9608 Program Amplifier and 9608A Program Distribution Amplifier

contents

1. general description

1.01 Tellabs' 9608 Program Amplifier and 9608A Program Distribution Amplifier modules (figure 1) are wideband, low-distortion amplifiers designed for use in program transmission applications. The 9608 is a single-input, single-output amplifier, while the 9608A is a single-input, five-output splitting amplifier. In all other respects, both modules are identical. An integral amplitude equalizer may be switched into the circuit to introduce up to 30dB of adjustable precision slope equalization for 5, 8, or 15kHz program applications. With the equalizer switched out of the circuit, amplifier response is essentially flat (±1dB) from 30Hz to 15kHz. As Metallic-Facility-Terminal (MFT)-configured modules, the 9608 and 9608A are designed for program transmission applications within the Western Electric MFT System family.

1.02 In the event that this practice section is reissued, the reason for reissue will be stated in this paragraph.

1.03 As stated above, the 9608 is a single-input, single-output Program Amplifier, while the 9608A is a single-input, five-output splitting Program Distribution Amplifier. The 9608A is arranged for one *primary* output channel and four *auxiliary* output channels. Gain control, equalization, and jack access for the auxiliary output channels of the 9608A are derived from the primary output channel controls.

1.04 Both 9608 and 9608A provide from 0 to 40dB of adjustable gain in switch-selectable 10dB increments (0 to 10dB, 10 to 20dB, 20 to 30dB, or 30 to 40dB). Within each increment, gain is continuously adjustable to within ±0.1dB of the desired level via a front-panel control. Maximum output level capability is +20dBm.

1.05 An active amplitude equalizer may be used to compensate for the frequency response of nonloaded telephone cable, in 5, 8, or 15kHz program applications. Equalization is controlled by adjustment of three potentiometers accessed through the modules' front panels. Two adjustments, one for high frequencies and one for low frequencies, establish the equalizer response shape. A third adjustment provides response trimming at very low frequencies. The composite equalizer is capable of slope correction in excess of 30dB for various lengths and gauges of nonloaded telephone cable. Equalization to within ±1dB is achievable for either 8kHz or 15kHz circuits. Adjustment is precise and can be accomplished with relative ease. Roll-off is provided at approximately 10kHz in the lower of the two switch-selectable equalization bandwidth ranges, and above 19kHz in the higher range.

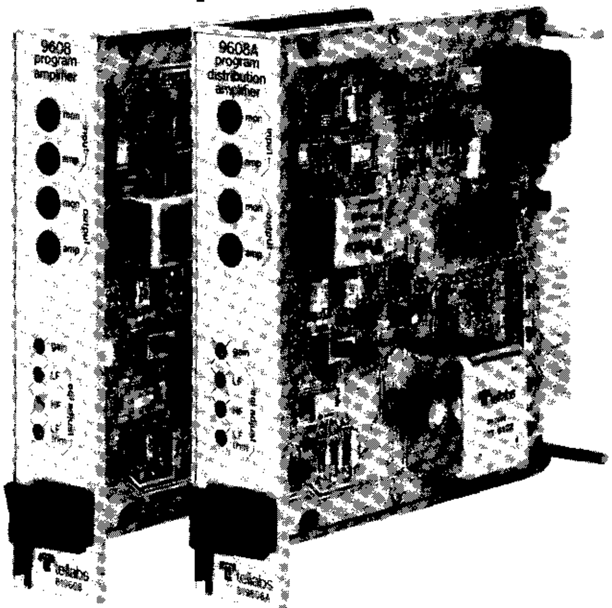


figure 1. 9608 Program Amplifier and 9608A Program Distribution Amplifier modules

1.06 The 9608 and 9608A are designed to operate between 600-ohm balanced or 150-ohm balanced or unbalanced source and load impedances. Input and output impedances are independently switch-selectable for 150 or 600 ohms. Input and output impedances are not affected by insertion of the active amplitude equalizer.

1.07 Secondary surge protection is provided at all Amplifier ports, including surge-current-limiting resistors in both input and output paths. Transient protection is also provided for the power regulating circuit in both modules.

1.08 The 9608 and 9608A are designed to operate on any filtered input voltage between −42 and −56Vdc. Quiescent-state current requirement for both modules is 40mA. At maximum output levels, the 9608 draws 60mA and the 9608A (with all five outputs at maximum) draws 80mA.

1.09 Use of tantalum capacitors and other carefully chosen components allows either module to operate within the temperature range of −40° to +140° Fahrenheit.

1.10 The front panels of the 9608 and 9608A are designed so that all adjustments can be made while the module is mounted in place. Front-panel gain and equalization controls are complemented by a full set of test jacks (input, output, input monitor, and output monitor) to facilitate alignment and testing of each module.

1.11 As MFT-configured modules, the 9608 and 9608A each mount in one position of a Western Electric MFT single-module (MTM-1), MFT double-module (MTM-2), or Customer-Premise Facility Terminal (CPFT) Shelf. The MTM-1 is a 12-position central-office-type shelf that is factory-prewired to accept up to 12 MFT-configured transmission units such as the 9608 and 9608A. The MTM-2 is a 12-position central-office-type shelf that is factory-prewired to accept up to 6 MFT-configured transmission units such as the 9608 or 9608A and up to 6 MFT-configured companion signaling units. Both MTM-1 and MTM-2 shelves are designed for 23-inch relay rack installation. For customer-premise installation, a Western Electric CPFT mounting shelf is also available. Each module plugs physically and electrically into a 40-pin connector at the rear of the mounting shelf position.

2. application

2.01 Tellabs' 9608 Program Amplifier and 9608A Program Distribution Amplifier modules provide the amplification, amplitude equalization, and linearity necessary for the transmission of high-quality, wideband audio signals over nonloaded telephone cable. Both modules accommodate standard 5kHz (am radio), 8kHz (television audio), or 15kHz (fm radio) bandwidth signals.

2.02 The 9608's primary application is conditioning the transmission facility (nonloaded telephone cable) from a radio or television station to a transmitter site, or from a remote pickup point to a studio or transmitter site. Switchable 150 or 600-ohm port impedances allow the 9608 to interface nonloaded cable (150-ohm option) or broadcast equipment (600-ohm option).

2.03 The 9608A is typically used in applications where up to five 150 or 600-ohm outputs must be derived from a single input. Either impedance may be individually switch-selected for each output. This module may be used in a private wired music system, where program material is distributed to several locations from a telephone central office, or it may be used at a radio or television network branching point composed of either carrier-derived channels or very short cable distribution loops. Switchable 150 and 600-ohm impedance options at all six ports allow the 9608A to interface nonloaded cable pairs (150-ohm option), and carrier-derived channels or broadcast equipment (600-ohm option).

2.04 The 0 to 40dB gain range of the 9608 and 9608A, in conjunction with the +20dBm output level capability, provides adequate amplification for applications within the limits of good transmission design. The four gain ranges (0 to 10dB, 10 to 20dB, 20 to 30dB, and 30 to 40dB) are selected via a DIP switch on the modules' printed circuit boards. Fine adjustment within each range is accomplished by means of a front-panel potentiometer. Levels may be accurately set to within ±0.1dB across the entire 0 to 40dB gain range.

2.05 The active equalizer in both modules is capable of inversely matching the slope of nonloaded telephone cable from either 50Hz to 15kHz or from 100Hz to 8kHz, where the loss differential between the lowest and the highest frequencies of interest is between 0 and 31dB. Equalizer response is independent of amplifier gain, permitting independent adjustment of facility frequency response and loss (or gain). Equalizer slope is matched to cable characteristics through adjustment of two potentiometers labeled *HF* (high frequency) and *LF* (low frequency) on the modules' front panels. A third front-panel potentiometer labeled *LF trim*, is provided to trim low-frequency (below 200Hz) response after primary equalization has been achieved. A composite frequency response for cable and amplifier that is flat within ±1dB from either 30Hz to 15kHz or from 50Hz to 8kHz can be achieved with the modules' equalizers.

2.06 Slope equalization provided by the active equalizer is limited to a loss differential of about 31dB between lowest and highest frequencies of interest. This limit is translated to equivalent cable lengths in tables 1 and 2. Table 3 lists the loss per kilofoot of various gauges of cable at both 8kHz and 15kHz.

cable gauge	maximum length	cable loss at equalization limit (600Ω terminations) 1kHz	8kHz
19	61.5kf	15.3dB	41.5dB
22	40	13.6	41.0
24	30	12.2	38.5
26	24	12.8	38.0

table 1. Approximate maximum equalization ranges — 5kHz and 8kHz program circuits

cable gauge	maximum length	cable loss at equalization limit (600Ω terminations) 1kHz	15kHz
19	46.0kf	11.5dB	42.5dB
22	31.2	10.5	45.6
24	22.2	8.8	40.8
26	18.0	9.5	40.4

table 2. Approximate maximum equalization limits — 15kHz program circuit

cable gauge	loss/kf at 8kHz	loss/kf at 15kHz
19	0.675dB	0.924dB
22	1.025	1.462
24	1.283	1.838
26	1.583	2.244

table 3. Loss per kilofoot of cable

2.07 When equalization is not required, the 9608 and 9608A's equalization circuitry may be electrically removed from the transmission path via switch option. In this mode, both 9608 and 9608A provide flat gain from 20Hz to 15kHz, with roll-off below 20Hz and above 19kHz.

2.08 Equalizer response is unaffected by choice of input and output impedance, but, in general, the 150-ohm cable interface impedance permits equalization of longer cable sections than the 600-ohm impedance. *The 150-ohm impedance-matching option presents a deliberate impedance mismatch that provides nominal slope equalization for non-loaded telephone cable.*

Note: *When optioned for 600-ohm impedance, the 9608 and 9608A must be used on balanced transmission facilities. Capacitors are connected between the midpoints of the input and output transformers and external connector pins. These pins may be grounded (either to power-supply ground or to local ground) to improve longitudinal balance. These capacitors will seriously degrade amplifier performance if either module is connected to an unbalanced 600-ohm source or load. The capacitors are electrically removed from the circuit when the 9608 or 9608A is optioned for 150-ohm impedance, thus permitting use of either Amplifier in this mode with unbalanced source and/or load terminations.*

2.09 A switch option provides somewhat closer adaption of both modules' equalization to long loops or short loops — long loops being those with greater than 17dB loss at the highest frequency of interest. Considerable overlap in the two ranges is provided by the front-panel equalization controls.

2.10 Both modules' input and primary output channels may be accessed via front-panel-mounted input and output jacks. The *input amp* and *output amp* jacks directely access the primary amplifier ports. Input and output monitor jacks, (*input mon* and *output mon*), provide bridging access to the primary amplifier ports, and, with the second plug inserted into the access jack, the external facility leads may be accessed through the appropriate monitor jack. Individual jack access is not provided for the 9608A's four auxiliary output ports.

Note: *When the input or output of either module is accessed through the* **input amp** *or* **output amp** *jacks, the current-limiting resistors are bypassed. This will cause input and output impedances to appear 11.2 ohms* **lower** *than will be measured at the input and output connector pins, creating a 0.1dB — greater difference in insertion loss with a 600-ohm termination and a 0.2dB — greater difference with a 150-ohm termination.*

3. installation

inspection

3.01 The 9608 Program Amplifier and 9608A Program Distribution Amplifier modules should be visually inspected upon arrival in order to find possible damage incurred during shipment. If damage is noted, a claim should immediately be filed with the carrier. If stored, the module should be visually inspected again prior to installation.

mounting

3.02 Each 9608 and 9608A module mounts in one position of a Western Electric MTM-1, MTM-2, or CPFT Shelf. The MTM-1 and MTM-2 Shelves are designed for 23-inch relay rack installation, while the CPFT Shelf is designed for customer-premise applications. Each module plugs physically and electrically into a 40-pin connector at the rear of the Shelf.

installer connections

3.03 Before making any connections to the mounting shelf, make sure that power is **off** and modules are **removed.** Modules should be put into place only **after** they are properly optioned and **after** wiring is completed.

3.04 Table 4 lists external connections to the 9608 and 9608A modules. All connections are made via wire wrap at the 40-pin connector at the rear of each module's mounting shelf position. Pin numbers are found on the body of the connector.

connect:	to pin:
AMPLIFIER INPUT	17 and 19
INPUT SIMPLEX	22
INPUT MIDPOINT CAPACITOR	21
SLEEVE GND (front-panel jacks)	1
PRIMARY CHANNEL OUTPUT	13 and 14
OUTPUT SIMPLEX (primary channel)	4
OUTPUT MIDPOINT CAPACITOR	7
−48V (−48Vdc input)	11
GND (ground)	18
AUX OUTPUT 1	5 and 6*
AUX OUTPUT 2	2 and 3*
AUX OUTPUT 3	10 and 12*
AUX OUTPUT 4	24 and 25*

*9608A module only

table 4. External connections to 9608 and 9608A

ground connections

3.05 When the 9608 or 9608A is located in a central office or at a location with local power, best results will be achieved when the transformer shield grounds are connected to the power-supply ground. The jack sleeves may be grounded either to frame ground or to power ground. At remote locations, the jack sleeves may be connected to local ground or left open, and the other grounds should be connected either to local ground or to power ground, whichever minimizes introduction of 60Hz noise.

option selection

3.06 All options on the 9608 and 9608A are selected via slide or DIP switches located as shown in the condensed alignment procedure, figure 2. Please note that switches *S7, S8, S9,* and *S10* are **not** provided on the 9608 module; all other switches are in the locations shown. Switch designations are indicated on the printed circuit board adjacent to each switch.

impedance

3.07 Switch *S1*, labeled *INPUT Z*, is used to select either module's input impedance. Switch *S6*, labeled *OUTPUT Z*, is used to select the 9608's output impedance. (On the 9608A, switch *S6* selects the impedance of the **primary** output channel.) Switches *S7* through *S10*, which are included on the 9608A only, are used to select the impedance of that module's four **auxiliary** output channels, *aux 1* through *aux 4*, respectively. These switches select either 150-ohm or 600-ohm impedance-match-options. In general, the 150-ohm option is used to interface nonloaded cable, while the 600-ohm option is used to interface broadcast equipment.

> **Caution:** *If the 600-ohm impedance option is selected, input and output connections to the 9608 and 9608A must be balanced if midpoint capacitors are grounded. Response measurements made with unbalanced instruments will be in error. If 150-ohm impedance is used, both modules may be connected to either balanced or unbalanced source and load terminations.*

equalization

3.08 Switch *S2* is set to enable or disable the 9608 and 9608A's integral equalization circuitry. In applications where equalization is required, set switch *S2* to the *EQL IN* position to enable the equalizer. In applications where equalization is not required, set switch *S2* to the *EQL OUT* position.

3.09 Switch *S4*, labeled *EQL BW (KHZ)*, set to condition either module's equalizer for the program application in which the module is to be used. The *8kHz*-option is selected in standard am radio (5kHz bandwidth) or television audio (8kHz bandwidth) applications, while the *15kHz*-option is selected in fm radio (15kHz bandwidth) applications.

3.10 If equalization is used, switch *S3* must also be set to configure the equalization shape for either long or short loops. Set this switch to the *LONG LOOP* position if the unequalized facility loss at the upper band edge (either 8kHz or 15kHz) exceeds 17dB, or to the *SHORT LOOP* position if facility loss at 8kHz or 15kHz is less than 17dB.

gain

3.11 Switch selection of either the 0 to 10dB, 10 to 20dB, 20 to 30dB, or 30 to 40dB gain range is accomplished in both modules by setting three-position DIP switch *S5*, labeled *GAIN RANGE*, as indicated in table 5. (Fine adjustment within the selected 10dB range is made via the front-panel *gain* control during alignment of the module. This control is continuously adjustable over a range of approximately 11dB to ensure overlap of the major gain increments.) Switch positions are identified as left, center, and right, rather than by number, because the numbering of switch positions by the various switch manufacturers is not consistent. The left position refers to the leftmost switch position as the module is viewed from the connector end; center refers to the next adjacent switch position, etc. If equalization is not used, refer to the circuit level record (CLR) card and set the *GAIN RANGE* switch for the 10dB range that encompasses the required transmission level. If equalization is used, initially set the *GAIN RANGE* switch for the 10 to 20dB range, and reset the switch (if required) after equalization is completed. (Selection of the 10 to 20dB range will introduce sufficient gain to overcome the loss inherent in the equalizer, thus ensuring accurate equalization.) Again, precise level adjustment will be made via the *gain* control.

> **special note:** *In some rare applications, it may be necessary to operate or test a circuit with a 9608 or 9608A at very high input levels – beyond the specified +10dBm maximum input. (This may be the case when a radio station performs deviation and modulation tests or frequency runs.) While input levels below +10dBm will not produce distortion through either module, input signals between +10dBm and +20dBm may produce overload distortion unless the following precautions are taken:*
>
> *1) Use the* SHORT LOOP *option for all loops with 1000Hz insertion loss below about 5dB (measured between 600-ohm source and load impedances).*
>
> *2) If compatible with system levels, set the* GAIN RANGE *switch for the 10-to-20dB range whenever the 9608 or 9608A is operated in the* SHORT LOOP *mode. This gain step overcomes loss inherent in the equalizer in the* SHORT LOOP *mode.*
>
> *3) Whenever practical, attempt to arrange signal levels and amplifier gain so that gain introduced by the front-panel 10dB* gain *control is minimized (fully counterclockwise). This means that gain should be introduced via the 10dB* GAIN RANGE *switch, especially in relatively short loop applications.*

gain range	right*	center*	left*
0 to 10dB	on/closed	on/closed	on/closed
10 to 20dB	off/open	on/closed	on/closed
20 to 30dB	off/open	off/open	on/closed
30 to 40dB	off/open	off/open	off/open

*as viewed from connector end of module

table 5. Switch selection of gain ranges

alignment

3.12 Alignment consists of sending test tones from the originating end of the circuit to the 9608 or 9608A, measuring the level of each tone at the module with a test set, and adjusting the module's equalizer and amplifier appropriately. In tandem applications (i.e., more than one Amplifier module in the circuit), there are two accepted methods of alignment. In the first method, each Amplifier module is isolated and aligned individually. Test tones are sent from the originating end of the circuit to the first Amplifier, and that module is aligned. The next Amplifier is aligned to test tones sent from the site of the first Amplifier. Subsequent Amplifier modules are aligned in similar fashion. In the second method of alignment, test tones are sent only from the originating end of the circuit and each Amplifier is aligned to those tones, beginning with the Amplifier closest to the originating end of the circuit. In both methods, alignment of the composite circuit should be verified via end-to-end measurements.

Note: *A condensed alignment procedure (figure 2) is included to facilitate alignment of the 9608 and 9608A.*

alignment – without equalization

3.13 After all options (including gain range) have been selected, insert the 9608 or 9608A into its mounting, adjust the *gain* control fully counterclockwise, and apply power. Adjust the gain of the Amplifier as described in paragraph 3.16.

alignment – with equalization

3.14 After all options have been selected, insert the 9608 or 9608A into its mounting position. Adjust the *HF, LF,* and *gain* controls fully counterclockwise and adjust the *LF trim* control to the approximate midpoint of its range. Apply power and perform the equalization and gain procedures in paragraphs 3.15 through 3.17.

Note: *For convenience, the following equalization procedure is based on either module's use in 15kHz applications. In 5kHz and 8kHz applications, the equalization procedure is identical, except for the frequencies at which level measurements are made. In 15kHz applications, measurements are made at 15kHz, 10kHz, 1000Hz, and 100Hz. In* **both** *5kHz and 8kHz, applications, measurements are made at 8kHz, 5kHz, 1000Hz, and 100Hz.*

3.15 To align the 9608 or 9608A's equalizer, it is essential that the procedures be followed precisely and in the order presented. Other procedures will result in failure to converge on the desired equalization characteristics.

A. Connect a properly terminated transmission measuring set (TMS) arranged for receive to the module's *output amp* jack, and request that personnel at the originating end of the circuit send 15kHz tone at the level specified on their circuit level record (CLR). Verify the frequency and record the received level.

B. Request that personnel at the originating end send 10kHz tone at the CLR-specified level. Verify the frequency and adjust the *HF* control clockwise until the 10kHz level is equal to the 15kHz level recorded in step A.

C. Request that the originating end again send 15kHz tone at the specified level. Verify the frequency and record the received level. Request that personnel at the originating end send 10kHz at the specified level and adjust the *HF* control until the 10kHz level is equal to the new 15kHz level measured in this step. Repeat this step until the 15kHz and 10kHz levels are equal. Be sure to record each level. *(As the* HF *control is adjusted clockwise, both the 10kHz and 15kHz levels will change. Therefore, several repetitions of adjustment and measurement between 15kHz and 10kHz will probably be required to achieve the desired flat response between the two frequencies.)*

D. Request that personnel at the originating end send 1000Hz tone at the CLR-specified level. Verify the frequency and adjust the *LF* control clockwise until the 1000Hz level is equal to the 10kHz level achieved in step C.

E. Request that the originating end send 10kHz tone at the CLR-specified level. Verify the frequency and record the level. If the 10kHz level is different from the 10kHz level achieved in step C, request that the originating end send 1000Hz at the CLR-specified level and adjust the *LF* control until the 1000Hz level is equal to the 10kHz level measured in this step. Repeat this step until the 1000Hz and 10kHz levels are equal. Be sure to record each level.

F. Request that the originating end send 15kHz tone at the CLR-specified level. Verify the frequency and record the level. Request that the originating end send 10kHz at the CLR-specified level and trim the *HF* control until the 10kHz level is equal to the 15kHz level measured in this step.

G. Request that personnel at the originating end send 1000Hz tone at the CLR-specified level. Verify the frequency and adjust the *LF* control until the 1000Hz level is equal to the 10kHz level achieved in step F. Record this new 1000Hz level.

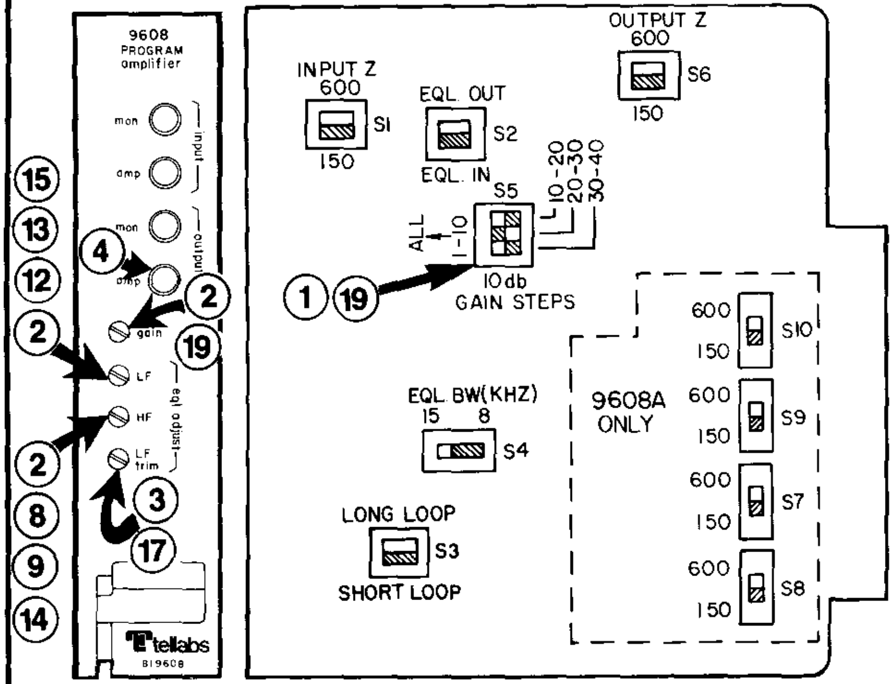
H. Request that the originating end send 100Hz tone at the CLR-specified level. Verify the frequency, and adjust the *LF trim* control until the 100Hz level is equal to the 1000Hz level recorded in step G.

I. Request that personnel at the originating end send 100Hz and 15kHz tones at the CLR-specified level. Verify the frequencies and verify that both levels are within ±1dB of the 1000Hz level recorded in step G.

3.16 To adjust the gain of either module, refer to the CLR card for the required transmission level and reset the *GAIN RANGE* DIP switch (if necessary) for the appropriate 10dB range. With a properly terminated TMS (receive) connected to the module's *output amp* jack, request that personnel at the originating end of the circuit send 1000Hz tone at the level specified on their CLR card. Verify the frequency and adjust the *gain* control clockwise until the transmission level specified on the CLR card is achieved.

Note: *The active equalizer used in the 9608 and 9608A is an absorption-type equalizer that functions by reducing insertion gain of the amplifier/equalizer combination below either 8 or 15kHz. Thus, with the equalizer in the circuit, maximum*

alignment continued on page 7



This condensed procedure is included to facilitate alignment of the 9608 and 9608A. The alignment procedure is based on either modules' use in 15kHz applications. In both 5kHz and 8kHz applications, the procedure is essentially the same except for the frequencies at which level measurements are made. When aligning for **both** 5kHz and 8kHz applications (am radio or television audio), level measurements are made at 8kHz, 5kHz, 1000Hz, and 100Hz. Refer to the CLR card for the required input and output impedances and the required transmission level. After all options have been selected (paragraphs 3.06 through 3.11), perform each step in numeric order. Detailed alignment instructions are provided in paragraphs 3.12 through 3.17.

1 Gain switches set to 10 to 20dB range. See paragraph 3.11 and table 5.

2 HF, LF, and GAIN controls fully counterclockwise.

3 LF TRIM control to middle.

4 Connect test set to output amp jack. Use a properly terminated TMS set for receive.

5 Send 15kHz tone. Request the originating end of the circuit to send 15kHz test tone at the level specified in the CLR.

6 Record 15kHz level. Verify that 15kHz tone is being sent and record the received level.

7 Send 10kHz tone. Verify that 10kHz tone is being sent, and. . .

8 Adjust 10kHz level to 15kHz level via HF control. Adjust the *HF* control clockwise until level at 10kHz is equal to 15kHz level recorded in step 6.

9 Recheck 15kHz level. Have 15kHz tone sent again and record the level. If 15kHz level has changed, have 10kHz tone sent again and adjust the *HF* control until the 10kHz level is equal to the new 15kHz level.

10 Repeat procedure until 10kHz and 15kHz levels match. Repeat step 9. Several rounds of measurement and adjustment may be required to match the 10kHz and 15kHz levels.

11 Send 1000Hz tone. Verify that 1000Hz is being sent, and. . .

12 Adjust 1000Hz level to 10kHz level via LF control. Adjust the *LF* control clockwise until the 1000Hz level is equal to the 10kHz level achieved in step 10.

13 Repeat until 1000Hz level equals 10kHz. Have 10kHz tone sent again, verify the frequency, and record the level. Have 1000Hz tone sent. Verify the frequency and adjust the *LF* control until the 1000Hz level is equal to the 10kHz level. Several rounds of measurement and adjustment may be required.

14 Readjust 10kHz and 15kHz levels. Have 15kHz tone sent. Verify the frequency and record the level. Have 10kHz tone sent. Verify the frequency and record the level. If the levels are different, adjust the *HF* control until the 10kHz level is equal to the 15kHz level.

15 Readjust 1000Hz level. Have 1000Hz tone sent and verify the frequency. If the 1000Hz level is not equal to the 10kHz level achieved in step 14, adjust the *LF* control until the 1000Hz level is equal to the 10kHz level. Record this 1000Hz level.

16 Send 100Hz tone. Have 100Hz tone sent. Verify that 100Hz tone is being sent, and. . .

17 Adjust 100Hz level to 1000Hz level via LF trim. Adjust the *LF trim* control until the 100Hz level is equal to the 1000Hz level achieved in step 15.

18 Compare 100Hz and 15kHz levels. Have 100Hz and 15kHz tones sent. If these levels are within ±1dB of the 1000Hz level recorded in step 15, the equalizer is correctly adjusted.

19 Set 1000Hz level via gain switches and control. Refer to the CLR card for the required transmission level. Reset the *GAIN RANGE* switch (if necessary) for the appropriate 10dB range (see table 5). Have 1000Hz tone sent. Verify the frequency and adjust the *gain* control clockwise until the required transmission level is achieved.

20 Check 50Hz and 15kHz levels. Recheck the equalization characteristic. Have 50Hz and 15kHz tones sent. Verify the frequencies and record each level. If these levels match within ±1dB, the equalizer is correctly aligned.

21 Frequency Run. Have test tones sent from 50Hz to 15kHz at 100Hz intervals. Levels should be within ±1dB of the 1000Hz level. Remove all test connections; alignment is completed.

figure 2. Condensed alignment procedure

amplifier gain (40dB) is realized only at frequencies near either 8 or 15kHz.

3.17 After completing the gain adjustment, request that personnel at the originating end of the circuit send 50Hz and 15kHz tones at the level specified on their CLR card. Verify the frequencies and verify that the 50Hz level is within ±1dB of the 15kHz level. Make a frequency run, checking levels at 100Hz intervals from 50Hz to 15kHz. Levels should be within ±1dB of the 1000Hz level.

4. circuit description

4.01 This circuit description is intended to familiarize you with the 9608 Program Amplifier and 9608A Program Distribution Amplifier modules for engineering and application purposes only. Attempts to test or troubleshoot the 9608 or 9608A internally are not recommended. Procedures for recommended testing and troubleshooting in the field are limited to those prescribed in section 7 of this Practice. Please refer to the 9608-9608A block diagram, section 5, as an aid in following this circuit description.

4.02 The input section of both modules consists of a wideband input transformer with a split primary winding, and a variable-gain *preamplifier.* The input transformer derives switch-selectable 600 or 150-ohm input impedance and, when optioned for 600 ohms, provides a center tap for derivation of two input simplex leads. The transformer secondary provides input to a variable-gain *preamplifier* that supplies adjustable gain (0 to 10dB) and prevents the equalizer input from affecting the amplifier input impedance.

4.03 With switch *S2* in the *EQL OUT* position, the *preamplifier* output is connected directly to the input of a *voltage amplifier* whose gain is incremented in 10dB increments from 0 to 40dB in response to switch settings of a three-position DIP switch. **In the 9608A only,** a *distributive power amplifier* following the *voltage amplifier* stage drives a distribution bus from which four resistively coupled outputs are derived. Individual auxiliary output ports are connected to the transformer secondary through precision resistors, which are switch-optioned to derive either 150 or 600-ohm impedance. A *power amplifier* stage following the *voltage amplifier* stage drives an output transformer with a split primary winding. The output transformer provides switch-selectable 600-ohm or 150-ohm output impedance. Output simplex leads are derived when the transformer is optioned for 600-ohm output impedance.

4.04 When switch *S2* is set to the *EQL IN* position, an active *slope equalizer* is inserted between the *preamplifier* and the *voltage amplifier* gain stage. The equalizer response is determined by the location of a pair of complex conjugate poles derived through use of controlled positive feedback around an operational amplifier. Network quality factor (Q), damping factor, and natural resonance are varied to control the response shape.

6. specifications

amplifier section

amplifier type
9608: single-input, single output amplifier
9608A: single-input, five output splitting amplifier (arranged for one primary output channel and four auxiliary output channels)

gain range
0 to 40dB in increments of 10dB, gain continuously adjustable within each 10dB range

frequency response (any gain setting, no equalization)
±1.2dB, re 1000Hz, 20Hz to 15kHz

gain stability
maximum deviation from gain at 70°F is ±0.7dB, −40° to +140°F, 20Hz to 20kHz

maximum output level
+20dBm, 30Hz to 15kHz; +18dBm, 20Hz to 20kHz

maximum output level (9608A auxiliary ports)
+15dBm, all ports terminated

gain offset (main output port to auxiliary output ports, 9608A only)
−5 ±0.5dB, with all auxiliary ports terminated

maximum input level (input stage overload point)
+10dBm, 30Hz to 20kHz (see note, page 4)

distortion
less than 0.25% THD, 50Hz to 15kHz, measured at +18dBm output level;
less than 1% THD, 20Hz to 20kHz, measured at +18dBm output level

gain linearity
less than 0.1dB compression, 20Hz to 15kHz, any output level below +18dBm

envelope delay
less than 15μs, 200Hz to 20kHz
less than 70μs, 100Hz to 20kHz

noise
maximum output noise measured with input terminated, flat weighting, 40Hz to 15kHz, is dependent upon amplifier gain as follows:

gain	8kHz channel	15kHz channel
10dB	5dBrN	5dBrN
20dB	10	12
30dB	20	22
40dB	20	24

equalizer section

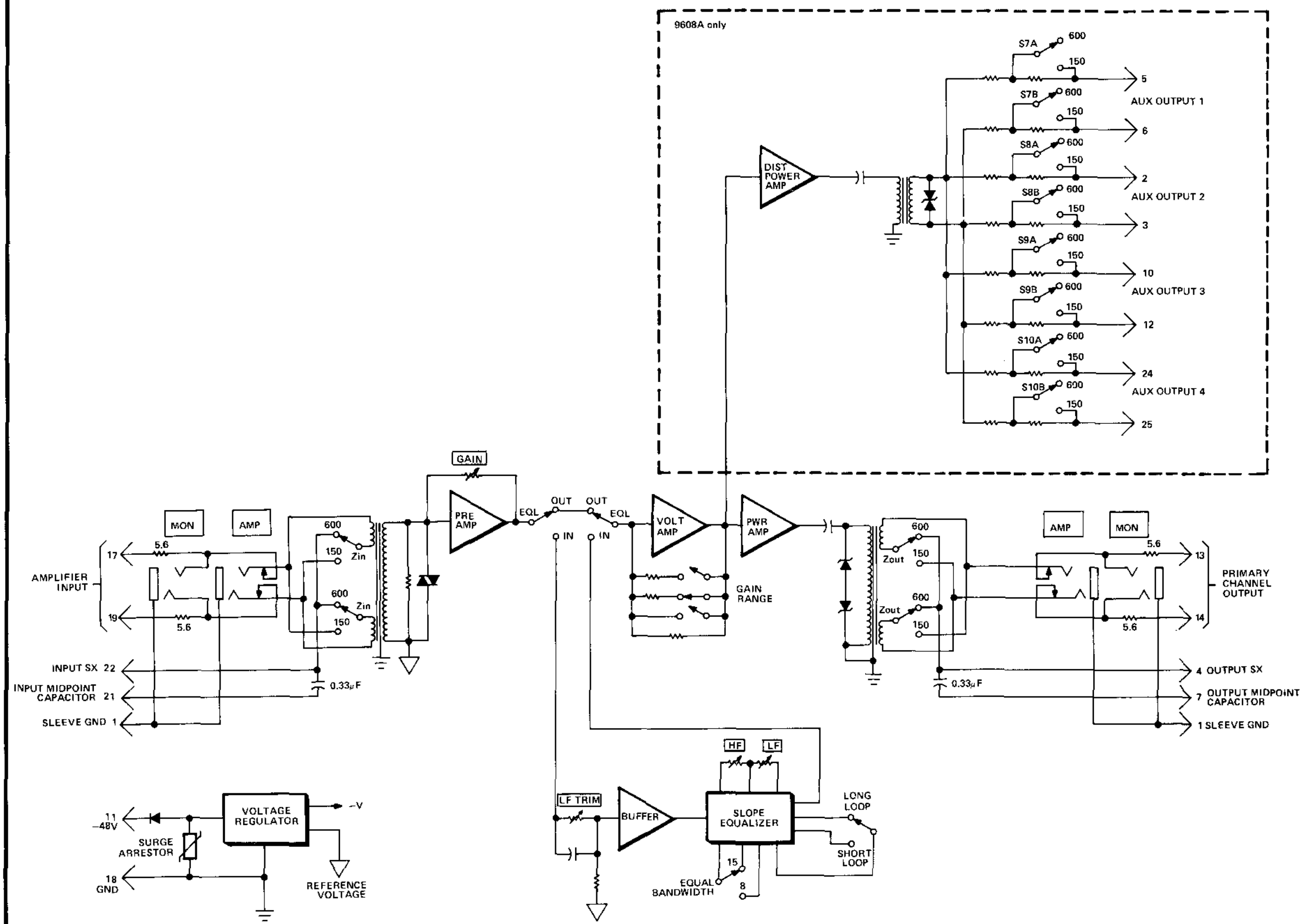
8kHz equalization
±1.0dB maximum deviation from flat response, 50Hz to 8kHz, for nonloaded cable with up to 30dB loss differential between 100Hz and 8kHz

15kHz equalization
±1.0dB maximum deviation from flat response, 30Hz to 15kHz, for nonloaded cable with up to 30dB loss differential between 50Hz and 15kHz

adjustments (8 and 15kHz equalizers)
high frequency
low frequency
low frequency trim

equalizer response stability
±0.5dB maximum variation, −40° to +140°F

specifications continued on page 9



9608 Program Amplifier/9608A Program Distribution Amplifier modules 819608/9608A

5. block diagram

common specifications (with or without equalizer)

input impedance
600 ohms ±5%, balanced, 20Hz to 15kHz
150 ohms ±15%, balanced, 20Hz to 15kHz

output impedance
600 ohms ±5%, balanced, 20Hz to 15kHz
150 ohms ±15%, balanced, 20Hz to 15kHz

9608A auxiliary port impedance
600 ohms ±5%, 100Hz to 15kHz
150 ohms ±20%, 100Hz to 15kHz

longitudinal balance (input and output)
greater than 65dB, 20Hz to 20kHz

maximum input voltage
−56Vdc

minimum input voltage (for +20dBm output level)
−42Vdc

current (quiescent)
40mA at 48Vdc

current (+20dBm output level)
60mA at 48Vdc (9608)
80mA (9608A only, all five ports at maximum output level)

operating environment
−40° to +140°F (−49° to +60°C), humidity to 95% (no condensation)

dimensions
7.91 inches (20.1cm) high
1.70 inches (4.32cm) wide
9.76 inches (24.8cm) deep (excludes locking catch)

weight
9608: 17 ounces (481.9 grams)
9608A: 25 ounces (708 grams)

mounting
relay rack via one position of a Western Electric MTM-1, MTM-2, or CPFT Shelf

7. testing and troubleshooting

7.01 The Testing Guide Checklist in this section may be used to assist in the installation, testing, or troubleshooting of the 9608 Program Amplifier or 9608A Program Distribution Amplifier module. The Checklist is intended as an aid in the localization of trouble to a specific module. If a module is suspected of being defective, a new one should be substituted and the test conducted again. If the substitute module operates correctly, the original module should be considered defective and returned to Tellabs for repair or replacement. We strongly recommend that no internal (component-level) testing or repairs be attempted on the 9608 or 9608A module. Unauthorized testing or repairs may void the module's warranty.

Note: *Warranty service does not include removal of permanent customer markings on the front panels of Tellabs modules, although an attempt will be made to do so. If a module must be marked* **defective,** *we recommend that it be done on a piece of tape or on a removable stick-on label.*

7.02 If a situation arises that is not covered in the Checklist, contact Tellabs Customer Service at your Tellabs Regional Office or at our Lisle, Illinois, or Mississauga, Ontario, Headquarters. Telephone numbers are as follows:

US central region: (312) 969-8800
US northeast region: (412) 787-7860
US southeast region: (305) 645-5888
US western region: (702) 827-3400
Lisle Headquarters: (312) 969-8800
Mississauga Headquarters: (416) 624-0052

7.03 If a 9608 or 9608A is diagnosed as defective, the situation may be remedied by either *replacement* or *repair and return.* Because it is more expedient, the *replacement* procedure should be followed whenever time is a critical factor (e.g., service outages, etc.).

replacement

7.04 To obtain a replacement 9608 or 9608A module, notify Tellabs via letter (see addresses below), telephone (see numbers above), or twx (910-695-3530 in the USA, 610-492-4387 in Canada). Be sure to provide all relevant information, including the 8X9608 or 8X9608A part number that indicates the issue of the module in question. Upon notification, we shall ship a replacement module to you. If the module in question is in warranty, the replacement will be shipped at no charge. Pack the defective 9608 or 9608A in the replacement module's carton, sign the packing slip included with the replacement, and enclose it with the defective module (this is your return authorization). Affix the preaddressed label provided with the replacement module to the carton being returned, and ship the module prepaid to Tellabs.

repair and return

7.05 Return the defective 9608 or 9608A module, shipment prepaid, to Tellabs (attn: repair and return).

in the USA: Tellabs Incorporated
4951 Indiana Avenue
Lisle, Illinois 60532

in Canada: Tellabs Communications Canada, Ltd.
1200 Aerowood Drive, Unit 11
Mississauga, Ontario, Canada L4W 2S7

Enclose an explanation of the module's malfunction. Follow your company's standard procedure with regard to administrative paperwork. Tellabs will repair the module and ship it back to you. If the module is in warranty, no invoice will be issued.

testing guide checklist appears on page 10

testing guide checklist

trouble condition	possible cause (in order of likelihood)
no gain	1) Incorrect setting of *GAIN RANGE* switch (see paragraph 3.11) □. 2) Power input polarity □.
excessive high-frequency roll-off	1) Use of unbalanced source or terminating meter with simplex leads or simplex capacitors grounded □.
excessive low-frequency loss	1) Improper equalizer adjustment □. 2) Use of capacitively coupled meter □.
inability to properly equalize facility	1) Loss in excess of 31dB between highest frequency of interest and 100Hz □ 2) Incorrect equalization adjustment (see 3.14 and 3.15, or figure 2) □. 3) Non-uniform cable frequency response, including presence of load coils, build-out capacitors, or impedance compensators □. 4) Presence of cable bridge tap, especially at point of connection of *repeater* □. 5) Split cable pairs in the program circuit □.
audible pick up of radio station	1) Unbalanced cable pairs on input side of amplifier □. 2) Improper power-supply grounding □. 3) Enclosure covers not in place □. 4) Improper grounding and shielding of leads □.
distortion at amplifier output	1) Excessive output signal level □. 2) Input signal level too high, especially at low frequencies (input signals above +10dBm may overload first equalizer stage) (see note, page 4) □.