

FEATURE DOCUMENT
EXTENDED RANGE
NO. 2 ELECTRONIC SWITCHING SYSTEM

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NOTICE

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FEATURE DEFINITION AND DESCRIPTION**1. DEFINITION/INTRODUCTION****DEFINITION**

1.01 The distance a customer can be served from the central office is generally limited by the distance voice and signaling can be transmitted and received using standard switching system circuits. The Extended Range feature allows customers who are beyond the normal operating range to have telephone service comparable to those customers who are within normal operating range. This is accomplished by using some form of amplification for those customers.

INTRODUCTION

1.02 The Extended Range feature is a customer loop design plan which allows central offices to serve customers with line loop resistances of 1300 to 3600 ohms. In the No. 2 Electronic Switching System (ESS), two methods are used to accomplish this.

- When lines have loop resistances of 1300 to 1600 ohms, zone 16 service is provided directly from the No. 2 ESS.
- When lines have loop resistances of 1600 to 3600 ohms, range-extension equipment is used.

1.03 Zone 16 service is a subscriber long route design plan that permits extending the customer lines to 1600 ohms, as described in the subscriber long route design plan (refer to item 1 of Part 19). In the No. 2 ESS, this service is provided by increasing the supervisory range of the ringing circuit and the customer dial pulse receiver, and by a redesign of the station ringer test circuit, the customer dial pulse receiver test circuit, and the ring control test circuit (refer to item 8 of Part 19 for details).

1.04 Range extension is a means of providing service to those customers whose line loop resistance is between 1600 and 3600 ohms. This can be done by using either one or both of the following methods.

- Subscriber long route design

- Unigauge design

1.05 Subscriber long route design provides service to those customers whose line loop resistance is between 1600 and 3600 ohms by using common systems equipment in the form of E6 repeaters and dial long lines (DLL) equipment, or range extenders with voice frequency gain (REG). This equipment is used on a per-line basis and is located between the customer line equipment and the switching equipment (refer to items 1 and 2 of Part 19 for details).

1.06 Unigauge design is an optional feature available with the No. 2 ESS which provides economical service to those customers whose line loop resistance is between 1300 and 2500 ohms. By using 26-gauge cable in outside plant and supplying central office gain, the unigauge plan reduces the amount of copper used, allows more pairs to fit into existing underground conduit, and simplifies office records by reducing the use of mixed gauges and the required number of loading coils.

1.07 The basic unigauge design is intended primarily for customer loop growth in the urban-suburban areas where the demand is essentially residential and predominately individual line service. However, party line and special services can be provided if certain design rules are followed (these rules are described in 2.06 of this document).

1.08 Since zone 16 service and resistance design range extension are covered extensively in other documents (see Part 19), the remainder of this document pertains to unigauge design extension as used in a No. 2 ESS office.

1.09 Unigauge range extension requires both software and hardware. Software includes the generic program and translations. Hardware required for this feature consists of the unigauge range-extension circuit (SD-2H145, A458) and the range-extension frame (J2H034A) in which the circuits are mounted. In addition, a number of other circuits have been modified to serve unigauge customer loops. These circuits include the ringing circuit, customer dial pulse receiver, station ringer test circuit, and several trunk and test circuits. These circuits are an integral part of the switching system and are standard in all No. 2 ESS offices.

1.10 The Extended Range feature is available with all versions of the No. 2 ESS generic program.

2. USER PERSPECTIVE

General

2.01 Unigauge range extension extends the maximum conductor loop resistance of the central office from 1300 ohms as permitted with resistance design to 2500 ohms. Additional transmission and signaling range for loops over 1300 ohms is obtained through the use of range-extension equipment at the central office. The unigauge range-extension circuit (SD-2H145-01, A458) provides audio gain and 72-volt line feed during talking connections. Unigauge loop design is primarily intended to be applied to customer loops that are within 30 kilofeet (kft) of their serving office and to use all 26-gauge facilities. All 26-gauge loops less than 15 kft use standard central office circuitry because their loop resistances are less than 1300 ohms. Heavier wire can be used beyond 15 kft to extend the maximum loop length (out to 52 kft with 22 gauge). The minimum 15-kft length of 26-gauge cable presents a standard impedance to the central office and makes it possible to use a single range-extender repeater design to provide gain on all range-extended unigauge loops. Unigauge customer loops are divided into three groups (Figure 1).

Outside Plant

2.02 The loops within 15 kft of the office are designed with all 26-gauge nonloaded cable and the standard 48-volt central office battery. This design is identical to resistance design. Loops in this area are designated as **Short Loop Unigauge**.

2.03 Loops between 15 and 24 kft of the office are designated **Long Loop Unigauge** and are designed with all 26-gauge nonloaded facilities. These loops have a resistance in excess of 1300 ohms, and their transmission and signaling losses are greater than those permitted with resistance design. These loops require range extension at the central office.

2.04 Loops between 24 and 30 kft from the central office are also part of long loop unigauge and are designed with all 26-gauge facilities. These

loops require range-extension treatment at the central office. However, the unigauge repeater does not provide enough gain to meet transmission requirements, and limited loading has to be applied to these loops. Loading consists of applying 88-mH coils starting at a point 15 kft from the central office and at 6000-foot spacings thereafter.

2.05 Thirty kft is the limit of strictly unigauge loop plant, i.e., plant constructed with only 26-gauge cable. Many of the unigauge features may be applied to loops that are more than 30 kft from the central office. These loops are treated with standard unigauge equipment. They are designed with the 15 kft adjacent to the office as 26-gauge nonloaded cable and the remaining portion of the loop as 22-gauge cable with H88 loading. The first load point for all loaded unigauge design loops is 15 kft from the office. This design is applicable to loops as long as 52 kft. These are known as **Extended Unigauge**.

Party Line and Special Services

2.06 Party line and special services can be provided on unigauge loops if certain design rules are followed. No. 2 ESS provides 2-party range-extension service by either central office bridging with a special unigauge bridge lifter (SD-99490-01) or by field bridging. Four- and 8-party customer lines may be served provided the office is equipped with a special ringing circuit (SD-2H126-02). Other services such as coin, private branch exchange (PBX), telephone answering service, and off-premise extensions require treatment for unigauge range extension in the form of per-line treatment using DLL circuits and E6 repeaters (refer to item 1 of Part 19).

Unigauge Range-Extender Circuit

2.07 All unigauge loops that require the range-extension circuit in the central office should have 15 kft of 26-gauge nonloaded cable adjacent to the central office. The impedance provided by this 26-gauge facility permits a single nonadjustable-type voice-frequency repeater to be used with all unigauge and extended unigauge loops. This permits the range-extension circuits to be placed within the switching equipment and switched as required, thus allowing concentration of range-extension devices. Stable operation of the repeater on mixed gauge loops requires a minimum loop resistance of 1200 ohms, removal of

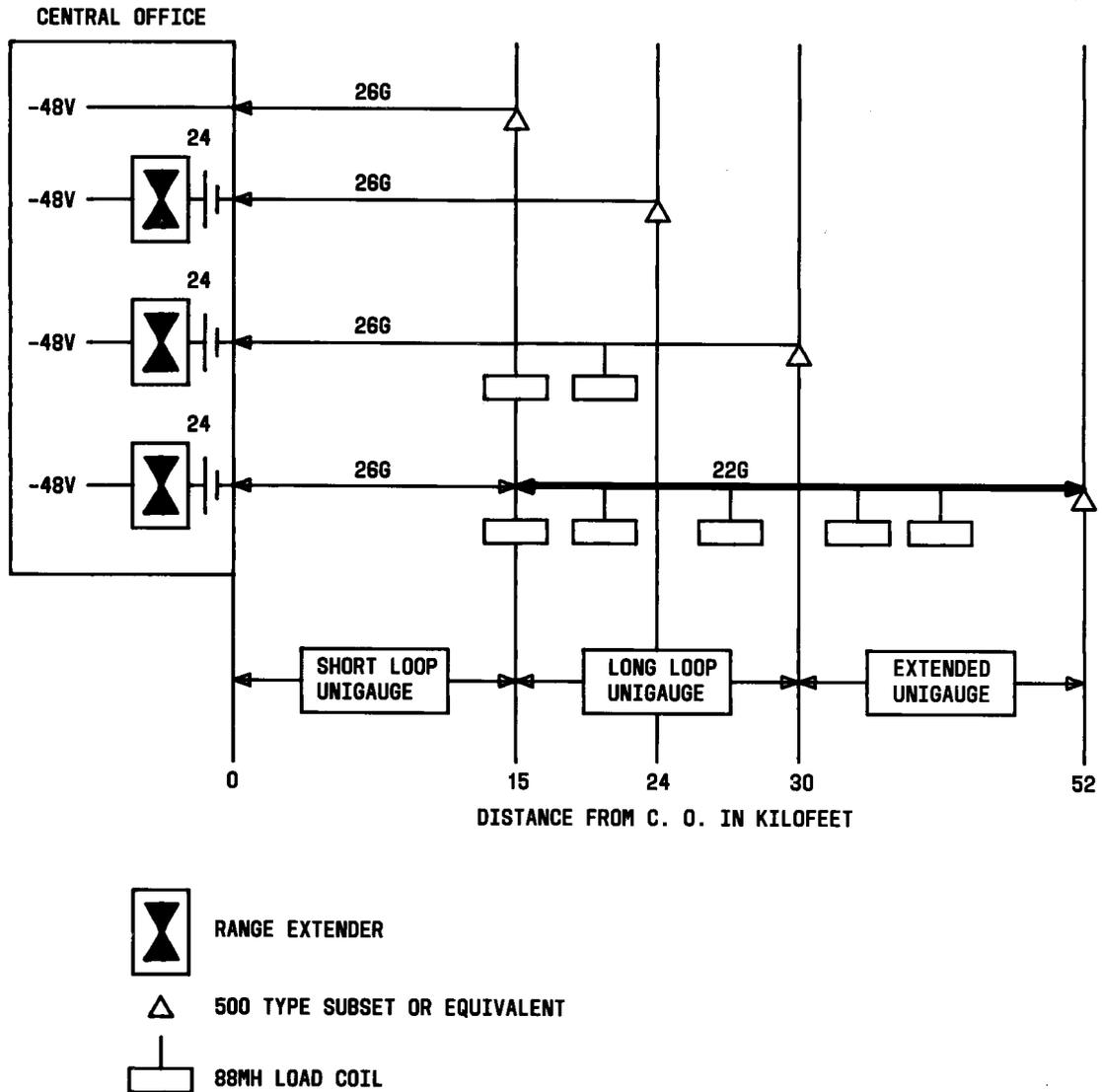


Fig. 1—No. 2 ESS Range Extension Unigauge Loop Plant

load coils located less than a nominal 15 kft from the office, and a section of 26-gauge cable provided adjacent to the central office.

2.08 As shown in Figure 2, range-extender repeaters are located in the network B-links between the second and third stages of switching. Either all or none of the B-links of a given concentrator are so equipped. These circuits (Figure 3) insert a frequency-shaped audio gain, and a line feed voltage boost to provide adequate current to supervise the loop and to power the subset transmitter and TOUCH-TONE® pad on range-extended loops. The unigauge repeater circuit

contains the audio amplifier, a voltage boosting dc converter, and a bypass relay B which allows the repeater to be switched out of the connection for ringing, other signaling operations and when connections to trunks and service circuits are made. This relay, which is controlled by the call processing program, also removes power from the circuit when it is idle.

2.09 Range-extension repeaters are provided in 16 circuit increments, corresponding to the 16 B-links on a network concentrator. Only concentrators serving range-extended lines have range-extension repeaters wired in the B-links.

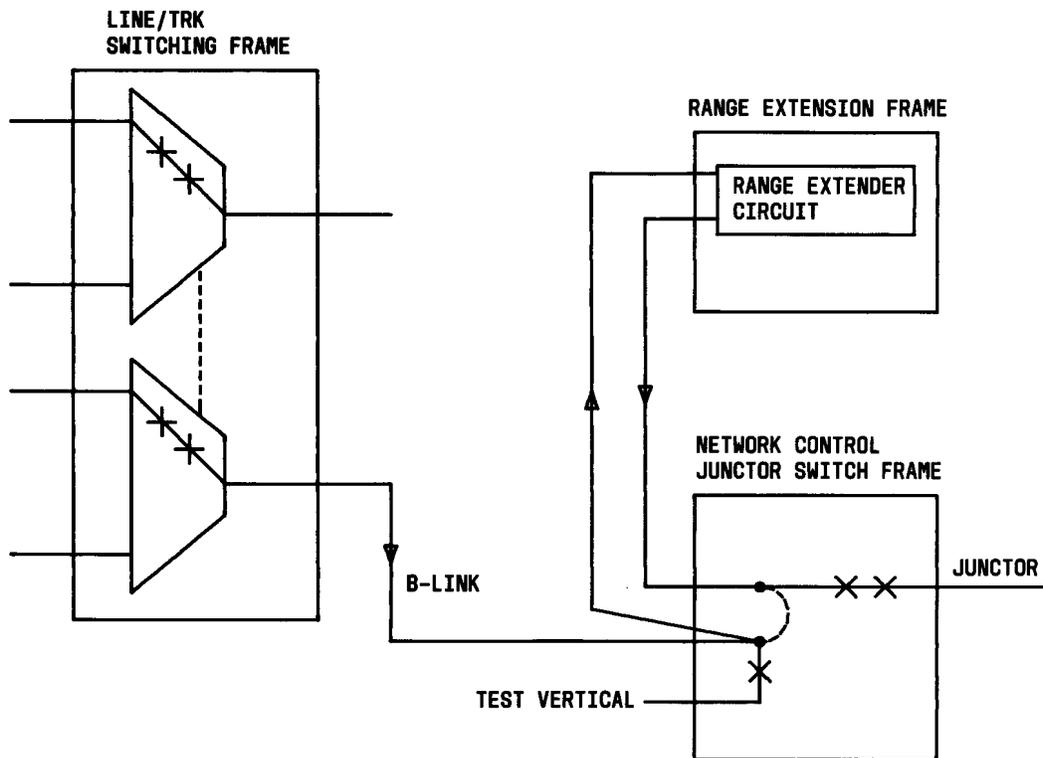


Fig. 2—No. 2 ESS Range Extension Circuit Interconnection

Trunks and service circuits can also appear as concentrator inputs and are nonrange extended. In an office with 4:1 concentration, one of the pair of associated concentrators may be nonrange extended and can serve regular lines.

2.10 Range-extension repeaters are packaged in units having three sets of eight amplifiers (J2H034AB) which are mounted in a range-extension frame (J2H034A). Refer to Part 10 of this section for details.

Call Processing of Range-Extension Calls

2.11 All terminals on a No. 2 ESS are assigned terminal equipment numbers (TENs) which are subdivided into concentrator groups of 32 terminals each. Since only lines which are range-extended appear on a range-extended concentrator, the generic program need only determine the concentrator with which that line is associated to establish the need for range-extension treatment. If the TEN of a line is associated with range-extended concentrator, then special programs are used to turn on (or idle) the B-link repeater

for connection to the line needing range extension, and to activate the range-extension state in the service circuits which are being connected to a line needing range extension. If the TEN of a trunk or service circuit is involved, the B-link repeater is ignored. Figure 4 shows network connections for calls involving range-extended lines.

3. SYSTEM PERSPECTIVE

FEATURE OPERATION

3.01 All terminals on a No. 2 ESS are assigned TENs which are subdivided into concentrator groups of 32 terminals each. When a customer line in a range-extension equipped office goes off-hook, two TEN translations are performed. One to obtain the standard line information and the other to determine if the concentrator with which that line is associated is a range-extended concentrator. If the TEN of the line is associated with a range-extended concentrator, the information derived from the range-extension translators is used by special peripheral order buffer (POB) programs to determine what range-extension action

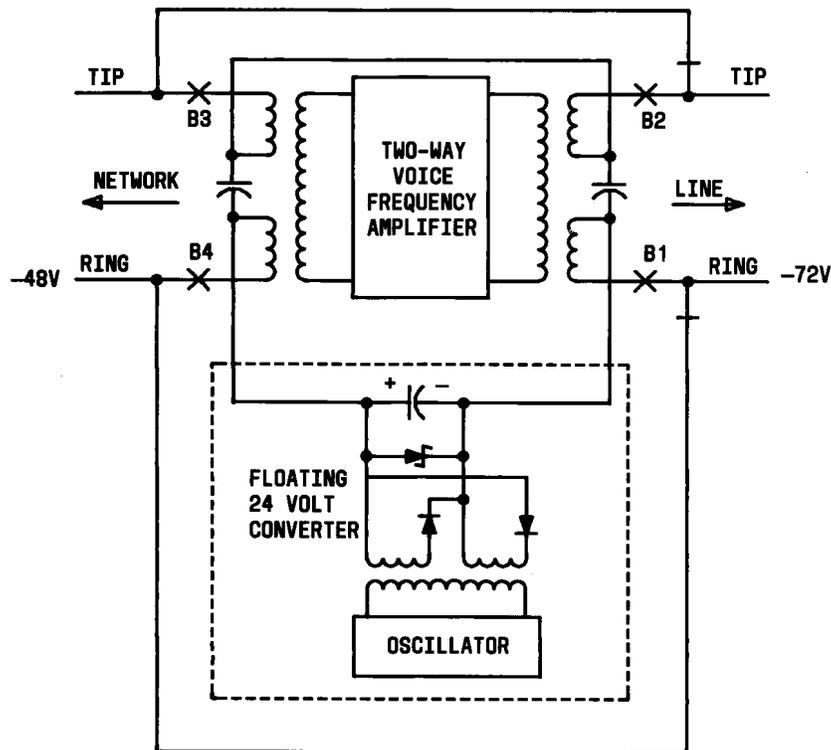


Fig. 3—Basic Unigauge Repeater Circuit

is required. The actions may be any one of the following:

- (1) Take no action for range extension. No range extension should be done in POBs involving test on line terminals (e.g., station ringer test, automatic line test), no-test vertical connections, and connections to service circuits which have no range-extension state.
- (2) Turn on (or idle) the B-link repeater for connections to a line needing range extension.
- (3) Activate the range-extension state in the service circuits which are being connected to a line needing range extension.

These translations and actions are also used on calls which terminate to a line requiring range extension.

HARDWARE

3.02 Hardware items that must be considered when providing this feature are:

- Terminal Equipment Numbers (Line and Trunk Switching Frame)
- Range-Extension Circuits
- Range-Extension Frames
- Central Pulse Distributor Points.

3.03 If party line or special services are to be provided, the following hardware may be required:

- Unigauge Bridge Lifters (2-, 4-, or 8-party)
- Special Ringing Circuit (only for 4- and 8-party)
- Dial Long Line Circuits (special services)

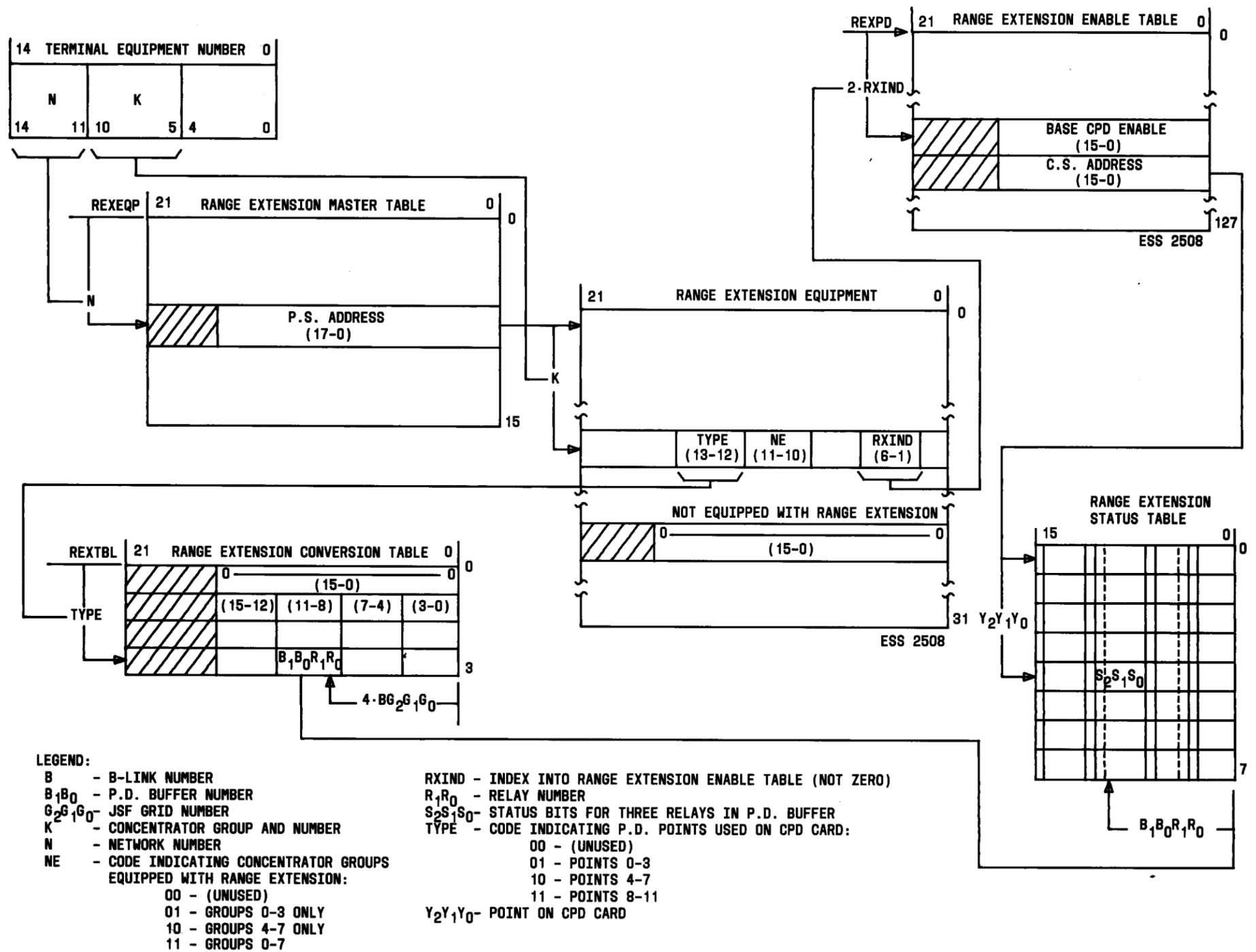


Fig. 7—Range Extension Parameters

options which must be incorporated to be compatible with a range-extension equipped No. 2 ESS office.

- (1) Incoming Trunk Circuit from Local Test Desk No. 14 or No. 16, or Local Test Cabinet No. 3 (SD-2H109-01).

- This circuit provides a metallic test path from the test desk through the network to customer lines. It has a wiring option for range extension which allows the switched gain repeater to be switched in and out of the transmission path.

- Switching is done with a PD relay via program. A Test Trunk Ringing Circuit (SD-96474-01) or Remote Testing Circuit—Far End (SD-99311-01) must be associated with the SD-2H109-01 circuit in order that a special audible signal be generated when a range-extended line is being tested. A PD controlled relay in the SD-2H109-01 sends a signal to the connecting circuit when a range-extended line is accessed.

- (2) Two-Way Trunk Circuit Switchboard No. 3CL in Distant Building (SD-2H110-01).

- When used as a no-test trunk, this circuit requires connection to the SD-2H170-01 circuit. The SD-2H170-01 circuit interconnects this circuit to a bridging amplifier (SD-99488-01) and provides the switching function required to switch the bridging amplifier in and out of the transmission path. The SD-2H170-01 also controls application of audible ring to the SD-2H110-01 circuit.

- (3) Outgoing Trunk Circuit to Local Test Desk No. 14 or No. 16 (SD-2H141-01).

- This circuit provides a metallic test path from customer lines (originated by maintenance personnel) to the test desk, via the network, for limited testing. The Test Trunk Ringing Circuit (SD-96474-01) must be associated with the SD-2H141-01 circuit in order that a special audible signal be generated when a range-extended line is being tested. A PD controlled relay in the SD-2H141-01 circuit sends a signal to the Test Trunk Ringing Circuit when a range-extended circuit is accessed.

- (4) Test Trunk Ringing Circuit (SD-96474-01).

- This circuit is used with connecting test circuits (SD-2H109-01 and SD-2H141-01) when required to provide a new source of ringing (20 Hz), tripping and supervisory signals. It also provides a range-extended mode, controlled by connecting circuits which produces a special audible tone when the test desk is connected to a range-extended line.

- (5) Remote Testing Circuit—Far End (SD-99311-01).

- This circuit is used with a connecting test circuit (SD-2H109-01) to test customer lines at distant offices under remote control of test desk. It provides a new source of ringing (20 Hz), tripping and supervisory signals as well as a 5-dB repeater (SD-99488-01) which is used when testing range-extended lines.

- It also provides a range-extended mode, controlled by connecting circuits, which produces a special audible tone when the test desk is connected to a range-extended line.

- (6) Primary and Secondary Test Cord Circuit Local Test Desk No. 14 (SD-95612-01).

- This circuit provides a means of testing customer lines when connected through network and test trunks (SD-2H109-01 and SD-2H141-01). It has the optional addition of a 5-dB switched gain repeater (SD-99488-01) used when testing range-extended lines.

- (7) Local Test Cabinet No. 3 Telephone and Test Circuit (SD-96181-01).

- This circuit is used for testing customer lines.

- It is portable, but can be mounted permanently and has the optional addition of a 5-dB switched gain repeater (SD-99488-01) which is used when testing range-extended lines.

- (8) Local Test Cabinet Supply Circuit (SD-96205-01).

- This circuit provides the various supply voltages for the local test cabinet No. 3

(SD-96181) including -72 volts for testing of range-extended lines.

(9) Main Distributing Frame Test Circuit (SD-90070-01).

- This circuit is used primarily for establishing a test path from the local test desk or cabinet to the MDF. It requires connection to a switched gain repeater (SD-99488-01) for bridging connections onto range-extended lines.

(10) Service Observing Circuit (SD-96553-01)

- This circuit provides a test path for a No. 7 Service Observing Set or No. 12 Service Observing Desk

7. COST FACTORS

MEMORY

Fixed

7.01 The fixed cost of providing unigauge range extension consists of the following translation words:

- One word per range-extension equipped network in the 16-word range-extension master table.
- One 32-word range-extension equipment table is required for each network with range-extended concentrators. The table contains one word for each concentrator of a 2:1 network or concentrator pair of a 4:1 network.
- Two words in a range-extension enable table are required for each two J-unit pairs which use points of the same CPD card.

7.02 Eight words of CS are required for a range-extension status table. There is one word for each point of the CPD. The state of each buffer point is recorded on one bit of the word for the CPD point for the PD pack.

Variable

7.03 There are no variable word cost for this feature.

HARDWARE

7.04 Refer to 3.02 through 3.13 for hardware requirements of this feature.

8. AVAILABILITY

8.01 No. 2 ESS unigauge range extension is available with all current issues of the system program.

CONSIDERATIONS FOR INCORPORATION OF FEATURE INTO SYSTEM

9. PLANNING

Introduction of Range Extension

9.01 Range extension can be introduced into an office for quite different reasons:

- (1) A new No. 2 ESS office could be a replacement for an older office in an area already designed for unigauge with sufficient requirements to justify range extension in the initial planning.
- (2) A new No. 2 ESS office could be an additional office in an existing exchange, or a consolidation of two or more existing offices, where designing new outside plant to the unigauge plan would result in considerable savings, and immediate advantage of the range-extension capabilities of the No. 2 ESS could be made.
- (3) No. 2 ESS could replace an existing switching system in an area not designed to the unigauge plan; however, plans to take advantage of the savings in unigauge for growth could be advantageous. In this case, range-extension growth could be quite slow and, based on initial cost, the use of range-extension capabilities of the No. 2 ESS may be marginal. In this case, the ultimate potential for range extension must be considered, and the getting started cost for range extension kept at a minimum.
- (4) The No. 2 ESS Range Extension feature can be used to reach into an adjacent electromechanical wire center to provide custom calling features.

Refer to items 1 through 5 and 15 of Part 19 for details.

Range-Extension Traffic Engineering Considerations

9.02 Traffic engineering and administration of No. 2 ESS offices equipped for unigauge may require segregating lines into separate loading divisions and one for extended-range loops (1300 to 2500 ohms). It should be noted that traffic loads exist on range-extension concentrators from trunks and service circuits as well as lines. The effect of this loading arrangement will probably have a minimal effect on the loading differential between range-extended concentrators and nonrange-extended concentrators. Unless specific office experience indicates a wide differential in loading between range-extended concentrators and short loops, it is suggested that a single load division be established. The following items should be considered when engineering an office for unigauge. (Refer to item 10 of Part 19 for details.)

Range-Extension Forecasts

9.03 Forecasting the number of main stations for short loop or nonunigauge lines, and long loop unigauge lines must be made separately. If the number of range-extended lines (or nonrange-extended lines) is small, the forecasts should be sensitive to the possibility of nonrandom calling (that is, a high percentage of intraoffice calls between range-extended lines) and to the presence of unusual lines. As the number of range-extended lines (or nonrange-extended lines) increases, these problems tend to diminish.

Load Balancing

9.04 Junctor engineering in the No. 2 ESS assumes that each line trunk network (LTN) offers traffic that is equally distributed over the office and that all "communities of interest" are equally distributed over all of the LTNs in the office. Traffic administration procedures should maximize the probability of equal distribution. The introduction of unigauge range extension into an office increases the possibility of nonrandom calling patterns. For these reasons, range-extended concentrators should be distributed over the LTN frames as evenly as possible.

9.05 One feature has been provided to reduce the impact of some of those administrative problems on the 4:1 network. This feature permits one of a pair of multipled concentrators to be used for short loops, and one for long loops. Since this

feature tends to reduce unigauge economics, it should not be used except in those cases where loading and balance problems are severe.

Main Frame—Long Jumper Problem

9.06 Range extension must be considered when deciding on the type of distribution frame to be used. The "nonrandom" assignment of unigauge range-extended lines to range-extended concentrators may result in increased use of long jumpers on the distribution frame. For this reason, the use of the modular ESS-type CDF should be restricted to those cases where either there is uniform distribution of range-extended and nonrange-extended lines in the plant or in nonrandom situations when range extension is estimated to be less than 10 percent or greater than 90 percent of the total office lines. Common system distribution frames should be considered for those wire centers projecting a 10 to 90 percent development of range extension in order to minimize the "long jumper" problem. In any event, range extension should be assigned so that the number of long jumpers is minimized.

Alternatives

9.07 It is not necessary to provide excessive range-extension capacity in order to provide for every contingency. If it turns out that subsequent forecasts result in an actual exhaust date for range extension that precedes the actual exhaust for the remainder of the office, consideration should be given to moving the office growth data, or as a temporary solution, per-line treatment could be considered until the next scheduled office growth is put into service.

10. HARDWARE

10.01 To equip a No. 2 ESS office for unigauge range extension, the following hardware items must be installed:

- No. 2 ESS Range-Extension Frames (J2H034A)
- Twenty-four Circuit Range-Extension Units (J2H034AB)
- Voice-Operated Switched Gain Repeaters (SD-99488-01)
- Trunk Peripheral Decoder Applique Circuits (SD-2H170-01)

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10.02 The No. 2 ESS range-extension frame, J2H034A, (Figure 6) consists of a 7-foot by 2-foot 2-inch bay equipped with filter panel, fuse panel, and a frame control panel. It may be equipped with a maximum of six J2H034AB range-extension units to provide 144-circuit capacity.

10.03 Cabling from this frame is required to the power distributing frame (two leads), central pulse distributor (12 leads maximum), and network control/junctor switching frame (four leads/circuit).

10.04 The 24-circuit range-extension unit, J2H034AB, is shown in Figure 5. The basic unit, list 1, is wired for 24 amplifier circuit packs and two

peripheral decoders. The four amplifiers mounted in the left half of the row are wired to the left-hand PD and the four amplifiers on the right are wired to the right-hand PD. A power control key is furnished for each PD and associated amplifiers. List 2 on the unit adds a second set of eight amplifiers in the center row. List 3 on the unit adds a third set of amplifiers in the bottom row. The entire unit is prewired; therefore, no additional wiring is required with the additions of lists 2 and 3.

10.05 Current drain and power dissipation per circuit are as follows:

<u>EQUIPMENT</u>	<u>+24V DRAIN</u>	<u>POWER DISSIPATED IN OFFICE</u>
Amplifier	11 mA	0.30 w
Converter (assume 35-mA loop current)	39 mA	0.16 w
Cut through relay	41 mA	1.0 w
Peripheral Decoder (PD)	1.5 mA	<u>0.04 w</u>
		1.5 w/operating circuit

10.06 Current drain and power dissipation shown apply only to active circuits. Assuming a 40-percent B-link occupancy and that lines contribute

67 percent of this traffic, a fully equipped No. 2 ESS range-extension frame current drain, electrical power requirement, and heat dissipation are:

$$\begin{aligned}
 (5 \text{ mA} \times 12 \text{ PDs}) + (1 \text{ mA} \times 39 \text{ outputs}) &= 0.10 \text{ amp} \\
 90 \text{ mA} \times 39 \text{ active ckts} &= 3.5 \text{ amp} \\
 \text{total +24 V current drain} &= 3.6 \text{ amp} \\
 \text{total +24 V electrical power required} &= 90 \text{ watts} \\
 \text{total frame heat dissipation} &= 58 \text{ watts}
 \end{aligned}$$

The difference between power required (from central office battery) and heat dissipated in the office can be attributed to power dissipated outside the central office in the customer's line and telephone.

10.07 The following circuits are not normally present in a No. 2 ESS office without range extension.

(1) Voice-Operated Switched Gain Repeater (SD-99488-01)

- This repeater is provided to enable testing and maintenance of the unigauge plant. Two versions are provided:

- (a) 5-dB gain, for use with the test desk.
- (b) High impedance for bridging across range-extended connection to prevent upsetting the range-extended amplifier.

(2) Trunk Peripheral Decoder Applique Circuit (SD-2H170-01) (four transfer contacts) arranged for use with switched gain repeaters.

- Six trunk peripheral decoder controlled relays are mounted on a 2-inch mounting plate. Four transfer contacts are available on each relay. Also mounted on the same plate are additional terminal strips for connection to a switched gain repeater (SD-99488-01) when used.
- SD-2H170-01 can be ordered separately or as part of a unit prewired to SD-99488-01. When SD-2H170-01 is ordered as part of a unit and prewired to SD-99488-01, four of the relays are prewired to two repeater circuits for the no-test function in a range-extended office.

10.08 Refer to Part 7 for other associated common hardware. Refer to item 10 of Part 19 for the type, order code, schematic drawing, and functional use of all hardware required for range extension.

11. DETERMINATION OF QUANTITIES

11.01 Worksheets and detailed instructions for determining quantities are found in item 10 of Part 19. Also see Parts 7 and 10 of this section for specific items needed to implement this feature.

12. ASSIGNMENTS AND RECORDS

Assignment Recommendations and Guidelines

12.01 Unigauge loops which are beyond 1300 ohms from the central office require the range-extension feature. All lines requiring range extension must be assigned to a TEN of a concentrator equipped for range extension (refer to Division 8, Section 5a4 of item 12 of Part 19 of this section for information on Range-Extension Table, ESS Form 2508, assignments). Lines which are assigned to unigauge loops must be assigned to an equipped concentrator and all lines assigned to that concentrator must be assigned to unigauge loops. The assignment of concentrators to be equipped with range-extension repeaters must be done in accordance with items 12 and 21 of Part 19 of this section. The Plant and/or Engineering Department is responsible for providing the Traffic Department with the following range-extension requirements.

- (a) Projected total for end of engineering period.
- (b) Specific lines required for initial translations.
- (c) New service after cut-over is handled by service order.

12.02 On jobs where new assignments of range-extension repeaters are to be made, the new assignments must be obtained in advance of the ODA run in order to make line assignments. For subsequent jobs, the assigned concentrators can be obtained from the ESS 2503-5F-R office record.

Input and Record Keeping

12.03 Refer to 3.24 and 3.25 of this section for details.

Uniform Service Order Codes

12.04 Not applicable.

13. NEW INSTALLATION AND GROWTH

13.01 Unigauge range-extension capability is an integral part of No. 2 ESS system design. New central office installations can provide unigauge range extension when initially equipped with the hardware and translations described in 3.02 through 3.23 of this section and unigauge design customer

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loop plant has been installed per items 4 and 5 of Part 19 of this section.

13.02 To add unigauge range extension to an existing No. 2 ESS office the following items must be implemented.

- (1) Customer loop plant that is to be range extended must be installed or modified in accordance to unigauge design criteria as specified in items 3, 4, and 5 of Part 19 of this section.
- (2) Hardware items described in 3.02 through 3.13 must be installed as required per item 10 of Part 19 of this section.
- (3) An ODA run is required to build the Range-Extension Tables defined on ESS form 2508.

14. TESTING

Program-Controlled Range-Extension Testing

14.01 Diagnostic testing of range-extension circuits has been provided to detect faulty circuits and remove them from service. This testing is performed under program control using the precise level test tone circuit (SD-2H169-01) and the tone presence detector (SD-2H132-01). These tests are normally performed daily. In addition, the tests may be automatically initiated by the system if trouble is suspected or by a manual request by office personnel. These tests check for continuity through the circuit, increased dc talk battery, and insertion gain of ac signals in both directions. The test circuit gains access to both sides of the range extender via the network crosspoints and the test vertical access shown in Figure 2. A circuit failure results in a diagnostic message identifying the faulty circuit and a trouble locating manual index. The range-extension circuits may also be connected to the trunk test panel for trouble analysis and repair verification.

Testing From LTC or LTD

14.02 When a line is dialed up from the No. 3 LTC, the No. 14 LTD, or the No. 16 LTD, and the line is not busy, a metallic test path is established between the tester and the dialed line. If the line being tested is a unigauge loop line, the range-extension amplifier is placed in the idle (bypass) state. The tester should operate the REX key on the LTC or LTD to increase the talk

battery to the line. If a test trunk ringing circuit (SD-96474-01) or the remote testing circuit far end (SD-99311-01) is provided, a tone burst is sent to the tester when ringing is tripped as a reminder that a unigauge loop line is being tested.

14.03 When a busy line is dialed over a no-test trunk, a bridged connection is established between the tester and the busy line. This connection includes a bridging amplifier if the busy line is a unigauge loop line. The amplifier is required to prevent oscillation of the active range-extension circuit on the busy line connection. Operation of the REX key by the tester is not required on bridged connections.

Load Boxes

14.04 If load boxes are used to test the No. 2 ESS with unigauge, each connection from the load box to a range-extended line must include an artificial cable or network to prevent the unigauge repeaters from singing.

14.05 The 4229A networks are well suited for this application since they are small and inexpensive compared to other forms of artificial cable. Each 4229A network should be inserted in series with the tip-ring connection between the load box and the switching network and should be set to 14 kft.

Communications Serviceman's Test Set

14.06 The communications serviceman's test set (butt-in) must not be used for testing on range-extended lines either within or outside the central office because it will cause the unigauge repeater to sing. The repeater is designed to work only with 26-gauge cable and will sing when the butt-in set drastically alters the line impedance.

14.07 The butt-in may be used if a 10-kilohm resistor is placed in series with either the tip or ring lead of the handset (or the equivalent, a 5-kilohm resistor in series with each of the two leads of the handset).

14.08 The communications serviceman may bridge an unmodified handset onto range-extended loops outside the central office if it is at least 15,000 feet or 1200 ohms from the central office, whichever is the farther.

14.09 Tests to verify translation information in the No. 2 ESS consist of various verify messages at the TTY. Refer to items 13 and 14 of Part 19 for information pertaining to the variable fields of the messages and the interpretation of the response to these messages.

15. MEASUREMENTS

15.01 The weekly schedule (W) provides 100-second usage measurements on all B-link groups for each network in the office and provides usage measurements on either 64 preselected customer lines or two preselected concentrators in the No. 2 ESS office. Four traffic registers of the H or C schedule are available to count the number of times a given noncentrex line is found to be in a busy or talking condition by another call attempt. Refer to item 7 of Part 19 of this section for details of input and verification messages and traffic schedules pertaining to this feature.

16. CHARGING

16.01 Charging is an operating company option.

SUPPLEMENTARY INFORMATION

17. GLOSSARY

17.01 The following list identifies terms and abbreviations used in this document.

- Combined Distributing Frame (CDF)
- Central Pulse Distributor (CPD)
- Dial Long Line (DLL) Equipment—Range-extension equipment used on a per-line basis to provide signaling amplification on lines that have line loop resistances between 1600 ohms and 3600 ohms. It is used in conjunction with E6 repeater equipment.
- E6 Repeater—Range-extension equipment used on a per-line basis to provide transmission amplification on lines that have line loop resistances between 1600 ohms and 3600 ohms. It is used in conjunction with DLL equipment.
- Kilofeet (kft)—One thousand feet

- Line Loop Resistance—The electrical resistance of the pair of wires between the central office and a customer station.
- Line Trunk Network (LTN)
- Line Trunk Switch (LTS) Frame
- Network Control Junctor Switching (NCJS) Frame
- Office Data Administration (ODA)
- Peripheral Decoder (PD)
- Peripheral Order Buffer (POB)
- Range Extender with Voice Frequency Gain (REG)—Range-extension equipment used on a per-line basis to provide signaling and transmission amplification on lines which have line loop resistances between 1600 ohms and 3600 ohms. It is used in place of or to replace E6 repeater and DLL equipment.
- Terminal Equipment Number (TEN)

18. REASONS FOR REISSUE

18.01 This is the initial issue of this document.

19. REFERENCES

19.01 The following documents may be referenced for supplementary information concerning the Extended Range feature.

- (1) Section 902-215-120—Introduction To Subscriber Long Route Design
- (2) Section 902-215-121—Subscriber Long Route Design
- (3) Section 902-315-001—Engineering and Implementation Methods System Loop Plant—Unigaugage Design
- (4) Section 902-315-300—Customer Loop Plant Unigaugage Design
- (5) Section 902-315-301—Customer Loop Plant Outside Plant Detail Design and Administration Unigaugage Facilities

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- (6) Section 820-610-153—Range-Extension Frame
- (7) Section 232-120-301—Traffic and Plant Measurements
- (8) Section 232-190-020—Zone 16 Service
- (9) Section 232-127-326—Manual Translation Modification Procedure, Changing Range-Extension Capability
- (10) Traffic Facilities Practices, Division D, Section 12
- (11) Dial Facilities Management Practices (DFMP), Call Processing Description, Division H, Section 10c
- (12) Translation Guide TG-2H
- (13) Input Message Manual No. 2 ESS IM-2H200
- (14) Output Message Manual No. 2 ESS OM-2H200
- (15) GL 75-08-034 (E.L. 4157) No. 2 ESS Unigauge Range Extension
- (16) PA-2H2XX—Office Data Tables Layout Specifications
- (17) PD-2H2XX—No. 2 ESS Office Data Assembler and Translations Program
- (18) PD-2H213—Translations Programs
- (19) PD-2H216—Peripheral Order Buffer Program
- (20) PD-2H219—Peripheral Order Buffer Execution Program
- (21) SD-2H090-01—No. 2 ESS Combined Distributing Frame Assignment Practices
- (22) SD-2H145-01 (A458)—Range-Extension Circuit
- (23) SD-2H126-02—Ringing Circuit
- (24) SD-2H170-01—Trunk Peripheral Decoder Applique Circuit
- (25) SD-2H109-02—Incoming Trunk Circuit from Local Test Desk No. 14 or No. 16, or Local Test Cabinet No. 3
- (26) SD-2H110-01—Two-Way Trunk Circuit Switchboard No. 3CL in Distant Building
- (27) SD-2H141-01—Outgoing Trunk Circuit to Local Test Desk No. 14
- (28) SD-2H169-01—Precise Level Test Tone Circuit
- (29) SD-2H132-01—Tone Presence Detector
- (30) SD-99488-01—Voice-Operated Switched Gain Repeater
- (31) SD-99490-01—Unigauge Bridge Lifter
- (32) SD-96471-01—Test Trunk Ringing Circuit
- (33) SD-99311-01—Remote Testing Circuit—Far End
- (34) SD-95612-01—Primary and Secondary Test Cord Circuit Local Test Desk No. 14
- (35) SD-96181-01—Local Test Cabinet No. 3 Telephone and Test Circuit
- (36) SD-96205-01—Local Test Cabinet Supply Circuit
- (37) SD-90070-01—Main Distributing Frame Test Circuit
- (38) SD-96553-01—Service Observing Circuit
- (39) J2H034A—Range-Extension Frame
- (40) J2H034AB—Range-Extension Unit