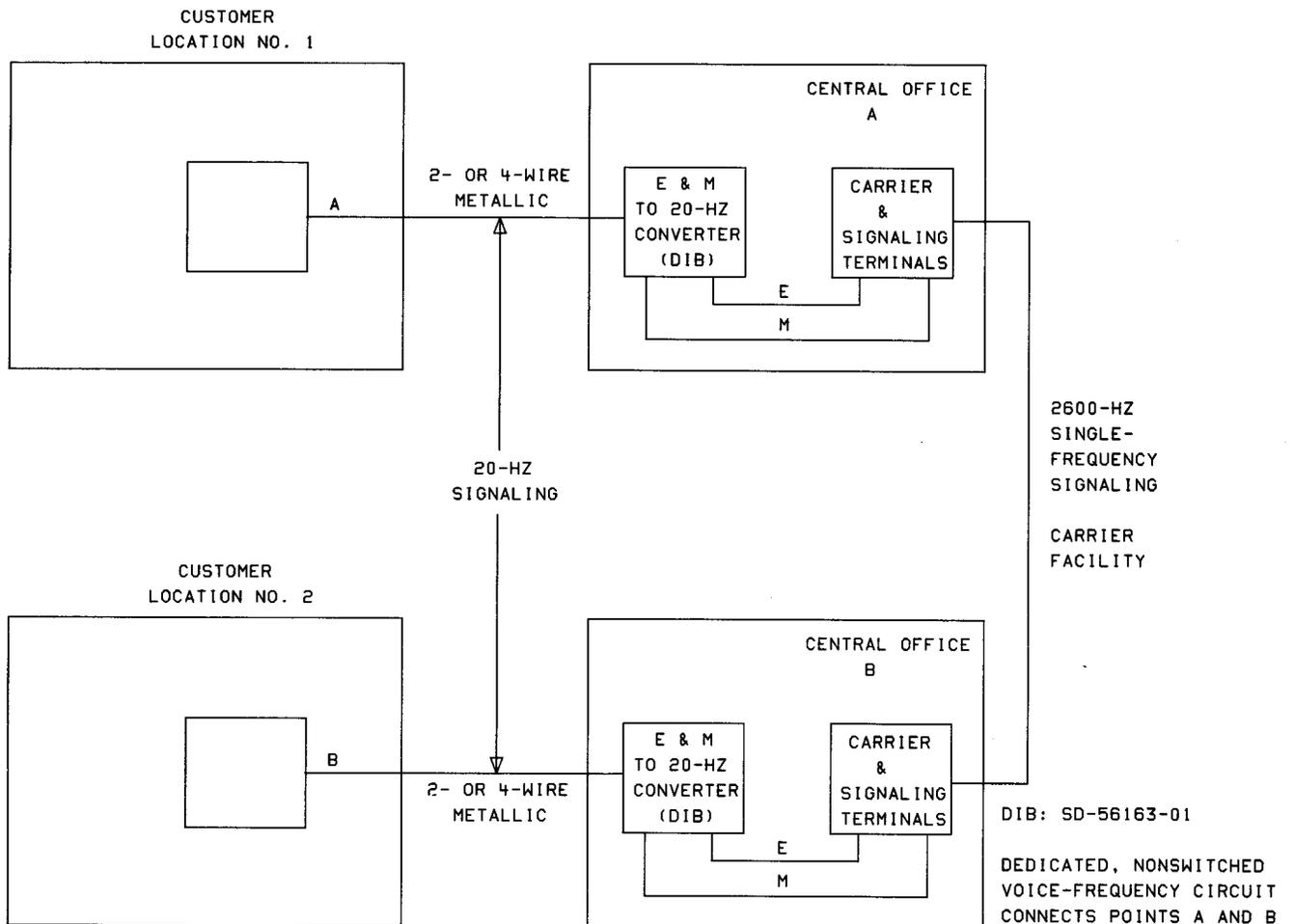


Fig. 3-13—Typical Ringdown Circuit with E & M to 20-Hz Converters (D1B)

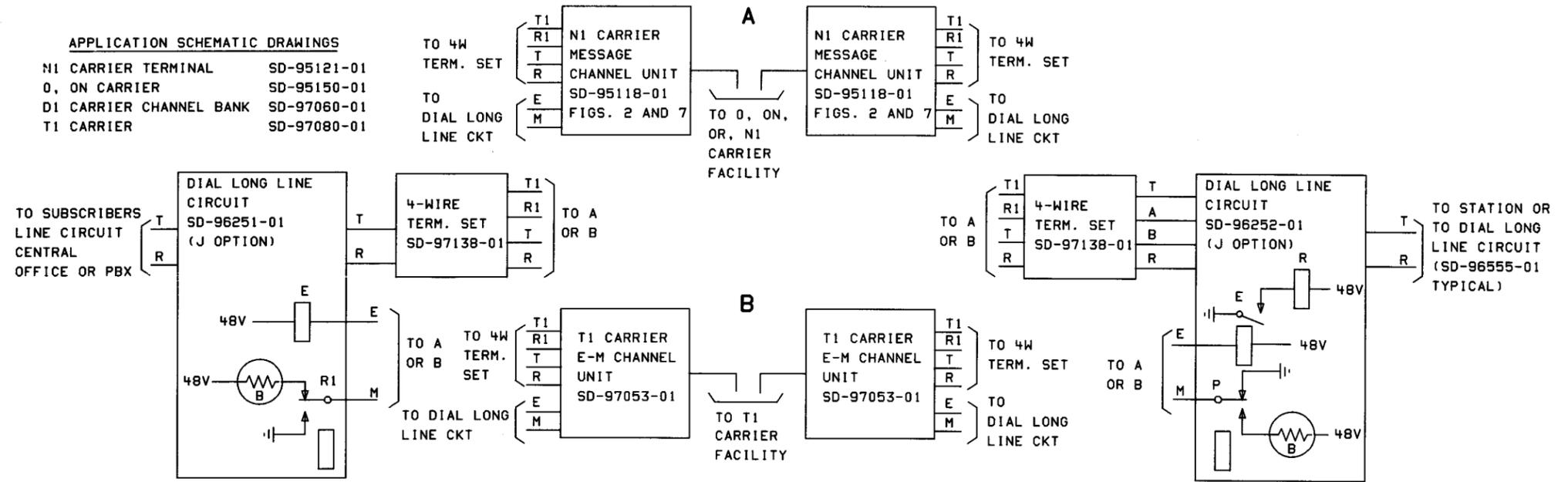


Fig. 3-14—Out-of-Band Signaling O, ON, N, and T1 Carrier Systems Loop Start

TABLE 3-D

**1000-Hz LOSS OBJECTIVES FOR 2-POINT PRIVATE LINES  
MAXIMUM DEVIATION FROM EML STATED ON  
CIRCUIT LAYOUT RECORD CARD**

	CIRCUIT ORDER	ROUTINE OR TROUBLE ISOLATION
STA-STC	±0.5 dB	±2.0 dB
STC-STC	±0.5 dB	±1.0 dB
OVERALL (STA-STA)	±1.0 dB	±4.0 dB
LOOP-BACK (STC-STA-STC)	±0.8 dB	±2.0 dB

TABLE 3-E

**FREQUENCY RESPONSE OBJECTIVES FOR 2-POINT  
PRIVATE LINES**

FREQUENCY	MAXIMUM ALLOWABLE DEVIATION FROM THE 1000 HZ LOSS MEASUREMENT
400 Hz	-2.0 dB to +8.0 dB
1000 Hz	0
2800 Hz	-2.0 dB to +10.0 dB

*Note:* (-) indicates less loss and (+) indicates more loss.

*Example:* When at a particular test point, the 1000 Hz loss measures -10 dB. The 400 Hz loss must measure between -8.0 and -18 dB to be within limits.

TABLE 3-F

**C-MESSAGE NOISE LIMITS FOR PRIVATE LINES  
BUSY HOUR NOISE MAINTENANCE LIMITS  
DBRNC MESSAGE WEIGHTING REFERRED TO 0 TLP**

LENGTH OF CIRCUIT IN MILES	CIRCUIT ORDER AND MAINTENANCE REQUIREMENTS MET IF NOISE IS AT OR BELOW	OBJECTIONABLE NOISE	
		REQUIRES INVESTIGATION AND ANALYSIS BETWEEN	REQUIRES IMMEDIATE ACTION IF ABOVE
	(A)	(B)	(C)
0 – 50	31	31 – 44	44
51 – 100	34	34 – 44	44
101 – 400	37	37 – 44	44
401 – 1000	41	41 – 50	50
1001 – 1500	43	43 – 50	50
1501 – 2500	45	45 – 50	50
2501 – 4000	47	47 – 50	50

*Note 1:* If the maintenance requirement in column A cannot be met by available maintenance techniques, the engineering of the system or the maintenance methods should be changed. The appropriate engineering group should be notified through the lines of organization.

*Note 2:* The supervisor should be informed if a trunk requires immediate action. The trunk should be removed from service unless the supervisor at the control office determines that it is needed because of traffic load conditions.

*Note 3:* The noise requirements apply to the total length of the circuit contributing noise at the point of measurement. These limits can be used as a guide to isolate a trouble to a portion of an overall circuit.

*Note 4:* Compandored Facilities:

- a. When a trunk is made up of compandored facilities, a combination of compandored and voice cable facilities, or two or more compandored facilities in tandem, above limits should be 5 dB stricter.
- b. When a trunk is made up of compandored plus noncompandored carrier facilities, such as N plus L, the requirements as listed in the table must apply.
- c. T carrier is considered to be a noncompandored facility when this table is used.

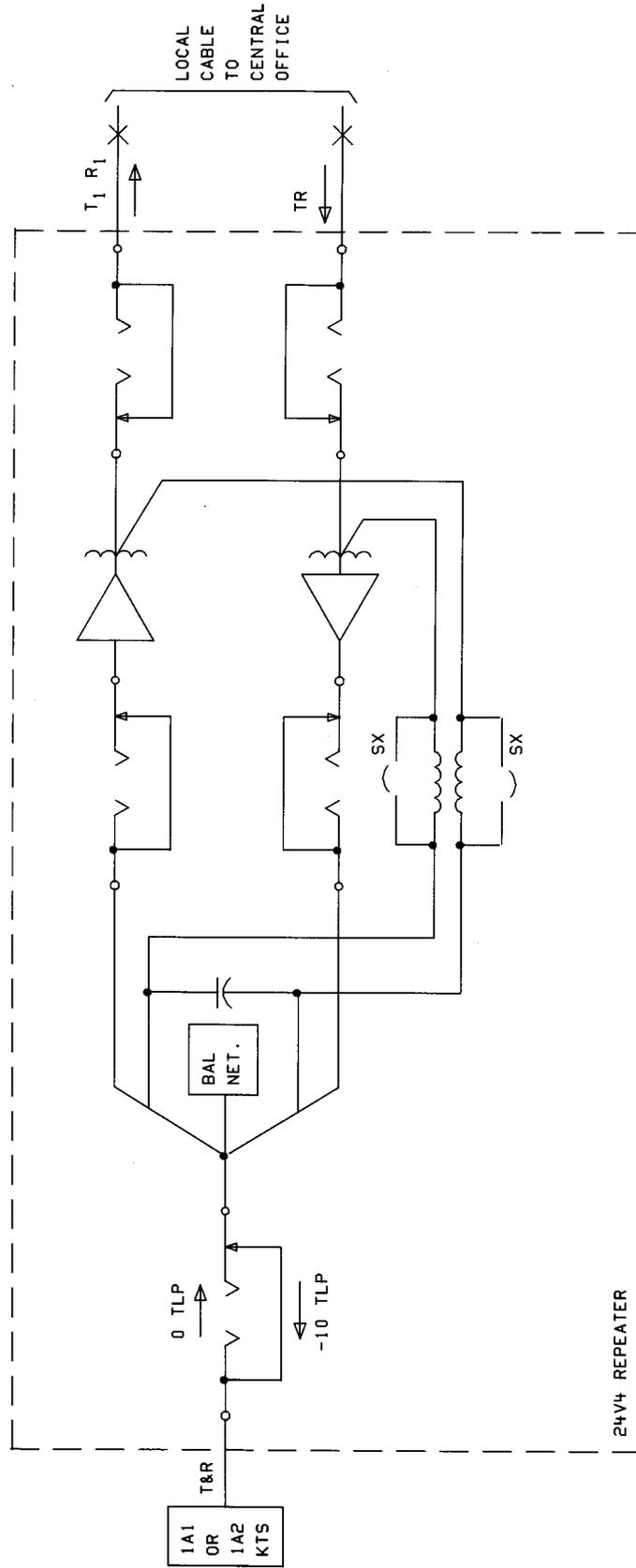


Fig. 3-15—Typical 2-Wire Station Termination Test Access Points

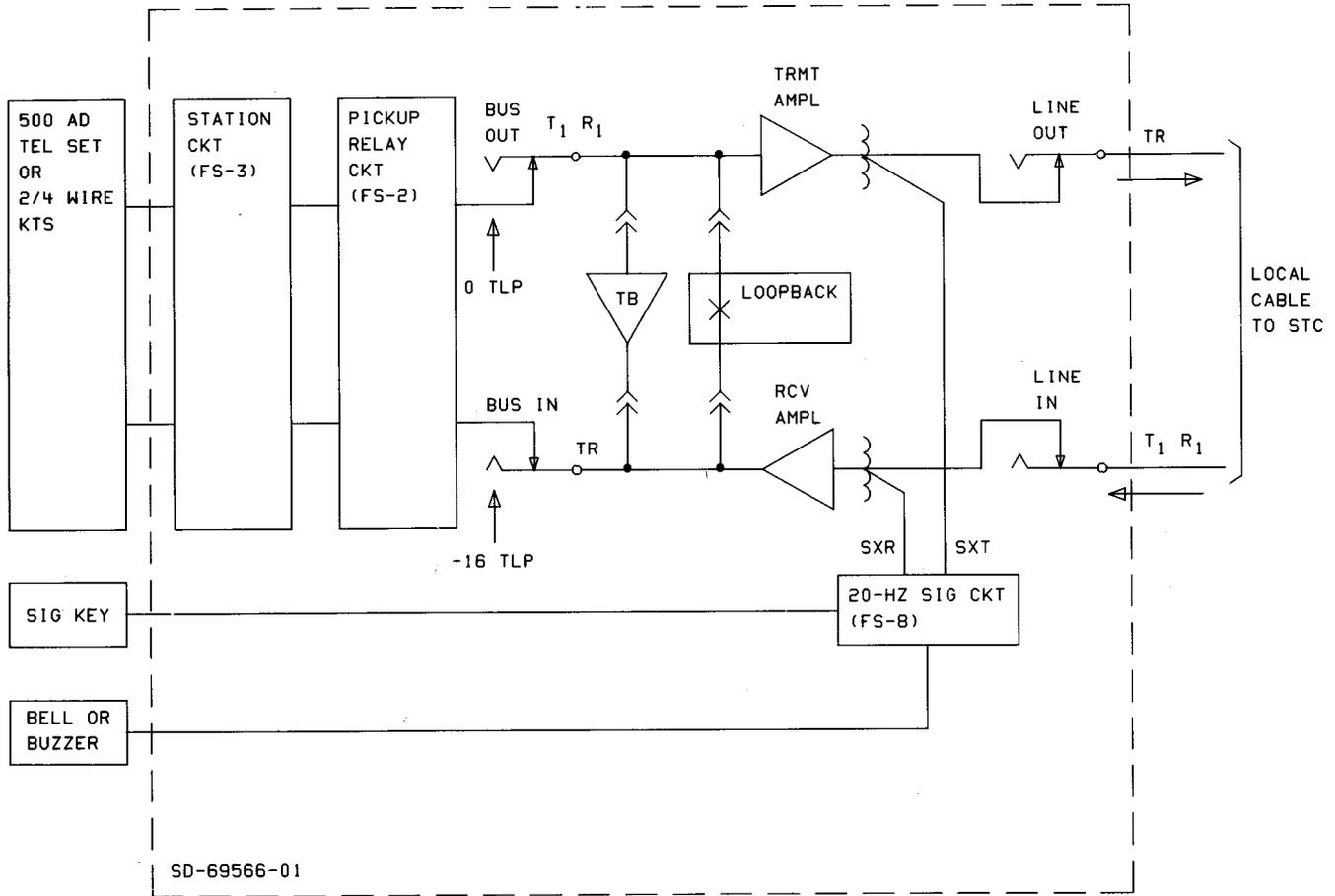


Fig. 3-16—4-Wire Private Line Telephone Station Termination Using SD-69566-01 Showing Test Access Points

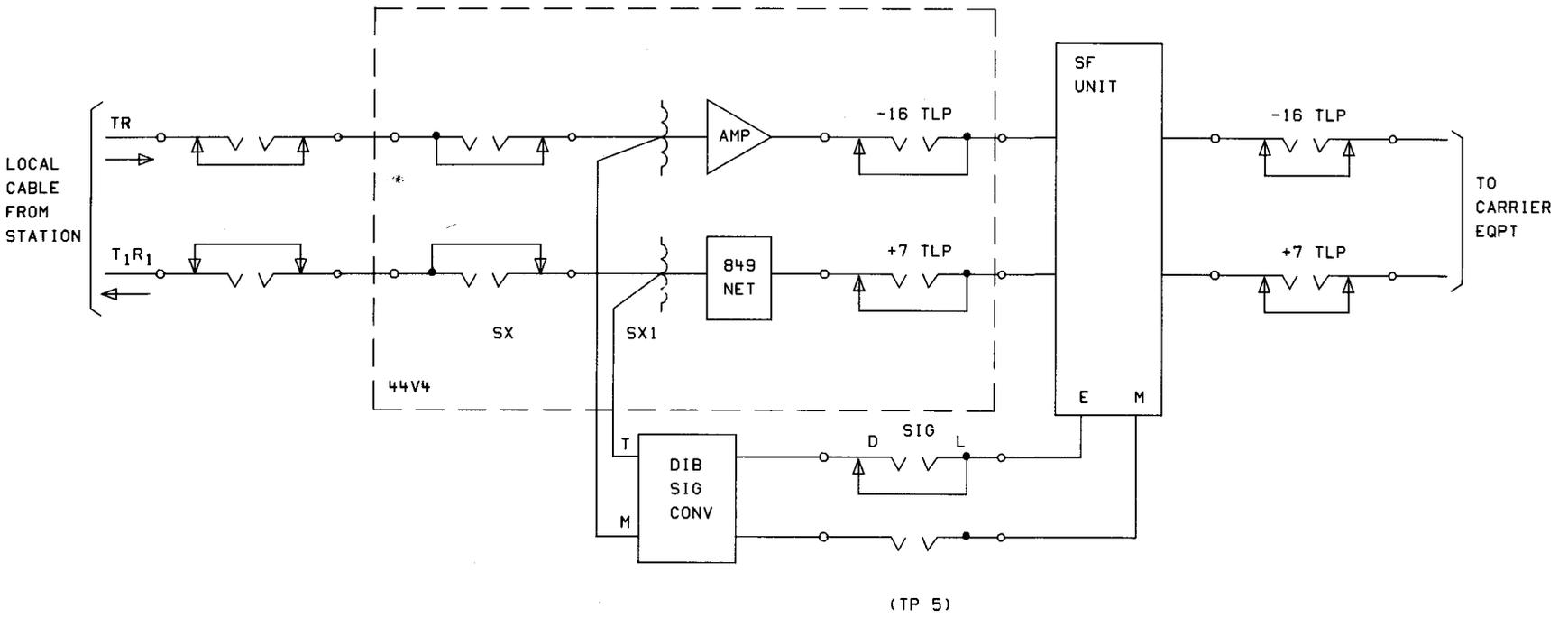


Fig. 3-17—Typical Central Office Arrangement for Two-Point Private Line Telephone Service and Test Access Points

TABLE 3-G

1000-Hz LOSS OBJECTIVES FOR MULTIPOINT PRIVATE LINES  
 MAXIMUM DEVIATION FROM EML STATED ON CLR

	CIRCUIT ORDER	ROUTINE/TROUBLE
END LINK	±0.5 dB	±2.0 dB
MIDDLE LINK	±0.5 dB	±1.0 dB
OVERALL BACKBONE	±1.0 dB	±4.0 dB

TABLE 3-H

FREQUENCY RESPONSE OBJECTIVES FOR  
 MULTIPOINT PRIVATE LINES  
 ALLOWABLE DEVIATION FROM 1000 Hz AML (IN dB)  
 MEASURED AT 400 Hz AND 2800 Hz

NO. MID LINKS ON CIRCUIT	REQUIREMENTS	
	END LINKS	MID LINKS
0	-1.5 To +4.0	
1	-1.0 To +4.0	-1.0 To +3.5
2	-1.0 To +4.0	-1.0 To +3.5
3	-1.0 To +3.5	-0.8 To +3.5
4	-0.8 To +3.5	-0.8 To +3.0
OVERALL BACKBONE	-2.0 To +8.0	

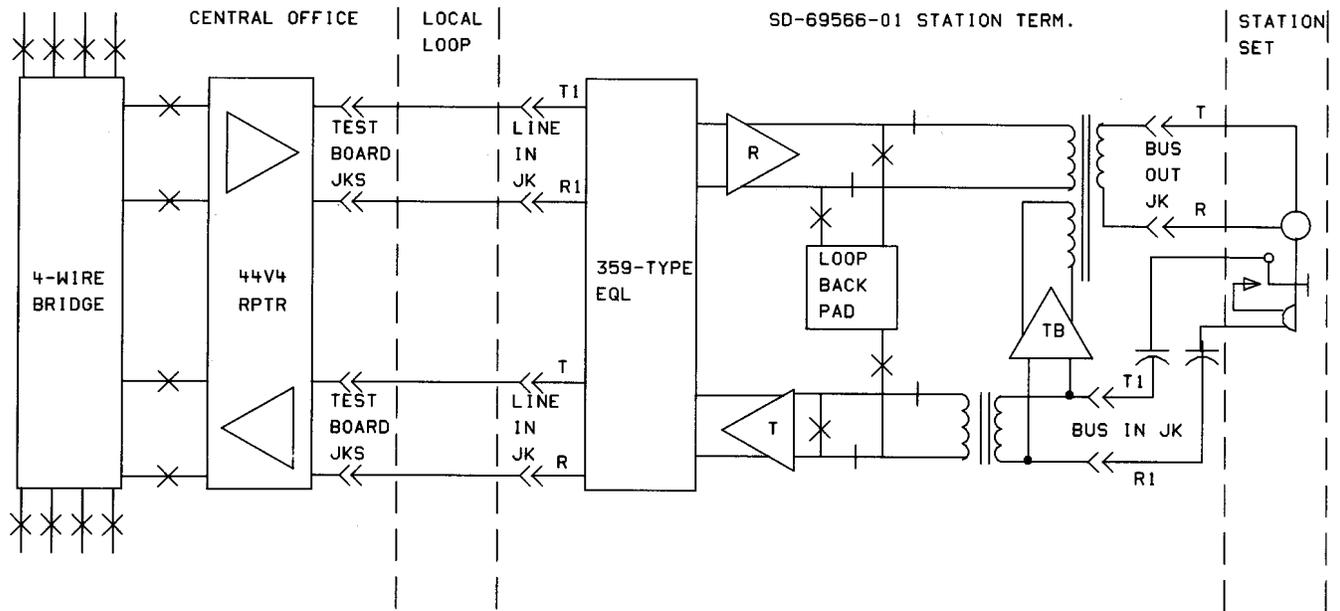


Fig. 3-18—Typical Multipoint Private Line and Station Arrangement Showing Test Access Points

TABLE 3-I

C-MESSAGE NOISE LIMITS FOR  
MULTIPOINT PRIVATE LINES

CIRCUIT LENGTH (MILES)	MAXIMUM NOISE (dBrc0)
0 — 50	31
51 — 100	34
101 — 400	37
401 — 1000	41
1001 — 1500	43
1501 — 2500	45
2501 — 4000	47
4001 — 8000	50
8001 — 16000	53
Satellite Channel	44‡

‡ Add this figure to land line requirement on a random power basis to obtain the overall circuit requirement.

TABLE 3-J

FREQUENCY RESPONSE OBJECTIVES FOR VOICE  
GRADE SWITCHED SPECIAL SERVICE CIRCUITS

CIRCUIT	ALLOWABLE DEVIATION FROM 1000 HZ	
	MEASURED AT 400 HZ	MEASURED AT 2800 HZ
LINES	-1.0 to +5.0 dB	-1.0 to +7.5 dB
TRUNKS*	-1.0 to +3.0 dB	-1.0 to +4.5 dB

*Note:* Frequency response is expressed in dB loss relative to 1000 Hz. Therefore, frequencies with losses higher than the 1000-Hz loss are + deviations and frequencies with losses lower than the 1000-Hz loss are - deviations.

\* Except PBX Tie Trunks. Refer to Table for Frequency Response Objectives for Tie Trunks.

TABLE 3-K

C-MESSAGE NOISE LIMITS FOR VOICEGRADE SWITCHED SPECIAL SERVICES CIRCUITS

CIRCUIT ORDER REQUIREMENT AND MAINTENANCE LIMIT	IMMEDIATE ACTION LIMIT
---	---------------------------

CIRCUITS DERIVED FROM LOOP PLANT FACILITIES		
LINES	Measured at Customer Station	Measured at CO
WATS, Off-Premises Extension, Secretarial Service, PBX On- and Off-Premises	<p style="text-align: center;">dBrc</p>	<p style="text-align: center;">dBrc</p>
TRUNKS	Measured at PBX	Measured at CO
PBX-CO, WATS, ACD, LD	<p style="text-align: center;">dBrc</p>	<p style="text-align: center;">dBrc</p>
CIRCUITS WITH ONE OR MORE LINKS OF TRUNK PLANT FACILITIES (VOICE FREQUENCY OR CARRIER)		
ROUTE MILEAGE	NONCOMPANDORED	COMPANDORED
0 - 15	<p style="text-align: center;">dBrc</p>	<p style="text-align: center;">dBrc</p>
16 - 50	<p style="text-align: center;">dBrc</p>	<p style="text-align: center;">dBrc</p>
51 - 100	<p style="text-align: center;">dBrc</p>	<p style="text-align: center;">dBrc</p>
101 - 200	<p style="text-align: center;">dBrc</p>	<p style="text-align: center;">dBrc</p>
201 - 400	<p style="text-align: center;">dBrc</p>	<p style="text-align: center;">dBrc</p>
401 - 1000	<p style="text-align: center;">dBrc</p>	<p style="text-align: center;">dBrc</p>
1001 - 1500	<p style="text-align: center;">dBrc</p>	<p style="text-align: center;">dBrc</p>
1501 - 2500	<p style="text-align: center;">dBrc</p>	<p style="text-align: center;">dBrc</p>
2501 - 4000	<p style="text-align: center;">dBrc</p>	<p style="text-align: center;">dBrc</p>

Note 1: Limits shown in dBrc (C-message weighting) at point of measurement. No corrections required.

Note 2: When the circuit being measured involves two or more links of mixed noncompandored and compandored facilities, the column headed NONCOMPANDORED is used for the noise objective unless the link over the compandored facility is the dominant noise contributor.

Note 3: For the purposes of these tests, T carrier is considered to be noncompandored.

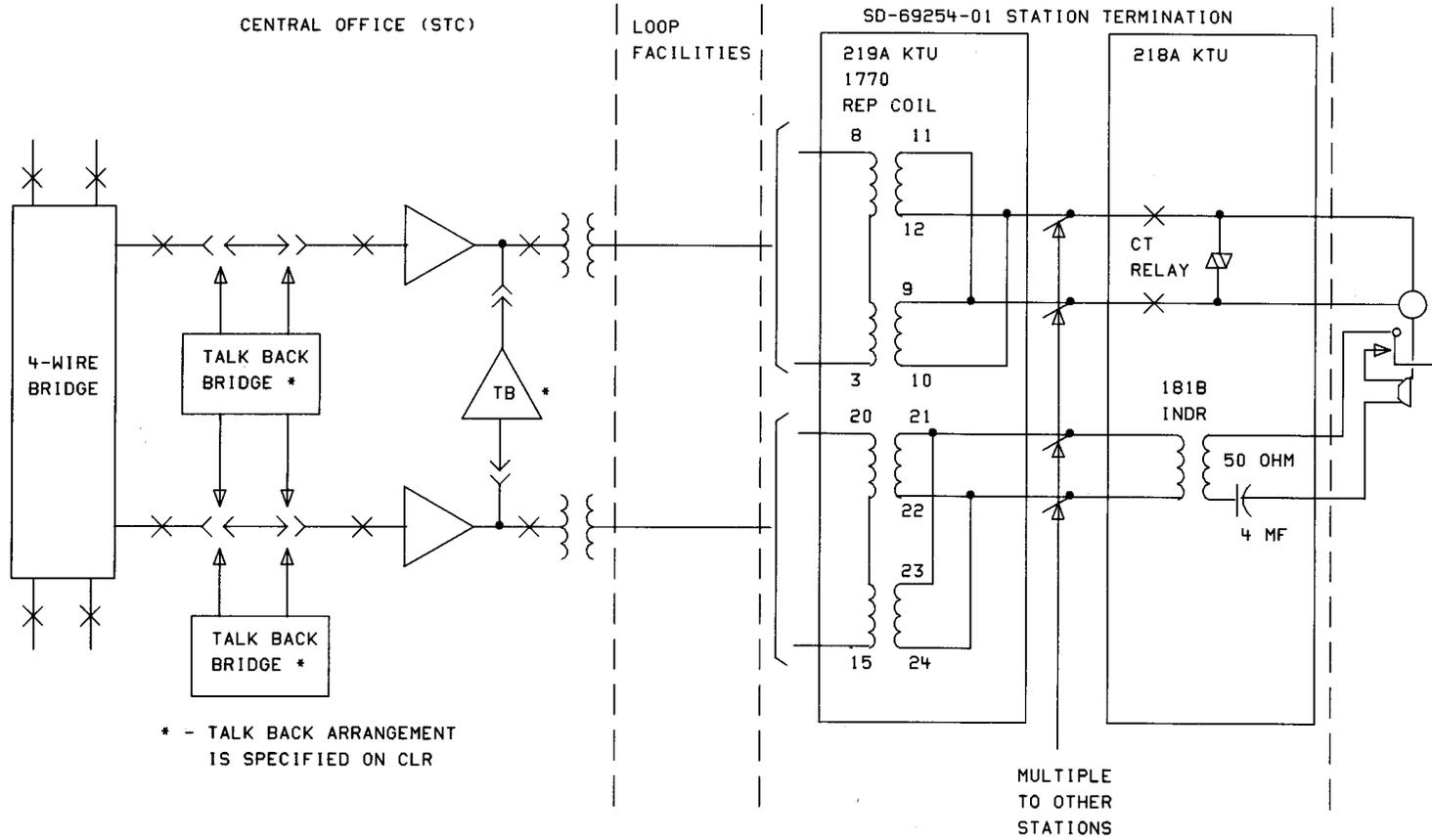
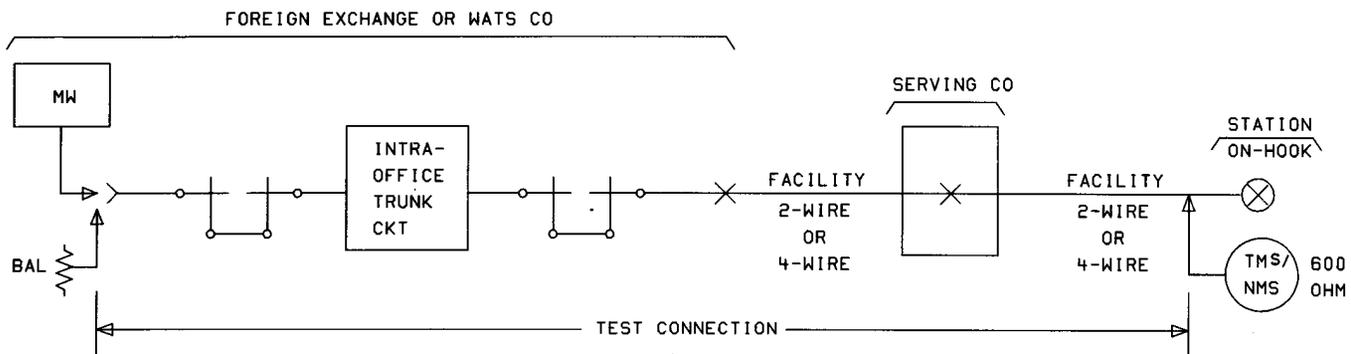


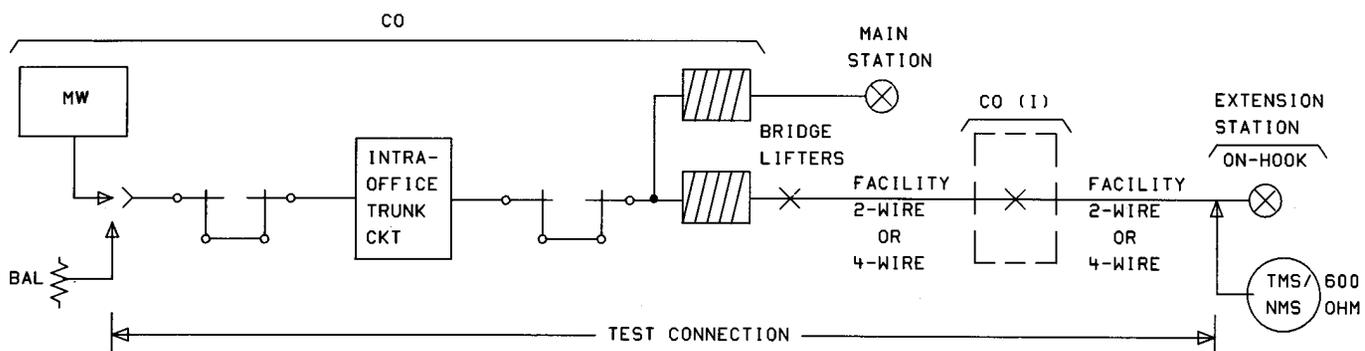
Fig. 3-19—Typical Multipoint Private Line CO and Station Arrangement Showing Test Access Point



NOTE:  
NOISE MEASUREMENT MAY ALSO BE  
MADE TOWARD STATION

SS

Fig. 3-21—Access for OFF Premises Extension Line



CO(1) - DENOTES INTERMEDIATE CO

NOTE:  
NOISE MEASUREMENT MAY ALSO BE MADE  
TOWARD STATION

Fig. 3-20—Access for Foreign Exchange or WATS Line

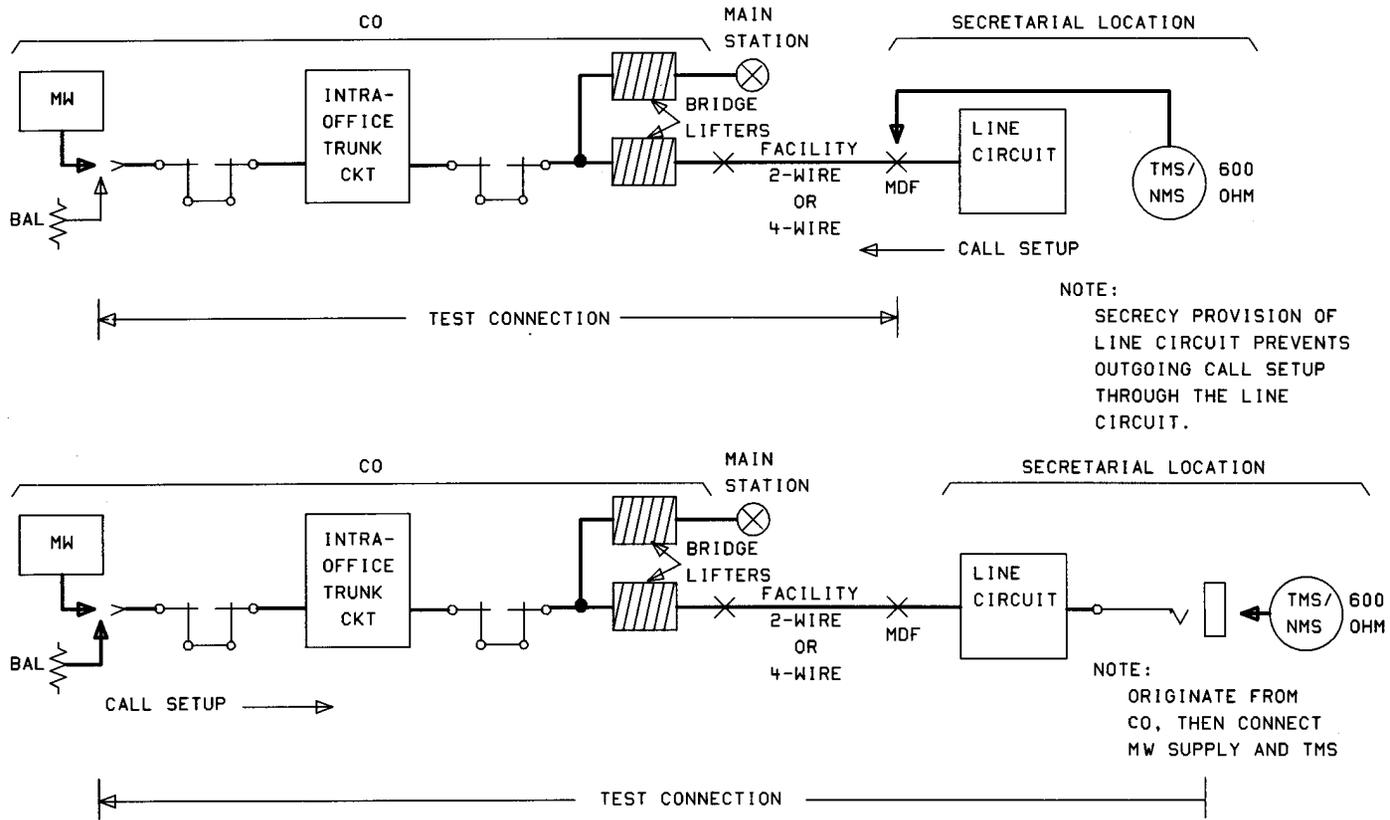
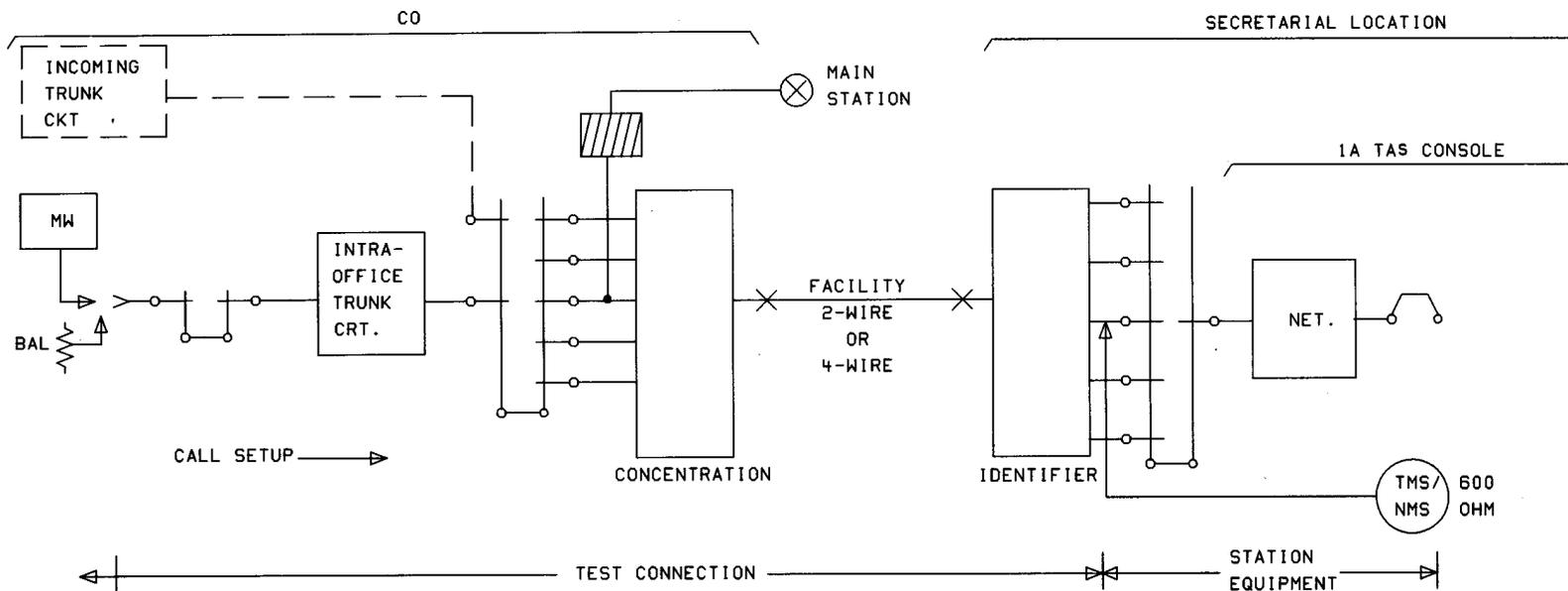
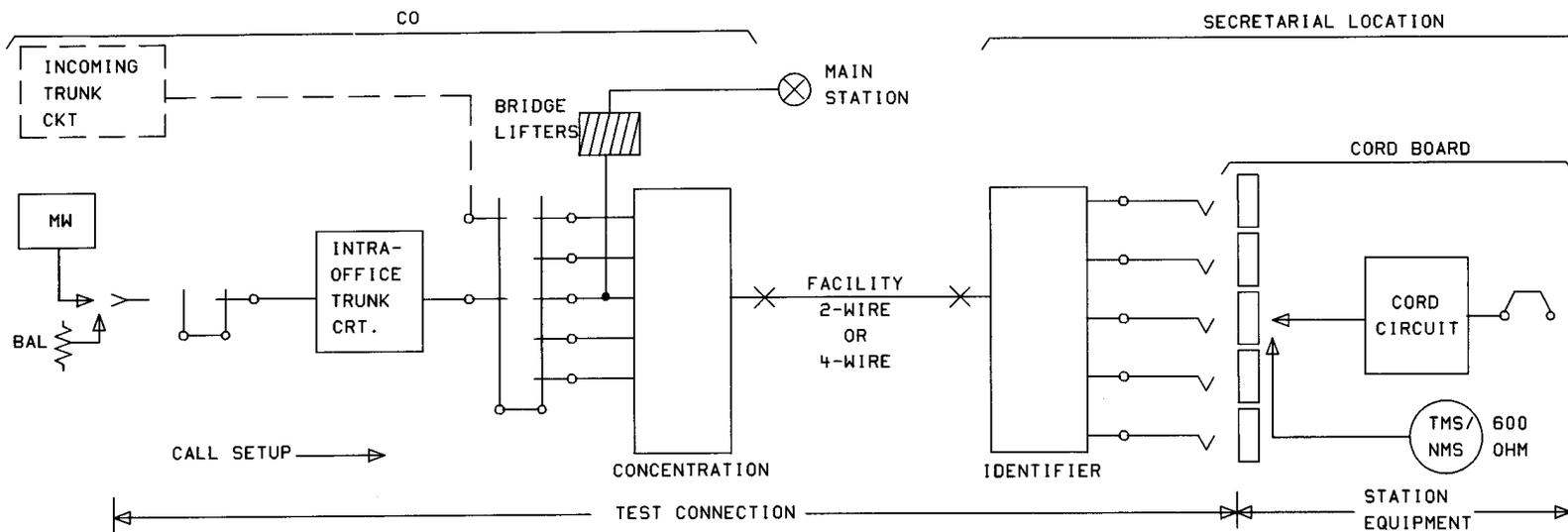


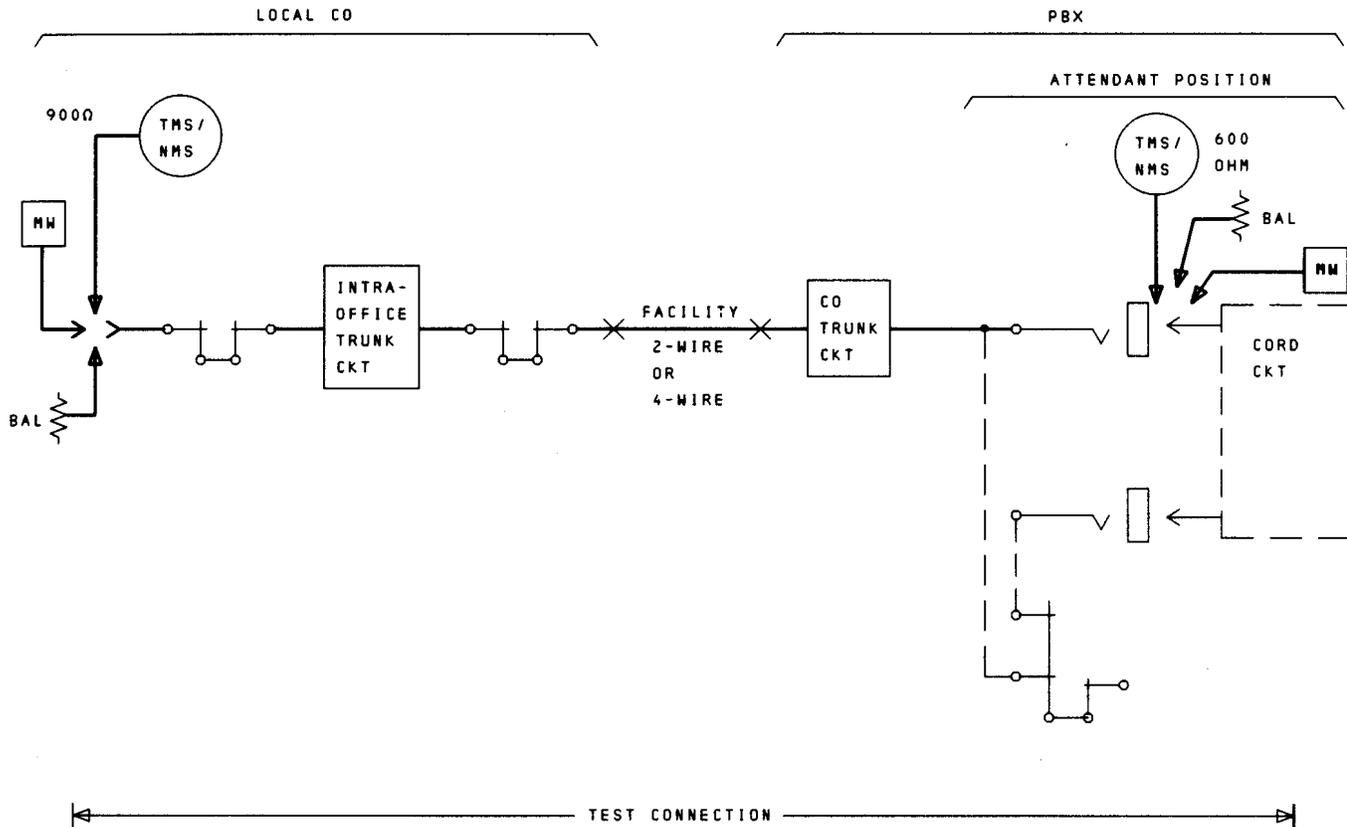
Fig. 3-22—Access for Direct-Loop Secretarial Service



NOTE:

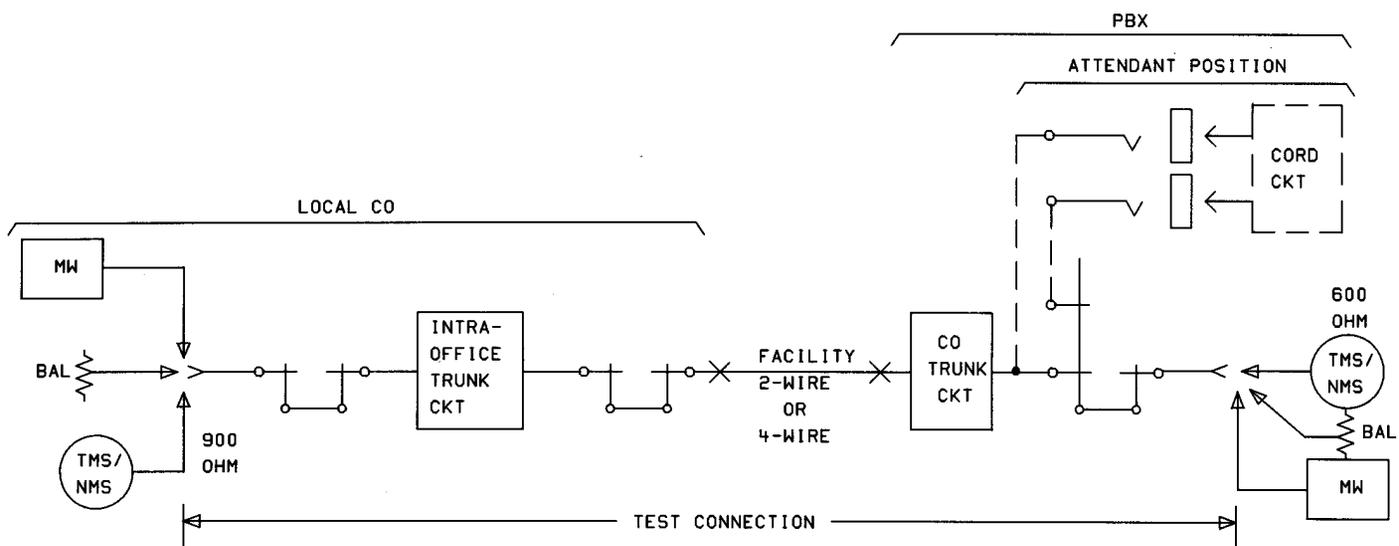
TWO-MAN EFFORT REQUIRED SINCE TEST CALL CANNOT ORIGINATE AT SECRETARIAL LOCATION. ORIGINATE CALL FROM CO, THEN CONNECT MW. SUPPLY AND TMS.

Fig. 3-23—Access for Concentrator—Identifier Secretarial Service



NOTE:  
NOISE MEASUREMENT CAN ALSO BE MADE  
TOWARD PBX

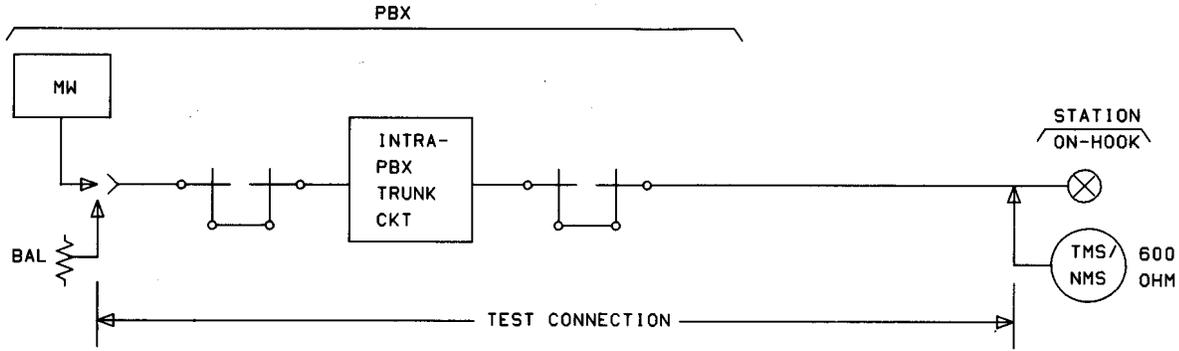
Fig. 3-24—Access for PBX-CO Trunks (Manually Accessible)



NOTES

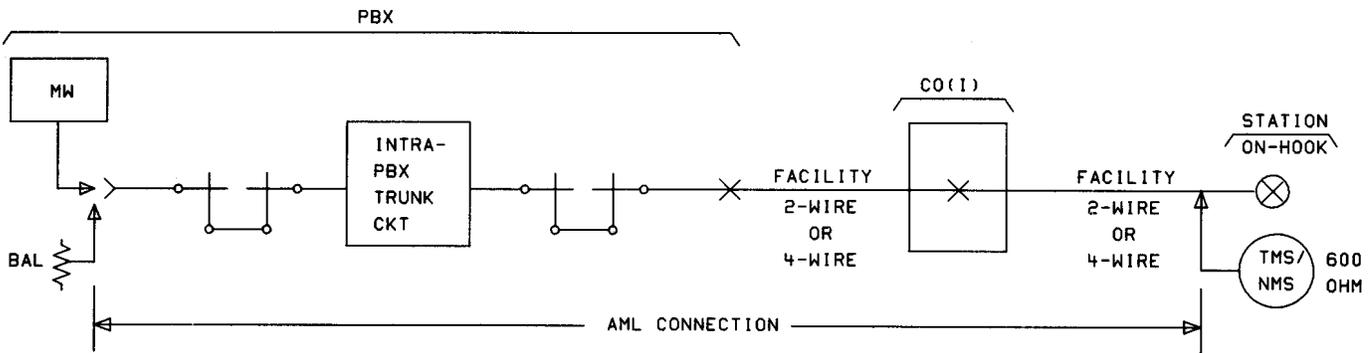
1. TEST CALL MAY BE SET UP IN EITHER DIRECTION
2. NOISE MEASUREMENT CAN BE MADE IN EITHER DIRECTION

Fig. 3-25—Access for PBX-CO Trunks (Dial Accessible)



NOTE:  
NOISE MEASUREMENT MAY ALSO BE  
MADE TOWARD STATION

Fig. 3-26—Access for PBX ON-Premises Station Line



CO(1) - DENOTES INTERMEDIATE CO

NOTE:  
NOISE MEASUREMENT MAY ALSO BE  
MADE TOWARD STATION

Fig. 3-27—Access for PBX-OFF-Premises Station Line

4. TEST EQUIPMENT

GENERAL

4.01 This part contains information concerning the test equipment commonly used to test special services. The information is divided into four types for each piece of test equipment:

- Brief Description

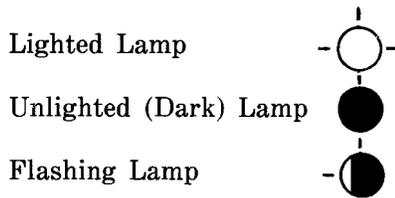
- Line drawing of faceplate with functions of switches, controls, and jacks
- Calibration procedures (where required)
- Operation for typical common tests.

4.02 The sequence in which the test equipment appears is determined by the general function as shown in Table 4-A. Table 4-A also includes a paragraph reference for each test set covered in this part of the section.

TABLE 4-A

EQUIPMENT	GENERAL FUNCTION	PARAGRAPH NUMBER	FIGURE NUMBER
Signaling Test Equipment			
1A Signaling Test Set	Signaling Test Equipment	4.08	3
2B Signaling Test Set		4.15	4
2AH Signaling Test Set		4.32	5 & 6
4A Signaling Test Set		4.37	7, 8 & 9
26B Signaling Test Set		4.68	10
Transmission Test Equipment			
3A, B, C, CR Noise Measuring Set (NMS)	Level and Noise Measuring Sets	4.80	11 & 12
21A Transmission Measuring Set (TMS)		4.104	13
23A, D TMS		4.108	14
TTS 4ANH and 4AN TMS		4.113	15
15B TMS		4.117	16
35B TMS		4.123	17
54A TMS		4.128	18
1110, 1103, 1105 TMS		4.133	19 & 20
3550B TMS		4.150	21
KS-19260 Oscillator (OSC)	Oscillators	4.154	22
KS-19353 OSC		4.158	23 & 24
2D, E Singing Point Test Set	Return Loss Measuring Sets	4.166	25 & 26
54C RLMS		4.175	27
KS-20501 RLMS		4.179	28
9041, 9031 RLMS		4.183	29
4A Frequency Analyzer	Frequency Analyzers	4.188	30
T132B Spectrum Analyzer		4.195	31
KS-14510 VOM	Miscellaneous	4.202	32
54B Test Stand		4.208	33
MFT Test Extender		4.209	34

4.03 When lamp indications are shown pictorially in this section they will be shown as follows:



4.04 Additional information such as options or alternate test arrangement is covered, when required, in notes or at the end of each section on that test set.

4.05 Common features of various models of a particular test set, such as the 3A, 3B, 3C, and 3CR Noise Measuring Set, are covered by the description of one model. Features unique to individual models are covered separately.

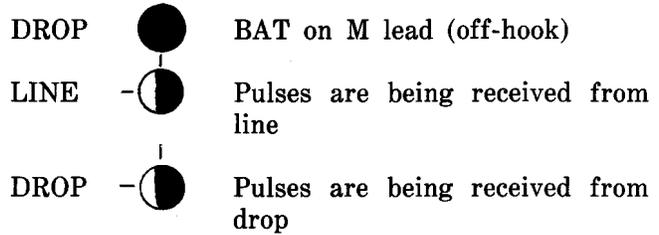
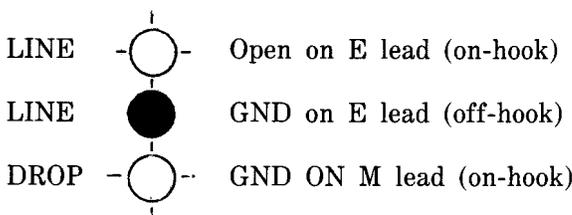
4.06 The application of dc voltage to the input of certain test equipment may damage the equipment and affect the accuracy of measurements. To prevent accidental exposure of the test equipment to dc voltage, a voltage measurement with a KS-14510 voltmeter (or equivalent) should first be made across the line pair. If 1 Vdc or greater is present, an isolation arrangement must be used.

4.07 Figure 4-1 shows the J94002AB (2AB) auxiliary transmission test set used to provide dc isolation. This is the recommended method, however, an alternate dc isolation arrangement can be developed locally as shown in Fig. 4-2. The loss in this arrangement at voice frequencies is negligible and no corrections are required.

**SIGNALING TEST EQUIPMENT**

**1A Signaling Test Set (Fig. 4-3)**

4.08 The 1A signaling test set covered by SD-95442-01 is a portable test set used to monitor E & M lead signaling conditions. Two lamps marked LINE and DROP which are associated with TEST LINE and TEST DROP jacks display the signaling conditions:



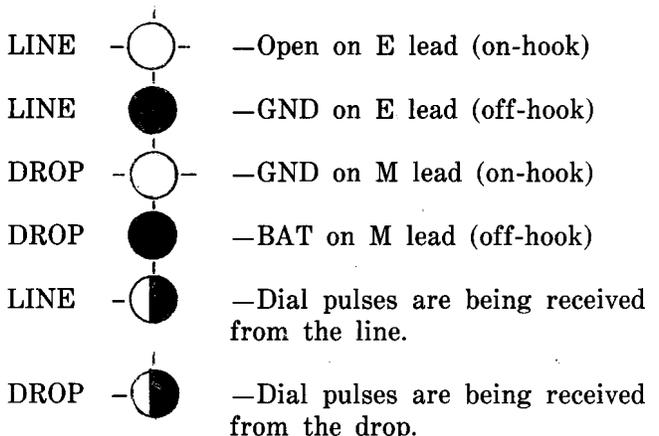
When dial pulses are being monitored, the lamps will alternate on/off following the pulses from the line or drop equipment. In the monitoring condition, the 1A does not interfere with normal signaling. The current in the M-lead can be measured by the M-LEAD meter when desired.

4.09 The test set can also be used to send off-hook or on-hook conditions toward the line or drop of a circuit. Dial pulses can be sent toward the line or drop by use of the dial and associated DIAL key. Current measurements of composite signaling circuits can be made by use on the CXL meter and appropriate jacks; however, due to limited use this application is not covered in this section. If more detailed information on the 1A is required, see Section 100-262-101.

**Operation of Test Set**

4.10 When observing or monitoring E & M lead signaling conditions, the following procedure should be performed.

- (1) All keys should be set to the normal position.
- (2) Input to test set should be via TEST LINE and TEST DROP jacks.
- (3) Observe LINE and DROP lamps, which have the following significance:



Procedure for use of 2AB:

1. Connect the line to be measured to the MEAS jack (selection of jack is determined by test cord available).
2. Connect the oscillator to the OSC jack or binding post.
3. Connect the measuring device to the TMS jack or binding post.
4. Operate the DIAL/SLV key to the normal position.
5. Operate the 20B PAD IN/OUT key to the OUT position.
6. Select mode of operation and impedance desired.
7. Allow for .5 dB loss in the 2AB set when reading the TMS and sending test tones.

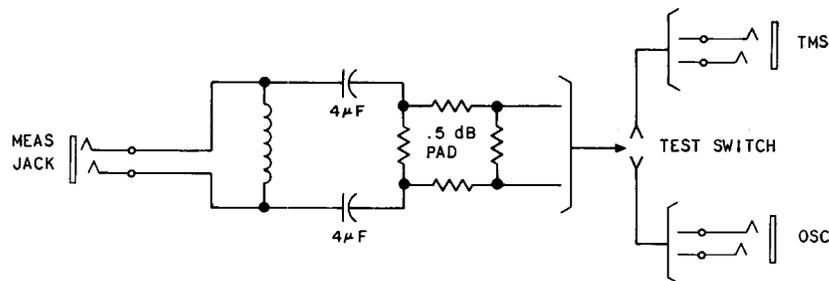


Fig. 4-1—2AB Set Used For DC Isolation

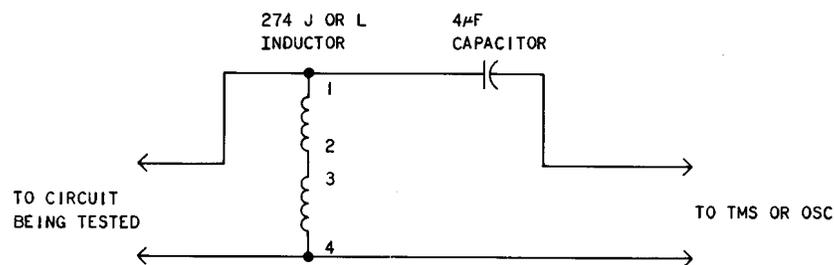


Fig. 4-2—Locally Prepared Holding Arrangement

**4.11** When transmitting an off-hook condition toward the line, the following procedure should be performed.

- (1) Patch from LINE jack on testboard (or equivalent) to TEST LINE jack on 1A.
- (2) Operate TWD L key to OFF HK.

**4.12** When transmitting an off-hook condition toward the drop, the following procedure should be performed.

- (1) Patch from DROP jack on testboard (or equivalent) to TEST DROP jack on 1A.
- (2) Operate TWD D key to OFF HK.

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**4.13** When transmitting dial pulses toward the line, the following procedure should be performed.

- (1) Input to test set is via TEST LINE jack.
- (2) Operate DIAL key to LINE.
- (3) Operate TWD L key to ON HK and then to OFF HK.
- (4) Dial the desired digits using the rotary dial on the front of the set.

**4.14** When transmitting dial pulses toward the drop, the following procedure should be performed.

- (1) Input to test set is via TEST DROP jack.
- (2) Operate DIAL key to DROP.
- (3) Operate TWD D key to ON HK and then to OFF-HK.
- (4) Dial the desired digits using the rotary dial on the front of the set.

### 2B Signaling Test Set (Fig. 4-4)

**4.15** The J64730B (2B) signaling test set covered in SD-56134-02 is a portable test set used to test signaling circuits using E & M lead signaling. The set is powered from office supplies of -48V, -24V, and +130V batteries, which are patched to jacks on the test set marked A TST (-48) and BAT B (-24 + 130). The 2B set can be modified (2B-1 or 2B-1R) to be used with a pulse repeating adapter for testing composite (CX), simplex (SX) and duplex (DX) signaling circuits, however, this application is not covered in this section.

**4.16** The 2B set can be used to monitor E & M lead conditions by means of two lamps marked L and D. The line or L lamp monitors conditions on the E lead and the drop or D lamp monitors the M lead. The lamps light with the presence of on-hook conditions and are dark under off-hook conditions. Pulsing from either the line or drop will result in the appropriate lamp flashing.

**4.17** On-hook and off-hook signals can be sent toward the line or drop by the operation of the TWD L and TWD D keys, respectively. Normally

this set furnishes an open E lead as an on hook and a ground E lead as an off-hook signal to the drop equipment. However, in some instances battery is required on the E lead to present an on hook to the drop equipment. The BG/OG key, when operated to the OG position, presents the E lead with the open/ground requirements and when operated to BG position presents the E lead with the battery/ground requirements.

**4.18** Continuous pulses or dial pulses can be sent toward the line or the drop by the proper operation of two keys, CONT PLS/DIAL PLS and PLS, and the rotary dial. With the CONT PLS key in the normal position (which is CONT PLS), the pulsing signal is continuously interrupted at a rate and for intervals dependent on the setting of the ADJ PPS and ADJ % BK controls. Procedures for these functions are covered in 4.26 through 4.29.

**4.19** The PPS meter can be used for measuring pulses being transmitted by the 2B to either the line or drop equipment. This meter can also be used for current and voltage measurements (under certain circumstances) by the proper positioning of the SCALE SEL switch, however, this application is not covered in this section.

**4.20** The 2B set can also be used to measure the percent break of continuous pulses being received from either the line or drop equipment. The MEAS % BK key selects either LINE or DROP direction from which the pulses are being received. The set cannot measure percent break of dial pulses since 10 pulses, the maximum produced by a dial, are insufficient for the percent break meter to come to a steady average reading. The % BREAK meter also indicates % break of continuous pulses being transmitted from the 2B. (For more detailed information on the 2B test set, see Section 804-911-155 and CD-56134-02. For tests and adjustments to the 2B test set, see Section 100-263-501.)

### Operation

**4.21** When observing or monitoring E & M lead signaling conditions, the following should be performed:

- (1) All keys should be set to the *normal* position.
- (2) Input to test set should be via TST 2 jacks marked L and D.

(3) Observe L and D lamps, which have the following significance:

L Lamp		Open on E lead (on-hook)
L Lamp		GND on E lead (off-hook)
D Lamp		GND on M lead (on-hook)
D Lamp		BAT on M lead (off-hook)
L Lamp		Pulses are being received from line
D Lamp		Pulses are being received from drop

**4.22** When transmitting an off-hook condition toward the line, the following procedure should be performed.

- (1) Input to test set is via TST 2 jack marked L.
- (2) TWD L key should be operated to ON HK and then to OFF HK.
- (3) BG/OG set to appropriate setting for circuit under test (see 4.17).

**4.23** When transmitting an on-hook condition toward the line, the following procedure should be performed.

- (1) Input to test set is via TST 2 jack marked L.
- (2) Operate TWD L key to ON HK.
- (3) Set BG/OG key to appropriate setting for circuit (see 4.17).

**4.24** When transmitting an off-hook condition toward the drop, the following procedure should be performed.

- (1) Input to test set is via TST 2 jack marked D.
- (2) Operate TWD D key to ON HK and then to OFF HK.
- (3) Set BG/OG key to appropriate setting for circuit under test (see 4.17).

**4.25** When transmitting an on-hook condition toward the line, the following procedure should be performed.

- (1) Input to test set is via TST 2 jack marked D.
- (2) Operate TWD D key to ON HK.
- (3) Set BG/OG key to appropriate setting for circuit under test (see 4.17).

**4.26** When transmitting continuous pulses toward the line, the following procedure should be performed.

- (1) Input to test set is via TST 2 jack marked L.
- (2) Operate PLS key to LINE.
- (3) Operate CONT PLS/DIAL PLS key to CONT PLS position (normal).
- (4) Operate SCALE SEL switch to PPS position.
- (5) Adjust pulses per second to desired output by ADJ PPS control.
- (6) Percent break is adjusted to desired output by using ADJ % BK control and ADJ % BK switch. (The S and M positions are used for short or medium pulse durations and the L position for obtaining longer pulse durations.) The % BREAK meter should be read on the black scale.

**4.27** When transmitting continuous pulses toward the drop, the following procedure should be performed.

- (1) Input to test set is via TST 2 jack marked D.
- (2) Operate PLS key to DROP.
- (3) Operate CONT PLS/DIAL PLS key to CONT PLS position (normal).
- (4) Operate SCALE SEL switch to PPS position.
- (5) Adjust pulses per second to desired output by ADJ PPS control.

- 1 — RELTST jack used to connect test set to test relays
- 2 — CXL METER jack used to connect CXL meter to CXL jacks for measurements.
- 3 — 48V jack used to connect test set to 48 volt source.
- 4 — TEST E and TEST M jacks are used to connect test set to E and M jacks of single frequency signaling units for current measurements.
- 5 — TEST LINE and TEST DROP jacks are used to connect line or drop circuit to test set for monitoring E and M signaling conditions, sending pulses toward line or drop and sending on hook/off hook conditions toward line or drop.
- 6 — MB jack is used to connect 1A to the MB jack of a composite signaling unit.
- 7 — PLS jack is used to connect 1A to the PLS jack of a composite signaling unit.
- 8 — TST jack is used to connect 1A to the TST jack of a composite signaling unit.
- 9 — Zero adjust of CXL meter.
- 10 — CXL meter used to measure current in composite signaling circuits, however this application is not covered in this section.
- 11 — The dial is used in connection with the DIAL key to transmit dial pulses.
- 12 — TWD D key selects either On Hook (ON HK) or Off Hook (OFF HK) condition to be sent toward the drop.
- 13 — TWD L key selects either On-Hook (ON HK) or Off Hook (OFF HK) condition to be sent toward the line.
- 14 — DIAL key used to select LINE or DROP direction for transmitting dial pulses.
- 15 — LINE lamp is used to monitor open or ground condition of E lead from line equipment.  
LINE lighted — On-hook (open on E lead) state on line equipment E lead.  
LINE dark — Off-hook (ground on E lead) state on line equipment E lead.
- 16 — BG/BG key selects open and ground or battery and ground conditions. The key should be set to the OG position when monitoring E and M signaling leads. The BG position is used on circuits with F and M signaling, which is not covered in this section.
- 17 — DROP lamp is used to monitor battery or ground condition of M lead from drop equipment.  
DROP lighted — On-hook (GRD on M lead) state on drop equipment M lead.  
DROP dark — Off-hook (BAT on M lead) state on drop equipment M lead.
- 18 — Zero adjust of M LEAD meter.
- 19 — M LEAD Meter is used to measure current of M lead, however this application is not covered in this section.

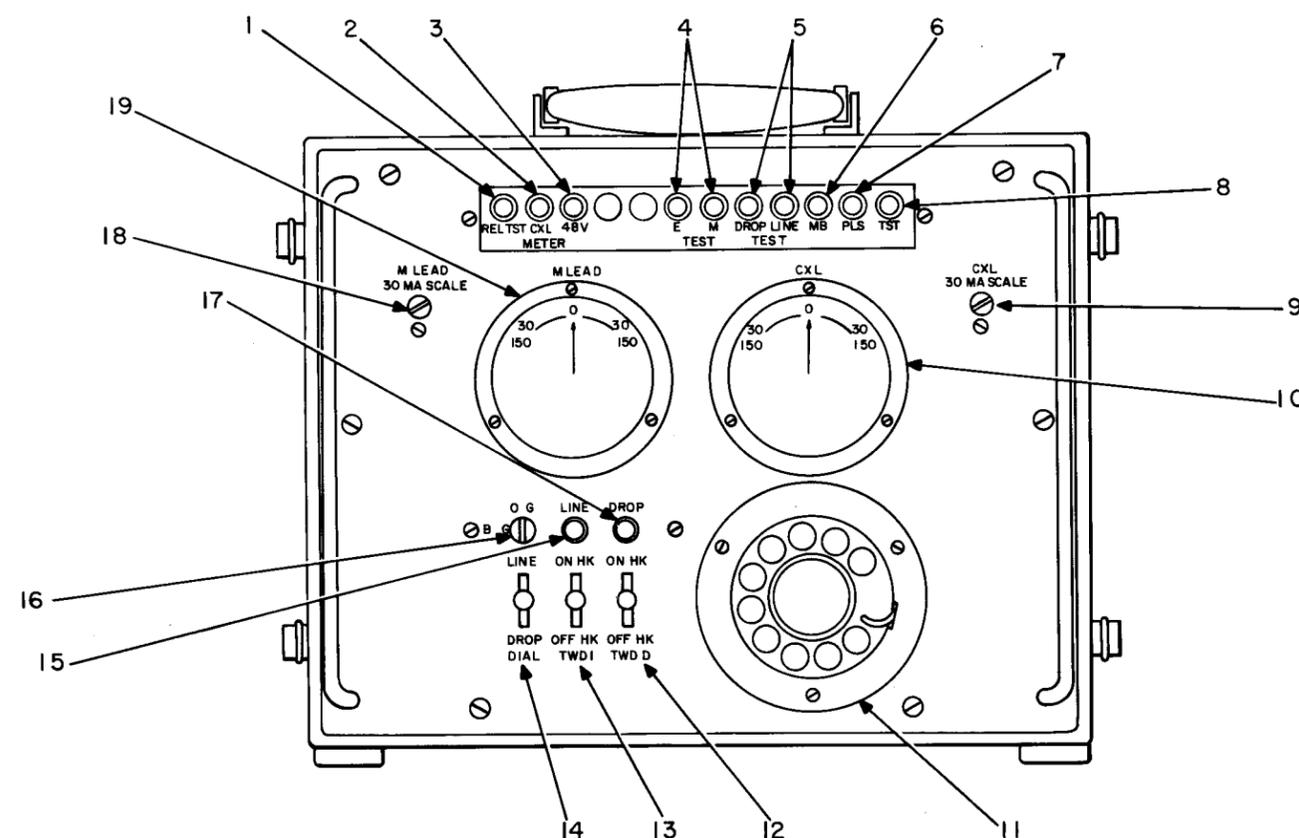


Fig. 4-3—1A Signaling Test Set

(6) Percent break is adjusted to desired output by using ADJ % BK control and ADJ % BK switch. (The S or M positions are used for short or medium pulse durations and the L position for obtaining longer pulse durations.) The % BREAK meter should be read on the red scale.

**4.28** When transmitting dial pulses toward the line, the following procedure should be performed.

- (1) Input to test set is via TST 2 jack marked L.
- (2) Operate PLS key to LINE.
- (3) Operate CONT PLS/DIAL PLS key to DIAL PLS position.
- (4) Operate SCALE SEL switch to PPS position.
- (5) Desired digits transmitted by operation of rotary dial.

**4.29** When transmitting dial pulses toward the drop, the following procedure should be performed.

- (1) Input to test set is via TST 2 jack marked D.
- (2) Operate PLS key to DROP.
- (3) Operate CONT PLS/DIAL PLS key to DIAL PLS position.
- (4) Operate SCALE SEL switch to PPS position.
- (5) Desired digits transmitted by operation of rotary dial.

**4.30** When receiving or measuring continuous pulses from the line, the following procedure should be performed.

- (1) Input to test set is via TST 2 jack marked L.
- (2) Operate MEAS % BK key to LINE.
- (3) Set SCALE SEL switch to PPS position.
- (4) % BREAK meter is read on red (inner) scale. (See Note.)

**Note:** Before pulses are received, the meter should be observed to see if the pointer is indicating zero on the red (inner) scale.

**4.31** When receiving continuous pulses from the drop, the following procedure should be performed.

- (1) Input to test set is via TST 2 jack marked D.
- (2) MEAS % BK key is operated to DROP.
- (3) SCALE SEL switch is set to PPS position.
- (4) % BREAK meter is read on black (outer) scale. (See Note.)

**Note:** Before pulses are received, the meter should be observed to see if the pointer is indicating zero on the black (outer) scale.

#### **2AH Signaling Test Set (Fig. 4-5 and 4-6)**

**4.32** The J68602AH (2AH) signaling test set, covered in SD-64125-01, is a portable ac voltmeter designed for measuring voltage of 20-Hz and 135-Hz signaling circuits. The principal application of this test set is to measure signaling energy (ringing voltage) received by the signaling circuit to assure sufficient voltage to cause the signaling circuit to operate properly.

**4.33** An example of a signaling circuit that requires an ac signal from the station equipment and sends an ac signal to the drop equipment is a 10D ringer. The 20-Hz ringing from the drop must be at least 15 Vac for the 10D to operate properly and place -24V battery on the SG lead. In the direction toward the drop the 10D ringer output must be 105 Vac at 20 Hz.

**4.34** When patching the 2AH set to the circuit under test, the set is patched in series with the circuit (see Fig. 4-6). However, the internal wiring arrangement of the meter bridges the circuit and, therefore, the impedance of the circuit under test is not altered to any appreciable degree.

**4.35** The meter range key should be set to 200 (normal position) until the voltage is first measured, thus preventing damage to the meter. Once it has been established that a lower scale

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can be used safely, the key should be set for that scale to obtain the most accurate reading.

**4.36** Due to the simplicity of the 2AH, no detailed procedure for operation is given here. However, Fig. 4-5 and 4-6 show control functions and typical test arrangements, respectively. (For more detailed information, see Section 100-265-101.)

### **4A Signaling Test Set (Fig. 4-7, 4-8, and 4-9)**

**4.37** The J94743 (4A) signaling test set covered in SD-1C244-01 is designed to test signaling functions on telephone circuits. The 4A is available in either a bay-mounted or portable unit which is powered from a 115V 60 Hz source. The set consists of a pulse generator, a measurement and display circuit, power supply in the main module (Fig. 4-7), and four optional plug-in interface units. The four interface units give the 4A the capability of testing loop, E & M, SF, and DX signaling systems (Fig. 4-8). The interface units are interchangeable and therefore can fit in any of the available positions.

### **Operation of Main Module**

**4.38** The pulse generating circuit is capable of an output of four types of pulsing: (1) a continuous pulse train, (2) a discrete train of from one to ten pulses, (3) a repeated discrete train of from one to ten pulses with an interdigital time of either 185 or 680 ms, or (4) steady state signals corresponding to on-hook or off-hook conditions. The pulse generating circuit is connected to the desired interface circuit by means of the SEND switch. The GEN SUPV key allows the setting of the PULSE WIDTH switch to correspond to either a make or break interval. The switches PULSE PERIOD and PULSE WIDTH control the pulses per second (PPS) and percent break (% BK), respectively, of the output of the pulse generator. Figure 4-9 should be used to determine the switch setting from the desired PPS and % BK.

**4.39** A continuous train of pulses is obtained by the following procedure.

- (1) Operate PULSE MODE switch to CONT.
- (2) Operate the OPERATE/CLEAR locking push-button (lamp lighted).

(3) If a certain % BK and PPS are desired, the setting of PULSE PERIOD and PULSE WIDTH switches should be determined from Fig. 4-9.

**Note:** Releasing the OPERATE/CLEAR push-button (lamp extinguished) will cause the pulses to stop.

**4.40** A discrete train of pulses is obtained by the following procedure.

- (1) Operate PULSE MODE switch to KEYSSET.
- (2) Operate the OPERATE/CLEAR push-button (lamp lighted).
- (3) Keying desired digit causes outpulsing.

The WAIT TO DIAL lamp will light during the pulsing of the keyed number and remains lighted for 680 ms after the last pulse. Once the WAIT TO DIAL lamp has extinguished, another pulse train can be sent by again keying the desired digit.

**4.41** For the repeated discrete trains of pulses, the \* or # key is depressed first; selecting an interdigital time of 185 or 680 ms, respectively, then the above procedure is used. Pulsing of the repeated train continues until the OPERATE/CLEAR push button is released (lamp extinguished).

**4.42** A steady-state on-hook signal may be obtained by the following procedure.

- (1) OPERATE/CLEAR push button released (lamp extinguished).
  - (2) GEN SUPV key to ON HK.
- or for 400-ms augmentation with SF interface unit.

- (1) PULSE WIDTH switch greater than PULSE PERIOD switch setting.
- (2) GEN SUPV to OFF HK.
- (3) PULSE MODE to CONT.
- (4) Operate the OPERATE/CLEAR pushbutton (lamp lighted).

- 1 — PPS meter used to measure pulses per second that are being sent by the 2B.
- 2 — BG/OG key is used to select proper condition of E lead representing on hook/off hook (see 4.16).
- 3 — % BREAK meter used to measured percent break of continuous pulses (sent and received):  
From Line — read % break on red (inner) scale  
From drop — read % break on black (outer) scale
- 4 — Rotary dial is used to dial pulse the desired digits between 1 and 10.
- 5 — ADJ % BK switch is used to expand the range of ADJ % BK control (see 6 below). Positions S and M are used for short and medium duration pulses and position L is used for longer duration pulses.
- 6 — ADJ % BK control is used to adjust the duration of break for continuous pulse outputs.
- 7 — MEAS % BK key selects LINE or DROP directions from which continuous pulses are received.
- 8 — TWD D key selects condition (ON HK or OFF HK) which is sent toward the drop.
- 9 — TWD L key selects condition (ON HK or OFF HK) which is sent toward the line.
- 10 — PLS key selects direction (LINE or DROP) to which pulses are sent.
- 11 — CONT PLS/DIAL PLS key selects either continuous pulses (CONT PLS) or dial pulses (DIAL PLS) to be sent toward direction selected by PLS key (10) above.
- 12 — ADJ PPS control is used to adjust the number of pulses transmitted per second.
- 13 — SCALE SEL switch selects the function that the PPS meter will display.
- 14 — TST A and BAT B jacks are used as input for power source.
- 15 — TST 2 jacks are used for input of E and M leads:  
L corresponds to E lead  
D corresponds to M lead

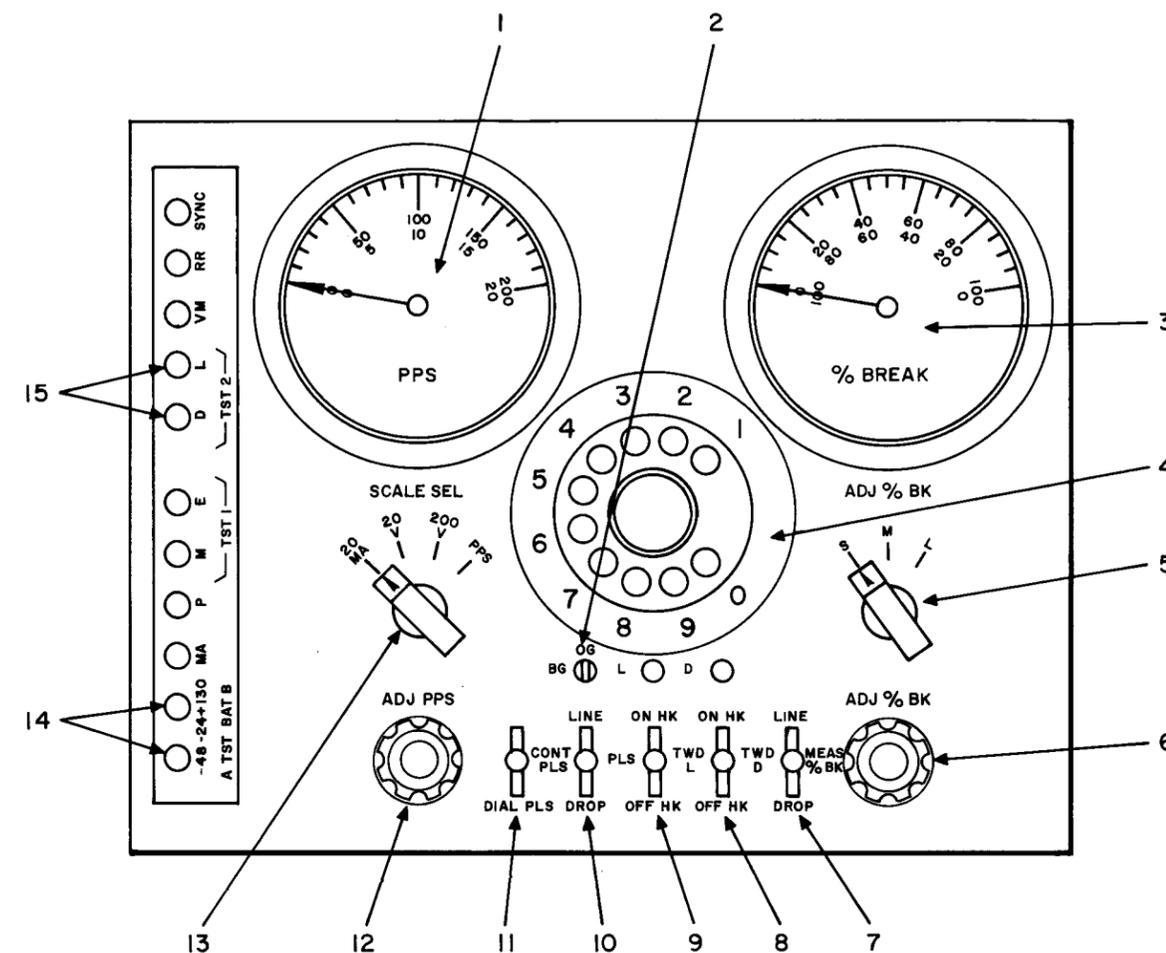


Fig. 4-4—2B Signaling Test Set

- 1 — T and R jacks are 2 conductor type used for connection to Tip and Ring of circuit (see Fig. 4-5).
- 2 — T and R jacks are 2 conductor types used for connection to Tip and Ring of circuit (see Fig. 4-5).
- 3 — L and D jacks are 2-conductor types use for connection to Line and Drop Facilities (see Fig. 4-5).
- 4 — SH/40 key when operated to SH, shunts the meters  $500\Omega$  and when operated to 40 selects the 40 scale on the VOLTS A.C. meter.
- 5 — LD key when operated connects tip and ring of D jack to tip and ring of L jack.
- 6 — Lever type key selects designated ranges of the VOLTS A.C. meter.
- 7 — VOLTS A.C. meter displays voltage measured on four scale ranges of 4, 20, 40, and 200 volts.

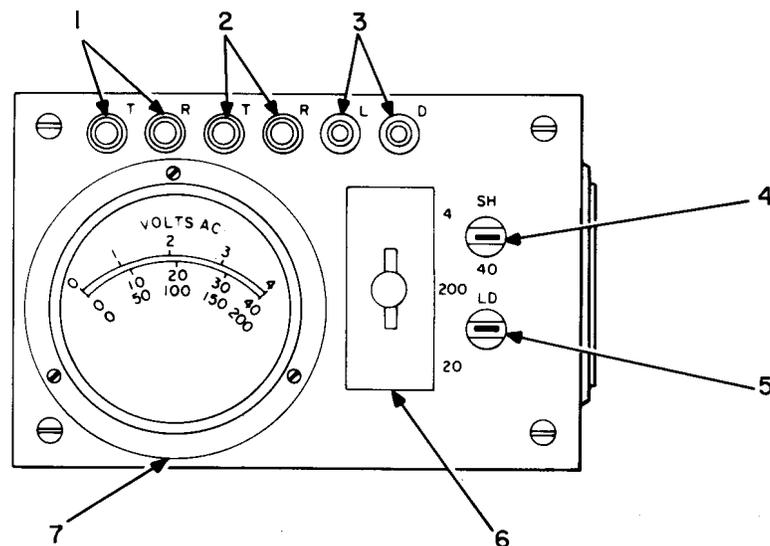


Fig. 4-5—2AH Test Set

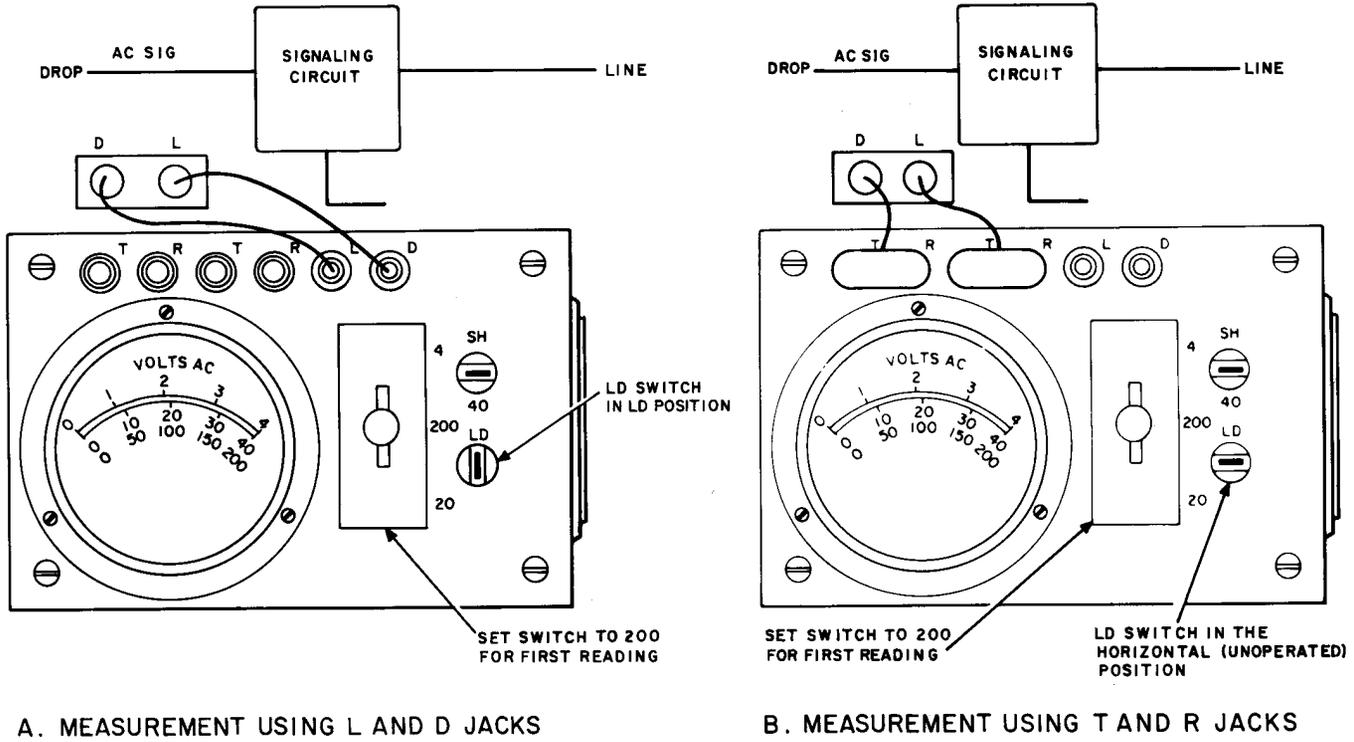


Fig. 4-6—Typical Test Arrangements

**4.43** The measurement and display circuit is connected to the interface unit by means of the RECEIVE switch. The internal circuitry allows the test set to measure (a) the number of received dial pulses, (b) average percent break, (c) average pulsing speed in pulses per second, and (d) millisecond intervals (break, make or period). The resulting measurement is displayed on a set of three NIXIE tubes. The OVER-RANGE lamp, when lit, indicates that the capacity of the measuring circuit has been exceeded.

**4.44** The START-STOP key either starts or stops the operation of the measuring circuit. The START-STOP key operated (lamp lighted) prepares the circuit for the next measurement (clear NIXIE tube display). When the key is released (lamp extinguished), a manual stop mode is employed and the last display remains on the NIXIE tubes. Manual stop should only be used when measuring number of pulses or millisecond intervals since erroneous readings may occur on speed or percent break measurements. The automatic stop mode is activated when the SELECTOR switch is set to a specific number of pulses. Measurements of speed, percent break, and millisecond interval can be made in the automatic stop mode. Once the number of pulses specified by the SELECTOR switch has been received, the measurement is automatically stopped and the measured value is displayed. If an OVER RANGE lamp occurs during either the manual or automatic stop mode, the START-STOP key must be released to extinguish the lamp and then reoperated to restart the measurement.

**4.45** The FUNCTION switch selects various modes of measurement as follows.

- (1) NO. OF PULSES MODE allows the test set to count the number of incoming break pulses under control of the START-STOP key up to a maximum of 999 pulses.
- (2) SPEED mode allows the test set to display the speed in pulses per second over a time span of nine periods. The display is updated after every nine pulses.

**Note:** The only function of the MS RANG switch when measuring percent break or speed is to provide split pulse cancellation when set to 999. The SELECTOR switch should be set to NORM.

(3) % BK mode allows the test set to measure percent break by averaging the break interval for nine pulses of a ten-pulse train. The START-STOP key must be operated.

(4) MSEC interval mode allows the test set to measure three intervals, as selected by the FUNCTION switch: break (BK), make (MK) and period (PER). The display on the NIXIE tubes is in milliseconds and the decimal placement is controlled by the MS RANG switch (99.9 or 999). Automatic stop control in this mode is used when the SELECTOR switch is set to the number of pulses or periods to be measured. The three types of measurements that can be made in the MSEC code, under the control of the READ switch, are minimum (MIN), maximum (MAX), and update (UPDATE). In the MIN position, the display will change only with the shortest interval of the pulse train; in the MAX position, the display changes only with a longer interval; and in the UPDATE position, the display changes with each new interval.

Connection of the headset for talking capabilities to a 2- or 4-wire circuit is accomplished by use of the jacks marked TALKING CKT. The headset is connected to the HEAD SET jacks and the 2-wire circuit to the TRMT (2-W) jack or, the 4-wire circuit to both the REC and TRMT jacks.

#### Operation of E and M Interface Unit

**4.46** The E & M interface unit has the capability of monitoring E & M lead conditions on both the line and drop equipment. The E & M interface unit also gives the 4A the capability of sending and receiving pulses and measuring these pulses on E & M lead signaling circuits. In the following paragraphs, the operations to be performed refers to controls of the E & M interface unit unless otherwise stated. All keys, switches, etc, are in the normal position except as specified in the procedures.

**4.47** To monitor E & M lead signaling conditions using the 4A, the following procedure should be performed.

- (1) Operate TWD LINE key to MON position.
- (2) Operate TWD DROP key to MON position.

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(3) Observe E & M lead conditions on LINE and DROP lamps which have the following significance.

LINE		On-hook from line
LINE		Off-hook from line
DROP		On-hook from drop
DROP		Off-hook from drop
LINE		Pulses from line
DROP		Pulses from drop

**4.48** To pulse the drop using the 4A the following procedure should be performed.

- (1) Operate PULSE/MEAS key to DROP position.
- (2) Operate TWD DROP key to OFF HK.
- (3) Operate SEND switch to E & M.
- (4) Operate PULSE MODE key on main module to KEYSET or CONT depending on type of pulses desired. In KEYSET position, desired digits are keyed from main module.

**4.49** To pulse the line using the 4A, the following procedure should be performed.

- (1) Operate PULSE/MEAS key to LINE position.
- (2) Operate TWD LINE key to OFF HK position.
- (3) Operate SEND switch to E & M position.
- (4) Operate PULSE MODE key on main module to KEYSET or CONT depending on type of pulses desired. In KEYSET position, desired digits are keyed from main module.

**4.50** To send an on-hook condition toward the drop using the 4A, the following procedure should be performed.

- (1) Operate TWD DROP key to ON HK position (open on E lead).

**4.51** To send an off-hook condition toward the drop using the 4A, the following procedure should be performed.

- (1) Operate TWD DROP key to OFF HK position.
- (2) Operate PULSE/MEAS key to DROP position.
- (3) Operate SEND key to any position other than E & M.

**4.52** To send an on-hook condition toward the line using the 4A, the following procedure should be performed.

- (1) Operate TWD LINE key to ON HK position (ground on M lead).

**4.53** To send an off-hook condition toward the line using the 4A, the following procedure should be performed.

- (1) Operate TWD LINE key to OFF HK position.
- (2) Operate PULSE/MEAS key to LINE position.
- (3) Operate SEND key to any position other than E & M (BATTERY on M lead).

**4.54** To measure pulses (percent break, pulses per second, or interval) from the drop using the 4A, the following procedure should be performed.

- (1) Operate PULSE/MEAS key to DROP position.
- (2) Operate TWD LINE key to MON position.
- (3) Operate RECEIVE switch on main module to E & M. Depending on type of measurement desired, other keys on main module may require specific operation—see 4.47.

**4.55** To measure pulses (percent break, pulses per second, or interval) from the line using the 4A, the following procedure should be performed.

- (1) Operate PULSE/MEAS key to LINE position.
- (2) Operate TWD DROP key to MON position.
- (3) Operate RECEIVE switch on main module to E & M. Depending on type of measurement desired, other keys on main module may require specific operation—see 4.47.

**Operation of SF Interface Unit**

**4.56** The SF interface units adapt the main module for testing SF signaling systems. It allows the test set to monitor (high impedance) the line or equipment, to pulse toward the line or equipment, and to measure from the line or equipment.

**4.57** To monitor the line or equipment, the following procedure should be performed.

- (1) Operate TWD LINE and TWD DROP keys to MON.
- (2) Operate PULSE/MEAS key to either LINE or EQPT position, depending on the desired direction of monitoring.
- (3) Operate NB/BB switch to NB position.
- (4) The EQPT/LINE lamp lights when receiving 2600-Hz tone and flashes when receiving pulsing.

**4.58** To send SF tone toward the line using the 4A the following procedure should be performed.

- (1) Operate PULSE/MEAS key to LINE position.
- (2) Operate TWD LINE key to ON HK position.

**Operation of Loop Interface Unit**

**4.59** The loop interface unit gives the 4A test set the capability of pulsing and measuring on loop signaling circuits. The interface unit simulates loop and leak conditions for the various types of circuits; however, the complexity of the simulation does not permit coverage in this section. (See Section 100-267-101.)

**4.60** Basically, there are two types of loop signaling circuits to be tested using the 4A.

- (1) Battery and ground are supplied from the distant end—pulses are generated by opening and closing the circuit.
- (2) Battery and ground must be supplied by the near end—pulses are generated by applying either battery or ground to the circuit depending on the configuration.

**4.61** To send pulses using the 4A, the following procedure should be performed.

- (1) Operate PULSE/DET SUPV/TALK key to PULSE.
- (2) Operate SEND key on main module to L1 position.
- (3) If a certain % BK and PPS are desired, the setting of PULSE PERIOD and PULSE WIDTH switches should be determined from Fig. 4-9.
- (4) Operate FUNCTION switch to LP position if circuit 1 (4.47) is being tested and BG position if circuit 2 (4.47) is being tested.

**4.62** To monitor or measure using the 4A the following procedure should be performed.

- (1) Operate PULSE/DET SUPV/TALK key to DET SUPV.
- (2) Operate RECEIVE switch on main module to LP position.
- (3) Operate FUNCTION switch to LP position if circuit 1 (4.47) is being tested and BG position if circuit 2 (4.47) is being tested.

**Operation of DX Interface Unit**

**4.63** The DX interface unit has the capability of monitoring and measuring, at any point along a DX loop, the on-hook, off-hook, or pulsing intervals of the circuit. The DX interface unit is capable of pulsing toward the equipment (nearer of two DX terminals) or pulsing toward the line (the farther of two DX terminals). While the DX interface unit is pulsing in one direction, on-hook or off-hook supervision can be supplied in the reverse direction.

**4.64** To monitor the DX circuit using the 4A, the following procedure should be performed.

- (1) Operate PULSE LINE/PULSE EQPT/MON MEAS key (double-ganged key) to MON MEAS.
- (2) Operate BIAS key to MON.

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(3) ON HK lamp will light if both ends are on-hook but will not light if either end is off-hook.

(4) Operate RECEIVE switch on main module to DX position.

**4.65** To measure dial pulsing using the 4A, the following procedure should be performed.

(1) Operate PULSE LINE/PULSE EQPT/MON MEAS key (double-ganged key) to MON MEAS.

(2) Operate BIAS key to ON HK position if the receiving DX end is idle and to OFF HK position if receiving DX end is in the off hook condition.

(3) Operate RECEIVE switch on main module to DX position.

**4.66** To determine the status of a circuit on a terminating basis, the following procedure should be performed.

(1) Operate FAC key to STATUS.

(2) Operate PULSE LINE/PULSE EQPT/MON MEAS key (double-ganged) key) to either PULSE LINE or PULSE EQPT depending on desired direction.

(3) Lighted ON HK lamp indicates on-hook condition while a lighted A/B lamp indicates proper orientation of A and B leads.

**4.67** To pulse the line or equipment using the 4A, the following procedure should be performed.

(1) Operate FAC key to 2W or 4W position according to the loop facility.

(2) Operate PULSE LINE/PULSE EQPT/MON MEAS key (double-ganged key) to either PULSE LINE or PULSE EQPT depending on desired direction of pulsing.

(3) Set SEND switch on main module to DX.

(4) Pulsing characteristics should be selected by controls of the main module as previously discussed.

(5) Set LINE RES keys to simulate line resistance.

### 26B Signaling Test Set (Fig. 4-10)

**4.68** The 26B signaling test set (manufactured by Northeast Electronics) is a portable test set designed to test loop and E & M lead signaling circuits. The 26B is capable of sending pulses and measuring the % break and speed (in PPS) of both transmitted and received pulses. The test set is also capable of monitoring E & M lead signaling conditions on a high impedance bridged basis. Power for the 26B can be supplied by either -48 volt office battery or a suitable external power source.

**4.69** The 26B signaling test set can be used to send and receive SF signals with the addition of a 26 BXS SF signal system test panel (Fig. 4-10). The 26 BXS is designed to mount as an accessory unit within the cover of the 26B test set. This unit is composed (electrically) of two parts. The first generates SF tones (2400 and 2600 Hz) at output levels from 0 to -36 dBm. The second part contains the amplifier and detector circuits to transform the received SF signals into DC pulsing which in turn is applied to the receive circuit of the 26B test set. (See 4.78 and 4.79 for operation.)

### Calibration

**4.70** The 26B signaling test set should be calibrated before measurements are made. However, the test set should be connected to the power source that will be used during the testing. The procedures below should be followed.

(1) With the SEND PPS switch in the PWR OFF position, check the position of the meter needle. If the indication is not 100 on the % BREAK scale, adjust the screw on the front of the meter case to bring it to this line. (After adjustment, back off the adjustment screw slightly to remove tension on the meter mechanism.)

(2) Set the SEND PPS switch to the desired PPS.

(3) Operate FUNCTION key to SEND OSC position.

(4) Operate the FUNCTION switch to CAL MTR position.

- 1 — READ switch allows three types of displays:  
 MIN — minimum interval is displayed  
 MAX — maximum interval is displayed  
 UPDATE — display is updated after each interval measured.
- 2 — START/STOP key when operated (lighted) allows measurement and display circuit to operated. When released (dark) allows for manual stop.
- 3 — OPERATE/CLEAR key causes outpulsing when operated (lighted) when released (dark) clears display.
- 4 — NIXIE Tube display.
- 5 — Next digit on keyset cannot be keyed until lamp is extinguished.
- 6 — TALKING CIRCUIT jacks are used for connection of headset and 2- or 4-wire circuit.
- 7 — PULSE PERIOD switch controls pulse period or pulses per second (see Fig. 4-7).
- 8 — Keyset allows outpulsing from one to ten pulses. \* selects 185 mx between repeated pulse trains and # selects 680 ms between repeated pulse trains.
- 9 — PULSE WIDTH switch controls pulse width or % break (see Fig. 4-7).
- 10 — GEN SUPV key determines steady - state output of test set.
- 11 — PULSE MODE switch selects either continuous output pulses or pulses determine by keyset operation.
- 12 — SEND switch selects interface unit connection to pulse generating circuit.
- 13 — RECEIVE switch selects interface unit connection to measurement and display circuit.
- 14 — SELECTOR switch used to stop readout automatically.
- 15 — MS RANG switch selects two millisecond readout ranges.
- 16 — FUNCTION switch selects type of measurement:  
 NO OF PULSES — allows reading number of pulses received.  
 SPEED — allows measuring pulses per second  
 % BK — allows measuring % BK of pulses  
 MK — used in conjunction with READ switch for make interval, measured  
 BK — used in conjunction with READ switch for break interval measured  
 PER — used in conjunction with READ switch for period measured.
- 17 — POWER switch applies power to test set.

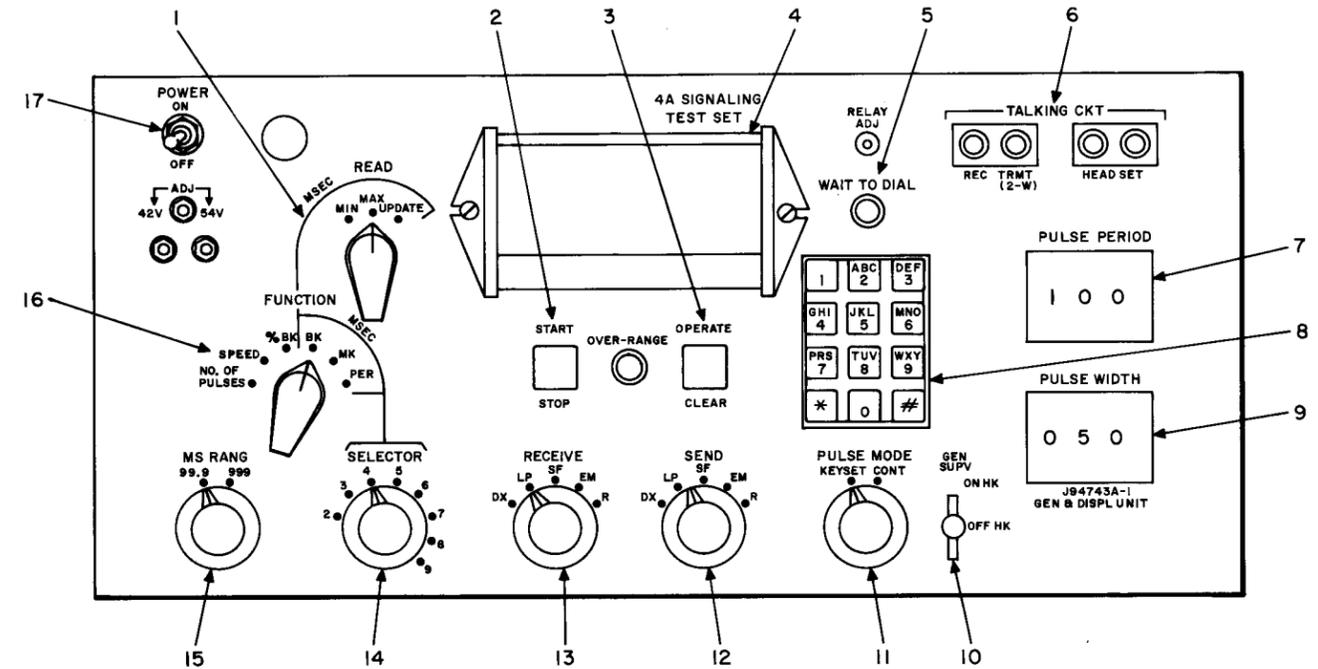
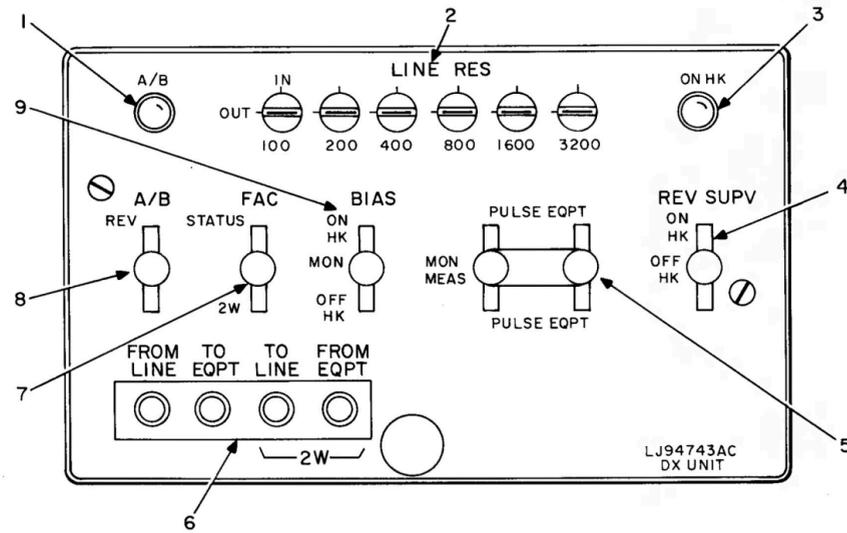
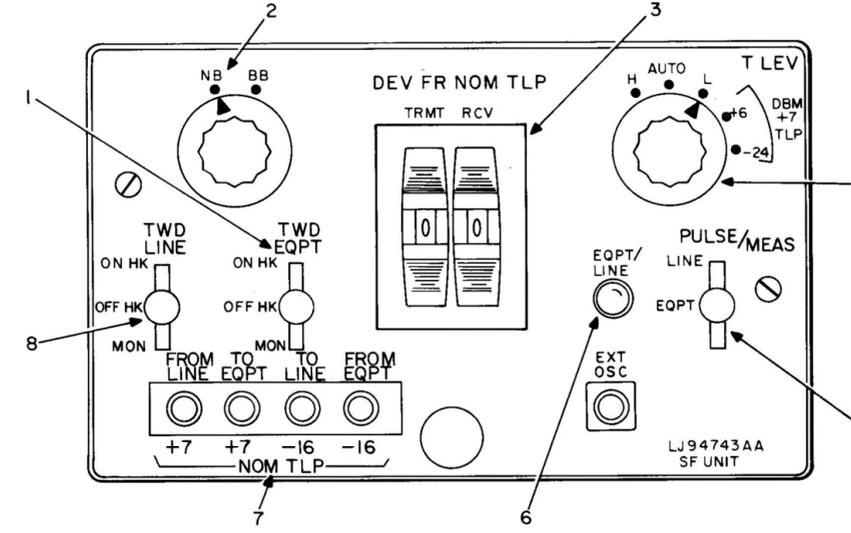
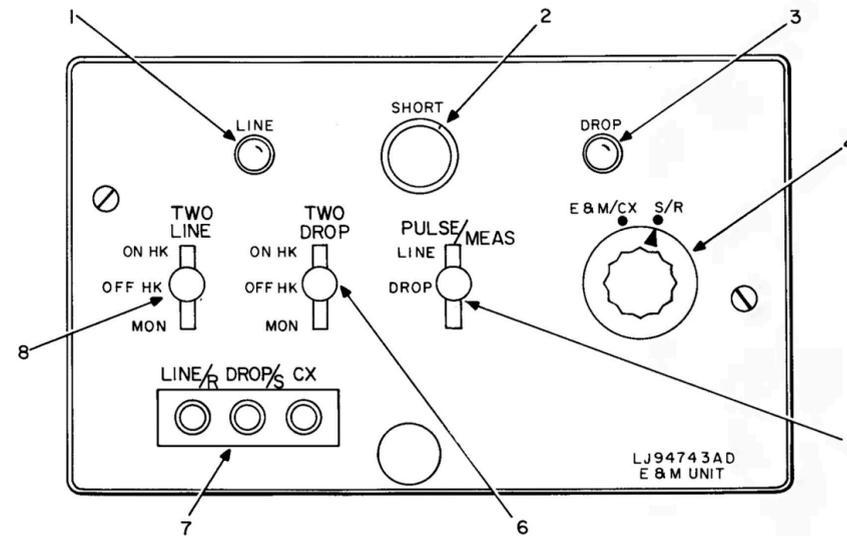


Fig. 4-7—4A Signaling Test Set Main Module

- 1 - A/B lamp monitors conditions on A and B leads.
- 2 - LINE RES switches allow for matching line resistance.
- 3 - ON HK lamp used in monitoring the circuit.
- 4 - REV SUPV key permits on-hook or off-hook supervision in opposite direction of pulsing.
- 5 - PULSE LINE/PULSE EQPT/MON MEAS. key selects function.
- 6 - Input jacks permit connection of circuit under test.
- 7 - FAC key selects 2- or 4-wire facility or status determination.
- 8 - A/B key reverses A and B lead tip and ring orientation.
- 9 - BIAS key used to prepare interface unit for monitoring or measuring.



- 1 - LINE lamp monitors E load conditions.
- 2 - SHORT switch shorts E & M leads.
- 3 - DROP lamp monitors M lead condition.
- 4 - E + M/CX - S/R switch allows testing in either position. The lever keys are disabled in the S/R position.
- 5 - PULSE/MEAS key selects the direction for measuring or pulsing (line or drop).
- 6 - TWD DROP key permits measuring or monitoring from the drop or pulsing toward the drop, as well as on-hook/off-hook supervisor signals toward the drop.
- 6 - Input jacks permit connection of circuit under test.
- 8 - TWD LINE key permits measuring or monitoring from the line or pulsing toward the line, as well as on-hook/off-hook supervisory signals toward the line.



- 1 - T/R key permits reversal of tip and ring.
- 2 - LOOP RES switches allow for matching loop resistances.
- 3 - FUNCTION switch selects the type of pulsing and measuring. Simulation of loop condition is also made in conjunction with this switch.
- 4 - RCV LOOP provides receive loop resistance in series with A1 relay.
- 5 - LEAK switch simulates line capacitance.
- 6 - SUPV LAMP monitors pulse and nonpulse conditions on the loop.
- 7 - PULSE/DET SUPV/TALK key permits outpulsing, monitoring or talking when the FUNCTION switch is in BG, LP, STA OFF.
- 8 - Input jacks are used for connection of circuit under test.
- 9 - SUPV key permits supervision, seizure, and ringing under of FUNCTION switch.
- 10 - CF key controls connection of CF jack to S or R jack.

- 1 - TWD EQPT key controls supervision, pulsing, and monitoring toward the equipment.
- 2 - NB/BB switch allows detection -F 2600-Hz tones in N position or all voice band signals in the BB position.
- 3 - DEV FR NOM TLP switches allow adjustment for operating the unit at levels other than +7 and -1t TLP.
- 4 - T LEV switch selects numerous outpulsing tone levels.
  - H - high level SF tone used for signaling
  - AUTO - automatic high to low level 12 db apart after 400 ms
  - L - low level SF tone used as an on-hook signal
  - +6 - absolute tone level used for checking upper limits of SF tone
  - 24 - same as above except lowest limits
- 5 - PULSE/MEAS key selects direction for pulsing, measuring and monitoring.
- 6 - EQPT/LINE lamp monitors equipment or line for presence of 2600 Hz
- 7 - Input jacks are used for connection of circuit under test.
- 8 - TWD LINE key controls supervision pulsing, and monitoring toward the line.

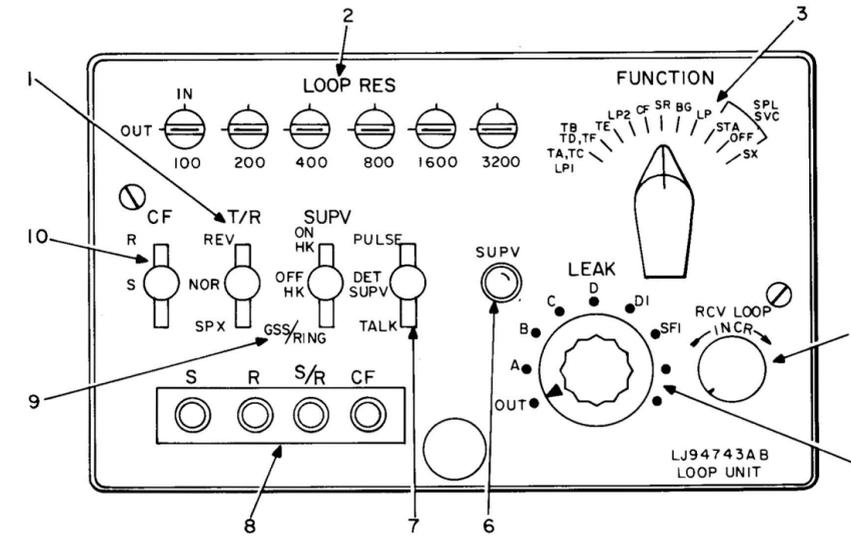
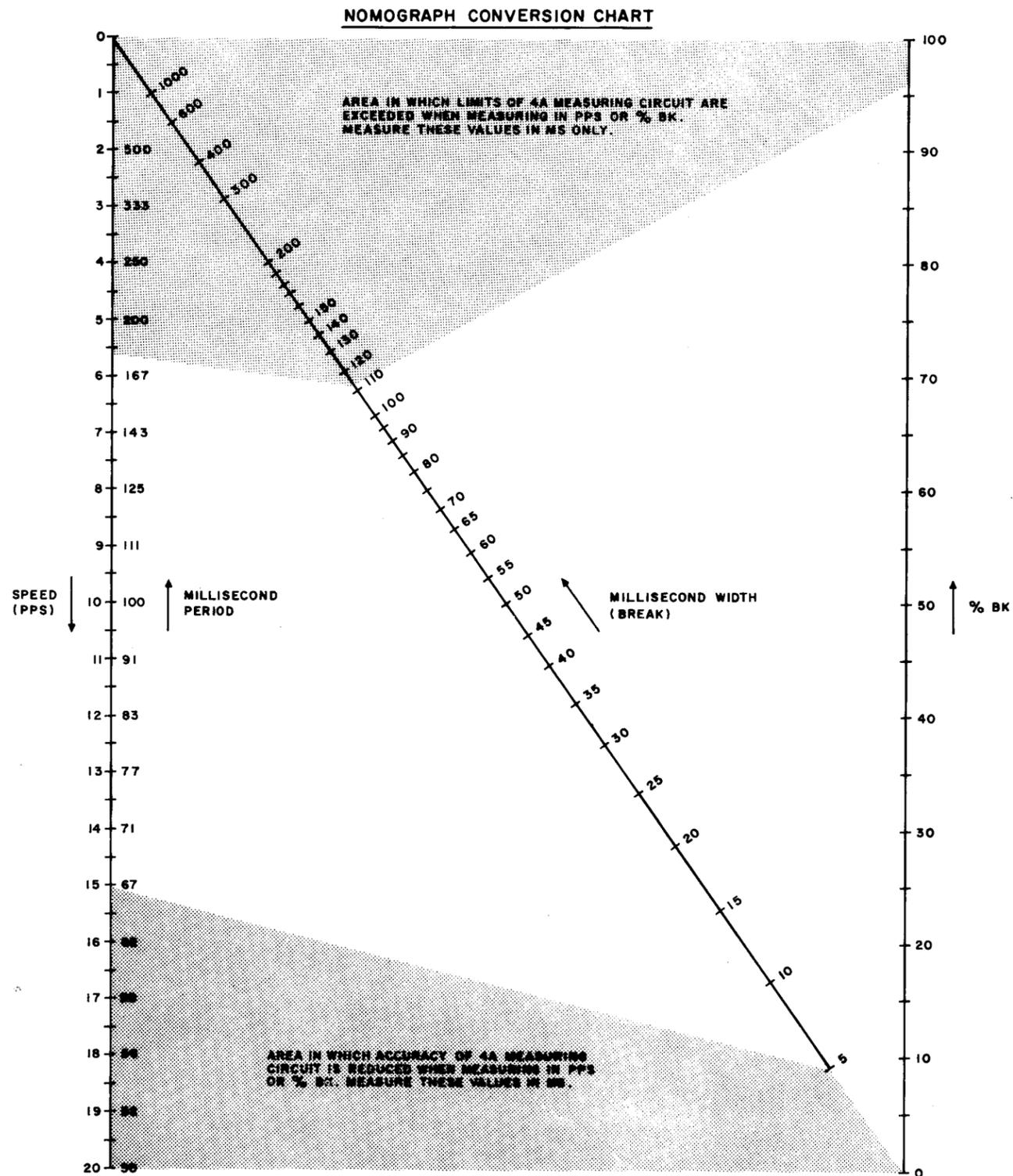


Fig. 4-8—Interface Units For Four Types of Signaling



The nomograph conversion chart may be used to convert from speed in pps to milliseconds period, or from speed and percent break to milliseconds width (break). Speed to millisecond period conversion may be read directly from the left vertical scale. Conversion to millisecond width (break) requires that speed or millisecond period and percent break be known. For example, at 12 pps (83 ms) and 60% bk, a straightedge is placed on the nomograph between these values. The straightedge will cross the millisecond width (break) line at 50 ms.

The nomograph can only provide an approximate value since in many cases interpolation is required. Greater accuracy may be achieved by obtaining the exact values directly from the 4A signaling test set using the self check feature. Set the SEND and RECEIVE switches to the R position, the PULSE MODE switch to CONT, the GEN SUPV key to OFF HK, and follow the table below. When a millisecond value is the unknown, approximate values for setting the PULSE PERIOD and PULSE WIDTH switches may be obtained from the nomograph.

	UNKNOWN	KNOWN	FUNCTION	PULSE PERIOD	PULSE WIDTH	NIXIE display	Read Unknown
1	Speed (pps)	Pulse Period (ms)	SPEED	Known ms value	approx. half of PULSE PERIOD switch setting	Speed (pps)	on NIXIE
2	Percent Break	Pulse Period (ms) Pulse Width (ms bk)	% BK	Known ms value	Known ms value	Percent Break	on NIXIE
3	Pulse Period (ms)	Speed (pps)	SPEED	Adj for desired NIXIE display	approx. half of PULSE PERIOD switch setting	Speed (pps)	PULSE PERIOD switch setting
4	Pulse Width (ms bk)	Speed (pps) Percent Break	% BK	Known ms value from 3 above	Adj for desired NIXIE display	Percent Break	PULSE WIDTH switch setting

Fig. 4-9—Conversion Chart

- (5) Adjust the METER CAL control to obtain 0 on the % BREAK scale of the meter.
- (6) Operate the FUNCTION switch to CAL ADJ % BREAK position.
- (7) Adjust the ADJ % BREAK control to the desired % break as indicated on the meter.

#### Operation

**4.71** The following paragraphs contain procedures for six tests using the 26B. The 26B can be used for other operations; however, these are not covered here. For more detailed information see the instruction manual normally accompanying the test set.

**4.72** To send loop signals on a loop signaling circuit the following procedure should be used.

- (1) Calibrate the test set as covered in 4.70.
- (2) Turn the FUNCTION switch to SEND & REC position. The FUNCTION key should be left in the SEND OSC position as in calibration procedure, Step (3). (See Note.)
- (3) Turn the SEND OR SEND AND REC switch to either of the SEND LOOP positions. If the SEND LOOP-REC LOOP is used, the turn button switch SEND (in lower left corner) must be set to RT ON 1 & 2.
- (4) Connect the circuit under test to LOOP SIGNALING SEND 1 & 2 jacks.
- (5) If it is necessary to dial and talk on the circuit under test, connect a handset to EXTERNAL DIAL jack; turn the EXT DIAL CIRCUIT switch to DIAL RLY-B&G; restore FUNCTION key to SEND DIAL and dial the desired connection.
- (6) After dialing on the circuit, it is possible to listen to the ringing and to talk by turning the EXT DIAL CIRCUIT switch to TALK EM.
- (7) To send pulses, operate the FUNCTION key to SEND OSC again.

**4.73** To send signals on E & M lead signaling circuits the following procedures should be used.

- (1) Calibrate the test set as covered in 4.70.
- (2) Turn the FUNCTION switch to SEND & REC position. (See Note.)
- (3) To send toward the line (M lead), set the SEND or SEND & REC switch to E & M M-LINE (E = G&O, M = B & G) for sending battery and ground (pulses), or to E & M-LINE (E = G&O, M = B&O) for sending battery and open (pulses).
- (4) To send toward the drop (E lead), set the SEND OR SEND & REC switch to E&M-DROP (E = G&O, M = B&G).
- (5) Operate FUNCTION key to SEND OSC.

**Note:** When the 26B is used to pulse repeaters, carrier pulsing units, etc, care should be exercised to simulate the pulsing source in the system under test. In many cases the pulsing source will have a spark suppression circuit across the pulsing contacts. Under these conditions, if the spark suppression in the 26B is not used, erroneous results will be obtained. If required, turn the SPARK SUP turnbutton to ON, otherwise it should remain in the OFF position.

**4.74** To measure % break on loop circuits, using the 26B, the following procedure should be used.

- (1) Calibrate the test set as covered in 4.70.
- (2) For wet loop circuits, turn the RECEIVE switch to B&G ON LOOP. For dry loop circuits, turn the RECEIVE switch to REC LOOP.
- (3) Turn the METER CIRCUIT switch to % BREAK DIRECT. (If the circuit has high inductance or capacitance that may distort the pulse wave shape, the METER CIRCUIT switch should be turned to % BREAK THRU METER RELAY instead so erroneous readings will not be obtained.)
- (4) Connect circuit under test to LOOP SIGNALING REC LOOP jack.

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- (5) Request an off-hook or short circuit at the point the signals are to be applied.
- (6) Turn the FUNCTION switch to CAL METER and adjust METER CAL control to obtain 0 on the % BREAK scale of meter.
- (7) Turn the function switch to SEND & REC and request the distant end to send the signal.
- (8) Read the % break on the % BREAK scale of the meter.

**4.75** To measure % break on the E & M leads using the 26B, the following procedure should be used.

- (1) Calibrate the test set as covered in 4.70.
- (2) To measure % break of battery and ground pulses on M lead set the RECEIVE switch to B&G (M). [To measure % break of battery and open pulses on M lead, set the RECEIVE switch to B&O (M). To measure % break on E lead (ground and open pulses) set RECEIVE switch to G&O (E).]
- (3) Turn the METER CIRCUIT switch to % BREAK DIRECT. (If the circuit has high inductance or capacitance which may distort the pulse wave shape, the METER CIRCUIT switch should be turned to % BREAK THRU METER RELAY.)
- (4) Request an off-hook or a short circuit from the distant end.
- (5) Turn the FUNCTION switch to CAL METER and adjust the METER CAL CONTROL for 0 indication on % BREAK scale of the meter.
- (6) Turn the FUNCTION switch to SEND & REC, request signal from distant end, and read % BREAK scale of meter.

**4.76** To measure the speed of pulses received using the 26B, the following procedure should be used.

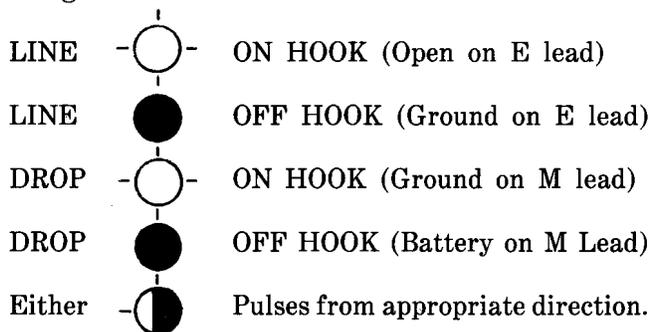
- (1) Calibrate the test set as covered in 4.70.
- (2) If the pulses are being sent over a dry loop set the RECEIVE switch to LOOP, however,

if a wet loop is used set the RECEIVE switch to B&G ON LOOP.

- (3) Turn METER CIRCUIT switch to 0-25 PPS.
- (4) Turn FUNCTION switch to METER CAL and adjust the METER CAL control to obtain 25 on the PPS scale.
- (5) Turn the FUNCTION switch to SEND & REC and read the pulse speed on the PPS scale of the meter.

**4.77** To monitor E & M lead signaling conditions the following procedure should be used:

- (1) Set FUNCTION key to TEST L&D and LINE (E) and DROP (M) in MONITOR position.
- (2) Set FUNCTION switch to SEND & REC position.
- (3) Observe the lamps above the LINE (E) and DROP (M) keys which have the following significance.



**4.78** To send SF pulses using the 26B with the 26BXS, proceed as follows:

- (1) On the 26B, turn the left hand button to SEND RT ON 1 & 2 and the right hand turn button to SPARK SUP OFF.
- (2) Set the RECEIVE switch for the desired receiving condition and the SEND switch at SND LOOP-REC LOOP.
- (3) Connect the appropriate patch cord to the appropriate 48-volt jack of the set. (This should precede connection to battery to avoid blowing a fuse.) Then connect the other end to 48-volt office battery.

- (4) Turn the PULSES PER SEC switch to the desired pulse rate. LINE (E) and DROP (M) lamps should light.
  - (5) Set the METER CIRCUIT switch at % BREAK DIRECT.
  - (6) Operate the TEST SEND key to SEND OSC.
  - (7) Plug in and lock in the connector plug on the cord from the accessory cover to the EXT ADAPT socket.
  - (8) Patch from the TO TTS 26 SEND jack to either #1 or # LOOP SEND jack on 26 BXS.
  - (9) On the 26BXS set the FREQ KC switch at the desired frequency and the OUTPUT LEVEL switch at the desired level. (If it is desired to check the calibration of this output, adjustment may be made by turning the SEND LEVEL ADJ trimmer screw as necessary.)
  - (10) Turn the FUNCTION switch of the 26B to CAL METER and adjust the METER CAL control to read 0 on the meter scale.
  - (11) Turn the FUNCTION switch to ADJ % BREAK and adjust the ADJ % BREAK control to obtain the desired % break.
  - (12) Turn the FUNCTION switch to SEND AND REC.
  - (13) To send SF pulses, move the key switch on the 26BXS to the PULSE position. The OFF HOOK position of the key switch establishes a "no tone" condition and the ON HOOK position a "steady tone" condition.
  - (14) Pulses now are available at the desired rate and level with a cord having a 310 type plug plugged into the LINE OUTPUT jack of the 26BXS. If these are used to pulse an SF signaling converter, the DC output of this converter may be received and measured at the appropriate receiving jack, with the RECEIVE switch in the proper position.
- 4.79** To measure SF pulses using the 26B with the 26BXS, proceed as follows.
- (1) On the 26B, turn the left hand turn button to the RT ON 1 and 2 position and the right hand turn button to SPARK SUP OFF.
  - (2) Set the RECEIVE switch at REC LOOP and, if pulses are to be sent out simultaneously (as into an SF signaling converter), set the SEND switch for the desired sending condition.
  - (3) Connect the appropriate patch cord to the appropriate 48-volt jack of the set. (This should precede connection to battery to avoid blowing a fuse.) Then connect the other end to 48-volt office battery.
  - (4) Turn the PULSES PER SEC switch to the desired pulse rate. LINE (E) and DROP (M) lamps should light.
  - (5) Set the METER CIRCUIT switch at % BREAK DIRECT.
  - (6) If the same set is being used to send and receive pulses, operate the TEST SEND key to SEND OSC, otherwise operate the TEST SEND key to TEST L&D. The TWD-L and TWD-D key may be operated to establish desired supervisory conditions.
  - (7) Plug and lock in the connector plug on the cord from the accessory cover to the EXT ADAPT socket.
  - (8) Patch from the TO TTS 26 REC LOOP jack of the 26BXS to the REC LOOP jack of the 26B.
  - (9) Turn the FUNCTION switch of the 26B to CAL METER and adjust the METER CAL control to read 0 on the meter scale.
  - (10) Turn the FUNCTION switch to ADJ % BREAK and adjust the ADJ % BREAK control to the desired % break if pulses are to be sent out simultaneously, otherwise omit this step.
  - (11) Turn the FUNCTION switch to SEND AND REC.
  - (12) Patch the circuit from which pulses are to be received to either the BRDG or TERM INPUT jack of the 26BXS, which ever is desired.

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(13) Turn the SF CAL control of the 26BXS completely counter clockwise; then holding the PRESS TO CAL button depressed, advance the SF CAL control clockwise until uniform pulses are observed on the SF CAL lamp.

(14) Release the PRESS TO CAL button and read the received % break on the meter of the 26B.

### TRANSMISSION TEST EQUIPMENT

#### 3A Noise Measuring Set (Fig. 4-11)

**4.80** The J94003A (3A) noise measuring set (NMS) covered in SD-95276-01 is a portable test set used to measure weighted or unweighted noise on telephone circuits. The set is normally powered by a self-contained 45-volt battery; however, an arrangement is available for powering the set from 120V 60 Hz by means of an external J87281A power supply.

**4.81** The 3A NMS does not have dialing and holding features. (See 3C NMS.)

**4.82** As shown in Fig. 4-11, the 3A has two input arrangements located in the top left corner. One is a pair of jacks that takes a 241A plug or equivalent, and the other input connection is a pair of binding posts that will accept banana plugs, clip leads, or bare wire. The two inputs are electrically identical. Beside the input binding posts is another binding post, GRD, for ground connections.

**4.83** Below the input jacks is a 2-position slide switch marked DAMP/NORM. Ordinarily, noise measurements are made with this switch in the NORM position. When measuring rapidly fluctuating noises, the switch should be operated to the DAMP position.

**4.84** Below the damping switch is the FUNCTION switch, which selects the proper input circuitry and allows for checking the battery and calibrating the set.

**4.85** To the right of the FUNCTION switch is a meter calibrated in dBrn. A red line and a shaded area on the meter scale are used for calibration and checking the battery.

**4.86** To the right of the meter is the DBRN switch which controls the attenuation of the signal from the input. The switch has a range of 0 to 85 dB and is adjustable in 5 dB steps. When reading the meter, the setting of the DBRN switch should be added to the DBRN meter reading. Example: The DBRN meter reads 6 dBrn and the DBRN switch is set to 40—the actual noise measured is 46 dBrn.

**4.87** Above the DBRN switch is the WTG receptacle which accommodates the various weighting networks. Two separate plug-in units, each containing two networks, are available. The 497A network has characteristics of C-message, and 3 kHz flat weighting; the 497B network has characteristics of program and 15 KHz flat weighting. When a unit is plugged into the set, the upright lettering indicates which of the two networks is connected. The other network of the unit can be used by removing the plug-in unit, rotating it 180°, and reinserting it.

**4.88** To the left of the WTG receptacle are two monitoring jacks, marked DC MON and AC MON. The DC MON jack can be used to connect external recorders or other dc measuring equipment. Insertion of a type 347 or equivalent plug into this jack disconnects the indicating meter. The AC MON jack is used to monitor with a 723A receiver equipped with a 2W46A testing cord assembly. The 2W46A cord has a built-in resistor that is required to preserve the accuracy of the measurement while monitoring. A type 347 or equivalent plug can be used to connect the monitoring output to an external ac meter. Insertion into the AC MON jack does not disconnect the meter.

**4.89** To the left of the monitor jacks is a screw-type calibration control marked CAL. It is used for adjustment of the sensitivity of the set when calibrated with a reference milliwatt source or the internal reference oscillator. Calibration procedures are covered in the following paragraphs.

#### Calibration

**4.90** The 3A NMS should be calibrated before any measurements are made.

- (1) Turn the FUNCTION switch to OFF and set the meter point over the base line at the left end of the scale.

- 1 — ADJ % BREAK POTENTIOMETER  
Provides the means for adjusting the % break of the transmitted pulses from the internal oscillator or from an external dial.
- 2 — TERMINALS  
The following terminals are provided:
  1. EXT ADAPT Connector — Provides for connection to accessory covers (Located in upper left of panel).
  2. EXT DIAL Binding Posts (2) — Provides for connection of an external dial, source of pulses, or of a telephone set (located in upper left of panel).
  3. GND Binding Posts — Provides access to the TTS 26B ground.
- 3 — METER  
Provides a display for all measurements.
- 4 — FUNCTION key switch  
Provides the following functions:
  1. TEST L&D (operated upward). This position disconnects the LINE and DROP, and the E and M jacks from access to other circuits of the set. The LINE (E) and DROP (M) lamp relays are bridged on, and the LINE and DROP jacks are connected together tip to tip and ring to ring.
  2. SEND DIAL (position normal)
  3. SEND OSC (operated downward)
- 5 — LINE (E) key switch  
Provides for the connection of the following supervisory and measurement functions toward the line:
  1. ON HOOK (operated upward)
  2. MONITOR (normal position)
  3. OFF HOOK (operated downward)
- 6 — LAMPS  
Two supervisory lamps, designated LINE (E) and DROP (M) are provided to indicate a busy (lamp dark) or idle condition (lamps lighted) on the line and drop circuits to which the set is connected, when E and M supervision is present on the circuits.
- 7 — DROP (M) key switch  
Provides for the connection of the following supervisory and measurement functions toward the line:
  1. ON HOOK (operated upward)
  2. MONITOR (normal position)
  3. OFF HOOK (operated downward)

- 8 — EXT DIAL CIRCUIT switch  
Provides the following modes of operation of the external dial circuit in clockwise sequence:
  1. TALK a. EM b. RT
  2. DIAL RELAY B&G
  3. DIAL RELAY a. LOOP b. M c. E
- 9 — SEND or SEND AND RECEIVE switch  
Provides the following sending modes in clockwise sequence, when the receive switch is in final clockwise position:
  1. SEND LOOP, REC G&B
  2. SEND LOOP, REC LOOP
  3. E&M LINE B&G on M DROP G&O on E
  4. E&M LINE B&O on M (See Note 1)

NOTE 1: The E lead status in this mode is controlled by the DROP toggle switch.

NOTE 2: The two SEND LOOP positions provide identical sending conditions; only the receiving functions are different in these positions when this switch is used to control both sending and receiving functions.
- 10 — SPARK SUP turnbutton switch  
Inserts an internal spark suppression circuit across the SEND RELAY CONTACTS.
- 11 — RECEIVE Switch  
Provides the following receive functions in clockwise sequence:
  1. B&G ON LOOP
  2. LOOP
  3. B&O (M)
  4. B&G (M)
  5. G&O (E)
  6. The final clockwise position permits the SEND or SEND AND REC switch to control both sending and receiving functions, as shown in item 6 following.
- 12 — METER CAL POTENTIOMETER  
Provides the means for calibrating the meter circuitry.

- 13 — Jacks  
The following 310-type jacks are provided from left to right:
  1. EXT DIAL (for connecting an external dial, pulsing source, or a telephone set)
  2. SEND RELAY (for direct connection to the relay contacts)
  3. LOOP SIGNALING — SEND 1
  4. LOOP SIGNALING — SEND 2
  5. LOOP SIGNALING — SEND B&G
  6. LOOP SIGNALING — REC LOOP
  7. E AND M SIGNALING — REC E&M
  8. E AND M SIGNALING — E (for connection to the E lead)
  9. E AND M SIGNALING — M (for connection to the M lead)
  10. E AND M SIGNALING — LINE
  11. E AND M SIGNALING — DROP
  12. 48 VOLT, S = BATT, T = GND
  13. 48 VOLT, S = GND, T = BATT
- 14 — SEND PPS  
Switch — Provides the following functions:
  1. Switches the power on or off.
  2. Controls the pulse rate of the internal oscillator for any one of the available seven discrete pulse rates.
- 15 — SEND turnbutton switch  
Provides the following SEND functions on the LOOP SIGNALING jacks SEND 1 and SEND 2:
  1. SEND RT ON 1&2 (operated clockwise)
  2. SEND SLEEVES (operated counter clockwise)  
In normal use this switch should be in the SEND RT ON 1&2 position. The principal use for the SEND SLEEVE position is for special application where direct access to the SEND relay armature, make, and break contacts is desired.
- 16 — FUNCTION SWITCH  
Provides the following functions in clockwise sequence:
  1. SEND a. ON HOOK b. OFF HOOK
  2. SEND AND REC
  3. CAL a. ADJ % BREAK b. CAL METER

- 17 — METER CIRCUIT switch  
Provides the following measuring functions in clockwise sequence:
  1. 0-25 PPS (Pulse Speed)
  2. % BREAK DIRECT
  3. % BREAK THRU METER RELAY
- 18 — DROP toggle switch  
Determines the sending status of the E lead, either ground and open or ground and battery.

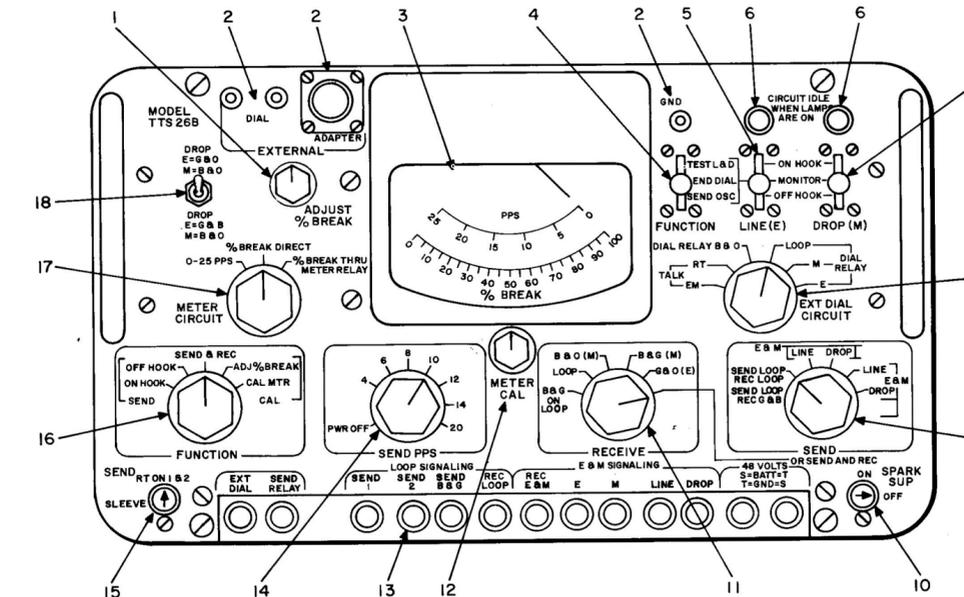


Fig. 4-10—26B Signaling Test Set

- (2) Insert properly the weighting network to be used.
- (3) Turn the DBRN switch to 85 (CAL).
- (4) Turn the FUNCTION switch to BAT. If the meter fails to indicate in the shaded area marked BAT, turn the FUNCTION switch to OFF and replace the battery. If the external J87281A power supply is being used, check the ac voltage or rectifier in accordance with Section 167-256-301.
- (5) Turn the FUNCTION switch to CAL. Adjust the CAL screw-type control for a meter indication on the red line of the scale.

### Operation

**4.91** When making a noise measurement with the 3A, the general procedure below should be followed.

- (1) Select the proper weighting network based on the information on the CLR and plug it into position, with appropriate orientation.
- (2) Calibrate the set as described in 4.90.
- (3) Turn the FUNCTION switch to the position which will be used for the measurement (see FUNCTION switch in Fig. 4-11).
- (4) Check for pickup from external magnetic and electrostatic fields. With no input connected to the set, adjust the DBRN switch to 0. If there is a deflection on the meter, position the set to minimize the deflection. **Make sure the GRD post of the 3A is connected to ground.**
- (5) Restore the DBRN switch to the 85 position.
 

**CAUTION: When using the 3A in the BRDG function on a working line, dialing pulses can become distorted. It is recommended that the set be connected to the line no longer than necessary.**
- (6) Connect the circuit to be tested to the input of the set, using the appropriate cord as described above.
- (7) Adjust the DBRN switch counterclockwise until a suitable deflection of the meter is obtained. The most accurate indication will be obtained when the meter indicates between +2 and +9. Observe the meter for about 10 to 30 seconds and establish the point at which the meter needle appears **most of the time**. Add the meter indication to the DBRN switch setting for total noise in dBrn with respect to the weighting used.
- (8) Always use the monitoring receiver in the course of measurements to aid in identifying the noise. The character of the noise heard should be recorded along with the noise measurement.
- (9) Rapidly fluctuating noise (ie, atmospheric, static, or switching type noise) can be more conveniently read on the meter by operating the DAMP/NORM switch to the DAMP position. The most frequently occurring peaks should be used in reading the meter, however, this type of measurement will not give an indication of the actual noise peaks.

### 3B Noise Measuring Set

**4.92** The 3B NMS is very similar to the 3A except it is designed for bay mounting. It is powered by a -48 volt central office battery and the battery filtering as well as voltage regulation is internal. In addition to the input connections of the 3A NMS, the 3B is equipped with input terminals at the rear of the set that can be wired to jacks at the testboard or other testing locations where the set is mounted.

**4.93** Internally the 3B set has a resistor in series with the AC MON jack so any standard low-impedance receiver can be used. The 2W46A cord should **not** be used with the AC MON jack of the 3B NMS. The 3B set also has additional AC MON terminals at the rear of the set that can be wired to a jack in the jack field of the testboard or other testing location where the set is mounted.

**4.94** All other features of the 3B NMS such as calibration and operation are the same as the 3A.

1. IN connectors are the input to the test set and accept clips, banana plugs, or bare wire.
2. GRD binding post is used for connecting to ground.
3. CAL screw is used to adjust the sensitivity of the test set.
4. MON jacks, AC and DC, are used to connect a 723A receiver and external dc measuring equipment, respectively.
5. 497A network in WTG receptacle gives 3A NMS characteristic of C-MESSAGE or 3 KHz flat weighting. 497B network gives 3A characteristics of 15 KHz and PROGRAM weighting.
6. DBRN switch controls attenuation to the input of meter. The setting of the switch should be added to meter indication to obtain actual noise measured.
7. DBRN meter displays measured noise in dB<sub>rn</sub>; red line is used for calibration; BAT (shaded area) is used for battery check.
8. FUNCTION switch selects seven circuit changes:
  - 1) OFF — shorts meter and disconnects battery
  - 2) BAT — arranges meter as a voltmeter to indicate battery voltage
  - 3) CAL — applies battery to the internal oscillator, so a 1 KHz tone is connected to the attenuator for calibration purposes
  - 4) N<sub>G</sub> — used to measure noise between a circuit and ground such as longitudinal noise
  - 5) BRDG — used to measure noise on a circuit without removing it from service
  - 6) 600 — used to measure noise on 600-ohm circuits
  - 7) 900 — used to measure noise on 900-ohm circuits.
9. DAMP/NORM switch is operated to DAMP only when measuring rapidly fluctuating noise.
10. IN jacks are input to test set; accepts 241A plug or equivalent.

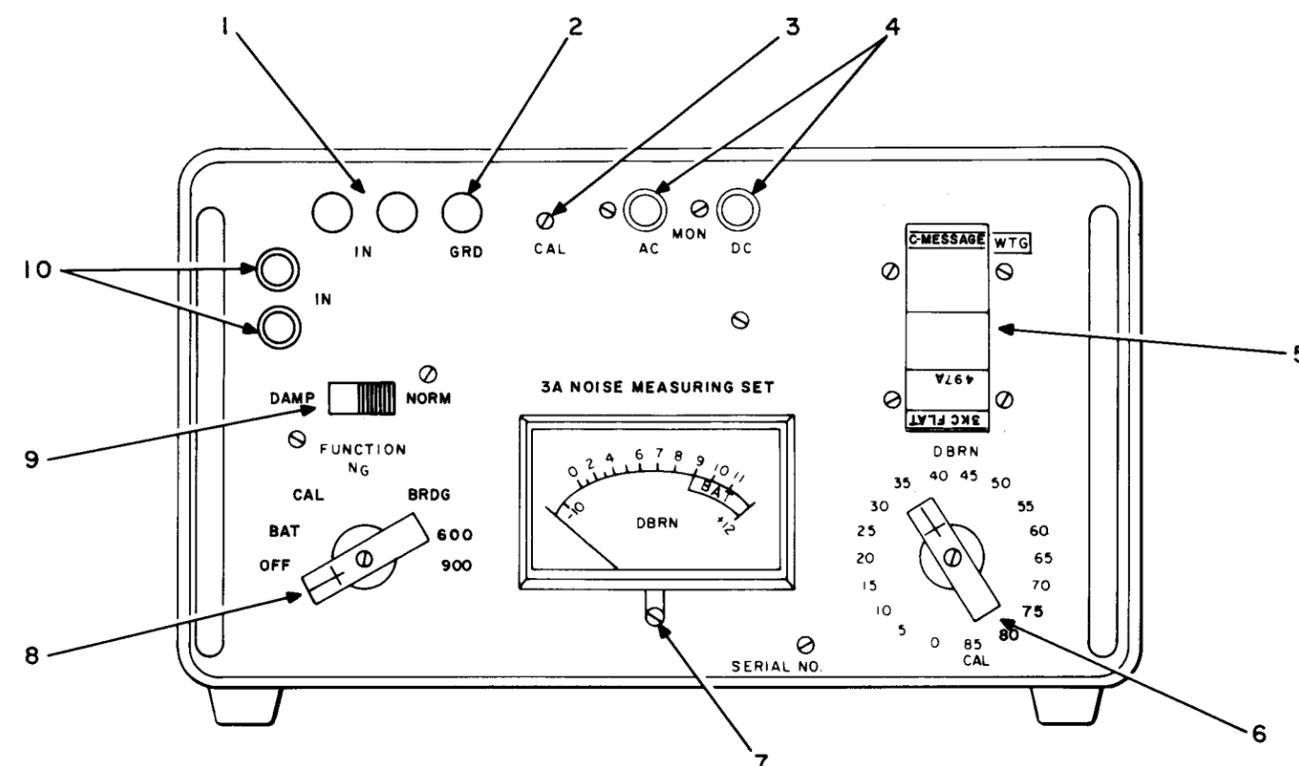


Fig. 4-11—3A Noise Measuring Set

**3C Noise Measuring Set (Fig. 4-12)**

**4.95** The J94003C (3C) NMS is very similar to the 3A except that the 3C has dialing and holding capabilities. The dial and hold features permit a distant termination to be dialed while the set is connected to the circuit under test and for the connection to be held during the noise measurement.

**4.96** As shown in Fig. 4-12 the 3C has a somewhat different input arrangement. Instead of two jacks, the 3C has only one which accepts a 310-type plug. The binding posts are marked T, R, and S and are connected into the tip, ring, and sleeve of the input jack.

**4.97** Below the input are two possible means of connecting the dialing apparatus. The jack accepts a 310-type plug and the connectors marked T and R accept test-type clips such as those on a W2EY cord. Adjacent to the clip connectors is the GRD binding post which is equipped with a sliding strap. Normally, this strap is inserted under the S binding post and a ground wire connected to the GRD post. However, if the test connection does not require ground on the sleeve, the strap is disconnected from the S binding post.

**4.98** Below the damping switch is the FUNCTION switch, which selects the proper input circuitry, and allows checking the battery, calibrating the set and dialing and holding. (See Fig. 4-12 for details on these functions.)

**4.99** The monitoring jacks are the same as the 3A except the AC MON jack is used with a 723A receiver that is equipped with a W2FS cord. It should be noted that the cord assembly cannot be used with the **3A or 3B NMS**.

**4.100** Calibration procedure is the same as 3A NMS.

**4.101** The only difference in measurement procedure is contained in the note below which follows in sequence between Steps 6 and 7 as the 3A procedure.

**Note:** If the measurement requires that a distant test termination be dialed over the circuit under test, connect a 1011-type hand test set or equivalent to the DIAL jack or DIAL T and R connections. Turn the

FUNCTION switch to DIAL and dial the appropriate digits to reach the distant test termination. When the distant termination has been connected, turn the FUNCTION switch to  $N_m$  600/900 HOLD to hold the connection during the measurement.

**3CR Noise Measuring Set**

**4.102** The J94003CR (3CR) NMS is a rack mounted version of the 3C; however, there are certain differences. The 3CR is powered from -48V central office battery. Input connections are on the rear of the unit and are normally wired to jacks in the face of the testboard or test frame. The FUNCTION switch has three positions.

- (a) The BRDG position is used to measure noise on circuits without removing them from service.
- (b) The  $N_m$  600/900 position is used as a termination when metallic measurements at either 600 or 900 ohms is specified. This position is also using during calibration of the set.
- (c) The  $N_G$  position is used to measure noise voltages between a circuit and ground, such as those resulting from longitudinal induction.

**Note:** The  $N_G$  position is not used in any present application of the 3CR NMS. Measurements of noise-to-ground on trunks at the points of access usually employed at testboards and test frames may be misleading because of the effect of the trunk circuit, repeating coils, battery supply circuits, blocking capacitors, etc, in the longitudinal path. The circuit was included in the 3CR set for future application.

**Calibration**

**4.103** Calibration should be performed before making a measurement. This is done as follows:

- (1) Remove the network from the WTG receptacle. (This opens the meter circuit). Set the meter needle to the base line at the left end of the scale. Return the network to the WTG receptacle with the proper orientation and turn FUNCTION switch to  $N_m$  600/900. This position is also marked CAL.

1. DIAI connectors are used to connect dialing equipment. 310 jack accepts 310-type plug and the T and R posts accept test-type clips.
2. IN connectors are the input to the test set.
3. GRD binding post is used for connection to ground.
4. CAL screw is used for adjusting sensitivity of test set.

5. MON jacks, AC and DC, are used for connecting external equipment. The DC MON jack can be used to connect recorders or other dc measuring equipment. The AC MON jack is used to monitor with a 723A receiver. Insertion into the AC MON jack does not disconnect the meter.

6. 497A Network in WTG (weighting) receptacle gives the 3C set, C-Message or 3 KHz flat weighting characteristics. As shown the C-Message network is in the circuit. The 497B network gives the 3c characteristics of 15 KHz and PROGRAM weighting.

7. DBRN switch controls attenuation to the input of the meter. The setting of the switch should be added to the meter indication to obtain the actual noise measured.

8. DBRN meter displays the measured noise in dB<sub>rn</sub>; red line and BAT (shaded area) are used for calibration and battery check, respectively.

9. FUNCTION switch selects nine circuit changes:

- 1) OFF — shorts meter and disconnects battery.
- 2) BAT — arranges meter as voltmeter to indicate battery voltage.
- 3) CAL — applies battery to internal oscillator, so a 1 KHz tone is connected to attenuator for calibration purposes.
- 4) BRDG — used to measure noise on circuits without removing them from service.
- 5)  $N_G$  — used to measure noise between a circuit and ground such as longitudinal noise.
- 6)  $N_M$  600/900 — used to measure metallic noise on 600- or 900-ohm circuits.
- 7)  $N_G$  HOLD — same as  $N_G$  except a holding network\* (700 $\Omega$ ) is connected across the input.
- 8)  $N_M$  600/900 HOLD — same as  $N_M$  600/900 except a holding network\* (700 $\Omega$ ) is connected across the input.
- 9) DIAL — connects input T and R to dial T and R for dialing far and termination over circuit under test.

\* Holding networks permit the dialed connection to be held while noise measurement is made.

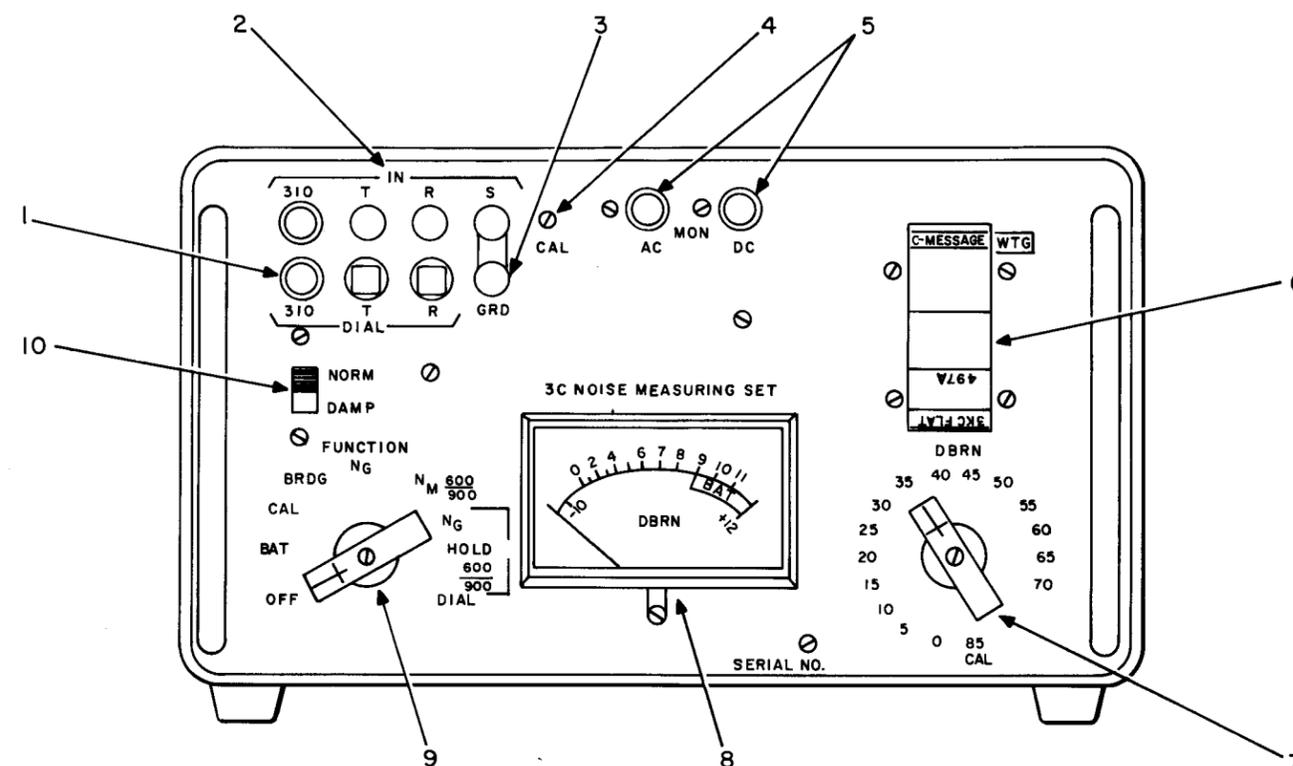


Fig. 4-12—3C Noise Measuring Set

- (2) Use a 1,000-Hz oscillator set to 0 dBm or calibrated milliwatt supply having an output impedance of 600 or 900 ohms to supply a calibration signal.
- (3) Adjust the DBRN switch to 80 (CAL) position.
- (4) Connect the input of the 3CR to the 1,000-Hz output.
- (5) Adjust the CAL screw for a meter indication of +10 (CAL).  $(80 + 10 = 90 \text{ dBm} = 0 \text{ dBm at 1,000 Hz})$ .

#### 21A Transmission Measuring Set (Fig. 4-13)

**4.104** The J94021A (21A) transmission measuring set (TMS) covered in SD-95115-01 is a portable measuring set used to transmit tones and measure gains and losses on voice and program transmission circuits. The TMS is powered from a suitable 115-volt 60 Hz source. The TMS is basically composed of an ac oscillator and a detector, which can be used separately or together in a looped arrangement. Monitoring capabilities are available through the MON jacks located on the front panel.

#### Calibration

**4.105** To insure accurate measurements the 21A should be checked for proper calibration before tests are made. The following procedure should be performed.

- (1) Connect the power cord to a 115V 60 Hz source; operate the ON/OFF switch to the ON position and allow 10 minutes for warm-up.
- (2) Set the FREQ MULT switch to X100 and FREQ dial to 10 (output of 1000 Hz).
- (3) Set DET INPUT and OSC OUTPUT switches to red 0.
- (4) Using a 2P14A, 3P14A, or equivalent cord, patch the OSC OUT 600A jacks to the DET IN 600A jacks.
- (5) Check that the meter indicates red 0 within 1 scale division.
- (6) Turn DET INPUT switch to white 0 and check that meter indicates black 0 within 1 scale division.
- (7) Turn OSC OUTPUT switches to black 0 and check that meter still indicates black 0 within 1 scale division.
- (8) Turn FREQ MULT switch to X10 and then to X100. Check that meter change is not more than 1 scale division in either position.

If check indicates further calibration, see Section 103-221-100.

#### Operation

**4.106** The following are typical procedures for using the 21A TMS.

#### Procedure for sending 0 dBm, 1000 Hz

- (1) Connect the power cord to the 115-volt ac power supply and if there is an associated test clip, connect it to building ground.
- (2) Operate the 115V 60 switch to the ON position.
- (3) Turn the FREQ MULT switch to X100 and the FREQ scale setting to 10.0 for 1000 Hz output.
- (4) Adjust OSC OUTPUT controls to 0 in the white or -dBm range.
- (5) Patch from the OSC OUT 600A jacks to the circuit under test.

#### Procedure for sending -16 dBm, 3300 Hz

- (1) Connect the power cord to the 115 Vac power supply and if there is an associated test clip, connect it to building ground.
- (2) Operate the 115V 60 switch to the ON position.
- (3) Turn the FREQ MULT switch to X1000 and the scale setting to 3.3 for 3300 Hz output.
- (4) Adjust the 10 dB step and the smooth OSC OUTPUT (right hand) controls to the white or -dBm scale settings of -10 and -6, respectively.

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- (5) Patch from the OSC OUT 600 $\Omega$  jacks to the circuit under test.

### Procedure for measuring received test power

- (1) Connect the power cord to the 115 Vac power supply and if there is an associated test clip, connect it to building ground.
- (2) Operate the 115V 60 switch to the ON position.
- (3) Turn the DET INPUT switch to maximum counterclockwise setting +20 or to the step nearest to the expected value if known.
- (4) Patch from the DET IN 600 $\Omega$  jack to the circuit under test.
- (5) Make the necessary arrangements for supplying testing power at the transmitting end of the circuit under test.
- (6) Increase by a clockwise turn the DET INPUT step control until an on-scale meter deflection is obtained. Note the color and designation of the DET INPUT switch setting. Read the meter pointer deflection using the red scale if the control step designation is positive or red, or the black scale if the control step designation is negative or white. Add the two values.
- (7) The sum is the magnitude of the received test power in dBm. A red plus "+", sign on control steps and meter scale indicates a power above 1 MW. A white minus, "-", control step designation sign with the black meter scale indicates a power below 1 MW.
- (8) If it is desired to make a monitoring observation of the input to the detector, connect a telephone headset to the MON jacks. The impedance of the monitoring set does not affect the measurement. The sensitivity adjustment which is suitable for on-scale meter indication is normally adequate for monitoring.

**4.107** If more detailed information on the 21A TMS is required, see Section 103-221-100.

### 23A Transmission Measuring Set (Fig. 4-14)

**4.108** The J94023A (23A) transmission measuring set (TMS) covered in SD-99700-01 is a

portable test set used to measure transmission levels of -15 to +10 dBm in the frequency range from 300 to 5000 Hz, on both 600- and 900-ohm circuits. Dialing and holding features are available for establishing connection of the test circuit. The 23A TMS is a measuring device and does not require batteries or external power.

### Calibration

**4.109** To insure accurate measurements the 23A TMS should be calibrated frequently, however, it is not usually necessary to calibrate before each measurement. Calibration procedures are given on the inside of the door that allows access to the calibration controls as well as in the following.

- (1) Place the set on a level surface with the meter face in a horizontal position.
- (2) Connect a 1000 Hz signal at 0 dBm to the T and R binding posts or to any MEAS jack.
- (3) Set the INPUT switch to 600 or 900 to match the impedance of the 1000 Hz source.
- (4) Set the DIAL-MEAS-SLV key to MEAS position.
- (5) Set the ADD DBM switch to 0 and adjust the potentiometer knob on inside of cabinet door for a reading of 0 on the meter.
- (6) Set the ADD DBM switch to +5 and adjust the lever on inside of door for a reading of -5 on the meter.
- (7) Repeat (5) and (6) until both the 0 and -5 readings are obtained without changing either adjustment (lever or knob).

### Operation

**4.110** When measuring signal levels with the 23A TMS, the following procedure can be performed.

- (1) Connect the circuit under test to either the MEAS (T & R) binding posts or MEAS jacks.
- (2) Operate INPUT switch to 600 or 900 to match the circuit under test.

- 1 — FREQ MULT switch changes the output frequency by factors of 10, 100, and 1000. The output frequency is determined by multiplying the switch setting by the setting of the FREQ dial.
- 2 — OSC OUT 600Ω jacks are used to connect the circuit under test to the output of the oscillator.
- 3 — DET IN 600Ω jacks are used to connect the circuit under test to the input of the detector circuit.
- 4 — 115V 60~ power cord and ON/OFF switch provide power to the test set
- 5 — DB meter indicated power of received signal. Red indicated values above 1MW Black indicated below 1MW.
- 6 — MON jacks are used to connect headset for listening purposes.
- 7 — DET SENS CAL adjustment is used in detailed calibration covered in Section 103-221-100.
- 8 — DET INPUT switch selects attenuation or gain for the input signal, therefore the switch setting is added to the meter indication. Red indicates values above 1MW and whites indicates valves below 1MW.
- 9 — OSC OUTPUT CAL adjustment is used in detailed calibration covered in Section 103-221-100.
- 10 — OSC OUTPUT switches control the output level of the oscillator (OSC OUT 600Ω jacks). Red indicates valves above 1MW and white indicates valves below 1MW.
- 11 — FREQ dial controls the output frequency on a scale of 2 to 20, however the FREQ MULT switch above changes this range for 20 to 20 KHz range.

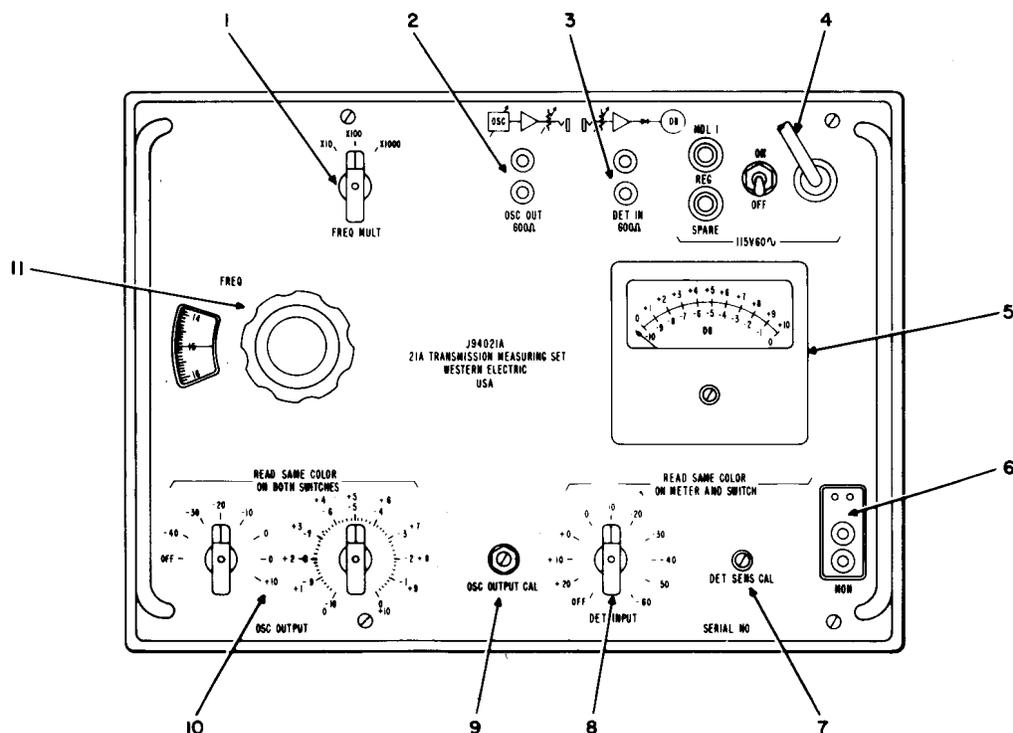


Fig. 4-13—21A Transmission Measuring Set

## SECTION 660-215-500

- (3) If a dial-up connection is desired, connect a handset or other dial equipment to the DIAL jacks, operate the DIAL-MEAS-SLV key to DIAL position, and establish the connection.
- (4) Operate the DIAL-MEAS-SLV key to MEAS position.
- (5) Operate the ADD DBM switch for an on scale indication on the DBM meter. The sum of the ADD DBM switch setting and meter indication is the measured level.

4.111 For more detailed information on the 23A TMS, see Section 103-223-100.

### 23D Transmission Measuring Set

4.112 The J94023D (23D) transmission measuring set (TMS) covered in SD-99700-04 is very similar to the 23A TMS covered in 4.108. The primary difference is that the feature that allows measurement of PBX cord circuits has been replaced by a provision for using the dialing and holding features with other externally connected test equipment. Calibration and operation are basically the same and therefore are not covered here. (For more detailed information on the 23D TMS, see Section 103-223-100.)

### TTS 4ANH Transmission Test Sets (Fig. 4-15)

4.113 The TTS 4ANH transmission test set (manufactured by Northeast Electronics) is a portable set designed to make transmission measurement on telephone circuits. The information on the 4ANH also applies to the 4AN TTS unless otherwise stated. The 4ANH TTS can be powered from internal batteries or -48V office battery. The oscillator is capable of sending 10 fixed frequencies from 300 to 3500 Hz at output levels of 0, -5, -10, -16, -20, -30, and -40 dBm. The receive portion is capable of measuring levels from -50 dBm to +18 dBm.

#### Calibration

4.114 The following procedure should be used to calibrate the 4ANH TTS before measurements are made.

- (1) Set SEND LEVEL and REC LEVEL controls to 0 (CAL) position.

- (2) Set FUNCTION switch to CAL SEND position.
- (3) Set the SEND IMP switch to 600P.
- (4) Adjust the CAL SEND control for a zero indication on the meter.
- (5) Set the FUNCTION switch to CAL REC position.
- (6) Adjust the CAL REC control for zero on the meter.

#### Operation

4.115 The following procedure should be used when testing with the 4ANH TTS.

- (1) Calibrate test set as covered in 4.114.

#### TO TALK

- (2) Connect line to be tested to LINE 310 or LINE 309 jack depending on type of plug available.
- (3) Connect 52 or 53 type telephone set to TEL SET jack.
- (4) Operate LINE key to TALK. This connects the telephone set to line.

#### TO SEND TONE

- (5) Set SEND FREQ to desired frequency.
- (6) Set SEND LEVEL to desired level.
- (7) Set SEND IMP to desired sending impedance.
- (8) Operate LINE key to SEND. This connects the output of the oscillator to the line.
- (9) After a predetermined length of time, restore the LINE key to TALK.

#### TO MEASURE TONE

- (10) Set REC IMP to desired impedance.
- (11) Request tone to be sent.
- (12) When tone is heard in the telephone set, operate LINE key to REC.

- 1 — DBM meter indicates the received level in association with the ADD DBM switch.
- 2 — DIAL jacks are used to connect a handset or other dial equipment to establish dial-up connections to a circuit.
- 3 — X jack is used to make measurements at a manual PBX where 1000-Hz test power is supplied from the central office.
- 4 — MEAS jacks are used to connect the circuit under test.
- 5 — MEAS (T, R) binding posts are same as MEAS jack (see 4) above.
- 6 — SM, SD binding posts are connected to measure- and dial-sleeve circuits, respectively.
- 7 — SX binding post is used to connect to X jack when DIAL/MEAS/SLV key is in SLV position.
- 8 — ADD DBM switch controls the attenuation to the input level. Sum of meter indication and switch setting is actual measured value.
- 9 — DIAL/MEAS/SLV key selects one of three functions:
  - 1) DIAL — dialing capabilities are connected to circuit under test
  - 2) MEAS — circuit under test connected to measure circuit in 23A
  - 3) SLV — supplies ground to ring side for holding connection to test power.
- 10 — INPUT switch selects the impedance to match the test circuit (600 or 900-ohms).

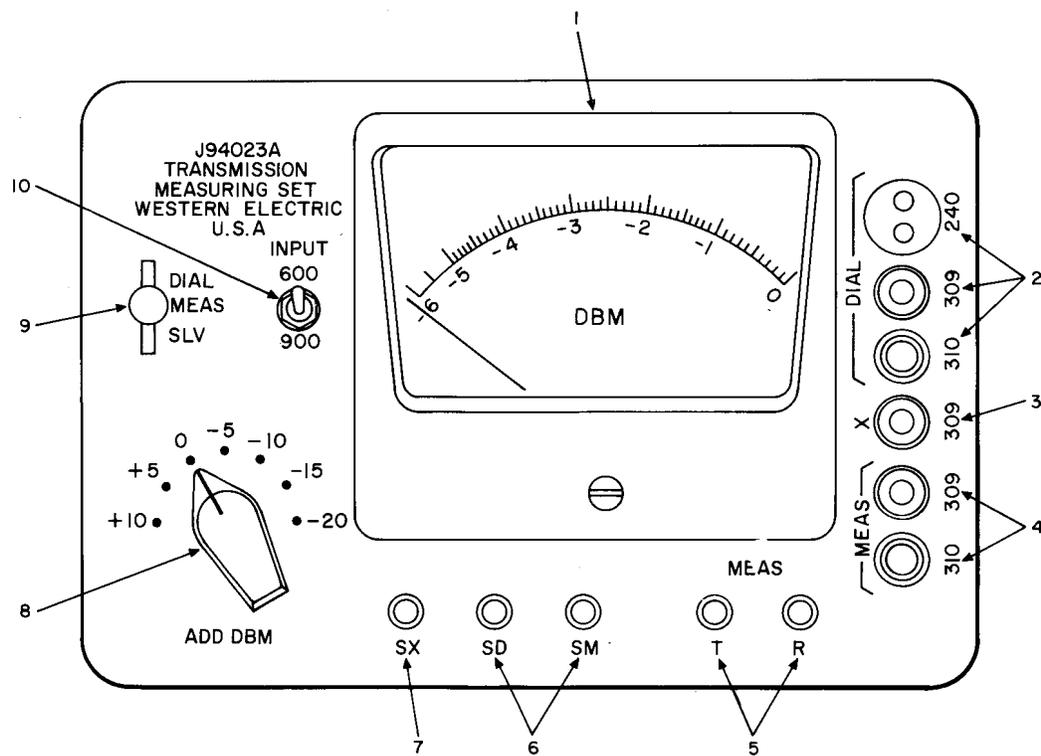


Fig. 4-14—23A Transmission Measuring Set

## SECTION 660-215-500

(13) Turn REC LEVEL switch to obtain a convenient reading on the meter (between the -3 and +3 marks, if possible). The level is the algebraic sum of the REC LEVEL switch and the meter reading.

### TTS 4BNH-N Transmission Test Set

**4.116** The TTS 4BNH-N transmission test set is very similar to the 4ANH covered in 4.113. The major difference is that the 4BNH-N has the capability of making noise measurements. Since both calibration and operation are similar to the 4ANH they are not covered here.

### 15B Transmission Test Set (Fig. 4-16)

**4.117** The 15B transmission test set (manufactured by Northeast Electronics) is a portable, battery powered test set used to test transmission circuits. The 15B can measure levels from +13 dBm to -37 dBm and send levels from 0 dBm to -37 dBm over a range of either fixed frequencies. A hold circuit and dial feature allow establishment of dial-up connections to test circuits.

#### Calibration

**4.118** Calibration of the 15B should be performed before any series of tests are made. The mechanical zero of the meter should be checked and, if necessary, adjusted using the screw type adjustment. The following calibration procedure is divided into two parts, Battery Check and Send Level Calibration.

#### Battery Check

- (1) Operate the SEND IMP and REC IMP switches to 600.
- (2) Turn the FUNCTION switch to SEND ADJ position.
- (3) Operate the TERM/BRIDGE switch to the TERM position.
- (4) Operate the FILTER switch to OUT position.
- (5) Turn the SEND ADJ control completely clockwise.
- (6) Operate the POWER switch to ON.

(7) The meter should indicate at least +1.5 in the red portion of the scale. If not, replace the batteries.

#### Send Level Calibration

- (1) Turn POWER switch to ON.
- (2) Check batteries as described above.
- (3) Set MEAS/900 $\Omega$  + 2 $\mu$ F TERM switch to MEAS.
- (4) Set HOLD switch to OFF.
- (5) Set TERM/BRIDGE switch to TERM.
- (6) Set SEND IMP switch to circuit impedance.
- (7) Set REC IMP same as SEND IMP.
- (8) Set FILTER switch to OUT position.
- (9) Operate SEND FREQ switch to 1000 position.
- (10) Operate REC LEVEL switch to nearest setting of desired sending level.
- (11) Set FUNCTION switch to SEND ADJ.
- (12) Adjust SEND ADJ control to 0 dBm on meter.

#### Operation

**4.119** The following procedures give steps for operation of the test set in two categories: sending tone and measuring tone. To dial (and talk) through the test set the following procedure should be used.

- (1) Turn POWER switch to ON.
- (2) Operate HOLD switch to OFF.
- (3) Connect a handset to EXT jack or binding posts.
- (4) Turn FUNCTION switch to LINE EXT position.
- (5) Connect the circuit under test to LINE jack.
- (6) Dial the desired number.

1. EXT FREQ jack is used to connect an external oscillator.
2. Meter displays level received. The true level is the sum of meter indication and switch setting.
3. CAL REC control is used to adjust the receive circuit.
4. POWER switch selects internal power (ON) or external source (48V).
5. 48V jack is used to connect external source of 48 volts.
6. REC LEVEL control is used to add attenuation to the signal displayed by the meter.
7. REC IMP key selects the impedance of the receive circuitry.
8. LINE key selects the mode of operation of the test set.
9. FUNCTION switch selects operation of test set.
10. INPUT jacks are used to connect to the circuit under test and to external equipment if needed.
11. LINE/MON key selects mode of operation of the test set.
12. SEND LEVEL switch controls output level of test set.
13. SEND IMP switch selects output impedance.
14. SEND FREQ switch selects from eight fixed frequencies or an external source (EXT FREQ) for the output of the test set.
15. CAL SEND control is used to adjust the send circuit.

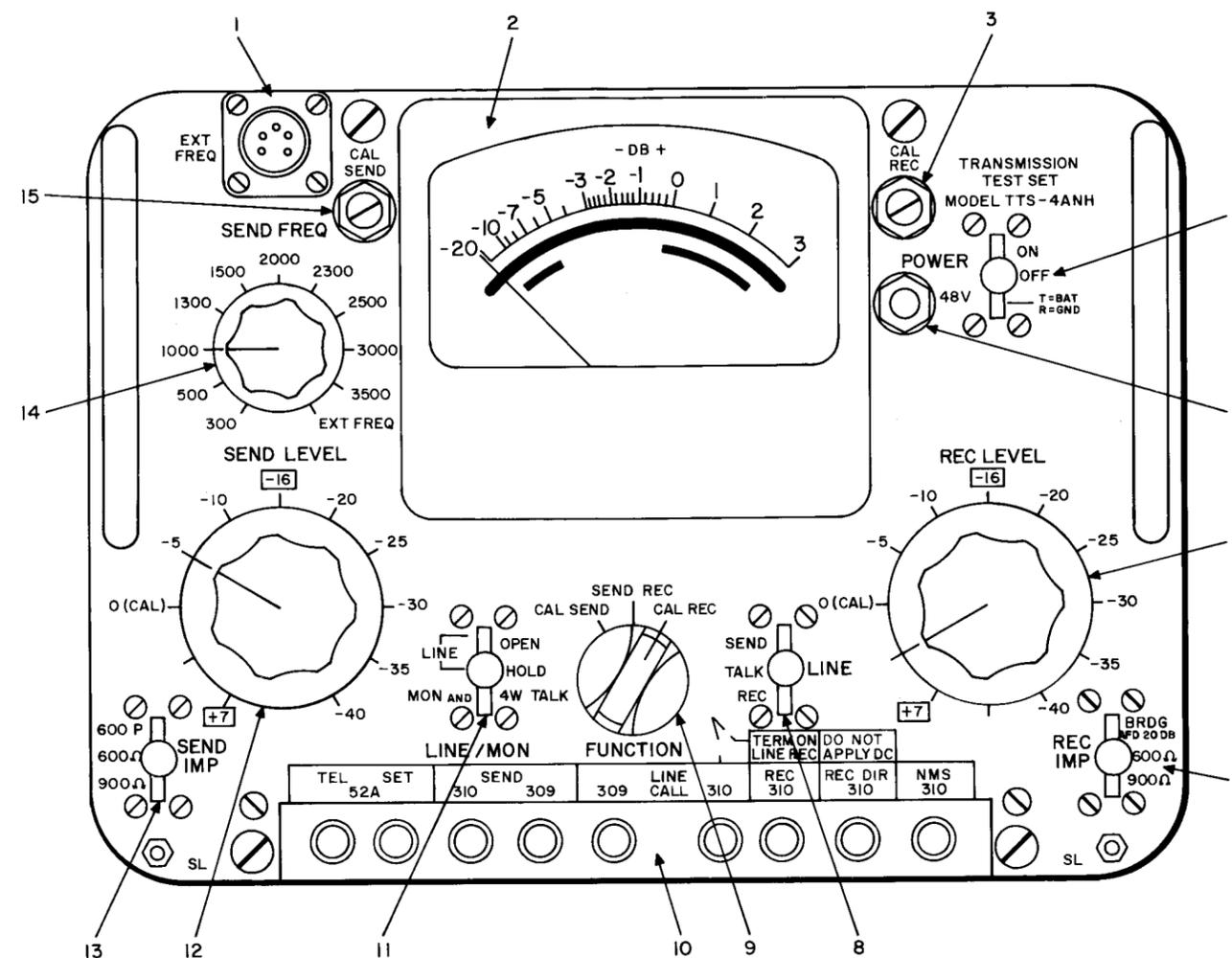


Fig. 4-15—4ANH Transmission Test Set

**4.120** To send tone on the line jack or binding posts, the following procedure should be used.

- (1) Turn POWER switch to ON.
- (2) Check batteries as described in 4.118.
- (3) Set MEAS/900 + 2  $\mu$ F TERM switch to MEAS.
- (4) Set HOLD switch to OFF.
- (5) Set SEND IMP switch to circuit impedance.
- (6) Set FREQ switch to desired frequency.
- (7) Set REC LEVEL switch for correct level.
- (8) Operate FUNCTION switch to SEND ADJ.
- (9) Adjust the SEND ADJ control for desired send level on meter.
- (10) Operate FUNCTION switch to LINE SEND.
- (11) Connect the circuit under test to LINE jack or binding posts.

**4.121** To measure a received tone on the line jack or binding posts, the following procedure should be used.

- (1) Turn the POWER switch to ON.
- (2) Check batteries as described in 4.118.
- (3) Operate MEAS/900 + 2  $\mu$ F TERM switch to MEAS position.
- (4) Set HOLD switch to OFF.
- (5) Set the TERM/BRIDGE switch to either TERM for a terminated measurement or BRIDGE for a bridged measurement.
- (6) Operate REC IMP switch to impedance of the circuit under test.
- (7) Set REC LEVEL switch to +10 position.
- (8) Operate FUNCTION switch to LINE REC position.

(9) Connect the circuit under test to LINE jack or binding posts.

(10) Adjust the REC LEVEL switch to obtain a meter indication between +3 and -3. The received level is the sum of the meter indication and the REC LEVEL switch setting.

**4.122** For more detailed information see the instruction manual normally accompanying the test set.

### **35B Transmission Measuring Set (Fig. 4-17)**

**4.123** The 35B transmission measuring set (TMS) (manufactured by Northeast Electronics), is a portable, battery operated, test set used to perform transmission and noise measurements. The send oscillator is capable of supplying eight fixed frequencies at output levels ranging from +3 dBm to -40 dBm.

#### **Calibration**

**4.124** Calibration of the 35B is limited to checking the batteries and calibration of the receive circuit. The following procedures should be used.

#### **Battery Check**

- (1) Set POWER switch to BATT.
- (2) Depress BATT TEST switch and observe that meter indicates in the GOOD area.

#### **Receive Circuit Calibration**

- (1) Using a 600 or 900 ohm 0 dBm at 1 kHz source, set up the 35B for receiving measurements. (See 4.125.)
- (2) Set SENS switch to 0.
- (3) VU-DB should indicate  $0 \pm 0.2$  dB.

#### **Operation**

**4.125** The following procedures cover some typical tests using the 35B.

#### **To send on 2-wire circuit:**

- (1) Operate the POWER switch to the appropriate ON position.

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- (2) Set the SEND FREQ switch to the desired frequency.
- (3) Set FILTER switch at 15 KC.
- (4) Set SND IMP switch to 600 or 900 depending on circuit impedance.
- (5) Set REC IMP switch same as SND IMP switch.
- (6) Set SEND LEVEL switch to 0.
- (7) Set A HOLD switch to OFF.
- (8) Set B HOLD switch to ON.
- (9) Set LINE switch to SND A.
- (10) Set FUNCTION switch to SND ADJ.
- (11) Set EXT CKT switch to MEAS A AND B.
- (12) Set INPUT switch to TERM.
- (13) Set the SENS switches as desired and adjust SEND ADJ control for 0 dB on black scale of meter.
- (14) Set FUNCTION switch to 2 WIRE (LA).
- (15) Connect circuit under test to A jack.

### **To receive on 2-wire circuit:**

- (1) Operate POWER switch to the appropriate position.
- (2) Set SEND ADJ control to OFF.
- (3) Set FILTER switch to desired position.
- (4) Set REC IMP switch to 600 or 900, according to circuit impedance.
- (5) Set LINE switch to SND A REC B.
- (6) Set FUNCTION switch to 2-wire (LA).
- (7) Set INPUT switch to TERM, unless making a bridged measurement.
- (8) Connect circuit under test to B jack.

- (9) Set EXT CKT switch to MEAS A AND B.
- (10) Adjust SENS switches for meter indications between +3 and -3 dB.

**4.126** To measure noise the procedure is the same as above except:

FILTER switch set to NOISE.

Meter indication between 7 dBrn and 13 dBrn on blue scale.

**4.127** For more detailed information on the 35B TMS see the instruction manual normally accompanying the test set.

### **54A Transmission Measuring Set (Fig. 4-18)**

**4.128** The J99254A (54A) transmission measuring set (TMS) covered in SD-97024-01 is a portable measuring set used to measure the individual gains of the series and shunt converters as well as the combined series and shunt converter gains of the E6 repeater. It also can be used to make a high-level gain test, just below the overload point of the E6 repeater so as to detect possible transistor malfunction that may not be apparent at lower signal levels. These gain measurements are made at 1000-Hz only. The 54A TMS is powered from a 48-volt supply in either of three ways: (1) through power jacks in the 54B test stand (see 4.208), (2) directly through the power jacks in the repeater bay, or (3) directly from an external power supply, such as the J87241B power supply.

### **Calibration**

**4.129** Calibration of the 54A is accomplished by setting switch S2 to the CAL position and adjusting the CAL ADJ control wheel for a 0 reading on the meter.

### **Operation**

**4.130** The operation of the 54A as discussed in this section is intended to check that the gain-unit gain of the E6 has remained at the initially-adjusted value  $\pm 0.2$  dB and that the gain-unit circuit is capable of handling loud speech signals without distortion. This test detects transistor failures which cannot be measured at lower test levels.

- |                                       |                      |  |
|---------------------------------------|----------------------|--|
| 1. LINE jack and binding posts        | All                  | Provides access to the SEND or RECEIVE circuitry within the set.   |
| 2. METER                              | TTS 15B and TTS 15BR | Provides a visual indication of received levels and instrument calibration.  |
|                                       | TTS 15C              | Provides visual indication of received levels instrument calibration and condition of power source.  |
| 3. EXT jack and binding posts         | All                  | Provides access to the send or receive circuitry within the set.   |
| 4. BRIDGE/TERM switch                 | All                  | Permits the operator to bridge or terminate the connections appearing at the LINE jack or binding posts.   |
| 5. POWER ON/OFF switch                | TTS 15B              | Applies internal battery power to the circuitry within the set.  |
| BATT/OFF/48V switch                   | TTS 15BR             | Provides power switching, input connections and protection against currents exceeding 200mA.   |
| POWER ON/OFF switch and 48V jack      | TTS 15C              | Provides power switching and input connections.  |
| 6. REC IMP switch                     | All                  | Selects the terminating impedance of the receiving circuitry within the set (600Ω or 900Ω).  |
| 7. FILTER IN/OUT switch               | All                  | Switches the high pass filter into or out of the receive circuitry.  |
| 8. REC LEVEL rotary attenuator switch | All                  | Adjusts the sensitivity of the receive circuitry over a range of 30dB in steps of 5dB.   |
| 9. CASE GND jack                      | TTS 15B              | Provides access to the case ground of the set.   |
| 10. FUNCTION switch                   | All                  | Determines one of the following five modes of operation:<br>(1) SEND ADJ — connects the SEND SECTION to the level measuring section to permit calibration of the SEND level.<br>(2) LINE/SEND — connects the SEND SECTION to the LINE jack.<br>(3) LINE/EXT — connects the LINE jack directly to the EXT jack. |

- |  |                     |  |
|--|---------------------|--|
| 10. FUNCTION switch (Cont)               |                     | (4) LINE/REC — connects the level measuring section to the LINE jack and connects the EXT jack to the receiver output for monitoring.<br>(5) LINE REC/EXT SEND — connects the level measuring section to the LINE jack and simultaneously connects the SEND SECTION to the EXT jack. |
| 11. External frequency network connector | TTS 15B and TTS 15C | Provides for the insertion of the external frequency determining network.  |
| REC CAL potentiometer                    | TTS 15BR            | Provides a sensitivity adjustment of the receive circuitry.  |
| 12. SEND FREQ rotary switch              | All                 | Selects either one of eight internal fixed frequencies or the external frequency determining network accessory.  |
| 13. SEND ADJ potentiometer               | All                 | Provides an adjustment of output level.  |
| 14. SEND IMP switch                      | All                 | Selects the output impedance for the send circuitry within the set.  |
| 15. HOLD ON/OFF switch                   | All                 | Switches a hold coil across the LINE jack or binding posts.  |
| 16. MEAS/900+2μF TERM switch             | All                 | Switches the receive circuitry or the 900Ω+2μF termination across the LINE Jack or binding posts.  |

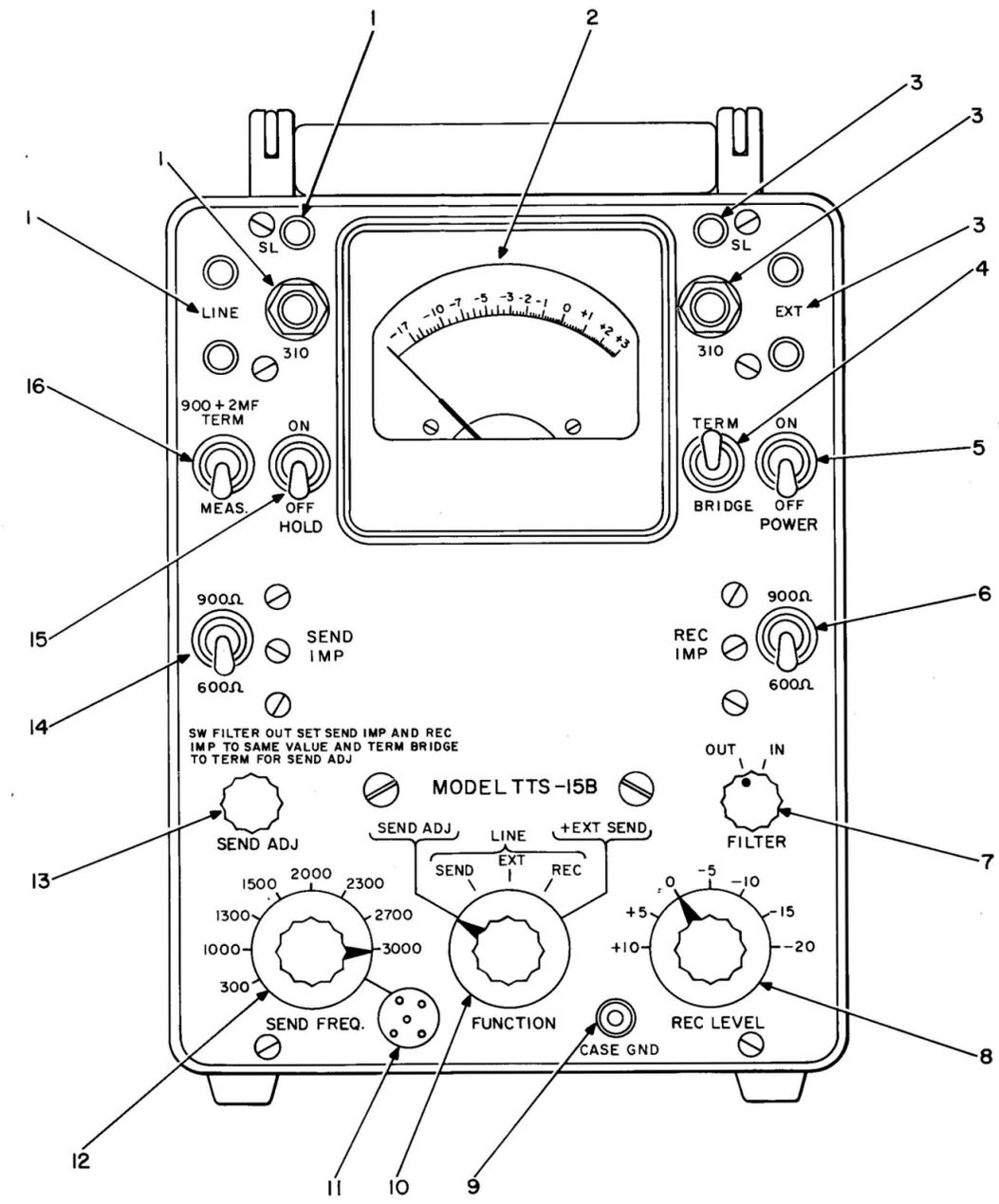


Fig. 4-16—15B Transmission Test Set

- 1 — SEND FREQ switch selects one of eight fixed send frequencies.
- 2 — SEND ADJ controls the output level of send circuit.
- 3 — EXT FREQ connector used to connect external frequency source.
- 4 — VU-DB meter indicates send level, receive level, and battery voltage.
- 5 — BATT TEST switch when depressed connects meter for testing battery source.
- 6 — FILTER switch selects the receiver frequency response filter used in measurement.
- 7 — REC IMP & TERM B switch selects receiver input impedance of 600Ω or 900Ω.
- 8 — SENS switches increases the range of the meter by adjusting the receiver sensitivity. Sum of SENS switches and meter indication is actual received level.
- 9 — LINE B HOLD switch connects hold coil across B jack.
- 10 — SENS switches increases the range of the meter by adjusting the receiver sensitivity. Sum of SENS switches and meter indication is actual received level.
- 11 — INPUT switch selects receiver input impedance required for bridged (BRDG), terminated (TERM), or noise-to-ground (N-GND) measurements.
- 12 — EXT CKT OR TEL SET switch controls connections of AX and BX jacks during 2- and 4-wire measurements.
- 13 — AC MON jack is used to connect external measuring equipment or headset.
- 14 — FUNCTION switch selects mode of measurement: 2-wire, 4-wire, or SND ADJ.
- 15 — LINE switch controls status of send and receive circuits during 2-wire and 4-wire measurements.
- 16 — T-BAT/S-GND jack is used to connect external source of 48 volts.
- 17 — POWER switch selects power source and removes power from set. BATT position connects to internal batteries, and 48V position to external source.
- 18 — SEND LEVEL switch inserts 10dB loss in the output of the send circuit.
- 19 — LINE A HOLD switch connects hold coil across A jack.
- 20 — SEND IMP & TERM A switch selects send circuit output impedance, 600 or 900 ohms.

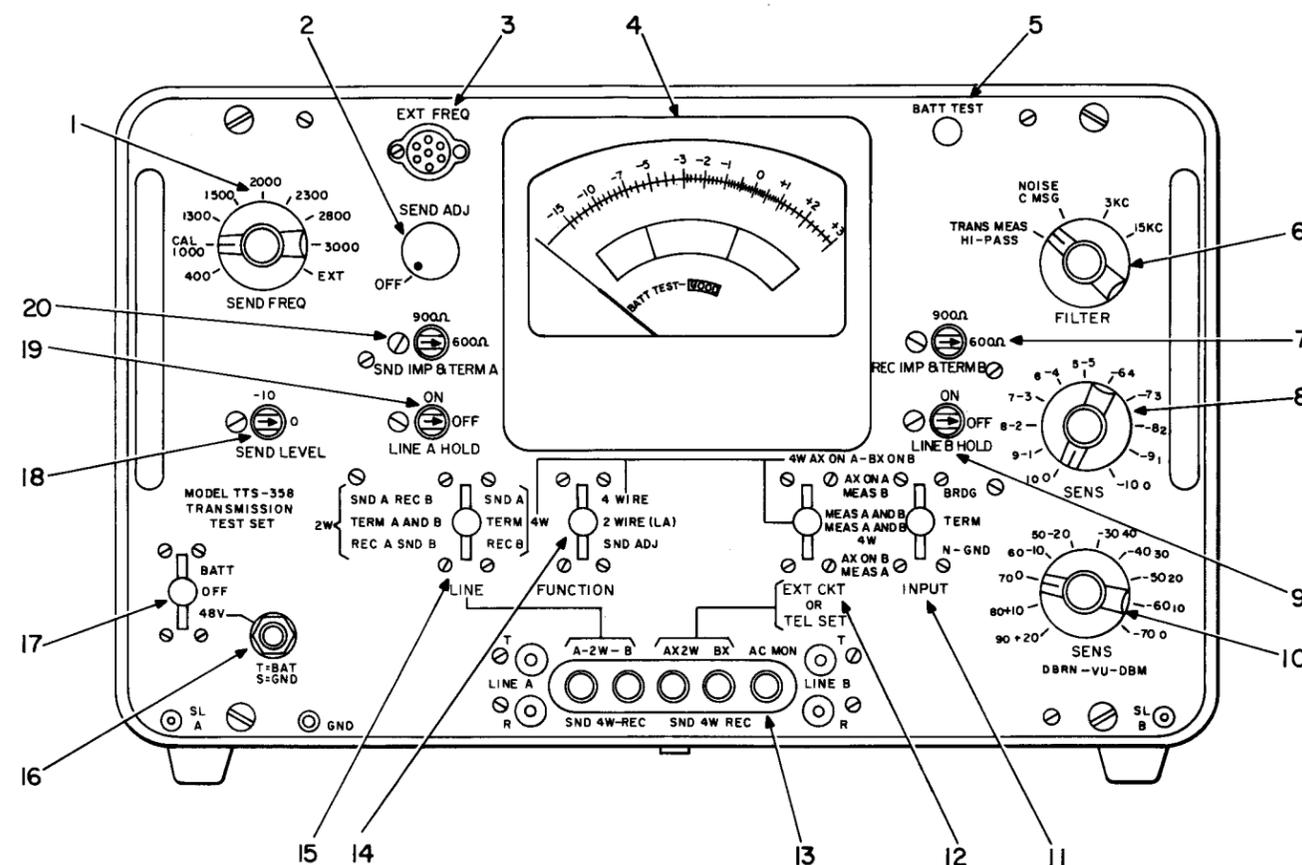


Fig. 4-17—35B Transmission Test Set

- 1 — A and B jack is used to connect to the 54B test stand.
- 2 — TST PWR socket is used to connect to the power connection of the 54B test stand.
- 3 — -DB+ meter indicates the level of the E6 repeater being measured.
- 4 — S3 switch selects shunt, series, or combined converters for measurement.
- 5 — S1 switch adjusts the attenuation to the input of the meter. Add switch setting and meter indication for actual measured value.
- 6 — CAL ADJ control is used to calibrate the meter when switch S2 is in CAL position.
- 7 — MON jacks are used to connect a headset for monitoring the gain of the repeater for possible singing.
- 8 — S2 switch selects the function of the test set, measure, load measure, or calibration.

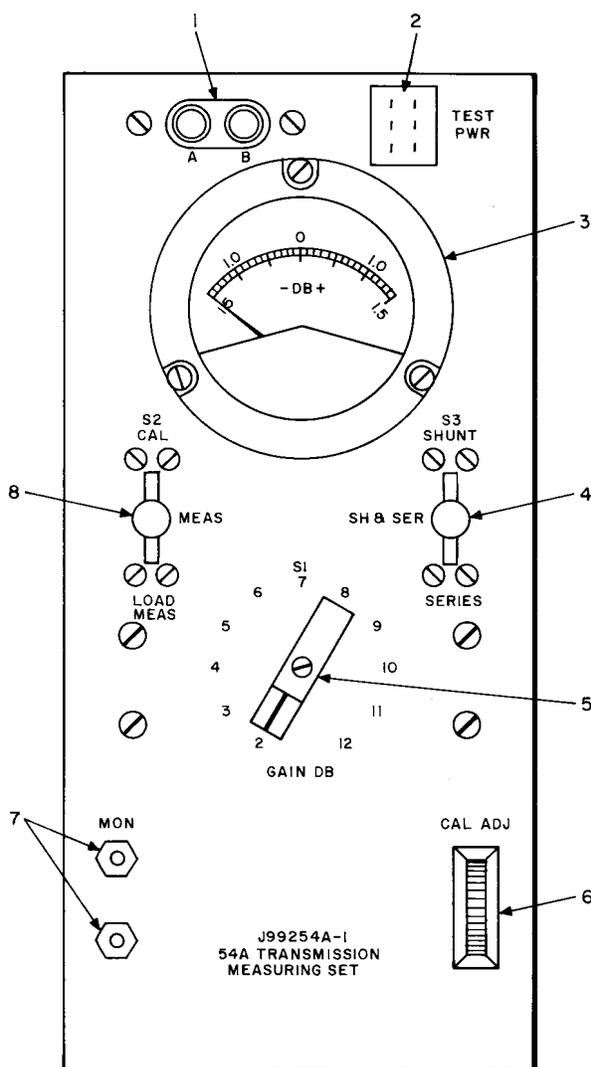


Fig. 4-18—54A Transmission Measuring Set

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**4.131** The following procedure is for gain and overload tests when test jacks are installed at the E6 bay. In this case the measurement can be made using the 54A TMS without removing the circuit from service.

- (1) Connect the P5F cord from the PWR jack on the 54A TMS to the PWR jack on the E6 repeater bay.
- (2) Connect a KS-14418 monitoring headset equipped with a 419A plug to the monitor jacks of the 54A TMS.
- (3) Connect one end of a 6P1A cord equipped with 338A or 425A plugs to the A and B jacks of the 54A TMS.
- (4) Operate S2 to CAL and adjust CAL ADJ for a 0 dB indication on the meter.
- (5) Release S2.
- (6) While monitoring with the headset, carefully insert the remaining end of the 6P1A cord part way into the test jacks of the repeater under test until the level of the tone drops. Monitor for an idle circuit, and when it becomes idle insert the plug fully.
- (7) Adjust S1 until the meter indicates a reading between 0 and +1 dB. Note the meter reading plus the setting of S1.
- (8) Operate S2 to the LOAD MEAS position and again note the meter reading.
- (9) Compare the readings obtained in Steps 7 and 8 with the original MEAS and LOAD MEAS values recorded on the front of the repeater.
- (10) If the values for MEAS are  $\pm 0.1$  dB and LOAD MEAS drop is less than 0.4 dB, the readings are satisfactory.
- (11) If the low level gain differs by 0.2 dB or more from the initial gain, the converters should be readjusted. However, if during the readjustment the series or shunt converter is more than 0.2 dB from the gains listed in Table A of Section 332-206-500, the 831-type gain unit should be marked defective and replaced with a spare unit.

(12) If the high level overload test causes a drop of more than 0.4 dB on the meter, the 831-type network should be marked defective and replaced with a spare unit.

**4.132** Where no test jacks are provided, the following procedure should be used for gain and overload tests. In addition to the 54A TMS a J99254B (54B) test stand and an additional power cord is required.

- (1) Set up the 54B test stand and 54A TMS near the -48V power outlet associated with the E6 repeater bay.
- (2) Using a P5F power cord, connect the TST PWR jack on the 54B to the -48V distribution outlet on the bay.
- (3) Connect the TEST PWR jack on the 54A TMS to the TMS TST PWR jack on the 54B test stand using a P5F cord.
- (4) Patch the TMS A and B jacks on the 54B test stand to the A and B jacks on the 54A TMS with 3P7B cords equipped with 310-type plugs.
- (5) Obtain a release or turn down the circuit to be tested.
- (6) Remove the repeater from the bay and insert it into the 54B test stand.
- (7) Operate S2 to the CAL position and adjust CAL ADJ for a 0 dB indication on the meter.
- (8) Release S2.
- (9) Adjust S1 until the meter indicates a reading between 0 and +1 dB. Note the meter reading plus the setting of S1.
- (10) Operate S2 to the LOAD MEAS position and note the meter reading.
- (11) Compare the readings obtained in Steps 9 and 10 with the original gain and overload values written on the front of the repeater.
- (12) If the gain values are within  $\pm 0.2$  and the LOAD MEAS drop is less than 0.4 dB, the readings are satisfactory.

- (13) If the low level gain differs by 0.2 dB or more from the initial gain, the converters should be readjusted. However, if during the readjustment the series or shunt converter is more than 0.2 dB from the gains listed in Table 4-A, the 831-type network should be marked defective and replaced with a spare unit.
- (14) If the high level overload tests cause a drop of more than 0.4 dB on the meter, the 831-type network should be marked defective and replaced with a spare unit.
- (15) If the tests prove satisfactory, return the repeater to its position in the bay.

#### 1110A Transmission/Noise Test Set (Fig. 4-19)

**4.133** The 1110A transmission/noise test set (manufactured by Telecommunications Technology, Inc.) is a portable test set designed to measure transmission levels, noise, and frequency. Frequency measurements are recorded on a separate display while either of the other measurements are being made. The test set also has an oscillator for sending tones from -40 dBm to +8 dBm at frequencies from 45 Hz to 60 kHz at the same time measurements are made. Monitor access, dial up and hold features are also available from the test set.

#### Calibration

**4.134** Calibration of the 1110A is not normally required and therefore is not covered here.

#### Operation

**4.135** Basically, three procedures cover the operation of the 1110A test set: send tone, level measurements, and noise measurements. These are covered in the following paragraphs. If frequency measurements alone are desired, use either the procedure for level measurements or noise measurements.

**4.136** To make transmission level measurements using the test set the following procedures should be used.

- (1) Set the POWER switch to the in position (power off).

- (2) Set the power slide switch on the rear panel to correspond with the source to be used.
- (3) Plug the power cord into the source and set the POWER switch to the out position (power on).
- (4) Operate the IMPEDANCE selection button corresponding to the impedance of the circuit under test.
- (5) Connect the circuit under test to the INPUT jack (or the SIGNAL INPUT terminal on the rear panel).
- (6) If a bridged measurement is desired set the TERM/BRDG switch to BRDG position. Set to TERM for terminated measurement.
- (7) If a dial up connection is required, connect a handset to the DIAL jack, operate the TERM/BRDG switch to TERM, operate the DIAL/TEST switch to DIAL, and dial the connection. Place the DIAL/TEST switch in the TEST position before unplugging the handset.
- (8) Operate the FUNCTION switch marked dBm to the in position.
- (9) The received level is indicated on the digital display in dBm. If rapid signal variations are observed, push the DAMPING switch in to steady the indication.
- (10) The frequency of the received signal is indicated on the righthand digital display when the COUNTER switch RCV/SEND is in the RCV position.

**4.137** To make noise measurements using the 1110A, the following procedure should be used:

- (1) Repeat Steps 1 through 4 in 4.136.
- (2) Operate the FUNCTION switch  $N_M$  or  $N_G$  to the in position.

**Note:**  $N_M$  switch is operated for metallic noise measurements (across tip and ring) and  $N_G$  is operated for noise-to-ground measurements (tip and ring to ground).

- (3) Select the appropriate noise weighting network by pushing one of the three NOISE WEIGHTING buttons.

**Note:** The 1110A is equipped with C-Message network, however, the others are optional.

- (4) Set the TERM/BRDG switch to the desired position.
- (5) Push the IMPEDANCE selection button corresponding to the impedance of the circuit under test.
- (6) The noise received is indicated on the digital display in dBrn. If rapid signal variations are observed, push the DAMPING SWITCH while reading the noise. If the Nc switch is operated add 40 dB to the digital display.
- (7) The frequency of the received signal is indicated on the right hand display when the COUNTER switch RCV/SEND is in the RCV position.

**4.138** To send tone at a given level and frequency using the 1110A test set, the following procedures should be used.

- (1) Repeat Steps 1 through 3 of 4.136.
- (2) Connect the OUT jack to the INPUT jack.
- (3) Set both IMPEDANCE pushbutton and switch to impedance of circuit under test.
- (4) Set FUNCTION switch dBm to in position.
- (5) Set TERM/BRDG switch to TERM.
- (6) Set COUNTER switch RCV/SEND to SEND.
- (7) Set FREQUENCY switch to either LO or HI; LO for frequencies from 45 Hz to 3500 Hz, and HI for frequencies from 2 kHz to 60 kHz.
- (8) Adjust the FREQUENCY knob for the desired output frequency as indicated on the righthand digital display.
- (9) Set the LEVEL controls to the desired output as indicated in dBm on the digital display.

- (10) Remove the connection to the INPUT jack and connect the OUT jack to the circuit under test.

**4.139** For more information on the 1110A see the instruction manual normally accompanying the test set.

#### **1105A Noise and Level Test Set (Fig. 4-19)**

**4.140** The 1105A noise and level test set (manufactured by Telecommunications Technology, Inc.) is a portable test set designed to make transmission level and noise measurements. The 1105A is identical to the measure circuit of the 1110A covered in 4.133 through 4.139. The oscillator portion and frequency measuring circuit are omitted. Since the operation is the same as the 1110A for level and noise see 4.136 through 4.137 and omit the step concerning frequency. For more information see the instruction manual on the 1105A.

#### **1103B Transmission Test Set (Fig. 4-20)**

**4.141** The 1103B transmission test set (manufactured by Telecommunications Technology Inc.) is a portable test set designed to measure transmission levels and frequency. The test set also has an oscillator capable of sending tones from -29 dBm to +10 dBm at frequencies from 25 Hz to 60 kHz. Dial up and hold features are also included. The 1103B is available in two models; one is powered by 115 Vac or 230 Vac and the other is powered by 115 Vac or internal batteries.

#### **Calibration**

**4.142** Calibration of the 1103B is not normally required and therefore is not covered here.

#### **Operation**

**4.143** Three basic operations can be performed using the 1103B test set, measure transmission level, measure frequency and send tone. Procedures for these are given in the following paragraphs.

**4.144** To measure transmission levels using the 11103B, the following procedure should be used.

- (1) Connect the test set to the appropriate power source and operate the POWER switch to the out position (power on).
- (2) Set the dBm/kHz switch to dBm.
- (3) Operate the TERMINATION pushbuttons for the appropriate impedance and type of measurement desired [BRDG (bridged) or TERM (terminated)]. If a dial up connection is desired the TERM switch must be in. For dial-up connection refer to Step 6 of 4.136.
- (4) Set the TEST/DIAL switch to TEST position.
- (5) Connect the circuit under test to the INPUT jack and operate the OUTPUT/INPUT switch to INPUT.
- (6) The level measurement is indicated on the display in dBm. If rapid variations are observed, operate the DAMPING switch IN to stabilize the indication.

**4.145** To measure the frequency of a signal using the 1103B, the above procedure should be used, except Step 2, the dBm/kHz switch should be set to kHz. The frequency measurement is indicated on the display in kHz.

**4.146** To send tone at a given level and frequency the following procedure should be used.

- (1) Repeat Steps 1 through 4 of 4.144.
- (2) Set the TERMINATION pushbuttons to the desired impedance and type measurement.
- (3) Set the OUTPUT/INPUT switch to OUTPUT.
- (4) Set TEST/DIAL switch to TEST position.
- (5) Set the dBm/kHz switch to dBm and adjust the LEVEL knob for the desired output as indicated on the display.
- (6) Set the dBm/kHz switch to kHz position.
- (7) Set the HI/LOW switch to desired position; LOW for frequencies from 25 Hz to 5 kHz, HI for frequencies from 1 kHz to 60 kHz.
- (8) Adjust the FREQUENCY knob for the desired output as indicated on the display.

- (9) Connect the circuit under test to the OUTPUT jack.

#### 1111A Line Switch (Fig. 4-19)

**4.147** The 1111A line switch (manufactured by Telecommunications Technology, Inc.) is an optional addition to the 1110A transmission/noise test set (see 4.128) which simultaneously holds two dialed up circuits. The 1111A permits the tester to use the 1110A to send on one circuit while receiving on the other, then to switch the send/receive direction without dropping either circuit. A built-in speaker permits audible monitoring of all tests.

#### Calibration

**4.148** The 1111A line switch requires no calibration but the switch position CAL permits both the level and frequency of the 1110A oscillator output to be simultaneously displayed, for each calibration of the output of the 1110A.

#### Operation

**4.149** When using the 1111A for two-trunk testing (loop around), the following procedure should be used.

- (1) Connect the two circuits to the two jacks (one circuit to one jack) on the 1111A line switch. The jacks are associated with the appropriate LINE 1 and LINE 2 positions of the 1111A switch.
- (2) Operate the 1111A switch to LINE 1 RCV-DIAL.
- (3) On the 1110A, connect a handset to the DIAL jack, operate the DIAL/TEST switch to DIAL, and TERM/BRDG key to TERM. DIAL up the desired connection.
- (4) Operate the 1111A switch to LINE 2 RCV-DIAL.
- (5) Repeat Step 3.

**Note:** A circuit connection can be dropped by operating the 1111A switch to the correct LINE RCV/DIAL position and the TERM/BRDG key to BRDG.

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(6) Now that the two circuits are connected, set the DIAL/TEST key on the 1110A to TEST and the 1111A switch to either LINE 1 SEND/LINE 2 RCV or LINE 2 SEND/LINE 1 RCV. By reversing the position of this switch, the oscillator output and the measuring circuit input of the 1110A can be reversed without dropping either circuit connection.

### 3550B Portable Test Set (Fig. 4-21)

**4.150** The 3550B portable test set (manufactured by Hewlett-Packard) is used for measurement of attenuation, gain and frequency response on transmission facilities. The test set can be rack mounted by using a rack adapter frame. The 3550B is composed of an oscillator, a patch panel and an AC voltmeter. The oscillator and voltmeter are operated from a rechargeable battery power supply, whereas the patch panel is a passive device and requires no power supply.

### Calibration

**4.151** Calibration procedures for the 3550B are essentially a check of the battery supply. The battery check procedures are given below.

- (1) Ensure that voltage selector switches on rear of oscillator and voltmeter are positioned correctly.
- (2) Operate FUNCTION switch to BATT TEST position. If meter does not indicate at least 2.4 volts on the 0-3 volt range, the batteries must be charged.
- (3) Set MEAS-CAL switch on patch panel to CAL position, OUTPUT IMPEDANCE control to 600, and FREQ switch to < KC position.
- (4) Rotate oscillator RANGE control to X10 position.
- (5) Terminate oscillator with 600 ohms, and adjust AMPLITUDE control clockwise as far as possible. The voltmeter should indicate at least 2.5 volts or the batteries must be charged.

### Operation

**4.152** To perform measurements using the 3550B, the following procedure should be used.

### Sending End

- (1) Turn the set on and check batteries as described above.
- (2) Set oscillator FREQ dial and RANGE switch as desired. (See Note.)
- (3) Set patch panel MEAS-CAL switch to CAL and OUTPUT IMPEDANCE switch to match impedance of circuit under test.
- (4) Connect patch panel OUTPUT to input terminals of circuit under test.
- (5) Adjust oscillator AMPLITUDE control to the level specified for the system. This level is indicated on the voltmeter.
- (6) Set patch panel MEAS-CAL switch to MEAS.

**Note:** To assure the exact frequency output, an external frequency counter can be used to monitor, while establishing the correct output.

### Receiving End

- (1) Set voltmeter RANGE switch to level desired.
- (2) Set patch panel MEAS CAL switch to MEAS and FREQ switch to correspond to testing frequency.
- (3) Set patch panel INPUT IMPEDANCE switch to match impedance of circuit under test, or to BRDG if the circuit is to be measured while connected to its normal load.
- (4) Connect the patch panel INPUT terminal to the circuit under test.
- (5) Indication on voltmeter is level measured.

**4.153** The above procedures can be used to make loop around transmission measurements also. For more detailed information on the 3550B, see the manufacturers manual.

- 1 — DAMPING switch is used to stabilize display for rapidly varying signals.
- 2 — FUNCTION switches select type of measurement:  
dBm — transmission level measurements  
Nm — metallic noise measurements  
Ng — noise-to-ground measurements
- 3 — Digital display indicates frequency of received or transmitted signal.  
Resolution of the display is either 1 Hz or 10 Hz.
- 4 — RCV/SEND switch selects the input to the frequency counter.
- 5 — 1 Hz/10 Hz switch selects resolution of display.
- 6 — L0/H1 switch selects frequency bands for oscillator output. L0 position allows output frequencies from 35 Hz to 3500 Hz and H1.
- 7 — FREQUENCY control permits varying the oscillator output frequency within the L0 or H1 bands.
- 8 — OUT jack is used to connect the output of the oscillator to the circuit under test.
- 9 — 135 /600 /900 switch selects the output impedance of the oscillator. The switch should be set to correspond to the impedance of the circuit under test.
- 10 — LEVEL VAR control permits varying the output level of the oscillator.
- 11 — LEVEL switch selects three fixed output levels and two variable levels.
- 12 — MON jack permits monitoring the circuit under test.
- 13 — NOTCH switch inserts the 1010 Hz notch filter for making notched noise measurements. This filter removes the 1010 Hz holding tone and permits measurement of only the noise.
- 14 — NOISE WEIGHTING switches select the appropriate noise weighting network; C-message, 3KHz Flat, 8 KHz program, and 15 KHz Flat.
- 15 — FILTER switch inserts a bandpass filter for noise protection during level measurements.

- 16 — DIAL/TEST switch select either dial mode or test mode.
- 17 — INPUT jack used to connect circuit under test.
- 18 — TERM/BRDG switch selects either a terminated or bridged type measurement.
- 19 — DIAL jack is used to connect handset or equivalent dial equipment.
- 20 — IMPEDANCE switches selects input impedance of test set.
- 21 — POWER switch turns the test set ON (out position) and OFF (in position).
- 22 — Digital readout shows level in dBm and noise in dBm.

- 23. VOL control
- 24. LINE 2 RCV jack
- 25. LINE 2 SEND jack
- 26. LINE 2 jack
- 27. LINE 1 jack
- 28. LINE 1 SEND jack
- 29. SWITCH
- 30. LINE 1 RCV jack

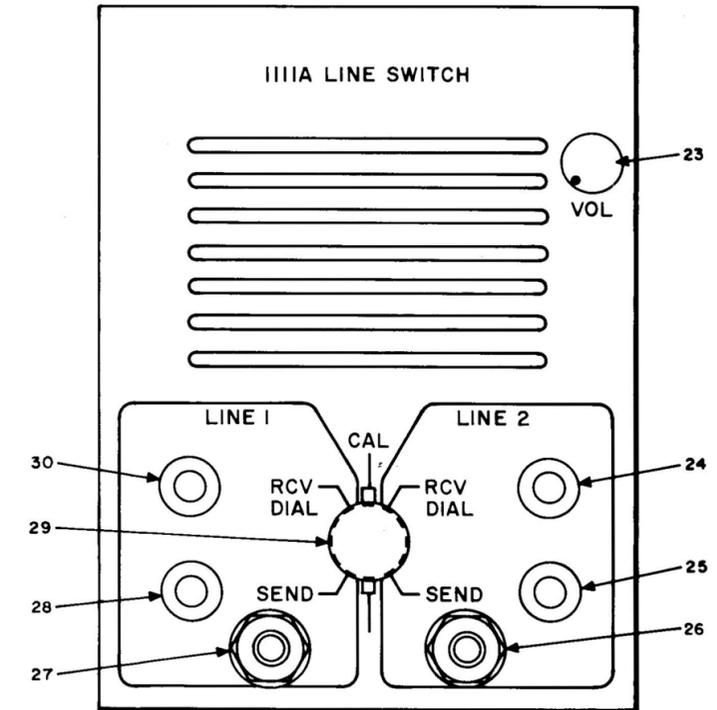
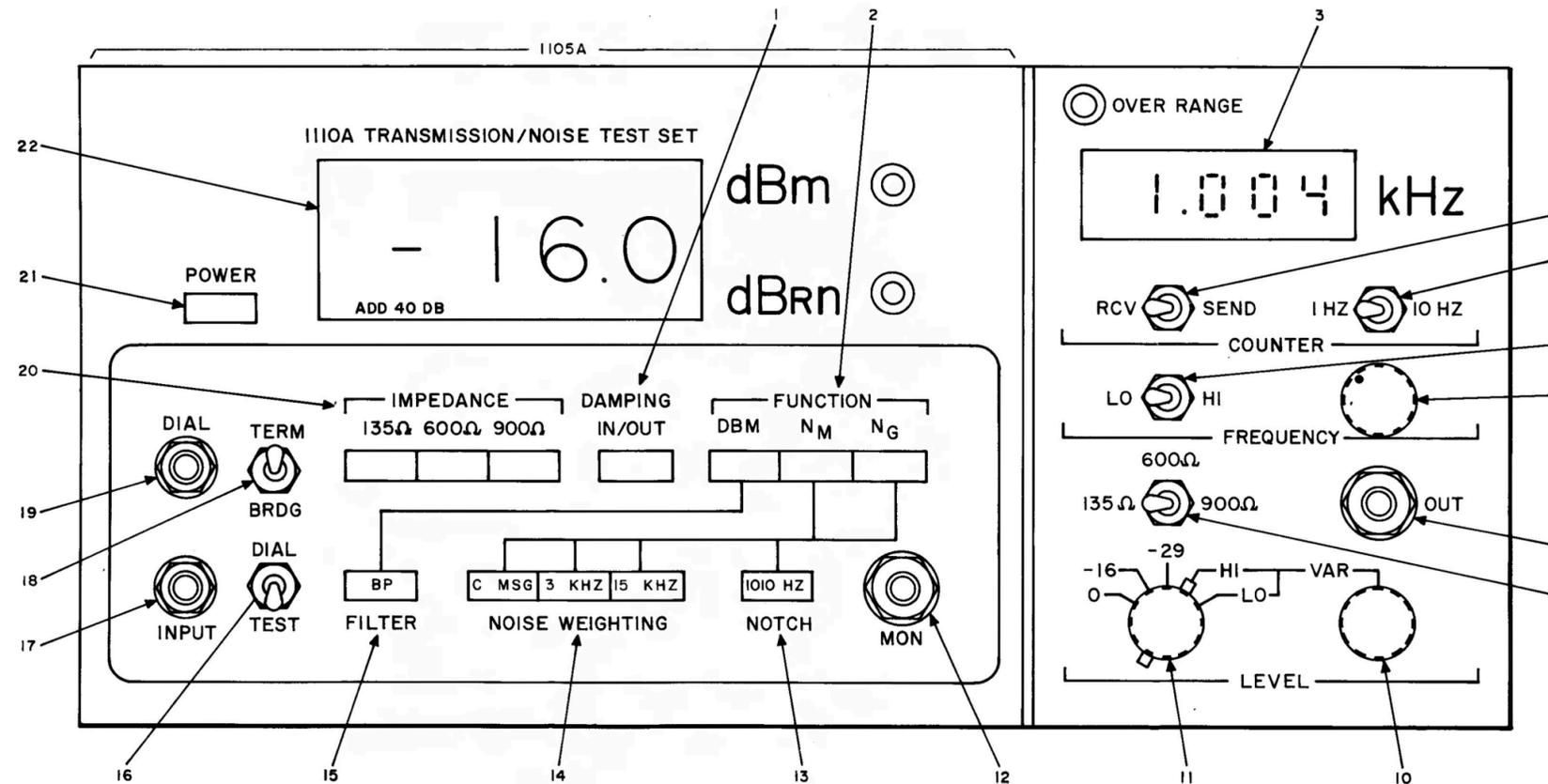


Fig. 4-19—1110A Transmission/Noise Test Set

1. POWER switch turns the test set ON (out position) and OFF (in position).
2. Digital display indicates level in dBm and frequency in KHz.
3. dBm/kHz switch selects either level or frequency measurements. The switch has three kHz positions, for 10 Hz, 1 Hz, and 0.1 Hz resolution.
4. FILTER switch inserts a noise protection filter.
5. DIAL jack is used to connect a handset or other dial equipment.
6. INPUT jack is used to connect the circuit under test to the input of the measure circuit.
7. OUTPUT/INPUT switch selects the signal being measured and displayed. In the OUTPUT position the oscillator output is indicated on the display.
8. TEST/DIAL selects the test function (measurement) or dial function (dial up connections, etc).
9. 135 $\Omega$ , 600 $\Omega$ , and 900 $\Omega$  switches select the input/output impedance of the test set.
10. FREQUENCY control allows for adjusting the output frequency within the HI or LOW bands.
11. HI/LOW switch selects either of two frequency bands, LOW position allows output frequencies from 25 Hz to 5 kHz and the HI position allows output frequencies from 4.5 kHz to 60 kHz.
12. LEVEL control is used to vary the output level of the oscillator.
13. OUTPUT jack is used to connect the circuit under test.
14. BRDG and TERM switches select either a bridged or terminated measurement.
15. DAMPING switch is used to stabilize the display for rapidly varying signals.

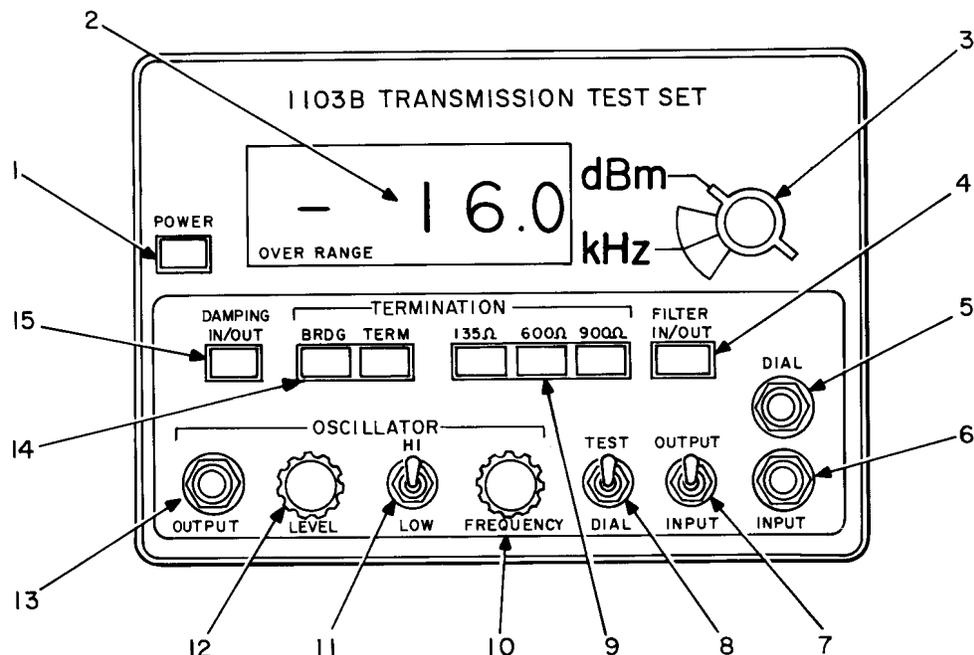


Fig. 4-20—1103B Transmission Test Set

- |      |                            |   |      |                         |  |
|------|----------------------------|---|------|-------------------------|--|
| 1.   | Frequency Dial             | Selects frequency within desired range. Dial setting multiplied by RANGE switch position indicates output frequency.                    | 18.  | DB control              | Provides attenuation of 10 dB to 110 dB between OSC terminal and output terminals in steps of 1 dB or 10 dB.                         |
| 2.   | Frequency Vernier          | Provides fine tuning of frequency dial.   | 19.  | OSC Connector           | Receives test signal from oscillator.  |
| 3.   | OUTPUT terminals           | Provide output connections to circuit being tested.   | 20.  | AMPLITUDE Control       | Selects desired output level from 0 to 5 volts rms (2.5 volts rms into 600Ω).  |
| 4.   | IMPEDANCE control (OUTPUT) | Selects output impedances of 135, 600, or 900 ohms to match impedance of transmission line being tested.                                | 21.  | Output Terminals        | Provides a 600Ω output at a frequency and amplitude determined by control settings.  |
| 5.   | MEAS-CAL switch            | Enables measurement of the signal from circuit under test on MEAS, or measurement of the signal from the oscillator on CAL.             | 22.  | SYNC                    | 1. Provides an input for an external sync signal.<br>2. Provides an output sync signal of 1.7 V rms.                                 |
| 6.   | IMPEDANCE control (INPUT)  | Selects input impedances to terminate the transmission line in 135, 600, 900, or 10,000 ohms.   | 23.  | RANGE switch            | Selects frequency range. In OFF position the batteries will charge (if connected to an ac source) but the oscillator is inoperative. |
| 7.   | INPUT terminals            | Provide input connections from circuit being tested.  | REAR | Distortion Switch       | Permits normal output or low distortion output on X5 or X10 frequency ranges.  |
| 8.   | DECIBELS RMS VOLTS meter   | Indicates voltages or decibels within range selected by the RANGE VOLTS DB control.   | REAR | CHARGE RATE switch      | Selects SLOW or FAST rate of recharging the nickel-cadmium cells.  |
| 9.   | Meter zero adjust          | Provides a means of setting the meter pointer to return.  | REAR | Ground strap            | Connects the floating circuit common to powerline ground when closed.  |
| 10.  | RANGE VOLTS DB control     | Selects range containing voltages to be measured. Volts from 0.001 to 300 and from -72 to +52 dB in 12 amperes (1, 3, and 10 sequence.) | REAR | Voltage Selector switch | Selects line voltage of 115 volts or 230 volts ac.   |
| 11.  | FUNCTION switch indicator  | Glowes when FUNCTION switch is at ON.   | 24.  | Ac power receptacle     | Provides connection to power receptacles on oscillator and voltmeter.  |
| 12.  | FUNCTION switch            | Provides positions for battery test and turning voltmeter off or on.  |      |                         |  |
| 13.  | INPUT terminals            | Provide input connections and chassis ground.   |      |                         |  |
| 14.  | Connecting Cables          | -hp- 11035A, dual banana plug to BNC, 12 inches.  |      |                         |  |
| 15.  | BATT. CHARGE indicator     | Lights red when FUNCTION switch is at ON and Test Set is connected to an ac power source.   |      |                         |  |
| REAR | Voltage                    | Permits operation from 115 volts or 230 volts ac.   |      |                         |  |
| REAR | AC power receptacle        | Connects voltmeter to power receptacle on test set cabinet  |      |                         |  |
| 16.  | VM connector               | Provides connection to voltmeter.   |      |                         |  |
| 17.  | FREQ switch                | Selects 50 Hz to 5 kHz or 5 kHz to 560 kHz frequency response.  |      |                         |  |

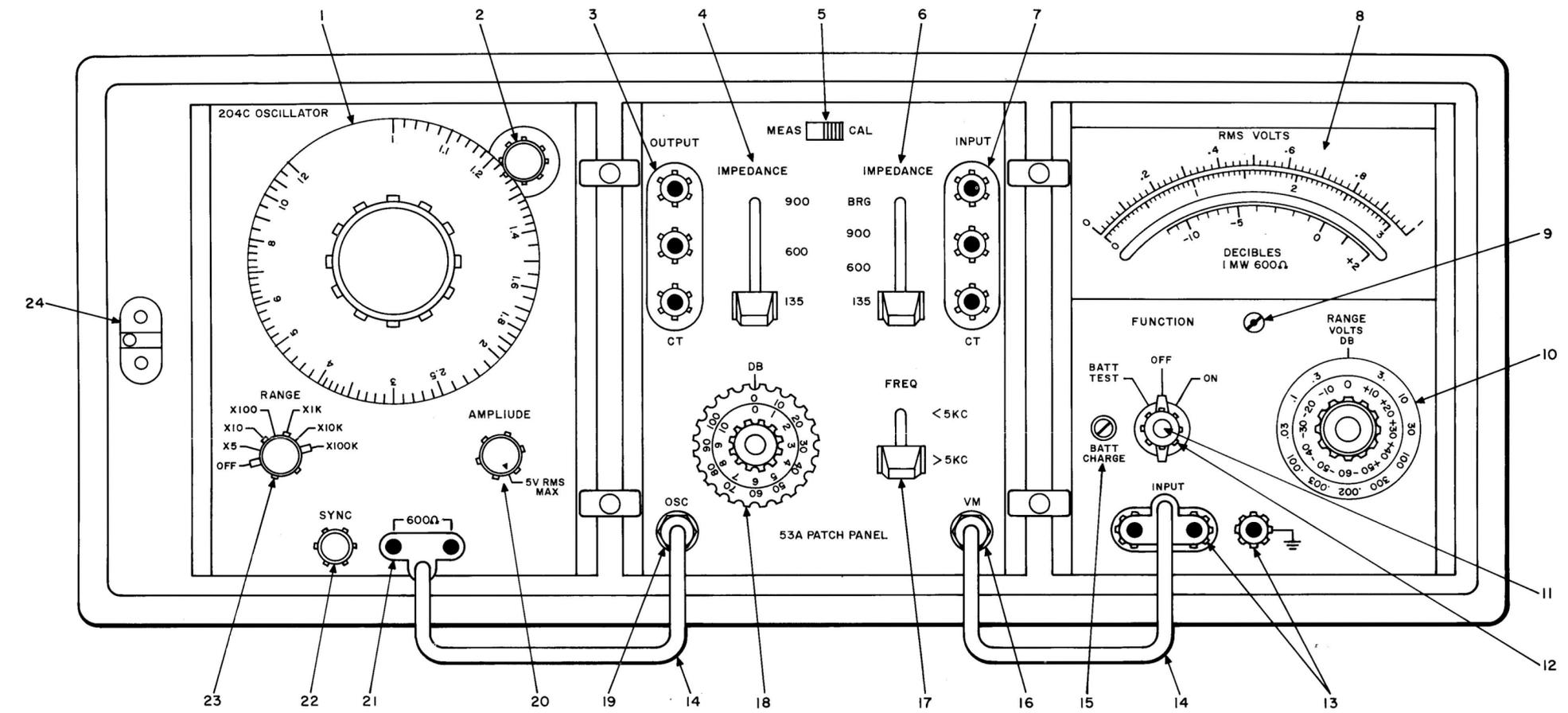


Fig. 4-21—Hewlett Packard Model 3550B Portable Test Set

**MISCELLANEOUS TEST EQUIPMENT****KS-19260 L1 Oscillator (Fig. 4-22)**

**4.154** The KS-19260-L1 oscillator (manufactured by Hewlett-Packard) generates sine-wave signals of from 100 Hz to 10 kHz at an output power level that is adjustable from +10 dBm to -30 dBm. Oscillator frequency is selected from two ranges by push buttons. From 100 to 999 Hz, frequency selection is in increments of 1 Hz, and from 1000 to 9990 Hz, selection is in 10 Hz increments. The FREQUENCY VERNIER control provides selection of frequencies between the 1 Hz and 10 Hz increments. This control also extends the oscillator output from 9990 Hz to 10 kHz. Output of the oscillator is via terminals on the rear panel, which can be wired to a jack field.

**Calibration**

**4.155** Calibration of the KS-19260 is not normally required except for maintenance purposes. Since the frequency, distortion, and balance calibration procedures are involved and require removing the cabinet, they are not covered here. However, calibration of the output power is covered in the following procedure.

(1) Connect a 600-ohm load and ac voltmeter across the 600Ω OUTPUT terminals on rear panel.

(2) Set the KS-19260 controls as follows:

FREQUENCY	100
MULTIPLIER	X10 CPS
FREQUENCY VERNIER	OUT
OUTPUT LEVEL	+10 dB
OUTPUT VERNIER	OUT

(3) Adjust OUTPUT CAL ADJ on rear panel for 2.45 volts indication on voltmeter.

**Operation**

**4.156** The following procedure should be used in operating the KS-19260 oscillator.

(1) Connect the output of oscillator to the circuit under test, 600 or 900 ohms. (Do not use both 600Ω and 900Ω outputs at the same time.)

(2) Select desired frequency using MULTIPLIER push button and FREQUENCY push buttons. Example: If the desired frequency is 4730 Hz, depress MULTIPLIER X10 CPS, and FREQUENCY pushbuttons as follows; 1st row number 4, 2nd row number 7, and 3rd row number 3.

(3) Operate OUTPUT LEVEL controls for desired output power level.

**4.157** If more detailed information is desired, see Section 103-302-100.

**KS-19353 L1 Oscillator (Fig. 4-23)**

**4.158** The KS-19353 L1 oscillator (manufactured by Northeast Electronics) is a variable frequency oscillator covering a range from 50 Hz to 560 kHz. It delivers any power level in the range from +10 dBm to -30 dBm with balanced output impedances of 600 or 900 ohms from 50 Hz to 50 kHz and 130 ohms from 5 kHz to 560 kHz. The oscillator is operated from an internal battery supply (12 D-size flashlight batteries) or a source of 115 volts 60 Hz.

**Calibration**

**4.159** Calibration is not normally required unless circuit elements have been changed, in which case Section 103-302-105 should be consulted. Before the oscillator is used for testing, the battery supply (internal or external) should be checked as follows.

**Internal Batteries**

(1) Place the FUNCTION switch in the DIAL/BAT position.

(2) Place the AC-BAT switch (on rear of the set) in the BAT position.

(3) Operate the POWER switch to the ON position.

(4) Observe the deflection of the BAT TEST meter. This must be within the green area, or the batteries should be replaced.

**External Supply**

- (1) Connect the AC power cord from the rear of the set to a suitable 115V 60 Hz source.
- (2) Place the AC/BAT switch on the rear of the set to the AC position.
- (3) Operate the POWER switch to the ON position.
- (4) Place the FUNCTION switch to DIAL/BAT and observe that the BAT TEST meter reads within the green area.

**Operation**

**4.160** The following procedure should be used to send a signal at a specific level and frequency using the KS-19353 L1 oscillator.

- (1) Turn the POWER switch to ON.
- (2) Set the FREQUENCY VERNIER to the OUT position.
- (3) Set the main tuning dial and FREQ RANGE switch to the desired frequency. If the frequency is critical, connect an external frequency counter to the appropriate OUTPUT jack and readjust the dials.
- (4) Operate the FUNCTION switch to the desired output impedance and connect an external power meter to an appropriate OUTPUT jack.
- (5) Set the OUTPUT LEVEL and OUTPUT VERNIER controls to give the desired output level as indicated on the meter. Disconnect the power meter.
- (6) If it is necessary to dial and hold a connection for testing, connect the line into the OUTPUT jack.
- (7) Connect a handset to the DIAL jack, place the FUNCTION switch to the DIAL/BAT position, and dial the desired number.
- (8) To send the tone at given output level and frequency, operate the FUNCTION switch to the desired output impedance.

**4.161** For more detailed information on the KS-19353 L1 oscillator, see Section 103-302-105.

**KS-19353 L4 Oscillator (Fig. 4-24)**

**4.162** The KS-19353 L4 oscillator (manufactured by Hewlett-Packard) is a variable frequency oscillator having a frequency range from 50 Hz to 560 kHz. It delivers power levels adjustable from +10 dBm to -31 dBm in steps of 10, 1, and 0.1 dBm. The FUNCTION switch selects a balanced output impedance of 600 or 900 ohms for frequencies from 50 Hz to 20 kHz and 135 ohms for frequencies from 5 kHz to 560 kHz. In two positions of the FUNCTION switch a hold feature of 600 and 900 ohm simulates an off-hook condition for holding a dial up connection. The oscillator is powered from either the internal 45-volt battery or an external source of 115/230 volts ac.

**Calibration**

**4.163** The following procedure should be used to calibrate the oscillator.

**Output Power**

- (1) Set FREQ RANGE switch to X100 and FREQUENCY CPS dial to 10 (output frequency of 1000 Hz).
- (2) Set FUNCTION switch to 600 and OUTPUT LEVEL control to 0 dBm.
- (3) Connect the oscillator OUTPUT to the INPUT of a 21A or 23A TMS.
- (4) Adjust the oscillator CAL OUTPUT ADJ for a 0 dBm indication on the 21A or 23A TMS.

**Output Frequency**

- (1) Check the frequency with a counter. If indicated error exceeds 3 percent, the oscillator should be sent to repair center for calibration.

**Operation**

**4.164** The following procedure should be used when operating the KS-19353 L4 oscillator.

- (1) Set the slide switch marked BAT/AC to correspond to the power source.
- (2) Operate the POWER switch to the ON position.
- (3) Connect the circuit under test to the OUTPUT jacks.

(4) Rotate the FUNCTION switch to the DIAL/DC position. The D.C. TEST meter should indicate in the GOOD area or the batteries need replacing.

(5) If a dial up connection is needed, connect a handset to the DIAL jacks and dial the desired number.

(6) After connection is established, rotate the FUNCTION switch to either 600 HOLD or 900 HOLD position.

(7) Set the FREQ RANGE switch and FREQUENCY CPS dial to the desired frequency.

(8) Set the OUTPUT LEVEL controls for the desired level.

**4.165** For more detailed information see the instruction manual normally accompanying the oscillator.

#### **2D Singing Point Test Set (Fig. 4-25 and 4-26)**

**4.166** The J94002D (2D) singing point test set covered in SD-95114-01 is portable and arranged for operation from a 115V 60 Hz supply. The 2D set is designed primarily for checking the impedance match in circuits employing hybrid coils, at test appearances such as 4-wire testboards, 4-wire voice frequency patching bays, and 2-wire repeater bays. The 2D set is also useful in obtaining the optimum adjustment of building-out networks from a singing standpoint.

**4.167** Input and output of the 2D is via two double jacks mounted on the front of the test set. These jacks are marked IN and OUT and accept connections to cords equipped with 241-type plugs, or equivalent. Two other double jacks are mounted on the front panel of the test set, one pair marked TST FREQ and the other marked MON. The MON jacks are used to connect a standard head set for monitoring singing point tests. The jacks designated TST FREQ are multiplied to the MON jacks with two 300-ohm resistors in series. An adjustable frequency oscillator may be connected to these jacks for the purpose of determining the singing frequency by the audible beat method of comparison. The TST FREQ jacks are on all sets except for a small initial production.

**4.168** Two rotary type dials, GAIN DB, allow adjustment of the gain of the two amplifier units in the 2D test set. The dial on the left is

adjustable in 5 dB steps from 0 to 50 dB while the dial on the right is adjustable in 1 dB steps from 0 to 10 dB.

**4.169** The FILTER switch connects the low pass filter into the test circuit when set to the IN position and limits the upper singing frequency obtained with the test set to about 3.5 kHz. When the FILTER switch is in the OUT position, the frequency range is extended to above 5 kHz.

**4.170** Since the reflected energy of a circuit can be returned in phase as well as out of phase, it is necessary to make singing point tests in both conditions. The POLING switch is used to reverse the output conductors, thereby changing the phase of the signal in the circuit. Singing point tests are made in both the NORMAL and the REVERSED positions and the lowest numerical reading is the gain necessary to cause the circuit to sing.

#### **Calibration**

**4.171** Calibration of the 2D is really a measure of the net gain between input and output. To do this the following procedure should be performed.

- (1) With the GAIN DB dials set to 0 dB, insert 1 mW at 1000 Hz into the IN jack.
- (2) Measure the output, OUT jack, for 1 mW output.
- (3) If the output is not 1 mW, the gain control potentiometer of the 2D set should be adjusted, until the output is 1 mW.

#### **Operation**

**4.172** To make a singing point test with the 2D the following procedure should be used.

- (1) Connect the 2D to a source of 115V 60Hz and clip the ground lead to framework ground.
- (2) Operate the ON/OFF switch to ON and allow at least two minutes for stabilization.
- (3) Check the calibration as described in 4.171.
- (4) Operate FILTER switch to OUT and POLING switch to NORMAL.

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- 1 — Push buttons for selecting frequency range. When X1 CPS is depressed, frequency range is 100 to 999 Hz in 1-Hz increments; with X10 CPS depressed, frequency range is 1000 to 9990 Hz in 10-Hz increments.
- 2 — Push buttons for selecting frequency within chosen range. The top row (1ST) selects the hundreds digit, middle row (2ND) selects the tens digit, and bottom row (3RD) selects the units digit. When X10 CPS is depressed, the digits selected are multiplied by 10 (top row now represents the thousands digit, etc.).
- 3 — When push button is depressed, oscillator is inoperative.
- 4 — Allows oscillator to be set to frequencies between 1-Hz or 10-Hz increments. When push buttons are set for 9990 Hz, this control will extend oscillator frequency to at least 10 kHz. In OUT position, control is inoperative and oscillator frequency is as indicated by push buttons.
- 5 — For selecting desired output level in 10 db steps.
- 6 — Indicates oscillator is operating; glows when OFF push button is not depressed.
- 7 — For selecting desired output level in 1-db steps. Used together, the 1- and 10-db step controls provide a total range of 40 db.
- 8 — Provides adjustment for output levels between 1-db steps. With 1-db step control in its 0 position, 10-db step control in its +10 position, and OUTPUT VERNIER in its OUT position, the output power level is 10 milliwatts.

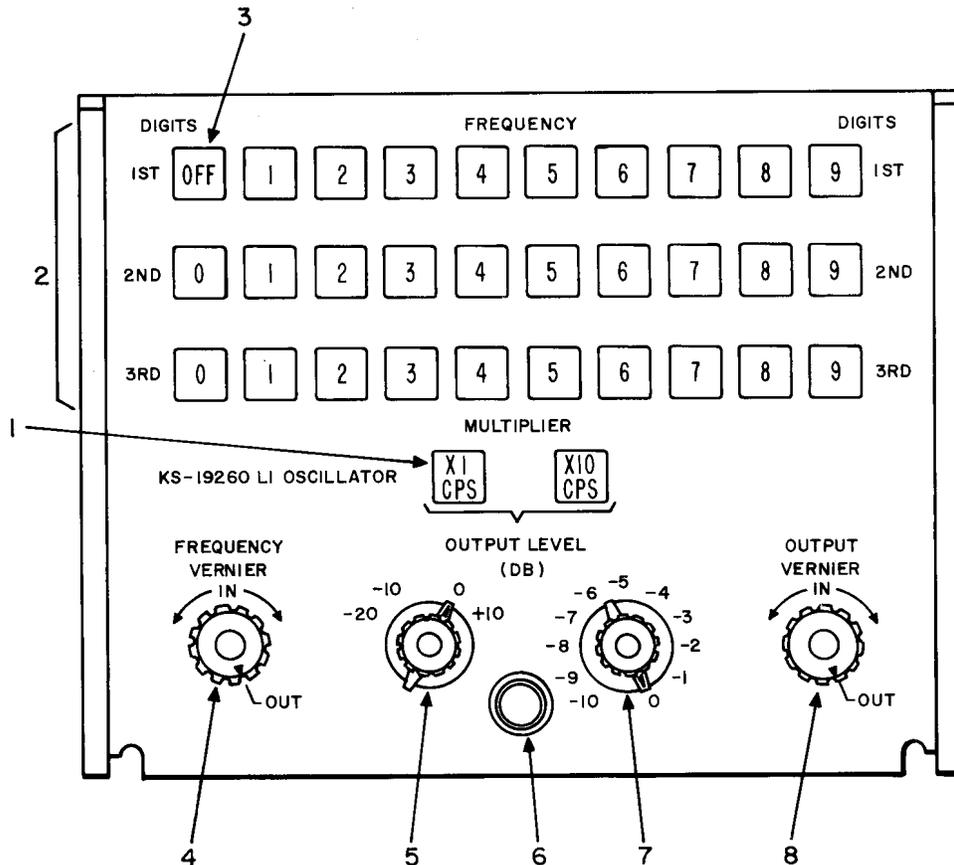


Fig. 4-22—KS-19260,L1 Oscillator

- 1 — BAT TEST meter indicates condition of battery supply.
- 2 — FREQUENCY CPS control and display is used to adjust the output frequency. Output frequency is selected by FREQ RANGE and this control.
- 3 — OUTPUT VERNIER allows for finer adjustment of output level.
- 4 — OUTPUT LEVEL controls output level of oscillator from -30 to +10 dBm.
- 5 — FUNCTION switch selects the matching impedance (and frequency range) as well as hold features.
- 6 — OUTPUT jacks allow connection of oscillator to circuit under test using various types of plugs.
- 7 — DIAL jacks are used to connect handset for dialing purposes.
- 8 — FREQ RANGE switch selects the range of frequency for which the FREQUENCY CPS control can be adjusted.
- 9 — FREQUENCY VERNIER allows for finer adjustment of output frequency.

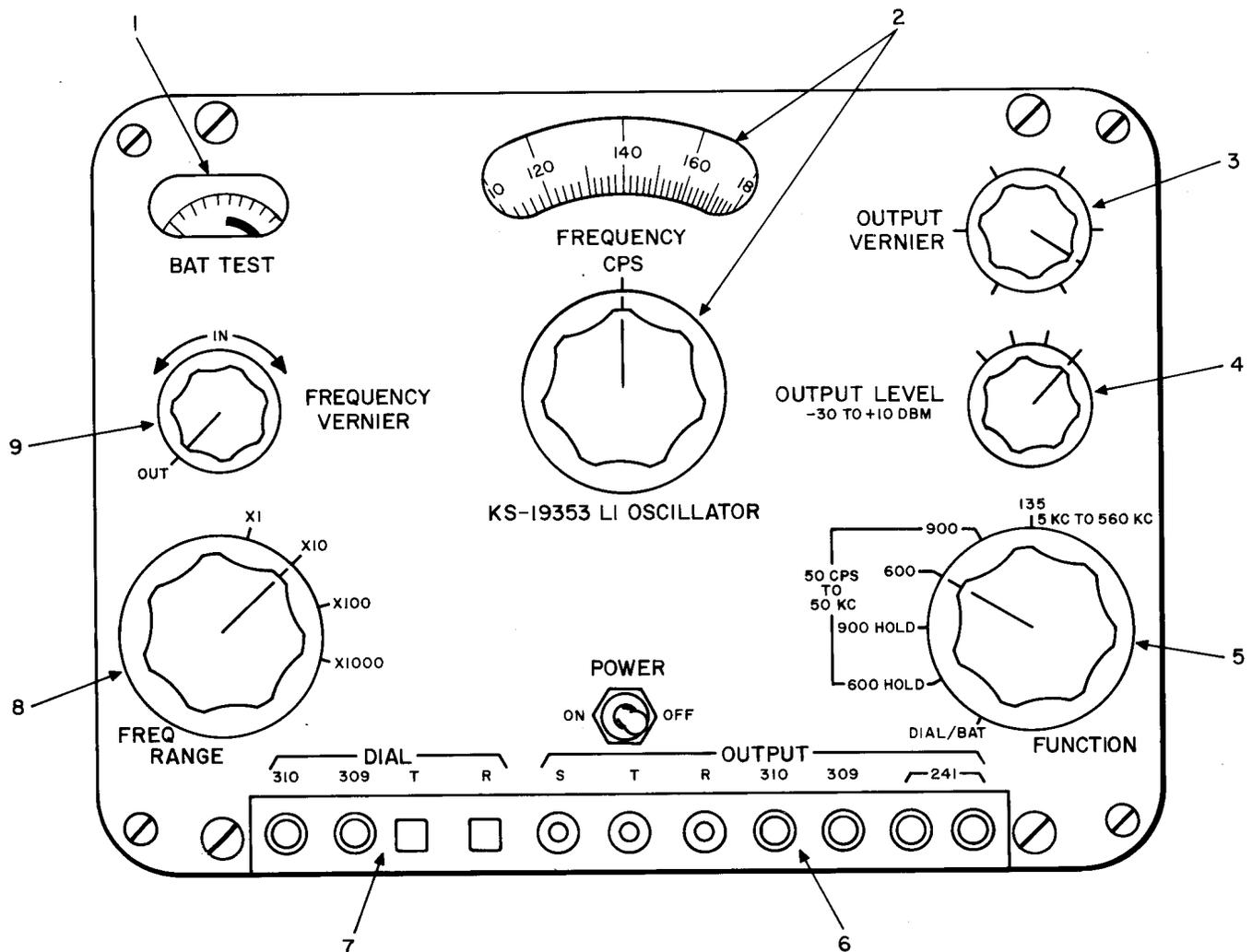


Fig. 4-23—KS-19353, L1 Oscillator

- 1 — DC TEST meter: monitors the unregulated power supply or battery voltage.
- 2 — FREQUENCY, CPS: varies the output frequency within the range selected by the FREQ RANGE switch. The dial reading multiplied by the FREQ RANGE setting is the Oscillator output frequency.
- 3 — VERNIER: provides fine frequency adjustment for the frequency dial.
- 4 — FREQ RANGE switch: selects one of four output frequency range multipliers (X10, X100, X1K, K10K).
- 5 — FUNCTION switch: selects output impedance and function. It has six positions: DIAL/DC, 600 HOLD, 900 HOLD, 600, 900 and 135. The 600 and 900 positions are for low frequency outputs (50 cps to 20 Kc). The 135 position is for high frequency outputs (5 Kc to 560 Kc).
- 6 — DIAL Connectors
  - T — Tip      Clip connectors to accept Western
  - R — Ring     Electric type 1011B lineman's handset.
  - 309 — Western Electric type 246A jack to accept Western Electric type 309 plug.
  - 310 — Western Electric type 238A jack to accept Western Electric type 310 plug.
- 7 — OUTPUT connectors:
 

T — Tip	Binding posts on 3/4 inch
R — Ring	centers to accept standard
S — Sleeve	banana plugs, phone tips,
G — Chassis and case ground	spade lugs or bare wires.

  - 241 — Western Electric type 223A jacks on 5/8 inch centers to accept Western Electric type 241 plug.
  - 309 — Western Electric type 246A jack to accept Western Electric type 309 plug.
  - 310 — Western Electric type 238A jack to accept Western Electric type 310 plug.
- 8 — POWER ON, OFF switch: turns instrument power off or on.

- 9 — POWER INPUT: this three-prong connector (left side of instrument case) is used to connect primary power to the Oscillator through the detachable power cord furnished with the instrument.
- 10 — AC-BAT power source slide switch: (left side of instrument case) connects either the battery or the power transformer to the input of the power supply board A2.
- 11 — OUTPUT LEVEL, DBM: selects output level in steps of 10 dbm, 1 dbm and 0.1 dbm. The output level is the algebraic sum of all output level settings.
- 12 — OUTPUT CAL ADJ: provides proper output level calibration. The calibration procedure is located on the inside of the Oscillator cover.

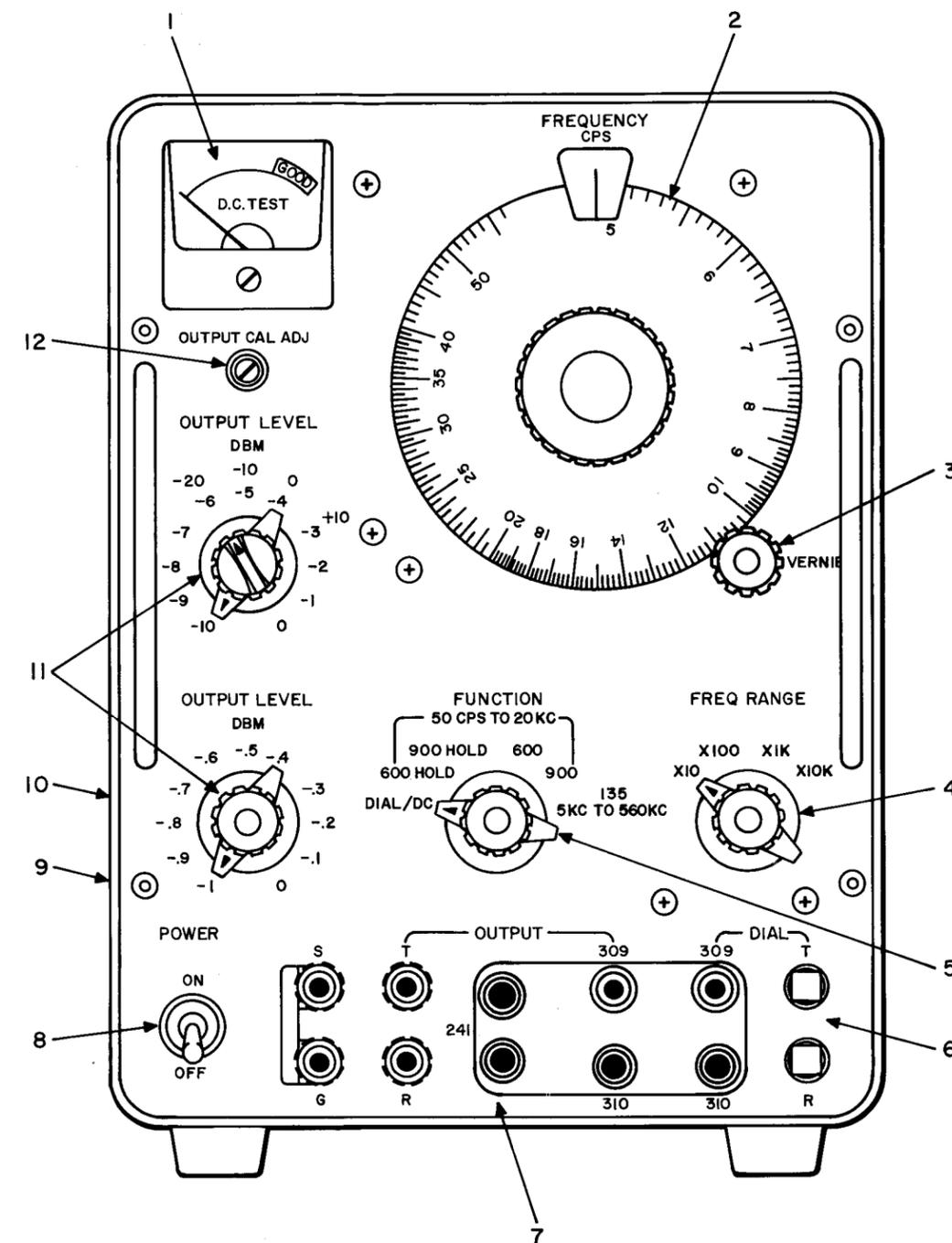


Fig. 4-24—KS-19353, L4 Oscillator

- (5) Turn GAIN DB dials to 0.
- (6) Connect the headset to the 2D test set.
- (7) Connect the 4-wire transmitting path of the circuit under test to the IN jack of the set and the 4-wire receiving path of the circuit under test to the OUT jack (Fig. 4-26). (See Note following Step 12.)
- (8) Turn the 50-dB dial clockwise until singing is heard in the headset and then turn it back one step (5 dB). The singing should cease; but if not, turn the dial back another step.
- (9) Turn the 10-dB dial clockwise slowly to 6 or until sustained singing begins. Singing should have begun before reaching 6; but if it has not, turn the 10-dB dial to 1 and increase the 50-dB dial 5 dB (1 step); then, the 10-dB dial should be turned slowly clockwise until a sustained singing is heard.
- (10) Operate the POLING switch to REVERSE and repeat Steps 8 and 9.
- (11) The POLING (NORMAL or REVERSE) value that is the smaller (total of both dials) should be taken as the gain necessary to cause the circuit to sing.
- (12) Singing point (SP) is determined by:

$$SP = \text{Gains minus Losses}$$

$$SP = 2D \text{ reading} - (\text{Loss on receive side} + \text{loss on transmit side})$$

**Example**

**Normal Reverse**

Total of 2D Dials      35dB      34 dB

Total Losses = 27 dB

$$SP = 34 - 27 = 7$$

**Note:** If the singing point test is being made toward the distant end, the circuit under test should be terminated. In this case, the 4-wire transmitting path of the circuit is connected to the OUT jacks and the 4-wire receive path to the IN jacks.

**4.173** For more detailed information on the 2D singing point test set, see Section 103-106-105.

**2E Singing Point Test Set**

**4.174** The J94002E (2E) singing point test set covered in SD-95114-01 is a panel arrangement very similar to the 2D singing point test set. Jack access to the 2E is via testboard or test frame connections, therefore, no jacks are mounted on the face of the 2E. A CAL adjustment is added to adjust the potentiometer of the amplifier for calibrating the 2E set. Other than this, the 2E is the same as the 2D and no additional information is provided here.

**54C Return Loss Measuring Set (Fig. 4-27)**

**4.175** The J99254C (54C) return loss measuring set (RLMS) covered in SD-97026-01 is a portable test set used to make return loss measurements on voice-frequency circuits. The 54C is powered from a 115V 60 Hz source and -48 volts office battery. The J87241B portable power supply can be used to furnish -48V battery when an office supply is not available.

**Calibration**

**4.176** The following calibration procedure should be performed before tests are made.

- (1) Connect the test set to 115V 60 Hz source and 48-volt battery source.
- (2) Operate ON/OFF switch to ON position.
- (3) Rotate switch AT1 to 0 dB position.
- (4) Hold nonlocking key S2 in SEND LEVEL CAL position.
- (5) Adjust SEND LEVEL ADJ control of frequency band being used to 0 dB return loss on meter.

**Operation**

**4.177** The following procedure should be used when making a return loss measurement using the 54C RLMS.

- (1) Connect the test set to 115V 60 Hz source and 48-volt battery source.

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- (2) Operate ON/OFF switch to ON position.
- (3) Rotate switch AT1 to 0 dB RETURN LOSS position.
- (4) Operate key S1 to 500-2500 position.
- (5) Operate switch S3 to 900 $\Omega$  2MF position.  
(If in the event the return loss measurement is to be made on other than a 900 ohm circuit, operate switch S3 to EXT NET and connect the appropriate network into the EXT NET jacks.)
- (6) Connect the circuit under test to the MEAS RL jack.
- (7) Calibrate 54C as covered in 4.176.
- (8) Release key S2 to MEAS position and rotate switch AT1 to a position which results in a meter indication between 0 and 10 dB. The return loss is the sum of the AT1 switch setting and the meter indication.
- (9) Repeat the procedure with key S1 set to the 2000-3000 position.

**4.178** For more detailed information on the 54C RLMS, see Section 103-106-100.

### KS-20501 L3 Return Loss Measuring Set (Fig. 4-28)

**4.179** The KS-20501 L3, return loss measuring set (RLMS), is a portable test set designed to make return loss measurements on 2-wire or 4-wire circuits. The RLMS is powered from a 115V 60 Hz source. The KS-20501 is capable of making return loss tests in three frequency bands as determined by the TEST TYPE switch position. In the ERL (Echo Return Loss) position measurements are between 560 Hz and 1965 Hz; SRL (Singing Return Loss) position measurements are between 260 Hz and 500 Hz; and SRL-HI (Singing Return Loss-High Frequency) position measurements are between 2200 Hz and 3400 Hz. A fourth position EXT OSC permits connection of an external signal source between 200 Hz and 15 kHz.

### Calibration

**4.180** Calibration procedures are not normally required except when using an external oscillator and therefore are not covered here. If calibration is required, consult the instruction

manual normally accompanying the set, or if an external oscillator is used, see Section 103-106-115.

### Operation

**4.181** The following procedures should be used when making return loss measurements using the KS-20501 L3 RLMS.

### 4-Wire Circuits

- (1) Set PWR switch to ON.
- (2) Set TEST TYPE switch to desired test (see 4.179).
- (3) Set TEST LOCATION switch to proper position; +23 dB (VFPB) when testing at the voice frequency patch bay or a +7/-16 TLP; +0 dB when it is necessary to compensate for hybrid losses; or 0 dB when testing from 4-type crossbar test frames or other 0/0 TLPs.
- (4) Set ADD dB switch to 0.
- (5) Connect TRMT jack to transmit side of circuit under test.
- (6) Connect RCV jack to receive side of circuit under test.
- (7) When using the +23 dB or +0 dB position of the TEST LOCATION switch:
  - (a) Short the tip and ring on the 2-wire side of the hybrid.
  - (b) Adjust the THL OR ADD controls for a 0 dB indication on the meter.
  - (c) If a 0 dB indication cannot be obtained in (b), set the ADD dB switch to the -10 position and readjust THL OR ADD controls. Return loss measurements must be reduced by 10 dB for correct readings.
  - (d) Remove short from 2-wire side.
- (8) Terminate the distant end of the circuit in the proper impedance.
- (9) Adjust the ADD dB switch for an on-scale meter indication. The return loss is the

1. ON/OFF switch closes and opens path to power source.
2. MDL1 1 AMP fuse and spare are used for protection from power source.
3. IN jacks are used for input to test set. Accepts 241-type plug.
4. OUT jacks are used for output of test set. Accepts 241-type plug.
5. FILTER switch connects low-pass filter into test set limiting obtainable frequency to 3.5 KH.
6. POLING switch reverses the conductor. SP measurement should be made in both conditions. The lowest value of gain is used to determine SP.
7. GAIN DB dials are used to add attenuation to the output of the test set.
8. MON jacks are used to connect standard head set.
9. TST FREQ jacks are used to connect adjustable frequency oscillator, for determining the singing frequency.

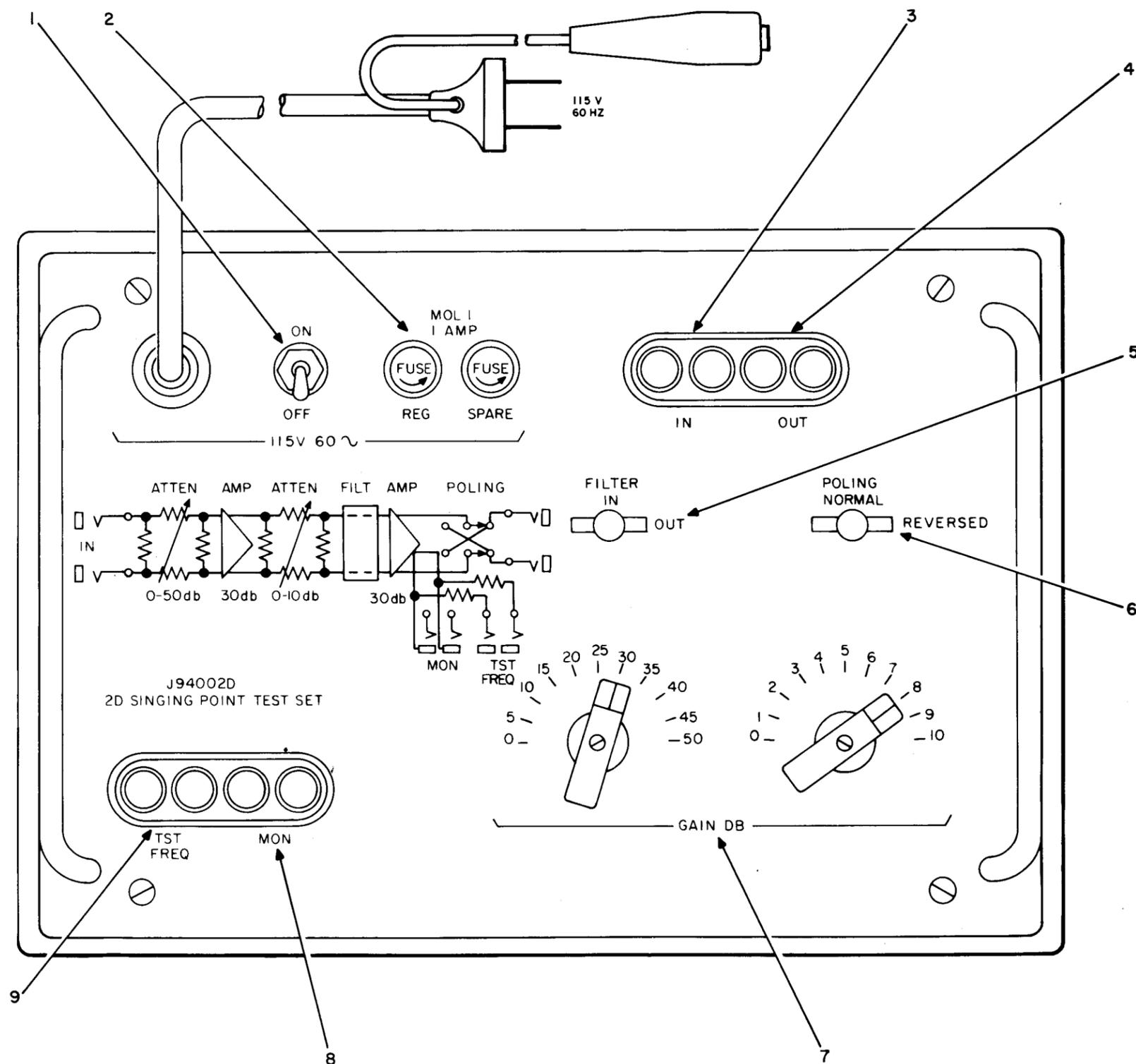


Fig. 4-25—2D Singing Point Test Set

DETERMINE GAINS NECESSARY TO CAUSE CIRCUIT TO SING TO SING

1. Connect 2 D to 4 wire side of Term Set.
2. Monitor with headset.
3. Add gain until circuit oscillates.
4. Note reading on gain dB switches.
5. Reverse poling and repeat 2-4.
6. Lowest reading is gain necessary to cause circuit to sing.

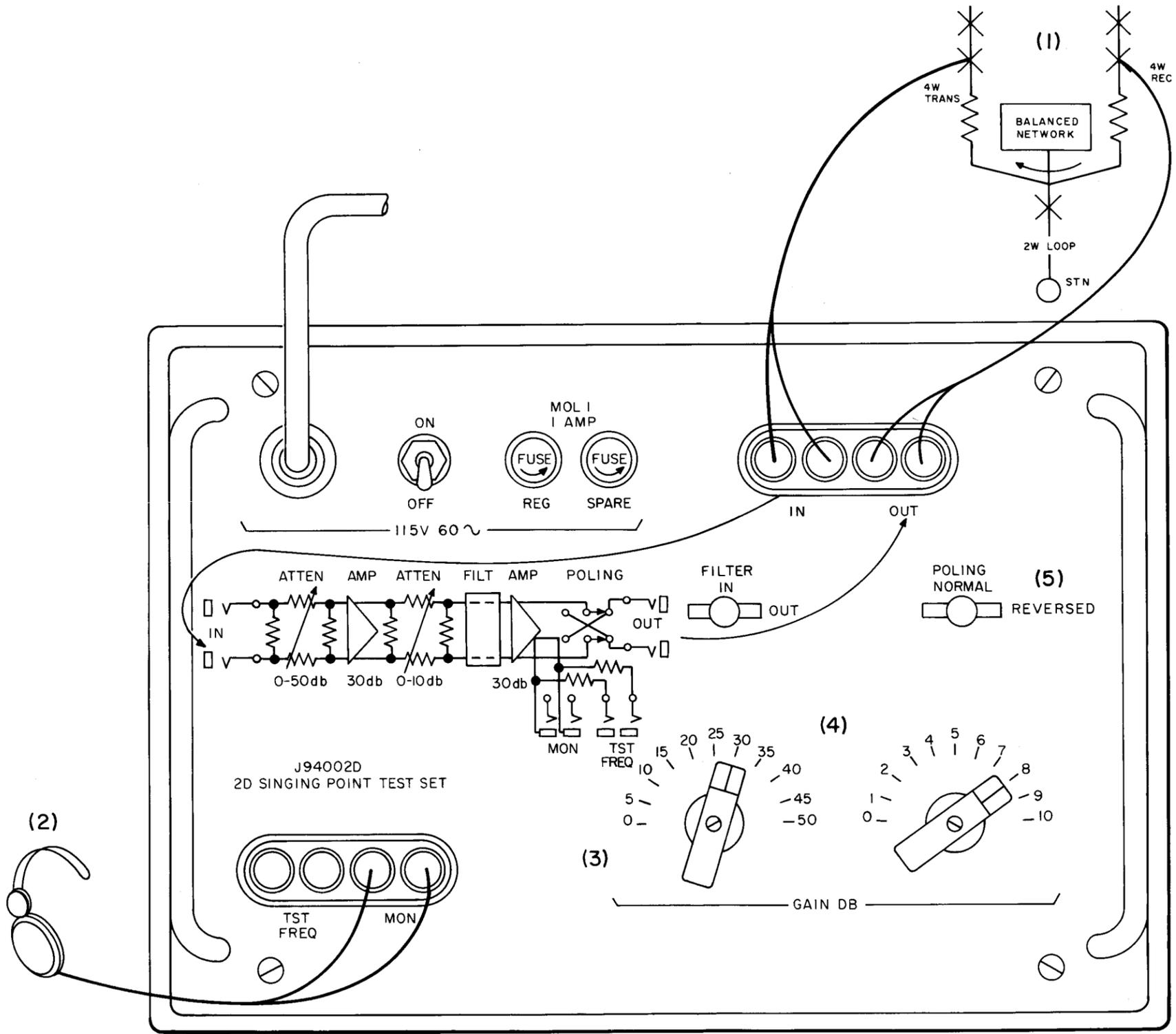


Fig. 4-26—Typical Test Arrangement

- 1 — 115V-60~ cord used to connect to power source
- 2 — TST PWR is used to connect to -48V source
- 3 — MEAS RL jacks are used to connect the circuit under test.
- 4 — S3 switch selects either internal 900Ω + 2μf network or external network as plugged into EXT NET jacks.
- 5 — SEND LEVEL ADJ controls adjust the output level for the two frequency bands under control of S1.
- 6 — S2 switch selects measuring or calibration circuit for meter.
- 7 — AT1 switch selects amount of attenuation or gain added to the received signal.
- 8 — S1 switch selects the frequency band in which measurements are made.
- 9 — METER CAL and DET CAL are used for calibration but only by WESTERN ELECTRIC SERVICE CENTER.
- 10 — ON/OFF switch disconnects set from power source.

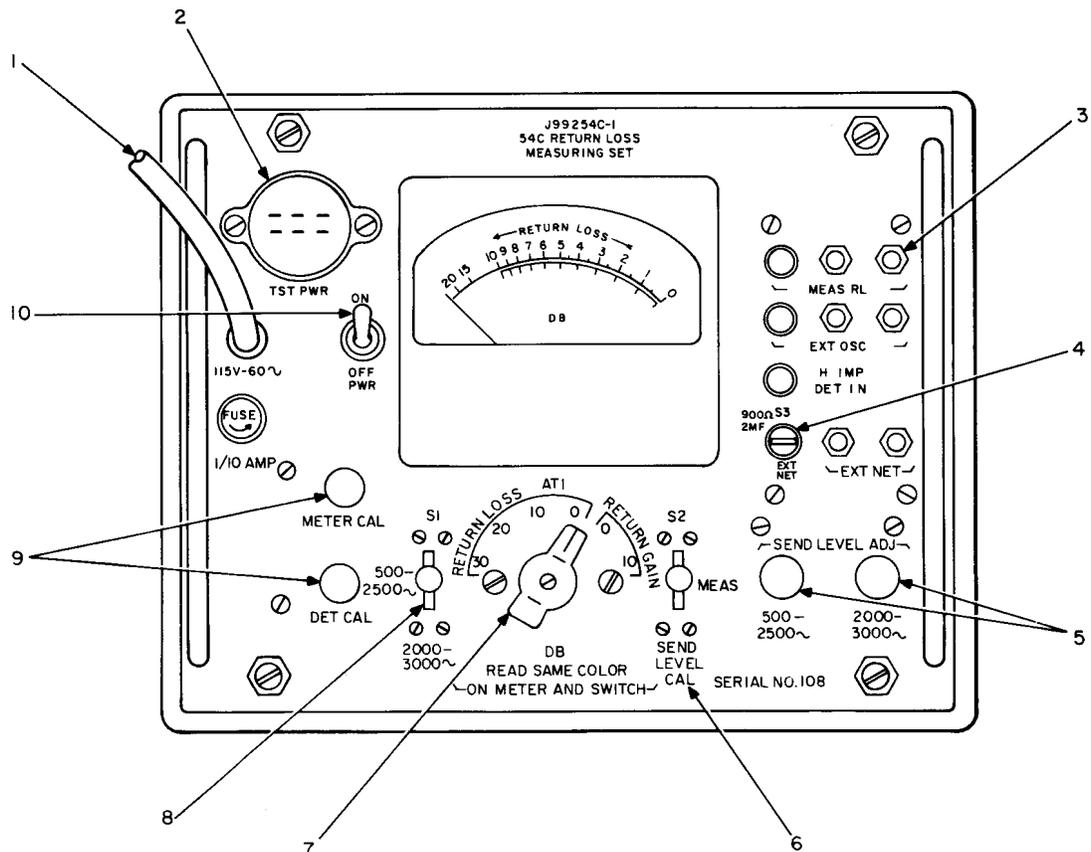


Fig. 4-27—54C Return Loss Measuring Set

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sum of the meter indication and the ADD dB setting.

**2-Wire Circuit**

- (1) Set PWR switch to ON.
- (2) Set TEST TYPE switch to desired test (see 4.158).
- (3) Set TEST LOCATION switch to 2W/600 or 900 depending on the impedance of the circuit under test.
- (4) Set the NETWORK switch to the INT position.
- (5) Connect the 2-wire circuit under test to the TRMT jack.
- (6) Adjust the ADD dB switch for an on-scale meter indication. The return loss is the sum of the meter indication and the ADD dB setting.

**4.182** For more detailed information see the instruction manual or Section 103-106-115.

**9041 Transmission Level and Return Loss Measuring Set (Fig. 4-29)**

**4.183** The 9041 transmission level and return loss measuring set (manufactured by Wiltron Co.) is a portable test set designed to measure transmission level, frequency response, echo return loss and singing return loss on 2- or 4-wire circuits. The 9041 has dial-up and hold features as well as on/off hook reverse battery supervision for 2-wire outgoing trunks. The 9041 is powered from 115 Vac or internal rechargeable batteries.

**Calibration**

**4.184** The following procedure should be used to check the performance of the 9041. If calibration is required detailed procedures are covered in the instruction manual.

- (1) Ensure that the ac power cord is disconnected from the measuring set. Momentarily press the BATTERY CHECK switch. The meter should indicate above 6 on the black scale if the battery is sufficiently charged to operate the measuring set.

(2) Switch the test set POWER on (either ac or internal battery may be used as desired).

(3) Set the controls as follows:

NETWORK	INT
RETURN LOSS TEST TYPE	ERL
TEST MODE	2-WIRE RETURN LOSS, 600 ohms
THL dB	0.0
ADD dB	0
NBO DECADE	0.00 $\mu$ F
DBO DECADE	0.00 $\mu$ F
TALK/DIAL	OPEN

(4) Check that the meter indicates 0  $\pm$ 0.1 dB. If necessary, adjust the 0 dB ERL CAL ADJ control to bring the meter indication to within  $\pm$ 0.1 dB of zero on the black scale.

(5) Short the 2W TRMT/RCV terminals. The meter should indicate 0  $\pm$ 0.1 dB. Remove the short.

(6) Patch the 4W TRMT terminals to the 4W RCV terminals. Set the TEST MODE switch to 4-Wire RETURN LOSS 0 dB. Check that the meter indicates 0  $\pm$ 0.1 dB. Adjust the 0 dB ERL CAL ADJ if necessary. Remove the patch.

(7) Patch the central office milliwatt supply (0 dBm, 1 kHz signal) to the LEVEL RCV jacks. Set the TEST MODE switch to LEVEL dBm, 600 ohms or 900 ohms depending on the output impedance of the milliwatt supply. Check that the meter indicates 0 dBm ( $\pm$ 0.1 dBm,  $\pm$ level accuracy of the milliwatt supply used) on the red scale. Disconnect the milliwatt supply from the measuring set.

**Operation**

**4.185** The 9041 is capable of many applications, however, the procedures below cover typical tests most appropriate to special services testing. The tests covered are 2- and 4-wire level measurements,

echo return loss and singing return loss on 2- and 4-wire circuits.

**Level Measurements (2- or 4-Wire)**

- (1) Check calibration as covered in 4.184.
- (2) Connect the circuit under test to the input marked 2W TRMT/RCV 4W RCV LEVEL RCV. (On 4 wire circuits, terminate the transmit or MOD IN -16 TLP in 600Ω.)
- (3) Set the TEST MODE switch to LEVEL dBm (600 or 900 ohms depending on the impedance of the circuit under test). On 4-wire circuits set the switch to LEVEL dBm 600Ω.
- (4) Set the NETWORK switch to INT position.
- (5) Adjust the ADD dB switch for an on scale meter indication (red scale). The received level is the sum of the meter indication and the ADD dB switch setting.

**Echo Return Loss and Singing Return Loss Measurement (4-Wire)**

- (1) Check the calibration as covered in 4.184.
- (2) Connect the receive leads of the circuit under test to the input marked 2W TRMT/RCV 4W RCV and the transmit leads to the 4W TRMT RETURN LOSS ONLY input.
- (3) Set the NETWORK switch to INT.
- (4) Set the RETURN LOSS TEST TYPE switch to ERL.
- (5) Set the TEST MODE switch to 4-WIRE RETURN LOSS, 0 dB.

(6) Patch the DBO decodes to the 2-wire drop side of the test hybrid.

(7) Press and hold the AC SHORT pushbutton (in the cover) while adjusting the THL dB controls for a 0 dB reading. Release the AC SHORT pushbutton.

**Note:** The AC SHORT pushbutton places an 8μf capacitor across the 2-wire side of the hybrid. This is done because a dc short may disturb the operator of some 4-wire circuits.

(8) Adjust the ADD dB switch for an on-scale indication on the meter (return loss scale). The return loss is the sum of the ADD dB switch setting and the meter indication.

(9) Measure the Singing Return Loss (High and Low) by setting the RETURN LOSS TEST TYPE switch to the appropriate position SRL-HI or SRL-LO. The lowest of the two readings is considered to be the singing return loss (or singing point).

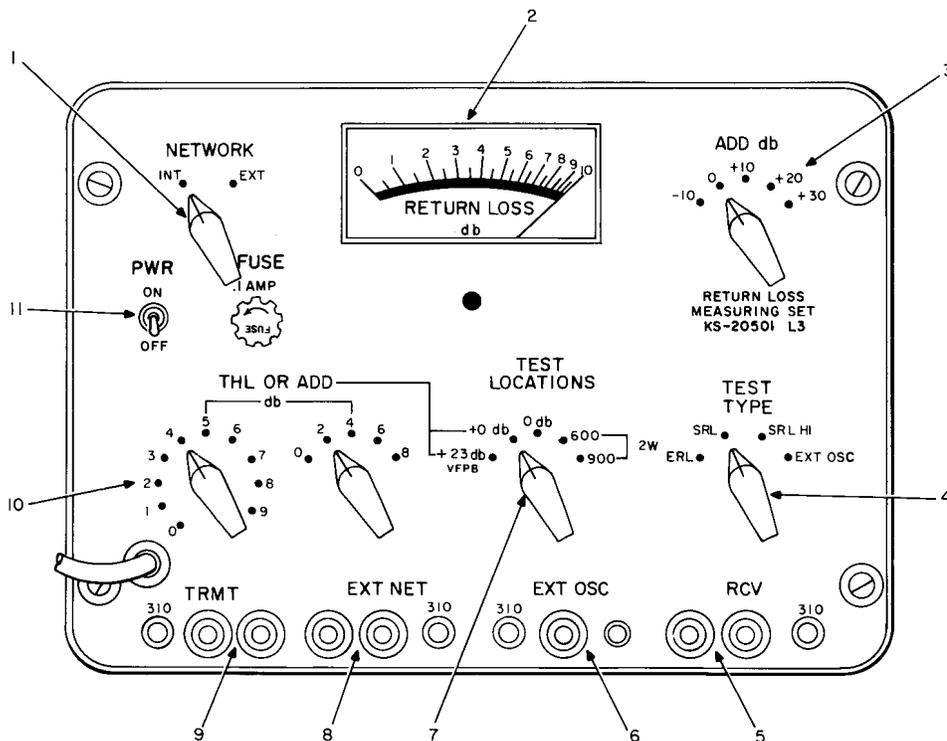
**4.186** For more information on the 9041 see the instruction manual.

**9031 Return Loss Measuring Set**

**4.187** The 9031 return loss measuring set (manufactured by Wiltron Co.) is very similar to the 9041 except it has no transmission level measurement capabilities. Since the calibration and operation is so similar no procedures are given here. (Refer to 4.184 and 4.185 or the instruction manual.)

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- 1 — NETWORK switch selects either INT (internal) or EXT (external) network for 2-wire measurements.
- 2 — RETURN LOSS Meter displays the measured return loss. Actual return loss is sum of meter indication and ADD dB switch setting
- 3 — ADD dB switch is used to select attenuation to the received signal to maintain the meter on-scale.
- 4 — TEST TYPE switch selects three types of tests; ERL (Echo Return Loss), SRL (singing Return Loss), SRL (Singing Return Loss), and SRLHI (Singing Return Loss High Frequency). Also the EXT OSC position allows connection of an external oscillator.
- 5 — RCV inputs are used to connect the receiving conductors of a 4-wire circuit
- 6 — EXT OSC inputs are use to connect an external oscillator
- 7 — TEST LOCATION switch selects the type of circuit under test and the position of test. See operation.
- 8 — EXT NET inputs are used to connect an external network when testing 2-wire circuits.
- 9 — TRMT connectors are used to connect the transmit conductors of a 4-wire circuit or the 2 conductors of a 2-wire circuit.
- 10 — THL OR ADD switches are used to adjust the sensitivity of the set to allow for losses in the 4-wire circuit being measured.
- 11 — PWR switch turns power on or off to set.



**Fig. 4-28—KS-20501 Return Loss Measuring Set**

- 1 — Meter indicates level on top scale and return loss on bottom scale.
- 2 — ADD dB switch adds loss to the received signal for an on-scale indication.
- 3 — RETURN LOSS TEST TYPE switch selects the type of measurement to be made.
- 4 — 2W TRMT/RCV, 4W RCV, LEVEL RCU inputs are used to connect the circuit under test;
- 5 — TEST MODE switch selects either level or return loss measurements.
- 6 — TALK DIAL input is used to connect dial equipment.
- 7 — 4W TRMT RETURN LOSS ONLY input is used to connect the circuit under test.
- 8 — THL dB switches compensate for hybrid loss in 4-wire return loss measurements mode.
- 9 — NETWORK switch selects either interval network or external.
- 10 — THL dB switch add gain to account for the trans-hybrid loss.
- 11 — Loss jacks are used to connect an external network.
- 12 — NETWORK switch selects internal or external network.

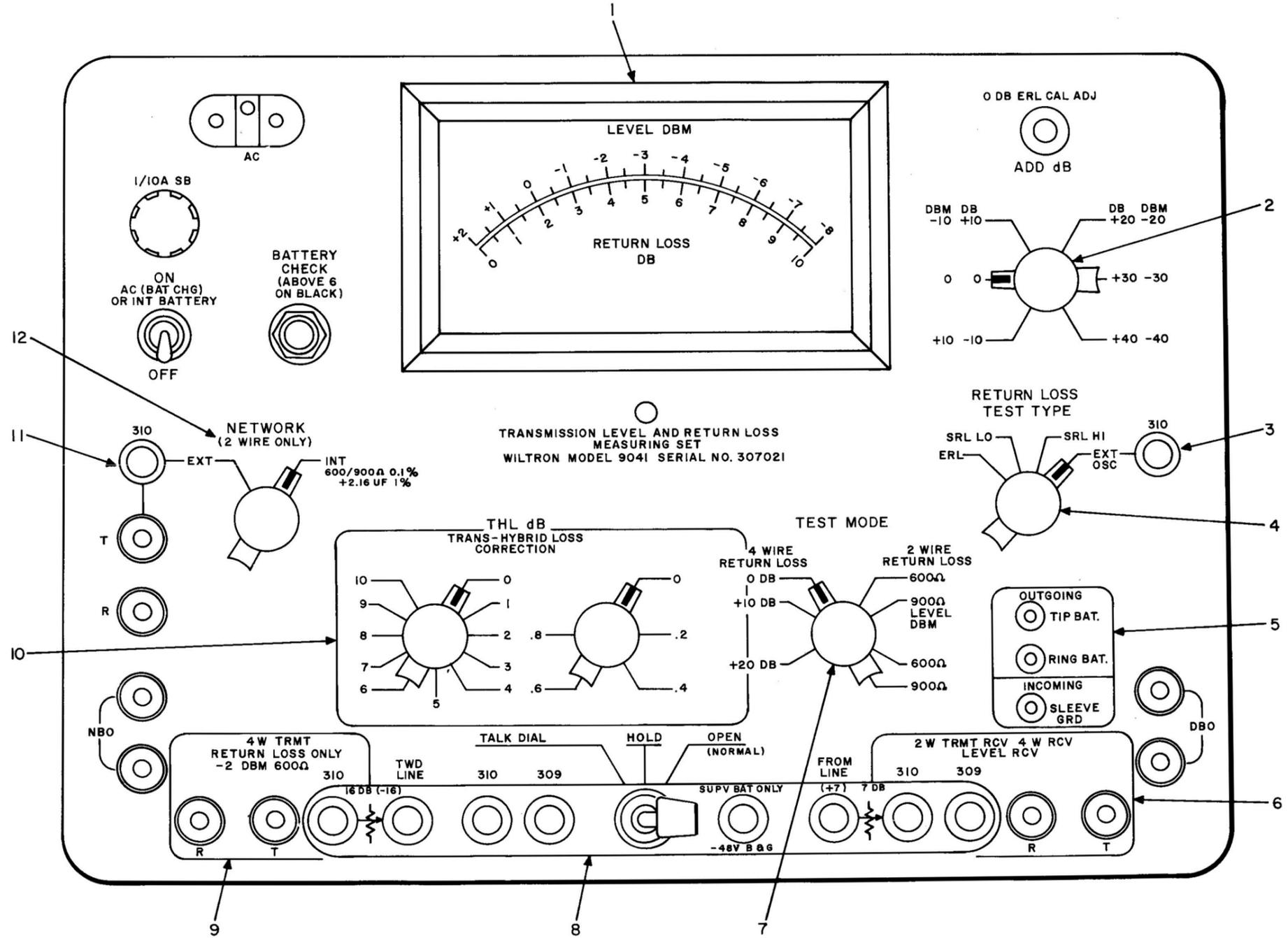


Fig. 4-29—9041 Transmission Level and Return Loss Measuring Set

**4A Frequency Analyzer (Fig. 4-30)**

**4.188** The 4A frequency analyzer is a portable self-powered test set used to measure frequencies (known and unknown) in the voice frequency range and to measure the level of the frequency. Input connection to the 4A is via four pairs of binding posts, which are connected to the internal circuitry by an INPUT SELECTOR switch. The binding posts are marked.

(1) POWER VOLTS	150V	40,000 Ohms
(2) POWER MILLIVOLTS	2V	1,000 Ohms
(3) TEL. CURRENTS	2MA	600 Ohms
(4) TEL. NOISE TO GRD	150V	100,000 Ohms

The voltage or current rating and impedance of the binding posts should be selected for the circuit under test. In special services testing, the binding posts TEL. CURRENT are normally used unless a noise to ground measurement is required. The TEL. NOISE TO GRD posts have a 100,000 ohm impedance to prevent disruption of the noise on either the tip-to-ground or ring-to-ground circuit. An EXT GRD binding post is used to connect to ground for any measurements.

**4.189** Two binding posts marked MON located just below the meter are used for connection of a receiver so the given frequency can be audibly monitored.

**4.190** Just beside the INPUT SELECTOR switch is an attenuation dial marked DECIBELS, which is adjustable from 20 to 90 dB in 5 dB steps. Any level readings obtained on the dB meter should be added to the dial setting to obtain the actual level measured.

**4.191** The drum-type scale marked FREQ KC is associated with the thumb wheel located beside it. The scale indicates the frequency of the signal being measured and the dB meter the level of that frequency.

**Calibration**

**4.192** The following procedures should be used to calibrate the 4A frequency analyzer before any measurements are made.

- (1) Operate the BATTERY switch to the CHK A position. The meter should indicate above the red line.
- (2) Operate the BATTERY switch to the CHK B position. The meter should indicate above the red line.
- (3) Set the BATTERY switch to the ON position.
- (4) Set the variable oscillator scale designated FREQ KC to 0 KC using the thumb wheel. Then adjust the four MODULATOR BALANCE controls (R COARSE, R FINE, C COARSE, and C FINE) for minimum deflection on the meter. (If badly out of balance, such that the meter deflection is off scale, first make the adjustment at a higher frequency such as .015 kHz.)
- (5) Set the DECIBELS attenuator dial to 40.
- (6) Set the variable oscillator scale FREQ KC to .9 KC.
- (7) Set the INPUT SELECTOR switch to CAL position.
- (8) Adjust the OSC ADJ for maximum deflection.
- (9) Depress the CAL B key and adjust the CALIBRATE B potentiometer for a 0 dB meter reading.
- (10) Release CAL B key and adjust CALIBRATE A for a 0 dB meter reading.
- (11) Repeat Steps 8, 9, and 10.
- (12) When the calibration and use of the 4A is complete, be sure the BATTERY switch is operated to OFF.

**Operation**

**4.193** To measure the frequency and level of signal the following procedure should be used.

- (1) Connect EXT GRD binding post to a reliable ground and calibrate the 4A as described in 4.192.
- (2) Connect the circuit under test to the proper binding post. (See 4.188.)

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- (3) Set the DECIBELS dial to 90.
- (4) Set the INPUT SELECTOR switch so it agrees with the input binding posts being used.
- (5) Set the BATTERY switch to ON.
- (6) Starting at one end (preferably the low end) of the FREQ KC scale, gradually rotate the thumb wheel while observing the meter. The presence of a frequency component in the range of 0 to 20 kHz is indicated by a deflection of the meter needle. The specific frequency of this component can be read directly on the FREQ KC scale. Many signals are complex and there may be several indications from a single circuit in the range of 0 to 20 kHz.
- (7) To determine the level of the frequency component, add to the meter reading the setting of the DECIBELS dial. If there is no meter indication with the dial set at 90, reset it to a lower value and again operate the thumb wheel across the scale of 0 to 20 kHz.
- (8) When finished with the 4A, be sure to set the BATTERY switch to OFF.

**4.194** For a more detailed description of the 4A, see Section 103-635-100.

### **T132B Spectrum Analyzer and Noise Measuring Set (Fig. 4-31)**

**4.195** The model T132B spectrum analyzer and noise measuring set (manufactured by Wilcom Products, Inc) is a portable test set designed to measure noise as well as amplitude and frequency of the components of complex wave shapes or individual tones. The T132B set can be powered from either the internal rechargeable batteries or a source of 115V 60 Hz. Monitor access, dial up and hold features are also available.

#### **Calibration**

**4.196** The T132B normally requires no calibration, however, before tests are made the batteries should be checked using the following procedure.

- (1) Set the POWER switch to BAT TEST 1 position.

- (2) The meter should indicate in the GOOD area.
- (3) Repeat Steps 1 and 2 for BAT TEST 2 position.
- (4) If the batteries do not check GOOD they should be recharged or replaced.

#### **Operation**

**4.197** The following paragraphs contain procedures for making typical measurements using the T132B test set. Additional measurements can be made using the T132B, however, they are not covered here because of the application.

**4.198** To make a noise or transmission measurement using the T132B, the following procedure should be used.

- (1) Check the battery supply as described in 4.196.
- (2) Set the POWER switch to ON position.
- (3) Connect the circuit under test to the INPUT jack or terminals.
- (4) If a dial up connection is desired continue with the next step; if not, continue with Step 9.
- (5) Connect a handset or equivalent to the square terminals associated with the DIAL position of the FUNCTION switch.
- (6) Place the FUNCTION switch in the DIAL position.
- (7) Set the HOLD switch to OFF and dial the desired connection.
- (8) When the connection has been established set the HOLD switch to ON.
- (9) Set the OPERATING MODE switch to NMS position.
- (10) Set the FUNCTION switch to the appropriate position:

BRDG 600—for a bridged measurement on either 600 or 900 ohm circuit—for

900 ohm circuits subtract 1.7 dB from indication.

TERM 600/900—for a terminated measurement on a 600 or 900 ohm circuit.

$N_G$ —for a noise-to-ground measurement. Add 40 dB to indication.

(11) Set the WEIGHTING switch to the desired position: FLAT 3 kHz, FLAT 50 kHz, or C-MSG.

(12) Adjust the LEVEL switch until the meter pointer indicates on scale. For noise measurements use the dBrn scale on both the meter and LEVEL switch, and for transmission measurements use the dBm scale on both. The actual measurements are the sum of the meter indication and the LEVEL switch setting.

**4.199** To use the spectrum analyzer portion of T132B test set, the following procedure should be used.

- (1) Repeat Steps 1 through 4 (through 8 if dial up connection is required) in 4.198.
- (2) Turn the OPERATING MODE switch to AFC OFF.
- (3) Select the appropriate positions on the FUNCTION and WEIGHTING switches as described in Steps 10 and 11 of 4.198.
- (4) Set the LEVEL switch to a position appropriate for the signal level to be measured.
- (5) Set the TUNING & SWEEP RATE switch to 10 or 20. (If better tuning resolution is required, use a lower tuning rate. Faster rates up to FAST SCAN can be used to tune more quickly over the selected range.)
- (6) Select the frequency range to be covered by tuning the TUNING & SWEEP RANGE switch to the desired position.
- (7) Operate the three-position lever switch to INCREASE FREQ to tune upward in frequency and to DECREASE FREQ to tune downward.

(8) As the tuning approaches the frequency of a signal, and an on-scale reading appears on the meter, turn the OPERATING MODE switch to AFC ON. The tuning will then automatically center on the signal frequency.

(9) The frequency of the signal will be displayed in the FREQUENCY-HZ readout.

(10) Adjust the LEVEL switch until the meter indicates on scale. The actual level of the measured tone is the sum of the meter indication and LEVEL switch position.

**4.200** For more detailed information on the T132B see the instruction manual normally accompanying the test set.

#### **KS-14510 Meter (Fig. 4-32)**

**4.201** The KS-14510 meter is a portable volt-ohm-milliammeter used for the measurement of ac and dc voltages, dc current and resistance.

#### **Calibration**

**4.202** Normally, the meter requires no calibration other than adjustment of the pointer for zero position before measurements are made. Adjustment is accomplished by turning the screw just above the OFF position of the range switch.

#### **Operation**

**4.203** The following paragraphs cover the various measurements available from the KS-14510 meter.

**4.204** Voltage measurements are made by connecting the test leads to the meter, using the red as the positive conductor, and black as ground or negative conductor. The range switch should be set to DC VOLTS, or AC VOLTS depending on the measurement.

**Caution:** *If the approximate voltage is not known, start with the highest range (600). From the initial reading, choose the most appropriate scale.*

The reading is taken from the appropriate meter scale.

## SECTION 660-215-500

**4.205** For current measurements the connection is the same, but the range switch is set to the DC MA range.

**4.206** For resistance measurements the connection is the same but the range switch is set to the OHMS range. The test probes should be shorted together and the ADJ knob operated until the meter pointer reads zero on the top green (ohm) scale. The battery should be replaced when the pointer cannot be adjusted for zero, when the multiplier is in OHMS X1 position.

**4.207** For more detailed information, see Section 100-520-101.

### **54B Test Stand (Fig. 4-33)**

**4.208** The J99254B (54B) test stand covered in SD-97025-01 is designed to hold the E6 repeater for testing and adjustments. The 54B holds the repeater so that adjusting screws are

accessible, furnishes connections from the shelf connector to the repeater, powers the repeater, and has jack access for test equipment like the 54A TMS (see 4.133) or the 54C RLMS (see 4.175). The test stand requires no calibration. Operational instructions are given in Sections 332-206-502 and -503.

**Caution: Lower, do not drop or force, the repeater into the test stand since force may damage the repeater terminals.**

### **MFT Test Extender (Fig. 4-34)**

**4.209** The J99343TB test extender covered in SD-1C485-02 is designed to allow adjustment and testing of Metallic Facility Terminal (MFT) transmission units. Also, jack access is available to signaling leads which pass through the transmission unit. The test extender does not require calibration. Operation and test procedures using the MFT test extender are given in Section 332-910-102.

1. CALIBRATE A and B controls are used to calibrate 4A. See CALIBRATION.
  2. BATTERY switch is used to turn power on/off and check battery A and B.
  3. CAL B is used to calibrate. See CALIBRATION 4.64.
  4. DB meter indicator level of measured signal.
  5. OSC ADJ control is used in calibration. See CALIBRATION.
  6. MON binding posts used to connect receiver for audible monitoring of the frequency.
  7. Thumb wheel controls FREQ KC sends.
  8. FREQ KC scale indicates the frequency being measured.
  9. MODULATOR BALANCE controls — see CALIBRATION.
  10. DECIBELS dial adds attenuation to meter reading. To obtain actual measured level add setting to meter indication.
  11. INPUT SELECTOR switch is used to select the binding posts that are the input to 4A.
  12. EXT GRD binding post used to connect 4A to ground.
  13. Input binding posts:  
 POWER VOLTS — 150V 40,000  
 POWER MILLIVOLTS — 2V 1,000  
 TEL. CURRENT — 2 MA 600  
 TEL. NOISE TO GRD — 150V 100,000
- The TEL. CURRENT binding posts are used in most special services applications except when measuring noise to ground, in which case the TEL. NOISE TO GRD posts are used.

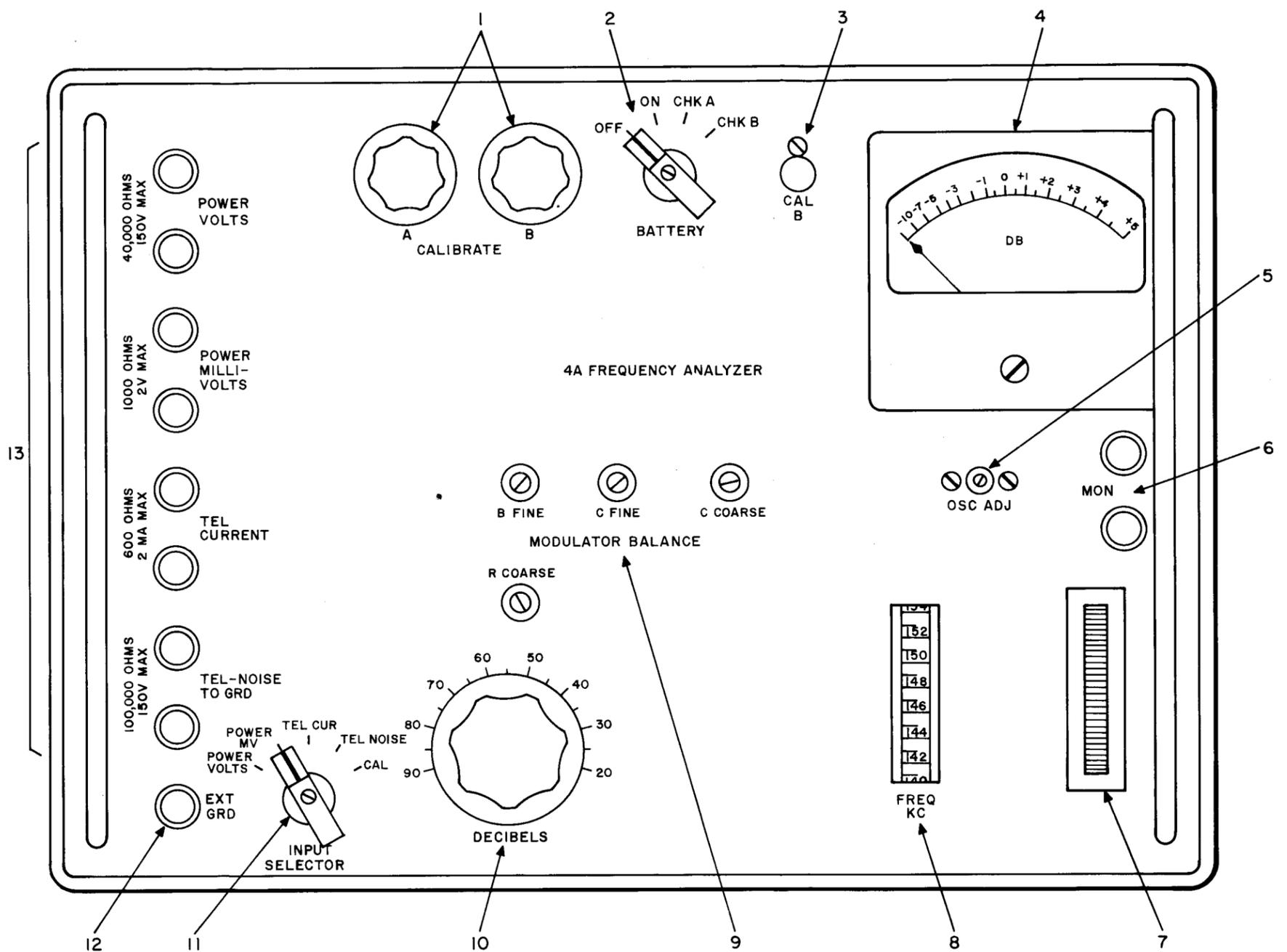


Fig. 4-30—4A Frequency Analyzer

- 1 — WEIGHTING switch selects desired weighting for the type of measurement.
- 2 — METER indicates noise level (dBrn scale) and transmission level (dBm scale).
- 3 — FREQUENCY-HZ displays frequency of received signal when OPERATING MODE switch is set to a position other than NMS.
- 4 — ON-OFF switch turns frequency display off when operating from internal batteries. This helps conserve battery life.
- 5 — TUNING & SWEEP RATE switch select rate of tuning across frequency range selected.
- 6 — Three position lever switch selects increase or decrease of frequency tuning.
- 7 — TUNING & SWEEP RANGE switch selects the range of frequencies through which the measurement is made.
- 8 — POWER switch turns set on, checks BAT 1 & 2 or charges batteries, when set is connected to AC source.
- 9 — OPERATING MODE switch selects type of test to be made.
- 10 — EXT. START used when operating in REP. SWEEP or Single Sweep mode.
- 11 — RECORDER inputs are used to connect external recording equipment.
- 12 — LEVEL switch adjusts the received signal for an on scale indication.
- 13 — MON jack is used to connect headset for monitoring received signal.
- 14 — PWR VOLTS input is used for power line harmonic analysis.
- 15 — INPUT jack or terminals are used to connect circuit under test.
- 16 — HOLD switch permits holding of a dialed connection.
- 17 — Terminals are used to connect handset or equivalent dial equipment.
- 18 — FUNCTION switch selects type of connection to circuit under test and type of measurement.

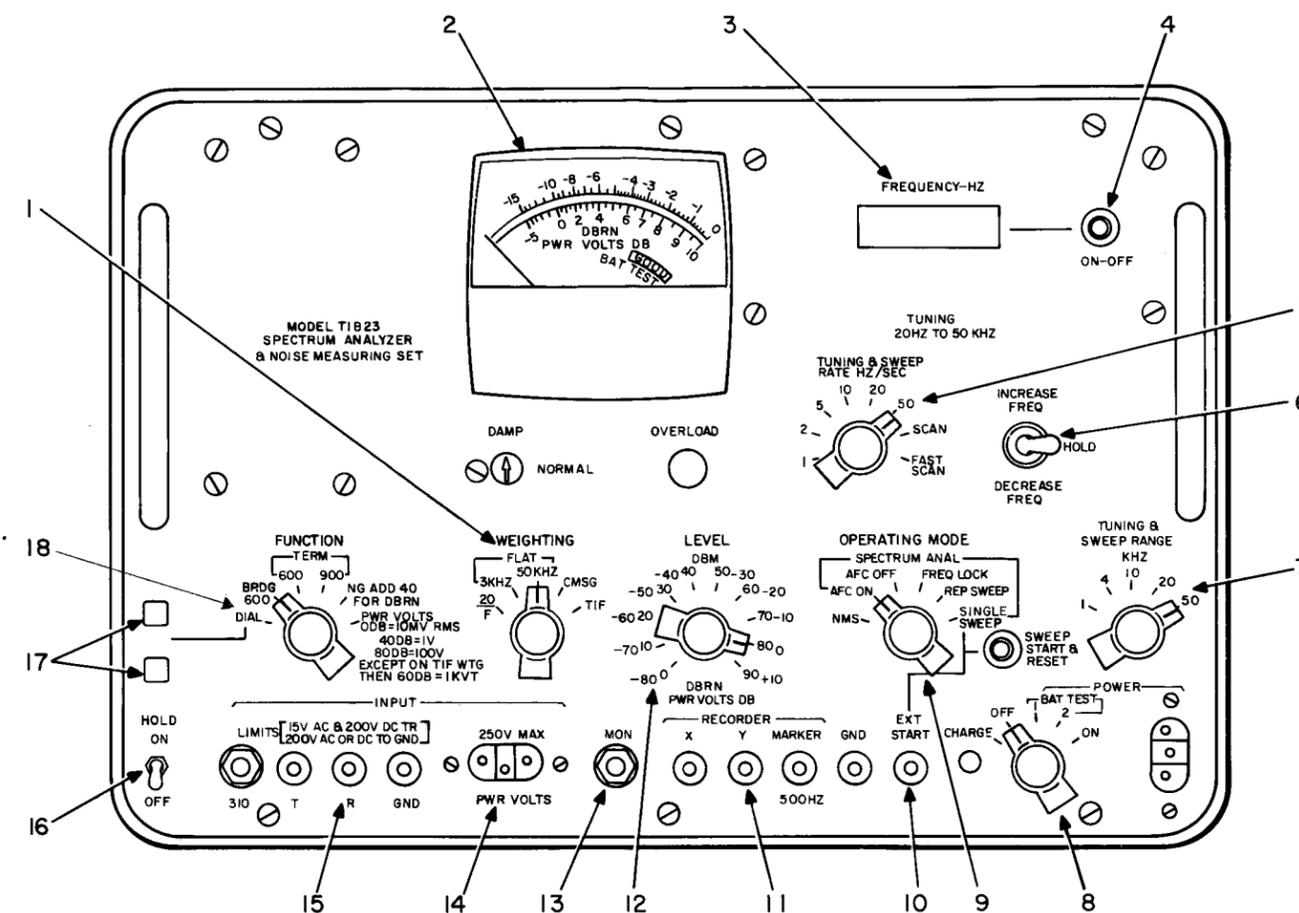


Fig. 4-31—T132B Spectrum Analyzer and Noise Measuring Set

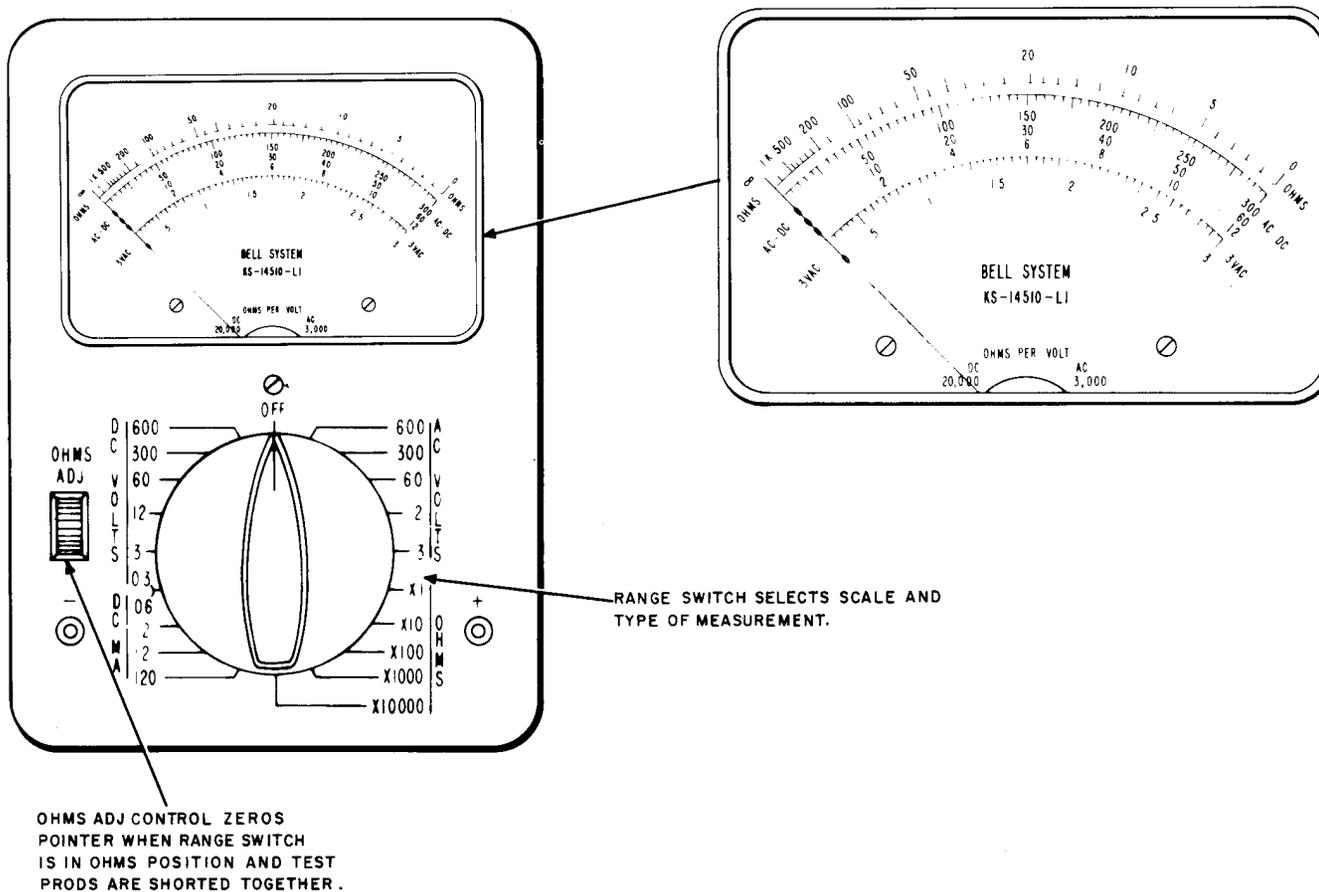


Fig. 4-32—KS-14510 Volt Ohm Milliammeter

- 1 — LINE A jacks are used to connect to the line (IN), the repeater (REP), the LBOA (LBO) and the gain unit (converter)
- 2 — LINE EXT jacks are used to connect the test stand to the repeater shelf by using the ED-97023-30, Group 2 cord. Connects are to LINE A and LINE B.
- 3 — TEST PWR RLMS socket is used to connect to the 54C RLMS TST PWR socket
- 4 — TEST PWR TEST STAND socket is used to connect the test stand to -48V dc supply.
- 5 — TEST PWR TMS socket is used to connect the 54A TMS TST PWR socket.
- 6 — TMS jacks are used to connect the 54A TMS A and B jacks and the 54C RAMS (RL)
- 7 — LINE B same as LINE A except for B side of repeater.
- 8 — E6 repeater holding stand is used to connect the E6 units and gives the tester access to adjustment on the E6.
- 9 — S1 switch selects the desired measurement:  
 NORM — LBOs are in circuit  
 GAIN — converters only  
 RL LINE A — Connects RL jack to Gain Unit  
 RL LINE B — Connects RL jack to Gain Unit
- 10 — S2 switch connects a balanced inductor between LINE A and LINE B providing a dc path for holding dialed up termination during return 1055 tests.

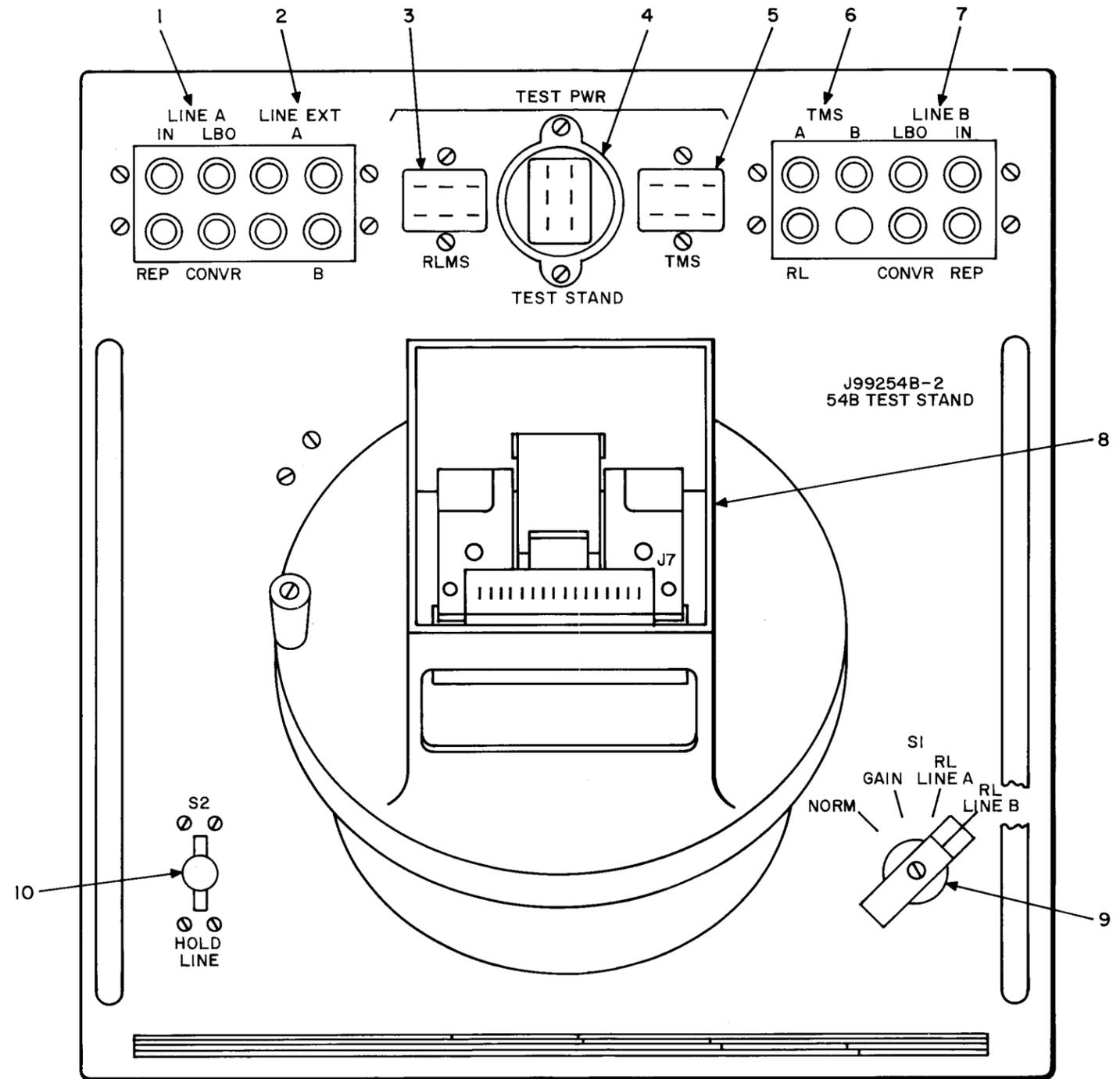


Fig. 4-33—54B Test Stand

Programs the transmission only section (see below) for 2- or 4-wire operation on the A side.

Selects either 600 or 900 ohms in series with 2.16  $\mu$ F internal compromise terminating and balancing network for A side of transmission unit under test.

Permits splitting jack access to T and R leads on A side of unit under test. EQUIP jack is connected to the MFT unit and the LINE jack looks at the facility. When only one jack is used a termination (600 or 900 ohms in series with 2.16  $\mu$ F as selected by the 600/900 ohm key) is connected across the other jack.

Permits monitoring of Pair II of a 4-wire circuit on the A side.

Permits splitting jack access to T1 and R1 on the A side of 4-wire units. The LINE jack accesses the facility and the EQUIP jack is connected to the unit under test.

Allows substitution of an internal compromise network for the precision network associated with the A side of the transmission unit under test. The key is normally in the OUT position. When return loss is measured on the A side, the key should be in the IN position. When transmission measuring sets are used to replace a cable pair a resistive termination (600 or 900 ohms) should be used in the EXT TERM jack.

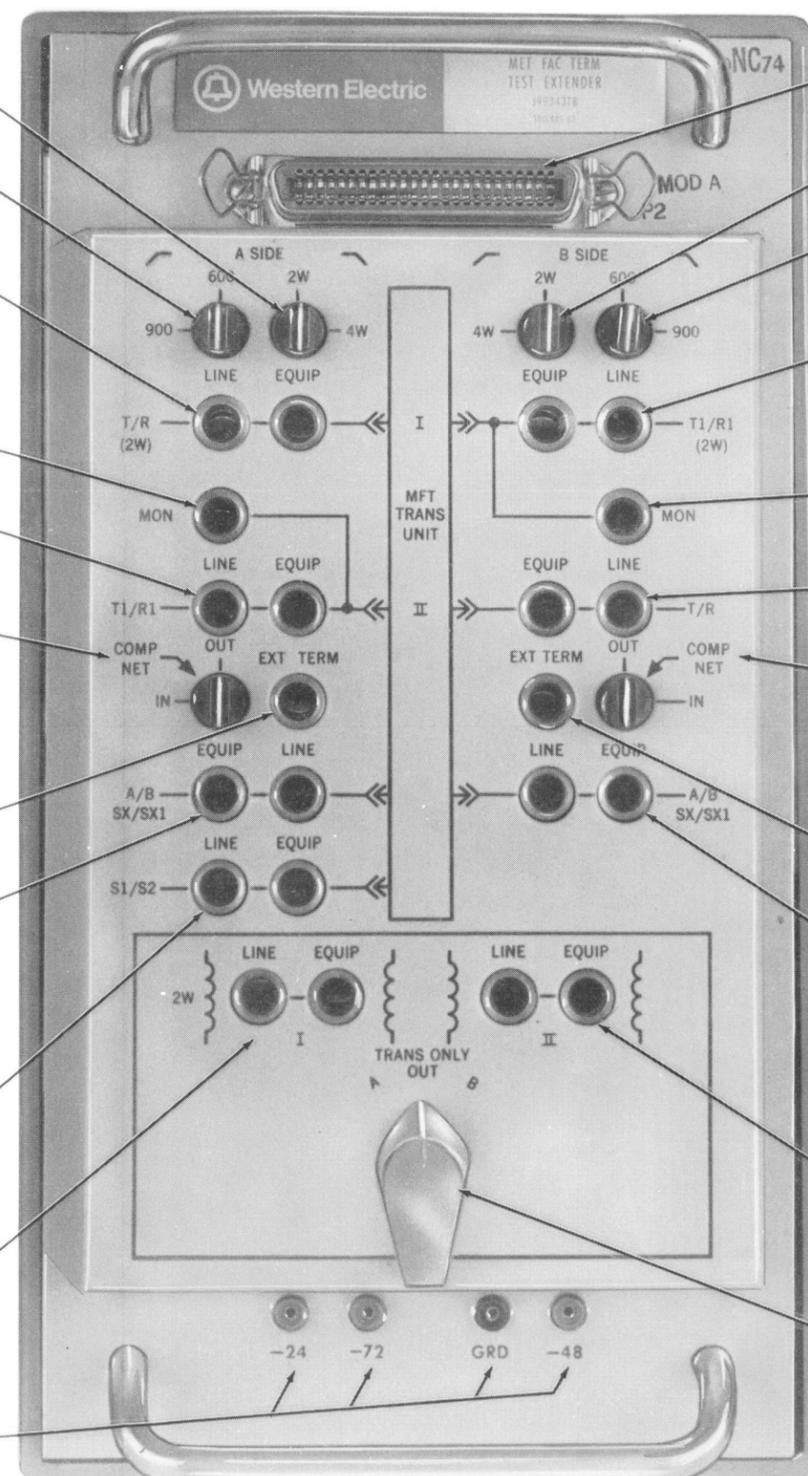
External balancing networks are connected to the hybrid in the A side of the MFT unit through this jack. The jack is wired to take precedence over the IN/OUT key.

Permits splitting jack access to A and B leads of 2-wire units or SX and SX1 leads of 4-wire units. The LINE jack accesses the facility through the transmission unit and the EQUIP jack accesses the signaling unit. These jacks access the A side signaling leads if the transmission unit REVERSE/NORMAL switch is in the NORMAL position. The B side leads are accessed if the switch on the transmission unit is REVERSED.

Permits splitting jack access to AS1 and AS2 leads — The LINE jack accesses the central office equipment and the EQUIP jack accesses the signaling unit through the transmission unit.

Replaces pair of jacks in path I on side selected by A/OUT/B switch (A position replaces T/R on A side of extender and B position replaces T1/R1 on B side).

Pin jacks for monitoring battery supply voltages and ground.



Connector for cable extender card.

Programs the transmission only section (see below) for 2- or 4-wire operation on the B side.

Selects either 600 or 900 ohms in series with 2.16  $\mu$ F internal compromise terminating and balancing network for B side of transmission unit under test.

Permits splitting jack access to T1 and R1 leads on B side of unit under test. EQUIP jack is connected to the MFT unit and the LINE jack looks at the facility. When only one jack is used a termination (600 or 900 ohms in series with 2.16  $\mu$ F as selected by the 600/900 ohm key) is connected across the other jack.

Permits monitoring of a 2-wire facility or Pair I of a 4-wire circuit.

Permits splitting jack access to T and R on B side of 4-wire units. The LINE jack accesses the facility and the EQUIP jack is connected to the unit under test.

Allows substitution of an internal compromise network for the precision network associated with the B side of the transmission unit under test. The key is normally in the OUT position. When return loss is measured on the B side, the key should be in the IN position. When transmission measuring sets are used to replace a cable pair a resistive termination (600 or 900 ohms) should be used in the EXT TERM jack.

External balancing networks are connected to the hybrid in the B side of the MFT unit through this jack. The jack is wired to take precedence over the IN/OUT key.

Permits splitting jack access to A and B leads of 2-wire units or SX and SX1 leads of 4-wire units. The LINE jack accesses the facility through the transmission unit and the EQUIP jack accesses the signaling unit. These jacks access the B side signaling leads if the transmission unit REVERSE/NORMAL switch is in the NORMAL position. The A side leads are accessed if the switch on the transmission unit is REVERSED.

Replaces pair of jacks in path II on side selected by A/OUT/B switch. (A position replaces T1/R1 on A side and B position replaces the T and R on the B side).

A/OUT/B switch allows replacement of four corresponding jacks on A side or B side of test extender for transmission only measurements. The dc continuity of the circuit under test is not interrupted.

Fig. 4-34—Functional Diagram of the J99343TB Test Extender

## 5. TROUBLE CLEARING

### GENERAL

**5.01** This part is intended to aid the test personnel in restoring service to the customer. The circuit involved may be out of service or the service may only be impaired; in either case, quick restoration of service is the objective. Restoration may be accomplished by patching a good circuit segment or circuit component in place of the circuit segment or circuit component causing the trouble. It may be necessary to repair or replace certain equipment in the circuit before service is restored. This process, from reported trouble to restored service (really to close-out of trouble ticket), is called trouble clearing.

**5.02** A logic sequence, Fig. 5-1, is given for clearing the basic types of trouble reports as listed in Table 5-A. The number in the START POSITION column, corresponds to one of the START blocks on the logic sequence. For example, the reader would start the logic sequence with START 2 if the trouble report type is REF-IN. The logic sequence is to be used as a *guide* only and not as step-by-step procedures. Some blocks may need further explanation, especially for less experienced personnel, therefore, references are given to paragraphs or other documents that contain additional information. It is recognized that more experienced test personnel will not require this guide except as a reference point to test procedures for specific tests.

**5.03** The ultimate goal in this part is to isolate the trouble to specific equipment, based on information concerning the operation of that equipment as found in Part 6.

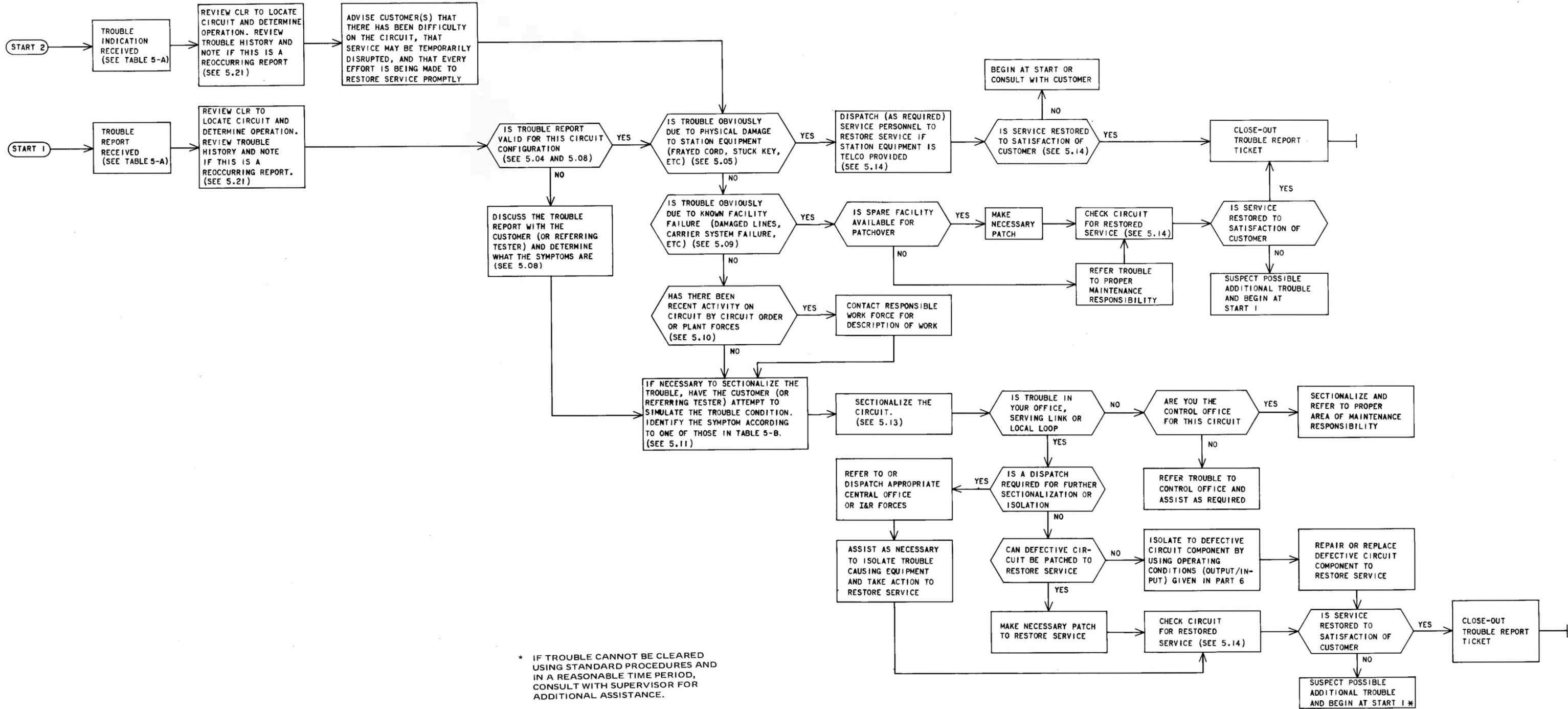
### SYMPTOM ANALYSIS

**5.04** One of the most basic parts of trouble clearing is symptom analysis. This is the decision making process that takes place before any tests are made. The decisions made by the tester affect the trouble clearing process in such a way that, in some cases, a large portion of a circuit can be sectionalized without testing. Decisions are made based on information the tester can obtain from the trouble report, the circuit layout record (CLR), the trouble history record, and in many cases the customer. The experienced tester will use past experience as an additional source of information, upon which these decisions are made.

**5.05** When a tester receives a trouble report, one of the first things done (after consulting the CLR) is decide if the symptom is valid for the circuit involved. In other words, the tester must decide if this symptom is possible on this circuit configuration. If the symptom is, "Can't get dial tone," and the CLR indicates that the circuit does not supply dial tone to that customer, then the symptom is invalid. Another example could be that the trouble is "Defective station equipment" and the CLR shows that the station equipment is customer provided. Since the telephone company tester would not be responsible for testing customer-provided equipment (CPE), the report is treated as invalid.

TABLE 5-A

TROUBLE REPORT	DESCRIPTION OF TROUBLE REPORT	START POSITION
DIRECT	Customer Reports Directly to Test Center	1
REF-IN	Another Test Center Refers Trouble Report (Usually Tester to Tester) for Further Trouble Clearing Action	1
EMP	Employee Reports Trouble Indication to Test Center (Employee Detected Trouble Causing Condition in Normal Performance of Duties)	2



\* IF TROUBLE CANNOT BE CLEARED USING STANDARD PROCEDURES AND IN A REASONABLE TIME PERIOD, CONSULT WITH SUPERVISOR FOR ADDITIONAL ASSISTANCE.

Fig. 5-1—Logic Sequence For Clearing Basic Trouble Reports

**5.06** When the tester decides that a symptom is invalid, another decision must be made. Since the customer may not know the technical term for the difficulty, the tester must decide if the symptom is invalid or simply reported incorrectly.

**5.07** The tester may need to translate the reported symptom into one that can be used to further investigate the trouble. For example, the customer could report that the circuit sounds like "talking in a rain barrel". While this report is not technically accurate, it can be easily translated into "hollow sounding", which should be more widely accepted as a valid symptom. Table 5-B gives a list of symptoms which should be sufficient to cover most trouble reports. Since the customer report may be quite different from the actual symptom, the tester should attempt to classify the customer report as one of those in Table 5-B.

**5.08** In many cases the customer will report the trouble directly to the tester. This gives the tester the advantage of talking to the person who knows a great deal about this problem. The customer can give the tester information concerning the circumstances related to the trouble. For instance, the customer can tell the tester if the trouble occurs on every call, various calls, or only on calls to or perhaps from selected stations. Another example of information the tester can obtain from the customer is additional clarification of the symptom. If the customer reported that the circuit was noisy, perhaps the tester could learn more about the cause of the noise by having the customer describe its sound. For instance, the customer indicates that the noise sounded like a high speed typewriter which would indicate cross fire (see cross talk) of a teletype circuit. In any case, the tester should always be alert to establish a dialogue with the customer so as to determine all the information possible about the trouble conditions. At the same time the tester must not request too much time from the customer; after all, the customer is paying for this service and expects the telephone company to restore service promptly.

**5.09** Another decision that must be made by the tester is related to obvious trouble. For example, if the tester is aware of a facility failure and the CLR indicates that the customer reporting trouble is served by this facility, then the most likely cause is the facility. In this case the tester should attempt to have the circuit patched to a

spare facility, or if none is available, inform the customer that the trouble has been located and every effort is being made to restore service promptly. Another example of what is considered obvious trouble might be a customer reporting "busy" during heavy usage periods on a dial circuit. In a case like this, the tester should verify that the customer is receiving a valid busy, even though there is reason to suspect an overload causing the trouble.

**5.10** If the circuit involved was recently turned up for service or was recently worked on by plant forces, the tester should consult with the responsible personnel. The trouble report can be the result of an error in this work. Once the tester is aware that trouble is occasionally caused during installation and maintenance work on the circuit, unnecessary sectionalization may be eliminated.

**5.11** Once a complete understanding of the symptom is obtained, the tester should check the circuit to identify the symptom as one of those in Table 5-B. In the initial check of the circuit, the tester should take care not to change the existing conditions of the circuit. Sometimes changing the conditions of the circuit will cause the trouble to clear before the cause can be located and corrected. If the symptom is not present on the circuit, the tester should attempt to repeat the circuit conditions prior to the trouble or have the customer repeat them. For example, if the customer reports "no dial tone", the tester may attempt to draw dial tone as the customer would or monitor the circuit while the customer tries. Here again, the tester must have a complete understanding of how the circuit operates. Individual circuit component operation is given in Part 6, and will aid the tester in understanding the overall circuit operation. Table 5-B also gives possible causes and common tests used to isolate trouble for the various symptoms.

**5.12** Up to this point in the trouble clearing process, the emphasis has been on symptom analysis. However, it should be noted again that some decisions made by the tester are actually steps which sectionalize the circuit. In the above example, if the tester could draw dial tone but the customer couldn't, the trouble has been sectionalized to that portion of the circuit between the tester and the customer. Obviously, not all troubles are sectionalized by the symptom analysis, therefore, further discussion of sectionalization is contained in the following paragraphs.

TABLE 5-B

SYMPTOM	COMMONLY REPORTED AS	COMMON CAUSES				TESTS
		STATION	LOCAL LOOP	CO	INTEROFFICE FACILITY	
A. STATIC/HUM	FRYING OR CRACKLING/TONE	<ul style="list-style-type: none"> <li>AC INDUCTION</li> <li>BAD TELSET TRANSMITTER</li> <li>FRAYED HANDSET CORD</li> <li>BAD PROTECTOR</li> </ul>	<ul style="list-style-type: none"> <li>AC INDUCTION</li> <li>WET CABLE PAIR</li> <li>OPEN T OR R</li> <li>GROUNDED OR CROSSED CABLE PAIR</li> </ul>	<ul style="list-style-type: none"> <li>AC INDUCTION</li> <li>HEAT COILS</li> <li>GROUNDED CARBONS</li> <li>LOOSE CONNECTION/COLD SOLDER JOINT</li> </ul>	<ul style="list-style-type: none"> <li>AC INDUCTION</li> <li>LOOSE CONNECTION/COLD SOLDER JOINT</li> <li>HIGH LEVELS</li> </ul>	<ul style="list-style-type: none"> <li>LISTENING</li> <li>LEVEL</li> <li>NOISE MEASUREMENT</li> <li>VISUAL</li> <li>VOLTMETER</li> </ul>
B. CROSSTALK (NOTE 1)	SOMEONE ELSE TALKING, BABBLE, DONALD DUCK EFFECT	<ul style="list-style-type: none"> <li>PBX SWITCHING TROUBLE</li> <li>DESIGN ERROR</li> <li>INSTALLATION ERROR</li> </ul>	<ul style="list-style-type: none"> <li>WET CABLE PAIR</li> <li>CROSSED CABLE</li> <li>HIGH LEVEL IN ADJACENT CIRCUIT</li> </ul>	<ul style="list-style-type: none"> <li>HIGH LEVELS</li> <li>DOUBLE CONNECTION</li> <li>SOLDER SPLASH/WIRE CLIPPINGS</li> </ul>	<ul style="list-style-type: none"> <li>HIGH LEVEL IN ADJACENT CIRCUIT</li> <li>CARRIER INTER-MODULATION AND/OR MISALIGNMENT</li> </ul>	<ul style="list-style-type: none"> <li>LISTENING</li> <li>LEVEL (NOTE 2)</li> <li>VISUAL</li> <li>VOLTMETER</li> </ul>
C. HOLLOW SOUNDING/SINGING/HOWLING	LIKE TALKING IN A BARREL/SHRILL NOISE, SQUEAL	<ul style="list-style-type: none"> <li>LOSS OF IDLE CIRCUIT TERMINATION</li> <li>TERM SET/NETWORK</li> <li>POOR RETURN LOSS</li> <li>EXCESSIVE GAIN</li> </ul>	<ul style="list-style-type: none"> <li>IMPEDANCE MISMATCH/LOADING, BRIDGE TAP</li> <li>OPEN T OR R</li> </ul>	<ul style="list-style-type: none"> <li>TERM SET/NETWORK</li> <li>IDLE LINE TERMINATION</li> <li>POOR RETURN LOSS</li> <li>EXCESSIVE GAIN</li> </ul>	<ul style="list-style-type: none"> <li>EXCESSIVE GAIN</li> </ul>	<ul style="list-style-type: none"> <li>LISTENING</li> <li>LEVEL</li> <li>RETURN LOSS</li> <li>SINGING POINT</li> <li>FREQUENCY RESPONSE</li> <li>VOLTMETER</li> </ul>
D. FADING	VARYING VOLUME, CUTOFF, RUSHING SOUND, CAN'T HEAR OR BE HEARD AT TIMES	<ul style="list-style-type: none"> <li>LOOSE CONNECTION</li> <li>DIRTY CONTACTS</li> <li>TUBE TYPE REPEATERS</li> <li>POWER SUPPLY</li> </ul>		<ul style="list-style-type: none"> <li>DIRTY CONTACTS</li> <li>TUBE TYPE REPEATERS</li> </ul>	<ul style="list-style-type: none"> <li>CARRIER</li> <li>TUBE TYPE REPEATERS</li> </ul>	<ul style="list-style-type: none"> <li>LISTENING</li> <li>LEVEL</li> <li>VISUAL</li> <li>VOLTMETER</li> </ul>
E. CAN'T HEAR/CAN'T BE HEARD/WEAK/DEAD		<ul style="list-style-type: none"> <li>OPEN T AND/OR R</li> <li>LOW LEVEL</li> </ul>	<ul style="list-style-type: none"> <li>OPEN T AND/OR R</li> </ul>	<ul style="list-style-type: none"> <li>OPEN T AND/OR R</li> <li>LOW LEVEL</li> </ul>	<ul style="list-style-type: none"> <li>OPEN T AND/OR R</li> <li>LOW LEVEL</li> </ul>	<ul style="list-style-type: none"> <li>LISTENING</li> <li>LEVEL</li> <li>VISUAL</li> <li>VOLTMETER</li> </ul>
F. NO DIAL TONE	DEAD	<p>THESE SYMPTOMS ARE NORMALLY CAUSED BY FAILURE OF SIGNALING EQUIPMENT. HOWEVER, TRANSMISSION FACILITIES MAY BE DEFECTIVE AND CAUSE TROUBLE REPORTS OF THIS TYPE ALSO. GENERALLY THE TEST REQUIRED TO SECTIONALIZE THESE SYMPTOMS IS SIMPLY TO CONDITION THE EQUIPMENT AND OBSERVE THE OPERATION. PART 6 GIVES OPERATION AND QUICK TEST FOR VARIOUS CIRCUIT COMPONENTS.</p> <p>CAUTION: CARE SHOULD BE TAKEN NOT TO CHANGE CIRCUIT CONDITIONS WHEN INITIAL OBSERVATION OF THE CIRCUIT IS MADE. IN SOME CASES CHANGES IN CIRCUIT CONDITIONS CAN CAUSE THE TROUBLE TO CLEAR WITHOUT THE TESTER ACTUALLY ISOLATING THE CAUSE OF TROUBLE.</p>				<ul style="list-style-type: none"> <li>LISTENING</li> <li>OPERATION</li> <li>VOLTMETER</li> <li>LEVEL</li> <li>PULSING</li> </ul>
G. DOESN'T ANSWER	CAN'T GET DISTANT END					
H. CAN'T RECEIVE AND/OR TRANSMIT	CAN'T CALL OUT					
I. CAN'T TRIP RINGING	CAN'T ANSWER INCOMING CALL					
J. WRONG NUMBERS						
K. CAN'T BREAK DIAL TONE	CONTINUOUS OR STEADY DIAL TONE					

NOTE 1: THE SYMPTOM OF CROSSTALK INCLUDES THE SYMPTOMS OF CROSS MODULATION (CROSS MOD) AND CROSS FIRE. SINCE THE TERM CROSSMOD DEALS WITH THE IMPROPER MODULATION OF A SIGNAL, THE REPORT OF CROSS MOD NORMALLY INDICATES A MISALIGNMENT OF CARRIER FACILITIES. CROSS FIRE NORMALLY IS ASSOCIATED WITH TELETYPE CIRCUITS FEEDING OVER INTO ANOTHER CIRCUIT.

NOTE 2: LEVEL MEASUREMENTS SHOULD BE MADE ON BOTH THE CIRCUIT INVOLVED IN THE TROUBLE REPORT AND ADJACENT CIRCUITS.

**SECTIONALIZATION**

**5.13** The prime objective of sectionalization is to isolate the equipment causing the trouble. This is done by testing various segments of the circuit, gradually eliminating segments that operate properly and thereby locating the segment that does not operate properly. The general procedure (see Logic Sequence) involves testing the segment in the testers office or the segment available to the tester first. This may also include the serving link of the responsible office. However, if the symptom and the CLR indicate that the trouble is located elsewhere, obviously the most probable segment should be checked first. In some cases it may be advantageous to check the largest portion of the circuit first, especially if trouble is expected at the distant end.

**5.14** Once the tester has "cleared his office" by sectionalizing the trouble to another area of maintenance responsibility, the trouble report should be **referred** to that area. In some cases the tester may need to request a **dispatch** of maintenance personnel in order to isolate the defective equipment. Since dispatching of maintenance personnel is costly and time consuming, the tester should be certain of the need before requesting a dispatch.

**Note:** Check CLR for a loopback arrangement that may be available at the customer location. If available, much testing can be accomplished without dispatching. (See Part 3 for more information on loopback arrangements.)

In either the referred or dispatched case, the tester should check periodically (according to local instructions) to assure if the service is restored and that the customer is satisfied.

**5.15** In the situation where the tester sectionalizes the trouble to within his (her) office or area of maintenance responsibility, it may be possible to restore service by patching the circuit to a spare circuit. If this can be done, it should be done **before** isolating the defective equipment. The tester may do this by patching either at the testboard or a nearby location. This is called **self-restoral**. The tester should then follow up, if possible, the isolating of the defective circuit component.

**5.16** The tests that may be used to sectionalize and eventually isolate trouble for a given symptom are listed in Table 5-B. References to BSPs containing procedures for the tests for various types of circuits are given in Table 5-C. Table 5-D lists other BSP references that may be helpful to the tester.

TABLE 5-C

TEST SECTIONS FOR SPECIAL SERVICE CIRCUITS

TYPES OF CIRCUIT	SECTION
BALANCE TEST PROCEDURES FOR PBX SWITCHED 4-WIRE TIE TRUNKS AND ACCESS LINES	311-350-500
PRIVATE LINE TELEPHONE SERVICE — SPECIAL MULTISTATION SYSTEMS — TESTS AND ADJUSTMENTS	310-400-500
TWO-POINT PRIVATE LINE TELEPHONE CIRCUITS — VOICE ONLY — TEST PROCEDURES	310-300-500
PRIVATE LINE TELEPHONE SERVICE — MULTISTATION SYSTEMS — TEST AND ADJUSTMENTS	310-405-500
PBX TIE TRUNK — TESTS AND ADJUSTMENTS	311-300-500
OVERALL SIGNALING ARRANGEMENTS AND TESTING — DIAL PULSING TESTS ON FX AND WATS CIRCUITS	333-125-500
OVERALL SIGNALING ARRANGEMENTS AND TESTING — PULSING TESTS ON DIAL TIE TRUNKS	333-126-500

TABLE 5D—MISCELLANEOUS BSP REFERENCES

ADMINISTRATIVE SECTIONS		TEST SECTION FOR VARIOUS EQUIPMENT	
TRANSMISSION TEST LINE DIRECTORIES — GENERAL DESCRIPTION	302-100-100	SINGLE-FREQUENCY SIGNALING SYSTEM — SIGNALING TESTS — TYPES E AND F — USING 2B SIGNALING TEST SET (J64730)	179-302-501
TRANSMISSION TEST LINE DIRECTORY — NPA YYY*	302-YYY*-10	SINGLE-FREQUENCY SIGNALING CIRCUITS — TYPES E1A, E1B, E2B, E3B, E4B, E1C, E2C, E3C, E4C, E5C, E1D, E2D, E3D, E4D, E5D, E1J, E1L, E2L, E1P, E1R, E1S, E2S, AND E3S, IN-SERVICE TESTS	179-314-501
TOLL TELEPHONE FACILITY MAINTENANCE — OFFICE RESPONSIBILITIES	660-201-010	DIAL LONG LINE CIRCUIT SD-96588-01—TEST	201-832-501
SPECIAL SERVICES — MECHANIZED RESULTS MEASUREMENT PLAN — PREPARATION AND USE OF THE SPECIAL SERVICE REPORT TICKET — FORMS E-4220M, E-4220D, AND E-4221	660-225-015	DIAL LONG LINE CIRCUITS SD-96589-01 — — 96590-01 — — 96591-01 — — TESTS USING TEST POSITION SD-96594-01	201-832-502
PROCEDURES FOR REPORTING AND HANDLING SERVICE REPORTS ON TOLL MESSAGE TRUNKS, PRIVATE LINES, AND VF CIRCUITS	660-625-300	PRIVATE LINE TELEPHONE SERVICE — 600/1500 — CYCLE SELECTIVE SIGNALING SYSTEM — MAINTENANCE AND TROUBLE LOCATION TESTS — CENTRAL OFFICE	310-430-500
PLANT ASSIGNMENT — CIRCUIT LAYOUT RECORD — DESCRIPTION	682-000-011	PRIVATE LINE TELEPHONE SERVICE — 600/1500 — CYCLE SELECTIVE SIGNALING SYSTEM — MAINTENANCE AND TROUBLE LOCATION TESTS — CUSTOMER'S PREMISES	310-430-501
NUMERICAL INDEX — DIVISION 795 — COMMON LANGUAGE	795-000-000	4-WIRE PRIVATE LINE CIRCUIT — POWERED FROM CENTRAL OFFICE SD-69902-01 — IDENTIFICATION, CONNECTIONS, AND TESTS	480-010-100
COMMON LANGUAGE — LOCATION IDENTIFICATION CODE — DESCRIPTION	795-100-100	SS-1 SELECTIVE SIGNALING SYSTEM — OVERALL TESTS — PRIVATE LINE TELEPHONE SERVICE	480-621-581
COMMON LANGUAGE — TRANSMISSION EQUIPMENT IDENTIFICATION — STANDARD CODING PROCEDURES	795-200-000		
COMMON LANGUAGE — CIRCUIT IDENTIFICATION — SPECIAL SERVICE CIRCUITS	795-402-100		
NOISE MEASUREMENTS SECTIONS			
MESSAGE CIRCUIT NOISE — GENERAL INFORMATION	331-100-100		
NOISE MEASUREMENTS ON TWO-WIRE SUBSCRIBER LOOPS — METHODS AND REQUIREMENTS — AT STATIONS	331-850-501		
METHODS FOR IDENTIFYING AND CORRECTING INDUCTIVE NOISE TROUBLES ON SUBSCRIBERS LINES	331-850-502		
NOISE MEASUREMENTS ON 2-WIRE SUBSCRIBER LOOPS — METHODS AND REQUIREMENTS — AT NO. 5 CROSSBAR CENTRAL OFFICES	331-850-505		
NOISE MEASUREMENTS ON 2-WIRE SUBSCRIBER LOOPS — METHODS AND REQUIREMENTS — AT SXS CENTRAL OFFICES	331-850-506		
NOISE MEASUREMENTS ON 2-WIRE SUBSCRIBER LOOPS — METHODS AND REQUIREMENTS — AT NO. 1 CROSSBAR CENTRAL OFFICES	331-850-507		
NOISE MEASUREMENTS ON 2-WIRE SUBSCRIBER LOOPS — METHODS AND REQUIREMENTS — AT PANEL CENTRAL OFFICES	331-850-508		
NOISE MEASUREMENTS ON 2-WIRE SUBSCRIBER LOOPS — METHODS AND REQUIREMENTS — AT NO. 1 ELECTRONIC SWITCHING CENTRAL OFFICES	331-850-509		

**CIRCUIT LAYOUT RECORD (CLR)**

5.17 For each special service circuit there is a circuit layout record (CLR), which contains essential information about that circuit. This information is normally abbreviated by use of the common language equipment code (see Section 795-YYY-ZZZ). Since there are many different CLR formats used in the Bell System, Fig. 5-2 shows only a typical CLR card. The complete CLR may consist of one or more cards.

5.18 The information given on each CLR is similar regardless of the format used. The list below shows the information that should be on the CLR and the numbers to the left correspond to the location on the typical CLR in Fig. 5-2.

**Entries on CLR:**

- (1) Circuit Identification—This line usually contains the circuit number (including a prefix which indicates the type of circuit—FX, PL, etc), the originating location (city or terminal A), the type signaling in both directions between locations, and the terminating location (city or terminal Z). The type of signaling in both directions between locations is an indication of when dial tone is provided to the customer. The customer that uses dial operation to signal will be provided with dial tone.
- (2) Switched Pad or Gain—This space indicates the code for the test pad arrangement or the switched gain available at each terminal. Codes are found in Section 682-000-011, Table B.
- (3) Over-all Active Balance—These spaces contain the computed overall active balance value required at each of the terminal offices (A and Z) when the circuit includes any 2-wire facilities.
- (4) Noise—These spaces contain the upper and lower values of the noise requirements at terminal A and Z as indicated per Section 660-403-500.
- (5) Circuit Order Number—This space contains the circuit order number and item number which authorize the layout given on the CLR. A local company numbering plan will be used since a common numbering plan is not available.
- (6) Control Office—This space contains the location code of the office designated as the control office for this circuit. Section 005-230-101 through —148 contains the proper location codes.
- (7) Circuit Mileage—This space gives the overall circuit length in miles (normally this number represents geographic miles).
- (8) Customer Name—This space gives the customer's name on a special service circuit.
- (9) Circuit Usage—This space contains a code indicating the use of the service.
- (10) Inserted Connection Loss—This space indicates the inserted connection loss (the net equivalent loss inserted by the circuit in an actual operating connection).
- (11) Maintenance Information—This column indicates dc signaling path data, repeater data, echo suppressor data, equalization data, singing point data, and other miscellaneous information that is required for circuit maintenance. Table E of Section 682-000-011 gives additional information concerning the contents of this column.
- (12) Name of Issuing Company—This space gives the name of the company issuing the CLR.
- (13) TLP Toward Terminal Z—This column indicates the Transmission Level Point (TLP) in dB at the output of each major equipment unit and line facility in the transmission path from terminal A to terminal Z. (See Note.)
- (14) TLP Toward Terminal A—This column is used to indicate the TLP in dB at the output of each major equipment unit and line facility in the transmission path from terminal Z to terminal A. (See Note.)

**Note:** The TLP values on the CLR are based on the application of a 1000-Hz tone of 0 dBm at the 0 TLP of each end terminal. **Any deviation in test tone frequency or level should be recorded on the CLR.** When the TLP indicated has a positive value, the entry will be prefixed by a plug (+) sign. When there is no prefix to the numerical value, it is to be assumed that the value is

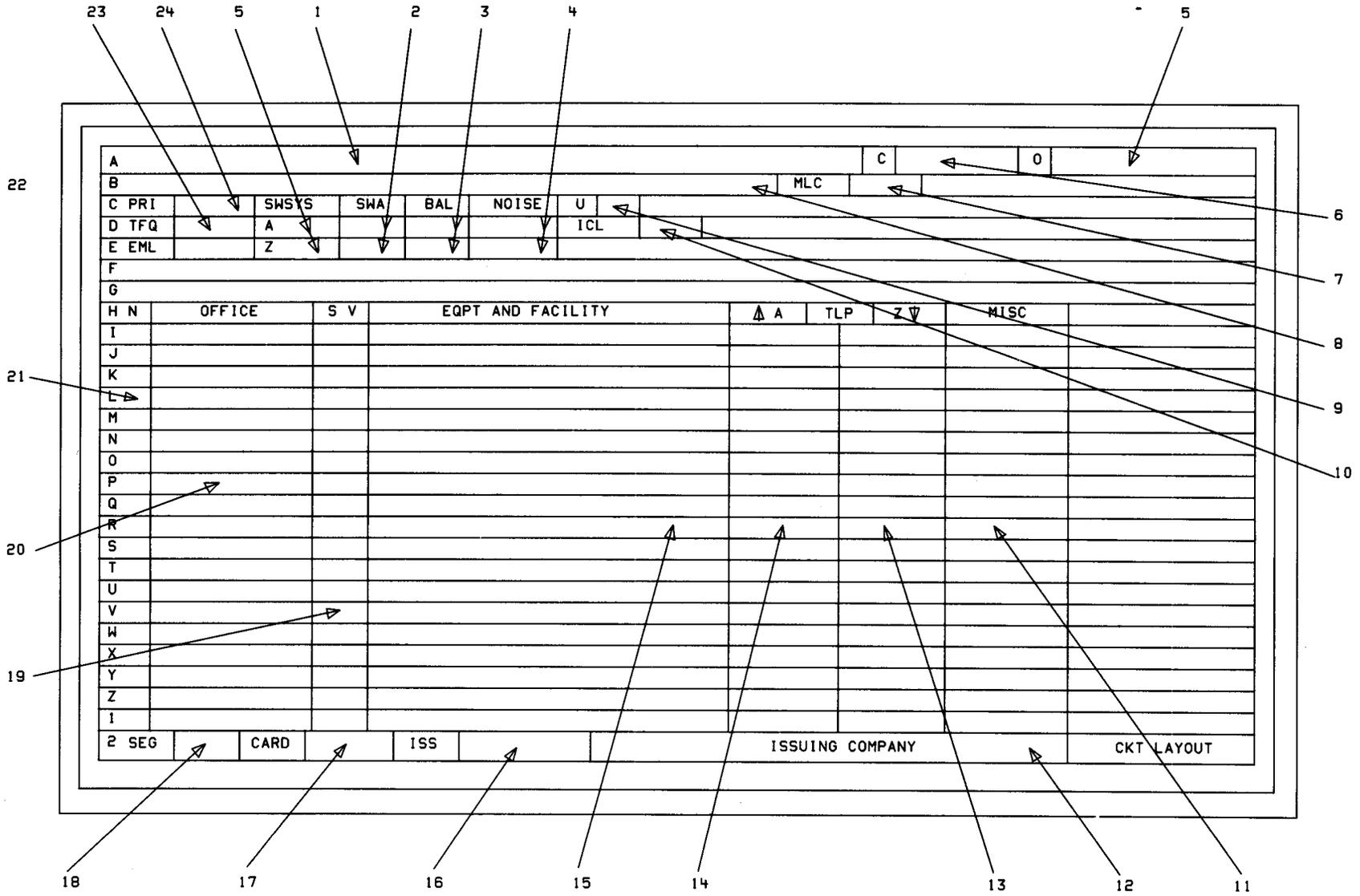


Fig. 5-2—Typical CLR

negative. The loss or gain contributed by any one equipment unit or line facility can be determined by subtracting the output value indicated for **the unit which immediately precedes the unit of interest** from the output value indicated for **the unit of interest**. (See Part 2 for more detailed information on TLP.)

- (15) Equipment And Facility—This column is used to list in wired sequence the equipment and line facilities which make up the layout of the circuit. Codes used are contained in Section 005-202-101.
- (16) Issue Date of Card—This space indicates the date the circuit card was issued.
- (17) Card Number and Total Number of Cards—This space indicates the number of this card and the total number of cards that comprise this CLR.
- (18) Segment Number—This space indicates the number assigned to the segment of the total circuit.
- (19) Signaling or Voice Path—This column indicates that a unit of equipment or a line facility is in the voice path, signaling path or both. The codes used in this column are:

CODE	SIGNALING PATH
X	Transmit and Receive Signaling Path
T	Transmit Signaling Path Only
R	Receive Signaling Path Only
A	Applique Signal Path
*	Exact Location Undefined

CODE	VOICE PATH
2	Two-Wire Voice Path
4	Four-Wire Voice Both Transmit & Receive
T	Four-Wire Voice Path Transmit Leg Only

R	Four-Wire Voice Path Receive Leg Only
A	Applique Voice Path
*	Exact Location Undefined

(20) Locations of Layout—This column indicates the location code of the office where each unit of equipment is located. Since a line facility is basically located between two offices, there will be no location code on a line which contains a line facility designation. One terminal office of the line facility is shown on the line above the facility designation, and the other terminal office is shown on the line below the designation. An asterisk (\*) on the line above or below a terminal office indicates that the office is the facility control office.

(21) Reference or Exception—This column consists of an alphabetical (excluding X) or a numerical reference to a note. When an X appears in this column it acts as an exception indicator which means the information on that line **does not** conform to CLR Outline requirements.

(22) Expected Measured Loss—This space indicates the expected measured loss (EML) as defined in Sections 660-450-300 through -302 and 660-450-501 through -505.

(23) Test Frequencies—This space indicates the upper and lower test frequencies in hundreds of Hertz; eg, 300 to 3000 Hz is indicated as 3-30.

(24) Restoration Priority—This space gives the proper code to indicate the sequence of restoration of service. The priority ratings are explained in Section 660-207-010.

(25) Type of Switching Equipment—These spaces contain the type of switching equipment used at terminal A and terminal B. Table A of Section 682-000-011 contains the valid codes for the various types of switching systems.

**WORK ORDER RECORD AND DETAILS (WORD)**

5.19 The work order record and details (WORD) document is used to give telephone personnel the circuit layout and test information required for installation and maintenance of special service circuits (and message trunks). A WORD document

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consists of three parts: 1) Work Authorization, 2) Circuit Details, and (3) Test Details. One WORD is issued per circuit and is designed to consolidate the many documents which the field forces now require.

**5.20** The work authorization acts as the authorizing work order and notice for circuit layout. This portion of the WORD document may replace a service order, a trunk order, a circuit order, an engineering service order, or any similar order.

**5.21** The circuit details gives the equipment components and assignment information for the circuit in transmission sequence from end to end. This information is entered prior to distribution if components are assigned on a centralized basis. However, if there is no centralized assignment of components, the field forces enter the information locally. The circuit detail portion also contains transmission values, configuration codes and miscellaneous information such as SD, J, and list numbers, screw settings, options, and gain information, etc.

**5.22** The test details contains an itemization of the tests to be performed, the expected measurement, and/or requirements of the tests and space to enter the actual measurements or results. The test details document also contains space to record completion information. Thus, it may be used as the turn-around document for positive reporting of completion and test results. However, a copy of test details containing actual results should be retained for future circuit maintenance.

**5.23** The following line number and character positions should be used as reference for the information contained on the WORD document shown in Fig. 5-3, 5-4 and 5-5:

**Line 1, Character Positions 5 through 72 - CKT:** Contains coded designation for identification of circuit. Format for special service circuits is described in Section 795-402-100. Type of pulsing or signaling used on the circuit is also given.

**Line 2, Character Positions 5 through 27 - ORD:** Contains company assigned number by which a service, circuit, trunk, or ISC order is identified. If applicable, an indicator identifying the latest supplement to the order will also be shown.

**Line 2, Character Positions 34 and 35 - ACTN:** Identifies the type of activity covered on the order; A for add, C for change, etc. The position will be blank for orders which involve multiple activity.

**Line 2, Character Positions 41 through 48 - CAC:** Contains the circuit access code which is applied to cross reference the circuit identification in TIRKS. (Refer to Section 756-554-011.)

**Line 2, Character Positions 53 through 56 - MI:** Contains the interchange mileage in whole numbers.

**Line 2, Character Positions 62 through 72 - PCO:** Identifies Plant Control Office.

**Line 3, Character Positions 6 through 35 - CUST:** Contains name of individual or company that is billed for the service — customer name.

**Line 3, Character Positions 41 through 43 - RRI:** Contains the rebate required interval in hours.

**Line 3, Character Positions 53 through 55 - MSC:** Contains YES, if the minimum service charge arrangement applies; NO, if it does not. (See Section 660-200-015.)

**Line 3, Character Position 62 through 64 - PRQ:** Contains SSM if Special Safeguarding Measures are required or SSP if Special Service Protection is required. (See Section 660-200-300 and 600-200-301.)

**Line 3, Character Positions 71 through 72 - RSP:** Contains restoration priority code. (See Sections 660-207-010 and 660-207-020.)

**Line 4, Character Position 5 through 24 - CLO:** Contains the TIRKS—assigned circuit layout order number associated with the order.

**Line 4, Character Position 38 - ORD TYPE:** Identifies the type of activity covered on the order - N for new service, C for change, etc. (See Section 756-556-790.)

**Line 4, Character Positions 52 through 59-DD:** Contains due date which is the date service is to be turned up for use or the date a disconnection or rearrangement is to take place.

**Line 5, Character Positions 6 through 46 - RCLO:** Contains the CLO number for a related order which is relevant to the installation of this service.

**Line 5, Character Positions 52 through 59 - PTD:** Contains the plant test date which is the date installation of all facilities and equipment, and associated test(s) on each segment of the circuit must be completed.

**Line 6, Character Position 5 through 46 - RO:** Contains the related order, other than the CLO, which the field forces should be aware of in planning the work on this order.

**Line 6, Character Positions 52 through 59 - PRD:** Contains the pre-installation due date which is the date design information, facilities and equipment, etc, must be available to the field forces in order to enable them to complete an order.

**Line 7, Character Positions 5 through 46 - CRO:** Contains other related orders that must be completed with the order. (Same due date.)

**Line 7, Character Positions 52 through 59 - APP:** Contains the application date which is the date the customer gives sufficient information for issuance of the service order or the date sufficient information is available to warrant the issuance of an order for the non-customer requested service, eg, trunk order, engineering service order, or equivalent.

**Line 8 Character Positions 11 through 46 - ORIGR/TEL:** Contains the name and telephone number of the salesman who negotiated the service order with the customer or the name and telephone number of the telephone company representative who initiated the order.

**Line 8, Character Positions 62 through 72 - ARO:** Contains the Administrative Reporting Office which is assigned responsibility for reporting the status of an order.

**Character Positions 1 through 72 - WORK DESCRIPTION AND NOTES:** Contains any additional information required to complete the order.

**Character Positions 1 through 72 - INDEX:** Contains ITEM, ACTN, ISS of Circuit Details and

Test Details and CKT ID. It provides an index of the most current set of Circuit Details and Test Details on which work is authorized to be performed.

**Character Positions 1 through 72 - DISTN:** Contains month, day, RRO (Responsible Reporting Office) and serial number. It also specifies the number of copies and the parts of WORD that each location receives. The serial number is a quick indicator for orders received via TTY that an office has received all orders for that day.

**Line 24, Character Position 1 through 10 - O/R MMDD-RRO:** Character Position 1 contains a code [Ø (blank) for Original, R for Redistribution] generated by the Order Distribution System in TIRKS. Character Positions 3 through 10 contains the month and day an order was sent to that Responsible Reporting Office (RRO).

**Line 24, Character Positions 15 through 18 - CO:** Contains the issuing company code.

**Line 24, Character Positions 28 through 43 - DSGNR:** Contains the designer initials and telephone number.

**Line 24, Character Positions 49 through 60 - ISS:** Contains the issue number in character positions 49 through 51 and date in character positions 53 through 60.

**Line 24, Character Positions 65 through 72 - PG:** Contains the page number of the Work Authorization. The letter W appears in character position 65 on all Work Authorization pages.

#### OPTIONAL ENTRIES - AS APPLICABLE

**Line 4, Character Positions 65 through 72 - IAD:** Contains the Inventory Availability Date if applicable.

**Line 5, Character Positions 65 through 72 - SDD:** Contains the Scheduled Due Date for the order, if applicable. The Scheduled Due Date is useful when many orders must be completed simultaneously to meet the needs of a cutover, busy season growth requirement, etc, and the need for spreading the actual work over some period of time is desired.

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**Character Positions 6 through 46 - SA:** Contains the service address which is the official address for the customer premises.

**Character Positions 62 through 72 - SPGO:** Contains the Supervising Office which is the office or administrative group that coordinates the activities related to circuit installation work.

**Character Positions 62 through 72 - NCO:** Contains the Network Control Office which is the designated office responsible for the service on the entire network of a special services customer. Section 660-005-011 and 660-201-010 define the responsibility of the Network Control Office.

**Character Position 62 through 72 - SCLO:** Contains the Subcontrol Office which may be designated on the Circuit Layout Record to assist the PCO in carrying out his responsibilities on a complex circuit.

**Character Position 62 through 72 - CNTO:** Contains the Contact Office which is defined in Sections 660-005-011 and 660-201-010.

**Optional Entries - Company Prerogative**

**Line 6, Character Positions 65 through 72 - ED:** Contains the engineering due date which is the date all information required to engineer the service is available and all facilities and equipment are assigned, reserved and/or ordered.

**Line 7, Character Positions 65 through 72 - SID:** Contains the schedule issued date which is the date the original orders authorizing the work is scheduled for issuance.

**Character Positions 62 through 72 - ECO:** Contains the Engineering Control Office which is the engineering office responsible for the overall design of a circuit.

**Character Positions 62 through 72 - SECO:** Contains the Station Engineering Control Office responsible for overall station engineering design.

The first 3/4 lines for Special Services orders (the first 2 lines for Message) and the last line of Page 1 of the Work Authorization appear on Page 1 of the Circuit Details and Test Details. Page 2 and subsequent pages of the Work Authorization, Circuit

Details and Test Details contain the first 2 lines and the last line of Page 1 of the Work Authorization.

**Circuit Details**

The first 2 lines (plus the third line for special service orders) and the last line of the Work Authorization are repeated on the first page of the Circuit Details and Test Details with the following variations.

ORD: Instead of the supplement indicator for the order being shown, the item number and an item supplement indicator for the circuit is shown.

PG: W - W is shown on the Work Authorization pages C - C on Circuit Details pages, and T - T on Test Details pages.

**Line 4, Character Position 1:** An entry in this position signifies a note. N indicates a note will follow. Any other alpha refers to a note following the transmission sequence.

**Line 4, Character Positions 3 through 20 - LOCN, EQPT and FAC:** Contains a sequential list of all locations, equipment and facilities on the circuit from end to end. The sequence begins with a location code whether a customer location or a central office. Hardwired equipment and facilities follow starting in character position 4. Facilities are depicted as follows: facility designation appears in character positions 4 through 8; facility type appears in character positions 10 through 18; channel/pair number appear(s) in character positions 33 through 37 in column headed "UNIT". This entry is preceded and followed by the terminals of the facility. Plug-ins appear in character position 5. Other entries appear as notes in character positions 6 through 38.

**Line 4, Character Positions 22 through 31 - FRAME ID:** Contains the frame identification (relay rack) which specifies where each wired equipment component is physically located in the building.

**Line 4, Character Positions 33 through 39 - UNIT:** Contains the number of the unit assigned for each hardwired component.

**Line 4, Character Position 41 - S:** Indicates that a unit of equipment or a line facility is in the signal path of a service. The codes used in this column are as follows:

TYPE OF SIGNAL PATH	CODE
Transmit and Receive Signal Path	X
Transmit Signal Path Only	T
Receive Signal Path Only	R
Applique Signal Path	A
Exact Location Undefined	*

**Line 4, Character Position 42 - V:** Indicates that a unit of equipment or a line facility is in the voice path of a service. The codes used in this column are as follows:

TYPE OF VOICE PATH	CODE
Two-Wire Voice Path	2
Four-Wire Voice Path Both Transmit and Receive	4
Four-Wire Voice Path Transmit Leg Only	T
Four-Wire Voice Path Receive Leg Only	R
Applique Voice Path	A
Exact Location Undefined	*

*Note:* Four-wire terminations sets will be considered to be in the two-wire path.

**Line 4, Character Positions 44 through 48 - Z - Z:** Contains the 1000-Hz transmission level in dBm that would be measured at the output of each major equipment unit, line facility, test line, etc. that is in the transmission path from Z to A. These values are based on the application of a 1000-Hz tone from the specified test line or the application of a 1000-Hz tone from some other source at the level specified. A plus sign (+) appears when the value is positive. When no sign appears, the value is negative.

**Line 4, Character Positions 50 through 54 - Z - Z:** Contains the 1000-Hz transmission level in dBm that would be measured at the output of each major equipment unit, line facility, test line, etc. that is in the transmission path from A to Z.

**Line 4, Character Positions 56 through 72 - MISC:** May contain lead sets for each wired component, strapping information, SD, J and List numbers, screw settings and options, gain information including switched gain, alternate transmission level information.

**Line 4, Character Positions 1 through 72 - PRE-SERVICE TEST INFORMATION:** Contains the required tests, objectives, and an area to record actual measured values. When parentheses appear in the RCV A/RCV Z columns, an actual measurement must be recorded. If some of the specified tests need not be repeated on a rearrangement or change order, enter the previous pre-service test results.

**Character Positions 1 through 72 - ROUTINE MAINTENANCE:** Following pre-service tests, routine maintenance requirements and intervals are provided.

**Character Positions 1 through 27 - BENCH MARK MEASUREMENTS:** Prior to turn up, bench mark measurements are made using loop back devices, CAROT, etc. A blank area has been left to record these measurements for reference.

**WORK PERFORMED AS AUTHORIZED:** This entry is made to record the fact that the work on the circuit was performed as authorized or with exceptions. A reminder is provided to report changes as specified in company instructions. This entry and all of the following entries appear on the last page of the Test Details.

**COMPLETION DATE:** Enter the date the authorized work on the circuit was completed in Character Positions 18 through 25. In character positions 49 through 51, enter the initials of the person who completed the work on the circuit at office A, in character positions 65 through 67 at the PCO.

**COMPLETION REPORTED DATE:** In character positions 27 through 34, enter the date completion of the order was reported.

#### Optional Entries - Company Prerogative

**PG/LN:** Enter the page and line number of the report on which completion was reported in character positions 42 through 50.

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**SER:** Enter the serial number of the record on which completion was reported in character positions 56 through 59.

**LOG:** Enter the log number of the record on which completion was reported in character positions 65 through 68.

**Optional Entry - As Applicable**

**IAD REPORTED DATE:** If an Inventory Availability Date is specified, enter the date the IAD function was reported in character positions 20 through 27.

WORK AUTHORIZATION

```

LINE -----
 1
 2   CKT                               A                               Z
 3   ORD                               ACTN  CAC                               MI   PCO
 4   CUST                               RRI                               MSC   PRQ           RSP
 5   CLO           OF           ORD TYPE           DD           IAD
 6   RCLO                               PTD           SDD
 7   RO                               PRD           ED
 8   CRO                               APP           SID
 9   ORIG/TEL
10   SA                               ARO
11                               SPGO
12                               NCO
13                               SCLO
14                               CNTO
15                               ECO
16                               SECO
16   WORK DESCRIPTION AND NOTES
17
18   ITEM  ACTN  CD  TD  CKT ID:  INDEX
19           ISS
20   DISTN
21
22
23
24   O/RMMDD-RR0 CO           DSGNR  /           ISS  /           -   -   PG W   -
-----

```

Character Position 12345678901234567890123456789012345678901234567890123456789012

WORK AUTHORIZATION

Fig. 5-3—Work Authorization

CIRCUIT DETAILS

LINE

LINE	CKT	ACTN	CAC	MI	MSC	PCO	PRQ	RSP
1								
2	ORD							
3	CUST							
4	N LOCN, EQPT AND FAC FRAME ID UNIT SV Z-A A-Z MISC							
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								
21								
22								
23								
24	O/R MMDD-RRO CO	DSGNR /	ISS /	-	-	PC	C	-

Character Position

12345678901234567890123456789012345678901234567890123456789012

CIRCUIT DETAILS

Fig. 5-4—Circuit Details

TEST DETAILS

LINE	-----											
1					A				Z			
2		ACTN	CAC			MI		PCO				
3			RRI			MSC		PRQ		RSP		
4	PRE-SERVICE TEST INFORMATION											
5	REQUIREMENTS							REC A		REC	Z	
6												
7												
8												
9												
10												
11												
12	ROUTINE MAINTENANCE											
13												
14												
15												
16	BENCHMARK MEASUREMENTS											
17												
18												
19												
20												
21	WORK PERFORMED AS AUTHORIZED	YES	NO			IF NO REPORT CHANGES						
22	COMPLETION DATE	-	-			INTLS A		Z		PCO		
23	COMPLETION REPORTED DATE	-	-	PG/LN	/			SER		LOG		
24	IAD REPORTED DATE	-	-									
	O/R MMDD-RRO CD		DSG NR	/		ISS	/	-	-	PG	T	-
	-----											

Character Position 12345678901234567890123456789012345678901234567890123456789012

TEST DETAILS

Fig. 5-5—Test Details

## 6. CIRCUIT COMPONENTS—FUNCTIONS AND TESTING

6.01 This part contains reference material for circuit components commonly used to make up a special service circuit. The components are divided into transmission and signaling except for the metallic facility terminal which is covered as one family of plug-in units. In general, the information given for each component is:

Block diagram

Quick test

Operation

Description

Options

Simplified schematic

Sequence chart

However, due to the nature of some of the components, this format is varied somewhat. The following lists gives the page numbers for the components in this part, first by alphabetical listing then numerical, then by SD number and finally by common language equipment codes.

ALPHABETICAL LISTING	PAGE NO.	ALPHABETICAL LISTING (Cont)	PAGE NO.
A			
Amplifiers — 227-Type (Table 6-I)	233	DX2 Signaling Lead Extension Circuit (6.34)	194
B			
Bridge Lifters (6.70)	250	D0B Ringdown Converter (6.13)	181
Bridges (6.68)	247	D1B Ringdown Converter (6.17)	182
C			
Code Select Ringer (CSR) (6.11)	180	Echo Suppressor (6.67)	245
Coil — Repeating (6.66)	244	Equalizer — 359-Type (Table 6-K)	235
Converter, D0B Ringdown (6.13)	181	E-Type Single Frequency (SF)	205/206
D1B Ringdown (6.17)	182	Signaling Units (6.52)	
LP1 Loop Signaling (6.21)	184	E6 Repeater (6.61)	239
LP2 Loop Signaling (6.25)	187	F	
LP3 Loop Signaling (6.28)	190	F-Type Single Frequency (SF) Signaling Units (6.54)	220
D			
Dial Long Line (DLL) Circuit (DLL01) (6.40)	197	G	
Dial Long Line (DLL) Circuit (DLL03) (6.44)	200	H	
Dial Long Line (DLL) Circuit (DLL62, DLL63) (6.48)	203	I	
DX1 Signaling Lead Extension Circuit (6.31)	192	Impedance Compensator — 837-Type (6.65)	243

ALPHABETICAL LISTING (Cont)	PAGE NO.	ALPHABETICAL LISTING (Cont)	PAGE NO.
J		U	
K		V	
L		V4 Repeater (6.57)	227
LP1 Loop Signaling Converter (6.21)	184	W	
LP2 Loop Signaling Converter (6.25)	187	XYZ	
LP3 Loop Signaling Converter (6.28)	190	NUMERICAL LISTING	
M		1-Type Terminating Set (Table 6-G)	230
Metallic Facility Terminal (MFT) (6.72)	251	10D Ringer (6.02)	176
N		30F Ringer (6.07)	178
Network — 830-Type (Table 6-M)	241	89-Type Resistors (Table 6-L)	239
837-Type (6.65)	243	227-Type Amplifiers (Table 6-I)	233
849-Type (Table 6-J)	234	359-Type Equalizers (Table 6-K)	235
4066-Type (Table 6-H)	231,232	830-Type Networks (Table 6-M)	241
4182-Type (Table 6-G)	230	837-Type Networks (6.65)	243
O		849-Type Networks (Table 6-J)	234
P		4066-Type Networks (Table 6-H)	231,232
Pulse Link Repeater (PLR) (6.37)	195	4182-Type Networks (Table 6-G)	230
R		SD-NUMBERS	PAGE NO.
Repeater — E6 (6.61)	239	SD-1C230-01 (Table 6-C)	220
Pulse Link (6.37)	195	SD-1C231-01 (Table 6-C)	220
V4 (6.57)	227	SD-1C359-01 (6.72)	251
Repeating Coils (6.66)	244	SD-1C363-01 (6.31)	192
Resistors — 89-Type (Table 6-L)	239	SD-1C364-01 (6.34)	194
Ringer — Code Select (6.11)	180	SD-55392-01 (6.07)	178
10D (6.02)	176	SD-55393-01 (6.07)	178
30F (6.07)	178	SD-55560-01 (6.02)	176
Ringdown Converter — D0B (6.13)	181	SD-56159-01 (6.13)	181
D1B (6.17)	182	SD-56163-01 (6.17)	182
S		SD-95060-01 (6.21)	184
Single Frequency (SF) Signaling Components (6.51)	204	SD-95061-01 (6.25)	187
T		SD-95095-01 (6.37)	195
Terminating Set — 1-Type (Table 6-G)	230	SD-95487-01 (6.31)	192
		SD-95488-01 (6.34)	194
		SD-95756-01 (6.65)	234
		SD-96234-01 (6.48)	203
		SD-96251-01 (6.40)	197
		SD-96252-01 (6.44)	200
		SD-96398-01 (6.28)	190
		SD-96555-01 (6.48)	203
		SD-97023-01 (6.61)	239
		SD-97047-01 (6.57)	227
		SD-97138-01 (Table 6-G)	230
		SD-98085-01 (Table 6-A)	207
		SD-98090-01 (Table 6-A)	207
		SD-98124-01 (Table 6-A)	207

**SECTION 660-215-500**

SD-NUMBERS (Cont)	PAGE NO.	COMMON LANGUAGE EQUIPMENT CODE (Cont)	PAGE NO.
SD-98137-02 (Table 6-A)	207	MTOOOO00000 (Table 6-R)	253/254
SD-98138-02 (Table 6-A)	207	MSCS000A (6.11)	180
SD-98140-02 (Table 6-A)	207	MSOOOO00000 (Table 6-S)	255/256
SD-98142-02 (Table 6-A)	207	PLRO000A(6.37)	195
SD-99490-01 (6.71)	250	RD1D222D (6.07)	178
SD-99779-01 (Table 6-A)	207	RD2D210H (6.02)	176
SD-99780-01 (Table 6-A)	207	SCEL000A (6.25)	187
EA-13338-SD (6.11)	180	SCET000A (6.28)	190
		SCLE000A (6.21)	184
		SFAS0000 (Table 6-A)	207
		SFAT0000 (Table 6-A)	207
		SFXS0000 (Tables 6-A and 6-C)	220
		SFXT0000 (Tables 6-A and 6-C)	220
		SF400000 (Table 6-A)	207
		SF600000 (Table 6A)	207
		VRM2000A (6.57)	227
		VRM4000A (6.57)	227

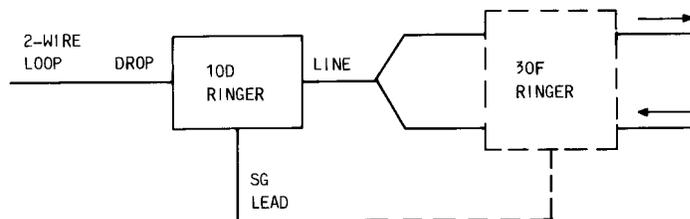
COMMON LANGUAGE EQUIPMENT CODE	PAGE NO.
DLC2000B (6.48)	203
DLOE000A (6.40)	197
DLSE000A (6.44)	200
DXSO000A (6.34)	194
DXTO000A (6.31)	192
EROO600N (6.61)	239

**SIGNALING**

**Note:** The following relationship for E & M lead signaling conditions and OFF HOOK/ON HOOK conditions should be understood when using the **Quick Test** or **Operation** portions of Part 6.

Ground E Lead	OFF-HOOK	LINE Lamp Dark
Battery M Lead	OFF-HOOK	DROP Lamp Dark
Open E Lead	ON-HOOK	LINE Lamp Light
Ground M Lead	ON-HOOK	DROP Lamp Light

**10D Ringer (Ringdown Signaling Circuit)**  
**Common Language Equipment Code: RD2D210H**  
**SD-55560-01**



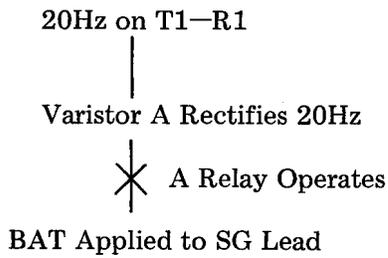
**Fig. 6-1—10D Ringer shown in Typical Application with 30F Ringer**

**6.02 Quick Test:** (1) Put -24V on SG lead and monitor T-R (loop) for 20-Hz ringing (should measure 105 Vac). (2) Put 20-Hz ringing on T-R into 10D and monitor SG lead for -24V.

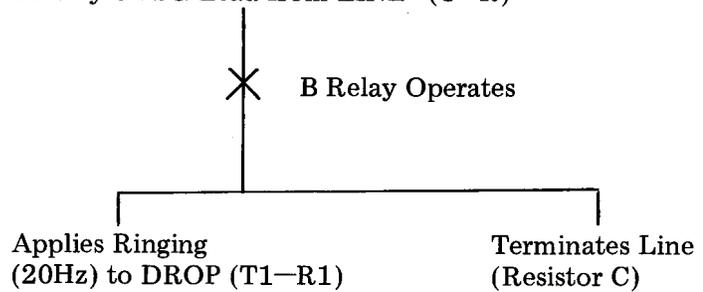


**SECTION 660-215-500**

SC1: Ringing From Drop (T1-R1)



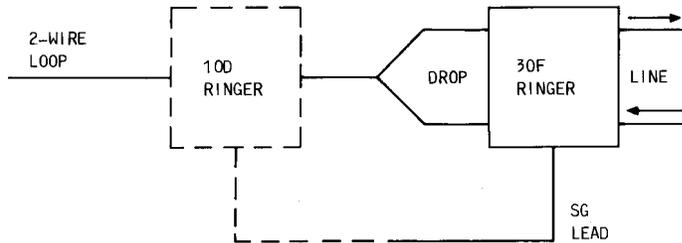
SC2: Battery on SG Lead from LINE (T-R)



**30F Ringer (Ringdown Signaling Circuit)**

**Common Language Equipment Code: RD1D222D**

**SD-55392-01 and SD-55393-01**



**Fig. 6-3—30F Ringer Shown in Typical application with 10D Ringer**

**6.07 Quick Test:** (1) Put -24V on SG lead and monitor transmit path (from 30F) for 1000/20 Hz. (2) Put 1000 Hz on receive path (into 30F) and measure -24 Vdc on SG lead.

**6.08 Description:**

	SG LEAD	REC LINE	TRNSMT LINE
Idle or Busy	GND	NO RINGING	NO RINGING
Incoming Ring (FROM LINE)	-24V	1000/20 Hz	NO RINGING
Outgoing Ring (TOWARD LINE)	-24V	NO RINGING	1000/20 Hz

**6.09 Description:** The 30F Ringer (Fig. 6-3) converts a 1000 Hz tone modulated by 20 Hz to -24 Vdc (and -24 Vdc to 1000 Hz modulated by 20 Hz) on the SG lead. The 30F is commonly used in conjunction with a 10D ringer or CSR (see 6.07 and 6.11, respectively) on the SG lead side of the circuit. The 30F receives a 1000 Hz tone modulated by 20 Hz from the line facilities and applies -24 Vdc to the SG lead. When -24 Vdc is applied to the SG lead of the 30F, it transmits a 1000 Hz tone modulated by 20 Hz to the line.

**6.10 Characteristic:** The ringing (1000 Hz modulated by 20 Hz), both receiving and transmitting, is 6 dB below normal transmission level.

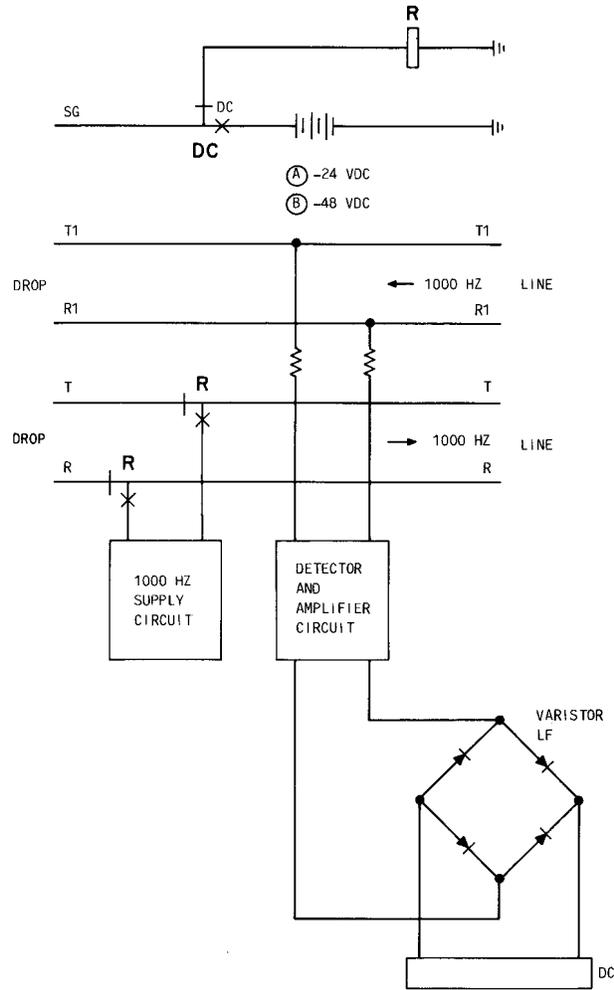
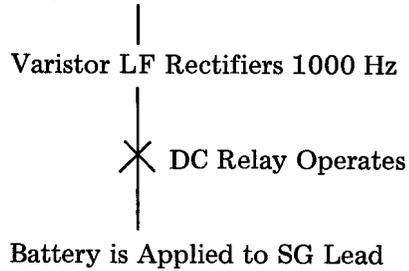
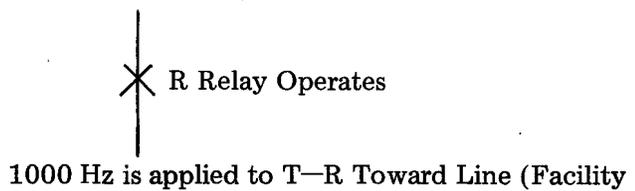


Fig. 6-4—Simplified Schematic of 30F Ringer

SC1: 1000 Hz Interrupted At 20 Hz Rate From Line (T1—R1)



SC2: Battery on SG Lead (From DROP)



SECTION 660-215-500

Code Select Ringer  
Common Language Equipment Code: MSCS000A  
EA-13338-SD

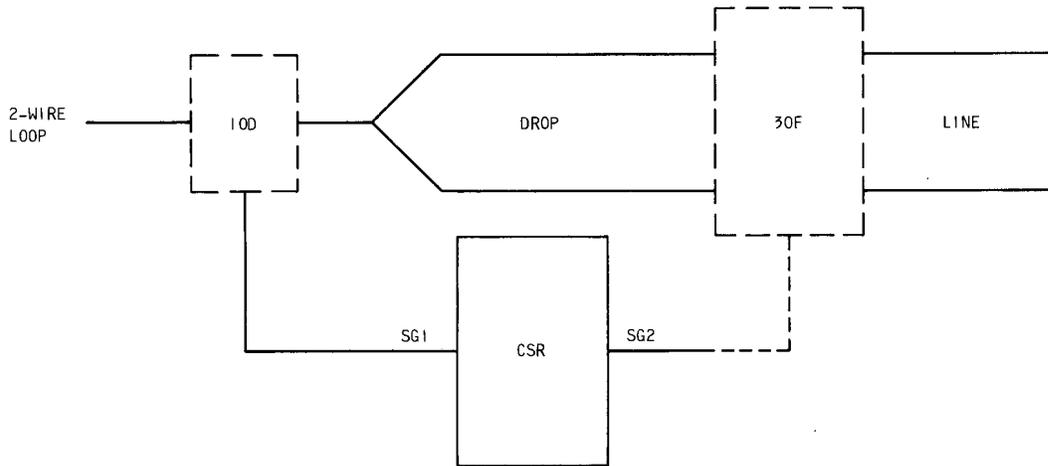


Fig. 6-5—CSR Shown in Typical Application

**6.11 Quick Test:** Apply the proper number of -24 Vdc pulses to SG1 lead (input to CSR) and check SG2 for -24 Vdc output.

**Note:** The number of dc pulses is dependent on the code for the particular CSR.

Apply the incorrect number of -24 Vdc pulses to SG1 lead and check SG2 for absence of -24 Vdc.

**6.12 Description:** The CSR (Fig. 6-5) is commonly used to select or count dialed pulses from 1 to 10 depending on the number for which it is wired. The CSR is used on multistation private line circuits.

DOB Ringdown Converter  
Common Language Equipment Code SCED110A  
SD-56159-01

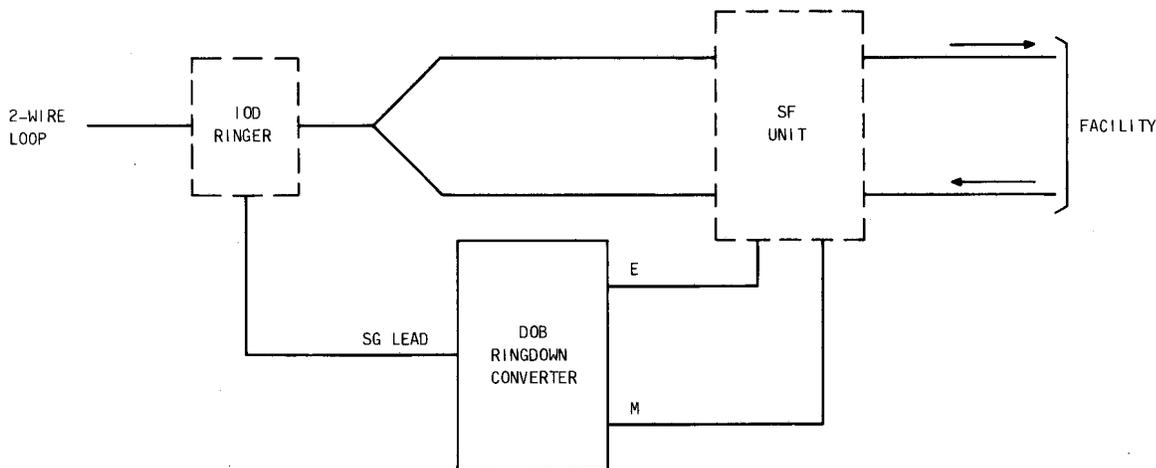


Fig. 6-6—DOB Ringdown Converter Shown in Typical Application with SF Unit and 10D Ringer

**6.13 Quick Test:** (1) Apply -24 Vdc to SG Lead and observe DROP Lamp Lighted (ground on M Lead)  
 (2) ground E Lead from SF (Line Lamp should Light) and measure SG Lead for -24 Vdc.

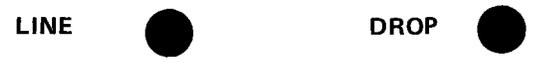
**6.14 Description:** The DOB ringdown converter (Fig. 6-6) converts battery and ground on the SG Lead to E & M Lead signaling (and E & M to SG Lead). When the E Lead changes from ground to open from the SF unit, the DOB places -24 Vdc on the SG Lead. When -24 Vdc is placed on the SG lead from the loop, the DOB (removes battery) applies a ground to the M Lead toward the SF unit.

**6.15 Options:** (U) -24 Vdc Output on SG Lead  
 (T) -48 Vdc Output on SG Lead

**6.16 Operation:**

**IDLE (NO RING) CONDITION**

No SF tone transmitting or receiving  
 Ground on E lead from SF (LINE lamp dark)  
 Battery on M lead from D1B (DROP lamp dark)  
 Ground on SG lead.



**OUTGOING RING (RING from LOOP)**

-24 Vdc is applied to SG lead (By 10D)  
 M Lead changes from battery to ground from DOB, (DROP Lamp lighted) SF tone is now being transmitted toward facility  
 E Lead and receive from facility no change from IDLE CONDITION.



**INCOMING RING (RING FROM FACILITY)**

SF Tone receiving from facility  
 E lead changes from ground to open from SF unit (LINE Lamp lighted), DOB applies -24 Vdc to SG Lead.

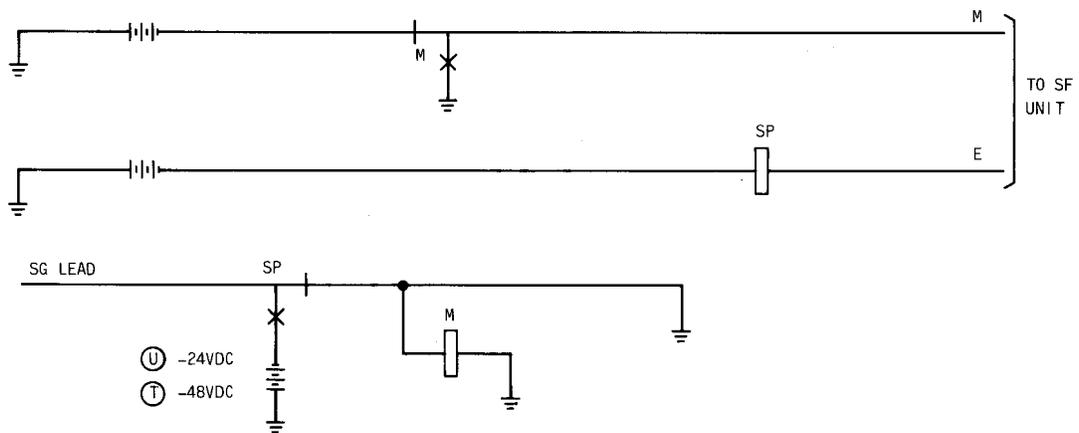


Fig. 6-7—Simplified Schematic of DOB Ringdown Connector

**SECTION 660-215-500**

Idle Circuit Condition: M Relay Released, SP Relay Operated, Ground on E Lead and SG Lead, Battery on M Lead

SC1: Incoming Call (SF Tone Received)

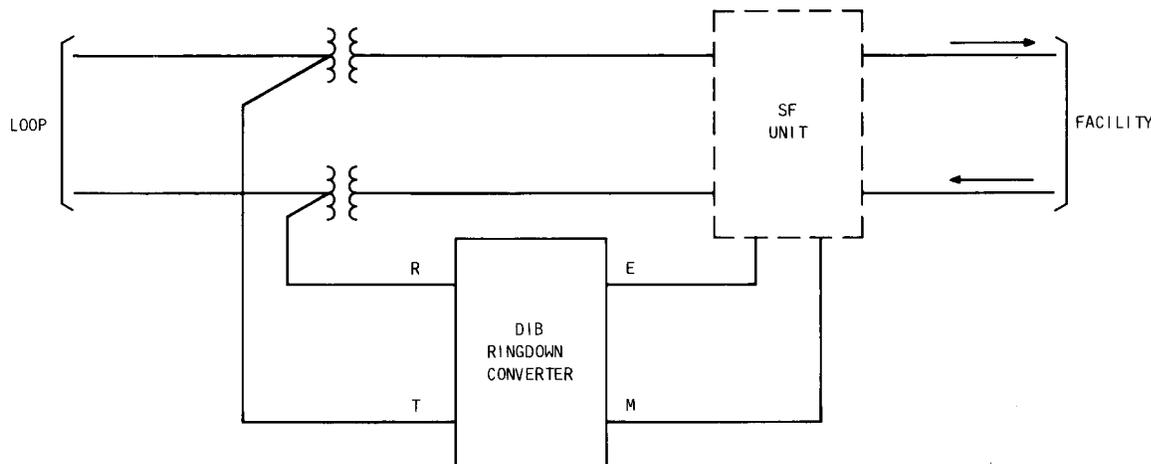
E Lead Opened from SF Unit  
 + SP Relay Releases  
 Battery Applied to SG Lead

SC2: Outgoing Call

24Vdc on SG Lead  
 \* M Relay Operates  
 Ground Applied to M Lead to SF Unit

**D1B Ringdown Converter**

Common Language Equipment Code: SCEZ000A  
 SD-56163-01



**Fig. 6-8—D1B Ringdown Converter shown in Typical Application with SF Unit**

**6.17 Quick Test:** (1) Open E lead from SF and measure 20 Hz output of D1B. (2) Put 20 Hz on T & R toward D1B and check for drop lamp lighted.

**6.18 Description:** The D1B ringdown converter (Fig. 6-8) converts 20 Hz ringing to E & M lead signaling (and E & M lead to 20 Hz) on a circuit using ringdown signaling. The D1B, which is simplexed to the loop, receives 20 Hz ringing from the loop and changes the battery on the M lead to ground. Likewise, when the E lead is open, the D1B applies 20 Hz to the loop. The E & M leads of the D1B are commonly connected to a E#B or F type SF unit (see 6.51).

**6.19 Characteristics:** The 20 Hz AC from the loop must be a minimum of 15 Vac and the 20 Hz output of the D1B is 105 Vac.

**6.20 Operation:**

**IDLE (NO RING) CONDITION**

LINE ●

DROP ●

No SF tone transmitting or receiving. Ground from SF on E lead and LINE lamp dark. Battery from D1B on M lead and DROP lamp dark.

**OUTGOING RING**

LINE ●

DROP ○

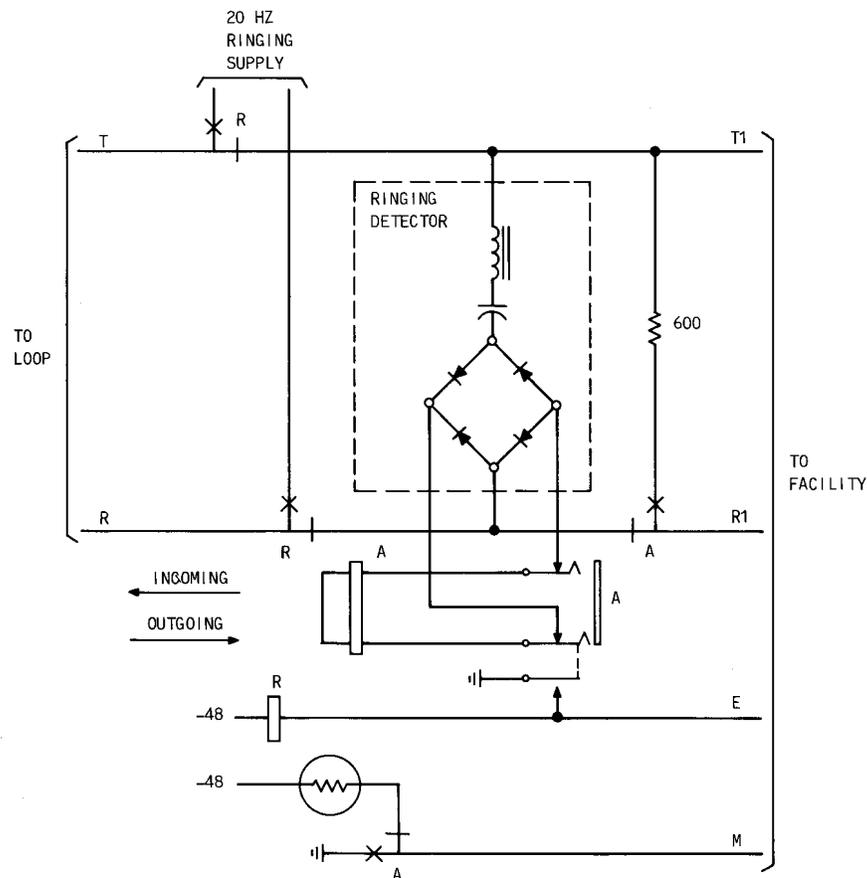
20 Hz ac from loop (requires 15V AC min). M lead changes from bat to gnd from D1B and DROP lamp lit. SF tone is now being transmitted toward facility. E lead and receive from facility unchanged (no SF). When 20 Hz is removed from loop, see idle condition.

**INCOMING RING**

LINE ○

DROP ●

SF tone receiving from facility. E lead changes from gnd to open from SF (LINE lamp lit), 20 Hz is applied by the D1B to the loop. (Output of D1B is 20 Hz at 105 Vac.)

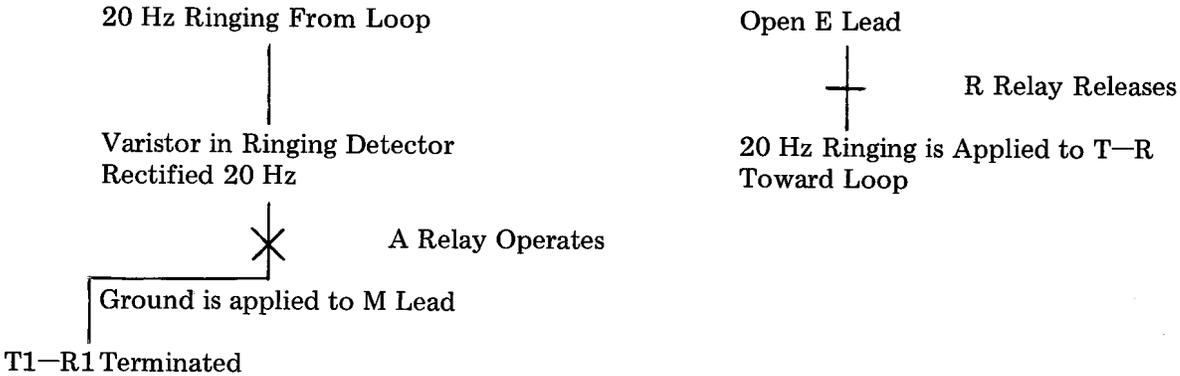


**Fig. 6-9—Simplified Schematic of DIB Ringdown Converter**

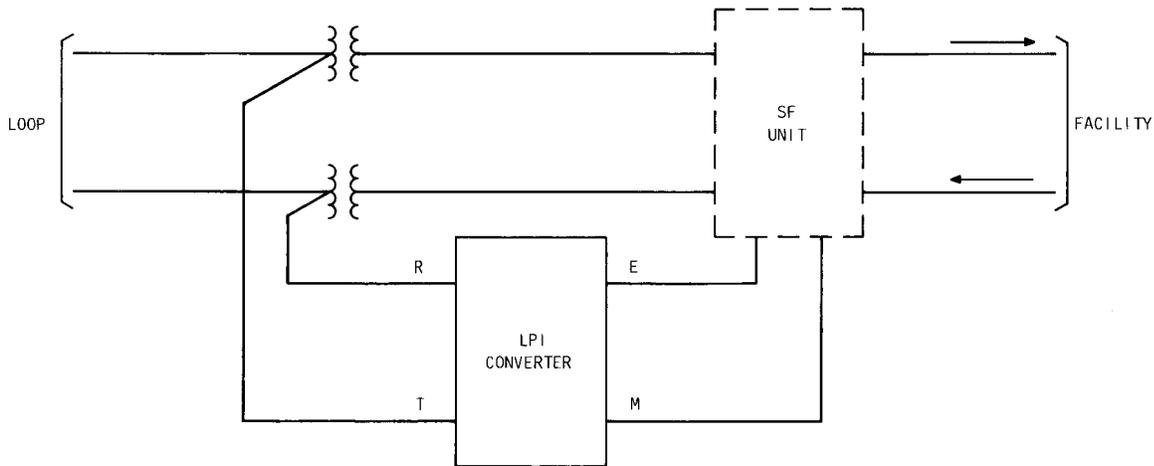
**SECTION 660-215-500**

Idle Circuit Condition: No 20 Hz To or From Loop, A Relay Released, R Relay Operated, Ground on E lead From Facility, Battery on M Lead.

SC1: OUTGOING CALL (Loop to FAC)      SC2: INCOMING CALL (FAC to Loop)



**LP1 Loop Signaling Converter**  
**Common Language Equipment Code: SCLE000A**  
**SD-95060-01**



**Fig. 6-10—LP1 Loop Signaling Converter shown on Typical Application with SF Unit**

**6.21 Quick Test:** Idle circuit condition—(1) Break SF tone both transmit and receive facility; observe LINE and DROP lamp should change from light to dark and, (2) Check tip for ground and ring for battery (see options).

**6.22 Description:** The LP1 loop signaling converter (Fig. 6-10) converts tip and ring signals (low or high resistance shorts) to E & M lead signals. The LP1 is normally connected to an E#B or F type SF unit via E & M leads and simplex to the tip and ring on the loop side. The principal use of the LP1 is to connect a signaling circuit (like an SF) to a trunk circuit (like PBX tie trunk SD-66039). The circuit can use either two-way automatic or one-way dial (from loop)/one-way automatic signaling.

**6.23 Options:** G Battery on Tip (Idle)  
Ground on Ring (Idle)

H Ground on Tip (Idle)  
Battery on Ring (Idle)

**6.24 Operation:** G option used

**IDLE CONDITION**

SF tone transmitting and receiving from facility  
E lead Open from SF (LINE lamp light)  
M lead Ground from LP1 (DROP lamp light)  
Battery on T from LP1  
Ground on R from LP1  
High resistance short between T and R from loop



**BUSY CONDITION**

No SF tone either transmitting or receiving  
E lead Ground from SF (LINE Lamp dark)  
M lead Battery from LP1 (DROP Lamp dark)  
Ground on T from LP1  
Battery on R from LP1  
Low resistance short between T and R from loop



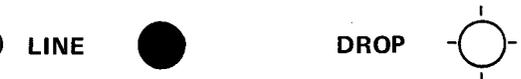
**OUTGOING CALL** (call originating from loop)

Low resistance short between T and R from loop  
M lead changes from ground to battery from LP1 (DROP Lamp from light to dark)  
SF tone is cut transmitting, T and R is unchanged from LP1 (IDLE CONDITION) until SF receive is cut (called party answers). If it is a dial circuit pulses will be low to high resistance from loop and will be followed by the M lead battery to ground, etc, respectively.



**INCOMING CALL** (Distant end originating call)

SF tone cut receiving  
E lead changes from open to ground from SF (LINE Lamp light to dark)  
T changes from battery to ground from LP1 (See Options)  
R changes from ground to battery from LP1 (See Options)  
When station (loop) answers, high resistance short across T and R from loop will change to low resistance short.



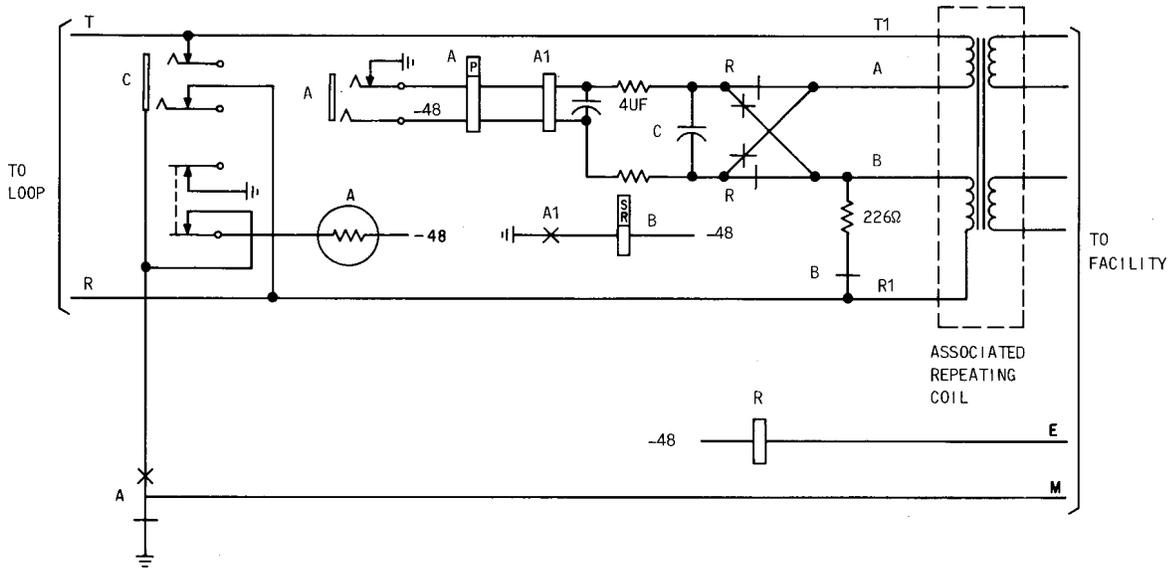
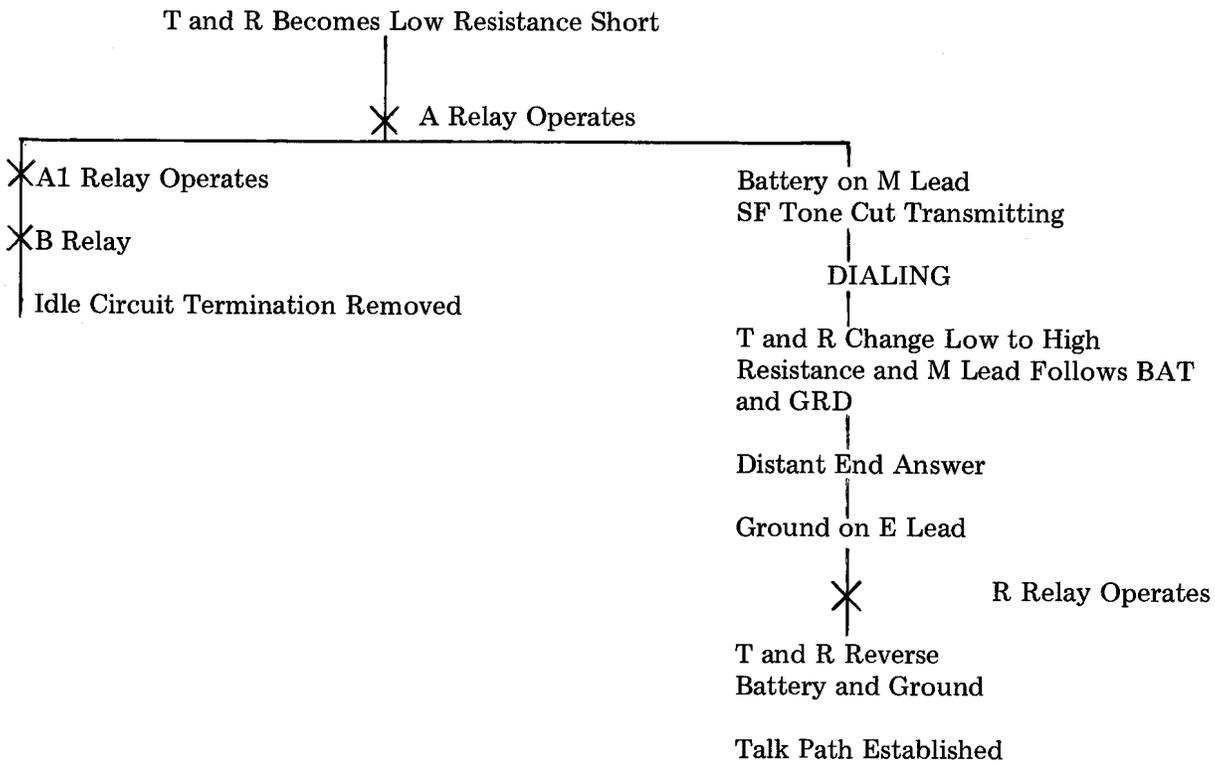
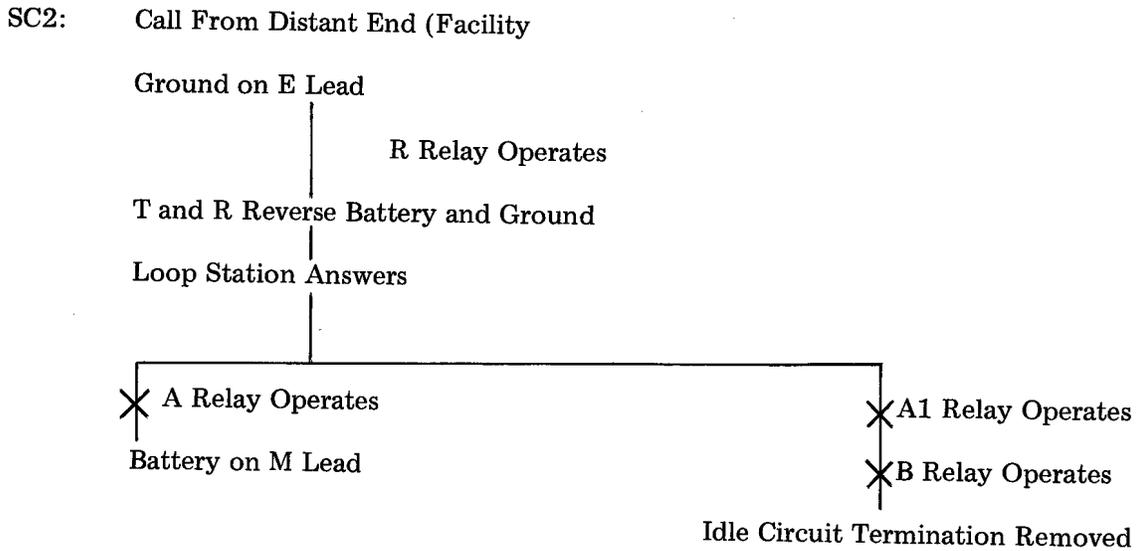


Fig. 6-11—Simplified Schematic of LP1 Loop Signaling Converter

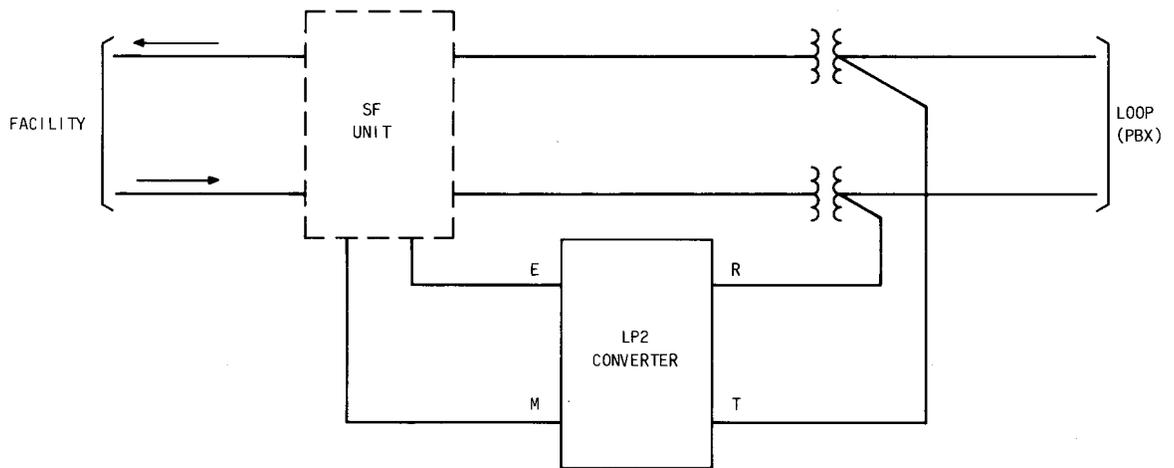
Idle Circuit Condition: High Resistance between T and R from Loop.  
 A and A1 Relays Released, R Relay Released, Ground on M Lead, Open on  
 E Lead, Ground on T, Battery on R.

SC1: Call From Loop





**LP2 Loop Signaling Converter**  
**Common Language Equipment Code: SCE1000A**  
**SD-95061-01**



**Fig. 6-12—LP2 Loop Signaling Converter shown in Typical Application with SF Unit**

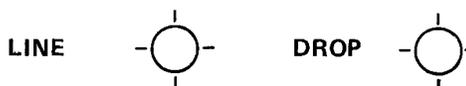
**6.25 Quick Test:** (1) Ground ring from loop and observe DROP Lamp dark (battery on M lead) and, (2) ground E lead and observe T and R reverse to battery and ground.

**6.26 Description:** The LP2 loop signaling converter (Fig. 6-12) converts loop signals to E & M lead signaling. The LP2 converts battery and ground reversals on T and R to E & M lead signaling. The LP2 is normally used at the automatic end of a one-way automatic/one-way dial tie trunk circuit. An E#B or F type SF unit is normally on the facility side of the circuit. Operation is similar to the LP1 except at the other end of the circuit.

6.27 Operation:

**IDLE CONDITION**

SF tone transmitting and receiving from facility  
 E lead Open from SF (LINE Lamp light)  
 M lead Ground from LP2 (DROP Lamp light)  
 Ground on T from Loop  
 Battery on R from Loop  
 High resistance across T and R to Loop



**BUSY CONDITION**

No SF tone transmitting or receiving  
 E lead Ground from SF (LINE Lamp dark)  
 M lead Battery from LP2 (DROP Lamp dark)  
 Battery on T from Loop  
 Ground on R from Loop  
 Low resistance across T and R to Loop



**OUTGOING CALL** (Loop end originating call)

Battery and ground reversal on T and R, respectively, from Loop  
 M lead changes from ground to battery from LP2 (DROP Lamp dark)  
 SF tone will cut transmitting, E lead and SF tone receiving will be unchanged (Idle condition) until distant end answers.



**INCOMING CALL** (from facility)

SF tone cut receiving  
 E lead Ground from SF (LINE Lamp dark)  
 Low resistance across T and R to LOOP  
 When Loop end answers; battery and ground reversed on T and R will cause M lead to change from ground to battery to SF and SF tone transmitting will be cut.

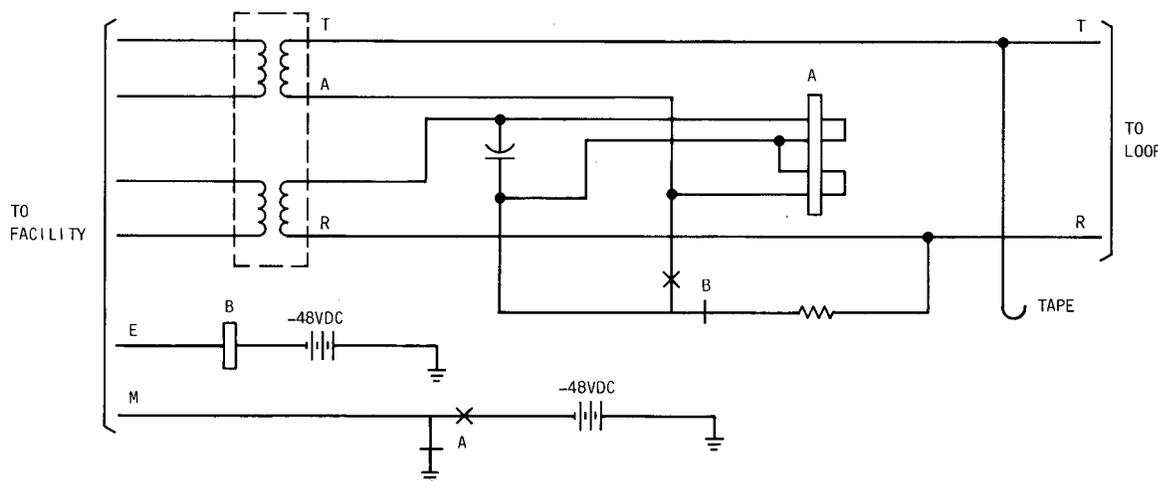
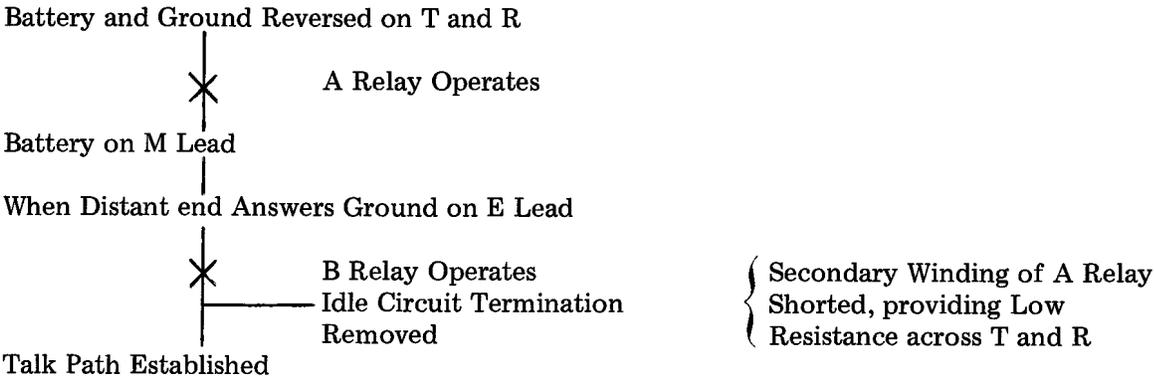
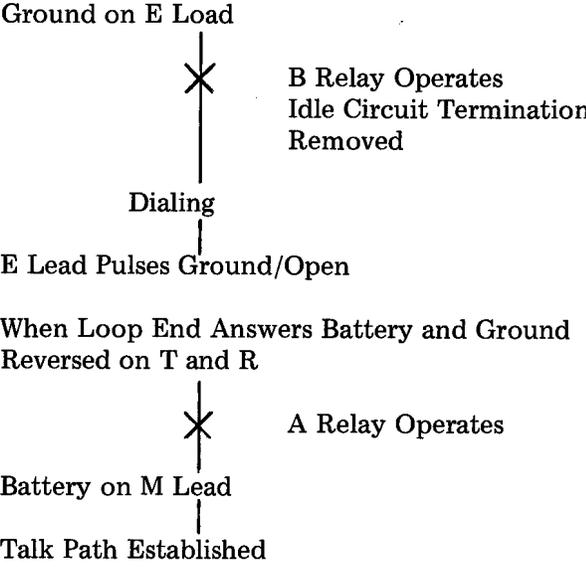


Fig. 6-13—Simplified Schematic of LP2 Loop Signaling Converter

SC1: Call From Loop End



SC2: Call from Facility End



LP3 Loop Signaling Converter

Common Language Equipment Code: SCET000A

SD-96398-01

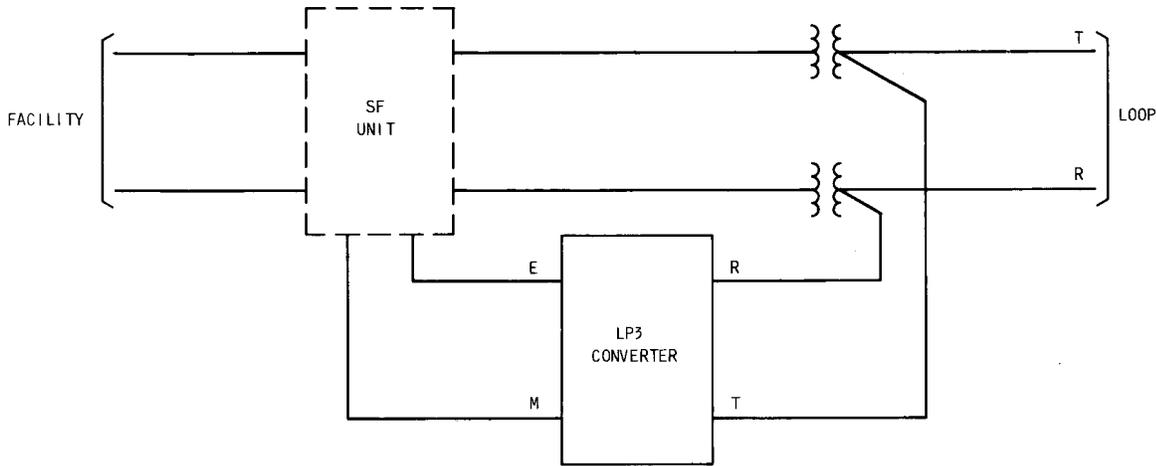


Fig. 6-14—LP3 Loop Converter Shown in Typical Application with SF Unit

**6.28 Quick Test:** (1) Ground E lead and observe low resistance across T-R from LP3, and (2) reverse T-R (ground-battery to battery-ground) and observe DROP lamp dark (battery on M lead).

**6.29 Description:** The LP3 loop converter (Fig. 6-14) converts E & M Lead signaling to loop signaling. The LP3 is used primarily at the incoming end of a one way dial repeating or one-way automatic tie trunk (SD-1A166-01 typically). An E#B or F type SF unit is normally on the facility side of the circuit.

**6.30 Operation:**

**IDLE CONDITION**

SF tone transmitting and receiving from facility  
 E lead Open from SF (LINE Lamp light)  
 M lead Ground from LP2 (DROP Lamp light)  
 Ground on T From Loop  
 Battery on R from Loop  
 High resistance across T and R to Loop

LINE



DROP



**BUSY CONDITION**

No SF tone transmitting or receiving  
 E lead Ground from SF (LINE lamp dark)  
 M lead Battery from LP2 (DROP Lamp dark)  
 Battery on T from loop  
 Ground on R from loop  
 Low resistance across T and R to loop

LINE



DROP



**INCOMING CALL (From Facility)**

SF tone cut receiving  
 E lead Ground from SF (LINE Lamp dark)  
 Low resistance across T and R to Loop  
 When Loop end answers; Battery and Ground reversal on T and R will cause M lead to change from Ground. Battery to SF and SF tone transmitting will be cut.

LINE



DROP



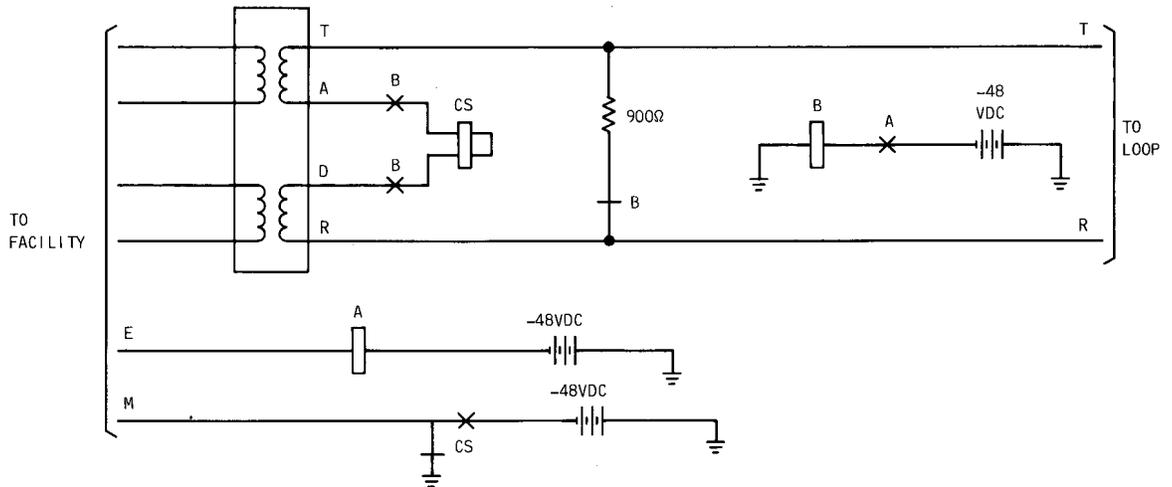


Fig. 6-15—Simplified Schematic of LP3 Loop Converter

Idle Circuit Conditions: E Lead Open, A Relay Released, High Resistance (Open) Across T—R, CS Relay Released, Ground on M Lead.

SC1: Incoming Call (From Facility)

SC2: Disconnect

Ground on E Lead

X A Relay Operates  
 X B Relay Operates,  
 CS Relay bridged Across  
 T—T. Idle Circuit  
 Termination Removed.

Open E Lead

X A Relay Releases  
 X B Releases  
 Idle Circuit Termination Restored

Dialing E Lead Follows Pulses,  
High Resistance Across T & R

Loop Ends Answers by Reversing  
Battery and Ground on T—R

CS Relay Operates

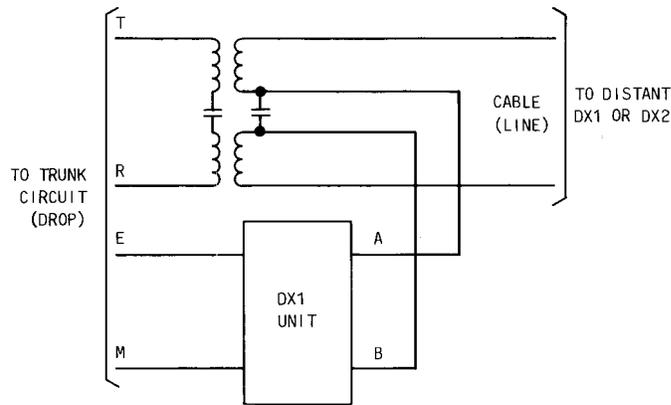
Battery on M Lead

Talk Path Established

**DX1 Signaling Lead Extension Circuit**

Common Language Equipment Code: **DXT0000A**

SD-95487-01 or SD-1C363-01



**Fig. 6-16—DX1 Signaling Lead Extension Circuit**

**6.31 Quick Test:** (1) Measure the B lead for -20 Vdc and high resistance ground and (2) put battery on M lead (off hook) and measure A lead for -48 Vdc. (This value may change because the DX balance has been interrupted when measuring.)

**6.32 Description:** The DX1 signaling lead extension circuit (Fig. 6-16) converts E & M lead signaling to A & B lead (duplex) signaling and likewise, A & B to E & M. This is done since A & B leads have a greater range than E & M (A & B 5000Ω). The A & B leads are normally converted back to E & M leads. The DX1 is normally used to connect two trunk circuits, where each trunk circuit “transmits” its signals on the M lead and “receives” its signals on the E lead. In this application, another DX1 circuit must be used at the distant end. The DX1 can be used to connect a trunk circuit to a signaling circuit. In this case, a DX2 signaling lead extension circuit is associated with the signaling circuit.

**6.33 Operation:**

**IDLE CONDITION**

- A lead Ground both directions
- B lead -20 Vdc both directions (never changes since it is used as a balance wire)
- E lead Open from DX1
- M lead Ground (on-hook) from drop into DX1



**BUSY CONDITION**

- A lead Battery (-48 Vdc) both directions
- B lead -20 Vdc both directions (never changes since it is used as a balance wire)
- E lead Ground from DX1
- M lead Battery (-48 Vdc) from drop into DX1



**OUTGOING SEIZURE (Loop to Cable)**

- M lead Battery from drop to DX1
- A lead changes to Battery (-48 Vdc) from DX1 (ground from cable)



**INCOMING SEIZURE (Cable to Loop)**

- A lead Battery from cable (simplex) (from DX1 is ground)
- E lead changes to Ground from DX1



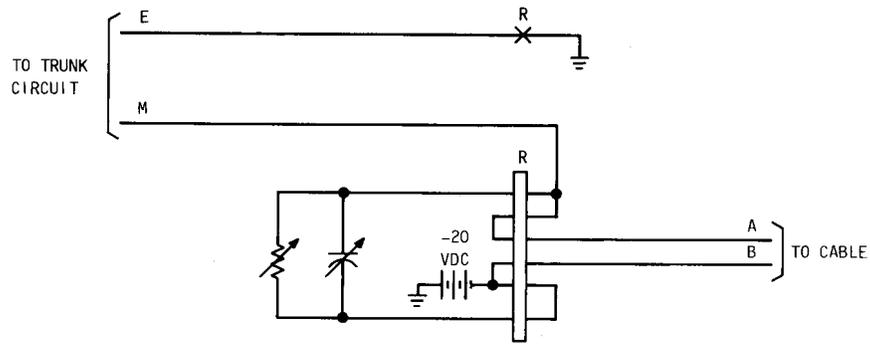
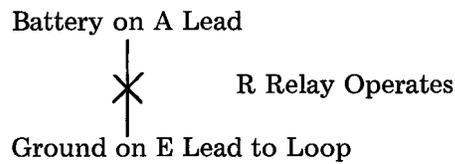
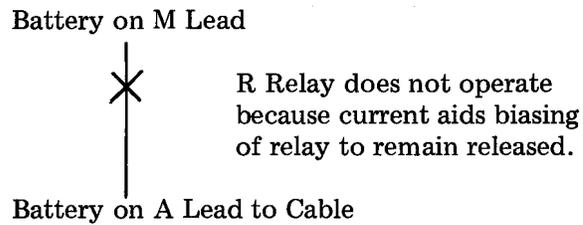


Fig. 6-17—Simplified Schematic of DX1

SC1: Incoming Seizure (From Cable)



SC2: Outgoing Seizure (From Loop)



**DX2 Signaling Lead Extension Circuit**  
**Common Language Equipment Code: DXS0000A**  
**SD-95488-01 and SD-1C364-01**

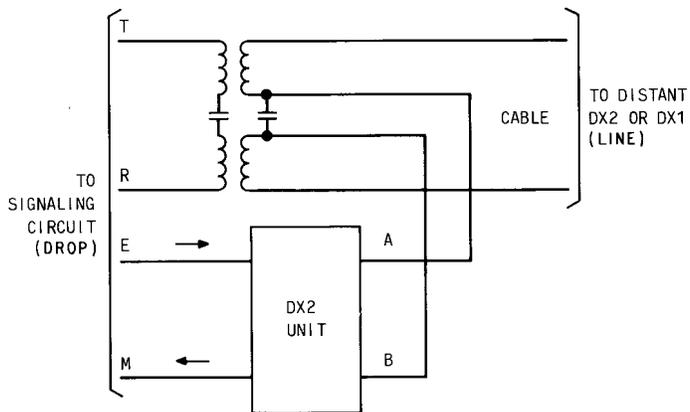


Fig. 6-18—DX2 Signaling Lead Extension Circuit

**SECTION 660-215-500**

**6.34 Quick Test:** (1) Ground E lead from signaling circuit and observe battery (-48 Vdc) on A lead from DX2 (this value may change since the dx balance is interrupted when measuring) and, (2) measure B lead for -20 Vdc.

**6.35 Description:** The DX2 signaling lead extension circuit (Fig. 6-18) converts E & M lead signaling to A & B lead (duplex) signaling and, likewise, A & B to E & M. This is done since A & B leads have a greater range than E & M (A & B 5000Ω where E & M only 75 Ω). The A & B leads are normally converted back to E & M leads at the distant end, thus simply extending the E & M leads. The DX2 is normally used in applications between signaling circuits (which could be SF type). This application has a DX2 at each end of the circuit. The DX2 can also be used in connecting a trunk circuit and a signaling circuit. In this case, the DX2 is used at the signaling circuit end and a DX1 is used at the trunk circuit end.

**6.36 Operation:**

**IDLE CONDITION**

A lead Ground both directions  
 B lead -20 Vdc both directions (never changes since it is used as a balance wire)  
 E lead Open from signaling circuit (LINE lamp light)  
 M lead Ground from DX2 (DROP lamp light)



**BUSY CONDITION**

A lead Battery (-48 Vdc) both directions  
 B lead -20 Vdc both directions (never changes since it is used as a balance wire)  
 E lead Ground from signaling circuit (LINE lamp dark)  
 M lead Battery (-48 Vdc) from DX2 (DROP lamp dark)



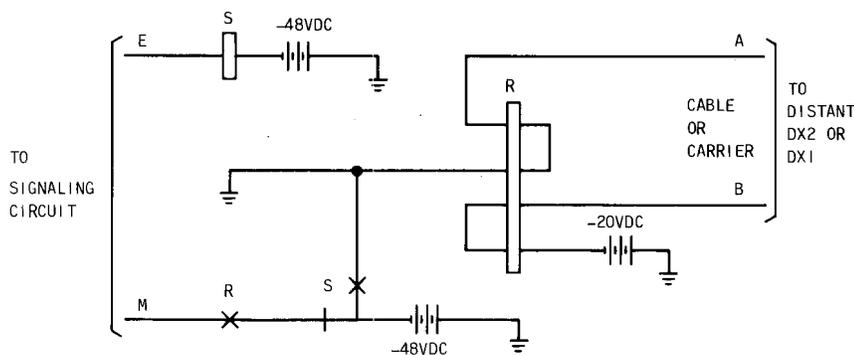
**INCOMING SEIZURE (from Signaling Circuit)**

E lead Ground from signaling circuit (LINE lamp dark)  
 A lead Battery (-48 Vdc) from DX2



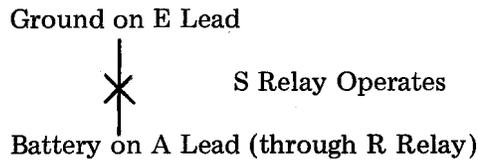
**OUTGOING SEIZURE (from distant DX)**

A lead Battery from simplex (distant DX)  
 M lead Battery from DX2 (DROP lamp dark)

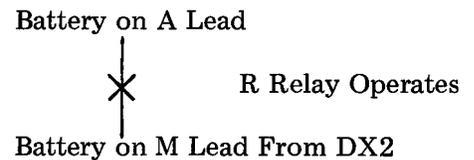


**Fig. 6-19—Simplified Schematic of DX2 Signaling Lead Extension Circuit**

SC1: Incoming Seizure from Signaling Circuit



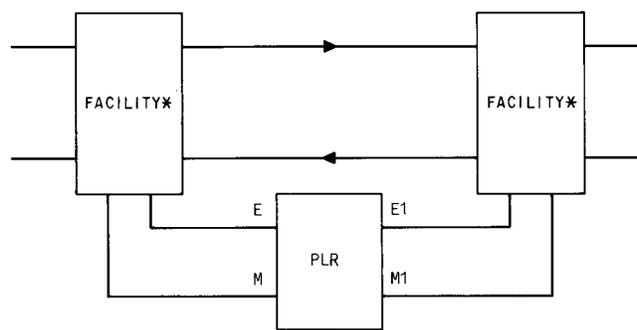
SC2: Outgoing Seizure from Distant End



**Pulse Link Repeater (PLR)**

Common Language Equipment Code: **PLR0000A**

SD-95095-01 J98605D



\* ONE OF THE FACILITIES MAY BE CARRIER AND THE OTHER AN SF UNIT.

**Fig. 6-20—Pulse Link Repeater Shown in Typical Application**

**6.37 Quick Test:** (1) Ground E lead and monitor M1 lead for battery (DROP lamp dark) and, (2) Ground E1 lead and monitor M lead for battery (DROP lamp dark).

**6.38 Description:** The PLR (Fig. 6-20) interconnects two facilities using E & M lead signaling. One of the facilities may be a carrier (like N1) and the other facility an SF (like F-type).

**6.39 Operation:**

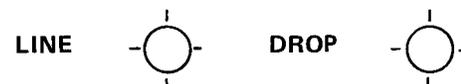
**INCOMING SEIZURE** (from Carrier)  
 E lead Ground from carrier (LINE Lamp dark)  
 M1 lead Battery from PLR (DROP lamp dash)



**INCOMING SEIZURE** (from SF side)  
 E1 lead Ground from SF (LINE lamp dash)  
 M lead Battery from PLR (DROP lamp dark)



**IDLE CONDITION**  
 E and E1 leads Open (both LINE lamp light)  
 M and M1 leads Battery (both DROP lamp light)



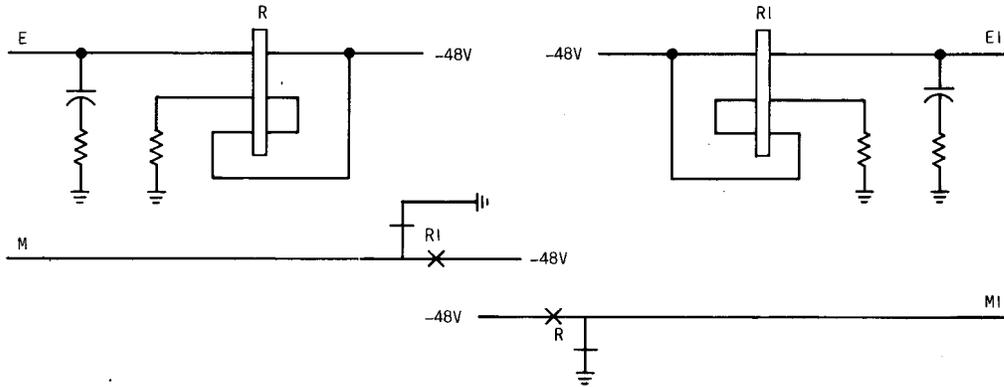
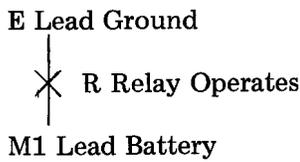
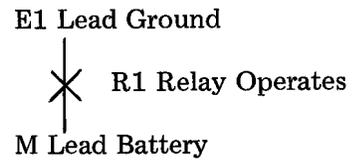


Fig. 6-21—Simplified Schematic of PLR

SC1: Call Left to Right



SC2: Call Right to Left



**DLL01 Dial Long Line Circuit**

Common Language Equipment Code: DL0E000A

SD-96251-01

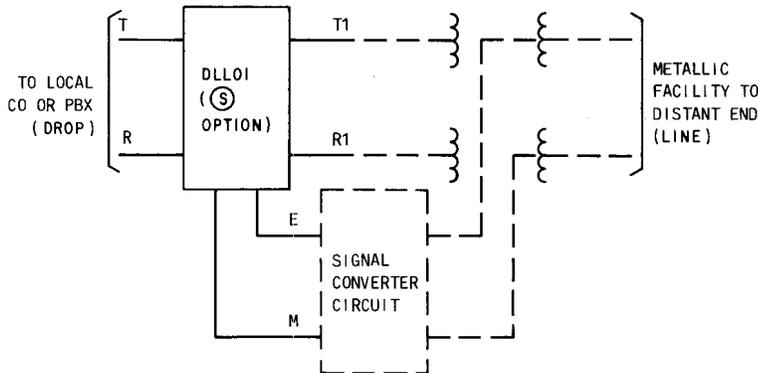


Fig. 6-22—DLL01 (S) Option Shown in Typical Application

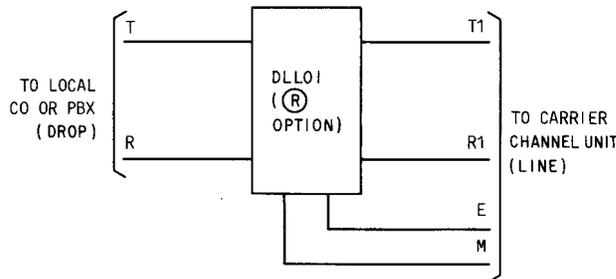


Fig. 6-23—DLL01 (R) Option Shown in Typical Application

**6.40 Quick Test:** (1) Ground E lead from facility and observe T-R shorted from DLL and, (2) apply 20-Hz ringing to T-R into DLL and observe DROP lamp light (M lead ground from DLL— (R) option) or DROP lamp dark (M lead battery from DLL— (S) option).

**6.41 Description:** The DLL01 (Fig. 6-22 and 6-23) is a loop to E & M lead signaling converter used at the CO or PBX end of a loop start circuit. It is normally associated with either out-of-band carrier signaling systems (O, ON, N1, or T1 Carrier) or CX, DX or SX signaling on metallic facilities. Other arrangements may be used such as association with SF signaling (In-band), however, those are non-standard and can cause difficulties. In either case, the basic operation of the E & M leads and T-R will remain the same. Primary applications are off premises extensions, WATS Lines, one-way PBX-CO trunks and some FX circuits. At the customer end (station) of the circuit, a DLL03 (see 6.45) is normally used to convert back to loop signaling.

**6.42 Options:** The DLL01 has two basic option wirings, (S) and (R) which in the past have been called (K) and (J), respectively. The primary difference in the options is in the operation of the M lead. The (S) option operation is given below. For the (R) option the M lead battery and ground are reversed (DROP lamps reversed, too). When using the (R) option, the DLL applies ground to the M lead as a ringing signal. The arrangement eliminates the danger of falsely ringing the station because of carrier "hits", carrier fading and carrier failure. This is referred to as the "tone-off" option.

**6.43 Operation:** (S) option

**IDLE CONDITION**

E lead Open from facility (LINE lamp light)  
 T-R Open from DLL and T ground, R battery from CO end.  
 M lead Ground from CLL (DROP lamp light)



**BUSY CONDITION**

E lead Ground from facility (LINE lamp dark)  
 T-R shorted from DLL  
 M lead Ground from DLL



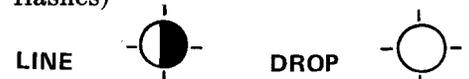
**RINGING (from CO end)**

20-Hz ringing on T-R from CO  
 M lead follow 20-Hz with battery from DLL (DROP lamp flashes)



**INCOMING CALL (from distant end)**

E lead changes from ground to open from facility when pulse is received (LINE lamp flashes) T-R follow E lead ground with short.



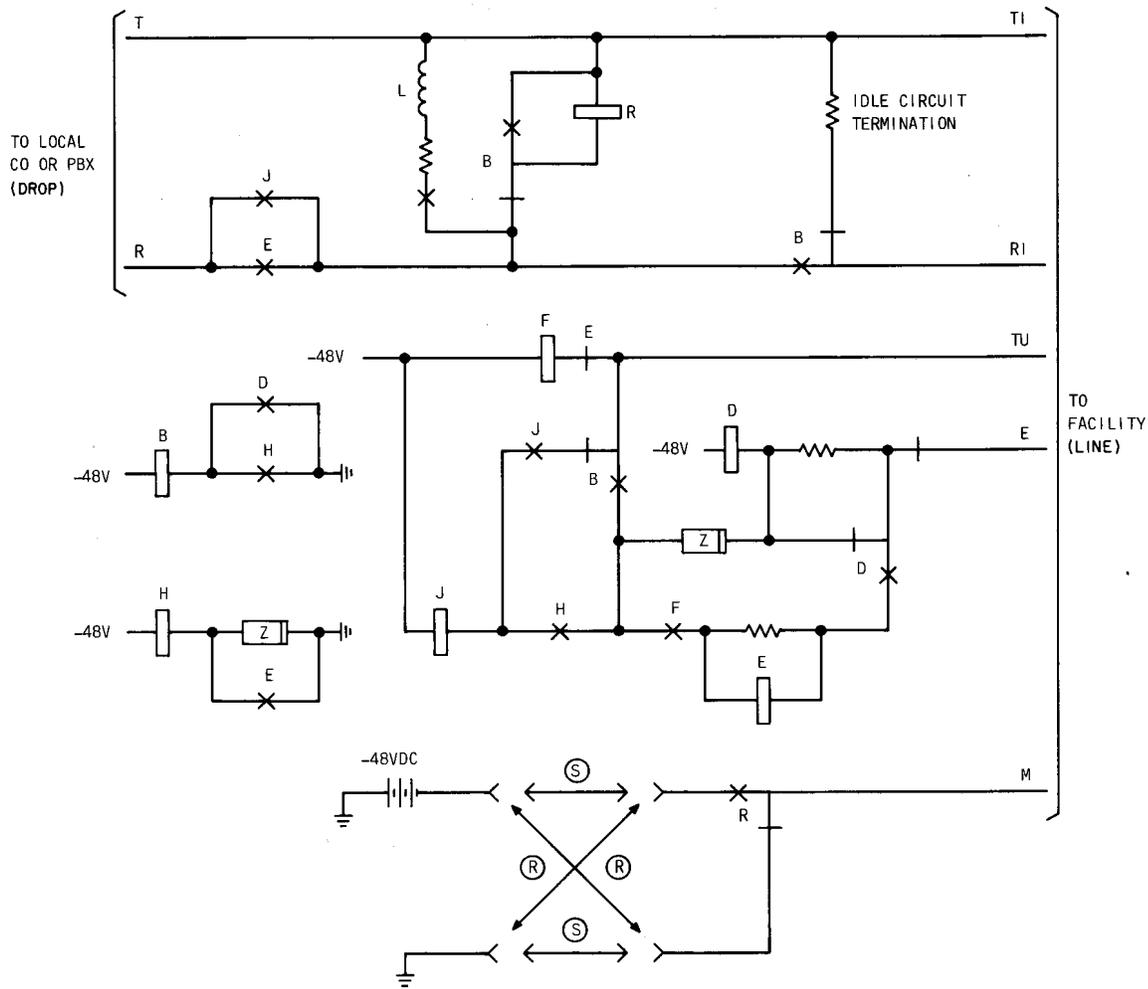


Fig. 6-24—Simplified Schematic of DLL01

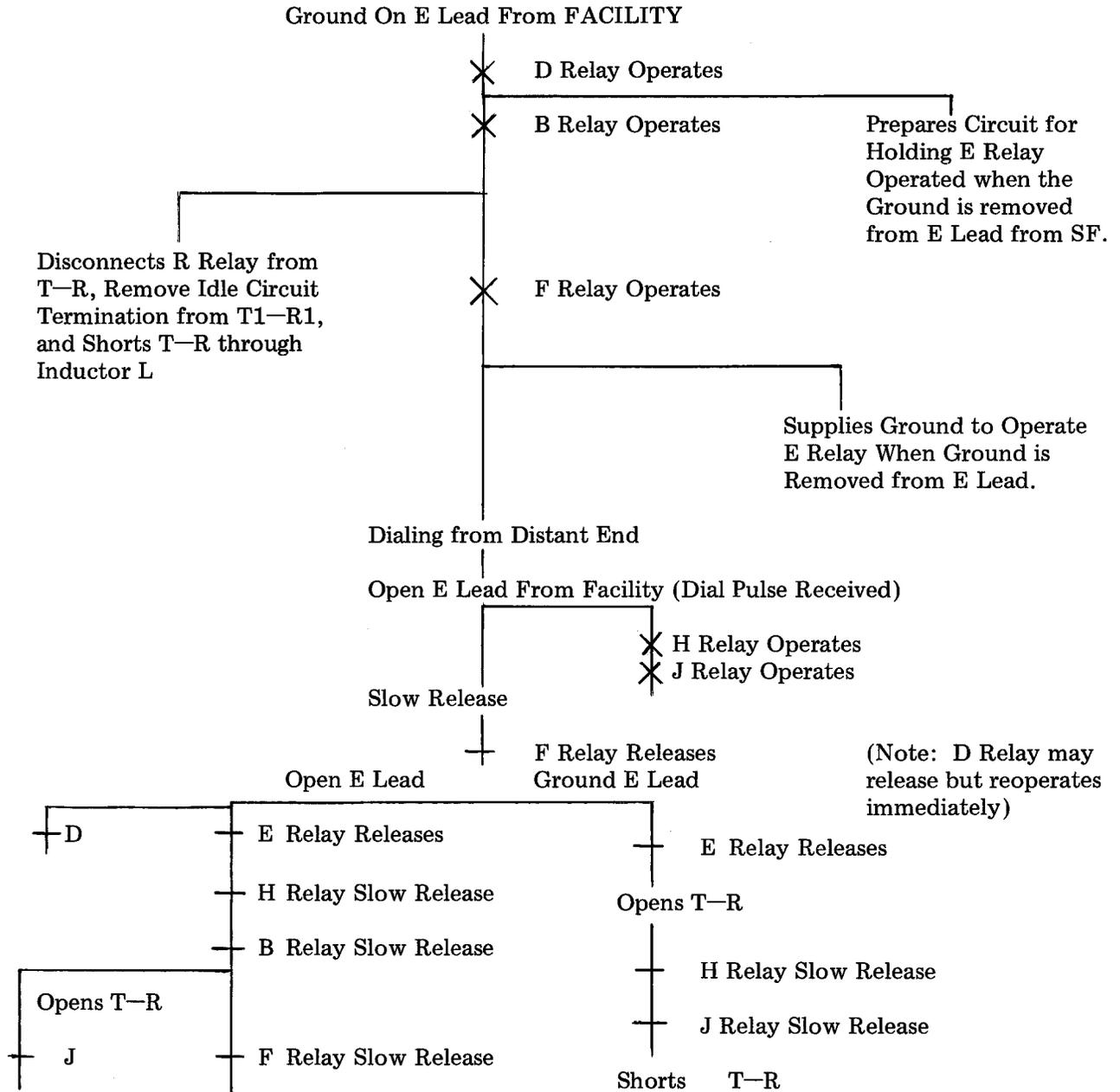
SC1: Ringing from Local CO or PBX

20-Hz Ringing across T-R



M Lead goes From Ground to Battery  
 (Option **(S)**) or Battery to Ground  
 (Option **(R)**)

SC2: Call Originated from Distant End (Customer)



**DLL03 Dial Long Line Circuit**

Common Language Equipment Code: DLSE000A

SD-96252-01

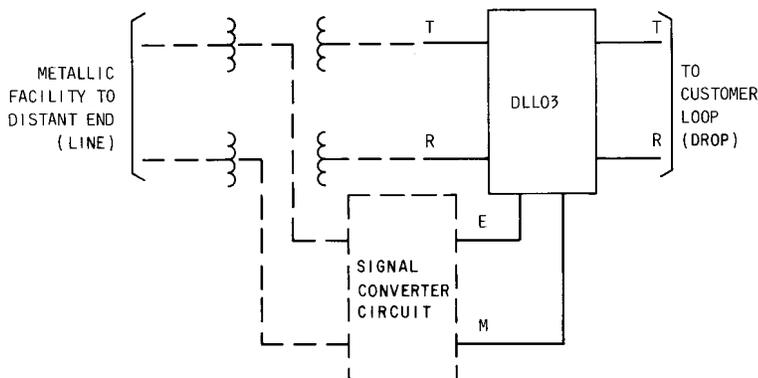


Fig. 6-25—DLL03 (A) Option) Shown in Typical Application

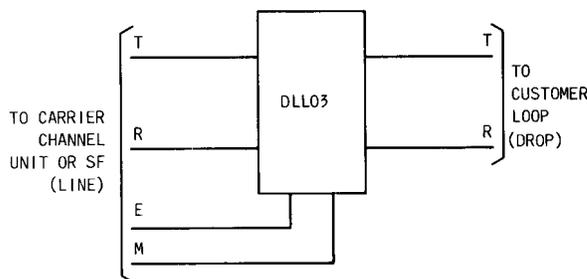


Fig. 6-26—DLL03 (J) Option) Shown in Typical Application

**6.44 Quick Test:** (1) Ground E lead into DLL (option H) or open E lead into DLL (option J) and observe 20 Hz applied to T-R toward customer from DLL and, (2) short T-R from Loop and observe DROP lamp dark (M lead battery from DLL).

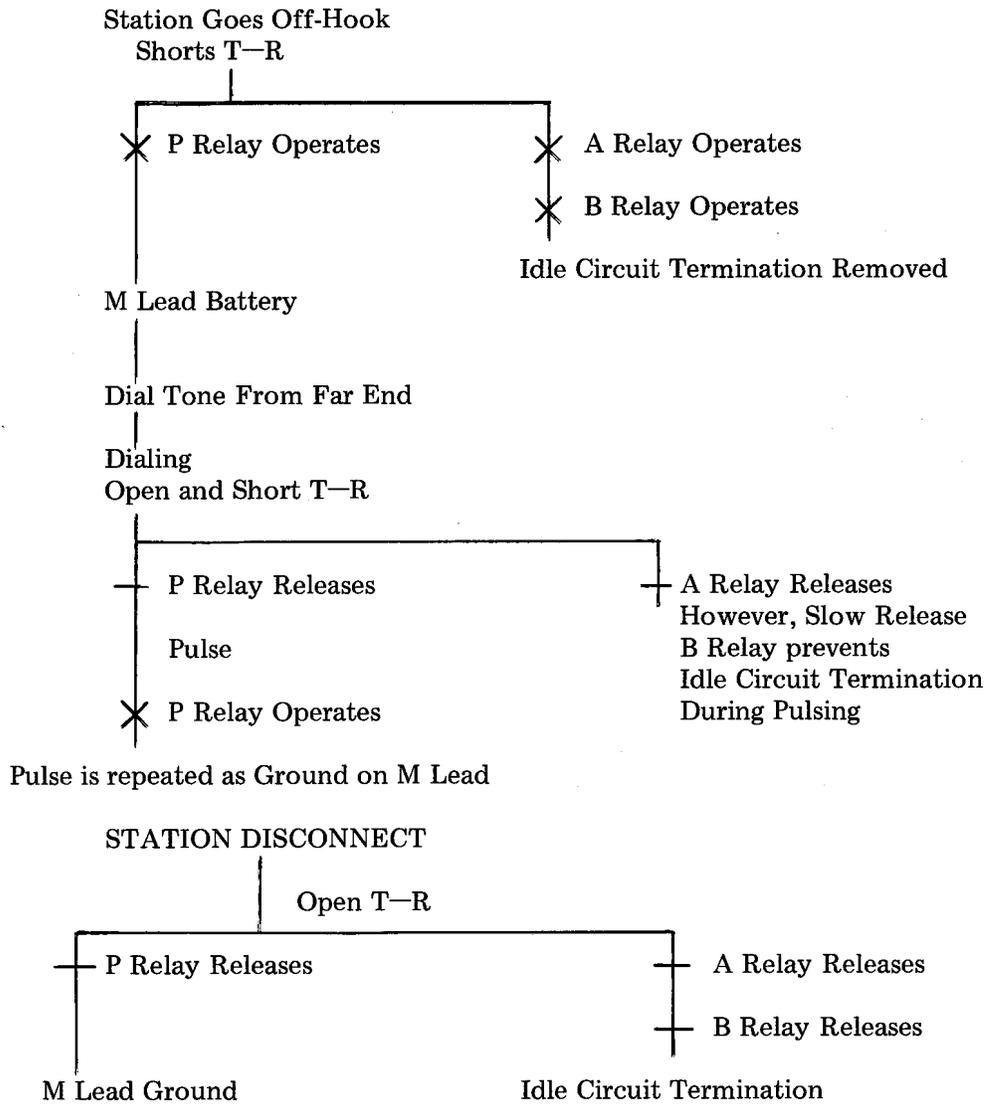
**6.45 Description:** The DLL03 (Fig. 6-25 and 6-26) is a loop to E & M lead signaling converter circuit used at the customer (loop) end of a loop start circuit. It is normally associated with either out-of-band carrier signaling systems (0, 0N, N1, or T1 carrier) or CX, DX, or SX signaling on metallic facilities. It can also be associated with an SF type signaling unit. Primary applications are off premises extensions, WATS Lines, one-way PBX-CO trunks, and some FX circuits. At the distant CO (switching) end of the circuit a DLL01 (see 6.41) is normally used to convert back to loop switching.

**6.46 Options:** The DLL03 has two basic option wiring, (J) and (H). The primary difference in the options is the operation of the E lead. The (H) option operation is given below. For the J option, the E lead open and ground are reversed (Line lamps reversed also). When using the (J) option, the E lead into the DLL is open as a ringing signal. This arrangement is compatible with the (R) option for DLL01 (see 6.41).

**Note:** The (H) option operation can be accomplished by using Fig. F of SD-96252 instead of Fig. E.



SC2: Outgoing Call (From Loop)



**DLL63, DLL62 Dial Long Line Circuit**  
**Common Language Equipment Code: DLC2000B**  
**SD-96555-01 and SD-96234-01**

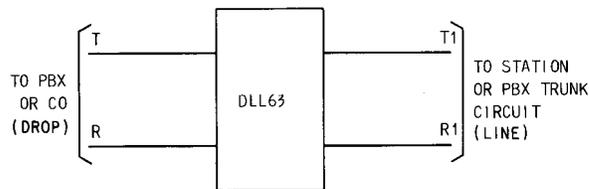


Fig. 6-28—DLL63 Shown in Typical Application

**6.48 Quick Test:** (1) Apply 20 Hz ringing to T1-R1 into DLL from CO end and observe 20 Hz applied to T-R toward station end and, (2) short T-R from station and observe T1-R1 shorted toward CO.

**6.49 Description:** The DLL63 (Fig. 6-28) is a dial pulse repeating circuit used to pass dial pulses in one direction and 20 Hz ringing in the other. The DLL63 is used as a means for a long PBX station to dial into a dial PBX or for a manual PBX to dial into a dial CO. The DLL63 can also be used to connect a subscriber line to a dial CO when the conductor resistance exceeds the office range. When ringing is received from the CO or PBX end, it is passed to the station or PBX in one of three methods: (1) directly through the DLL —BYPASS RINGING Option EI (the CO ringing current is sufficient to pass to the station.) (2)  $\pm 105$  Volts (this varies from + 105V to -105V 20 times per second) ringing, with tripping during the silent interval only Option (P). (3) 20-Hz ringing (84 to 88 volts), with tripping during silent and ringing interval (Option (U) or (S)). The latter is the only method covered here.

**Note:** DLL61 (SD-96034-01) and DLL62 are very similar to the DLL63. Basically, the DLL63 is a later variety and should be used in most cases. In some cases, the DLL61 and DLL62 are still being used and, for those cases, the operation of the DLL63 below can be substituted.

**6.50 Operation:**

**INCOMING CALL** (from CO end)

T1-R1 20 Hz in DLL

T-R 20 Hz toward station end

**OUTGOING CALL** (from station end)

T-R short from station

T1-R1 short from DLL

(When dial pulses are sent from station T1-R1 will change from short to open, etc)

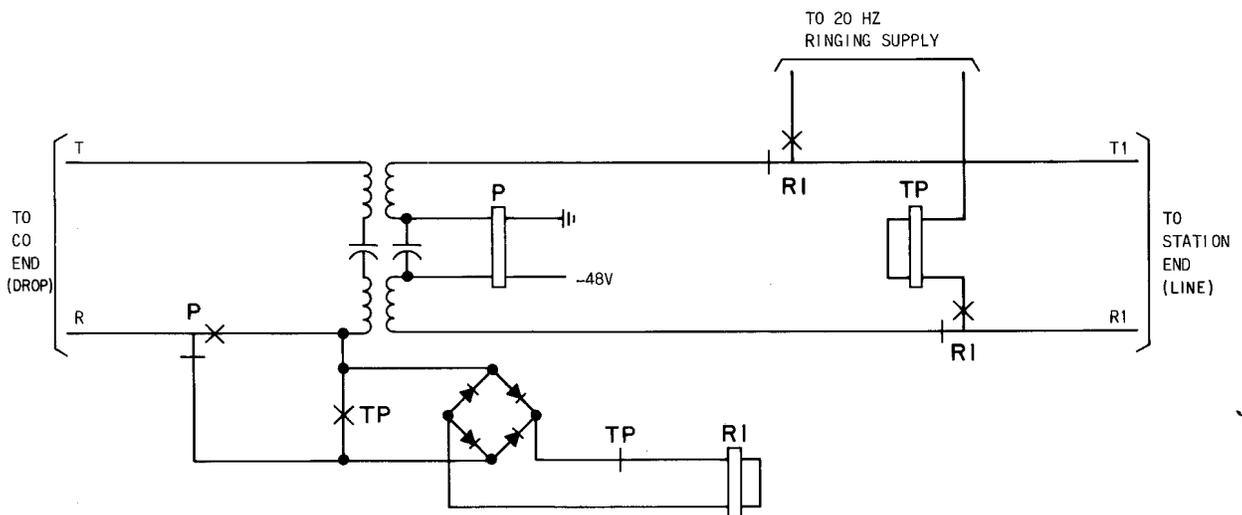
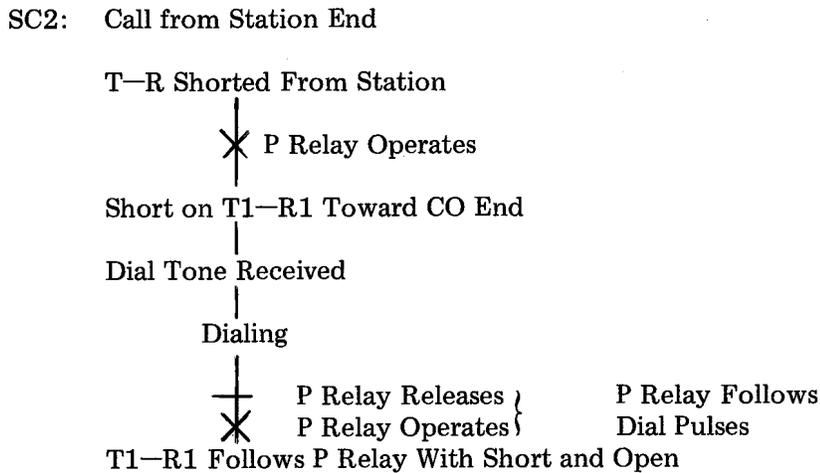
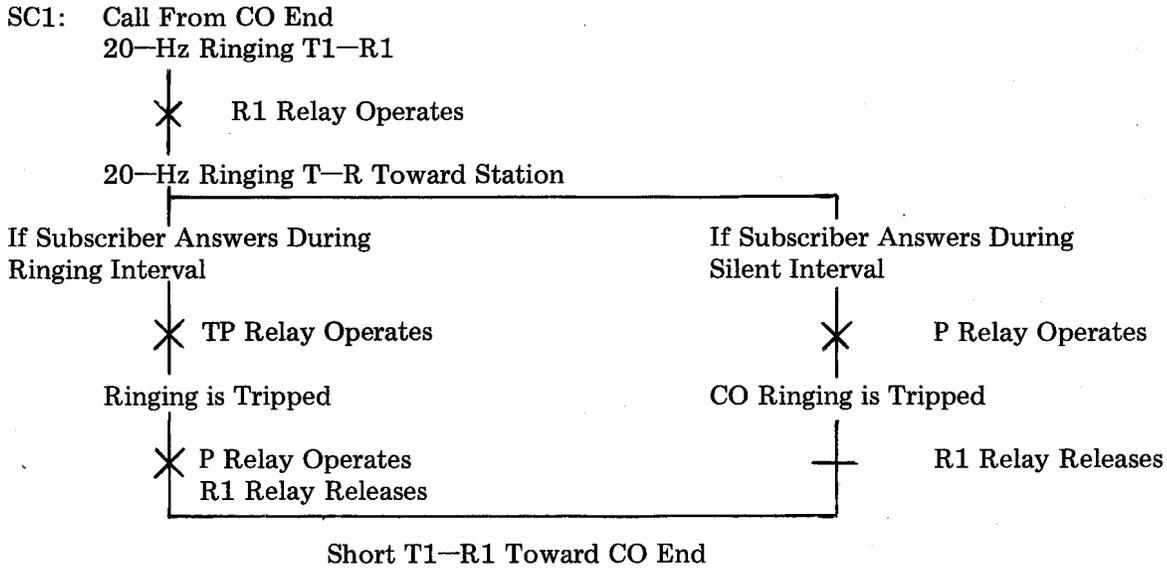


Fig. 6-29—Simplified Schematic of DLL63

SECTION 660-215-500



SF Signaling Components

6.51 The single frequency (SF) signaling systems convert dc signals from the CO or station end of a circuit to 2600-Hz tone. The 2600-Hz tone (in some cases 2400-Hz tone is used) is passed over carrier or metallic line facilities to a distant SF unit. At the distant end, the SF unit converts the 2600-Hz tone back to dc signals (Fig. 6-30). Basically, two families of SF units are being used; E-type and the newer F-type. Due to the structure of SF signaling systems, the format used here will differ somewhat from the format used for the other special service components covered in this part. Operation and testing information will still be covered.

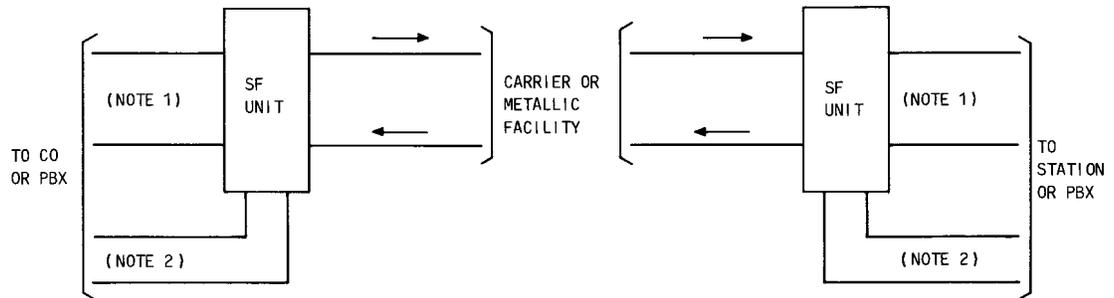


Fig. 6-30—Typical SF Circuit

**Note 1:** This represents the transmission path, 2-wire or 4-wire, which in some cases may also be used for dc signaling path.

**Note 2:** This represents the dc signal leads (most commonly E & M leads).

#### E-Type SF Units

- 6.52** Table 6-A shows the E-type SF units commonly used on special service circuits and their particular application.
- 6.53** Table 6-B shows the operating conditions for the SF units covered in Table 6-A and a **Quick Test** procedure.

TABLE 6-A

E-TYPE SIGNALING UNIT APPLICATIONS AND CHARACTERISTICS

UNIT	LINE FACILITY		4-WIRE TERM. SET		TRUNK SIGNALING		CUSTOMER LINE		PULSING			USE	FIG.	SD-NUMBER	COMMON LANGUAGE EQUIPMENT CODE
	2-W	4-W	INTERNAL	EXTERNAL	E&M	REVERSE BATTERY	LOOP START	GROUND START	DP	MF	RP				
E1B		X		X	X				X	X		Classes 1 to 5 Offices		98085-01	SF60 0000
E2B	X	X		X	X				X	X		Classes 1 to 5 Offices		98090-01	SF40 0000, SF60 0000
E3B	X	X		X	X	X	X		X	X		Classes 1 to 5 Offices		98124-01	SF40 0000
E4B		X		X	X	X	X		X	X		Classes 1 to 5 Offices		98124-03	SF60 0000
E2L		X	X				X		X			Cust. Line, Office End	31	98137-02	SFXT 0000
E2LA								X				Cust. Line, Office End	32	98142-02	SFAT 0000
E2S		X	X				X		X			Cust. Line, Station End	33	98138-02	SFXS 0000
E2SA*								X				Cust. Line, Station End	34	98140-02	SFAS 0000
E1P and E1P-A		X		X	X		X	X(A)	X			Office End	35, 36, 37	99780-01	SFXT 0000
E1R and E1P-A		X		X	X		X	X(A)	X			Station End	38, 39, 40	99780-01	SFSX 0000

TABLE 6-B  
E-TYPE OPERATION

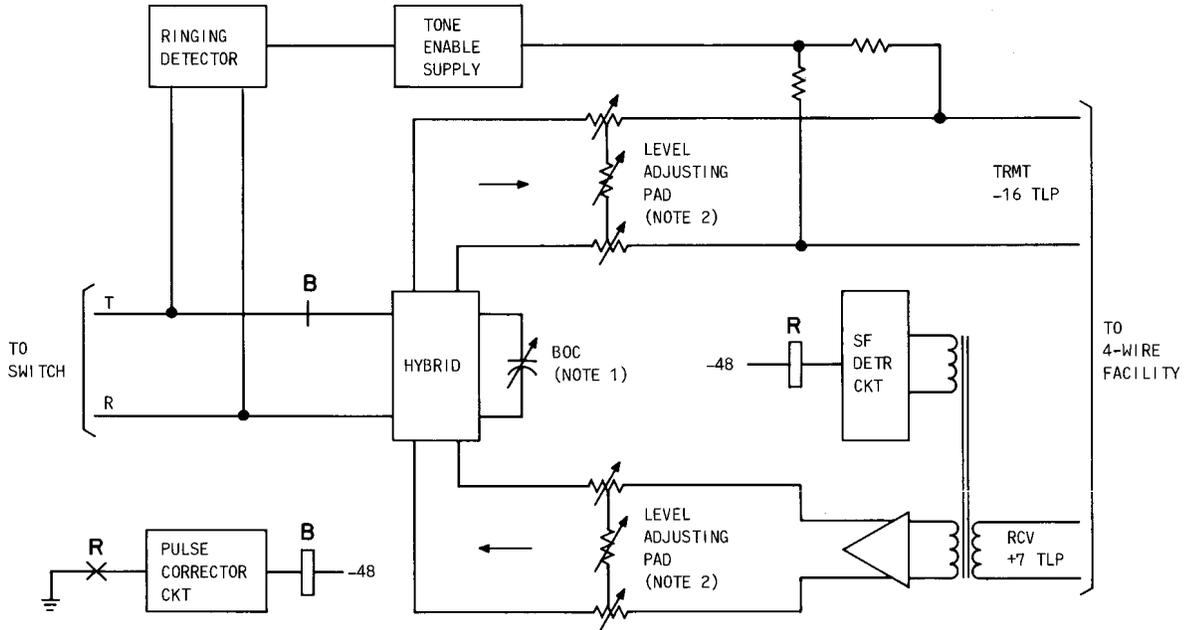
E-TYPE SF UNIT	IDLE CONDITION	BUSY CONDITION	INCOMING CALL (FROM FACILITY)	OUTGOING CALL (FROM STATION OR CO END)	QUICK TEST
E1B, E2B E3B, E4B	<ul style="list-style-type: none"> <li>• M lead Ground</li> <li>• E lead Open</li> <li>• SF TONE ON BOTH DIRECTIONS</li> </ul>	<ul style="list-style-type: none"> <li>• M lead Battery</li> <li>• E lead Ground</li> <li>• SF TONE OFF BOTH DIRECTIONS</li> </ul>	<ul style="list-style-type: none"> <li>• SF TONE OFF RECEIVE</li> <li>• E lead Ground FROM SF</li> </ul>	<ul style="list-style-type: none"> <li>• M lead Battery</li> <li>• SF TONE OFF TRANSMIT</li> </ul>	<ol style="list-style-type: none"> <li>1) Cut SF RECEIVE AND OBSERVE LINE lamp dark (E lead Ground).</li> <li>2) Apply Battery M lead AND MONITOR SF OFF TRANSMIT.</li> </ol>
E1P (LOOP START)	<ul style="list-style-type: none"> <li>• SF TONE ON RECEIVE</li> <li>• SF TONE OFF TRANSMIT</li> <li>• T-R HIGH RESISTANCE SHORT FROM SF</li> <li>• T-Ground, R-Battery FROM CO</li> </ul>	<ul style="list-style-type: none"> <li>• SF TONE OFF BOTH DIRECTIONS</li> <li>• T-R LOW RESISTANCE SHORT FROM SF</li> </ul>	<ul style="list-style-type: none"> <li>• SF TONE OFF RECEIVE</li> <li>• T-R SHORT FROM SF</li> </ul>	<ul style="list-style-type: none"> <li>• 20-HZ RING T-R FROM CO</li> <li>• SF TONE ON/OFF TRANSMIT (FOLLOWS 20 Hz)</li> </ul>	<ol style="list-style-type: none"> <li>1) CUT SF TONE RECEIVE AND OBSERVE T-R SHORT FROM SF.</li> <li>2) APPLY 20 HZ T-R FROM CO AND MONITOR SF TRANSMIT (ON/OFF FOLLOWS 20 HZ).</li> </ol>
E1P-A (GROUND START)	<ul style="list-style-type: none"> <li>• SF TONE ON BOTH DIRECTIONS</li> <li>• T-BATTERY R-BATTERY FROM SF</li> <li>• T-OPEN R-BATTERY FROM CO</li> </ul>	<ul style="list-style-type: none"> <li>• SF TONE OFF BOTH DIRECTIONS</li> <li>• T-BATTERY R-GROUND FROM SF</li> <li>• T-GROUND R-BATTERY FROM CO</li> </ul>	<ul style="list-style-type: none"> <li>• SF TONE OFF BOTH DIRECTIONS</li> <li>• T-BATTERY R-GROUND FROM SF</li> <li>• T-GROUND R-BATTERY FROM CO</li> </ul>	<ul style="list-style-type: none"> <li>• 20-HZ RING T-R FROM CO</li> <li>• SF TONE ON/OFF-TRANSMIT (FOLLOWS 20 Hz)</li> </ul>	<ol style="list-style-type: none"> <li>1) SAME AS E1P except T-R BATTERY-GROUND.</li> <li>2) SAME AS E1P.</li> </ol>
E1R (LOOP START)	<ul style="list-style-type: none"> <li>• SF TONE OFF RECEIVE</li> <li>• SF TONE ON TRANSMIT</li> <li>• T-R OPEN FROM LOOP</li> <li>• T-GROUND R-BATTERY FROM SF</li> </ul>	<ul style="list-style-type: none"> <li>• SF TONE OFF BOTH DIRECTIONS</li> <li>• T-R SHORT FROM LOOP</li> <li>• T-GROUND R-BATTERY FROM SF</li> </ul>	<ul style="list-style-type: none"> <li>• SF TONE ON/OFF RECEIVE (FOLLOWS 20 Hz FROM DISTANT END)</li> <li>• T-R 20 Hz FROM SF (FOLLOWS SF ON/OFF RECEIVE)</li> </ul>	<ul style="list-style-type: none"> <li>• T-R SHORT FROM LOOP</li> <li>• SF TONE OFF BOTH DIRECTIONS</li> <li>• DIALING BREAKS T-R (OPEN) AND SF TONE ON/OFF TRANSMIT (FOLLOWS DIAL PULSES)</li> </ul>	<ol style="list-style-type: none"> <li>1) CUT SF TONE RECEIVE AND OBSERVE 20 Hz FR.</li> <li>2) SHORT T-R FROM LOOP AND MONITOR SF OFF TRANSMIT.</li> </ol>
E1R-A (GROUND START)	<ul style="list-style-type: none"> <li>• SF TONE ON BOTH DIRECTIONS</li> <li>• T-BATTERY R-OPEN FROM LOOP</li> <li>• T-OPEN R-BATTERY FROM SF</li> </ul>	<ul style="list-style-type: none"> <li>• SF TONE OFF BOTH DIRECTIONS</li> <li>• T-BATTERY R-GROUND FROM LOOP</li> <li>• T-GROUND R-BATTERY FROM SF</li> </ul>	<ul style="list-style-type: none"> <li>• SF TONE ON TRANSMIT</li> <li>• SF TONE ON/OFF RECEIVE (MODULATED BY 20 Hz FROM DISTANT END)</li> <li>• T-R 20 Hz FROM SF (FOLLOWS SF RECEIVE)</li> </ul>	<ul style="list-style-type: none"> <li>• CUSTOMER SEIZES CIRCUIT R-GROUND FROM LOOP</li> <li>• SF TONE OFF BOTH DIRECTIONS</li> <li>• DIALING BREAK T-R (R-OPEN) AND SF TONE ON/OFF TRANSMIT (FOLLOWS DIAL PULSES)</li> </ul>	<ol style="list-style-type: none"> <li>1) SAME AS E1R.</li> <li>2) GROUND R lead From LOOP AND MONITOR SF OFF TRANSMIT.</li> </ol>

TABLE 6-B (Cont)

E-TYPE OPERATION

E-TYPE SF UNIT	IDLE CONDITION	BUSY CONDITION	INCOMING CALL (FROM FACILITY)	OUTGOING CALL (FROM STATION OR CO END)	QUICK TEST
E2L (LOOP START)	<ul style="list-style-type: none"> <li>• SF TONE OFF TRANSMIT</li> <li>• SF TONE ON RECEIVE</li> <li>• T-R OPEN FROM SF</li> <li>• T-GROUND R-BATTERY FROM CO</li> </ul>	<ul style="list-style-type: none"> <li>• SF TONE OFF BOTH DIRECTIONS</li> <li>• T-R SHORT FROM SF</li> </ul>	<ul style="list-style-type: none"> <li>• SF TONE OFF RECEIVE</li> <li>• T-R SHORT FROM SF (DRAWS DIAL TONE FROM CO)</li> <li>• SF TONE ON/OFF RECEIVE WHEN DISTANT END DIALS</li> <li>• T-R OPEN/SHORT (FOLLOWS PULSES)</li> </ul>	<ul style="list-style-type: none"> <li>• T-R 20-Hz RING FROM CO</li> <li>• SF TONE ON/OFF TRANSMIT (FOLLOWS 20-Hz RING)</li> <li>• RING STOPS WHEN SF TONE ON RECEIVE AND T-R SHORT FROM SF</li> </ul>	<ol style="list-style-type: none"> <li>1) CUT SF TONE RECEIVE AND OBSERVE T-R SHORT FROM SF.</li> <li>2) APPLY 20-Hz T-R FROM CO AND MONITOR SF TONE ON/OFF TRANSMIT.</li> </ol>
E2L-A (GROUND START)	<ul style="list-style-type: none"> <li>• SF TONE ON BOTH DIRECTIONS</li> <li>• T-BATTERY R-BATTERY FROM SF</li> <li>• T-OPEN R-BATTERY FROM CO</li> </ul>	<ul style="list-style-type: none"> <li>• SF TONE OFF BOTH DIRECTIONS</li> <li>• T-BATTERY R-GROUND FROM SF</li> <li>• T-GROUND R-BATTERY FROM CO</li> </ul>	<ul style="list-style-type: none"> <li>• SAME AS BUSY WHEN PULSES ARE RECEIVED THE T-R OPEN - FOLLOWS PULSES</li> </ul>	<ul style="list-style-type: none"> <li>• T-R 20-Hz RING FROM CO</li> <li>• SF TONE ON/OFF TRANSMIT (FOLLOWS 20 Hz)</li> </ul>	<ol style="list-style-type: none"> <li>1) CUT SF TONE RECEIVE AND OBSERVE T-R FOR BUSY CONDITIONS.</li> <li>2) APPLY 20-Hz RINGING TO T-R FROM CO AND MONITOR SF TONE ON/OFF TRANSMIT.</li> </ol>
E25 (LOOP START)	<ul style="list-style-type: none"> <li>• SF TONE OFF RECEIVE</li> <li>• SF TONE ON TRANSMIT</li> <li>• T-R OPEN FROM LOOP</li> <li>• T-GROUND R-BATTERY FROM SF</li> </ul>	<ul style="list-style-type: none"> <li>• SF TONE OFF BOTH DIRECTIONS</li> <li>• T-R SHORT FROM LOOP</li> <li>• T-GROUND R-BATTERY FROM SF</li> </ul>	<ul style="list-style-type: none"> <li>• SF TONE ON/OFF RECEIVE (FOLLOWS 20 Hz FROM DISTANT END)</li> <li>• T-R 20 Hz RING FROM SF (FOLLOWS SF ON/OFF RECEIVE)</li> </ul>	<ul style="list-style-type: none"> <li>• SF TONE OFF BOTH DIRECTIONS</li> <li>• T-R SHORT FROM LOOP</li> <li>• T-GROUND R-BATTERY FROM SF</li> <li>• DIAL TONE RECEIVED FROM CO. DIALING OPENS/SHORT T-R FROM LOOP (SF FOLLOWS ON/OFF TRANSMIT)</li> </ul>	<ol style="list-style-type: none"> <li>1) CUT SF TONE RECEIVE AND OBSERVE T-R 20 Hz FROM SF.</li> <li>2) SHORT T-R OBSERVE DIAL TONE.</li> </ol>
E25-A (GROUND START)	<ul style="list-style-type: none"> <li>• SF TONE ON BOTH DIRECTIONS</li> <li>• T-OPEN R-BATTERY FROM SF</li> <li>• T-BATTERY R-OPEN FROM LOOP</li> </ul>	<ul style="list-style-type: none"> <li>• SF TONE OFF BOTH DIRECTIONS</li> <li>• T-GROUND R-BATTERY FROM SF</li> <li>• T-BATTERY R-GROUND FROM LOOP</li> </ul>	<ul style="list-style-type: none"> <li>• SF TONE ON BOTH DIRECTIONS - RECEIVE MODULATED BY 20 Hz</li> <li>• T-R 20 Hz FROM SF (FOLLOWS SF RECEIVE)</li> </ul>	<ul style="list-style-type: none"> <li>• CUSTOMER SERIES CIRCUIT GROUND -R FROM LOOP</li> <li>• SF TONE OFF BOTH DIRECTIONS</li> <li>• DIALING SAME AS E25</li> </ul>	<ol style="list-style-type: none"> <li>1) CUT SF TONE RECEIVE AND OBSERVE T-R - 20 Hz.</li> <li>2) GROUND R Lead From LOOP AND MONITOR SF OFF TRANSMIT.</li> </ol>

SECTION 660-215-500



- NOTES:  
 1. ADJUST BOC FOR PROPER HYBRID BALANCE.  
 2. ADJUST PADS FOR PROPER LEVEL AT 2W SIDE AND TRMT LEG.

Idle CKT: GRD on T lead, BAT. on R lead from switch; TRMT tone Off; RCV tone On, R relay operated, B relay operated, open loop to switch.

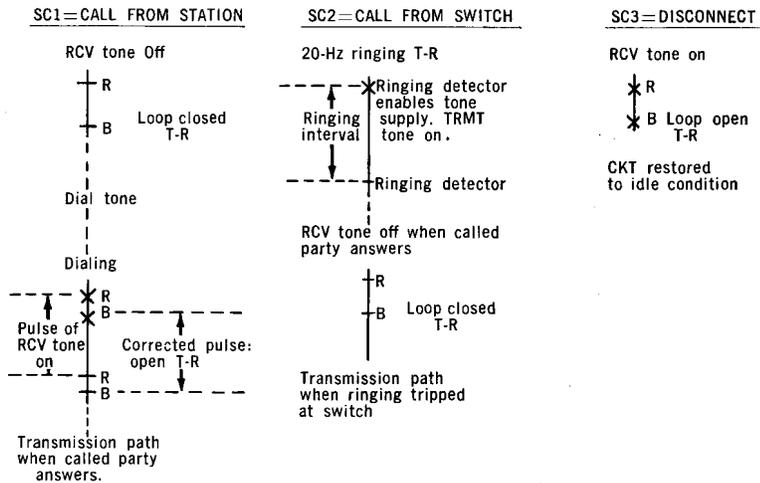
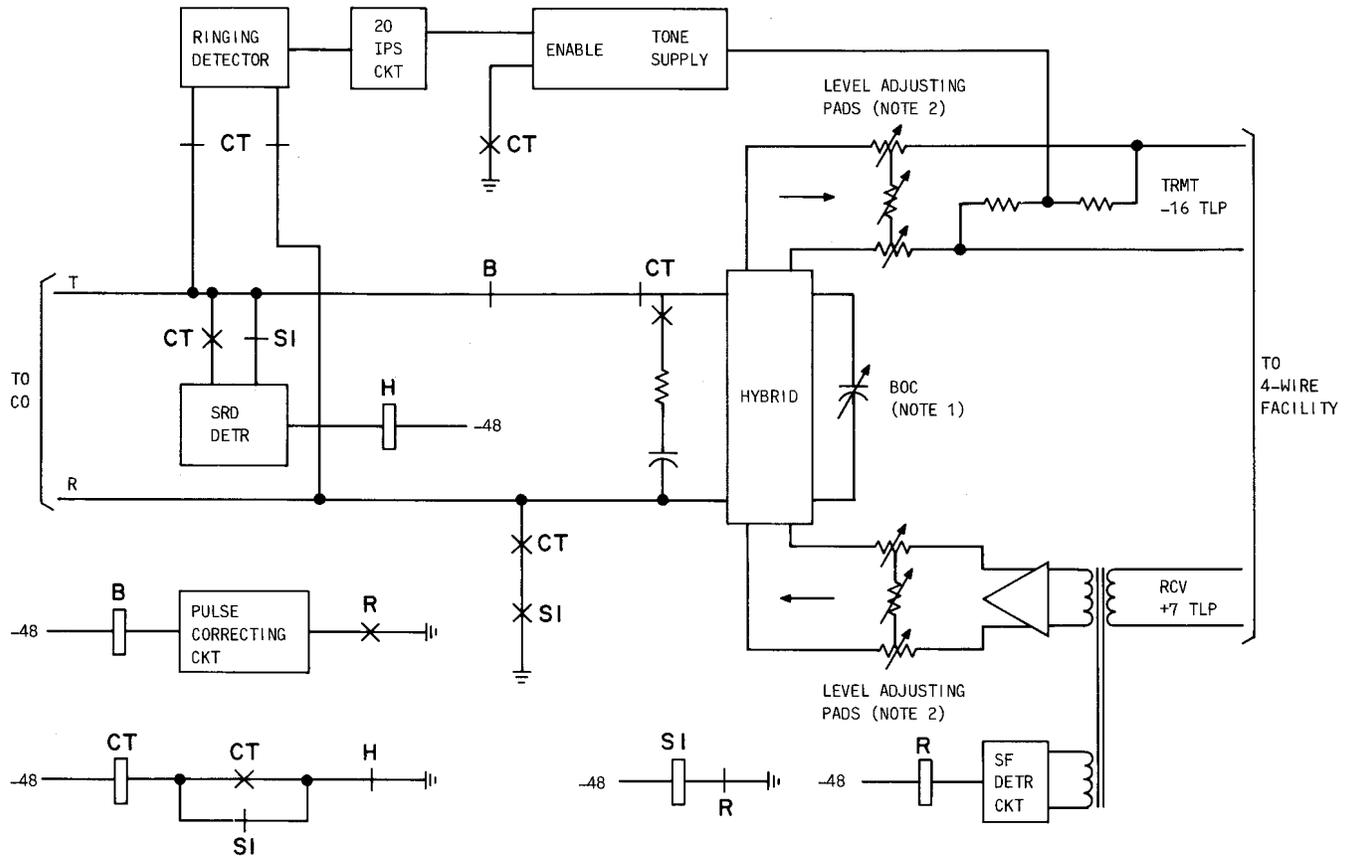


Fig. 6-31—Simplified Schematic of E2L



NOTES:

1. ADJUST BOC FOR PROPER HYBRID BALANCE.
2. ADJUST PADS FOR PROPER LEVEL AT 2W SIDE AND TRMT LEG.

Idle CKT: RCV tone on, R relay operated, S1 relay released, CT relay operated, R lead open to CO; T lead open from CO, H relay released, TRMT tone on.

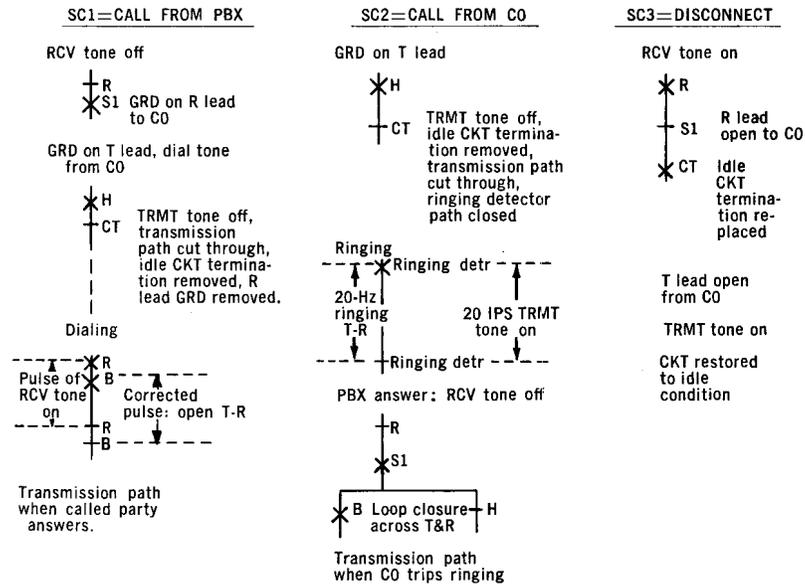
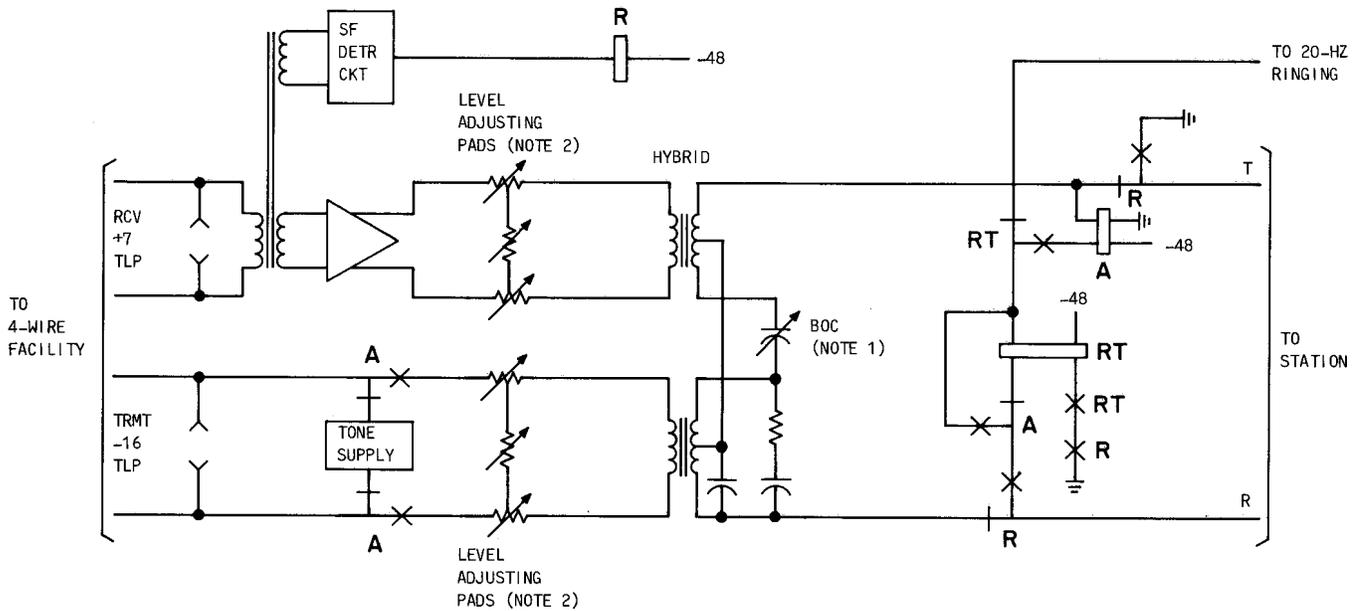


Fig. 6-32—Simplified Schematic of E2L + E2LA

SECTION 660-215-500



- NOTES:
1. BOC MUST BE ADJUSTED FOR PROPER HYBRID BALANCE.
  2. THE LEVEL ADJUSTING PAD IN THE RECEIVE LEG IS ADJUSTED FOR PROPER LEVEL AT THE 2-WIRE SIDE; THE TRANSMIT LEG PAD IS ADJUSTED FOR PROPER LEVEL AT THE TRMT LEG.

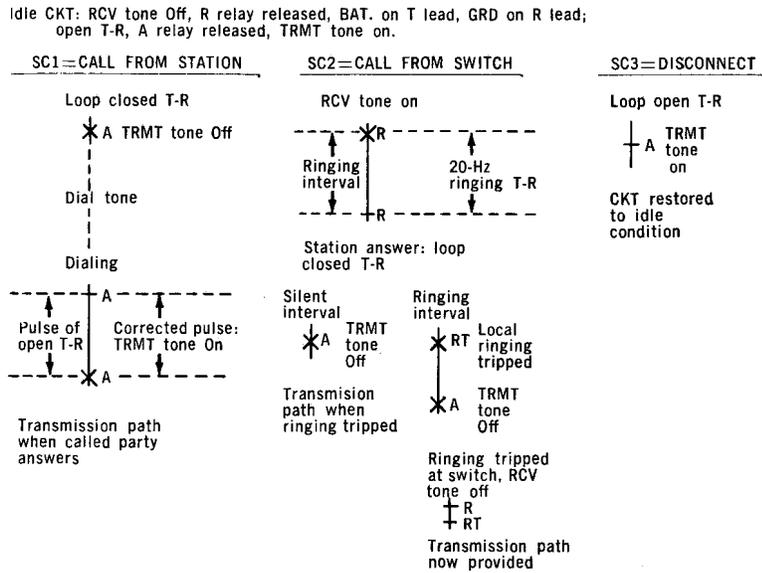
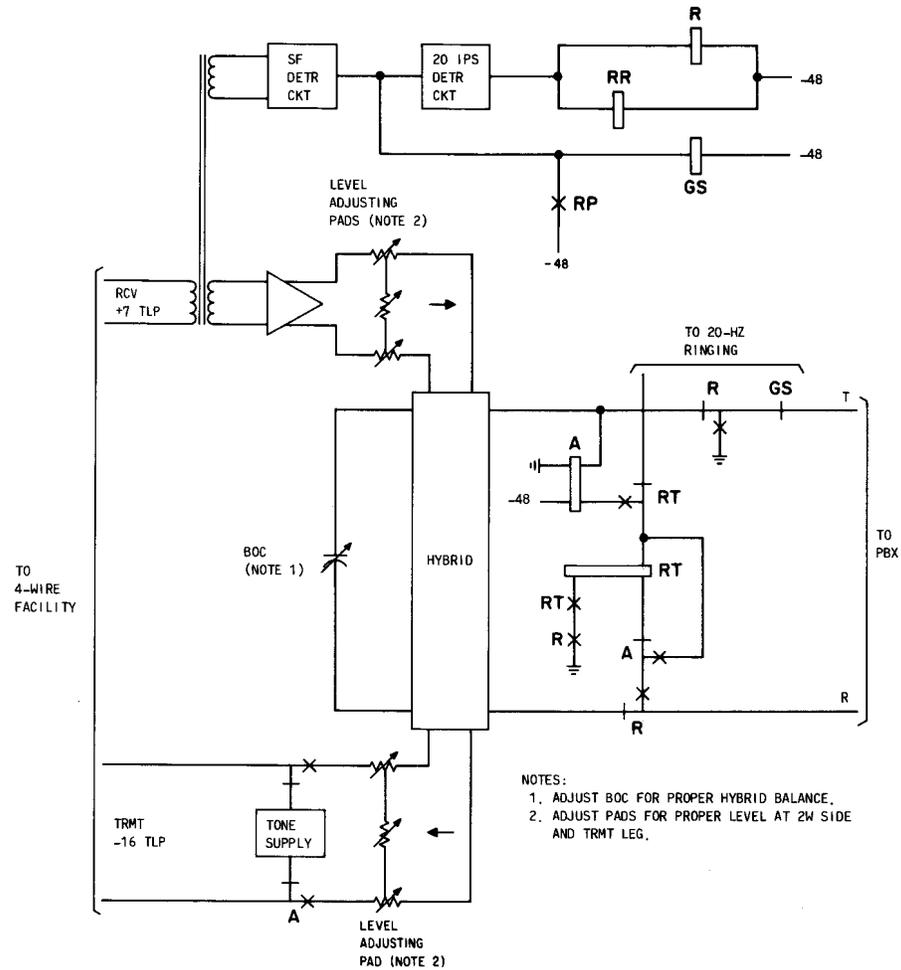


Fig. 6-33—Simplified Schematic of E25



Idle CKT: Open T-R, A relay released, TRMT tone off; RCV tone on, GS relay operated, T lead open to PBX.

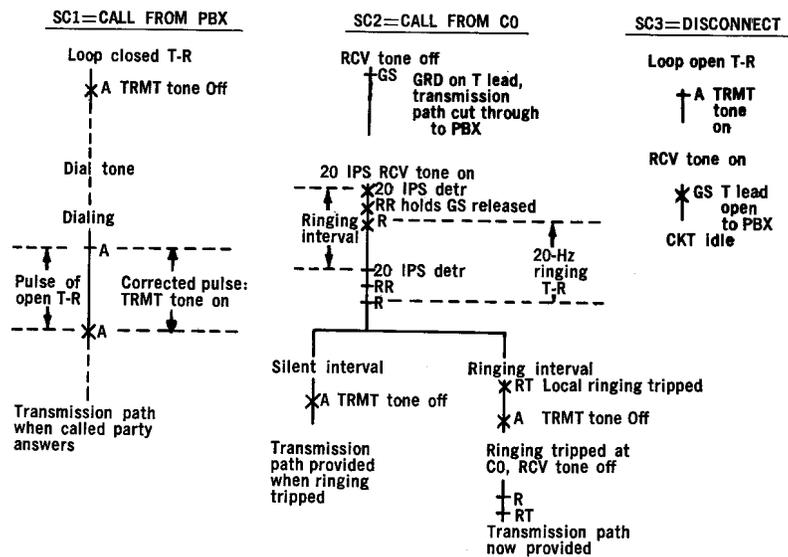
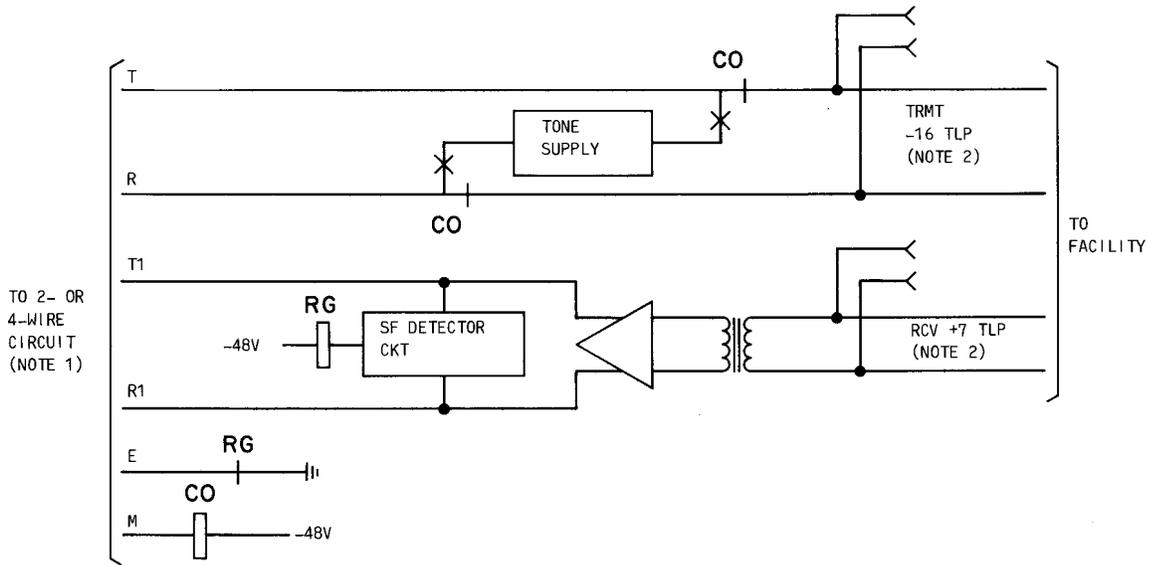


Fig. 6-34—Simplified Schematic of E2S + E2SA

SECTION 660-215-500



NOTES:

1. CONNECTING CIRCUIT MUST PROVIDE BATTERY ON M LEAD DURING IDLE CONDITION, GROUND FOR RINGING.
2. LEVEL ADJUSTMENT MUST BE PROVIDED EXTERNALLY TO E SIGNALING UNIT.

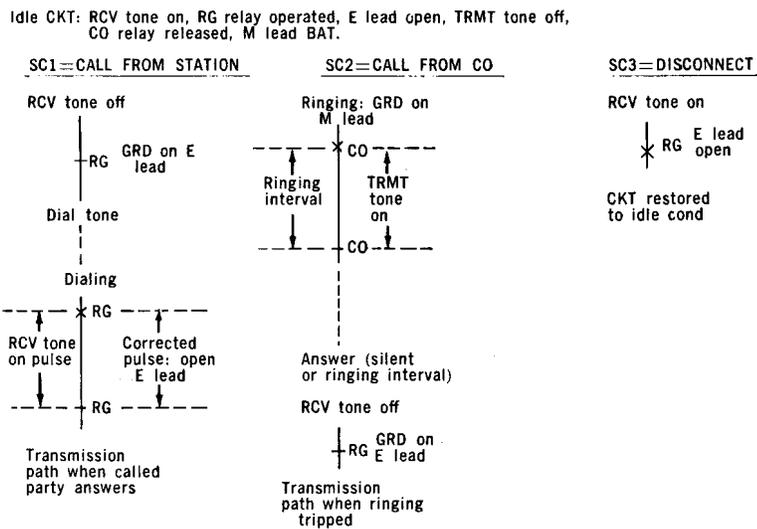
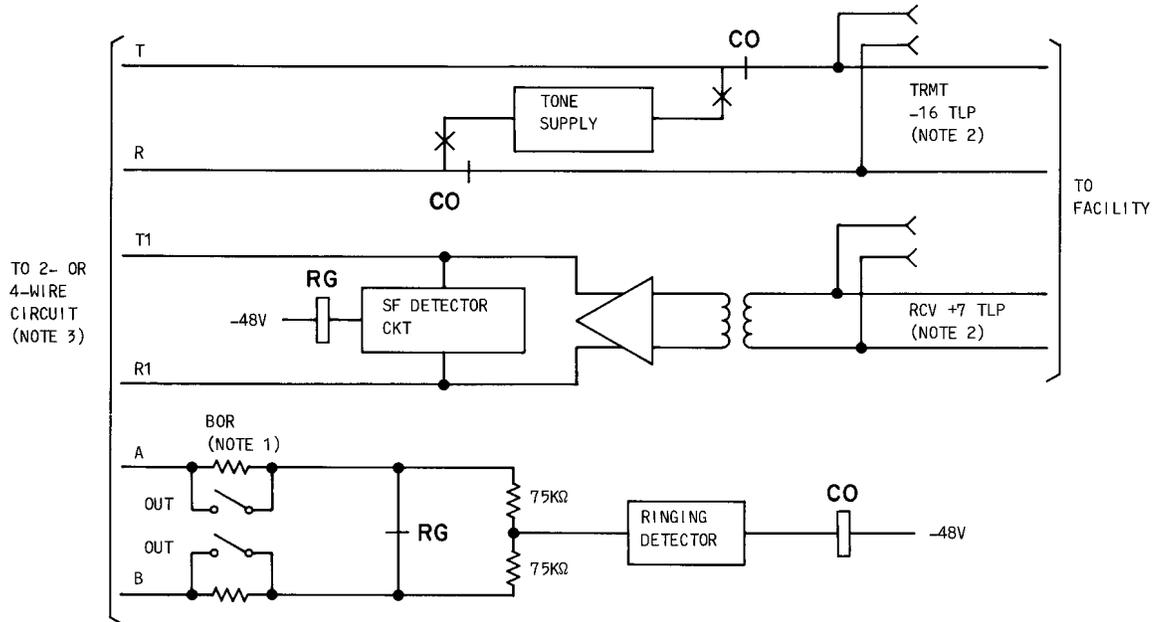


Fig. 6-35—Simplified Schematic of EIP



- NOTES:
1. BOR SWITCH IN WHEN EXTERNAL CONDUCTOR LOOP RESISTANCE IS LESS THAN 520Ω.
  2. LEVEL ADJUSTMENT MUST BE PROVIDED EXTERNALLY TO E SIGNALING UNIT.
  3. TERM. SET MUST PLACE SIMPLEX INDUCTORS IN SERIES WITH THE A & B LEADS TO PRESERVE THE LONGITUDINAL BALANCE OF THE CIRCUIT.

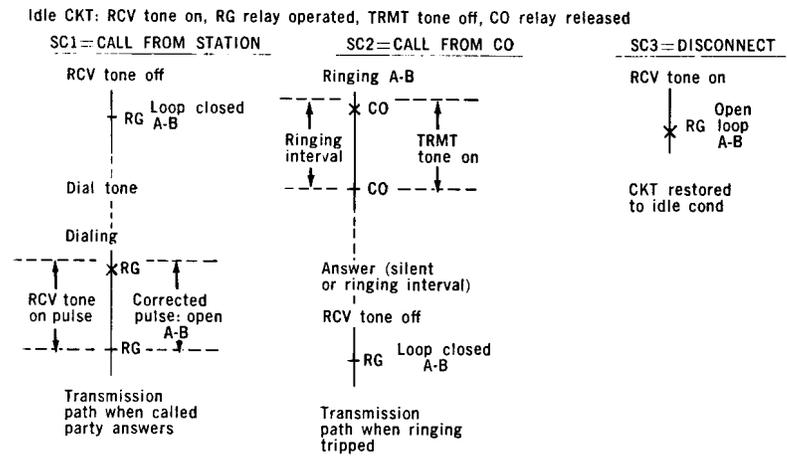
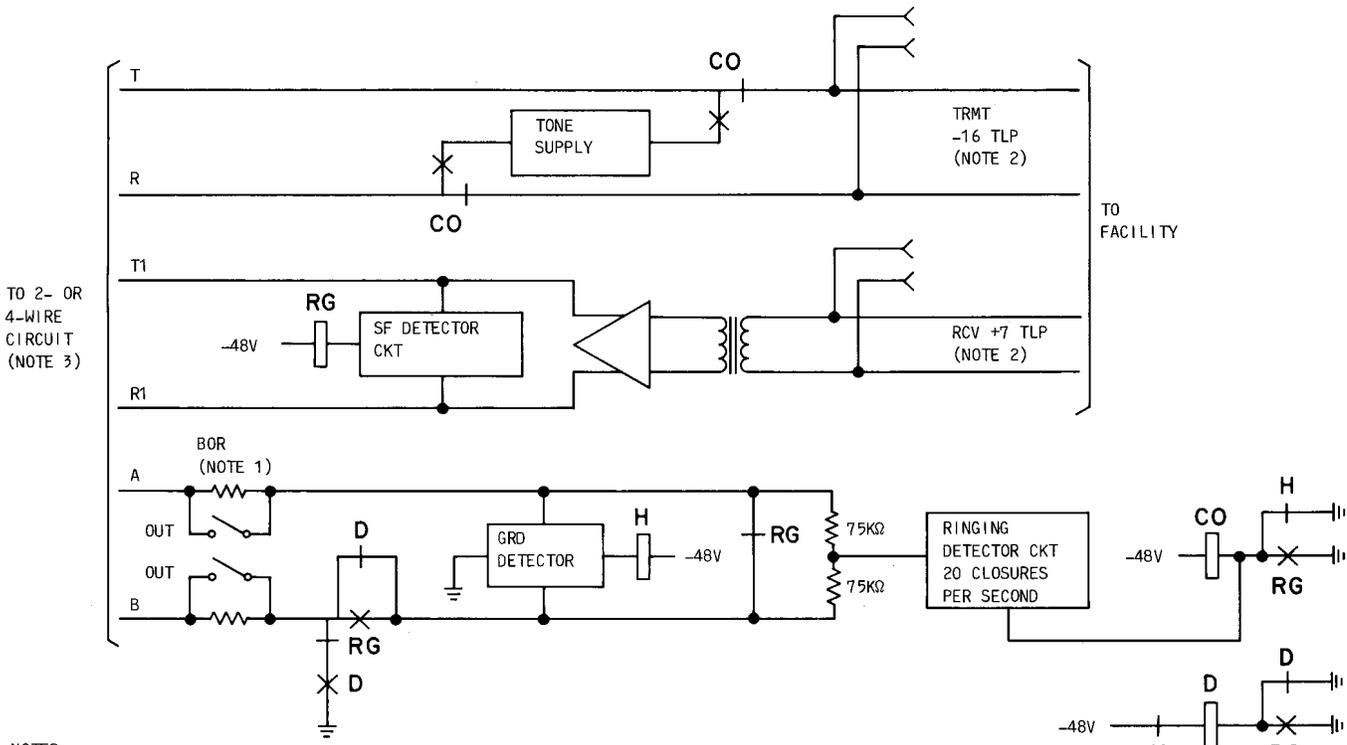


Fig. 6-36—Simplified Schematic of E1P Loop

SECTION 660-215-500



- NOTES:
1. BOR SWITCH IN WHEN EXTERNAL CONDUCTOR LOOP RESISTANCE IS LESS THAN 520Ω.
  2. LEVEL ADJUSTMENT MUST BE PROVIDED EXTERNALLY TO E SIGNALING UNIT.
  3. TERM. SET MUST PLACE SIMPLEX INDUCTORS IN SERIES WITH THE A & B LEADS TO PRESERVE THE LONGITUDINAL BALANCE OF THE CIRCUIT.

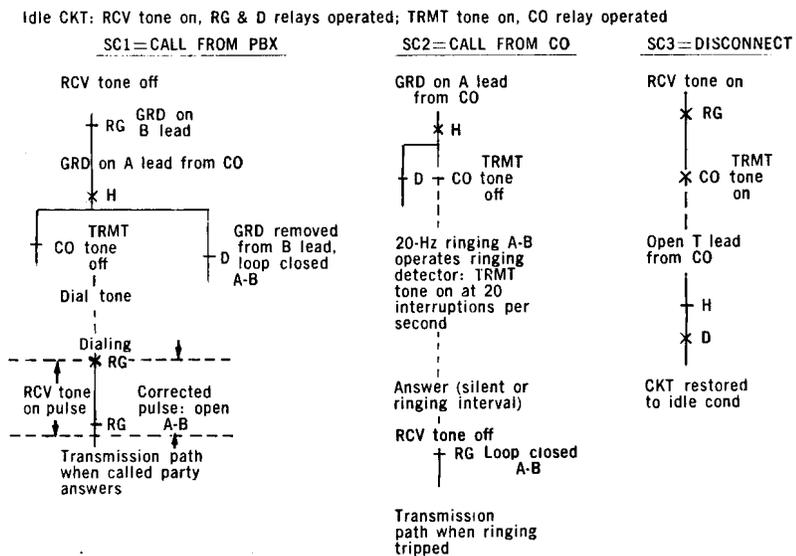
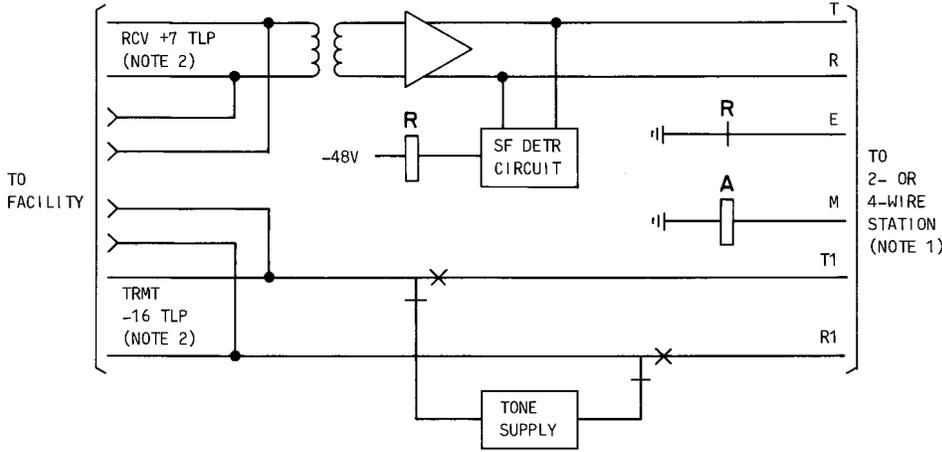


Fig. 6-37—Simplified Schematic of E1P-A



- NOTES:  
 1. CONNECTING SIGNALING CIRCUIT APPLIES GRD ON M LEAD DURING IDLE CIRCUIT CONDITION.  
 2. LEVEL ADJUSTMENT MUST BE PROVIDED EXTERNALLY TO E SIGNALING UNIT.

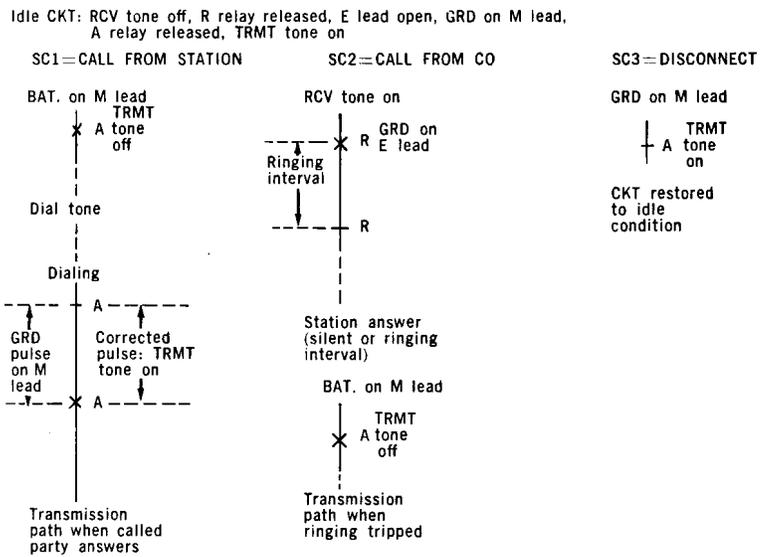
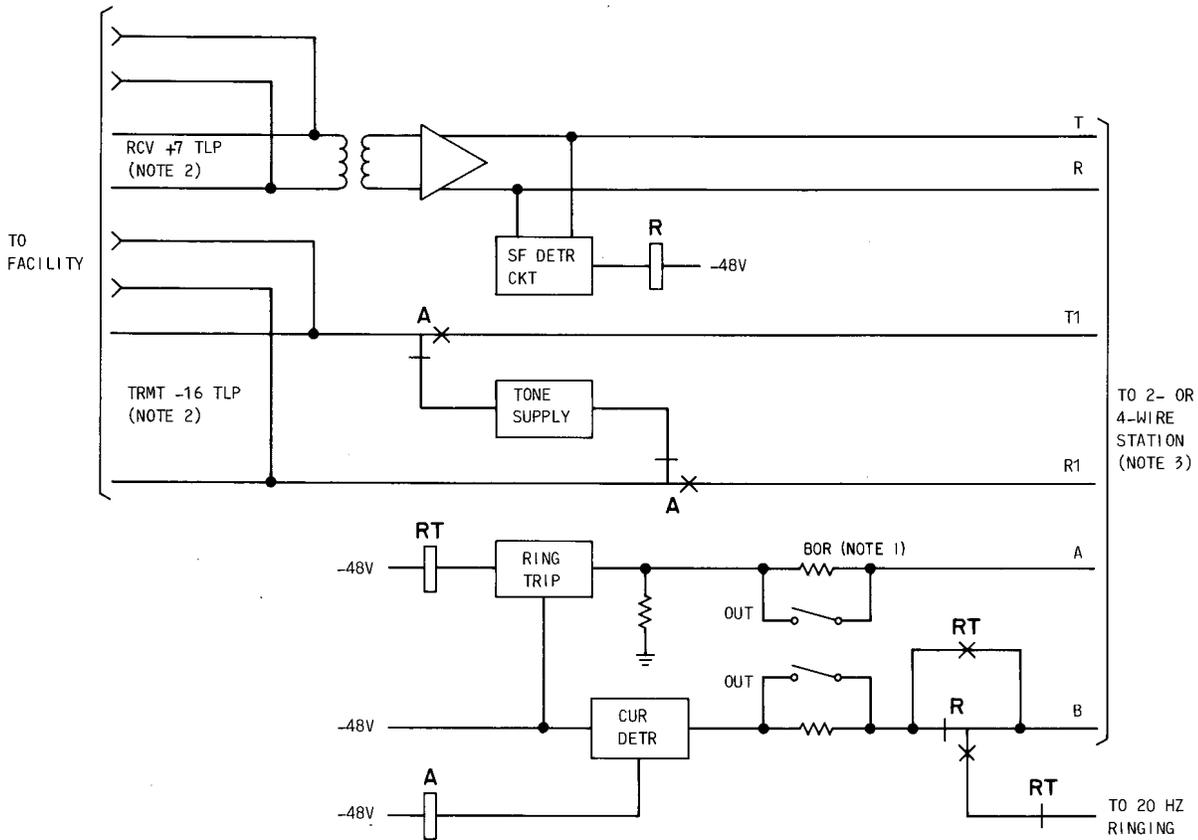


Fig. 6-38—Simplified Schematic of E1R

SECTION 660-215-500



- NOTES:
1. BOR SWITCH IN WHEN EXTERNAL CONDUCTOR LOOP RESISTANCE IS LESS THAN 520Ω.
  2. LEVEL ADJUSTMENT MUST BE PROVIDED EXTERNALLY TO E SIGNALING UNIT.
  3. TERM. SET MUST PLACE SIMPLEX INDUCTORS IN SERIES WITH THE A & B LEADS TO PRESERVE THE LONGITUDINAL BALANCE OF THE CIRCUIT.

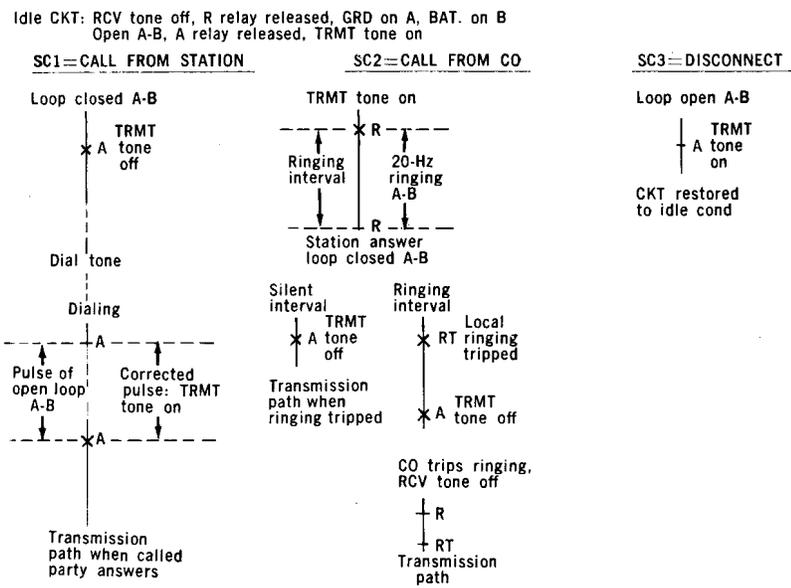
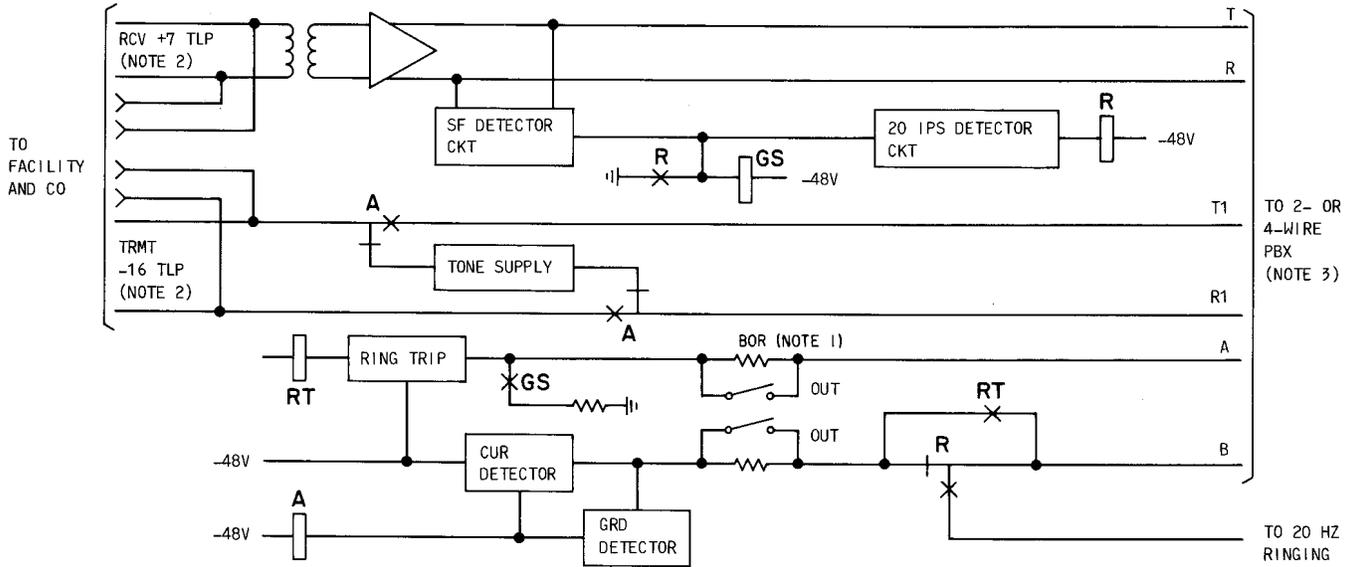


Fig. 6-39—Simplified Schematic of E1R Loop



- NOTES:
1. BOR SWITCH IN WHEN EXTERNAL CONDUCTOR LOOP RESISTANCE IS LESS THAN 520Ω.
  2. LEVEL ADJUSTMENT MUST BE PROVIDED EXTERNALLY TO E SIGNALING UNIT.
  3. TERM. SET MUST PLACE SIMPLEX INDUCTORS IN SERIES WITH THE A & B LEADS TO PRESERVE THE LONGITUDINAL BALANCE OF THE CIRCUIT.

Idle CKT: RCV tone on, GS & R relays released; BAT. on B lead, GRD on T lead to PBX  
 A-B open from PBX, A relay released, TRMT tone on

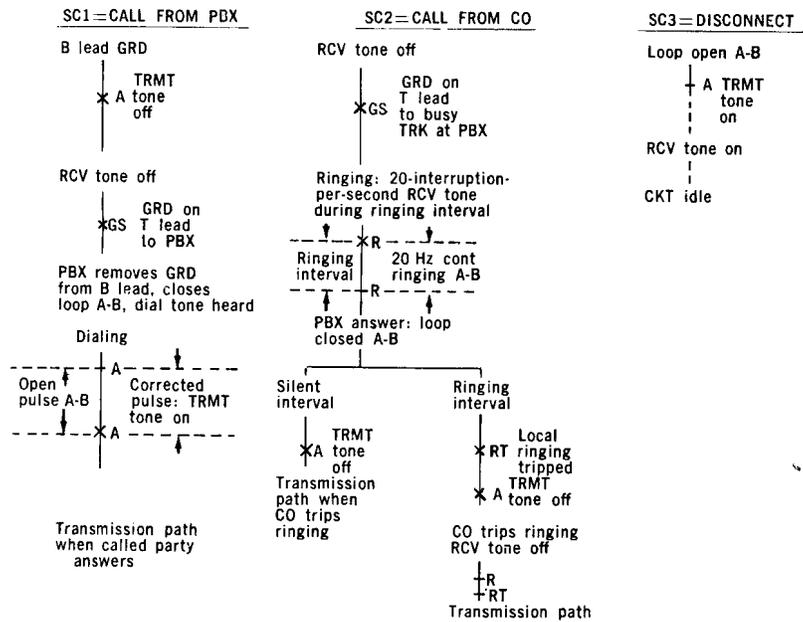


Fig. 6-40—Simplified Schematic of E1R-A

**SECTION 660-215-500**

**F-Type SF Signaling Units**

**6.54** The F-type SF signaling units are divided into two types: single module arrangements (FWA) and double module arrangement (FUA + an auxiliary unit). The FWA is covered in SD-1C225-01 and the common language equipment code is SF60XXXX. The FUA is covered in SD-1C226-01 and the code is SF6DXXXX. The FWA unit is a 4-wire E & M to SF converter. The FUA plus an auxiliary unit meet various needs. Auxiliary units that are covered in this part and their functions are listed in Table 6-C.

**6.55** Table 6-D shows the compatibility of the auxiliary units with E-type and F-type SF units.

**6.56** Table 6-E gives the operation of the F-type SF units.

**TABLE 6-C**

**F-TYPE AUXILIARY SIGNALING UNITS GENERAL INFORMATION AND APPLICATION**

CODE	FUNCTIONAL DESCRIPTION	GENERAL APPLICATION	SPECIFIC USE	TYPE E SF UNITS REPLACED	SD NUMBER	COMMON LANGUAGE EQUIPMENT CODES
FLA	Special Access CO End	Special Access Loop-Start or Ground-Start	2W-900 ohm	E2L-E2LA E1P + Term. Set		
FLB	Special Access CO End	Special Access Loop-Start or Ground-Start	2W-600 ohm	E1P + Term. Set		
FLC	Special Access CO End	Special Access Loop-Start	2W-900 ohm	E2L E1P + Term. Set	1C231-01	SFXT XXXX
FLD	Special Access CO End	Special Access Loop-Start	2W-600 ohm			
FPA	Special Access CO End	Special Access Loop-Start or Ground-Start	4-wire extension	E1P + Type 4182 network		
FRA	Special Access Station End	Special Access Loop-Start or Ground-Start	4-wire extension	E1R + Type 4182 network		
FSA	Special Access Station End	Special Access Loop-Start or Ground-Start	2W-900 ohm	E2S-E2SA E1R Term. Set		
FSB	Special Access Station End	Special Access Loop-Start or Ground-Start	2W-600 ohm	E1R Term. Set	1C230-01	SFXT XXXX
FSC	Special Access Station End	Special Access Loop-Start	2W-900 ohm	E2S E1R + Term. Set		
FSD	Special Access Station End	Special Access Loop-Start	2W-600 ohm	E1R + Term. Set		

TABLE 6-D

## COMPATIBILITY OF AUXILIARY UNITS WITH E – AND F – TYPE UNITS

CENTRAL OFFICE END	MODE OF OPERATION	CUSTOMER END							
		FRA	FSA FSB	FA- FB- FWA-	E2BK, E2BKA, E3BK, E3BKA, or E4B	E2S	E2SA	E1R	FSC FSD
FLA & FLB	Loop Start	✓	✓	1, 3	1	✓	No	✓	✓
	Ground Start	✓	✓	No	No	✓	✓	✓	No
FPA	Loop Start	✓	✓	1, 3	1	✓	No	✓	✓
	Ground Start	✓	✓	No	No	No	✓	✓	No
FLC & FLD	Loop-Start	✓	✓			✓	No	✓	✓
FWA	Loop Start	2, 3	2, 3						
	Ground Start	No	No						
E2L	Loop Start	✓	✓			✓	No	✓	✓
	Ground Start	✓	✓			✓	✓	✓	No
E2LA	Loop Start	No	No						No
	Ground Start	✓	✓						No
E1P	Loop Start	✓	✓			✓	No		✓
	Ground Start	✓	✓			✓	✓		No

*Notes:*

1. When used with SD-96252-01 DLL Circuit.
2. When used with SD-96251-01 DLL Circuit.
3. Not a desirable arrangement.

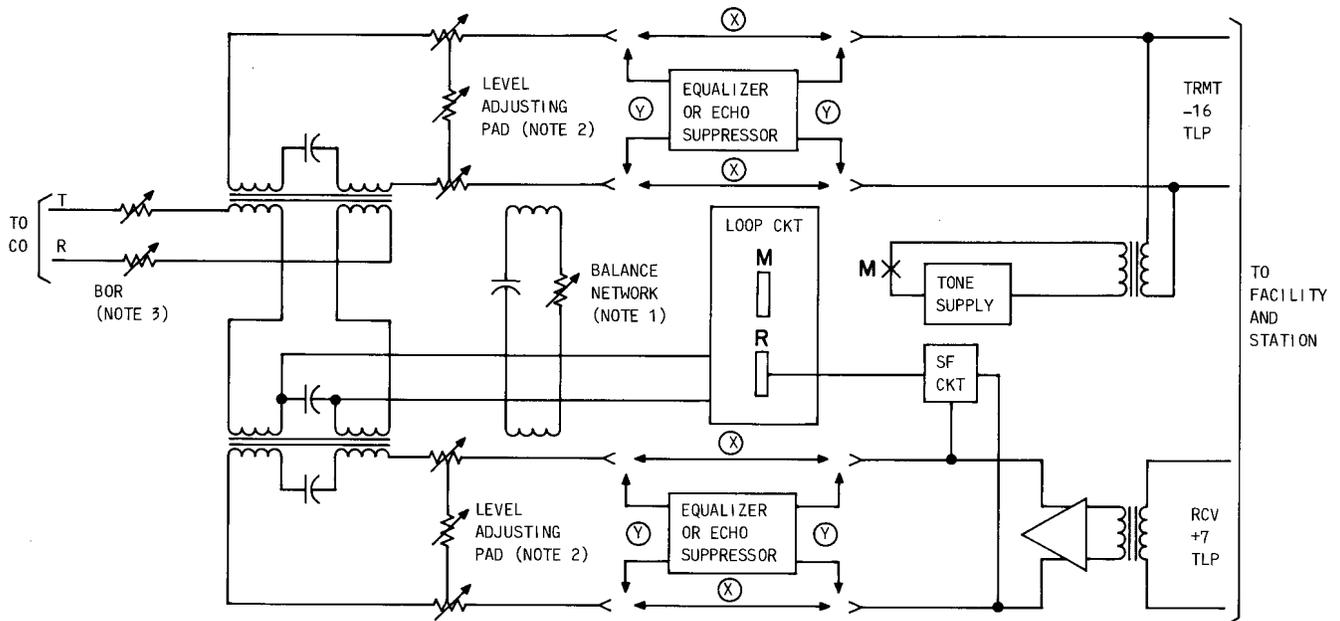
TABLE 6-E

## OPERATION OF F-TYPE SF UNITS

MODE OF OPERATION	CONDITION OF TRUNK	FP - AND FL - UNITS † (Fig. 6-40) 6-41)					FR - AND FS - UNITS † (Fig. 6-42) 6-43)				
		CONDITION OF SIG & TRMSN LEADS					CONDITION OF SIG & TRMSN LEADS				
		M LEAD	E LEAD	A & B LOOP	2600-Hz TONE		M LEAD	E LEAD	A & B LOOP	2600-Hz TONE	
					TRMT	RCV				TRMT	RCV
LOOP-START CALL ORIGINATED AT STATION END	Idle	BATT	Open	Open	OFF	ON	GRD	GRD	Open	ON	OFF
	Seizure	BATT	GRD	Closed	OFF	OFF	BATT	GRD	Closed	OFF	OFF
	Pulsing	BATT	Open-GRD	Open-Closed	OFF	ON-OFF	BATT-GRD	GRD	Open-Closed	ON-OFF	OFF
	Talking	BATT	GRD	Closed	OFF	OFF	BATT	GRD	Closed	OFF	OFF
LOOP-START CALL ORIGINATED AT CENTRAL OFFICE END	Idle	BATT	Open	Open	OFF	ON	GRD	GRD	Open	ON	OFF
	Seizure	GRD	Open	Ready for Ringing	ON	ON	GRD	OPEN	Open	ON	ON
	Ringing	GRD	Open	Open	ON	ON	GRD	OPEN	Open	ON	ON
	Talking	BATT	GRD	Closed	OFF	OFF	BATT	GRD	Closed	OFF	OFF
GROUND-START CALL ORIGINATED AT STATION END	Idle	—	—	Open	ON	ON	—	—	Open	ON	ON
	Seizure	—	—	B Lead Grounded	ON	OFF	—	—	B Lead Grounded	OFF	ON
	Pulsing	—	—	Open-Closed	ON	ON-OFF	—	—	Open-Closed	ON-OFF	ON
	Talking	—	—	Closed	OFF	OFF	—	—	Closed	OFF	OFF
GROUND-START CALL ORIGINATED AT CENTRAL OFFICE END	Idle	—	—	Open	ON	ON	—	—	Open	ON	ON
	Seizure	—	—	A Lead Grounded	OFF	ON	—	—	Open	ON	OFF
	Ringing	—	—	Open	ON*	ON	—	—	Open	ON	ON*
	Talking	—	—	Closed	OFF	OFF	—	—	Closed	OFF	OFF

\* In the GROUND-START Mode, during the ringing interval, 2600-Hz tone is interrupted at a 20 pps rate.

† The FLC, FLD, FSC, and FSD units do not have ground start capabilities.



NOTES:

1. BALANCE NETWORK ADJUSTMENTS:
  - A. COMPROMISE BALANCE - COMP NET, SCREW DOWN
  - B. PRECISION BALANCE - USE EXTERNAL PRECISION NETWORK AND ADJUST BOC SCREWS.
2. LEVEL ADJUSTING PADS: ADJUST SLIDE SWITCHES ON FRONT OF FUA FOR PROPER LEVELS.
3. BOR SCREWS OUT WHEN EXTERNAL CONDUCTOR LOOP RESISTANCE IS LESS THAN 520Ω.

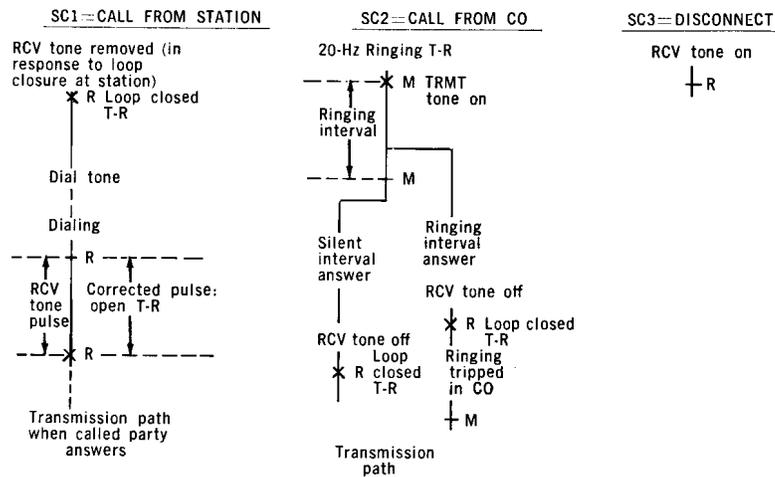
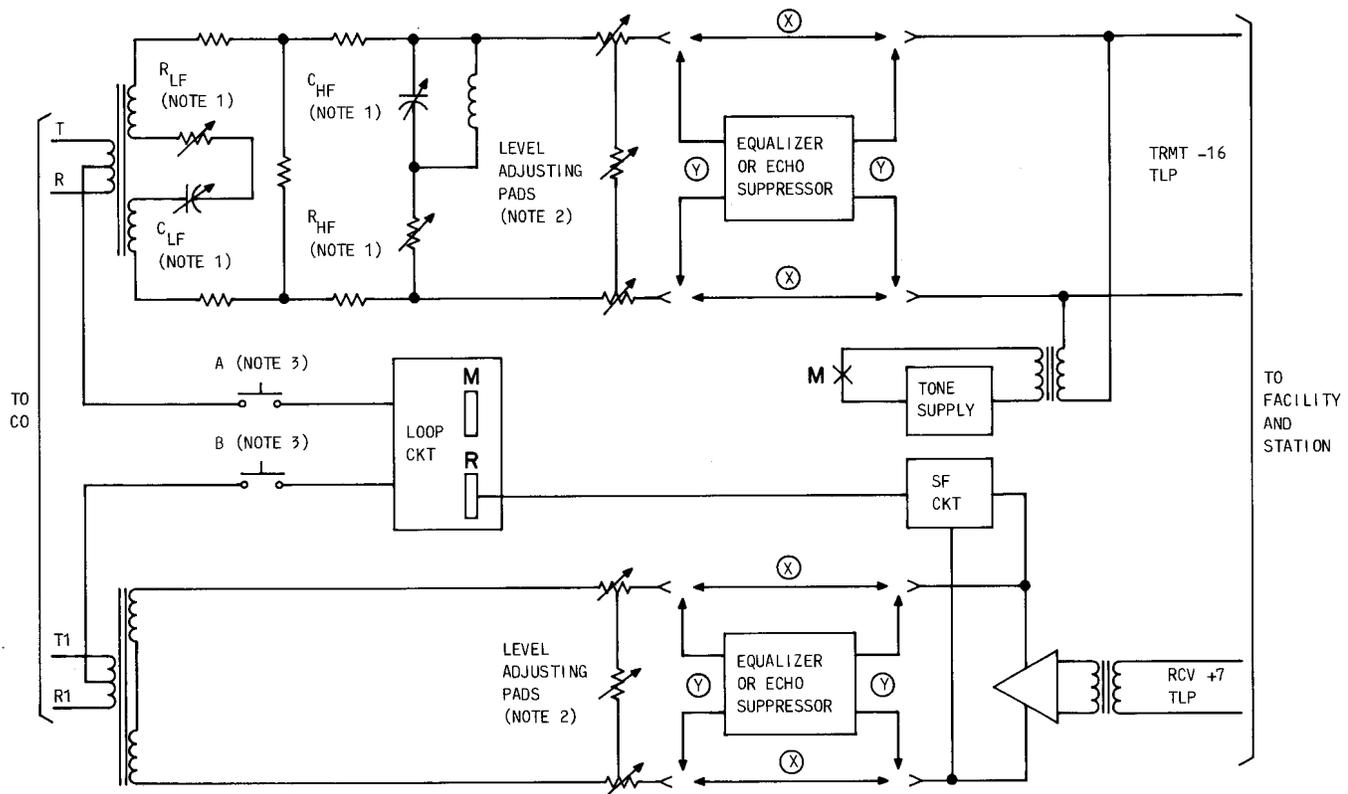


Fig. 6-41—Simplified Schematic of FL ( )

SECTION 660-215-500



NOTES:

1. LOW- AND HIGH-FREQUENCY COMPENSATION ADJUSTMENTS ARE IDENTICAL TO 4182C NETWORK IN THIS CHAPTER.
2. LEVEL ADJUSTING PADS: ADJUST SLIDE SWITCHES ON FRONT OF FUA FOR DESIRED OUTPUT.
3. A AND B SCREWS DOWN FOR OPERATION SHOWN HERE. FOR A AND B LEAD SIGNALING OPERATION, SEE BSP 179-365-101.

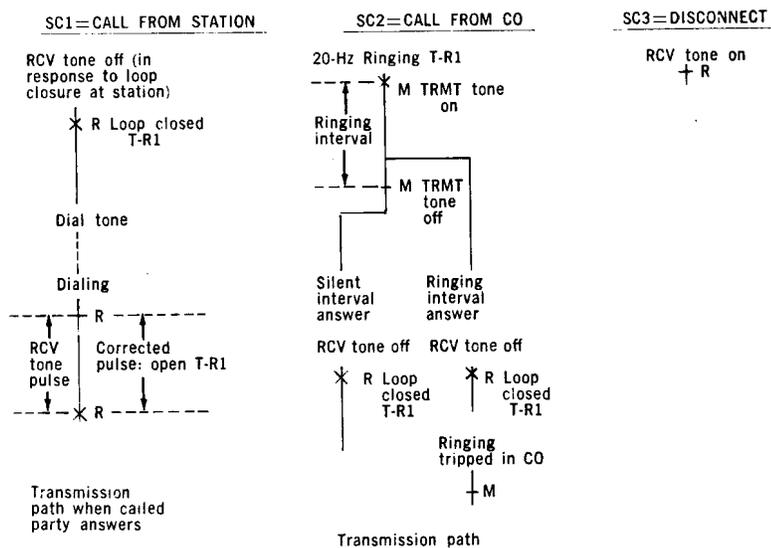
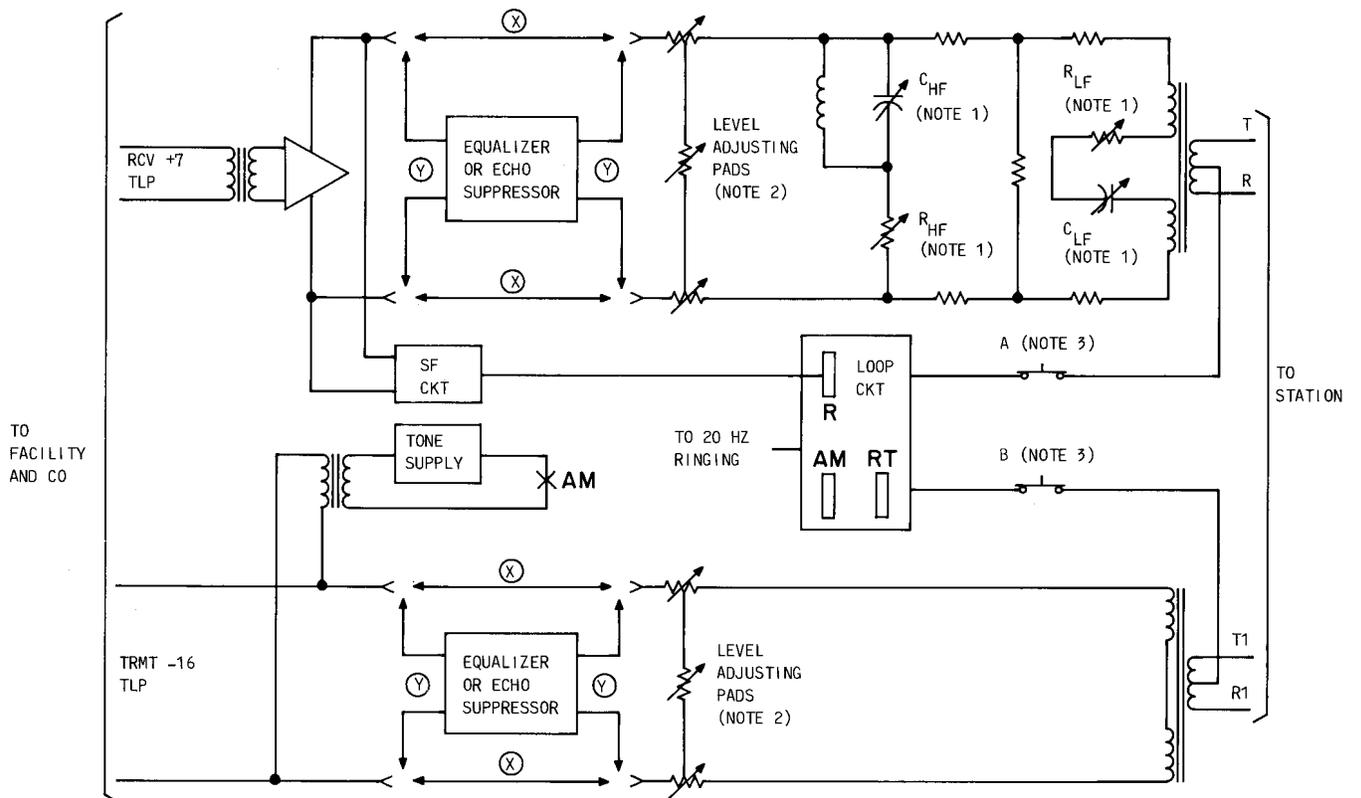


Fig. 6-42—Simplified Schematic of FPA



NOTES:

1. LOW- AND HIGH-FREQUENCY COMPENSATION ADJUSTMENTS ARE IDENTICAL TO 4182C NETWORK IN THIS CHAPTER.
2. LEVEL ADJUSTING PADS: ADJUST SLIDE SWITCHES ON FRONT OF FUA FOR PROPER LEVEL.
3. A AND B SCREWS DOWN FOR OPERATION SHOWN HERE. FOR A AND B LEAD SIGNALING OPERATION, SEE BSP 179-365-101.

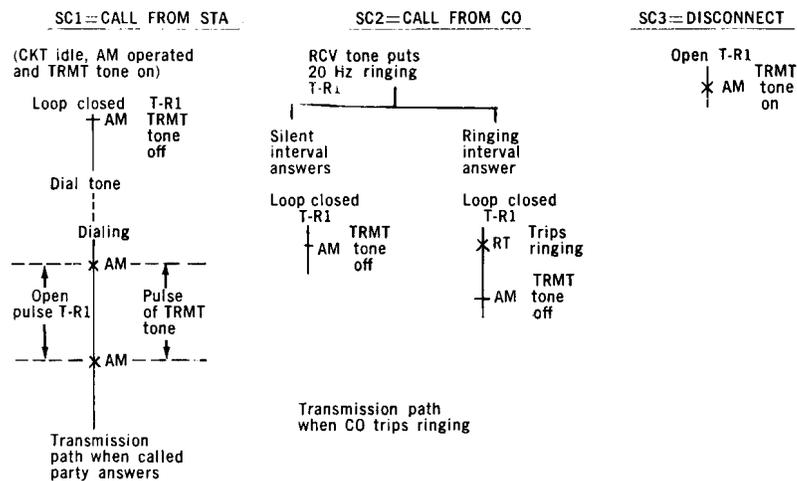
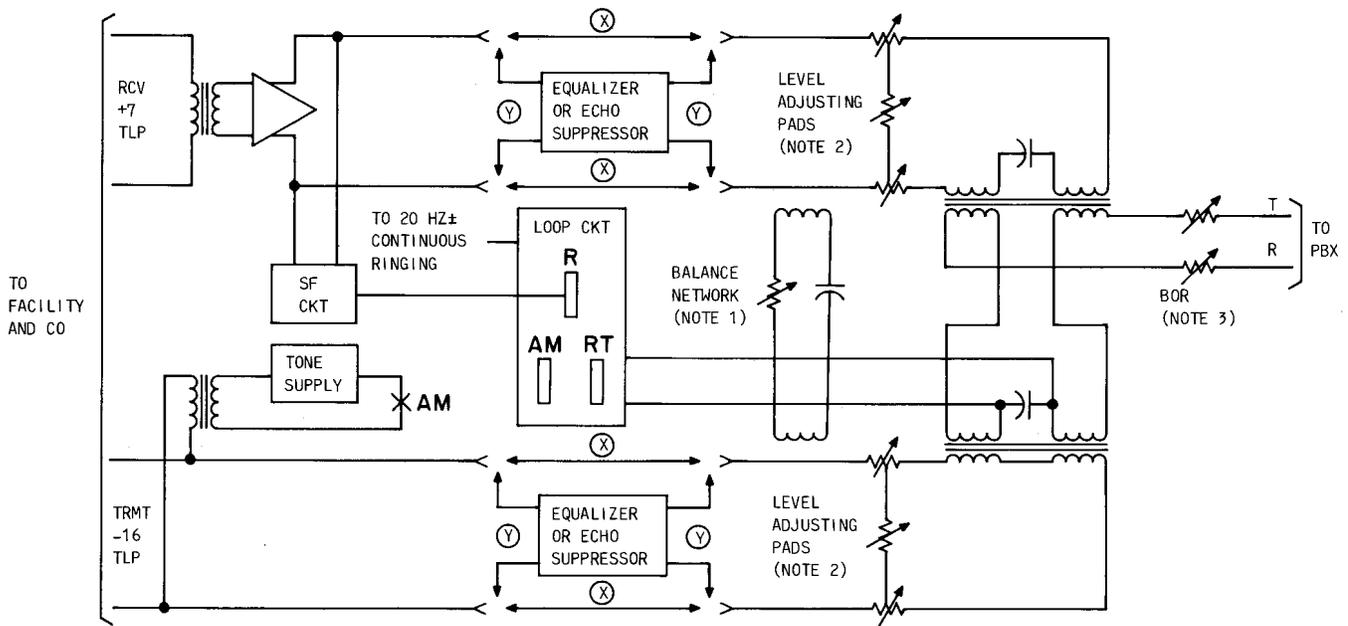


Fig. 6-43—Simplified Schematic of FRA



NOTES:

1. BALANCE NETWORK ADJUSTMENTS  
 A. COMPROMISE BALANCE: COMP NET, SCREW DOWN.  
 B. PRECISION BALANCE: USE EXTERNAL PRECISION NETWORK AND ADJUST BOC SCREWS.
2. LEVEL ADJUSTING PADS: ADJUST SLIDE SWITCHES ON FRONT OF FUA FOR DESIRED OUTPUT.
3. BOR SCREWS OUT WHEN EXTERNAL CONDUCTOR LOOP RESISTANCE IS LESS THAN 520Ω.

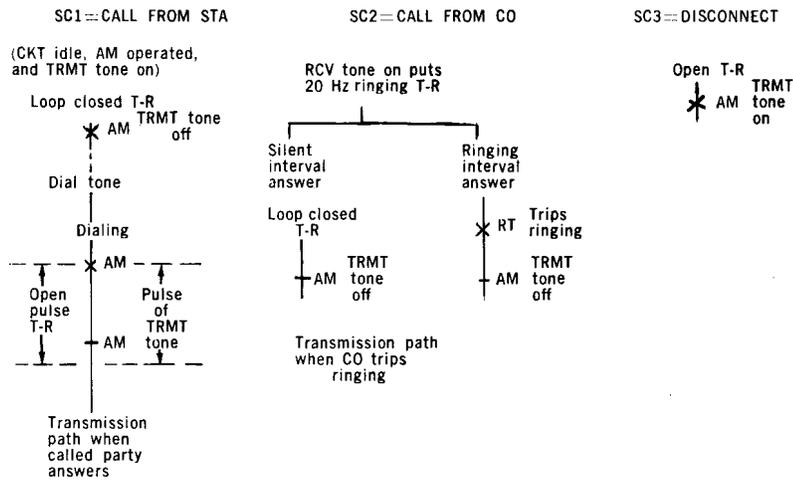


Fig. 6-44—Simplified Schematic of FS ( )

**TRANSMISSION****V4 Repeaters**

**Common Language Equipment Code: 24V4 VRM2000A**

**Common Language Equipment Code: 44V4 VRM4000A**

**SD-97047-01**

**6.57 Quick Test:** Check prescription settings of each plug-in against the CLR and correct any deviations. Measure overall gain of repeater in both directions and check these values against the CLR. Check individual gains of the 227-type amplifiers.

**6.58 Description:** The V4 repeaters are divided into two basic types: 24V4 and 44V4. The 24V4 (A, B, C, and D mountings) are used at junctions of 2-wire and 4-wire circuits. The 24V4 may be located at a 2-wire customer location that is served from a long 4-wire loop. The 44V4 (A and B mountings) are used at an intermediate or terminal point in a 4-wire circuit. Figure 6-45 shows a block diagram of a typical 24V4 repeater. The plug-in components that make up the V4 repeaters are covered in the tables referenced on the figure. Figure 6-46 shows a block diagram of a 44V4 repeater. The same plug-in components make up the 44V4 as those for the 24V4 except the 44V4 does not contain a terminating set. V4 repeaters amplify and maintain proper levels of all signals in the voiceband, including 2600 Hz SF. DC signals such as supervision, dial pulses, and 20 Hz ringing are bypassed around the amplifiers on a separate simplex path.

**6.59 Jack Arrangement:** Associated with each V4 mounting is a test jack arrangement. When making measurement at the 24V4 access jacks (Fig. 6-47), it should be remembered that any readings at a monitor (MON) jack is a bridged measurement, therefore, a meter indication would be inaccurate. In order to get a terminated measurement at a MON jack, a 600 $\Omega$  terminating plug should be inserted in the associated IN or OUT jack. This also holds true for sending tone from a MON jack. When a cord is placed in the IN or OUT jack the transmission path is opened and any measurement is made on a terminated basis. The jacks for the 44V4 are very similar (Fig. 6-48).

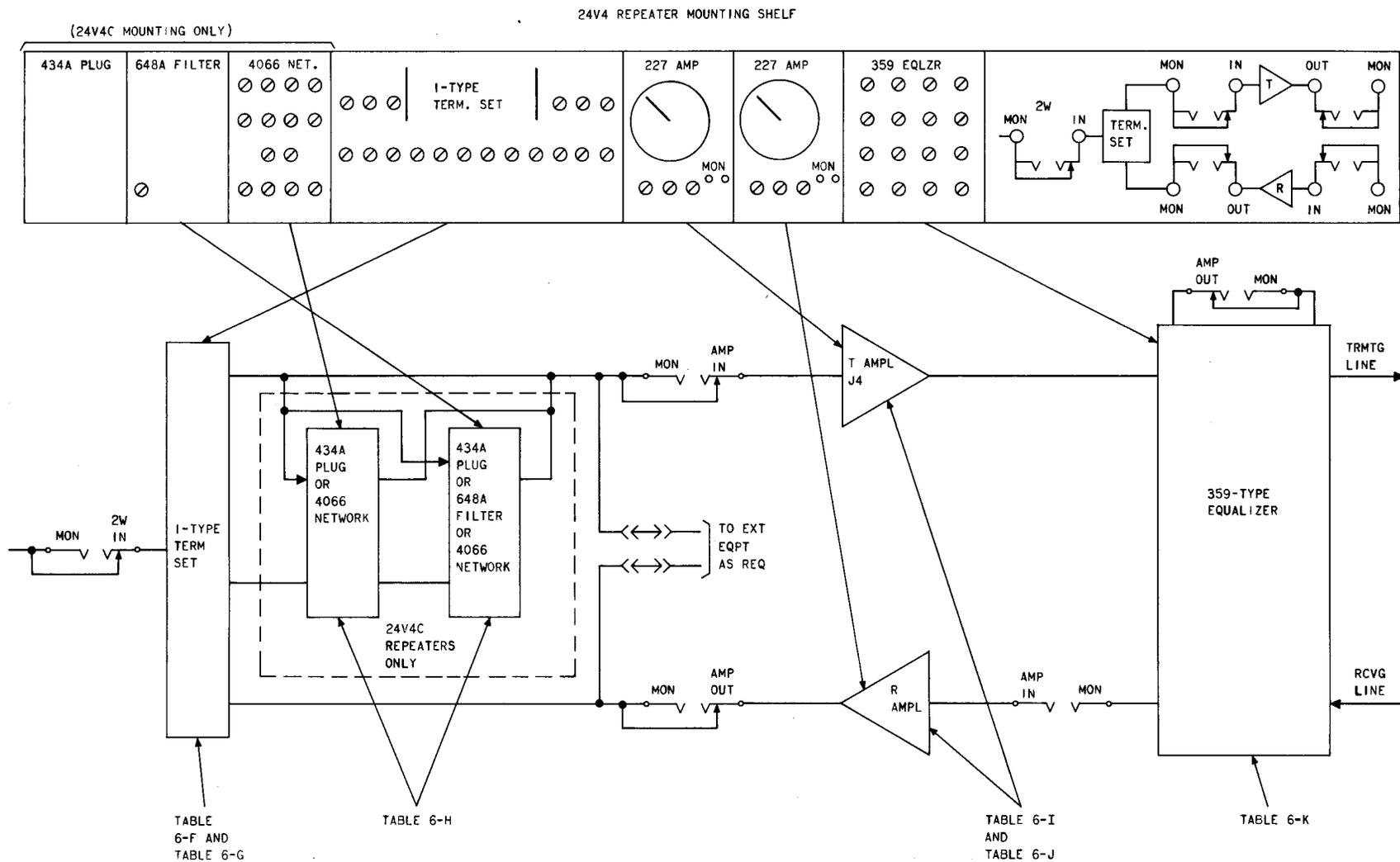


Fig. 6-45—Block Diagram of Typical 24V4 Repeater

TABLE 6-F  
1-TYPE TERMINATING SETS

TERM. SET (Note 1)	NOMINAL 2-WIRE IMPEDANCE (OHMS) (Notes 6, 9)	2-WIRE D. C. RESISTANCE (OHMS) (Note 2)	1 kHz 2W-TO-4W POWER LOSS BETWEEN NOMINAL IMPEDANCES			NOMINAL MIDPOINT CAPACITANCE (Mf)	EQUIPPED WITH SIMPLEX INDUCTOR (Notes 3, 4 and 5)	EQUIPPED WITH PAD SOCKETS (Note 8)
			HYBRID ALONE	HYBRID WITH AMPL SCREWS DOWN	HYBRID WITH NO AMPL SCREWS DOWN			
1A	900	51.6	3.8	4.1	4.2	1	Yes	No
1B	600	42.8	3.7	4.4	4.5	1	Yes	No
1C*	900	51.6	3.2	—	—	1	No	Yes
1D*	600	42.8	4.5	—	—	1	No	Yes
1F*	900	51.6	4.2	—	—	1	Yes	Yes
1G*	900	51.6	4.2	—	—	1 or 4	No	Yes
1H	(Note 1)							
1J	(Note 1)							
1K	900	51.6	3.8	4.1	4.2	1	Yes	No
1L	600	42.8	3.7	4.4	4.5	1	Yes	No
1M*	900	51.6	4.2	—	—	1	Yes	Yes
1N*	600	42.8	4.5	—	—	1	Yes	Yes
1P	Note 10							
REFERENCE INFORMATION								
SECTION		TITLE						
332-800-101		1A and 1K Terminating Set — Description						
332-800-102		1B and 1L Terminating Set — Description						
332-800-103		1C, 1F, and 1M Terminating Set — Description						
332-800-104		1D Terminating Set — Description						
332-800-105		1G Terminating Set — Description						
332-800-106		1H Terminating Set — Description						
332-800-107		1J Terminating Set — Description						

\* This unit is equipped with a hybrid circuit with a fixed impedance improving shunt. It does not have AMPL screws.

*Notes:*

- See SD-97138-01 for Term. set circuits. Special purpose 1H and 1J Term sets are not to be used in general applications. These sets are listed for reference only.
- For calculations of signal ranges, add 15% to the tabulated average values. This compensates for manufacturing variations and temperature.
- All Term. sets equipped with inductors provide for optionally shorting the inductors (except the 1F).
- The simplex inductors are wired in series with the A and B leads on Term. sets 1F, 1K, 1L, 1M, and 1N. They are wired in series with the SX(B1) and SX(A1) leads on Term. sets 1A and 1B.
- Term. sets with inductors in series with A & B leads must be used to prevent transmission of longitudinal noise from the 4-wire circuit over the simplex leads to the 2-wire circuit. This applies when used in combination with Dial Long Line circuits. (See Note 5.)
- Cabling on the 2-wire side of the Term. sets should not exceed 65 ohms series resistance in 900-ohm circuits or 45 ohms series resistance in 600-ohm circuits.
- 4182-type networks may be used interchangeably with 1-type Term. sets. Substitution of a 4182-type network for the 1-type Term. set effectively converts the 24V to a 44V repeater. This should be considered where 2-wire and 4-wire flexibility advantages outweigh space losses. See Table M when the 4182-type network or 437A plug is used.
- See 852-307-102 for pad information.
- Nominal 4-wire impedance is 600 ohms for all term. sets.
- 1P used for special application TSPS. See BSP-332-800-108.

**TABLE 6-G**  
**4182-TYPE NETWORKS AND 437A PLUG**  
**(4-WIRE EXTENSION NETWORKS)**  
(Notes 1 and 4)

NETWORK (NOTE 2)	APPLICATION	TRANSFORMER IMPEDANCE RATIO		SIMPLEX PATH RESISTANCE PER TRANSFORMER (OHMS) (NOTE 3)
		LINE	EQUIP	
4182A Note 5	Level Adjusting	—	—	—
4182B	Level Adjusting and Impedance Matching	150 600 1200 (Note 6)	600 600 600 (Note 6)	1.8 3.5 5.5
4182C	Level Adjusting and Loss Equalization	1200 (Note 7)	600 (Note 7)	5.5
437A Plug (Dummy)	4-Wire to 4-Wire Circuit Continuity (Note 8)	—	—	—
REFERENCE INFORMATION				
SECTION	TITLE			
332-700-101	4182A Network — Description			
332-700-102	4182B Network — Description			
332-700-103	4182C Network — Description			

**Notes:**

1. 4182-type networks may be used interchangeably with 1-type Term. sets. Substitution of a 4182 network for the Term. set effectively converts the 24V4 to a 44V4 repeater. This should be considered only where 2-wire and 4-wire flexibility advantages outweigh space losses.
2. On 4182-type networks terminals 10 and 11 (normally serve as leads NT and NR for precision balancing) must be extended to permit external connection to the 4-wire circuit.
3. For calculations of signaling ranges, add 15% to the tabulated average values. This compensates for manufacturing variations and temperature.
4. See SD-97138-01 for 4182-type circuits.
5. The 4182A should not be used for direct connection to cable facilities except when used as a continuity plug (equipped with 89A resistor-0dB).
6. The 4182B network provides impedance ratios as follows:

**TRANSFORMER RATIO****FACILITY**

150:600

Long lengths of nonloaded cable

600:600

Partial equalization for short lengths of non-loaded cable

1200:600

Loaded cable — H88

7. Intended for long lengths of H88 loaded cable.
8. When the 437A Plug is used, T1 and R1 will appear on pins 9 and 8 of P1 respectively. When the 4182-Type network is used, T1 and R1 will appear on pins 11 (NT) and 10 (NR) of P1 respectively.

TABLE 6 – H

**4066-TYPE NETWORKS (ASSOCIATED 684A FILTER AND 434A PLUG)  
FOR USE WITH 24V4 REPEATER**

NETWORK	CABLE FACILITY			APPLICATION (NOTE 5)
	GAUGE	LOADING	CAPACITANCE (MF)	
4066A	19, 22 24	H88 H88	.083 .072, .083	19, 22, 24 Gauge High Capacitance or 24 Gauge Low Capacitance H88 Cable
4066B	26	H88	.069, .079	26 Gauge High or Low Capacitance H88 Loaded Cable
4066C (Note 1)	—	—		Comp. Net (600/900) and BOC
4066D	19 (Side) 19 (PH)	H88 H50	.062	19 Gauge Cable Facilities Either H88 Loaded Side Circuit or H50 Loaded Phantom Circuit
4066E	19	H44	.062	19-Gauge H44 Loaded Cable — Side Circuits
4066F	24	Non-Loaded	.072, .083	Non-Loaded 24 Gauge High or Low Capacitance Cable
4066G	19,22,24,26		.072, .083, .079, .069	19, 22, 24, or 26-Gauge Non-Loaded Cable Pairs
4066H	(Note 2)	—		Balancing 500-Type, Including TOUCH-TONE or TRIM LINE, ® Telephone Sets
4066J	26	Non-Loaded or Loaded	.083	Unigauge
648A Filter (Note 3)				Low Pass Filter With an Impedance Match of 600:600 Ohms
434A Plug (Note 4)				
REFERENCE INFORMATION				
SECTION		TITLE		
332-852-100		4066 Type Network — Description		
332-852-101		4066A Network — Description		
332-852-102		4066B Network — Description		

TABLE 6 – H (Contd)

**4066-TYPE NETWORKS (ASSOCIATED 684A FILTER AND 434A PLUG)  
FOR USE WITH 24V4 REPEATER**

REFERENCE INFORMATION (Contd)	
SECTION	TITLE
332-852-103	4066C Network – Description
332-852-104	4066D Network – Description
332-852-105	4066E Network – Description
332-852-106	4066F Network – Description
332-852-107	4066G Network – Description
332-852-108	4066H Network – Description
332-117-101	648A Filter – Description

*Notes:*

1. The 4066C network combines a compromise network, 2.15 Mf and either 600 ohms or 900 ohms, and a building-out capacitor having a range to 0.127 Mf in steps of .001 Mf.
2. The 4066H network is designed specifically for balancing 500-type, TOUCH-TONE, or TRIM-LINE telephone sets.
3. The 648A filter is a low-pass device for preventing singing in a 4-wire section operated at a gain and extended by means of an H88 loaded 2-wire facility.
4. The 434A plug provides circuit continuity for certain combinations of plug-in apparatus, when a 684A filter or 4066-type network is not provided.
5. Capacitance for various cables is as follows:

**FOR 19,22,24 GAUGE**

High Capacitance 0.083 Mf Per Mile  
Low Capacitance 0.072 Mf Per Mile

**FOR 26 GAUGE**

High Capacitance 0.072 Mf Per Mile  
Low Capacitance 0.069 Mf Per Mile

TABLE 6 - 1

## 227-TYPE AMPLIFIERS

AMPLIFIER (NOTES 1, AND 2)	USE	IMPEDANCE (OHMS) (Note 3)		SIMPLEX PATH RESISTANCE (OHMS) (Note 4)			PROTECTION PROVIDED FOR LIGHTING OR INDUCED POWER VOLTAGES	SUITABLE FOR SPECIAL DATA CIRCUITS	REVERSES POLARITY AT INPUT AND OUTPUT (Note 5)
		INPUT	OUTPUT	INPUT	OUTPUT WINDING				
					600 OHM	1200 OHM			
227A	All Buried Cable	600 or 1200	600 or 1200	8.5	17.5	23.75	No	No	Yes
227B	Aerial or Buried Cable	600 or 1200	600 or 1200	8.5	17.5	23.75	Yes	No	Yes
227C	Aerial or Buried Cable	600 or 1200	600 or 1200	8.5	17.5	23.75	Yes	Yes	Yes
227D	Aerial or Buried Cable	600 or 1200	600 or 1200	8.5	17.5	23.75	Yes	Yes	No
227E	All-Buried Cable	600 or 1200	600 or 1200	8.5	17.5	23.75	No	No	No
227F	Aerial or Buried Cable	600 or 1200	600 or 1200	8.5	17.5	23.75	Yes	No	No
F58122	(Note 6)	600 or 1200	600 or 1200	8.5	17.5	23.75	Yes	Yes	Yes
REFERENCE INFORMATION									
SECTION				TITLE					
024-140-101				227A, B, E, and F Amplifiers - Description					
024-140-103				227C and 227D Amplifiers - Description					
332-104-501				227-Type Amplifiers - Test and Adjustments					
332-104-103				F58122 Amplifier					
332-104-503				F58122 Amplifier - Tests and Adjustments					

## Notes:

- The 227A, B, and C amplifiers are rated Mfr. Disc. and replaced by the 227E, F, and D respectively.
- All amplifiers have a gain of 0 to 36 dB and may be adjusted as follows:  
0-13 dB - S2 Screwdown  
10-24 dB - S3 Screwdown  
21-36 dB - S1 and S3 Screwdown
- The input and output transformers of the amplifiers are designed primarily to provide either 600- or 1200-ohm line impedances with a balanced center-tap connection for simplex signaling, additional input and output impedances of 150 and 300 ohms can be obtained for special applications through use of the center tap as one side of the transmission circuit. However, this precludes use of the center tap for simplex signaling.
- For calculations of signaling ranges, add 15% to the tabulated average values. This compensates for manufacturing variations and temperature.
- The 227A, B, and C amplifiers have a built in phase shift of approximately 180° (polarity reversal) between the input and output. In certain applications, such reversals are not acceptable. The 227D, E, and F amplifiers have been designed to eliminate this reversal.
- The F58122 amplifier, which has automatic gain control (AGC), is for use in the transmitting leg between customer-provided facilities and Bell System facilities. It provides limiting capability to ensure compliance with standards for inband signals.

TABLE 6 - J

## 849-TYPE NETWORKS

NETWORK (Notes 4 and 5)	4-WIRE FACILITY	ASSOCIATED WITH SOCKET DESIGNATED		1 KHz POWER LOSS BETWEEN NOMINAL IMPEDANCES (Note 6)	TRANSFORMER IMPEDANCE RATIO - OHMS		SIMPLEX PATH RESISTANCE (OHMS) (Note 3)
		24V4	44V4		EQUIP	LINE	
849A	Loaded Cable H88 or D88	T	1 or 2	0.4 + Pad	600	1200	15.7
849B (Note 2)	Loaded Cable H88 or D88	R	1 or 2	0.4 + Pad	600	1200	15.7
849C	600-ohm Equip. or Non-Loaded Cable	T or R	1 or 2	Pad	—	—	—
849D (Note 1)	Long Lengths of Non-Loaded Cable	—	—	0.5 + Pad	600	150	1.3
849E (Note 1)	Short Lengths of Non-Loaded Cable	—	—	0.5 + Pad	600	600	6.25
849F	Loaded Cable H44	T	1 or 2	0.3 + Pad	600	600	1.5
849G	Loaded Cable H44	R	1 or 2	0.3 + Pad	600	600	1.5
849H	Loaded or Nonloaded	Used in 424V4 repeater		—	—	—	22.0
REFERENCE INFORMATION							
SECTION				TITLE			
332-115-101				849A Network - Description			
332-115-102				849B Network - Description			
332-115-103				849C Network - Description			
332-115-104				849D Network - Description			
332-115-105				849E Network - Description			
332-115-106				849F Network - Description			
332-115-107				849G Network - Description			

## Notes:

1. The 849 D and E networks were designed for use in basic V4 repeaters and therefore, may not be used in 24V4 or 44V4 applications.
2. The 849B network was designed for use in 24V4 and 44V4 applications and should not be used in basic V4 applications.
3. For calculation of signaling ranges add 15% to the tabulated average values. This compensates for manufacturing variations and temperature.
4. The 849-type networks are used instead of 227-type amplifiers when amplification is not required.
5. The 849-type network receives an 89-type resistor on a plug-in basis. Loss is adjustable in 0.25 dB steps by selection of the proper 89-type resistor. See Section 852-307-102.
6. This is the loss used in computations of levels.

TABLE 6 – K  
359-TYPE EQUALIZERS

EQUALIZER	4-WIRE FACILITY	EQUALIZATION		1 Kz LOSS BETWEEN NOMINAL IMPEDANCES (Note 3)	TRANSFORMER IMPEDANCE RATIO		IMPEDANCE FACING FACILITIES (OHMS)	ADJUSTABLE
		TRANS	REC		EQUIP	LINE		
359A	Loaded Cable – H88 With Gain (Amplifier) Required	No	Yes	6.2 to 9.2	–	–	1200	Yes
359B	Long Lengths Non-Loaded Cable	Yes	Yes	0.5	600	150	150	No
359C Dummy	600-ohm Equip. (No Equalization)	No	No	0	–	–	600	No
359D	Loaded Cable – H88 With 849B Network Required	No	Yes	0 to 15.0	–	–	1200	Yes
359E Dummy	Short Lengths Loaded Cable – H88 With Amplifier (No Equalization)	No	No	0	–	–	1200	No
359F	Short Lengths Non-Loaded Cable	Yes	Yes	0.5	600	600	600	No
359G	Loaded Cable or Carrier Channels Data	No	Yes	8.5 to 20.0	–	–	600	Yes
359H	Loaded Cable or Carrier Channels Data	No	Yes	0.9 to 1.2	–	–	600	Yes
359J Dummy	Short Lengths Loaded Cable – H88 With 849B Network Required (No Gain or Equalization)	No	No	0	–	–	1200	No
359K (Note 2)	Loaded Cable – H44 With Gain (Amplifier) Required	No	Yes	6.2 to 7.8	–	–	600	Yes
359L	Loaded Cable – H44 With 849G Network	No	Yes	0 to 1.6	–	–	600	Yes
359M	Long Lengths Non- Loaded Cable Criti- cal Voice Band Data Systems	Yes	Yes	0.3	600	150	150	No
359N	Short Lengths Non- Loaded Cable Criti- cal Voice Band Data Systems	Yes	Yes	0.3	600	600	600	No
359P	Unigauged	No	Yes	6.2 to 24.5	–	–	1200	Yes
359R	Q44 Loaded	No	Yes	6.2 to 21.0	–	–	1200	Yes

TABLE 6 – K (Cont)

359-TYPE EQUALIZERS

REFERENCE INFORMATION	
SECTION	TITLE
332-116-101	359A Equalizer – Description
332-116-102	359B Equalizer – Description
332-116-103	359C Equalizer – Description
332-116-104	359D Equalizer – Description
332-116-105	359E Equalizer – Description
332-116-106	359F Equalizer – Description
332-116-107	359G Equalizer – Description
332-116-108	359H Equalizer – Description
332-116-109	359J Equalizer – Description
332-116-110	359K Equalizer – Description
332-116-111	359L Equalizer – Description
332-116-112	359M Equalizer – Description
332-116-113	359N Equalizer – Description
332-116-114	359P Equalizer – Description
332-116-115	359R Equalizer – Description

Notes:

1. For calculations of signaling ranges, add 15% to the tabulated average values. This compensates for manufacturing variations and temperature.
2. Includes a 6.2 dB pad.
3. This is the loss used in computation of levels. See Section 852-307-101 for 359-type equalizer screw settings.

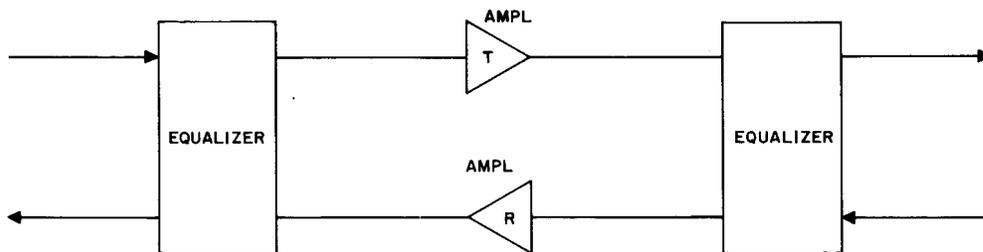


Fig. 6-46—Block Diagram of 44V4 Repeater

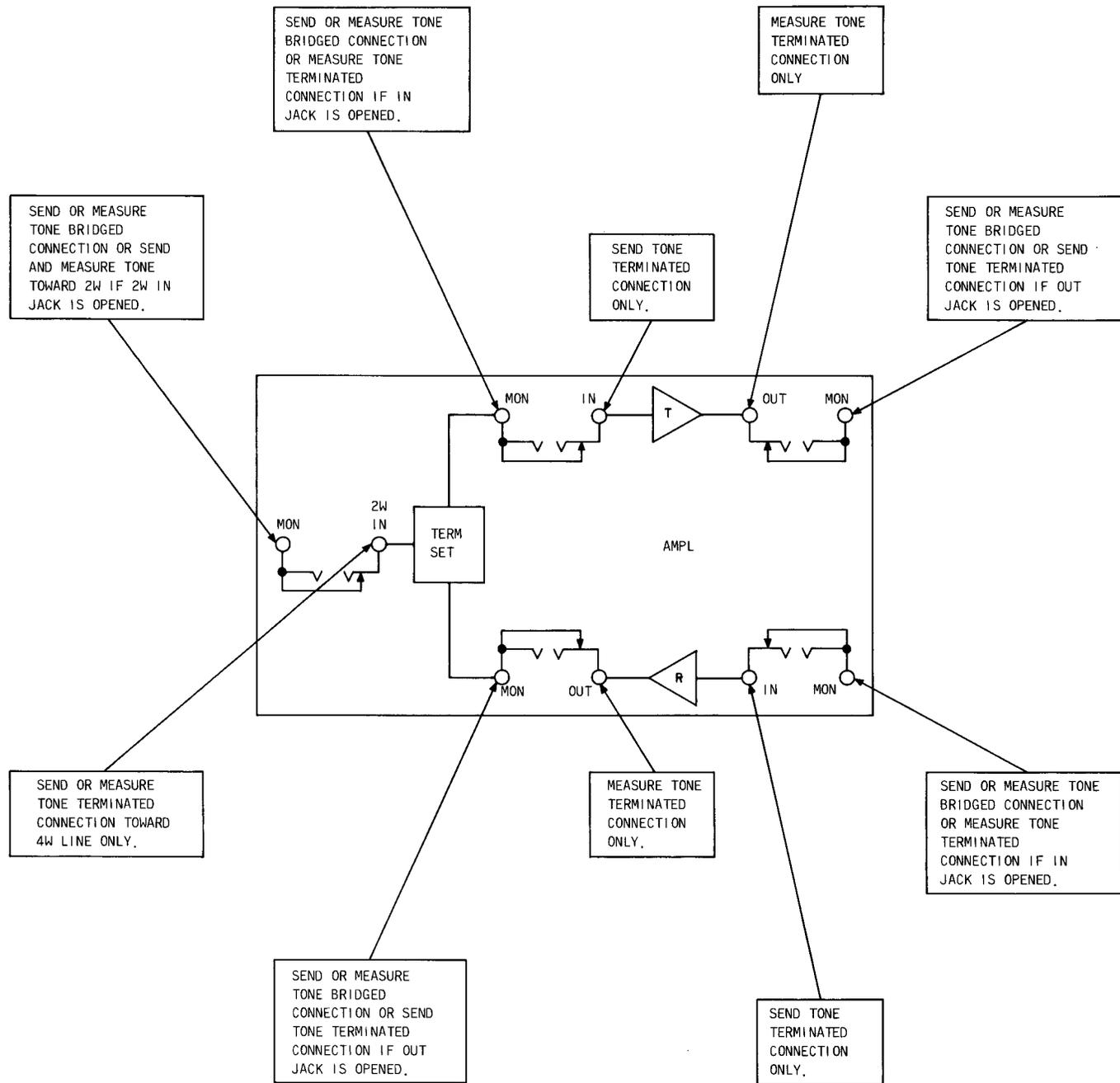


Fig. 6-47—Test Jack Arrangement for 24V4

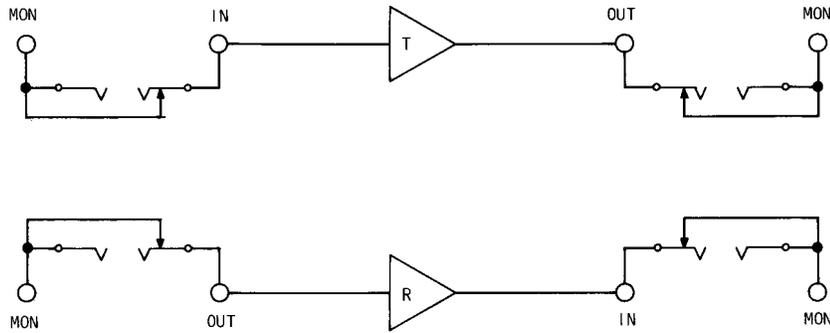


Fig. 6-48—44V4 Jack Arrangement

## 89—TYPE RESISTORS

**6.60 Description:** The 89-Type resistors are plug-in units that fit into pad sockets such as a 1C pad socket (Fig. 6-49). The 89-type resistors can be used in 849-type networks, 1-type terminating sets, and 4182-type networks that contain pad sockets. The 1000-Hz loss through the 89-type resistors when plugged into the pad socket is listed in Table 6-L. The impedance of both sides of the pad plus resistors is  $600 \Omega$ .

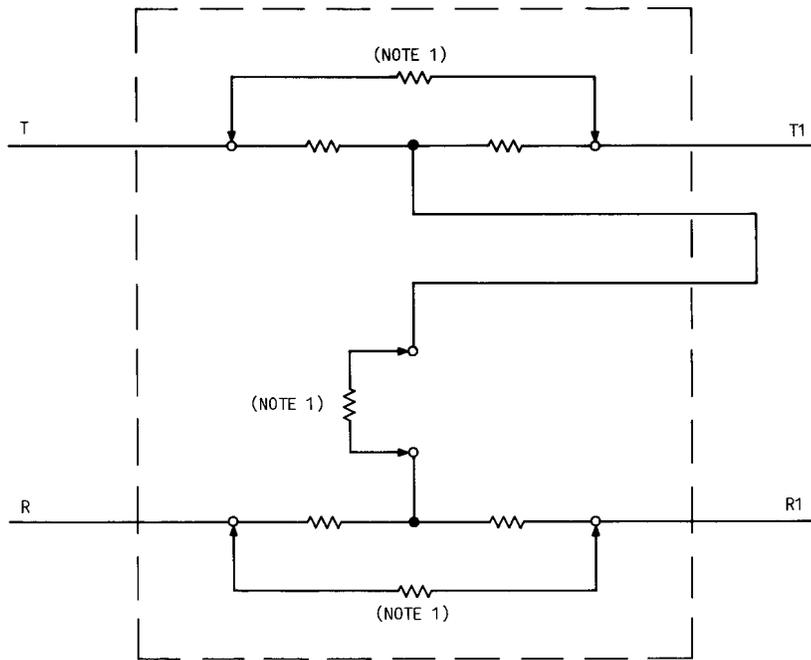


Fig. 6-49—1C Pad Socket and 89-Type Resistor

**Note 1:** These are part of the 89-Type plug-in resistors. The value will change with the different 89-Type. The other resistors are part of pad socket.

TABLE 6-L

## 89-TYPE RESISTORS

DB	TYPE	DB	TYPE	DB	TYPE
0.	89A	8.5	89AR	17.0	89BR
0.25	89CH	8.75	89AS	17.25	89DC
0.5	89C	9.0	89AT	17.5	89BS
0.75	89D	9.25	89AU	17.75	89DD
1.0	89E	9.5	89AW	18.0	89BT
1.25	89F	9.75	89AY	18.25	89DE
1.5	89G	10.0	89BA	18.5	89BU
1.75	89H	10.25	89CJ	18.75	89DF
2.0	89J	10.5	89BB	19.0	89BW
2.25	89K	10.75	89CK	19.25	89DG
2.5	89L	11.0	89BC	19.5	89BY
2.75	89M	11.25	89CL	19.75	89DH
3.0	89N	11.5	89BD	20.0	89CA
3.25	89P	11.75	89CM	20.25	89FT
3.5	89R	12.0	89BE	20.5	89CB
3.75	89S	12.25	89CN	20.75	89FU
4.0	89T	12.5	89BF	21.0	89CC
4.25	89U	12.75	89CP	21.25	89DJ
4.5	89W	13.0	89BG	21.5	89CD
4.75	89Y	13.25	89CR	21.75	89FW
5.0	89AA	13.5	89BH	22.0	89CE
5.25	89AB	13.75	89CS	22.25	89FY
5.5	89AC	14.0	89BJ	22.5	89GA
5.75	89AD	14.25	89CT	22.75	89GB
6.0	89AE	14.5	89BK	23.0	89DK
6.25	89AF	14.75	89CU	24.0	89GD
6.5	89AG	15.0	89BL	25.0	89CF
6.75	89AH	15.25	89CW	26.0	89GC
7.0	89AJ	15.5	89BM	27.0	89GE
7.25	89AK	15.75	89CY	28.0	89FP
7.5	89AL	16.0	89BN	29.0	89FR
7.75	89AM	16.25	89DA	30.0	89CG
8.0	89AN	16.5	89BP	35.0	89FS
8.25	89AP	16.75	89DB	INF	89B

**E6 Repeater****Common Language Equipment Code: ER00600N****SD-97023-01**

**6.61 Quick Test:** (1) Check prescription settings (screw settings) of networks against CLR (Note 3, Table 6-M), (2) Monitor E6 for singing by using a KS-14418 head set, plugged in across TST 2 jack on front of faceplate and, (3) Measure gain of E6 by removing the E6 package from the shelf, inserting it in the 54B Test Stand, sending tone at REP A jack and measuring at REP B jack on the 54B Test Stand (see part 4 for more information on 54B Test Stand).

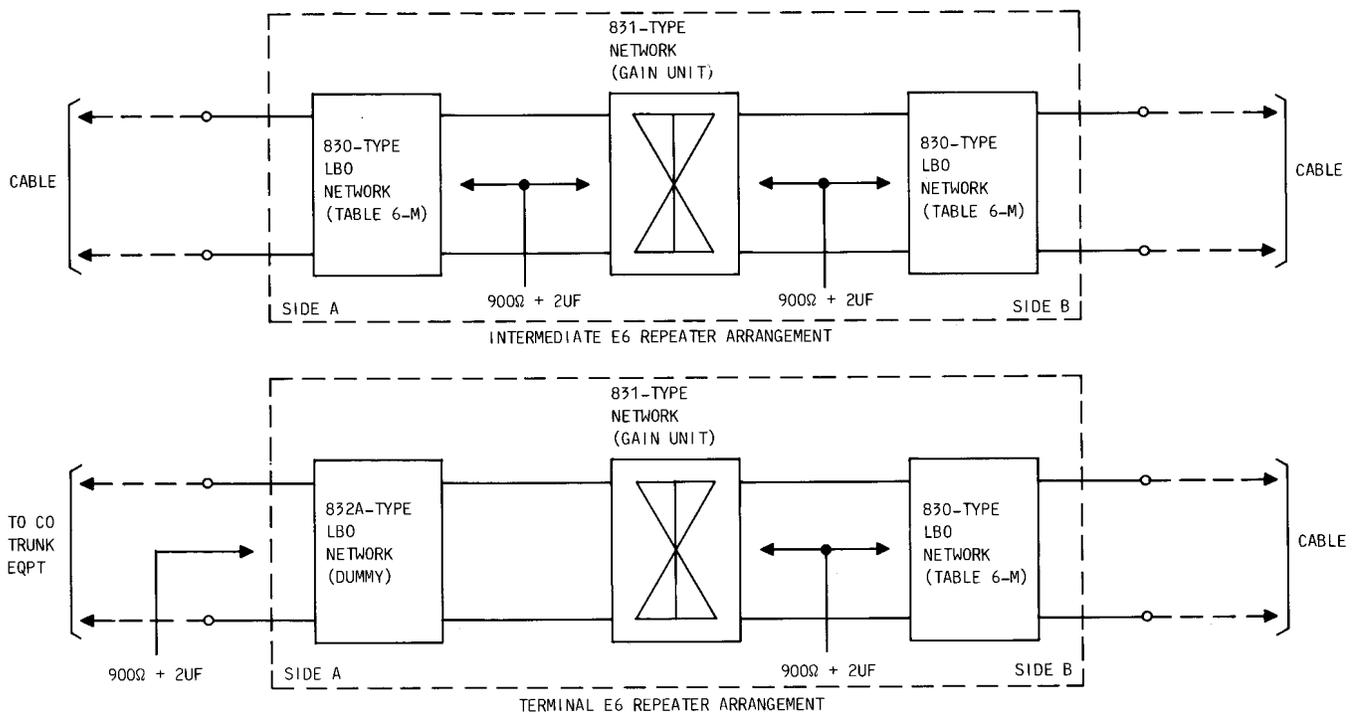
**6.62 Description:** The E6 repeater (Fig. 6-50) is designed to reduce transmission losses on 2-wire circuits. The E6 can be used in either intermediate or terminal applications. In the intermediate application, both sides of the E6 are connected to cable, whereas, in terminal applications one side of

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the E6 is connected to cable and the other to CO equipment. The E6 consists of one gain unit (831A Network) and two line building-out (LBO) networks (830-Type Networks), one LBO on each side of the gain unit. Since there are various adjustable LBOs, the E6 can be connected to various types of cable (see Table 6-M). When the E6 is used in terminal applications, the LBO on the CO equipment side of the gain unit is replaced by a dummy network (832A) which connects the gain unit directly to the CO equipment.

**6.63** A repeater disabler circuit (J99253L) is an optional (option **Y**) part of the E6 repeater arrangement (Fig. 6-51). The disabler removes repeater gain from the circuit during idle or circuit-switching periods.

**6.64 Test Access:** Test access for the E6 repeater is available in three ways: (1) bay mounted jacks, (2) 54B test stand (3) TST 1 and TST 2 jacks on the repeater faceplate. The bay mounted jacks (Fig. 6-51) are optional and give access to the gain unit only without removing the repeater from service. The 54B test stand (Fig. 6-52) gives access to input/output of both LBOs and the gain unit but requires that the E6 package be removed from the shelf and inserted in the test stand. (See Part 4 for more information on the 54B Test Stand.) TST1 and TST2 jacks (Fig. 6-52) are used to monitor the E6 for Busy/Idle conditions and singing by using a KS-14418 headset.



**Fig. 6-50—Application Arrangement of E6 Repeater**

TABLE 6-M

## 830-TYPE LINE BUILDING OUT NETWORKS

NETWORK (NOTE 1,2,3)	CABLE			1000-Hz LOSS (dB)	Adjustable BOR (Note 4)	Adjustable BOC (Note 4)	IMPEDANCE MATCHING	ATTENUATION EQUALIZER	REFERENCES
	GAUGE	LOADING	CAPACITANCE						
830A	19, 22, 24	H88	High	.3 to 1.3	✓	✓	✓		332-206-121 -221
830B	19	H88	Low	1.0 to 1.7	✓	✓	✓		332-206-122 -222
	19, 22	D88	High						
830C		NON		3.5 to 4.0	✓		✓	✓	332-206-123 -223
830E		NON		6.5 to 7.5	✓		✓	✓	332-206-125 -225
830G	26	H88	High	1.7 to 3.6	✓				332-206-127 -227
830H	26	NON	High Low	to 5.0	✓				332-206-128 -228

*Notes:*

1. The 830D Network presents high impedance on the line side. It is used to bridge assistance-operator trunks on other circuits. It is not adjustable.
2. The 830F Network is designed to give delay equalization in E6 - repeatered special-service data links that have combined delay distortion from the gain unit, nonloaded cable, and LBO Network of more than 100 microseconds between 1.0 and 2.5 kHz. It is not adjustable.
3. The 832B Network consists of a 900 ohm resistor in series with a 2.16  $\mu$ f capacitor. It is inserted on the office side (switching side) of the E6 repeater, for termination purposes, when adjusting the 837-type impedance compensator on non-loaded cable.
4. Prescription setting or adjustment of the LBO networks is made by screw type switches on the network. Tightening a build-out capacitance (BOC) screw adds capacitance to the circuit. Loosening a build-out resistance (BOR) screw adds resistance to the circuit.

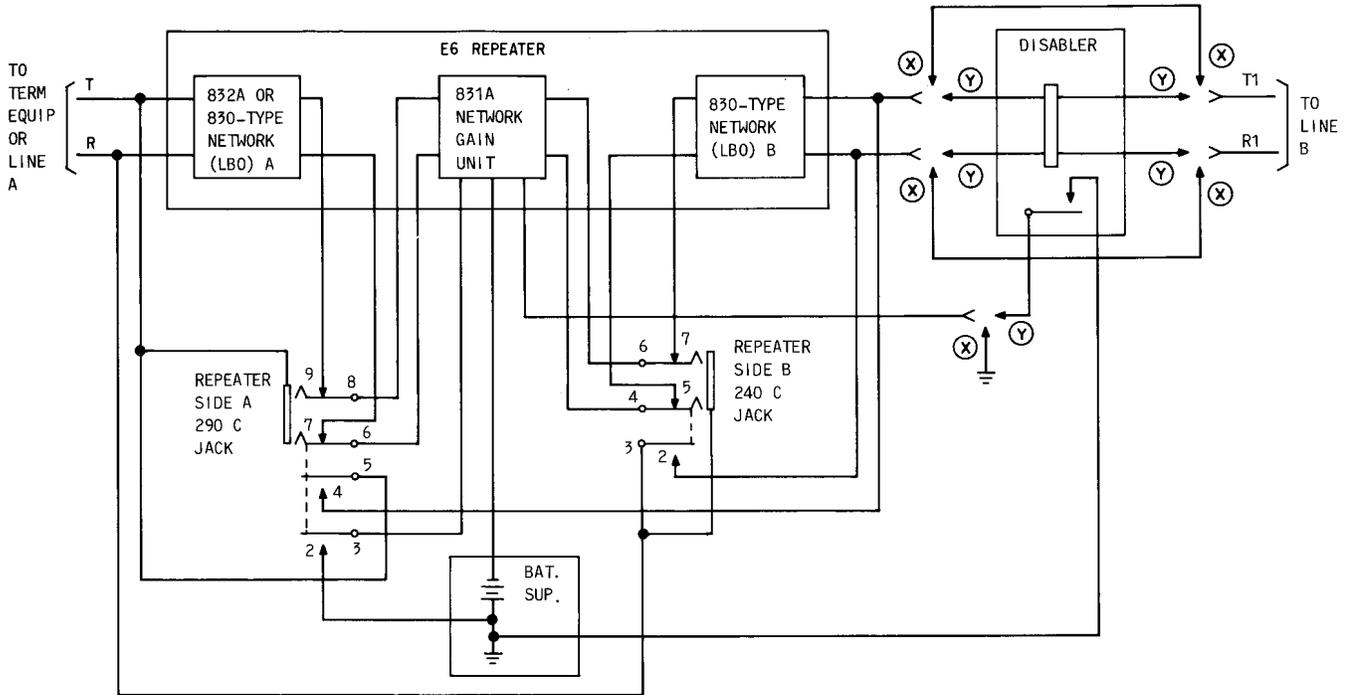
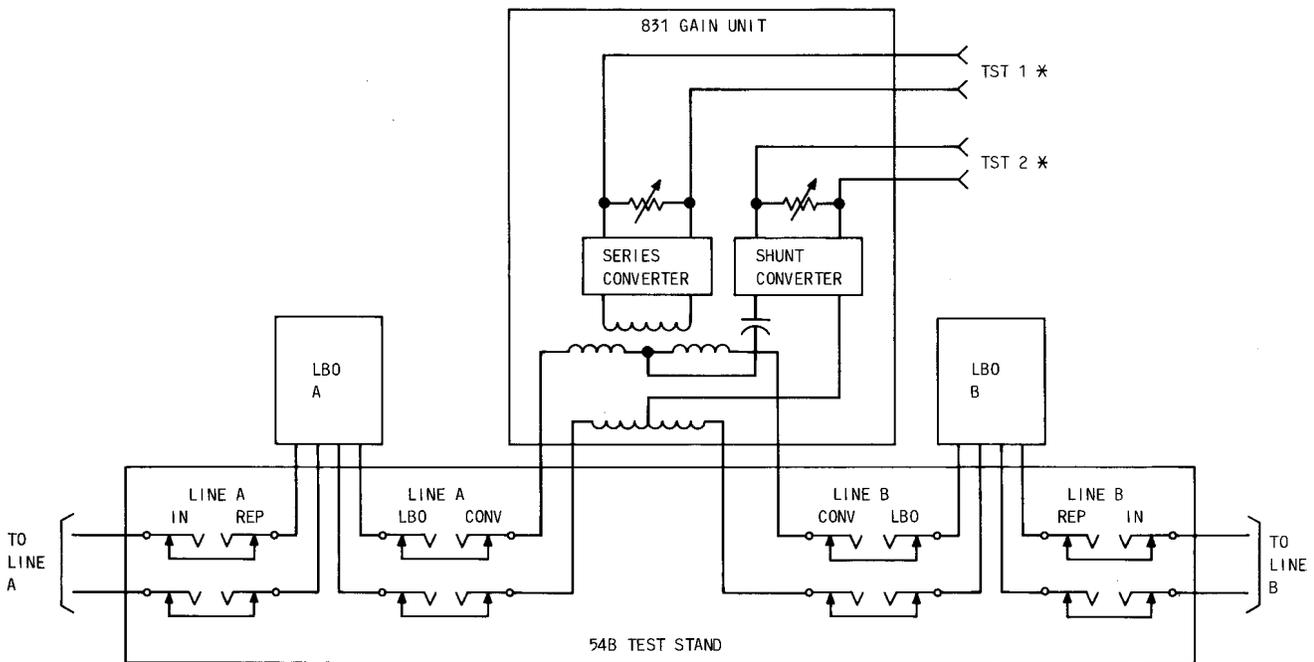


Fig. 6-51—E6 Repeater Shown with Optional Disabler and Bay Mounted Jacks



\* TEST JACKS ON FRONT PANEL OF E6 REPEATER

Fig. 6-52—E6 Repeater in 54B Test Stand

**Impedance Compensators (837-Type Networks and J99380—)**

**6.65 Description:** Impedance compensators, as covered here, are used for impedance matching at the PBX end of 2-wire CO-PBX trunks. Basically, there are three types of impedance compensators in use: 837-type networks, the J99380— networks, and the older type per SD-95756-01. The latter type is not covered here (see BSP 332-205-100 for more information). The J99380— is a plug-in unit that has two separate networks per unit and, therefore, can accommodate two circuits.

TABLE 6-N

## IMPEDANCE COMPENSATORS

TYPE NETWORK	TYPES CABLE	ATTENUATION EQUALIZER	IMPEDANCE	REFERENCE
837A	19, 22, 24 H88	No	900 $\Omega$	332-206-151
837B	19, 22, 24 H88	No	900 $\Omega$	332-206-152
837C (MD)	NL	Yes	900 $\Omega$	332-206-153
837D or (J99380AA)	22, 24, 26 NL	Yes	900/600 $\Omega$	332-206-154
837E or (J99380AB)	19, 22, 24 D88/H88	No	600 $\Omega$	332-206-155
837F	19, 22, 24 H88	No	600 $\Omega$	332-200-156
837G or (J99380AC)	26 H88	No	900 $\Omega$ 600 $\Omega$ *	332-206-157

\* The J99380AC is equivalent to an 837C Network plus a 120T repeat coil which make the impedance 600  $\Omega$ .

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Repeating Coils

**6.66 Description:** Repeating coils are used for matching impedances of facilities and equipment, for simplexing, and for improving longitudinal isolation. Repeating coils are used in signaling equipment to pass VF (ac) while blocking dc. The most commonly used types are the 120-type and 94-type shown in Fig. 6-53 and covered in Table 6-0.

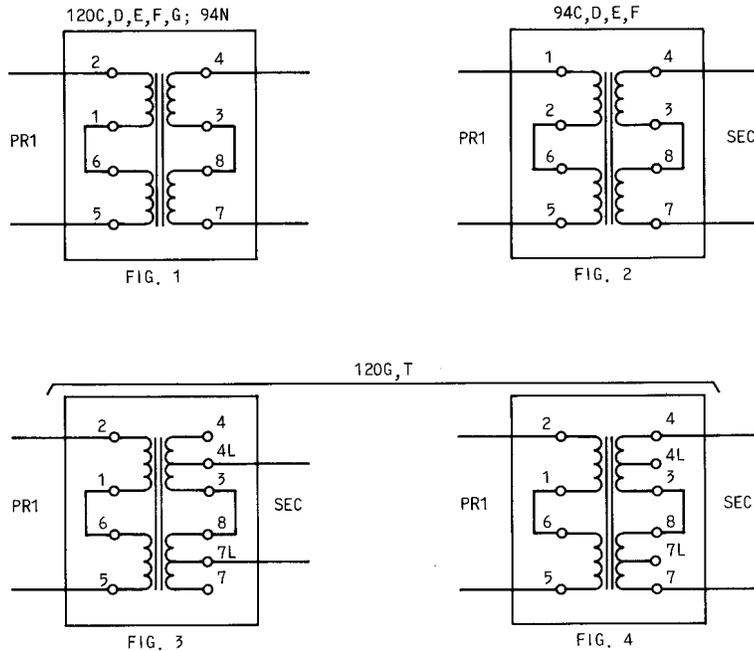


Fig. 6-53—Repeating Coils

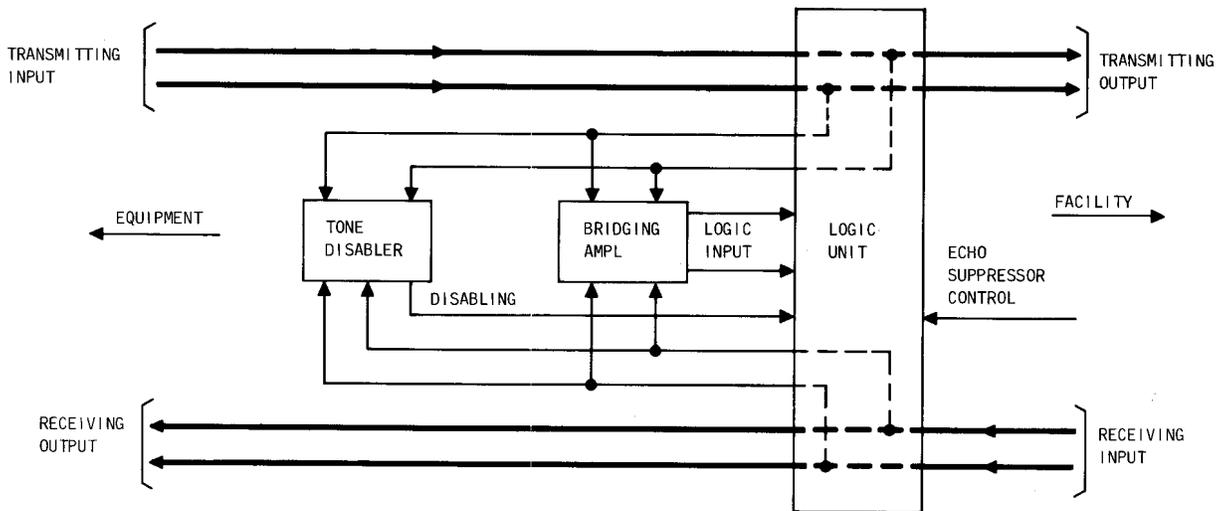
TABLE 6-0

CHARACTERISTICS

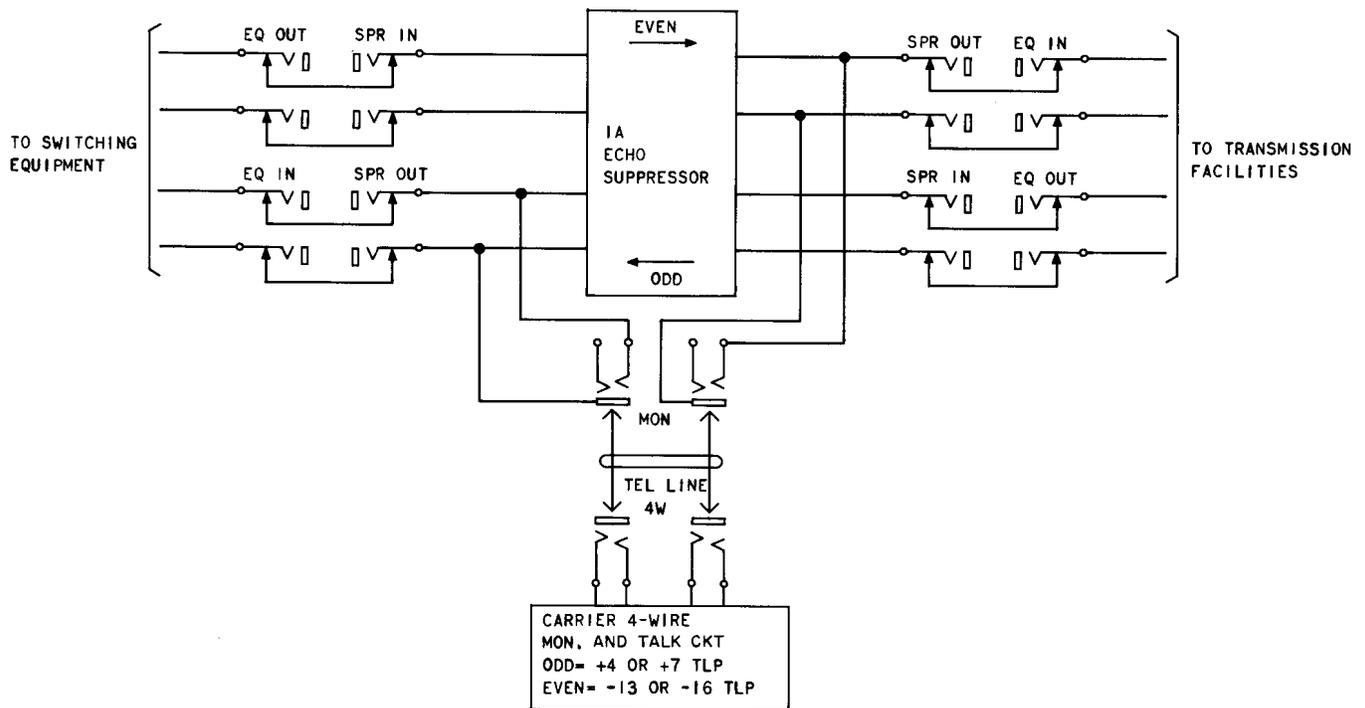
		Repeating Coil Type										
		120C	120D	120E	120F	120G	120G	120T	120T	84C	94D	94N
Figure		1	1	1	1	Fig. 3	Fig. 4	Fig. 3	Fig. 4	94E	94F	1
Resistance Between Windings, $\Omega^*$	1-2	9	15	6	3	3	3	9	9	23	35	6
	3-4	6	6	6	9	9	9	11	11	23	23	9
	5-6	9	15	6	3	3	3	9	9	23	35	6
	7-8	6	6	6	9	9	9	11	11	23	23	9
Impedance Ratio (PRI:SEC)		1:1	1.5:1	1:1.5	1:2.5	1:1.5	1:2.5	1.5:1	1:1	1:1	1.5:1	1:1
Normal Impedance, $\Omega$	PRI	900	1350	600	600	600	600	900	900	900	900	900
	SEC	900	900	900	1500	900	1500	600	900	900	600	900
Return Loss		When used in signaling equipment, satisfactory return loss (usually SRL) may be achievable only by use of a 120-type coil (NOT A 120( )S). The 120T will provide the best SRL.										

**Echo Suppressors**

**6.67 Description:** Echo suppressors are used on access lines and trunks to prevent the talker from hearing an echo of his own speech. This is accomplished by inserting a high loss into the receive path of the talker. Basically, three types of echo suppressors are used today: 1A, 3A, and 4A echo suppressors. Each can be used for full terminal or split terminal operation. Echo suppressor sensitivity (operate level) for all three is -31 dBmO; ie, a -31 dBm 1000-Hz tone applied to a 0 TLP will operate the echo suppressor. This value, adjusted for the TLPs at which the echo suppressor is aligned, is -24 dB at the + 7 TLP and -46 at -16 TLP. Figure 6-54 is a block diagram of the 4A echo suppressor. Jack access for the 1A and 3A is shown in Fig. 6-55 and 6-56, respectively. Jack access for the 4A echo suppressor is via a J68914TA test extender covered in BSP 332-414-105.



**Fig. 6-54—Block Diagram of 4A Echo Suppressor**



**Fig. 6-55—Monitoring and Patching of 1A**

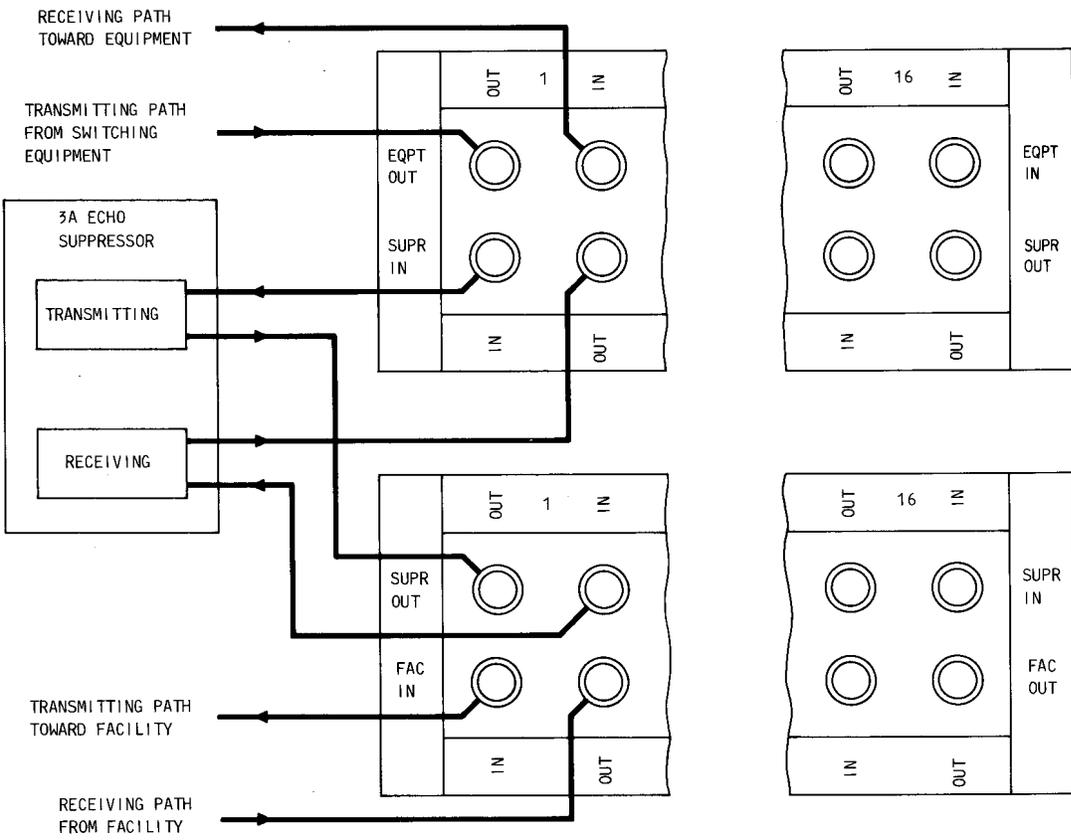
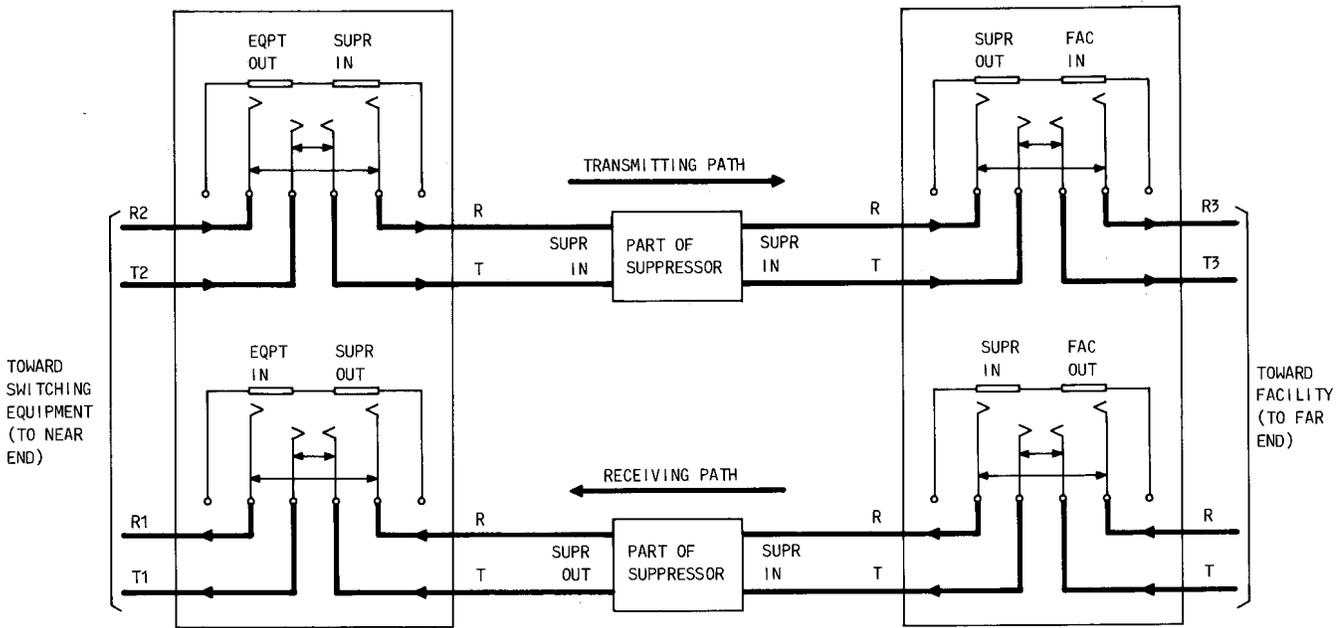
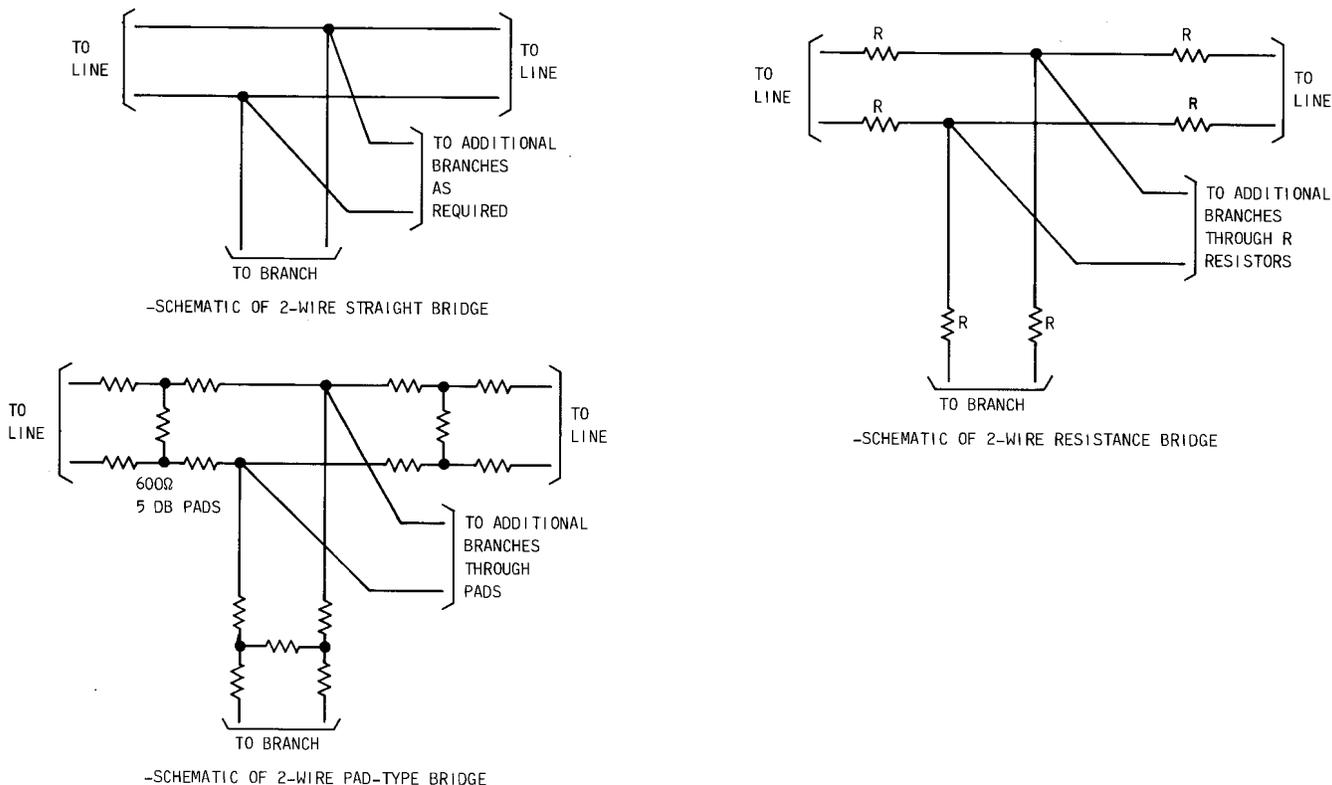


Fig. 6-56—Application Schematic Showing Jack Arrangement

**Bridges**

**6.68 Quick Test:** (1) Insert a test tone at INPUT 1 (Fig. 6-58) and measure the tone of OUTPUT 2 (the tester should choose the appropriate INPUT/OUTPUT for the trouble report), being sure to terminate the OUTPUT of the other legs in a characteristic impedance (do not open). Compare the measured loss with that on the CLR. If loss is not recorded on CLR, see BSP 795-200-901LL for bridge loss for the particular bridge being used.

**6.69 Description:** The bridges covered here are used on multistation private line circuits to connect three or more stations. Each station can transmit and receive to each or all of the other stations. Basically, there are two kinds of bridges: 2-wire and 4-wire. Each bridge is assigned a 6-character code which is explained in Table 6-P. As shown in Fig. 6-57, there are three types of 2-wire bridges. The advantages and disadvantages of each are given in Table 6-Q. Four-wire bridges are resistive network types and have four or six legs (Fig. 6-58 shows a typical 4-wire bridge). Since 4-wire bridges commonly connect to 4-wire station equipment (which does not have a talk-back path like 2-wire station equipment), talk-back paths are available in three basic arrangements: talk back amplifier, talk back bridge, and talk back from a spare leg. Figure 6-59 has an example of each.



**Fig. 6-57—Three Types of 2-Wire Bridges**

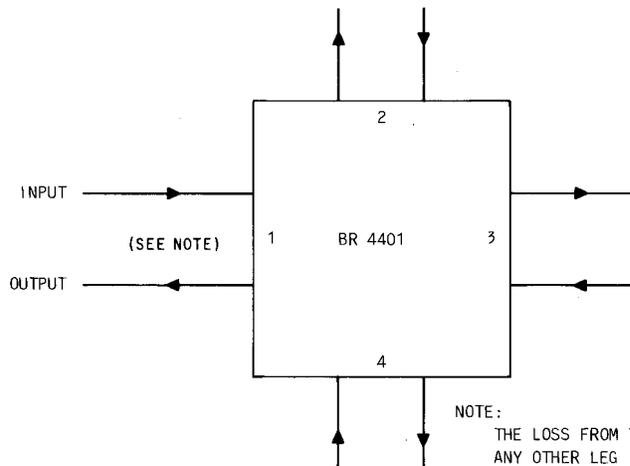
TABLE 6-P — BRIDGE CODE\*

CHARACTER POSITION	CODE	MEANING
1st and 2nd	BR	Bridge
3rd	2 or 4	2-wire or 4-wire
4th	3 to 9	Number of legs
	or M	More than 9 legs
	or T	Talk back
5th and 6th	01-99	Arbitrary numbers to achieve individuality

\* Not same as Common Language Equipment Code.

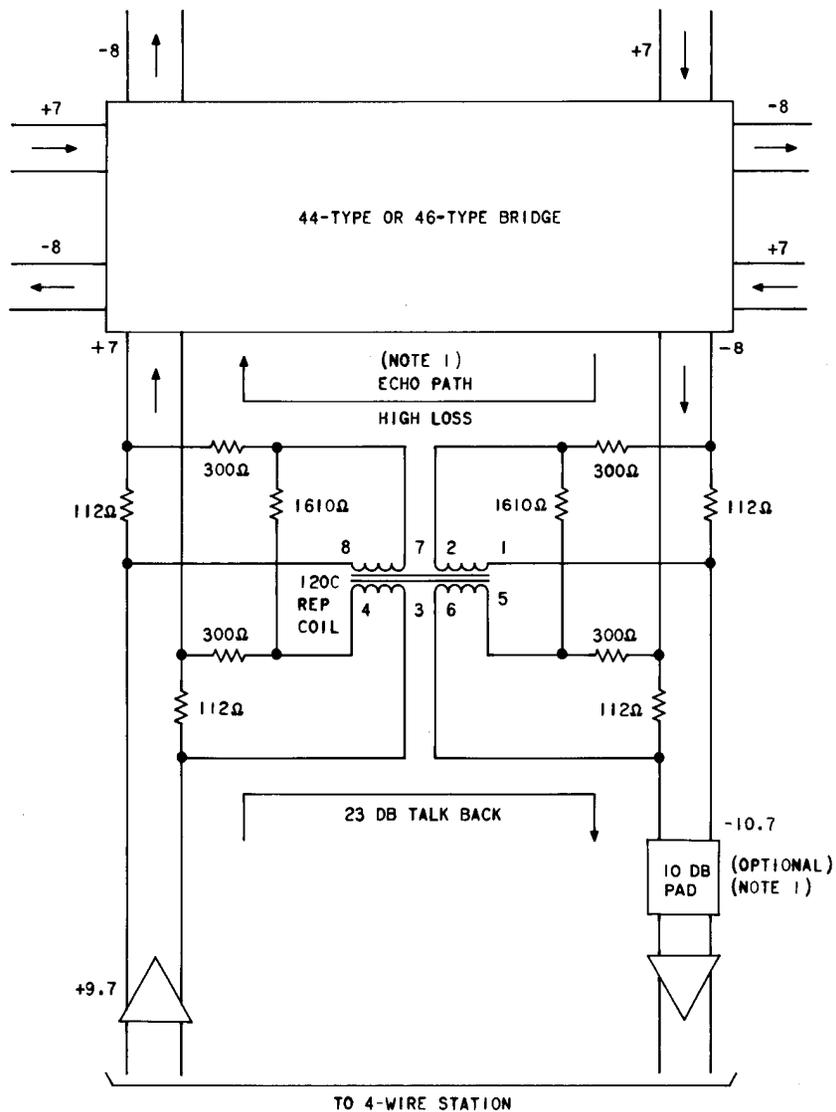
TABLE 6-Q — 2-WIRE BRIDGES

BRIDGE	ADVANTAGES	DISADVANTAGES	NOTES
STRAIGHT	LOW BRIDGING LOSS	POOR IMPEDANCE BALANCE - TROUBLE IN ONE LEG CAN DISRUPT ENTIRE CIRCUIT	For loss between input and output of other legs see BSP 310-405-100 and 795-200-901LL. The value of loss will vary for the different types of bridges especially since the PAD type has variable pad values. See also SD-55647, SD-1G002 SD-56229
RESISTIVE	MEDIUM LOSS SOME ISOLATION BETWEEN LEGS	MAY NEED REPEATER SINGING CAN BE PROBLEM IF POOR IMPEDANCE BALANCE	
PAD	GOOD ISOLATION AND IMPEDANCE CONTROL	HIGH LOSS AND USUALLY REQUIRES AMPLIFIER	

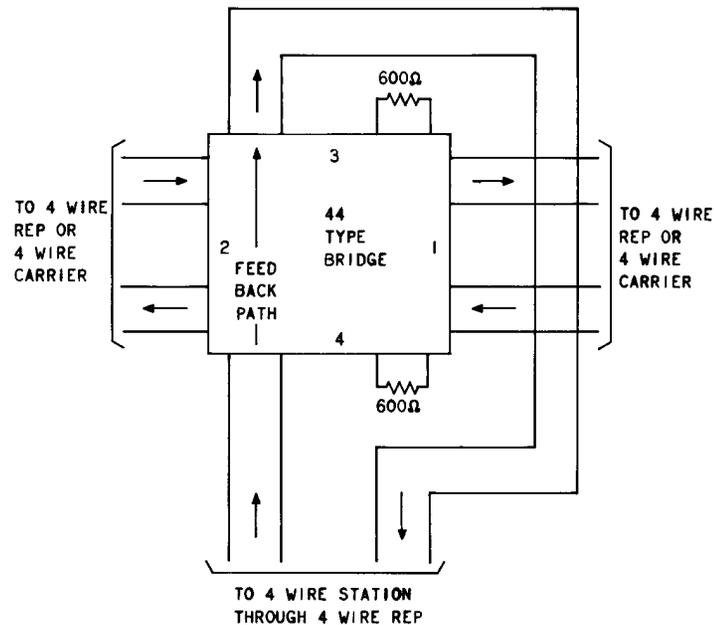


NOTE: THE LOSS FROM THE INPUT OF ANY LEG TO THE OUTPUT OF ANY OTHER LEG IS 15 dB. THE LOSS FROM THE INPUT OF A LEG TO THE OUTPUT OF THE SAME LEG IS 75 dB.

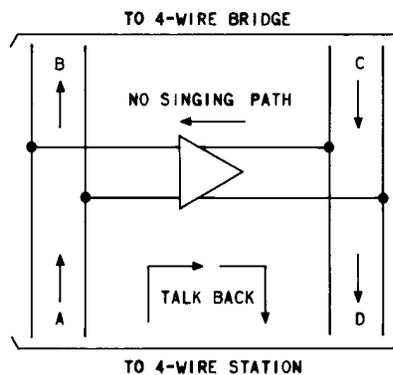
Fig. 6-58—BR4401 Typical 4-Wire/4-Way Bridge



LOW ECHO TALK-BACK BRIDGE BR4T03



TALKBACK OBTAINED FROM SPARE LEG OF 44-TYPE BRIDGE



TALK-BACK AMPLIFIER

- NOTES:
1. THE ECHO PATH LOSS IS ABOUT 62 DB WITHOUT THE 10 DB PAD AND ABOUT 82 DB WITH THE PAD.
  2. RESISTOR TOLERANCES ARE  $\pm 1\%$ .

Fig. 6-59—Typical Arrangements for Talk-back

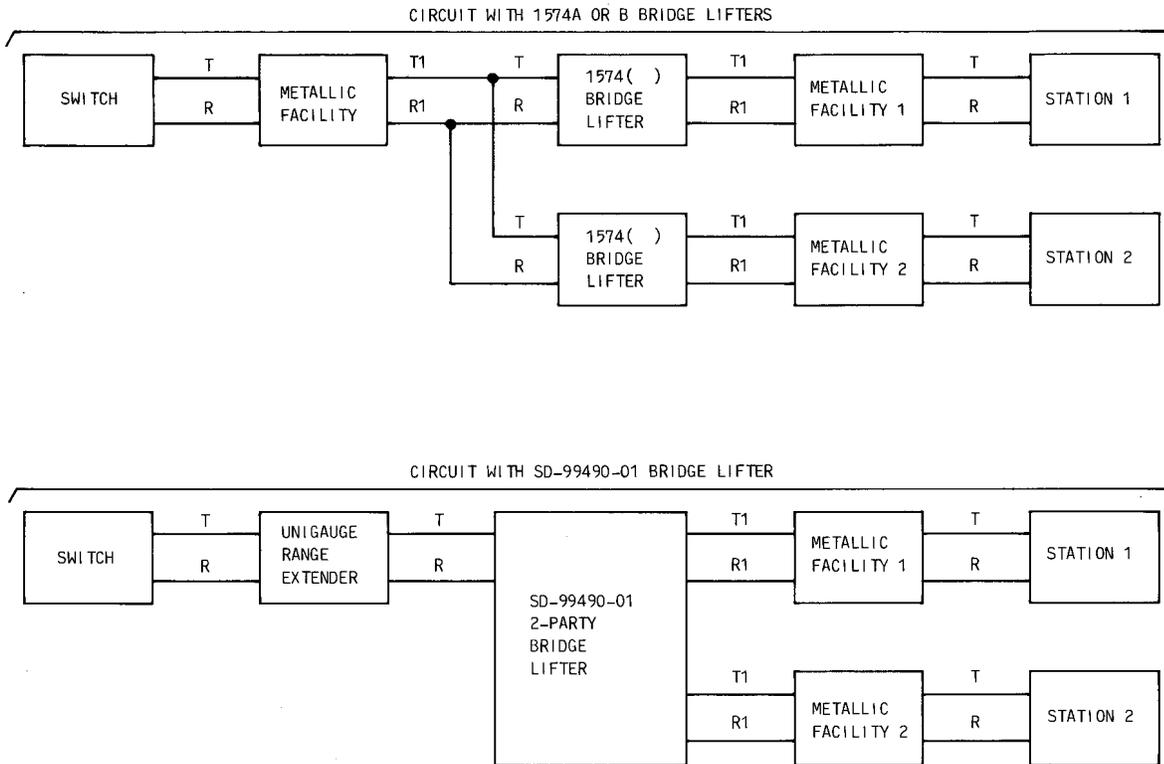


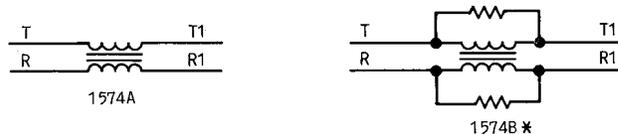
Fig. 6-60—Two Typical Bridge Lifter Arrangements

**Bridge Lifters**

**6.70 Description:** A bridge lifter (Fig. 6-60) is used to electrically remove an inactive bridged cable pair from the pair to which it is bridged.

**6.71 Operation:** (A) 1574A, 1574B (B) SD99490-01

**A.**



\* 1574B HAS GREATER TOLERANCE TO 60 HZ INTERFERENCE.

Fig. 6-61—1574A and 1574B Bridge Lifters

See Fig. 6-60.

1. Station 1 & 2 ON-HOOK — Only leakage current flows in both lines and loss of bridge lifters is very high.
2. Station 1 OFF-HOOK Station 2 ON-HOOK — Current in bridge lifter for station 1 reduces loss to a very low value. Loss of line 2 is increased by increase in loss of bridge lifter 2.
3. Station 1 & 2 OFF-HOOK — Current flow in both bridge lifters reduces loss in each. Transmission may be severely degraded by (1) the reduced current to both stations and (2) the bridge tap each line represents to the other.

B.

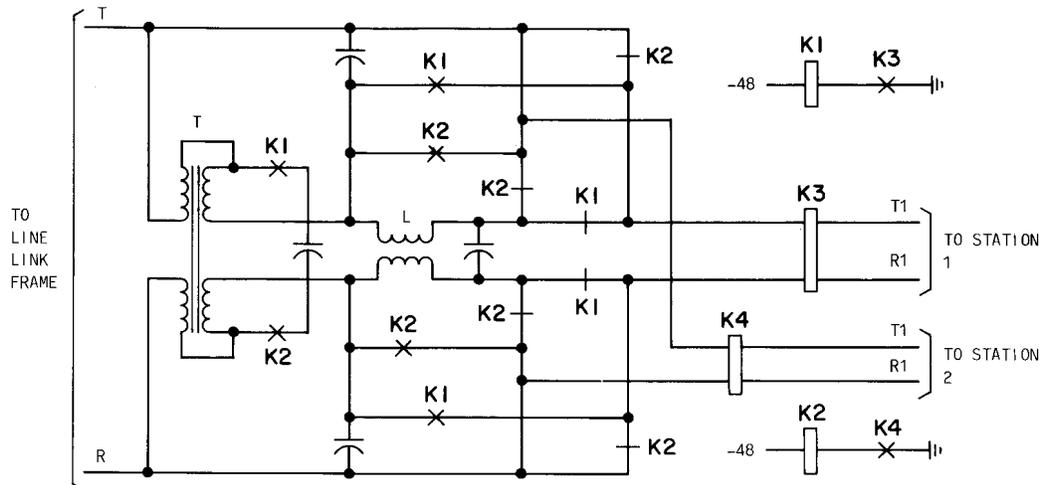


Fig. 6-62—SD-99490-1

1. Station 1 OFF—HOOK Station 2 ON—HOOK — K3 and K1 relay operated — Transmission patch to Station 2 open.
2. Station 1 ON—HOOK Station 2 OFF—HOOK — K4 and K2 relays operated and transmission path to station 1 opened.

**Metallic Facility Terminal (MFT)**  
SD-1C359-01

6.72 **Quick Test:** The following logic sequence should be performed before using the test extender.

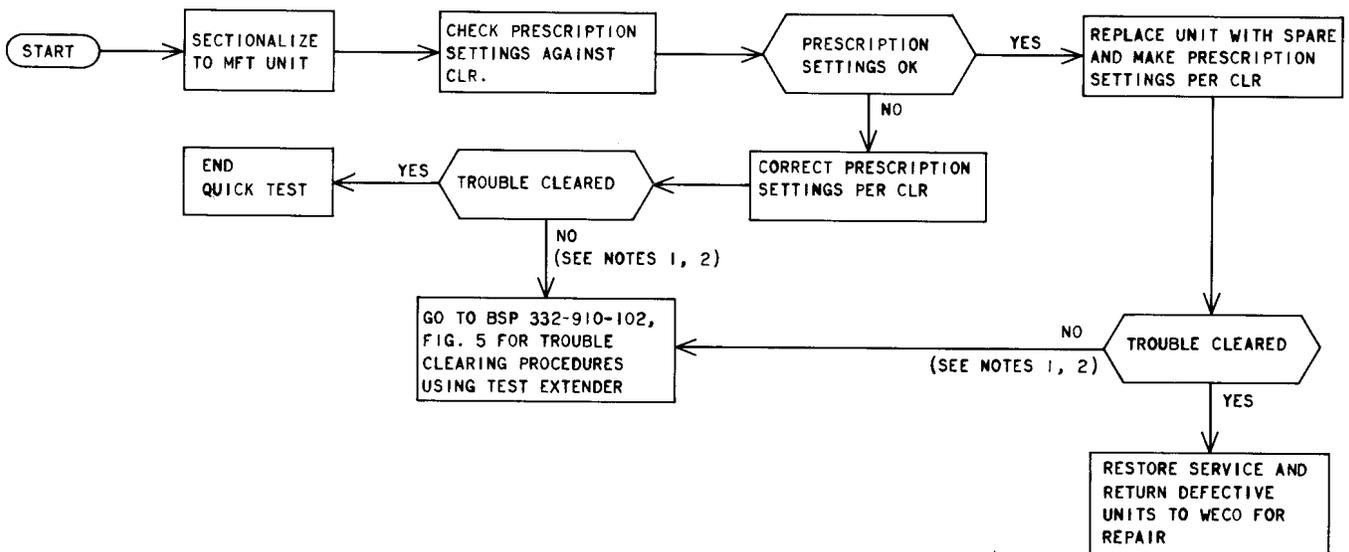


Fig. 6-63—Quick Test MFT

**Note 1:** Other parts of circuit may be defective or out of adjustment.

**Note 2:** Prescription settings on CLR may no longer be valid due to changes in facilities.

**6.73 Description:** The MFT is a standard arrangement of plug-in equipment which furnishes transmission and/or signaling functions for metallic (wire) facilities. The MFT equipment consists of two groups of plug-in modules: transmission and signaling. Transmission units and functions are covered in Table 6-R and signaling units are covered in Table 6-S. Normally, an MFT consists of one transmission unit and one signaling unit mounted in adjacent slots in a double module shelf or bay mounting arrangement. This pair of units is associated with one circuit only. The double module shelf accommodates 24 plug-in units or 12 pairs (12 circuits). Other arrangements of MFT units are available such as the single module shelf or bay arrangements.

TABLE 6-R

## MFT TRANSMISSION UNITS

"J" IDENTIFICATION	COMMON LANGUAGE CODE	NAME	FUNCTION	REFERENCES
J99343BA1 L1 BA1 L1, A BA2 L2 BA2 L2, A BA2 L2, B BA2 L2, A, C	MTT2100AAA MTT2101AAC MTT2100AAB MTT2100AAC MTT2101AAA MTT2101AAB	2-WIRE TRANSMISSION UNIT	PASSES TRANSMISSION FROM A SIDE TO B SIDE - NO GAIN. SIGNAL LEAD ACCESS VIA CENTER TAPPED TRANSFORMER. ALLOWS USE OF SIGNALING UNIT.	332-912-101
J99343BC1 L1	MTT2300AAA			
J99343BB1 L1 BB2 L2	MTT2200AAA MTT2200AAB	BYPASS TRANSMISSION UNIT	PERMITS USE OF MFT SIGNALING UNIT WITH V4 REPEATER.	332-912-101
J99343PA1 L1	MT22100AAA	2-2 TERMINAL REPEATER (L)	TERMINATES 2-WIRE H88 LOADED CABLE FACILITIES IN 900 $\Omega$ 2-WIRE EQUIPMENT ADJUSTABLE GAIN AND BALANCE NETWORK	332-912-111 332-912-211 332-912-212
J99343PB1 L1	MT22200AAA	2-2 TERMINAL REPEATER (NL)	TERMINATES 2-WIRE NON-LOADED CABLE FACILITIES IN 900 $\Omega$ 2-WIRE EQUIPMENT ADJUSTABLE GAIN AND BALANCE NETWORK	332-912-111 332-912-211 332-912-212
J99343PC1 L1	MTT22300AAA	2-2 INTERMEDIATE REPEATER (L-L)	FURNISHES GAIN BETWEEN TWO H88 LOADED 2-WIRE CABLE FACILITIES.	332-912-111 332-912-211 332-912-212
J99343PD1 L1	MT22400AAA	2-2 INTERMEDIATE REPEATER (NL-NL)	FURNISHES GAIN AND EQUALIZATION BETWEEN TWO NON-LOADED 2-WIRE CABLE FACILITIES	332-912-111 332-912-211 332-912-212
J99343PE1 L1	MT22500AAA	2-2 INTERMEDIATE REPEATER (L-NL)	FURNISHES GAIN AND EQUALIZATION BETWEEN AN H88 LOADED 2-WIRE CABLE FACILITY AND A NON-LOADED 2-WIRE CABLE FACILITY	332-912-111 332-912-211 332-912-212
J99343PF1 L1	MT22600AAA	2-2 INTERMEDIATE REPEATER (NL-L)	FURNISHES GAIN AND EQUALIZATION BETWEEN A NONLOADED 2-WIRE CABLE FACILITY AND AN H88 LOADED 2-WIRE CABLE FACILITY.	332-912-111 332-912-211 332-912-212
J99343RA1 L1 MOD A L2	MT24100AAA MT24100AAB	2-4 TERMINAL REPEATER	TERMINATES 4-WIRE LOADED OR NONLOADED CABLE FACILITIES IN EITHER 600- OR 900- $\Omega$ 2-WIRE EQUIPMENT. ADJUSTABLE GAIN AND EQUALIZATION.	332-912-131 332-912-231 332-912-232
J99343RD1 L1	MT24200AAA	2-4 INTERMEDIATE REPEATER (L)	FURNISHES GAIN BETWEEN AN H88 LOADED 2-WIRE FACILITY AND A 4-WIRE LOADED OR NONLOADED FACILITY AND POST-AMPLITUDE EQUALIZATION FOR THE 4-WIRE FACILITY.	332-912-121 332-912-221 332-912-222
J99343RE1 L1	MT24300AAA	2-4 INTERMEDIATE REPEATER (NL)	FURNISHES GAIN AND EQUALIZATION BETWEEN NONLOADED 2-WIRE CABLE FACILITY AND A 4-WIRE LOADED OR NONLOADED CABLE FACILITY	332-912-121 332-912-221 332-912-222
J99343RB1 L1	MT42100AAA	4-2 INTERMEDIATE/TERMINAL REPEATER (L)	FURNISHES GAIN AND EQUALIZATION BETWEEN A 4-WIRE CABLE FACILITY AND AN H88 LOADED 2-WIRE CABLE FACILITY. ALSO TERMINATES H88 2-WIRE CABLE FACILITY IN 600 $\Omega$ 4-WIRE EQUIPMENT	332-912-121 332-912-221 332-912-222
J99343RC1 L1	MT42200AAA	4-2 INTERMEDIATE/TERMINAL REPEATER (NL)	FURNISHES GAIN AND EQUALIZATION BETWEEN 4-WIRE CABLE FACILITY AND A NONLOADED 2-WIRE CABLE FACILITY. ALSO TERMINATES 2-WIRE (NONLOADED) CABLE FACILITY IN 600 $\Omega$ 4-WIRE EQUIPMENT	332-912-121 332-912-221 332-912-222
J99343SA1 L1	MT44100AAA	4-4 TERMINAL REPEATER	TERMINATES 4-WIRE LOADED OR NONLOADED CABLE FACILITIES IN 600 $\Omega$ 4-WIRE EQUIPMENT ADJUSTABLE GAIN AND EQUALIZATION	332-912-131 332-912-231 332-912-232
J99343SB1 L1	MT44200AAA	4-4 INTERMEDIATE REPEATER	FURNISHES GAIN AND EQUALIZATION BETWEEN LOADED OR NONLOADED 4-WIRE FACILITIES	332-912-131 332-912-231 332-912-232

TABLE 6-S

## MFT SIGNALING UNITS

"J" IDENTIFICATION	COMMON LANGUAGE EQUIPMENT CODE	NAME	FUNCTION	REFERENCES
J99343AA1 L1 AA1 L1, A AA1 L1, MOD A AA1 L1, A, B AA1 L1, A Mod B	MTSRG00AAA MTSRG00AAB MTSRG00AAC MTSRG20AAA MTSRG20AAB	LOOP SIGNALING REPEATER (LSR) LS-GS	REGENERATE DC AND 20-Hz RINGING FROM CO (A-SIDE) TOWARD STATION (B-SIDE) AND FROM STATION TOWARD CO. LOOP START AND GROUND START.	332-911-101
J99343AB1 L1 AB1 L1, A AB1 L1, A, B AB1 L1, A Mod B	MTSRL00AAA MTSRL00AAB MTSRL20AAA MTSRL20AAB	LOOP SIGNALING REPEATER (LSR) LSO	SAME AS LSR J99343AA except only LOOP START OPERATION.	332-911-101
J99343AC1 L1 J99343AD1 L1	MTSRG10AAA MTSRL10AAA	LOOP SIGNALING REPEATER LS-GS AND LSO	SAME AS ABOVE EXCEPT WIRED TO BE COMPATIBLE WITH REPEATER DISABLER.	332-911-101
J99343AE1 L1	MTSRC00AAA	LOOP START TO GROUND START CONVERTER (LS-GS CONV)	USED AT TERMINATING END OF PBX-CO TRUNKS. REGENERATES DC AND 20 Hz RINGING FROM CO TO STATION AND DC (INCLUDING DIAL PULSES) FROM STATION TO CO. LOOP START ON CO SIDE AND GROUND START ON STATION SIDE.	332-911-101
J99343CA1 L1	MTSX100AAA	LOOP SIGNALING RANGE EXTENDER (LSE)	BATTERY BOOST RANGE EXTENSION (-48 Volts up to -72 Volts) TD VERVE USED WITH CO TOLL DIVERSION	332-911-102
J99343CB1 L1	MTSX200AAA	LOOP SIGNALING RANGE EXTENDER PLUS TD (LSE-TD)		
J99343CC1 L1	MTSX110AAA	(LSE)		
J99343DA1 L1	MTDX100AAA	DUPLEX SIGNALING UNIT (DX1)	CONVERTS E&M LEADS TO DX SIGNALING.	332-911-103
J99343DB1 L1	MTDX200AAA	DUPLEX SIGNALING UNIT (DX1/ DX2)	CONVERTS E&M TO DX OR DX TO E&M.	332-911-103
J99343EA1 L1	MTSC100AAA	CODE SELECT RING DOWN CONVERTER (ESR)	CONVERTS DC (E&M OR SF) TO 20 Hz AND 20 Hz TO DC (E&M OR SG).	332-911-104
J99343EB1 L1	MTSC200AAA	RINGDOWN CONVERTER (RDC)	SG TO 20 Hz, LOOP SG TO 20 HZ, E&M TO 20 Hz LOOP E&M TO 20 Hz, E&M TO SG, LOOP E&M TO LOOP SG, LOOP E&M TO SG OR E&M TO LOOP SG.	332-911-104
J99343EC1 L1	MTSC300AAA	PRIVATE LINE AUTOMATIC RINGDOWN (PLGR)	TWO AUTOMATIC RINGING.	332-911-104
J99343MA1 L1	MTSRA00AAA	SIGNALING ACCESS UNIT	GIVES ACCESS TO SIGNAL LEADS TO AN NON MET SIGNALING UNIT.	332-911-106
J99343MB1 L1	MTSRB00AAA	BLANK SIGNAL UNIT	INSERT INTO BLANK SIGNALING SLOT TO PREVENT INSERT A TRANSMISSION UNIT.	

**SECTION 660-215-500**

**7. GLOSSARY**

**7.01** The following is a list of abbreviations and acronyms that are commonly used in association with special services.

ACD: Automatic Call Distributor

AML: Actual Measured Loss

BAT: Battery

BOC: Building-Out Capacitance

BSP: Bell System Practices

CD: Circuit Description

CENTREX: Centralized Exchange for Business Customer Services

CO: Central Office

CPE: Customer Provided Equipment

dB: Decibel

DDD: Direct Distance Dialing

DLL: Dial Long Lines

EML: Expected Measured Loss

ERL: Echo Return Loss

FX: Foreign Exchange

GRD: Ground

Hz: Hertz

ICO: Independent (Telephone) Company

ICT: Idle Circuit Termination

LBOC: Line Building-Out Capacitance

MFT: Metallic Facility Terminal

NBOC: Network Building-Out Capacitance

OPS: Off-Premises Station

OPX: Off-Premises Extension

PBX: Private Branch Exchange

PLR: Pulse Link Repeater

POTS: Plain Old Telephone Service

R: Ring

RCV: Receive

RL: Return Loss

SD: Schematic Diagram

SF:: Single Frequency

S/N: Signal-to-Noise Ratio

SP: Singing Point

STA: Station

STC: Serving Test Center

T: Tip

TRMT: Transmit

T-T: TOUCH-TONE

VNL: Via Net Loss

Z: Impedance

**7.02** The following is a list of words and terms, along with their standard definitions, that are commonly used in association with special services. Terms defined in the text are not listed and defined here (see the index).

**A and B Leads:** Strictly dc continuity leads usually derived through the use of a retard coil, repeat coil, or a 4-wire terminating set.

**Actual Measured Loss (AML):** The actual reading of the transmission measuring set when the test is made under the same test condition as that for which the EML was computed.

**ATTENUATION (Loss):** A term used to denote a decrease in magnitude of power from one point to another. A decrease in signal amplitude due to losses through equipment or transmission facilities. It is usually expressed in decibels (dB).

**Attenuator (Pad):** A device to reduce signal amplitude by a known amount without introducing distortion.

**Balancing Networks:** Equipment used to balance ac or dc line conditions. Their most common use is with terminating sets as either a compromise network or precision (adjustable) network. Balancing in this regard applies to minimizing the echo or energy that crosses between the four-wire legs of the term set and is returned to the originator.

**Central Office (CO):** A location at which telephone callers can access the DDD network and be switched (connected) to the called parties or routed onward by means of manual, electric, or electronic switches. A switching center serving subscribers in a given geographical area as a local central office.

**Channel:** One communication path via a pair of wires, phantom, carrier, or microwave. One circuit.

**Compressor:** A device for improving the signal-to-noise ratio and signal-to-crosstalk ratio of a communication link, and for decreasing the absolute levels of noise and crosstalk when no signal is being transmitted. It consists of a "compressor" at the transmitting end and an "expandor" at the receiving end. The compressor increases the signal levels selectively to narrow their range and increase their average without exceeding the levels for which the link was designed. The expandor restores the original volume range

of the signals, and, when no signal is being transmitted, reduces noise and crosstalk levels markedly.

**Concentrators:** Equipment used to connect a large number of circuits to a limited number of paths, for example:

- **Answering Service Concentrators:** Equipment provided in local central offices which, together with identifying equipment at the answering service location makes it possible to answer a large number of customer lines on a few pairs.

**Customer:** The person, firm, or corporation which orders service and is responsible for the payment of charges and compliance with Telephone Company regulations.

**Customer-Provided Equipment (CPE):** This includes any equipment provided by the customer and connecting to the Telephone Company facilities. This equipment may be customer-provided and maintained (CPM) or customer-provided and telephone company maintained (CPT). (May also be called customer-provided terminal equipment.)

**Decibel (dB):** A logarithmic unit of signal ratio which is commonly used for expressing transmission gains, loss levels, and similar quantities. Strictly speaking decibel is defined only for power ratios; however, as a matter of common usage, voltage and current ratios are also expressed in decibels. This is expressed as

$$1 \text{ dB} = 10 \log P_1/P_2$$

—Where P<sub>1</sub> and P<sub>2</sub> are measurements of power expressed in watts.

**Decibels-Millwatt (dBm):** Decibels related to one milliwatt dissipated in a resistance of a known value of 600 ohms as a reference level.

**Decibels Reference Noise (dBrn):** This ratio is expressed in decibels above reference noise. Reference noise is the magnitude of circuit noise meter reading equal to that produced by 10<sup>-12</sup> watts of electric power at 1000 Hz.

**Dial PBX:** A switching system located on the customer's premises in which the connections between two stations or outgoing calls from stations

to trunks can be machine switched under control of the PBX station dial. Incoming calls from central office trunks are received by the PBX attendant who extends them to the desired station via a cord switchboard or a console.

**Dial Pulsing:** A system of dc pulsing in which the digits are transmitted by the interruption of the dc circuit a number of times, one to ten interruptions corresponding to the digits "1" through "0" on the dial.

**Dial Tone:** A tone used in dial telephone systems to indicate that the equipment is ready for the dialing operation. This tone is 600 Hz modulated by 120 Hz when supplied by a tone alternator or 133 Hz when supplied by an interrupter. The modulating frequency gives this tone its low-pitched sound. Interrupted low tone is used for line busy, reorder, and no circuit tone signals reached by the customer.

**Direct Distance Dial (DDD) Network:** All Bell and Independent Telephone Company equipment and facilities used to permit customers to dial their own long distance (toll) calls.

**Drop:** On old manual switchboards, a ring from a station would drop a metal hinge exposing a jack that the operator answered with switchboard cords. Thus it became associated with the switching equipment end of a circuit.

**Exchange:** A geographical area, served by one or more central offices, within which the Telephone Company furnishes local telephone service at the exchange rates and under regulations applicable in that area as prescribed in the company's Filed Tariffs. Calls made from one station to another station in the same exchange do not include toll charges.

**Expected Measured Loss (EML):** The expected reading, in dB, of a transmission measuring set connected to a prescribed test point at one end of a circuit when sending power of a specific value (usually 1000 Hz at 0 dBm) is applied to a prescribed test point at the other end of the circuit.

**Gain:** An increase in level at signal strength by amplification (expressed in dB).

**Hertz (Hz):** An international unit of frequency equivalent to one cycle per second.

**Idle Circuit Termination (ICT):** An artificial load that is connected to a trunk or line equipment in its idle condition to prevent singing of a repeatered or carrier equipped trunk. This termination is automatically removed when the circuit is in use. It is commonly found as a feature of some term sets, repeaters, or dial long line equipment. Instead of a load, an ICT is sometimes provided as a short or open circuit. It is frequently used on multipoint private line circuits.

**Insertion Loss:** The insertion loss of a facility is the loss caused by inserting the facility between a source and a load impedance. It is determined by comparing the power in the load impedance when the line is inserted, with the power when the line is removed and the source is directly connected to the load.

**Level:** An expression of electrical or sound power expressed in decibels (dB) above or below some point of reference.

**Line:** Any type of circuit terminated in a telephone or equivalent at one end and a switching machine at the other end. The term line can be applied to any type of service when at least one terminal of the circuit cannot connect to any other circuit.

**Long-Haul:** A term applied to a transmission path having a round trip delay of greater than 6 milliseconds or where echo is a controlling factor. A long-haul circuit requires additional treatment and equipment to remove the echo and compensate for circuit losses.

**Loop:** The facility that connects a subscriber to a central office exchange. It is usually a metallic circuit.

**Loss:** The decrease in energy, expressed in dB, between two points in a circuit.

**Manual PBX:** A switching system located on the customer's premises in which all connections, whether between two stations or between stations and trunks, are made by a PBX attendant at one or more cord switchboards or cordless consoles.

**Message Circuit Noise:** The short-term average noise level as measured with a Western Electric Company 3-type noise measuring set or its equivalent. Noise measurements are described as follows:

dBrn - dB referred to reference noise

dBrnC - dBrn with C-message weighting network

dBrnCO - dBrnC referred to 0 TLP.

**Net Loss:** The sum of the losses in a circuit less the sum of the gains.

**Noise:** Disturbing electrical impulses within the audio range introduced in a circuit by equipment components, man's interference, or natural disturbance.

**Noise-Longitudinal:** A noise voltage that is induced along a telephone conductor. It produces a noise current in the receiver if unbalances exist between the two conductors of the telephone pair when they make up part of a ground return circuit.

**Noise-Metallic:** A noise voltage that exists between the two conductors of a telephone pair. It produces a noise current in the receiver in the same way that the speech current is produced, ie, by virtue of a voltage existing across the line terminals of the subscriber set.

**Noise-to-Ground:** A noise voltage that exists between a telephone conductor and ground. It may produce a noise current in the receiver because of unbalances between the two conductors of a telephone circuit pair and ground, or unbalances within the telephone set or central office.

**Off-Hook:** The condition that indicates the active state (loop closed) of a station line or other circuit. When a telephone handset is removed from its switchhook, the loop is closed and the line is said to be in the "off-hook" condition.

**On-Hook:** The condition that indicates the idle state (loop open) of a station line or other circuit.

When a telephone handset is resting on its switchhook, the loop is open and the line is said to be in the "on-hook" condition.

**Pad:** A resistance network of value needed to introduce a specific transmission loss.

**Patching:** The connection of circuits by means of cords inserted into appropriate jacks.

**Percent Break:** The ratio of the open circuit time and the sum of the open and closed (total) circuit times allotted to a single pulse.

**Protector:** A device used to prevent damage to lines or equipment by dangerously high voltages or currents. The device may be a sparkgap, varistor, thermistor, etc. The device usually has a very high resistance to ground until the presence of an abnormal voltage or current causes the resistance to decrease. The device will then conduct and eliminate the dangerous condition.

**Repeater:** An electronic device used on long circuits to amplify voice signals and/or repeat supervision, (D.C.) signals.

**Short-Haul:** For special circuits, a circuit with a round trip delay of 6 ms or less.

**Signal-to-noise (S/N) Ratio:** Ratio of the magnitude of the signal to that of noise.

**Station:** Denotes transmitting and/or receiving equipment at any location on a customer's premises.

**Toll Call:** Any call for a destination outside of the local service area of the calling station.

**Via Net Loss (VNL):** The lowest loss in dB at which it is desirable to operate a trunk facility. The exact value depends on the type of facility and its length.

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