AUTOMATIC TRANSMISSION TEST AND CONTROL CIRCUIT (ATTC) DESCRIPTION NO. 4A AND 4M TOLL SWITCHING SYSTEMS

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1. INTRODUCTION

1.01 This section describes the automatic transmission test and control circuit (ATTC) which is used for making automatic transmission loss measurements and noise checks of intertoll trunks. The ATTC is used in conjunction with the automatic outgoing intertoll trunk test frame (AOIT) in 4-type toll offices. The term trunk test frame or trunk test circuit as used in this section refers to the AOIT.

1.02 This section is reissued to incorporate material from the addendum in its proper location. In this process marginal arrows have been omitted.

1.03 Section 103-235-100 describes the far-end equipment used in the distant offices for automatic transmission loss measurements and noise checks and explains the general methods of making the measurements on an automatic or manual basis. The ATTC equipment uses the same type amplifier, amplifier-rectifier, and adjustable pads as the far-end equipment, and functions in a generally similar manner while making a measurement. This section covers the general method of operation of the circuits and equipment at the near end for performing the tests and for the suitable presentation of the results of the tests

2. GENERAL DESCRIPTION

2.01 The automatic transmission test and control circuit (ATTC) provides the means for making the transmission loss measurements and a noise check at the originating or near end of the trunk and for recording the results of the test on a fully automatic basis. The transmission loss measurement consists of adjusting the loss of a set of receiving pads, with the far end sending 1000-cycle test power, so as to bring the test power level at the output of the receiving pads to 1 mw. The ATTC equipment, together with the teletypewriter, is mounted in the ATTC frame adjacent to the AOIT. A schematic of the transmission path is shown in Fig. 1.

2.02 When the trunk test circuit is not engaged in making transmission tests, the ATTC remains idle and the ATTC side of the coil is terminated in a 600-ohm resistor at the trunk test frame. The trunk test circuit is set up for making transmission tests by the operation of the TRANS & NOISE key or the TRANS ONLY key on the trunk test frame. The trunk test circuit acts as a control for the ATTC during a transmission test and provides timing intervals by means of a multivibrator timing circuit.

2.03 The ATTC makes two transmission loss measurements during a trunk test, one of the trunk loss in the far-near direction, and one for registering the trunk loss in the near-far direction. This requires two amplifiers and two sets of pads. For the near-far measurement, test power is sent to the far-end equipment by the operation of relay SND (Fig. 1). The near-far trunk loss is then measured and registered at the far end. When the far-near measurement is to be made, relay REC 1 (Fig. 1) operates to extend the TL and RL leads from the trunk test circuit to the far-near amplifier for receiving test power from the far end. The far-near trunk loss is then measured and registered at the ATTC by the far-near amplifier and the set of far-near receiving pads.

2.04 For registering the near-far trunk loss measurement at the ATTC, relay AC (Fig. 1) operates to add the near-far amplifier and the set of near-far receiving pads in tandem with the far-near amplifier and pads. Test power from the far end is extended to the amplifiers and the two sets of pads by the operated relay REC 1. The near-far trunk loss is then registered on the near-far receiving pads at the ATTC.

2.05 When associated with the AOIT, both the far-near amplifier and the near-far amplifier are set for a fixed gain of 19.9 db. The amplifiers are alike except that the far-near amplifier is equipped with a noise weighting network. The 1000-cycle supply is adjusted to zero level at the MW or (1000, 0, 600) jack on the ATTC bay. Compensation for office wiring loss is provided by trimmer pads in the line side of the AOIT hybrid.

2.06 The amplifier-rectifier gain is adjusted so that relay P in the output circuit will operate to its contact 2 when the test power level output from the receiving pads is 1 mw or higher. Relay P will release and close its contact 3 when this power level is reduced to 0.1 db below 1 mw. Relay P is used as the control device during the pad adjustment to bring the test power level to 1 mw.

2.07 Each set of receiving pads consists of nine separate pad units having losses of 10, 5, 4, 2, 1, 0.5, 0.4, 0.2, and 0.1 db, respectively. Each pad unit is inserted in the transmission path by the operation of a corresponding pad control relay. By operating the nine pad control relays in various combinations, the loss in the transmission path can be adjusted to any value between 0 and 19.9 db in 0.1 db steps. This permits the test power level to be adjusted to 1 mw to within ±0.1 db. At the start of a test all pad control relays are normal and the total receiving pad loss is 0 db.

2.08 Each pad control relay operates a supplementary relay to control the loss in a set of check pads. Each set of check pads has nine pad units having losses of 10, 5, 1, 2, 1, 0.5, 0.1, 0.2, and 0.1 db, respectively. At the start of a test, the total loss in each set of check pads is 19.9 db. When a pad control relay operates to insert a loss in the transmission path, the supplementary relay removes an equal loss from the check pads. Consequently, the total loss in the transmission path and the associated check pads is always 19.9 db regardless of which pad control relays are operated. This feature is used for checking purposes as explained later.

2.09 The supplementary pad control relays carry additional contacts, not shown in Fig. 1. These are used to translate the pad control relay settings to measured losses of the trunk when the deviations are to be computed for recording by the teletypewriter.

2.10 The trunk check pads and loop check pads indicated in Fig. 1 are used in connection with accuracy checks as explained later.

2.11 The noise check makes use of the far-near amplifier, which is equipped with a network to provide F1A noise weighting. Relay AC is released to remove the near-far amplifier and pads. Relay PCO is operated to reduce the loss of the near-far pads to 0 db. The gain of the amplifier-rectifier is increased by reducing the amount of feedback. The noise check may be made at 35 dba, 40 dba, or 45 dba, as determined by optional wiring in the amplifier-rectifier.

2.12 The control circuit includes a computer for computing the deviation of the measured loss of the trunk in each direction from the specified loss class value. The computer obtains information regarding the specified loss from the class relays and information regarding the measured loss in the two directions from the settings of the far-near and near-far supplementary pad control relays. The teletypewriter prints the specified net loss class and the deviation for each direction of transmission, together with the proper sign, as a part of the trunk test record. This presents the results of the test in a form suitable for a statistical analysis of the transmission performance of the trunks tested. The computer also controls the operation of a set of deviation registers. These are manually resettable counters which provide a tally of all deviations measured, in 1/2 db increments, from +8.0 db to −8.0 db. Since the ATTC cannot measure gains, the maximum negative deviations which can be recorded is limited to the specified net loss of the trunk under test. The readings of these counters serve to reduce the effort required when making statistical analyses of the transmission performance after tests of a large number of trunks.

2.13 The control circuit includes checking features to insure that all phases of a test are completed correctly. The trunk test circuit blocks and sounds an alarm if the transmission test cannot be completed successfully and within the designed time limits.

2.14 The trunk test frame selects the trunk to be tested and pulses forward the proper code to reach the transmission measuring and noise checking equipment in the distant office. When the distant end is ready to start the test, it returns a steady off-hook signal over the trunk. This signal operates the supervisory relay of the trunk test circuit, which then makes certain checks of the trunk relay equipment in the home office before starting the transmission test. Up to this point, the trunk test circuit functions in exactly the same way as if it were making a code 103 test line test. Any irregularities in the trunk circuit functions will result in a trouble indication in the same way as when running a code 103 test line test cycle. If these initial tests are successful, the trunk test circuit starts the transmission test.

2.15 All measurements by the ATTC are in terms of the terminal net loss (TNL) of the trunk under test, and are therefore consistent with tests made by the toll testboard. A test hybrid is included in the AOIT in the transmission path between the ATTC and the trunk under test. In split pad offices, the AOIT provides a pad control signal to remove the 2 db portion of the A pad from the trunk. In a single A pad office, where S = 2 db, the AOIT provides a signal to remove the entire A pad from the trunk. In the latter case, the test hybrid circuit is built out to a loss of (A+2) db.

3. TRANSMISSION TEST AND NOISE CHECK

3.01 The transmission test is carried out in four steps. These steps are (1) sending toward the far end, (2) receiving test power from the far end for the far-near loss measurement, (3) receiving test power from the far end for the near-far loss measurement, and (4) the noise check. Fig. 5 is a flow chart showing the various functions performed during Steps 1, 2, 3, and 4. These various functions are described in greater detail in the subsequent paragraphs. The paragraph numbers listed in Fig. 5 refer to the paragraphs in the following text describing the particular function.

A. Step 1 — Sending

3.02 When the initial tests (2.14) are finished, the trunk test circuit grounds lead "SND" (Fig. 1), operating relays SND and 1MW to send 1000-cycle test power to the TL and RL leads. From a transmission standpoint, this send condition is the same as when sending on the same trunk from the intertoll trunk test jacks at the toll testboard. While the test power is connected, the far end measures the loss and checks the measurement. After about 3 seconds, the trunk test circuit removes ground from lead "SND" to stop sending and then pauses for about 1/2 second.

3.03 If the measurement is not successful, the far end will return a short on-hook signal during this pause. This momentarily releases the supervisory relay of the trunk test circuit as a "repeat test" signal. This signal causes test power to be sent for another trial. After a third unsuccessful attempt, the trunk test circuit will block and sound an alarm with lamp FNCK lighted. The far end will time out in about 6 seconds after the trunk test circuit blocks and will return a reorder signal causing the SV lamp on the trunk test frame to flash at 120 ipm.

3.04 If the measurement at the far end is successful in any one of the first three attempts, the far end will not return the repeat test signal. After the 1/2-second pause, the trunk test circuit grounds lead "SND" for about 1/2 second to send a short spurt of test power to the far end. This is an "automatic test" signal to notify the far end that this is an automatic test. The trunk test circuit then causes the ATTC to prepare to receive test power from the far end. This completes Step 1 of the measurement. The trunk test circuit then starts a 9-second (approximately) timing interval for the completion of Step 2. If the measurement is not completed during this interval, the trunk test circuit will block and sound an alarm.

3.05 If the trunk loss in the near-far direction exceeds 19.9 db, the far end will be unable to detect the test power and start a measurement. In this case the far end will time out about 6 seconds after seizure and will return a 120 ipm flashing supervisory signal before the 9-second timing interval elapses. This will cause the trunk test circuit to block and sound an alarm with lamp NFO lighted.

B. Step 2 — Far-Near Measurement

3.06 *Preparation for Receiving:* The ATTC receiving circuits remain idle up to the end of Step 1, but immediately thereafter the far end will return test power for Step 2. The ATTC must be put into condition to detect the test power and to start the measurement when it arrives. The method of doing this is shown in Fig. 2.

3.07 At the time the trunk test circuit sends the automatic test signal, it operates relays ON and TA. Then the automatic test signal is removed and relay REC is operated, which operates relay REC 1 of Fig. 1. This extends the

TL and RL leads of the trunk test circuit to the input of the far-near amplifier, enabling the ATTC to receive test power from the far end. Relay REC also opens the original operating path of relay TA, leaving relay TA locked operated through contact 3 of relay P on the amplifier-rectifier. When the test power arrives, relay P operates and releases relay TA. Relay TA, released, operates relay TA1 which starts the measurement.

3.08 If the trunk loss in the far-near direction exceeds 19.9 db, the received test power will be too weak to operate relay P on the amplifier-rectifier and the measurement will not start. Also, if the far end fails to return the test power, relay P will not operate. The trunk test circuit, at the end of the 9-second timing interval, will then block and sound an alarm with lamp FNO lighted.

3.09 ***Far-Near Loss Measurement:*** The far-near loss measurement consists of increasing the loss by connecting the far-near receiving pads into the circuit (Fig. 1), so as to reduce the test power level at their output to exactly 1 mw. At this fixed power level, the far-near trunk loss bears a fixed relation to the far-near receiving pad loss and the trunk loss can be determined from the pad loss.

3.10 When the test power level at the pad output is 1 mw or higher, relay P on the amplifier-rectifier operates to its contact 2 but when the power level is reduced to only 0.1 db below 1 mw, relay P releases and closes its contact 3 (2.06). The scheme of measurement, therefore, is to increase the far-near receiving pad loss until relay P is just on the verge of moving from contact 2 to contact 3. At this point the power level is 1 mw and the receiving pad adjustment stops.

3.11 The pad adjustment takes place in steps by means of 204-type selectors. These are driven by a polar relay-type pulse generator. The action which takes place is described in the following paragraphs and illustrated in Fig. 3.

3.12 When relay TA1 operates upon the arrival of the test power (3.07), it starts the pulse generator which drives relay P1 at about 8.5 pulses per second. Relay P1, operated, (1) opens the input path to tube V4 on the amplifier-rectifier (shown as leads "M" and "D" in Fig. 3) which causes relay P to release and close its contact 3, (2) advances selector A to position 1, and (3) operates relay OTM. Relay OTM simply introduces a delay to prevent closure of the path to brush 1 until selector A is seated on position 1.

3.13 When relay OTM operates, pad control relay 10A operates and locks. This inserts the 10 db far-near receiving pad (shown in Fig. 1) which reduces the power level. A moment later, during the open period of the pulse, relay P1 releases and recloses the input path to tube V4 on the amplifier-rectifier (leads "M" and "D" in Fig. 3). Relay P will now reoperate on the test power from the far end if the power level at the output from far-near receiving pads in Fig. 1 is still 1 mw or higher; otherwise, relay P will remain on its contact 3.

3.14 The method of control, therefore, is as follows: If the test power level, after the 10 db far-near pad is inserted, is less than 1 mw, relay P on the amplifier-rectifier will remain on its contact 3 during the open period of the pulse. The +130 volt battery at relay TA1 will then be routed through contact 3 of relay P, various other contacts, and brush 2 of selector A to the winding of pad control relay 10A. This shunts down relay 10A, which removes the 10 db far-near pad before the selector is advanced to position 2. If, however, the power level is still 1 mw or higher, after the 10 db pad is inserted, relay P will operate to its contact 2 during the open period of the pulse. This opens the shunt down path and relay 10A remains locked in the operated position to retain the 10 db pad as the selector is advanced to position 2.

3.15 It will be noted that when relay P1 releases, it operates relay RTM. The shunt down path mentioned above is carried through a contact of relay RTM. Relay RTM introduces a delay after relay P1 releases to prevent the pad control relay from being shunted down prematurely, before relay P on the amplifier-rectifier has had an opportunity to operate, if it is going to do so.

3.16 As selector A is advanced, a far-near receiving pad unit is inserted at each step in the order 10 db, 5 db, 4 db, etc. If the power level at any step drops below 1 mw after the pad unit is inserted, the control relay for that unit will be shunted down, as explained above, to remove the pad. Then, at the next step, the next lower value of pad will be tried. If the power level at any step is still 1 mw or higher, after the pad unit is inserted, that pad unit will be retained. At position 9 of the selector all nine receiving pad units will have been tried, ending with the 0.1 db pad, and the receiving pad loss will have been increased so as to reduce the power level to 1 mw.

3.17 With the AOIT, the gain of the far-near amplifier is 19.9 db. Therefore, the following relationship will exist.

Far-Near Rec Pad Loss = 19.9 db — Far-Near Trk Loss

This relation permits the far-near pad control relay settings to be translated directly to the trunk loss in the far-near direction. (The loss of the hybrid on the AOIT is included as a part of the trunk loss as discussed in 2.15. From a transmission standpoint, this receive condition is the same as when using the toll testboard transmission measuring system.)

3.18 At position 10 of selector A, transfer relays TR1 and TRA operate to transfer control leads "ORM," "OPR," and "RPR" to selector B. Selector B then starts to move and the control circuit proceeds with a "trunk check."

3.19 ***Trunk Check:*** After the pad adjustment is finished, the power level should be very near 1 mw. However, if one or more of the pad control relays failed to operate and lock, or if they failed to be shunted down properly, or if the trunk net loss is negative (i.e., a gain), it would not be possible to bring the test level power to 1 mw. Also, if the trunk loss should change suddenly while the pad adjustment is in progress, it might not be possible to bring the power level to 1 mw. The far-near pad control relay settings would then be incorrect and would pass incorrect information to the computer regarding the trunk loss. The trunk check guards against errors from such causes. If the check fails, a repeat test signal is returned to the far end so that another trial can be made to secure a better adjustment. The trunk check is made in the following manner.

3.20 At position 1 of selector B, relay HCK operates and inserts trunk check pad A (Fig. 1) in the transmission path to reduce the power level 0.5 db. If the power level was not more than about +0.5 dbm at the start of the check, this reduction will cause relay P to remain on its contact 2 after relay P1 has released. Therefore, relay HCK will be shunted down during the open period of the pulse, removing check pad A. At position 2 of selector B, relay LCK operates and removes check pad B, increasing the power level 0.5 db. Relay P will operate when relay P1 releases if the power level at the start of the check was about −0.5 dbm or higher. Consequently, relay LCK will not be shunted down at position 2, and check pad B remains out of the transmission path. At position 3 of selector B, a ground is routed to the contacts (shown in Fig. 3) of relays HCK and LCK. If the check indicates that the test power level is satisfactory, the ground goes to open contacts at the released HCK and the operated LCK. However, if HCK remained operated (power level too high), or if LCK was released (power level too low) the ground has a path to relay TKR, which operates and locks. This condition will cause another trial to be made to secure a better adjustment.

3.21 ***Check for Removal of Test Power:*** The trunk check utilizes test power from the far end and must be completed before the far end removes the test power. After the trunk check, the ATTC must be able to detect when the far end removes the test power so that it can prepare for Step 3. This is done in the following manner.

3.22 At position 4 of selector B, pad cut-out relay PCO operates and locks. This releases relay TA1 (see Fig. 2) which stops the pulse generator, leaving selector B at position 4. Relay PCO short-circuits the series elements and opens the shunt paths of the far-near receiving pads (Fig. 1), reducing the loss to 0 db. Relay P on the amplifier-rectifier then reoperates on the test power from the far end and operates relay TR (Fig. 3). The circuit rests in this position to await the removal of the test power at the far end.

3.23 During the far-near measurement and trunk check, the trunk test circuit is on a 9-second timing interval (3.04). If the far end fails to remove the test power before this interval elapses, the trunk test circuit blocks and sounds an alarm with lamp LTR lighted. This provides a check of the far end in case the far end fails to respond to the automatic test signal and returns test power for 10 seconds, as on a manually dialed test.

3.24 When the far end removes the test power, relay P on the amplifier-rectifier releases, releasing relay TR. A ground is then routed from the contacts of relay TA1 through contact 3 of the P relay, various other contacts, and brush 2 and position 4 of selector B to the trunk test circuit over lead "TTR." The 9-second timing interval is canceled and, if the trunk test was successful, the ATTC is prepared for Step 3. In doing this, relay AC (Fig. 1) operates to add the near-far amplifier and near-far pads. Relay TA (Fig. 2) is reoperated to prepare to receive test power for Step 3 and to release relay PCO to reinsert the far-near receiving pads (Fig. 1). The trunk test circuit will then start a new 9-second timing interval, during which time Step 3 of the measurement should be completed.

3.25 If the trunk check failed, (relay TKR operated) the ATTC will not prepare for Step 3. Instead, a short spurt of test power will be sent to the far end as a repeat test signal, and the control circuit, the far-near receiving pads, and selectors A and B will be restored to the condition prevailing at the start of Step 2. The far end will send test power for another trial. The trunk test circuit will block and sound an alarm with lamp HNCK lighted after a third unsuccessful attempt.

C. Step 3 — Near-Far Measurement

3.26 *Use of "Add 10" Signal:* During Step 1 the far end adjusts a transmitting pad so that the transmitting pad loss is equal to the trunk loss in the near-far direction, provided the trunk loss is less than 10 db. If the trunk loss in the near-far direction is 10 db or more, the transmitting pad loss is adjusted to a value 10 db less than the trunk loss. (This arrangement is to avoid having the far end send test power at a very low level. By use of the "add 10" signal this level is never lower than −9.9 dbm). The far end sends through the transmitting pad for Step 3. The arrangements are such that the loss measured by the ATTC in Step 3 is the loss of the transmitting pad at the far end. Consequently, the ATTC must know whether the transmitting pad loss at the far end is equal to the trunk loss in the near-far direction, or whether it is 10 db less than the trunk loss. An "add 10" signal provides this information as follows.

3.27 In case the far end had adjusted the transmitting pad loss to a value 10 db less than the trunk loss, it will, just prior to sending for Step 3, return a short on-hook signal over the trunk. This signal causes the trunk test circuit supervisory relay to release and ground the AD10 lead to the ATTC. Ground on the AD10 lead causes the ATTC to add 10 db when the near-far pad control relay settings are translated to the trunk loss in the near-far direction. If the transmitting pad loss at the far end is equal to the trunk loss in the far-near direction, the far end will not return the "add 10" signal. The ATTC will then translate the near-far pad control relay settings directly without the 10 db correction.

3.28 The far end pauses about 1/2 second after Step 2 and then sends test power for Step 3. Should the far end fail to return test power for Step 3 before the 9-second timing interval elapses, the trunk test circuit will block and sound an alarm with lamp LTA lighted. This provides a check on the far end in case the far end is unable, for any reason, to continue through the test sequence.

3.29 *Near-Far Loss Measurement:* When test power arrives, relay P operates and starts the measurement as described in 3.07. Selector B (Fig. 3) starts to step and the near-far receiving pads are adjusted in the same manner as previously described for the far-near pads. At position 10 of selector B, transfer relays TR2 and TRB operate to transfer control leads "ORM," "OPR," and "RPR" to selector C. Selector C then starts and continues the pad adjustment. At position 4 of selector C, the near-far receiving pad adjustment is completed.

3.30 At positions 5 and 6 of selector C, relays HCK and LCK are operated to make a trunk check as described in 3.20. The control circuit then proceeds with a "loop check."

3.31 *Loop Check:* Several conditions may arise, other than improper pad control relay operation which is taken care of by the trunk check (3.19), which could result in an inaccurate measurement. Some such sources of error are as follows:

(a) The gains are adjusted so that relay P on the amplifier-rectifier will just operate when the test power level at the output from the receiving pads is 1 mw (2.06). If the gain of the amplifier-rectifier or of either amplifier changes from the initially calibrated setting, relay P will operate on some power other than 1 mw. This will cause a corresponding error in the measurement.

(b) If the test power supply deviates from the standard value, it will cause a corresponding error in the near-far loss measurement at the far end. The far end will then return incorrect information regarding the trunk loss in the near-far direction.

(c) Faulty pad control relay contacts or defective pad components or wiring might cause the loss of one or more of the receiving pad units or check pad units to be incorrect. This would result in an incorrect pad loss setting with a corresponding error in the measurement.

The loop check guards against errors from such causes.

3.32 The loss introduced in the transmission path by each set of receiving pads plus the loss remaining in the associated set of check pads (Fig. 1) is always 19.9 db (2.08). The effective gain of each amplifier is also 19.9 db (2.05). Therefore, if all the receiving pads, check pads, and both amplifiers are connected in tandem, the net loss of the combination should always be the same, after the measurements are finished, regardless of the trunk losses being measured. The loop check test checks this loss using the local test power supply and the amplifier-rectifier and relay P so as to include all items which might affect accuracy. The measurement is rejected if this loss is not within about ±0.2 db of the normal value. The ±0.2 db tolerance permits slight cumulative deviations in the losses and gains of the various parts. The loop check is made in the following manner.

3.33 At position 7 of selector C (Fig. 3), relay LP operates and in turn operates relay 1 MW of Fig. 1. Referring to Fig. 1, this connects the local test power supply through the far-near, near-far, and loop check pads, the two amplifiers, and the two sets of receiving pads to the input of the amplifier-rectifier. Relay AC is still operated to include the near-far amplifier and receiving pads in the transmission path. Also, relay LCK is operated and relay HCK is released if the trunk check was successful, so that trunk check pads A and B are both cut out. With this arrangement the net loss between the test power supply and the amplifier-rectifier will be 0.3 db if everything is in perfect order. This provides 0.2 db margin for the operation of relay P. However, if the net loss is more than 0.2 db above normal due to incorrect pad losses, low gains, or low test power supply, relay P will not operate. Relay LP will then be shunted down during the open period of the pulse before selector C advances to position 8.

3.34 At position 8 of selector C, relay LPC operates. Referring to Fig. 1, this inserts the 0.5 db loop check pad which reduces the power level 0.5 db. This is 0.2 db less than the power required to operate relay P. Therefore, if the check is satisfactory, relay LPC will be shunted down during the open period of the pulse, removing the 0.5 db loop check pad. However, if the net loss is more than 0.2 db below normal due to incorrect pad losses, high gains, or a high test power supply, relay P will operate and cause relay LPC to remain operated at position 8.

3.35 At position 9 of selector C, relay RLP operates which releases relays LP and 1 MW to restore the transmission path to normal.

3.36 Referring to Fig. 3, if the trunk check failed at position 5 or 6 of selector C (relay HCK operated or relay LCK not operated), the operation of relay LP at position 7 causes relay TKR to operate and lock. This will cause a repeat test to be made regardless of the outcome of the loop check. If relay LP was released at position 7, the operation of relay LPC at position 8 causes relay LPR to operate and lock. Also, if relay LPC was not released at position 8, the release of relay LP at position 9 causes relay LPR to operate and lock. Relay LPR, operated, indicates failure of the loop check, and will cause a repeat test to be made even though the trunk check was successful.

3.37 At position 10 of selector C the pad cutout relay PCO again operates, which functions as described in 3.22, and stops selector C at position 10. The control circuit then waits for the removal of the test power at the far end.

3.38 If the far end fails to remove the test power before the 9-second timing interval elapses, the trunk test circuit will block and sound an alarm with lamp LTR lighted.

3.39 When the far end does remove the test power, the circuit again functions as described in 3.24, up to the operation of relay AC. The trunk test circuit then causes the ATTC to prepare for the noise check in Step 4. However, if the trunk check or loop check failed (relay TKR or LPR operated), the ATTC will not proceed with Step 4. Instead, a short spurt of test power will be sent to the far end as a repeat test signal and the control circuit, pads, and selectors A, B, and C will be restored to the condition prevailing at the beginning of Step 2. The far end will then return test power to repeat both Step 2 and Step 3. The trunk test circuit will block and sound an alarm with lamp HNCK lighted after a third unsuccessful attempt.

D. Step 4 — Noise Check

3.40 When the far end removes the test power at the end of Step 3, the circuit functions as described in 3.24, up to the operation of relay AC, and the trunk test circuit causes the ATTC to prepare for a noise check, if the near-far measurement was successful. In doing this, relay AC (Fig. 1) is released to remove the near-far amplifier and near-far pads. Relay PCO remains operated to keep the far-near pad loss at 0 db. The amplifier-rectifier circuit is rearranged to increase the gain in preparation for the noise check. The trunk test circuit then starts a 5-second (approximately) timing interval for the noise check.

3.41 During the 5-second timing interval, the output of the amplifier-rectifier charges a capacitor through a high resistance. The arrangements are such that the voltage charge accumulated on the capacitor will be proportional to the integrated noise voltage over the 5-second interval. This arrangement is the same as that described in Section 103-235-100. At the end of the 5-second interval, the voltage on the charged capacitor is presented to the current amplifier tube on the amplifier-rectifier panel. If the capacitor voltage is high enough, relay P will operate momentarily. At this same time relay CN (Fig. 3) is operated momentarily. If the noise voltages were high enough to cause relay P to operate, relay P will, in turn, operate relay HEN which locks. Relay HEN causes the teletypewriter to print the letter "N" (for noise) in the next to the last column on the test record and lights lamp HEN on the trunk test frame as an indication of the high noise condition at the home end of the trunk. However, if relays P and HEN remain normal during the noise check, the test will go to completion without the high noise indication. The amplifier-rectifier is set, by means of optional wiring, to give a high noise indication when the noise exceeds 35, 40, or 45 dba.

3.42 On completion of the noise check, the trunk test circuit will start a new 9-second timing interval during which the far end should complete its noise check and return a disconnect signal. If the disconnect signal does not arrive during the 9-second timing interval, the trunk test circuit blocks and sounds an alarm with lamp LDC lighted.

3.43 When the far end completes the noise check, it returns an on-hook signal as a disconnect signal. This will be a 120 IPM flashing signal if a high noise condition was registered at the far end. In this case, the ATTC will cause the teletypewriter to print the letter "N" in the last column on the test record and will light lamp FEN on the trunk test frame to indicate a high noise condition at the far end. If the disconnect signal is a steady on-hook signal, the test goes to completion without the high noise indication for the far end.

3.44 Upon receipt of the disconnect signal, the ATTC causes the teletypewriter to complete the test record. When the test record is complete, the trunk test circuit breaks down the connection and advances to the next trunk.

3.45 When the TRANS ONLY key on the trunk test frame is operated, the noise check is omitted. On completion of Step 3 the teletypewriter starts printing the results of the transmission measurements. When the record is complete, the trunk test circuit breaks down the connection and advances to the next trunk without waiting for the completion of the noise check.

4. RECORDING RESULTS OF TESTS

A. General

4.01 Analyses of the deviations in over-all trunk net losses from the specified values are of assistance in the maintenance of these trunks. They give a rating to the quality of transmission maintenance on the plant involved. They also furnish clues as to where specific maintenance effort should be applied.

4.02 For such analyses there is considerable advantage in obtaining the results in a short period of time as is done with the ATTC, where it is applicable. The ATTC is arranged to provide the data in convenient form. It includes a computer circuit which computes the deviation for each direction of transmission on each trunk tested and the results are printed by the teletypewriter, together with the proper sign, + or −. In addition, deviation registers classify the deviations in the 1/2 db steps useful for these analyses.

4.03 Busy trunks may be omitted from the test cycle by operating key APB (automatic pass busy) on the trunk test frame. With key APB normal, the teletypewriter will print a record of the identification number of the busy trunks passed over without test, and also print the cue letter "B". The test can be arranged, with the AOIT only, to wait 2 minutes or 4 minutes for the busy trunk to become idle, by operating key TM2 or key TM4 on the AOIT.

B. Computer

4.04 The deviation is the difference obtained by subtracting the specified net loss from the measured loss. If the measured loss is greater than the specified, the deviation is + (excess loss), while if the measured loss is less than the specified, the deviation is − (excess gain). The computer makes this computation for each direction of transmission on each trunk tested in the following manner.

4.05 There are 28 class relays associated with the trunk test circuit and the ATTC, representing specified net loss classes. These relays are designated 3.9, 4.2, 4.5, etc, to 12.0, and correspond to specified net loss values from 3.9 db to 12.0 db in 0.3 db steps. For each trunk, the net loss class relay is chosen which agrees with the specified net loss of the trunk. Class relays are associated with trunks by means of cross connections at the test connector frame of the trunk test circuit. Lamps are provided on the ATTC to give a visual indication of which class relay is operated. When the test connector crosspoints close, the class relay operates a number of relays in the computer to set up a 3-digit number in the computer representing the specified net loss class. These relays remain operated throughout the test. The trunk test circuit will time out if these relays do not operate properly.

4.06 When the measurement is finished, some combination of the nine far-near pad control relays and some combination of the nine near-far pad control relays remain locked in the operated position, depending upon the measured loss in the far-near and near-far directions, respectively. Contacts on the supplementary relays supply grounds over a number of leads to the computer. The combination of leads which are grounded give to the computer a 3-digit number which is the measured loss of the trunk.

4.07 Because two computations must be made, the leads from the pad control relays are closed through to the computer through cut-on relays. Thus, to compute the deviation in the far-near direction, far-near cut-on relays will close through to the computer seven sets of leads from the far-near pad control relays, as shown in Fig. 4. One, and only one, lead in each group is grounded. Some of these leads operate relays to the computer. Ground supplied from the pad control relays on the remaining leads are then extended through the computer to the output leads to the teletypewriter. The combination of output leads which are grounded represent the result obtained after subtracting the specified net loss class from the measured loss in the far-near direction.

4.08 When the teletypewriter is ready to print a deviation, it operates cut-on relays, momentarily, one at a time, to close through the separate sets of output leads representing (1) the sign, (2) the tens digit, (3) the units digit, and (4) the tenths digit in that order. Only one lead in each set of output leads will be grounded. This operates a code relay in the teletypewriter control circuit for printing the proper digit. Should an open or cross occur on the leads from the pad control relays through the computer to the teletypewriter, the code relay will not operate properly and the teletypewriter will "stick." The trunk test circuit will then time out.

4.09 After the tenths digit of the far-near deviation is printed, the far-near computer cut-on relays release. The near-far computer cut-on relays then operate and the process is repeated for the near-far direction.

4.10 The leads from the class relays to the computer are also multipled to cut-on relays in the teletypewriter control circuit. These leads supply information to the teletypewriter for printing the specified net loss class.

C. Deviation Registers

4.11 In calculating bias and distribution grade, the deviations are grouped in 1/2 db increments between −8.0 db and +8.0 db. All deviations falling within a particular increment are tallied on a corresponding line on the stroke sheet. In the ATTC this collection into 1/2 db increments and the tally within each increment is taken care of automatically by manually resettable counters. There are 33 of these counters provided for use with the AOIT. The counters correspond to the 1/2 db tally lines on the stroke sheet as follows:

POSITIVE DEVIATIONS	COUNTER
+7.8 db or more	+8.0
+7.3 db to +7.7 db, incl	+7.5
+6.8 db to +7.2 db, incl	+7.0
etc to	
+0.3 db to +0.7 db, incl	+0.5

NEGATIVE DEVIATIONS	COUNTER
−7.8 db or more	−8.0
−7.3 db to −7.7 db, incl	−7.5
−6.8 db to −7.2 db, incl	−7.0
etc to	
−0.3 db to −0.7 db, incl	−0.5
−0.2 db to +0.2 db, incl	0

4.12 A total tests register, TT, is also provided for each set of deviation registers. The TT register strokes one count for each one-way measurement (two per trunk tested). The reading of the TT counter serves as a check of the sum of the readings of the deviation counters.

4.13 Prior to the start of a transmission test cycle, all of the counters are reset manually to "0". Whenever a deviation is computed, one of the counters will be operated to stroke one count in the proper increment, depending upon the magnitude of the deviation. When the test cycle is finished, the readings of each counter can be entered directly on the corresponding line on the stroke sheet for calculating bias and distribution grade.

4.14 A key, XDR, on the trunk test frame disables the deviation registers. This key is provided so that two operations of the register for the same trunk can be avoided. It is used, for example, when making a repeat test on a trunk following a trouble condition, or when interrupting a test cycle for a special test of a particular trunk. The key is restored when the regular test cycle is resumed.

D. Wide Deviation Checking Feature

4.15 A deviation checking arrangement is provided to give an indication whenever a deviation in either direction exceeds a prescribed limit. This limit can be set, by means of optional wiring, to a single office value of ±3.0, ±4.0 or ±5.0 db.

4.16 When relay LCK operates during the trunk check following the far-near measurement (3.20), the far-near computer cut-on relays operate and a deviation computation is made for the far-near direction. The teletypewriter is at rest at this time but one of two register relays in the computer will be operated, depending upon whether the far-near deviation is above or below the checking limit. When relay LCK operates during the trunk check following the near-far measurement (3.30), the near-far computer cut-on relays operate and a similar computation is made of the deviation in the near-far direction. At the completion of a test, the deviation checking feature causes the trunk test circuit and teletypewriter to function as follows:

(a) If the teletypewriter is turned off, a deviation in either direction in excess of the checking limit, or a high noise condition registered at either end, will cause the trunk test frame to block and sound an alarm.

(b) If the teletypewriter is turned on and if key XTP on the trunk test frame is normal, the teletypewriter will print a test record for each trunk tested. In addition, the letter "U" will be printed in the next to the last column if the deviation checking limit in the far-near direction is exceeded. However, if the trunk is also noisy in the far-near direction, the letter "N" will be printed instead of "U". If the checking limit is not exceeded and the trunk is not noisy, this column is left blank. Teletypewriter functions similarly for the near-far direction except that the letters "U" or "N" are printed in the last column of the test record. These letters stand out on the test record to "mark" those trunks having unusually large deviations or high noise.

(c) If the teletypewriter is turned on and if key XTP on the trunk test frame is operated, the teletypewriter will not print a transmission test record for each trunk tested. The record will be printed only when the deviation in one or both directions exceeds the checking limit or when a high noise condition is registered at one or both ends. When the records of the results of all trunks tested are not to be used for analysis purposes, this arrangement eliminates a large amount of data which is not needed, but still maintains a record of those trunks having unusually large deviations or high noise.

E. Deviation Alarm

4.17 An alarm is provided which locks in under the control of a deviation alarm key, DA, on the trunk test frame when a deviation is ±5 db or more. This alarm is entirely independent of other alarms and of the wide deviation checking feature. With the alarm locked in, testing will continue. When the attendant comes to the trunk test frame to silence the alarm, he notes from the teletypewriter record the identity of the trunk with a deviation in excess of 5 db. Appropriate action can then be taken with respect to that particular trunk.

F. Lamp Display of Measured Losses

4.18 The actual measured losses (not deviations) can be displayed on lamps on the trunk test frame by operating key LPS. Operating key TA causes the trunk test circuit to stop when a test is finished so that the lamps may be observed. When a test is finished, lamp cut-on relays operate to cut through the lamp leads for lighting the proper lamps. Release of key TA allows the test to continue. Two sets of lamps are used, one set to display the measured loss in the far-near direction, and one set to display the measured loss in the near-far direction. These lamps are useful when making a local test on the ATTC to check the operation of the pad control relays.

5. PROVISION FOR TESTS AND ADJUSTMENTS

A. 1000-Cycle Test Power Supply

5.01 A jack designated MW or (1000, 0, 600) in 4-type offices is provided to permit checking the test power supply. A 22A milliwatt reference meter (or a 7A transmission measuring set, if the 22A is not available) is connected to the above jack. When the ATTC is used with the AOIT, the test power supply should be 0.0 dbm. If the meter reading deviates from this value by ±0.05 db or more, the output of the test power supply shall be checked and corrected. Use the 22A meter, or the 7A TMS in conjunction with the 2AA milliwatt reference set, to check that the test power supply output is adjusted to within ±0.03 db of the specified value. Inaccuracy of the test power supply at either the near end or the far end will cause corresponding errors in the measurements. The loop check will fail if the difference between the deviations of the two supplies exceeds 0.2 db.

Note: The +0.5 dbm jack should not be used for any other purpose than calibration and tests with the ATTC.

B. Amplifier Gain

5.02 Test pads are terminated on jacks on the ATTC to facilitate amplifier gain adjustment. A 19.9 db pad is furnished when the amplifiers are used in conjunction with the AOIT (2.05). The test power supply is connected, by means of a patch cord, through the appropriate test pad to the amplifier input. The amplifier output is connected to the 22A or the 7A set. If the gain is correct, the meter will indicate zero deviation from 0.0 dbm. A screwdriver adjusted potentiometer on the amplifier panel is used for gain adjustment. An error in the gain adjustment of the near-far amplifier will cause a corresponding error in the near-far measurement. However, large errors will be detected by the loop check, as covered in 3.32. Each amplifier includes negative feedback to maintain gain stability. The gains should show no measurable departure from the initially calibrated setting, so long as the tubes and components remain in good condition.

C. Amplifier-Rectifier Gain Adjustment for Transmission Tests

5.03 The amplifier-rectifier gain in the transmission measuring condition is adjusted so that the polar relay in the output just operates to its contact 2 when the test power level at the output of the receiving pads in Fig. 1 is 1 mw. Two keys, ADJ PT and REL PT, are provided on the ATTC to facilitate this adjustment. Key ADJ PT connects lamps PB and PF to contact 3 and contacts 2, respectively, of the polar relay, P, on the amplifier-rectifier so that the position of relay P can be observed. Key REL PT operates the 0.1 db far-near pad control relay to insert the 0.1 db far-near receiving pad in the transmission path. (See Fig. 1.)

5.04 To adjust the gain, key ADJ PT is operated which causes lamp PB to light. The 1000-cycle test power is then patched through the 19.9 db test pad (associated with AOIT) to the input of the far-near amplifier. Connection of the test power should operate relay P on the amplifier-rectifier if the gain is high enough. This retires lamp PB and lights lamp PF. The gain can be increased, if necessary, by potentiometer PT on the amplifier-rectifier panel until lamp PF just lights. Key REL PT is then depressed to insert the 0.1 db far-near receiving pad. If the gain is not too high, relay P will release, which lights lamp PB and retires lamp PF. Potentiometer PT is used to obtain the correct gain setting.

5.05 The procedure in 5.04 provides a quick and easy check of the over-all gain of the far-near amplifier and amplifier-rectifier. If the requirements are not met, the test power supply and the gain of the far-near amplifier should be checked before readjusting the gain of the amplifier-rectifier.

D. Amplifier-Rectifier Gain Adjustment for Noise Checks

5.06 The gain of the amplifier-rectifier in the noise checking condition is set to give a high noise indication when the noise at the terminal of the trunk under test exceeds 35, 40, or 45 dba, depending upon the value chosen for the particular office. The noise values correspond to a steady 1000-cycle power of −50, −45, or −40 dbm, respectively.

5.07 During the noise check, the output of the amplifier-rectifier charges a capacitor, as described in 3.41. The objective during the gain adjustment is to set the gain so that, with the above values of test power applied, the voltage on the capacitor at the end of the timing interval will be just high enough to cause a high noise indication. Accordingly, the multivibrator timing circuit on the trunk test frame is made to operate in the same manner as on a trunk test so that the timing interval during the gain calibration will be the same as when making a regular noise check. This is done by blocking certain relays on the trunk test frame and ATTC during the adjustment.

5.08 The test power is connected to the input of the far-near amplifier through a 600-ohm attenuator, such as the 5A. The loss in the attenuator is set at 50 db, 45 db, or 40 db (ATTC associated with the AOIT) for noise checking limits of 35 dba, 40 dba, or 45 dba, respectively. Key PN OPER on the ATTC is then operated. This starts the multivibrator timing circuit on the trunk test frame and causes the circuits to function as on a regular noise check. At the end of the noise check, lamp HEN on the trunk test frame should light if the gain is high enough. The gain can be increased, if necessary, by means of potentiometer PN until lamp HEN just lights. Key PN OPER is then restored and key PN NO operated. Key PN NO functions like key PN OPER and, in addition, inserts the 0.1 db far-near receiving pad in the transmission path to reduce the power. Under this condition lamp HEN will not light unless the gain is too high. Potentiometer PN is adjusted so that both of the above conditions are met.

E. Operational Check of Pad Circuits

5.09 Keys are provided on the ATTC so that a loss measurement can be simulated locally to check the operating features of the pad circuits. For this purpose, the loss of an attenuator is measured, and the loss setting of the attenuator checked against the measured loss shown by the loss display lamps on the trunk test frame (4.18). A test pad, adjustable in 0.1 db steps by means of keys, is terminated on jacks on the ATTC. When associated with the AOIT, the test pad loss can be adjusted from 0 to 1.2 db. This test pad can be used in tandem with a 600-ohm attenuator, such as the 5A, to obtain loss values as required.

F. Over-all Check of Accuracy

5.10 Arrangements are incorporated in the AOIT so that the ATTC can be checked against the far-end transmission measuring and noise checking circuit in the home office. This test functions the same as any trunk test and prints out a deviation on the teletypewriter record if either the ATTC or the far-end equipment is in error. With the AOIT, the class mark (8.1M in split "A" pad offices or 11.1M in single "A" pad offices) is such that a deviation of −0.1 db would indicate the correct loss. Any variation of ±0.2 db or more in excess of this value should be investigated. That is the deviation should be within the limits of +0.1 db to −0.3 db. If these limits are exceeded, then all measurements made by the ATTC, or all measurements made by other offices to the far-end equipment, are in error.

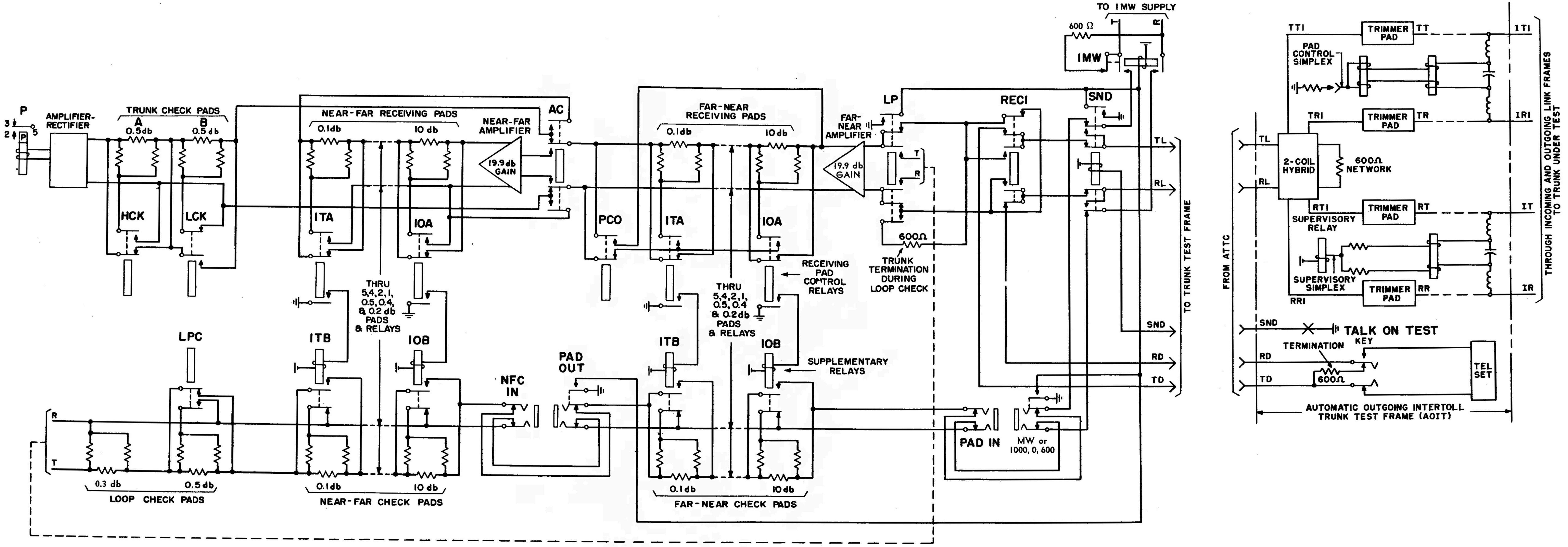

Fig. 1 – Schematic of Transmission Path

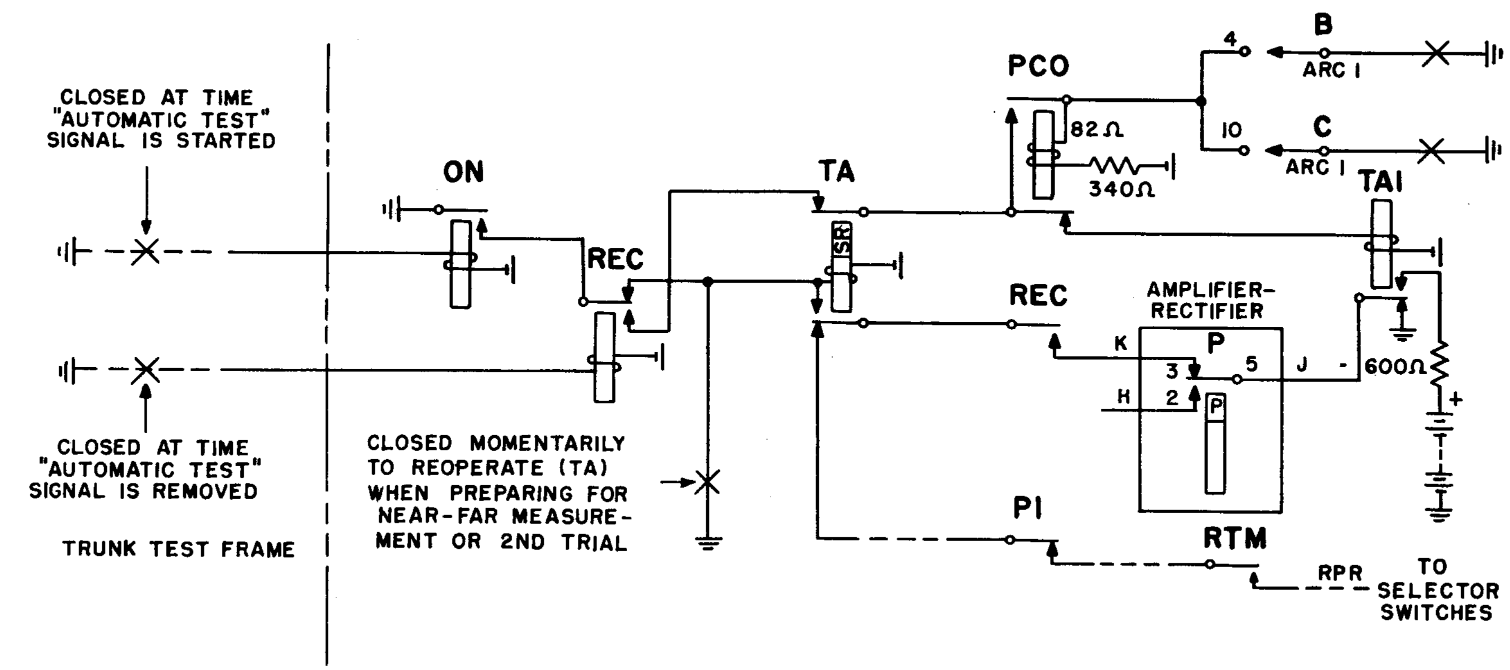

Fig. 2 – Preparation to Receive

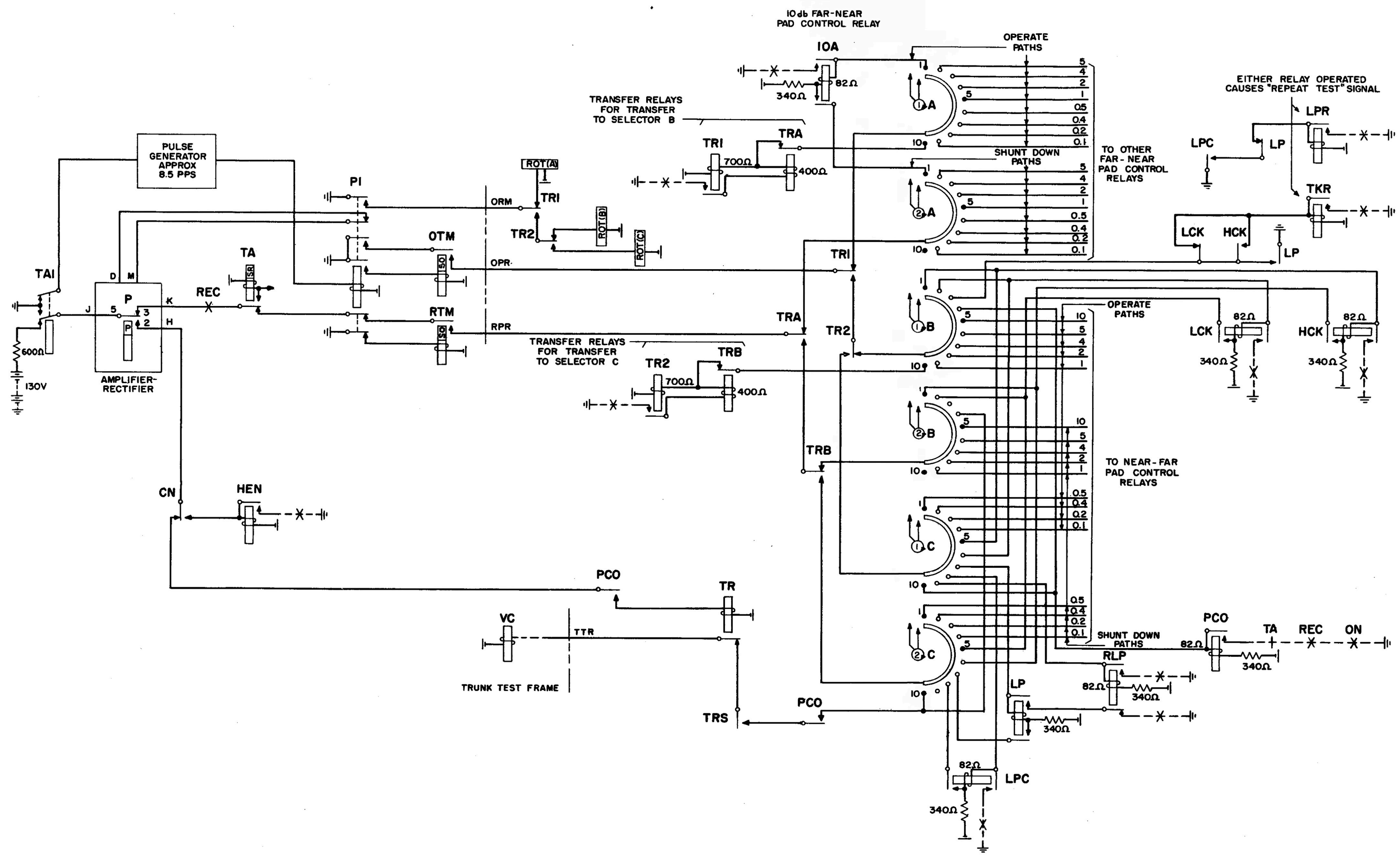

Fig. 3 — Control of Receiving Pad Adjustment and Accuracy Checks

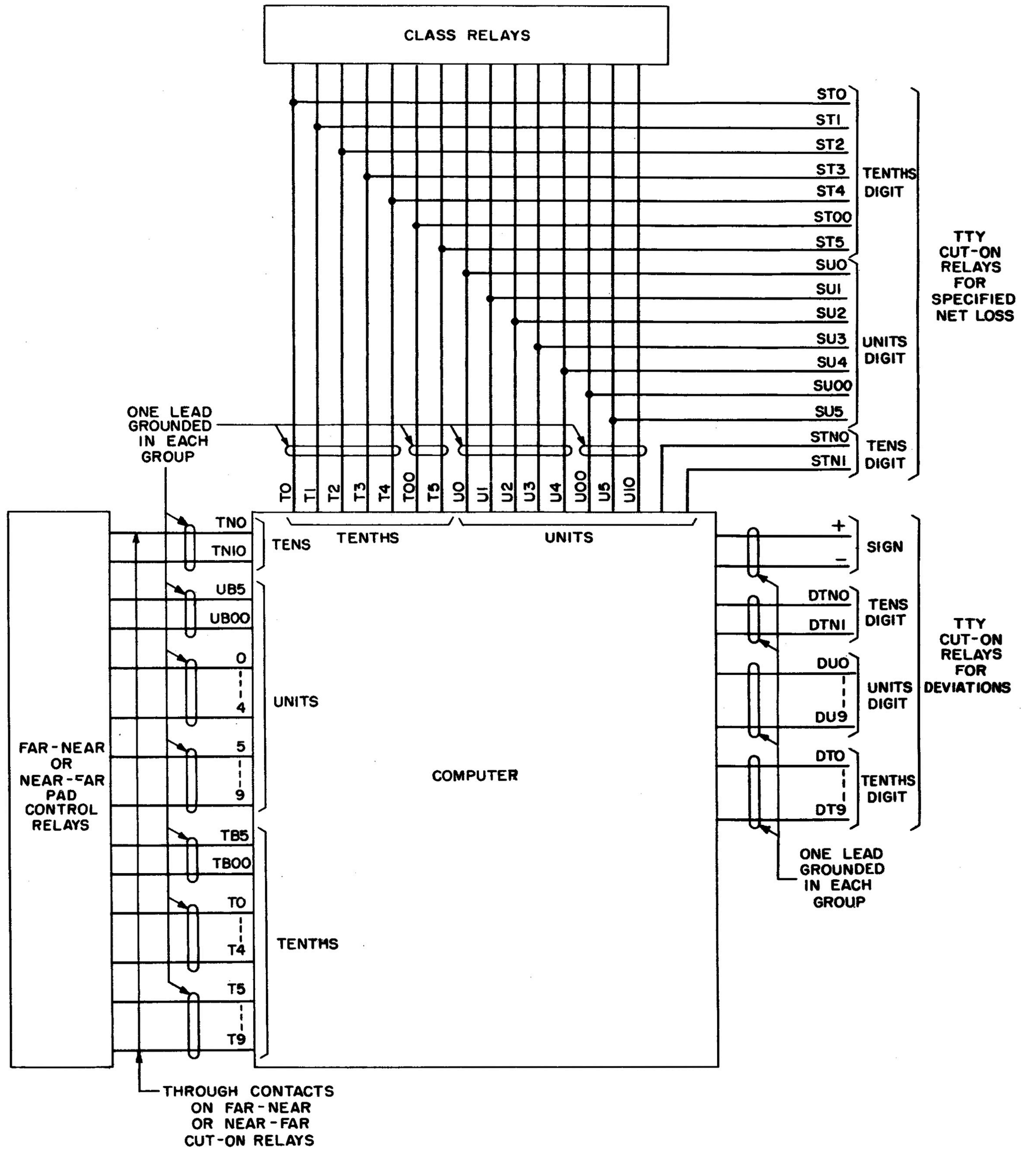

Fig. 4 — Input and Output Connections of Computer

NOTES:

1. CHART IS SHOWN FOR CONDITION WITH TELETYPEWRITER PRINTING A TEST RECORD FOR ALL TRUNKS TESTED.
2. **IF TROUBLE IS ENCOUNTERED IN SETTING UP TEST CALL, TRUNK TEST FRAME WILL BLOCK BEFORE TRANSMISSION TEST STARTS.**
3. FAR END WILL CONTINUE WITH TEST BY SENDING FOR STEP 3 AND THEN MAKING NOISE CHECK PER STEP 4. FAR END THEN RELEASES. (SV) LAMP WILL FLASH IF NOISE CHECK LIMIT AT FAR END IS EXCEEDED.
4. FAR-NEAR DEVIATION IS COMPUTED AT THIS TIME AND CHECKED AGAINST DEVIATION CHECKING LIMITS. IF LIMITS ARE NOT EXCEEDED LAMP (FNS) LIGHTS, OTHERWISE LAMP (FNU) LIGHTS.
5. IF ATTC FAILS TO SEND "AUTOMATIC TEST" SIGNAL OR FAR END FAILS TO RECEIVE IT, IF SENT, FAR END WILL RETURN TEST POWER FOR 10 SECONDS.
6. NEAR-FAR DEVIATION IS COMPUTED AT THIS TIME AND CHECKED AGAINST DEVIATION CHECKING LIMITS. IF LIMITS ARE NOT EXCEEDED, LAMP (NFS) LIGHTS, OTHERWISE LAMP (NFU) LIGHTS.
7. A **TOTAL OF ONLY** 3 TRIALS WILL BE MADE; **e.g.** IF A SECOND TRIAL WAS MADE DURING FAR-NEAR MEASUREMENT (STEP 2) THE **TRUNK TEST FRAME WILL BLOCK IF THE SECOND TRIAL DURING NEAR-FAR MEASUREMENT (STEP 3) IS NOT SUCCESSFUL.**
8. IF KEY (XTP) ON **TRUNK TEST FRAME IS OPERATED, TELETYPEWRITER WILL NOT START UNLESS DEVIATION CHECK LIMITS WERE EXCEEDED (NOTES 4 AND 6).**
9. IF KEY (XTP) ON **TRUNK TEST FRAME IS OPERATED, AND IF DEVIATION CHECK LIMITS WERE NOT EXCEEDED, TELETYPEWRITER WILL BE AT REST UP TO THIS POINT. IT WILL START AT THIS POINT ONLY IF NOISE CHECK LIMITS ARE EXCEEDED. OTHERWISE TRUNK TEST FRAME WILL ADVANCE TO NEXT TRUNK WITHOUT PRINTING A TEST RECORD.**
10. IF TELETYPEWRITER IS TURNED OFF, **TRUNK TEST FRAME WILL BLOCK AT THIS POINT IF DEVIATION CHECKING LIMITS IN EITHER DIRECTION OR NOISE CHECK LIMITS AT EITHER END ARE EXCEEDED.**

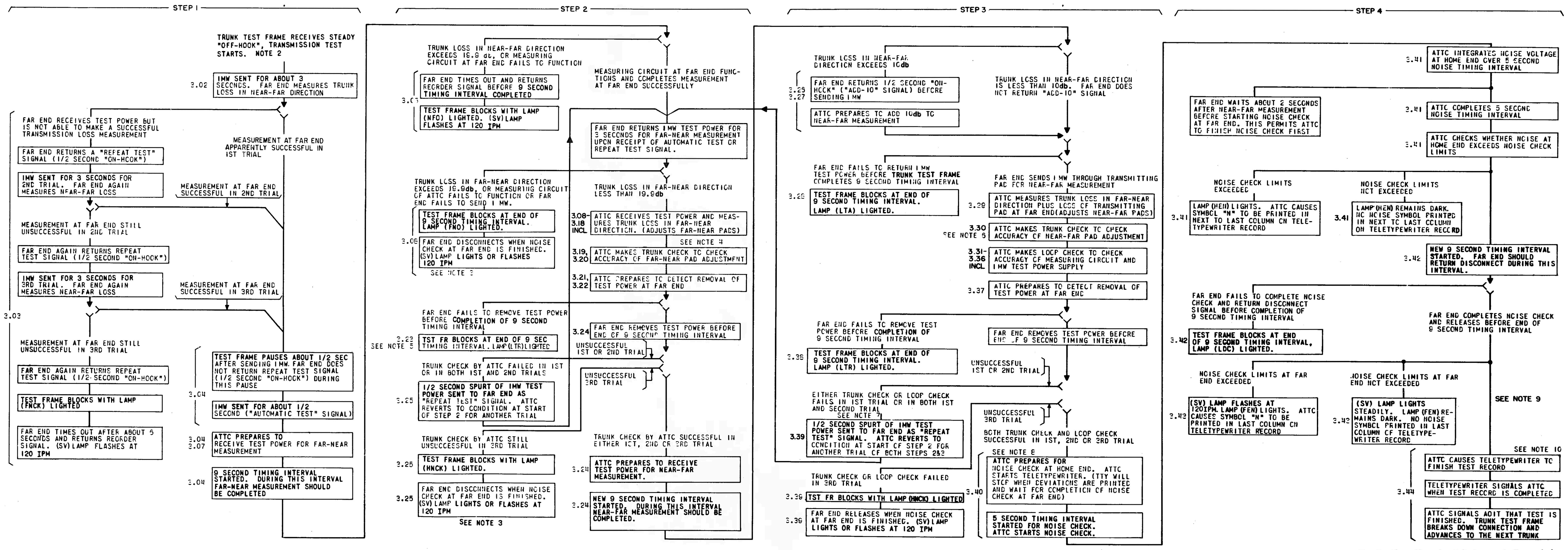

Fig. 5 — Flow Chart for Full Automatic Transmission Test and Noise Check