

DATA LINE SWITCHING PLAN

WADS B1 TRUNKS

CIRCUIT ORDER, ROUTINE, AND TROUBLE TESTING

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1. GENERAL DESCRIPTION

A. General

1.01 This section specifies the initial circuit order, routine, and trouble investigation tests to be made on trunks between WADS primary or secondary offices using B1 Data Carrier facilities. These trunks will be lined up and tested at 20A testboards installed at or near the B1 Data Carrier Terminal (DCT) locations in the WADS offices.

1.02 As in the case of WADS trunks using full voice bandwidth facilities, covered in Section 314-016-301, these trunks are operated at

an expected measured loss (EML) of 0 db at F2M (2225 cycles) when used for thru switching at both ends. Switched pads of 4 db are included in the trunk circuits at both terminating WADS offices and are switched, as required, to provide an overall 8 db EML at F2M for terminal to terminal connections.

1.03 Line facilities between B1 Data Carrier Terminals will consist of channels on standard telephone message carrier systems or combinations of these carrier channels and voice frequency facilities as described in more detail below. B1 type trunks will require equalization for envelope delay which is applied by prescribed equalizers located at the receiving terminals of the line facility carrier section. Attenuation equalization may also be required for either or both of the carrier and voice frequency sections, as described below, depending on the length and complexity of the facilities used.

B. Definition of Terms

1.04 Measurements on WADS trunks are made in many cases at frequencies and levels not generally used in the telephone message layout. For that reason certain terms applying to WADS trunks used in this section are defined.

(a) F2M

Transmission measurements on WADS facilities are referred to F2M (2225 cycles per second), instead of the 1000 cycles per second reference frequency used in the general telephone network. F2M is the higher *mark* signal frequency employed by the WADS data set — hence the designation F2M. (F2S, the higher *space* frequency is 2025 cycles.)

(b) F1S

In some circuits the “attenuation-slope” requirements are defined by referring the loss at F1S (1070 cycles per second) to the loss

at F2M. F1S is the lower *space* signal frequency employed by the WADS data set. (F1M the lower *mark* frequency is 1270 cycles.) It should be noted that although these definitions are correct for the basic WADS system, the Mark and Space designations may be reversed in some special applications.

Note: Use of Other Test Frequencies

The WADS requirements are expressed in terms of F1S and F2M. However, 1000 cycle and 2300 cycle test frequencies may be used instead of F1S and F2M except for tests through B1 Carrier Terminal Equipment, where the exact F1S or F2M values should be used.

(c) WADS Test Level

As indicated in Fig. 1, the F2M test levels used in lining up and testing WADS B1 systems are approximately 12 db below the usual 1000 cycle test levels used on message circuits. Specific testing levels to be used at various points in the system are covered in the line-up procedure.

(d) Section

Each carrier facility between voice frequency terminals, is herein defined as a section. Where two carrier facilities are interconnected at other than voice frequencies, i.e., group frequencies, the entire arrangement is considered as a single section. A voice frequency extension [see (g) below] greater than 6000 feet in length will require attenuation equalization and is considered to be a separate single section.

(e) Equalizer Test and Patch Point (ETPP)

In the B1 Data Carrier trunk the ETPP is defined as the access jacks on the testboard side of the Delay Equalizer Circuit. (See Fig. 1.) It is a point at which the equalized sections of the trunk can be measured in either direction.

(f) Line Facility

The line facility consists of one or more sections of carrier facilities. These facilities are lined up and maintained in accordance with standard procedures using 1000 cycle measurements and standard office levels between terminating voice frequency patch bays.

(g) Voice Frequency Extension

Any cable facility between a WADS switching office and the voice frequency patch bay of the line facility.

C. B1 System Description

1.05 The data signal from the customer data set to the B1 Data Carrier Terminal consists of a frequency shift mark-space modulated signal centered around either F1 (1170 cycles) or F2 (2125 cycles). The frequency shift is ± 100 cycles so that the mark frequencies are 1270 cycles (F1M) and 2225 cycles (F2M) and the space frequencies are 1070 cycles (F1S) and 2025 cycles (F2S). The originating station transmits in the F1 band and receives in the F2 band. The called station sends in the F2 band and receives in the F1 band.

1.06 Six of the above customer lines (or six incoming WADS trunks) may be connected simultaneously thru the No. 5 office switches to the six WADS trunks derived from a single B1 terminal. The signal level is adjusted by means of transmitting pads in the data set to deliver a nominal level to the trunk link frame of -10 dbm (F2) and -15 dbm (F1). On a thru switch, signals from an incoming trunk will be 4 db lower (nominal) than the above, but the terminal 4 db pad is omitted on thru connections so that in either case the input level on each trunk to a B1 terminal is nominally -14 dbm (F2) and -19 dbm (F1).

1.07 The B1 terminal derives six data channels and a seventh supervisory channel for transmission over a 4-wire voice bandwidth channel. The original F1 or F2 signal frequencies are translated to one of six line frequencies (740, 1217.5, 1695, 2172.5, 2650 or 3127.5 cycles, modulated ± 100 cycles) for transmission over the line facility to the receiving B1 terminal.

1.08 The B1 Transmitting Terminal accepts an F2 input signal from -9 to -26 dbm (-14 dbm nominal), and an F1 signal from -14 to -31 dbm (-19 dbm nominal), and through automatic gain control action delivers a nominal output signal to the line of -24 dbm per channel. The total signal power at this point for seven channels is approximately -15.4 dbm.

1.09 The B1 Receiving Terminal accepts a nominal line signal level of -24 dbm per channel and delivers a nominal output signal of -19 dbm (F1), and -14 dbm (F2) to the terminating trunk equipment. (See Fig. 1.)

1.10 The supervisory circuit samples on-hook and off-hook M lead signals, converts these to frequency shift signals (350 ± 35 cycles) and transmits these signals, for all of the six data channels, over the supervisory channel by means of a time division multiplex scheme.

1.11 Outpulsing sender address signals are F1 frequency shift pulses (1170 ± 100 cycles) and are transmitted by the FSP sender over the trunk channel in the B1 terminal. Answer-back signals from the FSP register and call progress are F2 tones transmitted in the opposite direction over the same trunk.

D. Envelope Delay Equalization

1.12 Envelope delay distortion is the difference in delay between the mark and space frequencies within a given band (either F1 or F2), that is the difference, for instance, between F1M and F1S. The permissible delay limits for WADS trunks on B1 Data Carrier facilities are such that delay equalization will be required for all carrier channels.

1.13 Envelope delay equalization is provided on a prescription basis for each facility involved by means of the Delay Equalizer Unit (J99292-B) consisting of a unit shelf with permanent equipment and five mounting positions for the plug-in equalizers.

1.14 The delay equalizer unit is located at the receiving end of the carrier line facility and provides post-equalization. Equalization for the opposite direction of transmission is provided by a similar unit located in the receiving side in the other carrier terminal office.

1.15 The delay equalizer unit circuit has a 600 ohm balanced input and output and includes a permanent 9 db pad, the five plug-in equalizer positions and an adjustable 227A type amplifier. Input and output jack circuits are provided for amplifier adjustment and for measurements to terminal testboards. THE FIVE

PLUG-IN POSITIONS ARE WIRED IN SERIES AND IT IS NECESSARY THAT ALL POSITIONS BE FILLED. The dummy equalizer plug (426A plug) is used in any positions not required for equalizer units. The T and R pads (1C type) are mounted on the delay equalizer unit and are used to build out the nonequalized voice frequency extensions and to adjust ETPP levels where voice frequency extensions are not used. The adjustment of these pads is covered below under the line-up procedure.

1.16 The following envelope delay equalizers are used for WADS trunk facilities in the plug-in positions.

366A Delay Equalizer — Provides delay equalization for a single carrier section using "A" type channel banks. Typical carrier systems are "K" or "L" carriers.

366B Delay Equalizer — Provides delay equalization for a single "N" section equipped with special service channel units. Where two "N" carrier sections are interconnected using thru or special service channel units, the sections will be considered as two sections and require two 366B Delay Equalizers.

366C Delay Equalizer — Provides delay equalization for a single "ON" section equipped with a special service channel unit and 529D and E Filters. Where two carrier sections are interconnected using thru or special service channel units, the sections will be considered as two sections and require two 366C Delay Equalizers.

367A Delay Equalizer — Provides delay equalization for two "A" type channel bank sections connected in tandem. The 367A Delay Equalizer is used in place of two 366A Delay Equalizers wherever possible, as the residual delay for the single 367A Delay Equalizer is generally less than that of two 366A Delay Equalizers. The 367A Delay Equalizer Unit occupies the same space as two 366A Delay Equalizers.

426A Dummy Equalizer Plug — To be used in any plug-in position not required for an equalizer unit.

E. Attenuation Equalization

1.17 In order to satisfy attenuation-frequency requirements for WADS B1 trunks, attenuation equalization may be required on both the line carrier section and the voice frequency extension, or extensions, if present in the layout. The need for such equalization will depend on the type of facility and length involved of each section. A number of equalizer types and combinations are used. The equipment arrangements, locations and basic requirements for different facilities are outlined below. Detailed adjustments of the equalizers is covered in the line-up procedure and in Section 314-016-125.

(1) Line Facility Equalization

1.18 Attenuation equalization is required on any line facility using a single type N or ON carrier section or three or more carrier sections using "A" type channel banks. Preattenuation equalization is provided using 44V4L3 (J98615AH List 3 shelf) repeater equipment at the terminal toll office.

1.19 The line facility attenuation equalizers and associated amplifiers are adjusted so that the overall gain of the carrier section will be:

- (a) The same at F2M (2225 cycles) as the actual measured 1000 cycle gain of the carrier facilities between voice frequency patch bays.
- (b) Within ± 2.0 db of the F2M gain from 600 to 3300 cycles.
- (c) Within ± 3.0 db of the F2M gain at 300 cycles.

1.20 When one or both of the terminal toll offices use -13 and $+4$ dbm levels at the VFPB, the equalized gains at the above frequencies will be 3 or 6 db less than those in -16 and $+7$ dbm offices. For example, for a carrier section between two -13 and $+4$ toll offices the 1000 cycle gain VFPB to VFPB will be 17 db, the equalized F2M gain, 17 db, the gain between 600 and 3300 cycles from 15 to 19 db and the gain at 300 cycles between 14 and 20 db.

1.21 This carrier attenuation equalizer (44V4L3) is located between the carrier voice frequency patch bay and the delay equal-

izer unit. The 359H Equalizer (EQL 2), the 359G Equalizer (EQL 1) and the 227 amplifier (AMP 2) provide pre-equalization and gain adjustment in the transmitting direction (toward the carrier facilities). The 849C network and the strap thru wiring of the 359H Equalizer in the receiving direction (toward the near circuit terminal or VFE) provide zero insertion loss and zero equalization. Proper operating levels and test levels at these points are covered in the line-up procedure. Equalization in the opposite direction of transmission is provided by a similar equalizer unit at the far end of the carrier section.

(2) Voice Frequency Extension Equalization

1.22 Voice Frequency Extensions up to 6000 feet in length (MDF to MDF) made up of 22 or 24 ga. exchange cable will not require attenuation equalization. These short extensions will, however, be built out by 1C type T and R pads to the same F2M losses as the longer extensions, that is, to have an F2M loss of 14 db transmitting and 9 db receiving except as in Par. 1.24.

1.23 Voice Frequency Extensions of from 6000 feet up to 54,000 feet will be equalized. The equalizer is adjusted so that the loss between 300 and 3300 cycles is within ± 1.0 db of the F2M loss as measured between the delay equalizer unit and the 20A testboard Line Test and Patch Bay.

1.24 These values of 14 db transmitting and 9 db receiving F2M losses are intended for voice frequency extensions terminating in toll offices using the -16 and $+7$ dbm carrier levels. For offices using the -13 and $+4$ dbm levels the extensions should be built out to values of 11 db transmitting loss and 6 db receiving loss with the same equalization requirement of ± 1.0 db of the F2M value over the 300 to 3300 cycle frequency band.

1.25 Three types of equalization arrangements are provided for these voice frequency extensions, one each for short and long lengths of nonloaded exchange cable and one for loaded exchange cable. They are summarized below. Details of equipment arrangements and adjustment of the equalizers are covered in the line-up procedure of this section and in Section 314-016-125.

Equalization of 6000 to 18,000 feet of 22 ga. non-loaded cable or 6000 to 12,000 feet of 24 ga. non-loaded cable.

1.26 Arrangements of equalizers for extensions in this class are shown in Fig. 8 of Section 314-016-125 (upper diagram). Two amplifiers are used in tandem at each end of the cable. Adjustment of equalizer settings is covered in Section 314-016-125. Amplifier gains and operating levels are covered in the line-up procedure of this section.

Equalization of 18,000 to 24,000 feet of 22 ga. non-loaded cable or 12,000 to 18,000 feet of 24 ga. nonloaded cable.

1.27 Equalizer arrangements for these longer nonloaded lengths are similar to that in Par. 1.26 except for the use of a different equalizer unit and an additional 227 amplifier at the toll office to make up for greater cable loss. The arrangement is shown in Fig. 8 of Section 314-016-125 (lower diagram). The additional amplifier (AMP 2) in the toll office replaces the 849C network in the 44V4L2 repeater. Adjustment of equalizers and amplifier gains is covered in the line-up procedure and in Section 314-016-125.

Equalization of 12,000 to 54,000 feet of 22 gauge or 24 gauge H44 loaded cable.

1.28 An equalizer arrangement for the above length and type of loaded exchange cable is shown in Fig. 9 of Section 314-016-125. Amplifiers are used only in WADS No. 5 office. Pad, equalizer and level adjustments are covered in the line-up procedure and in Section 314-016-125.

2. LINE-UP PROCEDURE

2.01 The WADS trunk line-up procedure is based on the assumption that the B1 terminals are tested as independent units in accordance with standard practices for these terminals. The line facilities are then equalized and adjusted, as outlined below, between 20A testboards and then connected to the B1 terminals. After this is completed certain overall measurements are made thru the B1 terminal equipment and are included here as part of the line-up procedure. The overall circuit inside the B1 terminals, between the two 20A Testboard Line

Test and Patch Bays is operated at 0 db EML (F2M) equalized as required for delay and attenuation frequency variations. (See Fig. 1.)

2.02 The step-by-step procedure outlined below to be done in both directions of transmission, assumes the maximum WADS B1 trunk layout, that is, a trunk made up of a carrier line section or sections requiring both delay and attenuation equalization and two voice frequency extensions, one at each end, which also require attenuation equalization. In cases where attenuation equalization is not required in one or more of the sections, or where one or both voice frequency extensions do not exist, certain of the following steps will be omitted and in some cases points of measurement will have to be changed to the nearest available access point in the circuit, but overall losses and operating levels at critical points in the circuit should be the same.

Note: Before starting step-by-step line-up procedure, the calibration of all measuring equipment should be checked. Where no specific tolerances are given, sending and received levels should be adjusted as closely as possible to required values.

A. 1 Kc Line-Up of Carrier Section (See Figs. 1 and 2.)

The carrier section should be lined up between voice frequency patch bays in accordance with standard practices. Measurements should be made at 1000 cycles and levels adjusted to those standard for the toll office involved. This will result in an overall section gain of 23 db between -16 and +7 dbm offices and gains of 20 or 17 db where one or both toll offices use the -13 and +4 dbm levels.

B. Preliminary Noise Measurements

After the carrier layout has been lined up to standard 1 kc levels as above, and before proceeding with equalizer adjustments, preliminary noise measurements should be made between terminating voice frequency patch bays at WADS locations to determine the suitability of the assigned channels for this service. Both steady and impulse noise measurements should be made in both directions during the busy hour with the far end terminated in 600 ohms.

Step 1: Steady noise should be measured with a 3A NMS using "C Message" weighting and should not exceed the following values. These values are direct meter readings at the indicated points and should not be further corrected unless the actual channel operating level at 1 kc is not exactly standard at time of measurement.

TYPE TRUNK	STEADY NOISE LIMIT (Preliminary Test) MEASURED AT VFPB	
	+7 dbm OFFICE	+4 dbm OFFICE
"Final" Trunks up to 1500 Miles	48 dbrn	45 dbrn
"High Usage" Trunks up to 1500 Miles	50 dbrn	47 dbrn
"Final" Trunks over 1500 Miles	51 dbrn	48 dbrn
"High Usage" Trunks over 1500 Miles	53 dbrn	50 dbrn
Any trunk using N or ON Carrier (Non- compandored)	54 dbrn	51 dbrn

Step 2: Preliminary impulse noise measurements should be made in both directions between VFPBs (far end terminated in 600 ohms) with a 6A Impulse Counter using "Flat" weighting. Impulse noise should not exceed 20 counts in 30 minutes at 72 dbrn in a +7 dbm office or 69 dbrn in a +4 dbm office. These values have been corrected for the measuring point level and should not be further corrected.

C. Preliminary Line-Up of Delay Equalizers

Step 1: Plug in the proper delay equalizer units for the facilities involved in the delay equalizer circuit, as covered in Part 1D of this section, in the receiving branch at both ends of the carrier section.

Step 2: Using a 21A transmission measuring set at the delay equalizer bay, measure between the input and output jacks of the delay equalizer circuit and adjust the 227 amplifier unit for an overall loss of 0 db. Measure-

ment should be at F2M (2225 cycles) sending at a level of -5 dbm. Repeat for delay equalizer unit at the opposite end of the carrier section.

D. Adjustment of Line Facility Attenuation Equalizers

Step 1: Replace the 359G and 359H networks in the Line Facility Attenuation Equalizer panel with 359E and 359C dummy strapping networks, respectively. (*These must not be reversed.*)

Step 2: Using a 21A TMS, or equivalent, adjust the 227 amplifier (AMP 2) in the transmitting side of the line facility attenuation equalizer so that the loss at F2M is 0 db measuring between the AMP 2 IN and OUT jacks. Measurement should be made at -28 dbm.

Step 3: Using a 21A TMS, or equivalent, measure from the Equalizer Test and Patch Point jack (ETPP) located on the near-end delay equalizer panel to the corresponding ETPP jack on the delay equalizer at the far end of the carrier section. Sending at a level of -28 dbm, measurements should be made at 600, 2225 and 3300 cycles to determine the attenuation characteristic of the carrier facilities and amount of equalization required.

Step 4: From Table E of Section 314-016-125 determine the equalization required for the 600 to 3300 cycle band in the 359G and 359H networks. From Tables A and B of the same section determine the proper screw adjustments. Adjust the two units accordingly and replace the networks in their original locations in the equalizer panel. (*Do Not reverse networks.*)

Step 5: Adjust the 227 AMP 2 to again give a 0 ± 0.1 db gain at F2M, measuring from AMP IN to AMP OUT jacks of the equalizer unit. (Measure at -28 dbm.)

Step 6: Measure from near-end ETPP to far-end ETPP. Transmit at -28 dbm. Measure at 300, 600, 2225 (F2M) and 3300 cycles.

Requirement:

- (a) The gains at 600 and 3300 cycles should not differ by more than ± 2.0 db from the F2M gain.
- (b) The gain at 300 cycles should not differ by more than ± 3.0 db from the F2M gain.

If requirements (a) or (b) above are not met, additional "mop-up" adjustment of the 359G and 359H networks may be required. Proceed in accordance with Par. 5.05 of Section 314-016-125.

Step 7: Check the actual operating level of the carrier section (at 1000 cycles) between voice frequency patch bays. At the time the final adjustment of the F2M gain is made (Step 8 below), this 1 kc gain may deviate from the nominal section gain and the F2M gain should be adjusted accordingly. Nominal 1 kc gains are:

- 23 db between -16 and $+7$ dbm offices.
- 20 db between -13 and $+7$ dbm offices.
- 20 db between -16 and $+4$ dbm offices.
- 17 db between -13 and $+4$ dbm offices.

Step 8: Send F2M at -28 dbm into the transmitting jack of the near-end ETPP. Measure the level at the receiving jack of the far-end ETPP. Adjust the gain of the 227 amplifier in the far-end delay equalizer unit to give an overall gain at F2M as close as possible to the actual operating 1000 cycle gain measured between VFPB's in Step 7. This will result in a received level at the distant ETPP of -5 dbm (F2M) modified by the deviation from nominal of the 1 kc gain of the carrier facilities. These sending and received

F2M levels are for use in -16 and $+7$ dbm offices. When the near-end office is a -13 dbm office the sending level should be -25 dbm instead of -28 dbm. For either type of transmitting office the level received at the distant ETPP will be -5 dbm (F2M) if this receiving location is a $+7$ dbm office or -8 dbm (F2M) if a $+4$ dbm office (either level being modified by the deviation from nominal of the actual operating 1 kc carrier gain).

E. Adjustment of VFE Attenuation Equalizers

Note: Cases 1, 2 and 3 below cover VFE equalization to offices using standard carrier levels (1 kc) of $+7$ and -16 dbm. Case 4 indicates the variation for an equalized VFE to a $+4$ and -13 dbm office. Case 5 covers the case where only a short non-equalized VFE or no VFE exists between the carrier terminal and the WADS office.

Case 1 — Nonloaded Facilities — Short Extensions

Refer to Section 314-016-125, Fig. 8, upper diagram and Par. 5.02 of the same section. For clarity here, the location of the B1 terminal, 20A TB, and adjacent equalizer unit is referred to as the WADS office. The location of the distant equalizer, delay equalizer, etc, is referred to as the toll office.

Step 1: Send F2M at -14 dbm into the AMP IN jack of the AMP 1 in the WADS office 44V4L3 repeater (hereafter called L3). This "amplifier" is an 849C network and should be equipped with a 0 db pad.

Step 2: Measure at the AMP OUT jack of the AMP 1 in the WADS office 44V4L2 repeater (hereafter called L2) and adjust the gain of this 227 amplifier to obtain a -7 dbm level at the measuring point.

Step 3: Send as in Step 1. Measure at the AMP OUT jack of AMP 2 in the toll office L2 repeater and adjust the pad in this 849C network to obtain a level of -28 dbm. The value of this pad will depend on the cable loss in the extension.

- Step 4:** Replace the 359H network of the L3 repeater in the toll office with a 359C network.
- Step 5:** Send as in Step 1. Measure at the AMP OUT jack of the AMP 2 in the toll office L3 repeater. Adjust the gain of the 227 amplifier AMP 2 to obtain a level of -28 dbm.
- Step 6:** Repeat the Step 5 measurement at 600 cycles to determine the amount of low-frequency equalization required.
- Step 7:** From Fig. 12 and Table B of Section 314-016-125 determine the proper screw settings for the 359H network. Adjust the network accordingly and replace it in the L3 repeater.
- Step 8:** Repeat Step 5 and readjust AMP 2 in the toll office L3 repeater to obtain an F2M level of -28 dbm. Measure level also at 300 and 3300 cycles.

Requirement: The 300 and 3300 cycle levels should not differ from the F2M level by more than ± 1.0 db. If this requirement is not met, further adjustment of the 359H network may be required.

Adjustment in the opposite direction is made as follows:

- Step 9:** At the toll office, send into the AMP IN jack of AMP 1 of the L3 repeater 2225 cycles (F2M) at -5 dbm. This "amplifier" is an 849C network and should be equipped with a 0 db pad.
- Step 10:** Send as in Step 9. Measure at the AMP OUT jack of AMP 1 of the toll office L2 repeater and adjust the pad in *this* 849C network to obtain a level of -7 dbm.
- Step 11:** Send as in Step 9. Measure at the AMP OUT jack of AMP 2 in the WADS office L2 repeater and adjust the gain of this amplifier to obtain a level of -14 dbm.
- Step 12:** Replace the 359H network in the WADS office L3 repeater with a 359C network.

Step 13: Send as in Step 9. Measure at the AMP OUT jack of AMP 2 in the WADS office L3 repeater and adjust this amplifier to obtain an F2M level of -14 dbm. Repeat this measurement at 600 cycles but do not readjust the amplifier.

Step 14: From Fig. 12 and Table B of Section 314-016-125 determine the proper screw settings for the 359H network. Adjust the network accordingly and replace it in the WADS office L3 repeater.

Step 15: Repeat the Step 13 measurement at F2M and readjust AMP 2 in the WADS office L3 repeater to again obtain the -14 dbm level. Measure this level also at 300 and 3300 cycles.

Requirement: Same as that for the opposite direction. (See Step 8.)

Note: The above equalization obtains the correct operating levels at the carrier delay equalizer without further pad adjustment. The 1C pads associated with the delay equalizer panel should therefore be equipped with 0 db pads in both transmitting and receiving branches.

Case 2 — Nonloaded Facilities — Long Extensions

Refer to Section 314-016-125 Fig. 8, lower diagram and to Par. 5.03 of that section. Equalization is similar to that for Case 1 except that adjustment of both high and low frequency equalization is required. Both 359G and 359H networks are used and must be adjusted. An additional amplifier is also used in the toll office in one direction.

- Step 1:** Send F2M at -14 dbm into the AMP IN jack of AMP 1 in the WADS office 44V4L3 repeater (hereafter called L3). This "amplifier" is an 849C network and should be equipped with a 0 db pad.
- Step 2:** Measure at the AMP OUT jack of AMP 1 in the WADS office 44V4L2 repeater (hereafter called L2) and adjust the gain of this 227 amplifier to obtain a -7 dbm level at the measuring point.

- Step 3:** Send as in Step 1. Measure at the AMP OUT jack of AMP 2 in the *toll* office L2 repeater and adjust the gain of this amplifier to obtain an F2M level of -28 dbm.
- Step 4:** In the L3 repeater in the toll office replace the 359H network with a 359C network and replace the 359G network with a 359E network.
- Step 5:** Send as in Step 1. Measure at the AMP OUT jack of AMP 2 of the toll office L3 repeater and adjust this amplifier gain (AMP 2) to obtain an F2M level of -28 dbm at the measuring point. Repeat this measurement at 600 and 3300 cycles to determine amount of equalization required.
- Step 6:** From Table E of Section 314-016-125 obtain settings for the 359H and 359G networks. Before entering the table, add 1.0 db to the relative loss at 600 cycles (difference between 600 and 2225 cycle losses) in order to be sure of sufficient slope adjustment to meet requirements at 300 cycles. From Tables A and B of the same section determine the screw settings for the networks. Adjust the networks accordingly and replace them in the L3 repeater.
- Step 7:** Repeat Step 5 and readjust AMP 2 of the toll office L3 repeater to again obtain an F2M level of -28 dbm. Measure the level at 300 and 3300 cycles.

Requirement: The 300 and 3300 cycle levels should not differ from the F2M level by more than ± 1.0 db. If this requirement is not met, further adjustment of the networks should be made. This can be done readily by moving one column or line in the required direction in the Table E reading and readjusting the network screw settings accordingly. The 359H largely controls the 300 cycle correction and the 359G controls the 3300 cycle correction.

Equalizer adjustment in the opposite direction of transmission is the same as the above except for the operating levels at the different circuit points.

- Step 8:** Send F2M at -5 dbm into the AMP IN jack of AMP 1 in the *toll* office L3 repeater. Place a 0 db pad in this 849C network.
- Step 9:** Measure at the AMP OUT jack of AMP 1 of the toll office L2 repeater and adjust the pad in the AMP 1 (L2) 849C network to obtain an F2M level of -7 dbm at the measuring point.
- Step 10:** Send as in Step 8. Measure at the AMP OUT jack of AMP 2 of the *WADS* office L2 repeater and adjust this amplifier gain to obtain a level of -14 dbm.
- Step 11:** Replace the 359H and 359G networks in the *WADS* office L3 repeater with 359C and 359E networks, respectively.
- Step 12:** Send as in Step 8. Measure at the AMP OUT jack of AMP 2 in the *WADS* office L3 repeater and adjust the gain of this amplifier to obtain a level of -14 dbm at F2M. Repeat this measurement at 600 and 3300 cycles.
- Step 13:** Same as Step 6.
- Step 14:** Repeat Step 12 and readjust the gain of AMP 2 in the *WADS* office L3 repeater to again obtain a level of -14 dbm. Measure this level at 300 and 3300 cycles.

Requirement: Same as in Step 7 for opposite direction.

See Note following Step 15 of Case 1.

Case 3 — Loaded Facilities (12,000 to 54,000 feet of 22 or 24 H44 cable)

Refer to Section 314-016-125, Fig. 9, and to Par. 4.04, 4.05 and 5.04 of that section.

- Step 1:** Adjust the screws on the 359A network in the *WADS* office 44V4L2 repeater (L2) in accordance with Table D of Section 314-016-125. Note that since only H44 facilities will be used for *WADS* B1 trunks, the high frequency section of the equalizer will not be used and the HF IN screw should be open (turned out).

Step 2: Adjust the screws in the 359D network in the toll office L2 repeater in the same manner as in Step 1.

Step 3: Send F2M at -14 dbm into the AMP IN jack of AMP 1 in the WADS office L2 repeater.

Step 4: Measure at the AMP OUT jack of AMP 1 in the WADS office repeater and adjust the gain of this amplifier to obtain an F2M level of -7 dbm.

Step 5: Send as in Step 3. Measure at the AMP OUT jack of AMP 2 in the *toll* office. Adjust the pad in the 849B network (AMP 2) in this repeater to obtain an F2M level of -28 dbm. Repeat this measurement at 300 and 3300 cycles.

Requirement: The 300 and 3300 cycle levels should not differ from the F2M level by more than ± 1.0 db. If this requirement is not met further adjustment may be required. See Par. 4.05 of Section 314-016-125.

Step 6: Send F2M at -5 dbm into the AMP IN jack of AMP 1 in the *toll* office repeater.

Step 7: Measure at the AMP OUT jack of AMP 1 of the toll office repeater and adjust the pad in the 849A network in the toll office repeater to obtain an F2M level of -7 dbm at the measuring point.

Step 8: Send as in Step 6. Measure at the AMP OUT jack of AMP 2 in the WADS office repeater. Adjust the gain of this amplifier to obtain an F2M level of -14 dbm. Repeat this measurement at 300 and 3300 cycles.

Requirement: Same as in the opposite direction. (See Step 5.)

Note 1: As in Cases 1 and 2 the above procedure will give correct operating levels at both ends of the VFE without further pad adjustment. Therefore the 1C pads associated with the delay equalizer panel should be equipped with 0 db pads in both directions.

Note 2: The preceding procedures Cases 1, 2 and 3 cover attenuation equalization of one equalized VFE at one end of the circuit. If the layout includes a second VFE at the far end these same procedures must be applied at the far-end WADS and toll offices using the appropriate case for the facilities used.

Case 4 — Equalized VFE to -13 and $+4$ dbm offices

Test levels specified in Cases 1, 2 and 3 assume the toll office to use standard -16 and $+7$ dbm values. Certain modifications are required when the VFE connects the WADS office to a toll office using -13 and $+4$ dbm values.

Transmitting toward the carrier section the output level at the AMP OUT jack of AMP 2 of the toll office repeater is specified as -28 dbm F2M. When transmitting into a toll office with a -13 dbm carrier input level this should be -25 dbm F2M. This will require a 3 db greater gain in AMP 2 in Cases 1 and 2, and a 3 db lower loss pad in Case 3.

Transmitting from the carrier section toward the VFE the input to the toll office repeater is specified as -5 dbm for a $+7$ dbm toll office. In a $+4$ dbm toll office this should be -8 dbm. In this direction 0 db pads should be used in the toll office equalizers in the 849C networks of both L2 and L3 repeaters for the nonloaded case and in the 849A network of the toll office L2 repeaters for loaded facilities. Then, transmitting from the toll office at -8 dbm adjust the gain of AMP 2 of repeater L2 in the WADS office to obtain the standard -14 dbm level at the AMP OUT jack of AMP 2 in the L2 WADS office repeater.

Case 5 — Nonequalized VFE or No VFE

When the voice frequency extension is too short to require equalization or where no VFE exists, the operating levels from the circuit terminal to the carrier section are controlled entirely by the 1C pads associated with the delay equalizer unit. In this case proceed as follows:

- Step 1:** At the 20A Line Test and Patch Bay send F2M at -14 dbm on the line toward the carrier terminal.
- Step 2:** Measure at the ETPP jack on the transmitting delay equalizer unit and adjust the associated 1C transmitting pad to obtain a level of -28 dbm in a -16 dbm toll office or -25 dbm in a -13 dbm office.
- Step 3:** Send F2M into the receiving ETPP jack on the delay equalizer panel toward the 20A TTB at a level of -5 dbm in a +7 dbm toll office or a level of -8 dbm in a +4 dbm toll office.
- Step 4:** Measure at the receiving line jack at the 20A TTB and adjust the 1C receiving pad associated with the delay equalizer panel to obtain a level of -14 dbm at the testboard jack. (This -14 dbm level applies to either +7 or +4 dbm toll offices.)

F. Line-Up Check of 4-Wire Layout

After line-up and equalization, if required, of the carrier line section and one or both voice frequency extensions if present, or the terminal pads as covered in Case 5 if they are not, the facilities should be connected thru and measured at F2M between terminal 20A testboards. Measurements should be made in both directions from the line test and patch bay at an F2M (2225 cycle) level of -14 dbm. The received level should not deviate from -14 dbm by more than the permissible deviation in Table 1.

TABLE 1

Permissible Deviations From Specified Received Level

TYPE OF 4-WIRE LAYOUT	LENGTH OF LAYOUT IN MILES		
	0-100	101-500	OVER 500
No VFE			
Single Link Cxr Section — Cable or Radio	±0.6 db	±1.0 db	±1.0 db
VFE — CXR			
Single Link Cxr Section — Cable or Radio	±1.0 db	±1.0 db	±1.0 db
VFE — CXR			
Multilink Cxr. or Combination Cxr. and VF	±1.0 db	±1.0 db	±1.5 db

If these limits are exceeded, the component sections of the circuit should be remeasured to determine location of excess deviation and the faulty section or sections readjusted.

G. Final Noise Measurements

After completion of Parts A to F of the line-up procedure, steady and impulse noise measurements should be made in both directions on each of the six data channels and the supervisory channel of the B1 system. Measurements should be made from the 20A testboards and may be made in the two directions simultaneously if desired. All measurements should be made during the busy period for the particular offices. *Requirements given below for all measurements are direct meter readings and should not be further corrected for point of measurement.*

G1 — Steady Noise Measurements — Data Channels

Test calls should be set up thru the office switches over each of the six data trunks and steady noise measured in both directions at the two testboards. The 3B Noise Measuring Set should be set for 900 ohms and equipped with the "C Message" weighting network. The 3B NMS at the distant testboard serves as a termination and permits measurements to be made at both ends simultaneously. Measured noise should not exceed the following values on any circuit in either direction.

TYPE TRUNK	STEADY NOISE LIMIT — DBRN
"Final" Trunks up to 1500 Miles	35
"High Usage" Trunks up to 1500 Miles	37
"Final" Trunks over 1500 Miles	38
"High Usage" Trunks over 1500 Miles	40
Any trunk using type N or ON Carrier (Noncompandored)	41

G2 — Impulse Noise Measurements — Data Channels

Using the same test connections as in Part G1 above, measure the impulse noise on each of the six data trunks in both directions. Operation of the TTG-LTC key at either test-

board will transfer the noise measuring circuit from the 3B NMS to the 6E Impulse Counter. The 6E Impulse Counter in the testboard originating the call should be equipped with the F2 (2125 cycle) plug-in filter and the counter at the called testboard equipped with the F1 (1170 cycle) plug-in filter. (Set 6E Counter Switch S1 to EXTERNAL.)

Requirements: *At calling testboard (6E with F2 filter), not more than 20 counts in 30 minutes at 58 dbrn. (Use 57 dbrn setting.) At called testboard (6E with F1 filter), not more than 20 counts in 30 minutes at 53 dbrn. (Use 54 dbrn setting.)*

G3 — Steady Noise Measurement — Supervisory Channel

Make a steady noise measurement on the supervisory channel in both directions thru the channel selector filters in the 20A testboard. Use the 3B NMS equipped with the "3 Kc Flat" network. The data terminal and associated six trunks should first be removed from service at both ends and the measuring connection set up by patching the Line Test MON cord to the DXMT MON jack in the Line Test and Patch Bay. The channel selector switch should be set to SUPV. Operation of the READ and NSE keys of the line test cord will permit a noise measurement on the supervisory channel band. During measurements the circuit should be terminated at the far-end testboard unless measurements are made in both directions simultaneously.

Requirement: *Noise as measured above should not exceed 36 dbrn at either end of the channel.*

G4 — Impulse Noise Measurement — Supervisory Channel

Using the same test connection as in G3 above, make an impulse noise measurement for a 30 minute period on the supervisory channel from both ends. Use the 6E Impulse Counter in the 20A testboard set for "Flat" weighting and for 54 dbrn. (Operation of the TTG-LTC key transfers the noise leads from the 3B NMS to the 6E Counter.)

Requirement: *Not more than 20 counts should be recorded in 30 minutes at 54 dbrn in either direction.*

H. Overall System Measurements

After line-up and adjustment procedures have been completed on the four wire line facilities, overall measurements of distortion, supervisory channel operation and AGC level control should be made thru the B1 terminal equipment. Before proceeding with these tests it is assumed that the B1 terminals at both circuit ends have been tested in accordance with the standard practices covering the terminal equipment. These overall system measurements should be made between terminating 20A testboards using standard measuring methods for this testboard as covered in Part 4 of this section and in more detail in Section 314-016-160, CD-56526-01 and CD-56528-01. Distortion measurements on either the data channels or supervisory channel may be made in either of two ways. The peak distortion can be read directly on the indicating "per cent distortion meter" of the 906A Data Distortion Display Unit, or the number of "distortion hits" greater than a given preset amplitude, occurring in a given period of time, may be recorded on the Distortion Counter. The "per cent threshold" above which a distortion hit is recorded is set on the DIST CTR switch. The duration of the test may be set on the timer on the 906A panel. When using the distortion meter the maximum swing of the needle should be read as the peak distortion in per cent. When requirements are given as a maximum number of hits above a certain threshold, the counter and timer should be used. When setting the timer for the desired duration of the test, the dial should be rotated beyond the desired time and then turned back in order to avoid the effect of any backlash in setting.

H1 — Data Channel Distortion

Establish a connection between terminal 20A testboards over CHANNEL 1 of the B1 System and make the following channel distortion measurements. All measurements should be made on all six data channels in both directions of transmission and then repeated with the test calls set up in the opposite direction. (See Step 7.)

Step 1: From the originating testboard distortion measuring set, transmit *random* signals at the **F1 frequency** as follows:

GEN. MODE — RANDOM (RDM)
 GEN. SPEED — 200 (bits per second)
 LEV. OUT — LO (12 db down)
 DLY. DIST. — Normal (0 added delay distortion)

Measure distortion in the F1 signal received at the far-end testboard.

Requirement: *Not more than one hit of greater than 12 per cent distortion should be recorded on the counter in a 5-minute period.*

Step 2: Repeat Step 1 except:
 At originating testboard operate Delay Dist. Key to "+". (Adds positive distortion.)

Requirement: *Not more than one hit of greater than 16 per cent distortion should be recorded on the counter in a 5-minute period.*

Step 3: Repeat Step 1 except:
 Delay Dist. Key. — Operate to "-". (Adds negative distortion.) — Requirement same as Step 2.

Step 4: Repeat Step 1 except transmitting at high level. Transmit random signals at the F1 frequency as follows:

GEN. MODE — RANDOM (RDM)
 GEN. SPEED — 200 (bits per second)
 LEV. OUT — "HI" (5 db high)
 DLY. DIST. — Normal (0 delay added)

Requirement: *Same as Step 1.*

Step 5: Same as Step 1 except:
 Transmit F2 from the called testboard and measure at the originating testboard.
 (Delay Dist. Key should be normal.)

Requirement: *Same as Step 1.*

Step 6: Repeat Step 5 at the F2 frequency transmitting from the called testboard at "HI" level.

Requirement is the same.

Step 7: After completion of Step 6, test calls should be set up from the previously called testboard and Steps 1 thru 6 repeated.

H2 — Supervisory Channel — Operation

Before testing on the supervisory channel, the B1 terminals and the six associated trunks should be removed from service. At both testboards, the six rear signal test patch cords should be inserted into the SIG L jacks in the miscellaneous jack field and the six front cords into the SIG L jacks of the six trunks. This prevents false operations thru the terminals into the office equipment during tests on the supervisory channel. Use of the keys associated with the SIG L jacks in the miscellaneous jack field will place "off hook" or "on hook" conditions at both ends of all trunks.

Check the proper transmission of off-hook and on-hook signals over the supervisory channel in both directions for all six data channels as follows:

At receiving testboard, insert MON cord into D XMT MON jack, set CHAN SEL switch to SUPV, operate DATA READ and SUPV MON keys.

At transmitting testboard, on-hook and off-hook signals may be transmitted by operation of keys associated with SIG L jacks. Keys are operated to the right to transmit an off-hook signal and normal for an on-hook signal.

At the far-end testboard, corresponding E lamps associated with the SIG L jacks and the SPV DEMULT white lamps will be lit by an on-hook signal and extinguished by an off-hook signal. The SYN lamp (green) should be lit to indicate that the demultiplexer is in synchronism with the incoming supervisory channel signal. This operation should then be reversed to check the transmission of signals in the opposite direction. More detailed description of the operation of these lamps and their use in making trouble investigation tests is covered in Section 314-016-160 and in CD-56528-01 and CD-73022-01.

H3 — Supervisory Channel — Distortion

Two methods of measuring distortion in the supervisory channel are possible. The method

described here utilizes signals generated by the transmitting B1 terminal equipment and **should be used in the line-up procedure** and normal routine testing. An alternate method, described in Part 4E of this section, utilizes signals generated by the 906A Signal Generator in the Data Distortion Test Circuit. This alternate method eliminates the transmitting B1 terminal equipment and is therefore useful in trouble testing to locate the source of distortion but should not be used for an overall check of the system as required in line-up testing. When this alternate method is used, the requirement should be more severe than when using the line-up method because the distortion contributed by the 906A generator is about 4 per cent less than that contributed by the B1 terminal.

For line-up and routine testing, proceed as follows: Measure distortion in both directions over the supervisory channel. The signal test patch cords should be left up as in Part H2 above. For this test the keys associated with the SIG L jacks should be turned to transmit an off-hook signal (turned right) on data channels 1 and 3 and an off-hook signal (key normal) on channels 2, 4, 5 and 6. At the terminating testboard verify that the CSP, DMB and GB lamps are not lighted (distortion measuring equipment available) and insert a MON cord into the DXMT MON jack in the line test and patch bay. Operate channel selector switch to SUPV. Operate the SUPV and DATA READ keys to measure distortion on the indicating meter. To make a pulse count, operate the DMR key and set the DIST CTR switch to the per cent distortion at which pulses are to be counted.

Requirement: Not more than 7 counts should be recorded in 5 minutes of over 16 per cent distortion.

Note: If, in investigating trouble or for other reasons, it is desired to use the alternate method given in Part 4E of this section, the above requirement should read "Not more than 7 counts in 5 minutes over 12 per cent distortion."

H4 — AGC Operation and Operating Level Check

Calls should be set up over each of the six data channels and the following tests made. Transmit F1 from the **originating** test-

board and F2 from the **called** testboard as specified in the following steps. On 2-way trunks, after completion of Step 6, calls should be set up over all channels from the far-end (previously the called) testboard and Steps 1 thru 6 repeated, sending F1 from the new calling testboard and F2 from the new called testboard.

Step 1: Using the 909A Test Oscillator at the originating testboard, send F1 signals at **normal** level (LEV OUT key NORMAL). Measure the level received at the called testboard.

Requirement: Received F1 level should be -23 ± 4.0 dbm.

Note: *The actual measured value should be permanently recorded for use in future routine measurements.*

Step 2: At the originating testboard operate the sending level key (LEV. OUT) to "LO" and to "HI" (Transmits 12 db below and 5 db above normal level). Measure the received F1 levels at the far-end testboard.

Requirement: The received F1 signal at both "HI" and "LO" levels should not vary more than ± 1.0 db from the actual level received in Step 1.

Step 3: Transmit F2 signals at "Normal" level from the 909A Test Oscillator in the far-end (called) testboard. Measure the received level at the originating testboard.

Requirement: The received F2 level should be -18 ± 4.0 dbm.

Note: *The actual measured value should be permanently recorded for use in future routine measurements.*

Step 4: At the called testboard, send F2 at low and high levels (LEV. OUT key to "LO" and "HI"). Measure the F2 level received at the "originating" testboard.

Requirement: The received F2 signal at both high and low levels should not vary more than ± 1.0 db from the actual level received in Step 3.

Step 5: At the originating testboard, disable the AGC action by operating the "Sub AGC" key (this transmits F1 signals 18 db below normal level). Measure level at far-end testboard.

Requirement: The received F1 level should be less than -35 dbm.

Step 6: At the called testboard, operate the "Sub AGC" key and transmit F2 signals. Measure level received at "originating" testboard.

Requirement: The received F2 level should be less than -35 dbm.

Step 7: See first paragraph, Part H4. Set up calls over all channels in the opposite direction and repeat Steps 1 through 6.

3. ROUTINE MEASUREMENTS

Three types of routine measurements should be made on all WADS B1 systems at intervals specified below. These are (A) Level Check on the 4-wire layout, (B) AGC operation and level check on the data channels and (C) Distortion Measurements on the six data channels and the supervisory channel. Distortion measurements should be made during the busy period for the offices involved. Measurements on the trunk channels may be made by turning down only the trunk being tested. Measurements on the supervisory channel and on the 4-wire layout will require turning down the two B1 terminals and associated six trunks during the testing period.

A. Level Check on Four Wire Layout — At three month intervals

Overall loss measurements at 2225 cycles should be made in both directions of transmission in the same manner as covered in Part 2F of this section.

Requirement: Received levels should not deviate from -14 dbm by more than the permissible deviation in Table 2. If this deviation is exceeded, the layout should be re-adjusted to meet the deviation limits of Table 1 of Part 2 F.

B. AGC Operation and Level Check — At one month intervals

Tests should be made in the same manner as in Part H4 of this section, Steps 1 thru 7.

Requirement: The F1 level received in Step 1, and the F2 level received in Step 3 should not differ by more than ± 2.0 db from the corresponding levels measured on each circuit in each direction on initial line-up of the system. Requirements for other steps are the same as in Part H4.

C. Trunk Distortion Measurements — At six month intervals

(1) **Data Channels**—Distortion measurements should be made on each of the six data channels for a period of 30 minutes. Measurements should be made in both directions in the same manner as in Part H1, Steps 1 and 5 of this section. Measurements in the two directions may be made simultaneously if desired. The test calls should then be set up from the previously called testboard and these measurements repeated.

Requirement: Not more than 3 counts should be recorded in 30 minutes above 12 per cent distortion.

(2) **Supervisory Channel**—Distortion should be measured in both directions on the supervisory channel for a period of 30 minutes in the same manner as in Part H3 of this section.

Requirement: Not more than 42 counts should be recorded in 30 minutes above 16 per cent distortion.

TABLE 2

Permissible Deviation in Db from Specified Received Level for Routine Tests

TYPE OF 4-WIRE LAYOUT	LENGTH OF LAYOUT		
	0-100 MI.	101-500 MI.	OVER 500 MI.
No VFE			
Single Link Cxr. Section — Cable or Radio	± 1.0 db	± 1.5 db	± 1.5 db
VFE — CXR			
Single Link Cxr. Section — Cable or Radio	± 1.5 db	± 1.5 db	± 1.5 db
VFE — CXR			
Multilink Cxr. or Combination Cxr. and VF	± 1.5 db	± 1.5 db	± 2.0 db

4. 20A TESTBOARD — OPERATIONS FOR NORMAL AND TROUBLE TESTING

A. Originating a Call

Until the originating 20A testboard is equipped with trunk selection equipment, the assistance of the office MTF attendant will be required to set up a test call over a specific B1 system trunk. This is outlined below as the "interim method."

A1 — Interim Method (Using terminal test cord)

- (1) Insert MB plug into MB jack of trunk.
- (2) Insert front term. test cord into trunk MON jack.
- (3) Operate MON key to verify trunk is idle.
- (4) Request MTF on a communication cord to connect the selected trunk to distant testboard incoming line or trunk termination. MTF dials up code.
- (5) Remove test cord from MON jack, insert it into TP900 jack. (All keys normal.)
- (6) Patch TP600 jack to TST jack of trunk.
- (7) Insert signal test cord into SIG L and SIG D jacks of trunk. Operate keys TEST and TWD L OFF HK of signal test cord.
- (8) Request MTF to disconnect.
- (9) When MTF disconnects, remove cord from trunk signal jacks.
- (10) To test, operate TST key of terminal test cord. (Communication with distant testboard must be over separate voice channel.)

A2 — Use of Position Connector Circuit

After installation of Position Connector Circuit (SD-56538-01) and test Trk Jack (SD-56526-91, Fig. 27) the following method may be used.

- (1) Set rotary switches in Position Connector Circuit for the desired route, and trunk.
- (2) Operate TALK key of test cord and check desired trunk for busy condition by touching cord tip to sleeve of Trunk Test Jack. (Click indicates busy trunk.)

(3) If not busy, connect to above jack. Pre-set dialing signal will be transmitted over trunk by the trunk test register.

(4) Trunk may be released by removing test cord from Trunk Test Jack.

Note: Details of equipment operation involved in the above are covered in CD-27648-01 and CD-56538-01 and associated drawings.

B. Answering Incoming Call

(Call incoming on either incoming line or trunk circuit will light associated lamp in trunk multiple.)

- (1) Insert rear cord of terminal test cord into line or trunk jack.
- (2) Operate cord TALK key. Lamp will go out. (On full voice band trunks communication may be over this channel. On narrow band B1 trunks a separate voice frequency channel must be established for communication.)
- (3) To test, operate terminal test cord TST key. This will condition the receiving 906A Data Distortion Test Circuit to receive F1 signals and the data signal modulator and 909A Oscillator to send F2 signals during testing.

C. Overall Data Distortion

- (1) *At originating testboard*, verify GB lamp is out. (Data signal generator not in use.)
- (2) Set GEN SPEED switch to bit rate desired.
- (3) Set GEN MODE switch to RDM (Random).
- (4) Operate SND key. (F1 random signal is transmitted.)
- (5) *At terminating testboard*, verify that the DMB lamp is out. (Distortion measuring equipment not in use.)
- (6) Set GEN SPEED switch to bit rate being transmitted.
- (7) If distortion hit count is required — set DIST CTR switch to desired distortion pulse threshold level.

- (8) Operate DMR key. Distortion of F1 signals being received on the connect cord may now be read on distortion meter or counter.
- (9) Set transmitting mode switch to DOT. Read bias by operating DMS key to BIAS while holding DMR operated.
- (10) To read supervisory peak distortion, set transmitting GEN. MODE switch to RDM, operate DMS key to SUPV while holding DMR operated.
- (11) To introduce delay distortion (at F1) have originating testboard operate DLY DIST key to "+" or "-" while transmitting.
- (12) To measure distortion in opposite direction of transmission, the above procedure (Steps 1 thru 10) should be applied at the called testboard while holding the same connection. The called testboard (previously receiving) will now send F2 data on the connect (rear) cord and the originating testboard will be receiving F2 data and measuring distortion at F2 on the test (front) cord. Omit Step 11 in this direction — delay distortion can only be added by the originating testboard at the F1 frequency.

D. Overall Level Measurement

D1 — Using 909A Data Distortion Test Oscillator

- (1) Establish test call to the far-end testboard. Use test cord to transmit F1 frequency or a connect cord to transmit the F2 frequency.
- (2) Operate the MK or SP key of the terminal test cord to transmit Mark or Space signals at normal sending level.
- (3) At the receiving testboard, verify that the MB lamp is not lighted (meter is available).
- (4) Operate TMR key of terminal test cord in receiving testboard. The received transmission level may be read on the meter.

Note: To test the automatic gain control action of the transmitting B1 terminal, operate the LEV OUT key at transmitting testboard to "LO". This lowers the normal transmitting level 12 db. Operating key to

"HI" raises transmitting level 5 db. Operation of the SUB AGC key lowers normal transmitting level 18 db and disables the AGC circuit. The effect of these changes in transmitting level on the received level in a properly operating B1 system are covered in Part H4 of this section.

D2 — Using 906A Data Distortion Test Circuit Signal Generator

- (1) At originating testboard, set up the test call and verify that the local GB lamp is not lighted. (Generator therefore not busy.) In setting up the call use the test cord to send F1 or the connect cord to send F2.
- (2) Set the GEN SPEED switch for desired bit rate.
- (3) Set the GEN MODE switch to MK or SP (for mark or space signals).
- (4) Operate SND key of terminal test cord.
- (5) Measure at receiving testboard as in Steps 3 and 4 of D1 above.

Note: The AGC action may be tested when using the 906A equipment in the same way as with the 909A Oscillator — see Note Part D1 above.

D3 — Using KS-19260 Oscillator in Trans. Meas. Set or Other Suitable Variable Frequency Oscillator

- (1) Establish the call to the far-end testboard and patch the oscillator to the transmission measuring equipment.
- (2) Adjust oscillator for desired frequency and level.
- (3) Verify that the TMB and MB lamps are not lighted. (Trans. Meas. Eq. not in use.)
- (4) Operate TMS and TMR keys of the terminal test cord.
- (5) Measure received level as in Steps 3 and 4 of D1 above.

E. Distortion Tests — Supervisory Channel

The method outlined below uses signals generated by the 906A Signal Generator and eliminates the transmitting B1 terminal equipment. It is primarily useful in trouble testing

to locate a source of excess distortion. The method covered in Part H3 of this section should be used in normal line-up and routine testing. See Part H3 for the maximum permissible distortion as measured by both methods.

Before making these tests both B1 terminals and associated trunks should be made busy and removed from service at both ends. At both testboards insert the six rear signal test patch cords in the SIG L jacks in the miscellaneous jack field, and the six front cords in the SIG L jacks of the six trunks assigned to the terminal.

- (1) *At the originating testboard* — Insert a line-drop cord in the XMTL jack in the line test and patch bay.
- (2) Verify that GB lamp is not lighted and set GEN MODE switch to RDM.
- (3) GEN SPEED switch may be ignored — a bit rate of 95.5 will be transmitted on this test regardless of switch setting.
- (4) Operate SEND SUPV key. Supervisory signals of 385 and 315 cycles will be transmitted at a bit rate of 95.5 bps.
- (5) *At the terminating testboard* — insert a MON cord into the DXMT MON jack in the line test and patch bay.
- (6) Verify that CSP, DMB and GB lamps are not lighted. Operate the channel selector switch to SUPV and operate the SUPV and DATA READ keys.
- (7) Operate the position control DMS key to SUPV and read supervisory distortion on the distortion meter. To make a pulse count, set DIST CTR switch to per cent distortion required.
- (8) A check may be made of the distortion present in the *transmitted* signal by performing Steps 5 to 7 also at the originating testboard.
- (9) Distortion should be measured in both directions by reversing operations at originating and called testboards.

F. Supervisory Signal Tests

To check the proper transmission of on-hook and off-hook signals for the trunks assigned

to a B1 system, make all six trunks busy at both ends and proceed as follows:

(1) *At both transmitting and receiving testboards*, insert the six rear signal test patch cords into SIG L jacks 1 to 6 in the miscellaneous jack field, and insert the six front cords into the SIG L jacks of the trunks assigned to channels 1 to 6 of the B1 terminal.

(2) *At the receiving testboard*, insert a MON cord into the DXMT MON jack. Set the CHAN SEL switch (if channel selector is idle) to SUPV and operate keys DATA READ and SUPV MON.

(3) On-hook and off-hook signals may be transmitted from the originating testboard by operation of the six keys associated with the SIG L jacks. Keys are operated to the right to transmit an off-hook signal and operated normal for an on-hook signal. At the far end, corresponding E lamps associated with the SIG L jacks and the SPV DEMULT white lamps will be lit by an on-hook signal and extinguished by an off-hook signal. The SYN lamp (green) should be lit to indicate that the demultiplexer is in synchronism with the incoming supervisory channel signal.

(4) Check operation of all six channels and then repeat in the opposite direction. If trouble exists it may usually be sectionalized by comparing at each testboard, the operation of the E lamps associated with the SIG L jacks with the corresponding white SPV DEMULT lamps associated with the demultiplexer.

G. Frequency Measurements

G1 — Overall transmitted and received frequency check.

Set up a call using terminal test cords at both testboards. Frequency may be checked while other tests are being made over the connection. At either testboard use test (front) cord to transmit F1 frequency or connect (rear) cord to transmit F2 frequency. Either the 909A oscillator or the 906A Data Signal Generator may be used to transmit signal — see Parts D1 and D2.

- (1) *At the originating testboard* — If FMB lamp is not lighted (frequency counter available), operate the FRS CHK key. The frequency being transmitted may be read directly on the counter.

(2) *At the receiving testboard* — If FMB is not lighted, operate the FRR key. The frequency being received may be read directly on the counter.

Note: Transmitted and received frequencies may also be checked when making sectionalized measurements on the B1 line and using the Line Test Cord by operating the **FREQ** key at the transmitting testboard and the **FREQ** key and **READ** key at the receiving testboard.

H. Noise Measurements

Noise measurements and requirements for the initial line-up procedure of B1 systems are covered in Parts 2B and 2G of this section. The following additional measurements are intended primarily for trouble locating of sources of excess noise.

H1 — Overall Steady Noise Measurements — Data Channels

- (1) At both testboards verify that the NSB lamps and the TTC-LTC lamps are not lighted (3B measuring set is not in use).
- (2) Set 3B NMS function switch to 900.
- (3) Insert network for "C Message" weighting, and dbrn switch to 85.
- (4) Operate the NSE key of the terminal test cord.
- (5) Both testboards may now read the incoming noise level by gradually reducing the dbrn dial setting until a reading of about +7 or more is obtained on the 3B NMS meter. Measured noise level is the sum of the dbrn dial reading and the meter reading.

H2 — Steady Line Noise Measurements

(B1 Data Terminals and the six associated trunks must be removed from service.)

- (1) At the testboard making the noise measurement, insert the Line-Drop cord into the LRCV jack. At the far-end testboard, insert a 262B plug into the LXMT jack. (Reverse this procedure to test the other direction of transmission. Both directions may be tested simultaneously if desired.)

(2) At the measuring testboard, verify that the NSB lamp and the TTC-LTC lamp (in the miscellaneous jack field) are not lighted, and set the function switch on the 3B NMS to 600, and the dbrn switch to 85. Use "C Message" or "3 Kc Flat" weighting networks as specified.

- (3) Operate keys **READ** and **NSE** of the line test cord circuit.
- (4) Measure noise level as in Part H1 Step 5.

H3 — Noise in B1 Terminal

To check for excess noise in either B1 terminal, both testboards should proceed as in H2 above, except that the Line-Drop cord is inserted into the DRCV jack in the line test and patch bay.

H4 — Sectionalized Noise Measurement — Data Channels

- (1) Originate a test call on one of the data channels using a terminal test cord.
- (2) To measure noise leaving the office insert a MON cord into the D RCV MON jack.
- (3) To simultaneously measure noise received at the called testboard, insert the MON cord at that board into the DXMT MON jack.
- (4) At both testboards, if CSB lamps are not lighted, (Chan Selector available) operate **CHAN SEL** switches to channel being measured.
- (5) If noise measuring equipment is available (NSB lamp not lighted), measure noise by operating **READ** and **NSE** keys at either or both testboards.

H5 — Impulse Noise Measurements

- (1) Overall impulse noise measurements (on a trunk) are made using a terminal test cord. Impulse noise measurements on the line facilities are made using a line test cord.
- (2) Verify that no cords are inserted in the TST jack or 4W jacks. Operate the TTC-LTC key. This transfers the noise measuring leads of the data test cord circuit from the 3B NMS to the 6E Impulse Counter.

(3) The insertion of a cord in either the TST or 4W jacks will now hold this condition operated. When testing with a terminal test cord the other cord of the pair should be inserted into the TST jack and all keys restored to normal to make the impulse count. (If desired a patch may be made instead from the TST jack to the TST jack of the trunk under test.) The 4W jack may be patched to jacks in the circuit patch bay for line noise measurements.

I. Sectionalized Distortion Measurements

Normal distortion measurements on overall data channels are made as in Part 2H and in Part 4C above. The following measurement is used primarily when it is desired to locate the source of excess distortion found on the overall channel measurement. The following method is based on channel measurements, made on the four wire facilities, thru the channel selection filters.

- (1) Establish a distortion test connection over a data trunk as in Part 4C above using a terminal test cord. Use the test (front) cord to send F1 signals and the connect (rear) cord to send F2 signals. (Set GEN SPEED, GEN MODE switches and SND key as required.)
- (2) At the originating testboard, insert a MON cord into the D RCV MON jack of the B1 system in the line test and patch bay.
- (3) At the called testboard, insert a MON cord into the DXMT MON jack.
- (4) Check at both ends that the data signal generator, distortion measuring set and channel selectors are available, (DMB, GB and CSB lamps not lighted.)
- (5) Set the CHAN SEL switch at both testboards to the particular channel being tested. If a pulse count is desired, set the DIST CTR switch to pulse limit required.
- (6) Operate the DATA and DATA READ keys at both transmitting and receiving testboards. Distortion present in the line signal as transmitted and as received may now be read simultaneously at the two boards.
- (7) A similar measurement in the opposite direction may be made on the same test call by transmitting F2 signals from the called

testboard and measuring simultaneously at the DRCV MON jack at the called location and at the DXMT MON jack at the originating location.

(8) Bias distortion may also be measured on the above connection by operation of the DMS key in the position control circuit to BIAS. DOT mode of signals should be transmitted instead of RDM for bias measurements.

J. Distortion of Local Signal Generator

Distortion present in the F1 and F2 signals from the data signal generator may be checked and the distortion measuring set calibrated in the following manner:

- (1) To test F1 signals, neither "test" nor "connect" cords of the terminal test cord circuit should be inserted in any jacks, except that the "test" cord may, if any other testing is in progress, remain in the TST jack of a trunk.
- (2) To test F2 signals, the connect cord should be inserted into the GS jack or in an incoming line or trunk jack.
- (3) Verify that GB and DMB lamps are not lit. Set GEN SPEED switch to desired bit rate. Set GEN MODE switch to RDM. Set DIST CTR switch if a pulse count is desired.
- (4) Operate the DMO key of the terminal test cord and read the peak distortion of the generator signal on the distortion meter or counter.
- (5) To check the operation of the delay distortion circuit (F1 signals only) operate the DLY DIST key to "+" or "-". The measured distortion should increase approximately 4 per cent.
- (6) Change the GEN MODE switch to DOT while reading distortion as in Step 4. Adjust the calibrate key at the distortion measuring set to read zero. Change the GEN MODE switch to + BIAS. Distortion meter should read approximately +12.5 per cent. Change the GEN MODE switch to - BIAS. Distortion meter should read approximately -12.5 per cent.

K. Check of Local Tones

K1 — 909A Data Distortion Test Oscillator

- (1) Set up test call on terminal test cord as in Part D1. Use test (front) cord for F1 signals and connect (rear) cord for F2 signals. Operate MK-SP key to measure both signals.
- (2) Operate SND LEV key and read sending level of each frequency on transmission meter. High, normal and low sending levels may be checked, if desired, by also operating HI-LO key of terminal test cord.
- (3) Frequency of any local tone may be checked by operation of FRS CHK key.

K2 — 906A Signal Generator

- (1) Set up test call as in Part D2 Steps 1 thru 4.
- (2) Same as Part K1 Step 2.
- (3) Same as Part K1 Step 3.

K3 — Call Progress Tones

Note: Call progress tones consist of two frequencies 2025 and 2225 shifted at a 20-cycle rate. The local tones are available for test at the F2S jack, F2M jack and the F2MS jack in the testboard miscellaneous jack field.

- (1) Verify that the TMB and MB lamps are not lit. Insert connect cord in one of above jacks and operate TMR key. Read local tone level on transmission meter.
- (2) To check the frequency of the basic tones, insert either a test or connect cord into the call progress tone jack and operate the TST and FRR keys of the terminal test cord.

5. REFERENCES

SECTION	SUBJECT
E40.467	6A Impulse Counter
E43.130.00	V4 Telephone Repeater
314-016-125	WADS — Attenuation Equalization
314-016-150	B1 DCT — General Description
314-016-160	20A WADS Toll Testboard

SECTION	SUBJECT
314-016-301	Voice Band WADS Trunks — Testing
314-016-500	17B Testboard for WADS Trunks
314-016-505	Balance Testing — WADS Offices
314-016-550	B1 DCT — Location of Defective Circuits
314-017-150	B1 DCT — Channel and Line Circuit Description
314-017-550	Same — Maintenance Tests
314-018-150	B1 DCT — Supervisory Signaling Circuit
314-018-550	Same — Trouble Location Tests — Modulator
314-018-551	Same — Trouble Location Tests — Demodulator
314-019-150	B1 DCT — Carrier Supply — Description
314-019-550	Same — Trouble Location Tests
314-020-150	B1 DCT — Channel Line Frequency Allocation
314-300-300	WADS and TWX Access Lines — Testing
314-820-103	Envelope Delay of 366 and 367 Type Equalizers

Circuit Descriptions (CD) and Drawings (SD)

CD and SD	
25850-01	Outgoing Trk Circuit — No. 5 Office to Testboard
27643-01	Trunk Test Register Circuit
27648-01	Trunk Test Circuit to Line Link
27651-01	Trunk Test Register Connector
55039-01	Automatic Outgoing Trunk Test Frame
55925-01	20A MF Keyset Circuit
56497-01	Signaling Test Circuit
56526-01	20A Jack Circuits
56527-01	20A Testboard B1 Alarm Circuit
56528-01	20A Data Test Cord Circuit
56530-01	"101" Type Test Trunk Circuit (LLF to 20A)

SECTION 314-016-305

CD and SD (Cont'd)

56538-01 Position Connector Circuit
64613-01 20A Testboard Cord Circuit
64616-01 20A Testboard Position and Tel. Circuit
64761-01 20A Testboard Dial Cord Circuit
73022-01 906A Data Distortion Test Circuit

CD and SD

73024-01 909A Test Oscillator Circuit
95276-01 3A and 3B Noise Measuring Sets
95900-01 Transmission Measuring Circuit
96516-01 Monitoring Amplifier Circuit
98149-01 Delay Equalizing Circuit
99721-01 6E Impulse Counter Circuit

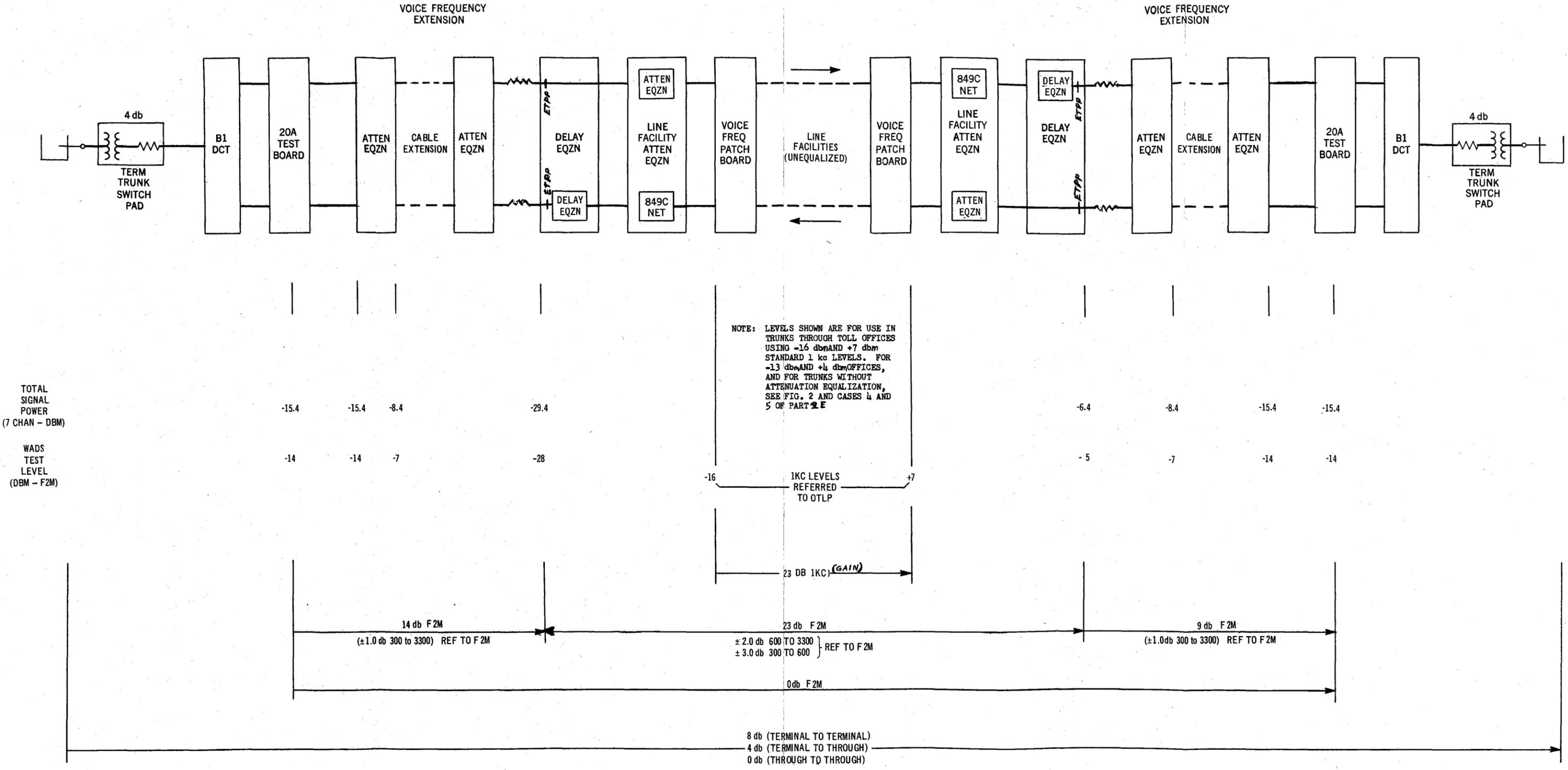
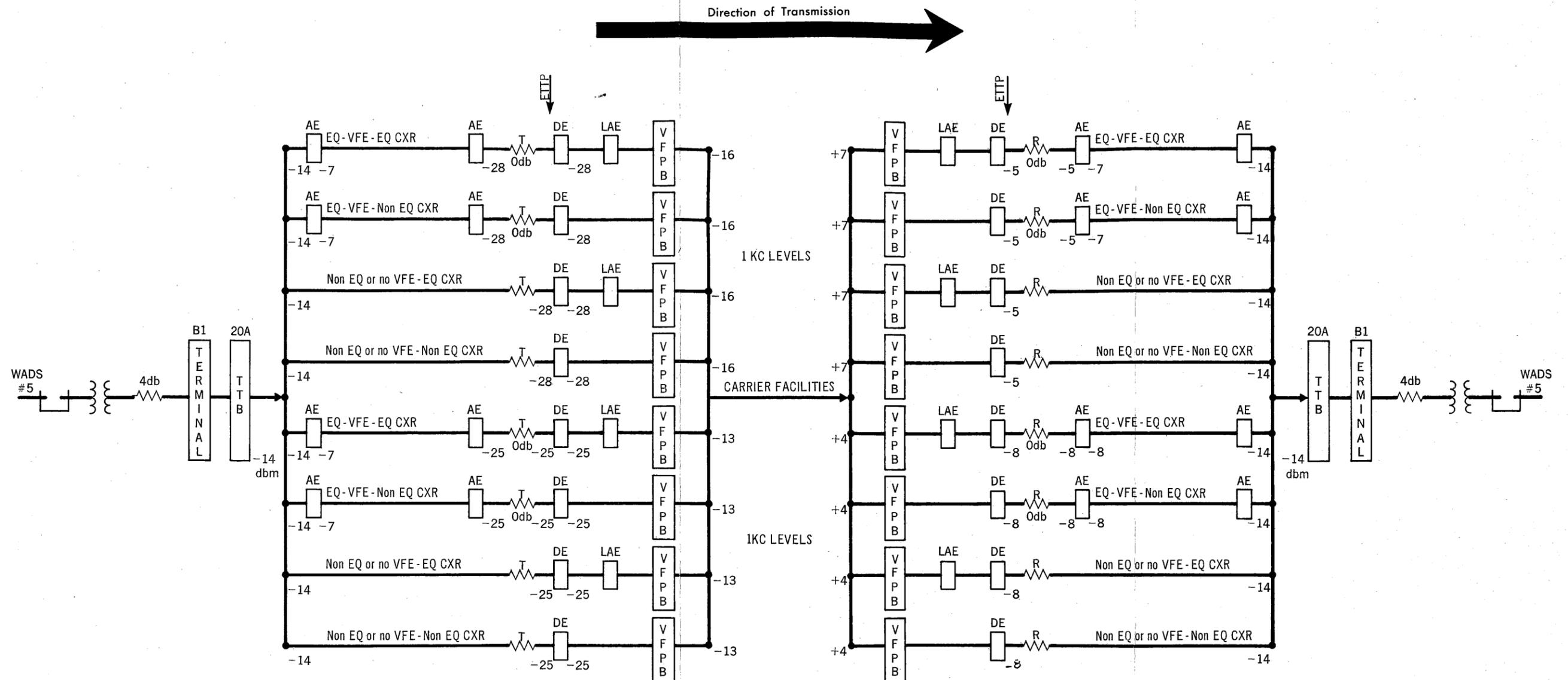


Fig. 1 - B1 Data Carrier Trunk



NOTES:

1. Levels are shown in one direction of transmission only. Test levels in opposite direction by symmetry.

2. Any originating arrangement on the left may connect to any terminating arrangement on the right.

3. Levels shown are WADS test levels in dbm at F2M except the standard TLP office levels of -16, -13, +7, +4 dbm at 1000 cycles indicated at VFPB points.

4. VFE - Voice Frequency Extension
Attenuation equalized or not equalized depending on length.
AE - Attenuation Equalizer - Used or not used depending on length and type facilities.
DE - Delay Equalizer
All circuits are delay equalized regardless of attenuation equalization requirements.
LAE - Line Attenuator Equalizer
for carrier facilities

5. T and R pads used for level adjustment only where VFE - attenuation equalizers are not used. Zero db (1C) pads should be inserted in all cases where other valves are not required.

Fig. 2 - WADS B1 Trunks — Typical Facility Arrangements and Test Levels