

**SWITCHED SERVICES NETWORKS**  
**USING CENTRAL OFFICE SWITCHING MACHINES**  
**TRANSMISSION TESTING METHODS AT**  
**SUBSCRIBER STATIONS**

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**1. GENERAL**

**1.01** This section provides plant personnel with transmission testing methods at the station location on 4-wire subscriber lines and key station lines associated with Switched Services Networks. This section is reissued to include additional information.

**1.02** Transmission tests on subscriber line facilities are usually controlled by the serving switching center. 4-wire subscriber lines are served by a 4-wire No. 5 crossbar or 4-wire No. 1 ESS office. The tests are directed from the 19A testboard in 4-wire No. 5 crossbar offices in accordance with Section 310-200-500, Part 4. Key station lines may be served from either a 2-wire or 4-wire office. At 4-wire No. 5 offices, the 19A testboard directs tests in accordance with Section 310-200-500, Part 4. At 2-wire No. 5 offices, the tests may be directed from the 17E testboard or the master test frame in accordance with Section 310-200-501, Part 4. The tests are directed from the 21A testboard in 4-wire No. 1 ESS of-

fices in accordance with Section 310-200-510, Part 4. The craftsman at the subscriber station may refer to these sections in assisting with the transmission tests. This section adds information on test equipment, test access points, etc, which will aid the craftsman to work efficiently with the distant testboard.

**1.03** This section assumes that testing will generally be done by pre-arrangement at the request of the control office. When the craftsman arrives at the station, he should call the switching center and advise them when ready for tests.

**2. TEST EQUIPMENT**

**2.01** Test equipment for use at 4-wire stations should be arranged to make measurements at 600 ohms. Test equipment for use at 2-wire stations must be arranged to make measurements at 900 ohms. Equipment arranged only to operate at 600 ohms must be connected through a 2AB Auxiliary Test Set or equivalent for tests at 900 ohms. Loss measurements made in this manner must have 0.5 db subtracted for the loss in the matching coil.

**2.02** If 600-ohm test equipment is used to make measurements on a 900-ohm circuit without an impedance matching device an error will result.

**2.03** A transmission measuring set is required for multifrequency tests and for 1000-cycle loss tests. Some suitable TMSs are:

23A TMS

21A TMS equipped with 2AB Auxiliary Test Set

25A Gain and Delay Measuring Set.

Northeast Electronics TTS-4

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Equivalent sets may be used. They should be capable of measurements at 600 or 900 ohms with an accuracy of  $\pm 0.2$  db or better, and must be arranged for DC blocking. When the 2AB set or equivalent is used, subtract 0.5 db from the measured loss for the matching coil loss. The TMS should be checked for calibration before using. A 71B MW Reference Generator may be used for calibrating.

**2.04** An oscillator is required for multifrequency tests and 1000-cycle loss tests. Some suitable oscillators are:

KS-19353 Oscillator

21A TMS equipped with 2AB Auxiliary Test Set

25A Gain and Delay Measuring Set

Northeast Electronics TTS-4 equipped with variable frequency cover

Equivalent oscillators may be used if they are capable of sending up to +10 dbm at 600 or 900 ohms. They should be equipped for sending frequencies from 300 cycles to 4000 cycles with a setting accuracy of 2 per cent or better. They must be arranged for DC blocking. A TMS should be used with the oscillator to check output at all frequencies.

**2.05** Steady noise measurements require the use of the 3A NMS. The 6A Impulse Counter is necessary for impulse noise measurements.

**2.06** In addition to the usual test equipment, if the subscriber lines are equalized to correct envelope delay distortion, delay measuring sets should be available. The 25A Gain and Delay Measuring Set is preferred and should be used when available. In most cases, it will be required for accuracy.

**2.07** The 901, 902, and 903 portable data set sets should be available for trouble investigations.

**2.08** Practices providing information on testing equipment are shown in Table I.

**2.09** Cords should be provided as needed to connect the test set. In practically all cases, cords terminated at one end with small alligator clips are required. A 1011-type test handset will also be useful.

**2.10** 2-wire stations are normally arranged for loop supervision. The test sets should be equipped with a holding coil to maintain the connection on test calls. It will be necessary when making noise measurements to provide a hold coil. A 274J coil equipped with clip leads is suitable. A convenient arrangement which can be made up locally is shown in Fig. 7. A 274J coil and a 600-ohm resistor both equipped with clip leads are required.

**3. TEST ACCESS POINTS**

**(A) 4-Wire Stations**

**3.01** There are several arrangements of 4-wire line circuits in use. They are generally assembled from key telephone units. It is necessary to make transmission tests at terminals on KTUs unless test jacks are provided locally at the proper test points. It is necessary to provide a holding feature and to hang up the telephone set after the call is established to be sure the circuit is not double terminated during tests.

**TABLE I  
PRACTICES FOR TEST EQUIPMENT**

SET	SECTIONS
23A TMS	103-223-100
21A TMS	103-221-100 103-221-101
2AB Auxiliary Test Set	103-202-100
Northeast TTS-4 Test Set	103-204-100
KS-19353 Oscillator	103-302-105
KS-15878 Receiver and KS-15877 Transmitter	103-111-100
25A Gain and Delay Measuring Set	103-115-100
3A NMS	103-611-100
6A Impulse Counter	103-620-100
5M Portable Echo Suppressor Test Set	103-105-100
903A or B Data Test Set	107-200-100
902A or B Data Test Set	107-300-100
901A or B Data Test Set	107-100-100

**3.02** An arrangement for termination of 4-wire subscriber lines in 112A key equipment is shown in Fig. 1. It is necessary to block the M relay (SD-69482-01) and hang up the telephone set after the call is established to hold the connection in the condition for testing.

**3.03** Fig. 2 shows an arrangement for terminating 4-wire lines in 4-wire telephone sets. The connection is held for testing by blocking the TB relay in the operated position on the 255A KTU (SD-69488-01) after the call is established. The telephone set must be placed on hook for testing.

**3.04** Fig. 3 shows an arrangement for termination in 112A key equipment with alternate access from a 4-wire telephone. It combines the features of Figs. 1 and 2 through a transfer key.

**3.05** Fig. 4 shows an arrangement for termination of a 4-wire subscriber line in a 4-wire telephone set with auxiliary termination in data sets. A transfer key arrangement provides for connection to a data set after placing or receiving a call at the station instrument. An auxiliary transfer permits the use of a second data set which may be of a different type or may be secure voice equipment. The circuit is held for testing by connecting a hold coil across the transmitting test point on the 242A or 243A KTU (SD-69414-01) after the call is established. The handset must be on hook for transmission tests.

For tests at the 4-wire line circuit, the test call must be answered at the station and the circuit held as described above. To make tests at the data set terminations, the test call must be answered at the telephone set and the transfer key operated to hold up the connection.

**3.06** Fig. 5 shows another arrangement for auxiliary terminations that may be used either with 112A key equipment or 4-wire station sets. In this arrangement, test calls are answered at the telephone set, and the circuit held for testing as described in 3.05. Test calls to the data set terminations must be answered at the telephone set and the transfer key operated to hold up the connection.

**3.07** Fig. 6 shows an arrangement for termination of a 4-wire subscriber line in a 307 Switching System. Transmission measurements are made at the LTJ and LRJ jacks on the line circuit per SD-69506-01. The circuit is held for testing by an off-hook signal at the station instrument. The jacks are arranged to prevent bridging losses due to the handset termination.

#### **(B) 2-Wire Stations**

**3.08** Tests on lines terminated in 2-wire stations are made at the connector block. An arrangement should be assembled locally as shown in Fig. 7. All tests are made on a 900-ohm basis.

### **4. TESTING METHODS**

#### **(A) General**

**4.01** All tests are coordinated from the testboard at the distant central office. It is assumed that the craftsman reports to the distant testboard when ready for testing. The testboard then originates the test call, so all tests are made at the station on an incoming basis. The only exception is in the case of lines terminated in 2-wire stations which are served from 2-wire No. 5 offices. In some cases, these lines do not appear at the testboard. Tests are, therefore, coordinated from the master test frame.

**4.02** 4-wire subscriber lines are arranged for E and M signaling and are tested with 600-ohm equipment. The station handset is put on hook for testing, when the connection is held up by using a hold coil or blocking a relay.

**4.03** 2-wire stations are arranged for 900-ohm loop signaling. When answering test calls it is necessary to provide an alternate hold coil if the test set is not equipped for holding before disconnecting the instrument for testing.

**4.04** When ready for transmission testing, it is necessary to advise the testboard and wait for a return call. To answer test calls and prepare for tests, proceed as follows:

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**FIG. 1**

- Step 1 — Answer the call at the attendant telephone set and arrange test procedures. Block the M relay operated and hang up.
- Step 2 — For receiving tests, use the terminals indicated for the receive side and connect the test set with clip leads.
- Step 3 — For sending tests, use the terminals indicated for the transmitting side and connect the test set with clip leads.
- Step 4 — After completion of all tests, disconnect the test equipment and release the M relay.

**FIG. 2**

- Step 1 — Answer the call at the telephone set and block the TB relay operated on the 255A KTU. Then hang up.
- Step 2 — For receiving tests, bridge the test set on the receiving side at the terminals indicated on the 255A KTU with clip leads.
- Step 3 — For sending tests, use the terminals indicated on the 255A KTU. Connect the test set with clip leads.
- Step 4 — After completion of tests, disconnect test equipment and release the TB relay.

**FIG. 3**

- Step 1 — Make tests at the key equipment termination first as described for Fig. 1. The adjustment of pads for this appearance affects measurements at the 4-wire telephone set.
- Step 2 — Request a test call to the 4-wire telephone set. Operate the auxiliary service transfer key and hang up at the 112A equipment.

Step 3 — Make tests at the 4-wire telephone set as described for Fig. 2.

Step 4 — Before releasing the circuit disconnect test equipment, be sure all relays are restored and operation of the circuit is normal.

**FIG. 4**

Step 1 — Answer the test call at the 4-wire telephone set and arrange test procedures. Clip a 274J hold coil across the transmitting test point and hang up.

Step 2 — To make receiving tests, bridge the test set on the receiving side at the terminals on the 242A or 243 KTU with clip leads.

Step 3 — To make transmitting tests, use the transmit side terminals indicated on the 242A or 243 KTU and connect the test set with clip leads.

Step 4 — After completion of tests, disconnect the test sets and operate the transfer key.

Step 5 — To make transmitting or receiving tests at the data set, remove the data set connections and connect test sets to terminals on the appropriate 245A KTU as indicated.

Step 6 — After completion of tests, restore the data set connections.

Step 7 — If a second data set termination is provided, operate the auxiliary transfer key and make tests at the second data set termination in the same manner as for the first.

Step 8 — After completion of all transmission tests, disconnect test equipment and restore all transfer keys. Be sure operation is normal before releasing the circuit.

FIG. 5

- Step 1 — Answer the test call at the attendant telephone set or 4-wire telephone set and arrange test procedure. Block the M relay operated and hang up.
- Step 2 — Make test at the 4-wire line circuit as described for Fig. 1 or 2.
- Step 3 — Operate the transfer key or auxiliary transfer key and make tests at the data set terminations as described for Fig 4.
- Step 4 — After the completion of tests, restore all relays and transfer keys, disconnect test equipment and be sure operation is normal before releasing the circuit.

**Note:** If there is only one data set termination, common pads may be used.

FIG. 6

- Step 1 — Answer the test call at the telephone set and arrange test procedures. Operate the "Hold" key or leave the handset off hook to hold the circuit for testing.
- Step 2 — For sending tests, connect the test set to the LTJ jack. This automatically disconnects the station transmitter, and the test cord must be removed from the jack to restore talking capability.
- Step 3 — For receiving tests, connect the test set to the LRJ jack. This automatically disconnects the station receiver, and the test cord must be removed from the jack to restore listening capability.
- Step 4 — After completion of tests, disconnect all test cords and restore the circuit to service.

### (B) 4-Wire Stations

**4.05 1000-Cycle Loss Tests** — 4-wire lines are designed to specified overall 1000-cycle losses. Part or all of the loss may be in the cable or carrier facility. When the facility loss is small, the remainder of the loss is provided in the line circuits by means of adjustable pads. The losses should be specified on the CLR card.

The testboard sends 1000-cycle tone at 0 dbm through a 2 db test pad toward the 4-wire station. The desired received levels at the 4-wire telephone set and testboard are generally specified on the CLR card. Pads are chosen to meet the desired values as nearly as possible. Strap-pable pads (SD-69414-01) are adjustable in 2 db steps. They are strapped to the nearest value.

The craftsman will be asked to send 1000-cycle tone at 0 dbm to establish the desired receive level at the testboard.

Pad values are prescribed on circuit orders. If the pad values are in error by more than 1.0 db, do not change the pads without permission. The variation may be due to circuit troubles.

**4.06 Attenuation-Frequency Tests** — These tests are made in the same manner as 1000-cycle tests. They are made only after the 1000-cycle loss tests are completed. They are made to test transmission characteristics of the circuit or adjust equalizers. The craftsman's responsibility is to send tone or make receiving measurements at the request of the testboard personnel while adjustments are being made in the equalizers.

Whenever an auxiliary service termination is provided to connect a data set, operate the auxiliary transfer key and connect the test sets at the auxiliary termination.

**4.07 Message Circuit Noise Measurements** — The testboard requires a 600-ohm termination on the transmitting pair for noise measurements. The 3A NMS (at 600 ohms) is used for measurements of noise on the receiving pair. The testboard must furnish a 600-ohm termination at the distant end for this measurement. The test of the receiving path can also be made on a routine basis by dialing the central office balance test line.

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Make noise measurements as requested and report actual meter readings in dbrnc.

**4.08 Impulse Noise Measurements** — The testboard requires a 600-ohm termination on the transmitting pair for impulse noise measurements. Use a 600-ohm resistor or connect a 600-ohm TMS. The 6-type Impulse Counter is used to make tests on the receiving pair. To make tests, proceed as follows:

Step 1 — The correction factor is the EML as shown on the CLR card.

Step 2 — Subtract the correction factor from 59 dbrnc0 (lower the number). Set this level on the impulse counter. If it can't be set exactly, use the next higher setting.

Step 3 — Connect the counter to the receive path and make measurements in accordance with instructions for the test set. Report the measurements in counts per half hour.

**4.09 Delay Distortion Measurements** — These tests are required to determine facility characteristics or to test delay equalizers in central offices.

The 25A Gain and Delay Set is preferred as it is more accurate and does not require external DC blocking equipment. The set should be calibrated on each occasion of use. A 20 minute warm-up period is necessary before calibration checks are made.

When measuring accuracy of not better than 100 microseconds is required, the KS-15877 Transmitter and KS-15878 Receiver or equivalent delay distortion measuring sets may be used. A 30 minute warm-up period is necessary before calibration checks are made on the KS sets. External DC blocking equipment is required. A 1:1 ratio transformer designed to work between 600 ohms may be used as a DC blocking device. The transformer should be measured to determine its effect on the final delay distortion measurements.

Section 103-115-100 or 103-111-100 as appropriate should be available with the sets. These should be followed carefully because of the complexity of the sets.

Tests are made in both directions and at frequencies requested by testboard personnel. Make the tests at the data set whenever it is provided.

**4.10 Transmitter Current Tests** — Good transmission depends on the provision of proper current through the handset transmitter, and it should not be too high, particularly when TOUCH-TONE sets are used. To measure the current, connect a KS-14510 volt-ohm-milliammeter or equivalent in series with the transmitting tip or ring lead to the station set. Set the scale to 0-.120 amp and lift the handset. The current should not be less than .027 amp. It should not be more than .055 amp in TOUCH-TONE sets.

### (C) 2-Wire Stations

**4.11** Overall transmission tests can be made readily at the telephone set by first assembling a test arrangement as shown in Fig. 7. Test calls can be answered at the instrument and transferred to a test set without losing supervision. The telephone set can be reconnected at any time via the key for communication with the testboard.

**4.12** Transmission tests are required in both directions. Since only one direction can be tested at one time, arrangements should be made with the testboard as to procedure before starting tests.

**4.13** Some 2-wire station lines are not terminated at a testboard in the switching center. They may be tested from a master test frame. In either case, the tests are controlled from the switching center.

## 5. TROUBLE INVESTIGATIONS

**5.01** When trouble reports are received on station lines, the craftsman may be requested to assist. In many cases, it will be necessary to make tests on the station equipment. If the

trouble appears to be in the station line, the testboard may wish to repeat the circuit order transmission tests to determine the trouble.

**5.02** Other tests which may require assistance at the station are:

(a) **DC Tests on Cable Pairs** — If cable facilities are included in the circuit, tests may require opens, shorts, crosses, grounds, etc, at the station.

(b) **Carrier Channel Net Loss Tests** — Carrier channel tests may be required, if the carrier system has been terminated at the customer's premises.

(c) **Repeater Tests** — Repeaters located at the station may require test and adjustments for proper gain as specified on the CLR card.

(d) **SF Unit Tests** — SF unit tests located at the station may require routines performed in accordance with appropriate practices.

(e) **DX Unit Tests** — DX unit tests may be required in accordance with Section A220.684.

(f) **Overall Pulsing Tests** — Overall signaling and pulsing tests may require assistance in accordance with appropriate sections.

**5.03** When data transmission troubles are reported, the testboard may request the use of the 900 Series Data Test Sets. These may be used to determine whether the trouble is in the line or the station. Procedures for their use are covered in Sections 107-100-100, 107-200-100, 107-300-100.

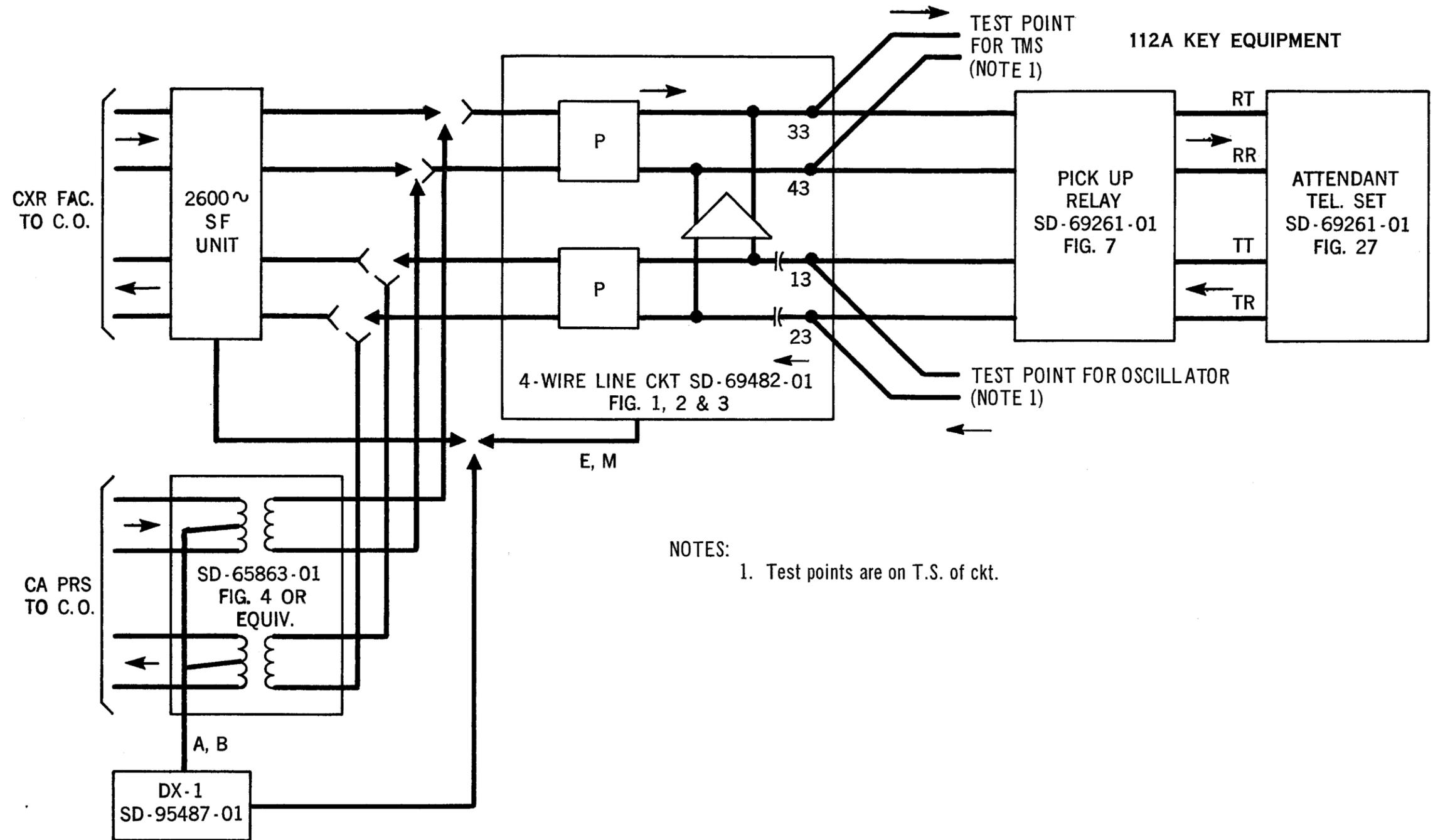


Fig. 1 — Typical 4-Wire Subscriber Line Termination in 112A Key Equipment per SD-69482-01 With E & M Signaling and Local Battery

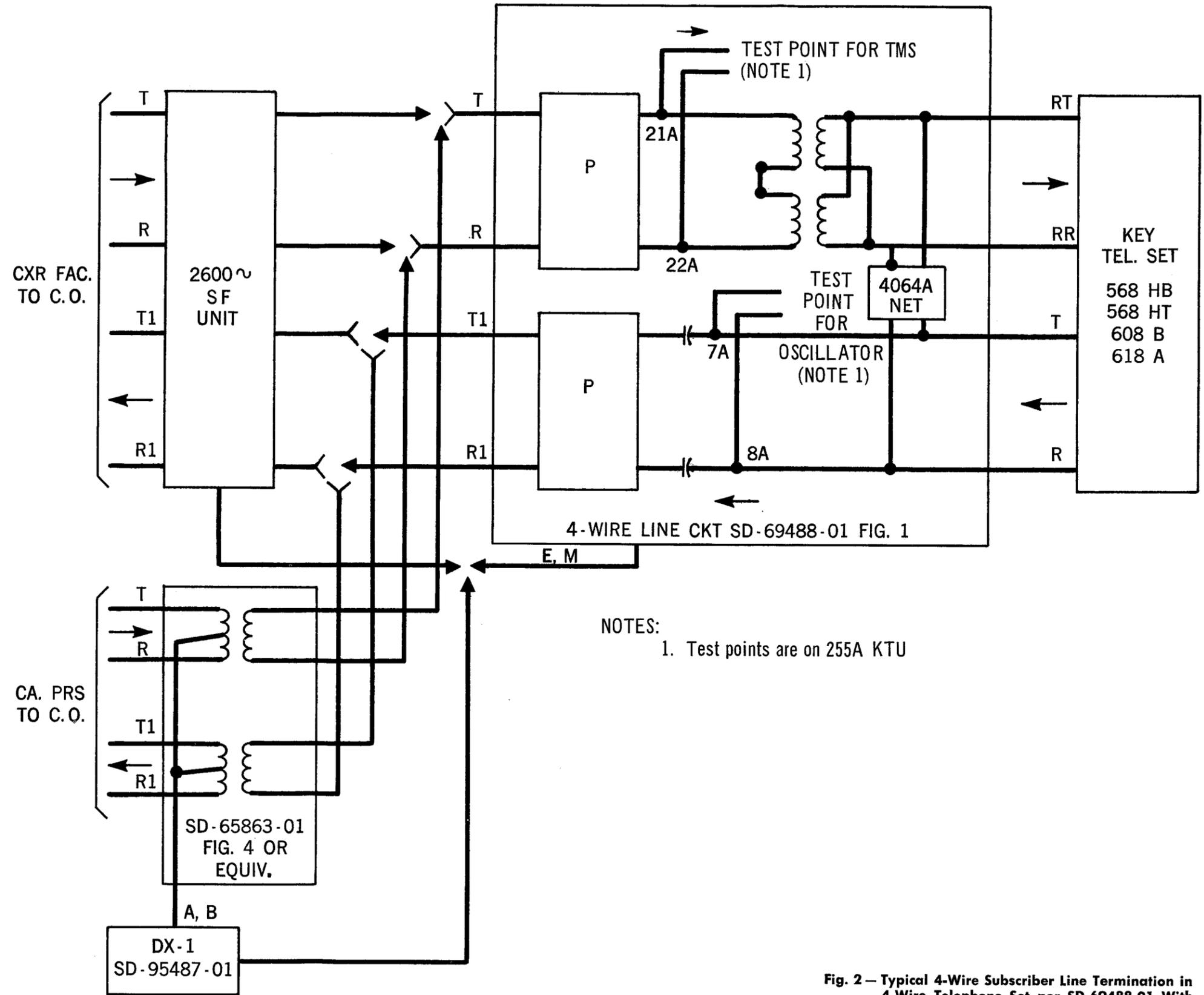


Fig. 2 — Typical 4-Wire Subscriber Line Termination in 4-Wire Telephone Set per SD-69488-01 With E & M Signaling and Local Battery

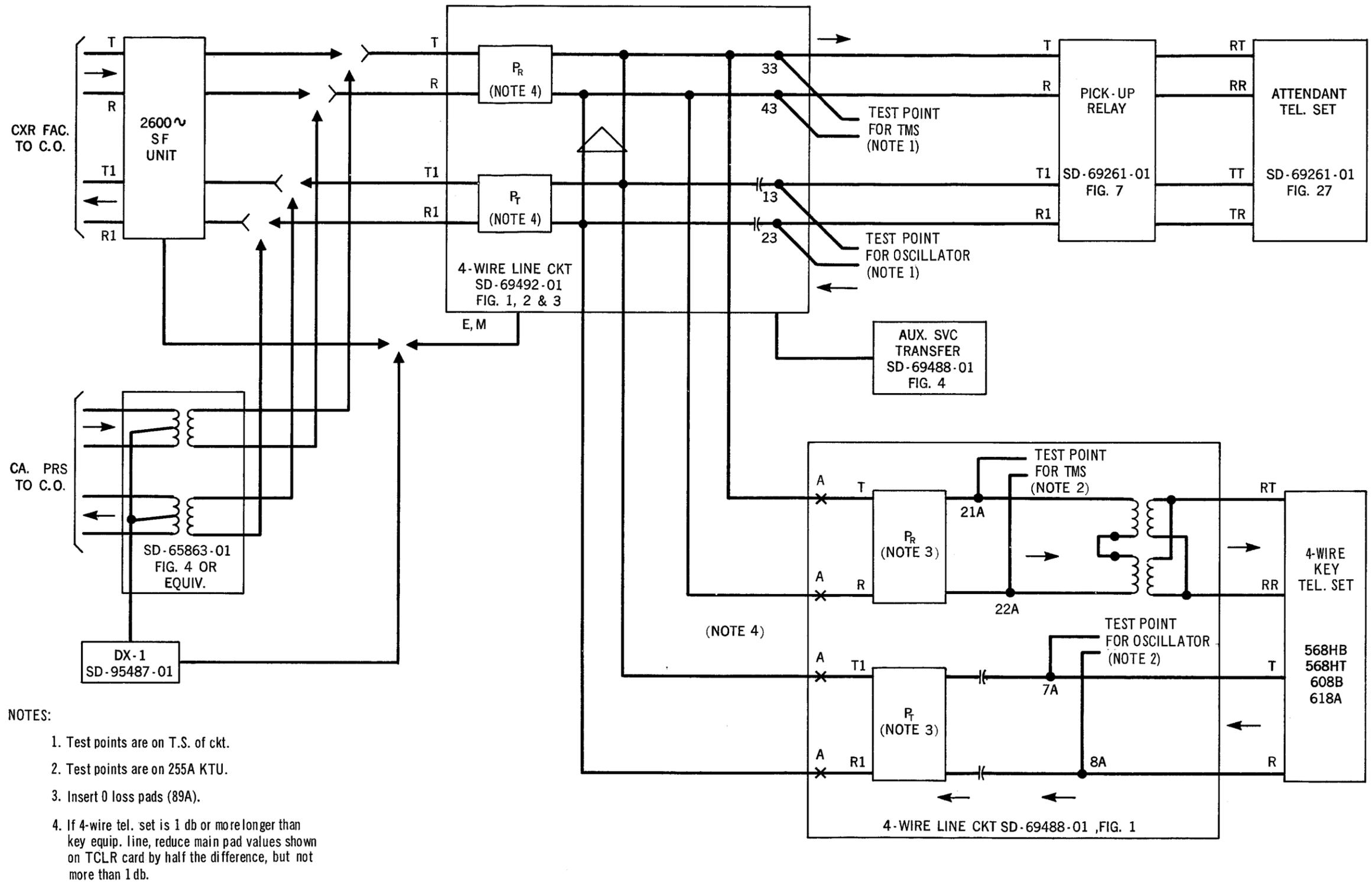
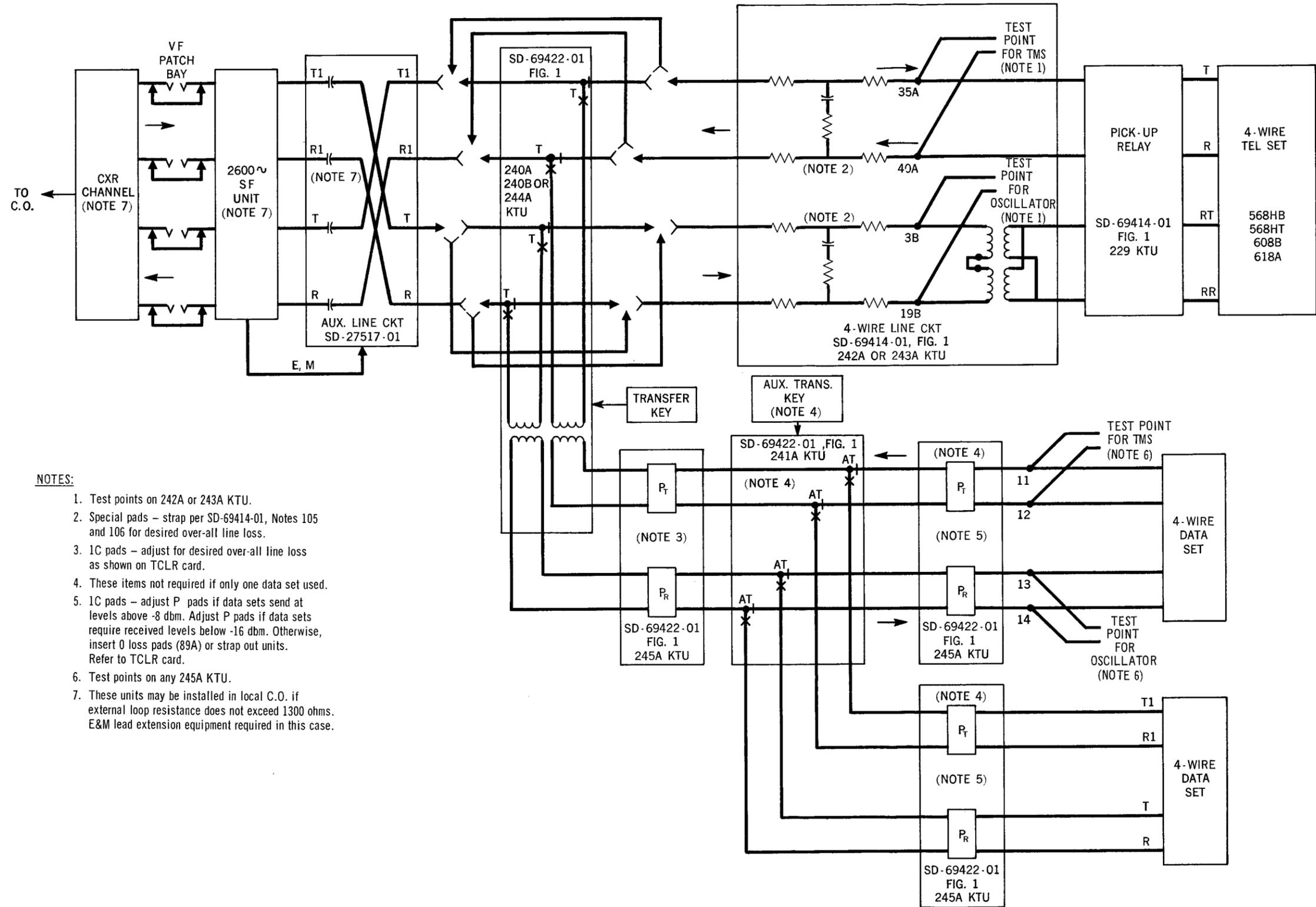


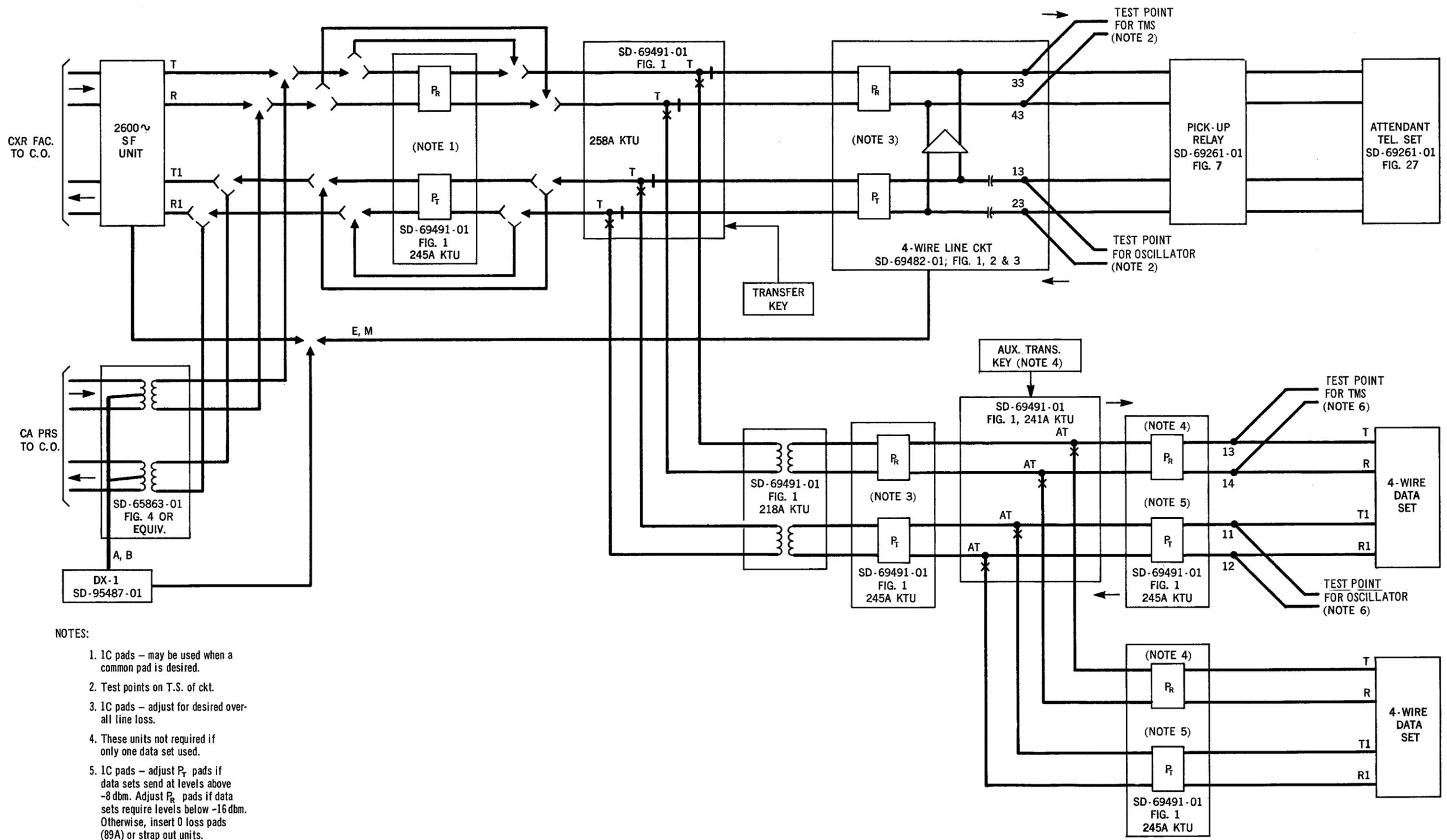
Fig. 3 - Typical 4-Wire Subscriber Line Termination in 112A Key Equipment and 4-Wire Telephone Set per SD-69482-01 and SD-69488-01 With E & M Signaling and Local Battery



**NOTES:**

1. Test points on 242A or 243A KTU.
2. Special pads – strap per SD-69414-01, Notes 105 and 106 for desired over-all line loss.
3. IC pads – adjust for desired over-all line loss as shown on TCLR card.
4. These items not required if only one data set used.
5. IC pads – adjust P pads if data sets send at levels above -8 dbm. Adjust P pads if data sets require received levels below -16 dbm. Otherwise, insert 0 loss pads (89A) or strap out units. Refer to TCLR card.
6. Test points on any 245A KTU.
7. These units may be installed in local C.O. if external loop resistance does not exceed 1300 ohms. E&M lead extension equipment required in this case.

**Fig. 4 – Typical 4-Wire Subscriber Line Termination in 4-Wire Telephone Set per SD-69414-01 and Auxiliary Termination per SD-69422-01 With E & M Signaling and Local or Common Battery**



- NOTES:
1. IC pads - may be used when a common pad is desired.
  2. Test points on T.S. of ckt.
  3. IC pads - adjust for desired overall line loss.
  4. These units not required if only one data set used.
  5. IC pads - adjust P<sub>T</sub> pads if data sets send at levels above -8 dbm. Adjust P<sub>R</sub> pads if data sets require levels below -16 dbm. Otherwise, insert 0 loss pads (89A) or strap out units.
  6. Test points on any 245A KTU.
  7. Refer to TCLR card for pad values.

**Fig. 5 - Typical 4-Wire Subscriber Line Termination in 112A Key Equipment per SD-69482-01 With Auxiliary Termination per SD-69491-01 With E & M Signaling and Local Battery**

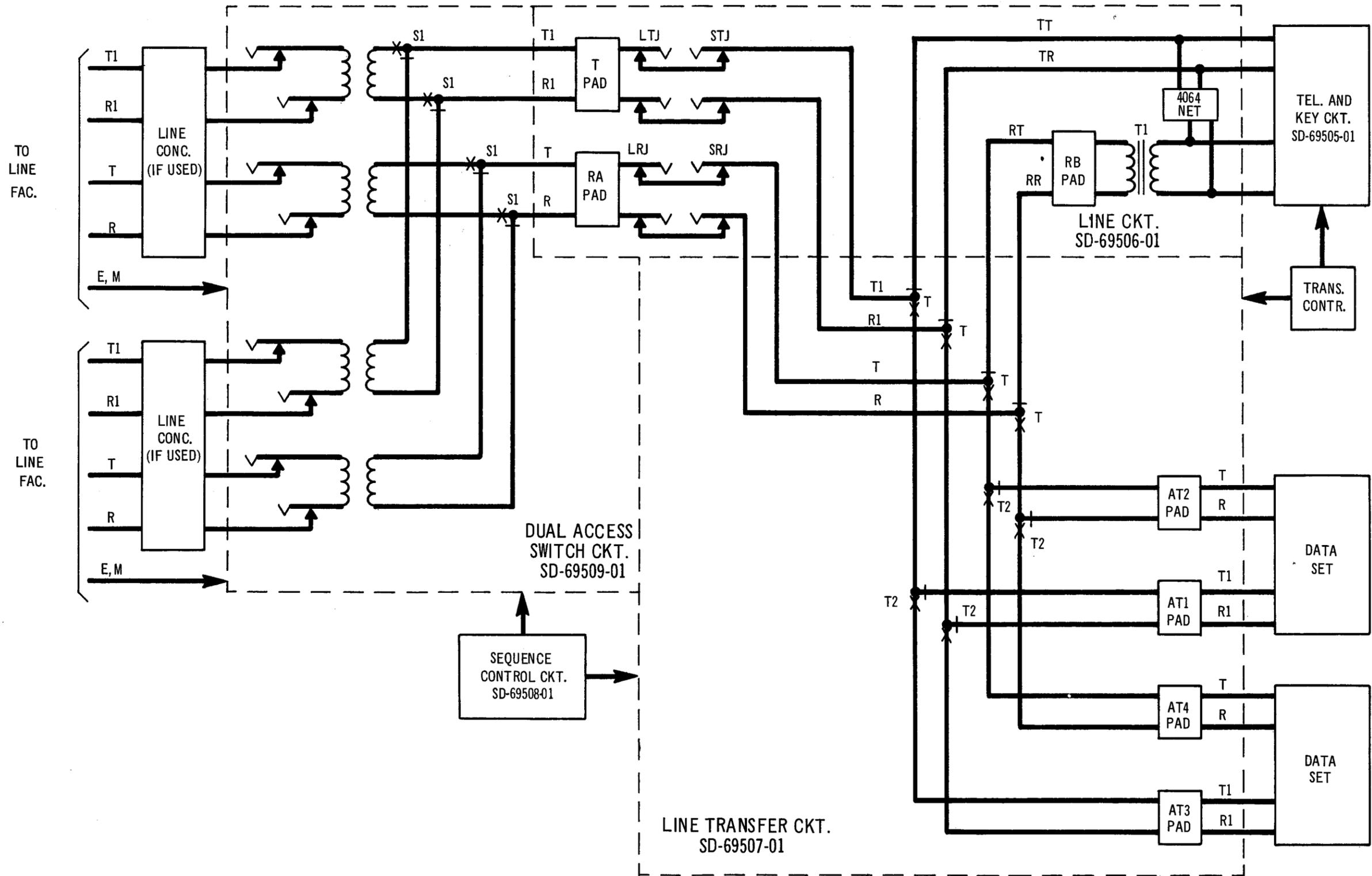
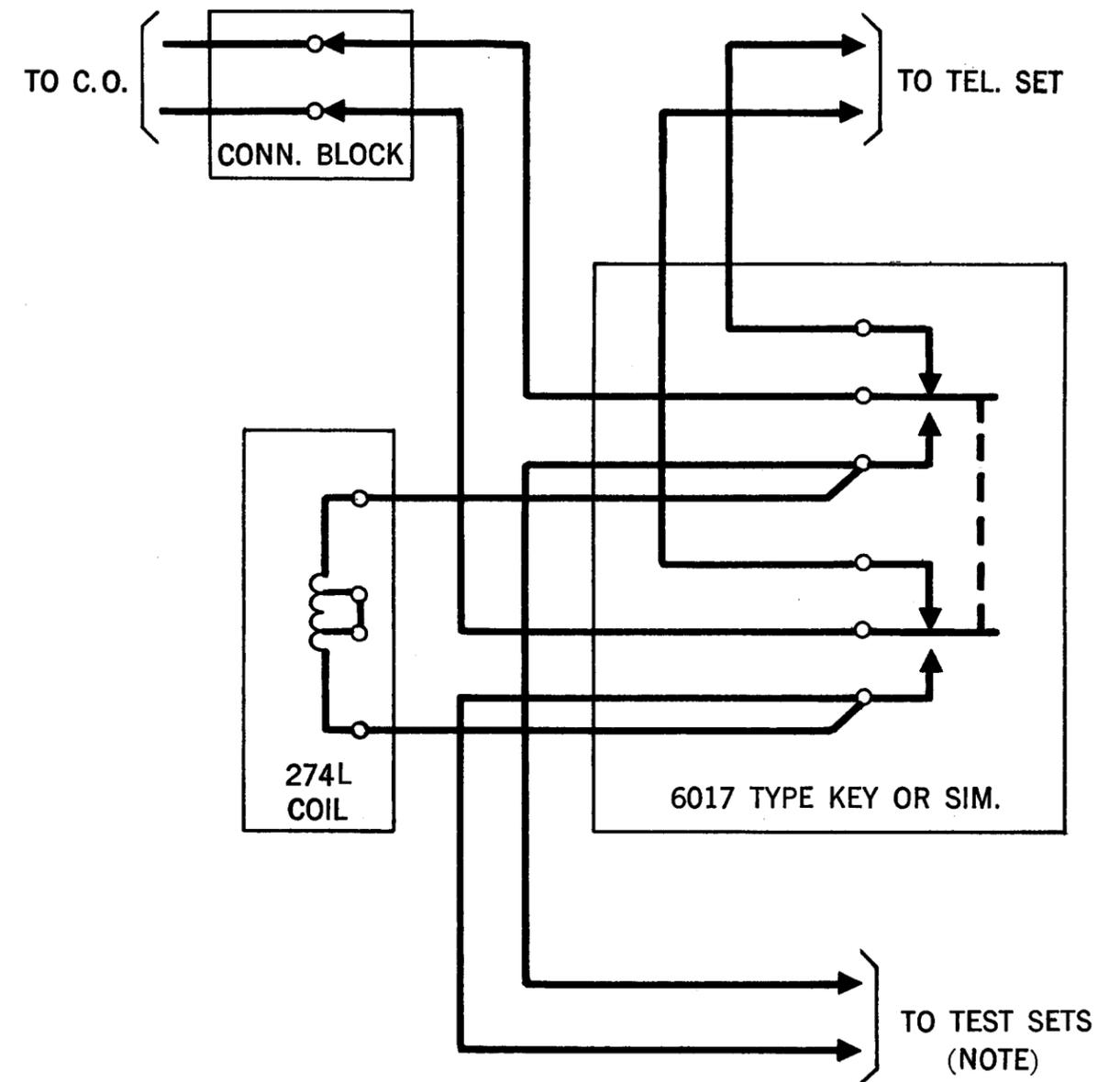


Fig. 6 — Typical 4-Wire Line Termination in 307 Switching System



Note - If test set does not have DC blocking, connect a 437 type or similar 4MF capacitor in series in each leap.

Fig. 7 - Arrangement for Testing on 2-Wire Station Lines