BENCHMARK MEDIA SYSTEMS, INC.

Audio World™ Interface - Instruction Manual

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1.0 Overview

The Audio World™ Interface, sometimes abbreviated AWI, is a 1/2 width, 1 RU stand alone device that will interface all audio and video tape recorders. Additionally, it will perform as a balanced-in, balanced-out line amp, with a simple switch actuation. A second switch allows line amp operation with reversed channels, and with both switches engaged, the device becomes a mono mix amplifier, with two outputs, each of which have independent level control. In the mix mode, the input gain controls provide an adjustment for the relative mix level.

The Audio World™ Interface has electronically balanced inputs and outputs. It provides corresponding unbalanced outputs and inputs. The Audio World™ Interface has gain adjustment of both L and R inputs and outputs by way small trim resistors, accessible through the front panel. The rack mountable chassis includes LEDs to indicate line amp and mix selections (red), power presence (yellow), signal presence (green) and onset of overload (flashing red-green).

Power for the AWI is provided by a PS-1 wall mount ±16 V regulated supply.

2.0 Features and Typical Performance

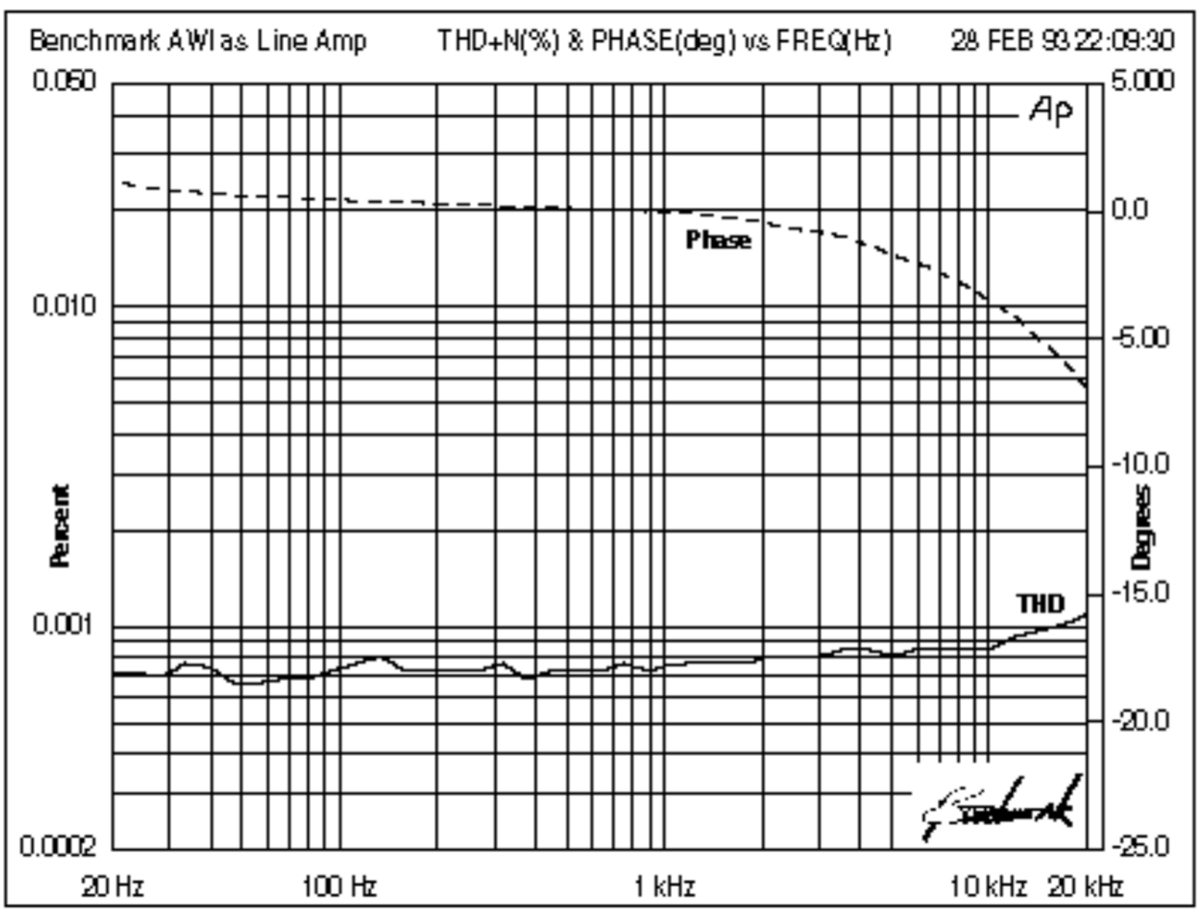

Figure 1. Total Harmonic Distortion and Phase of the AWI as a Line Amp

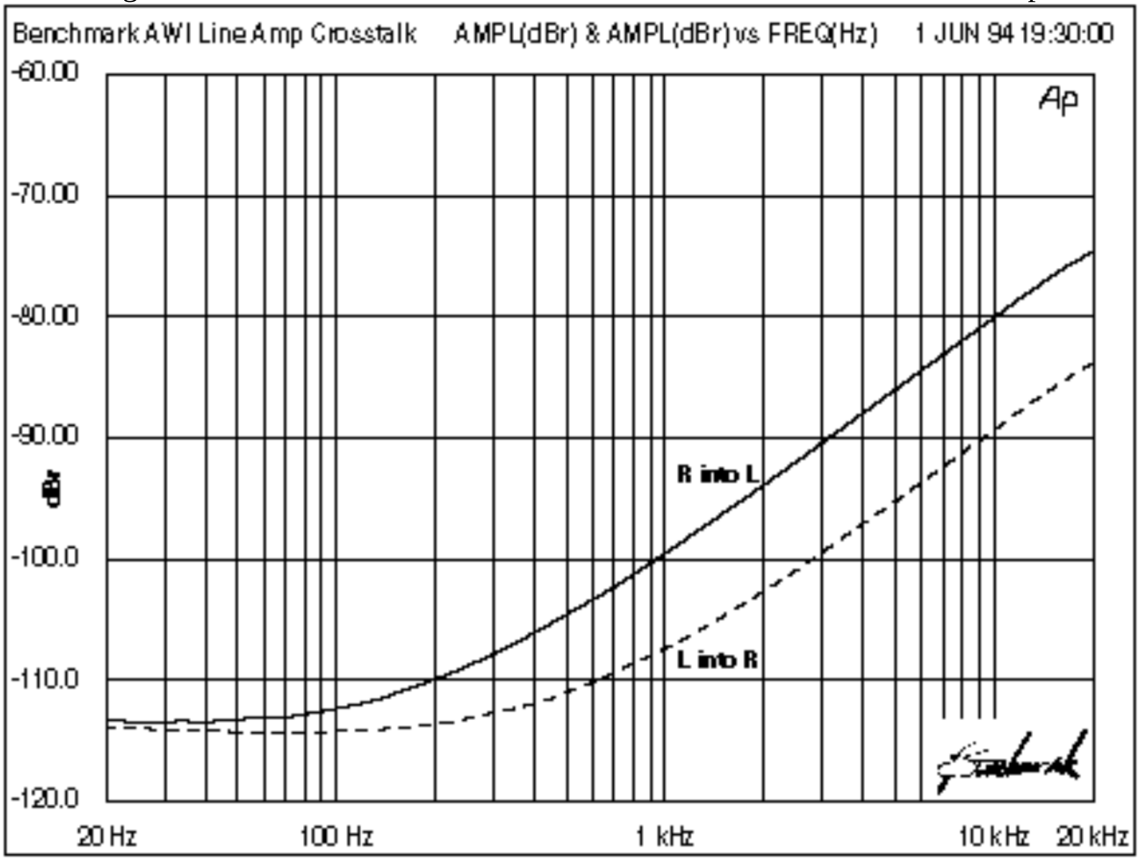

Figure 2. Typical Crosstalk Performance - Line Amp Mode, L into R, and R into L

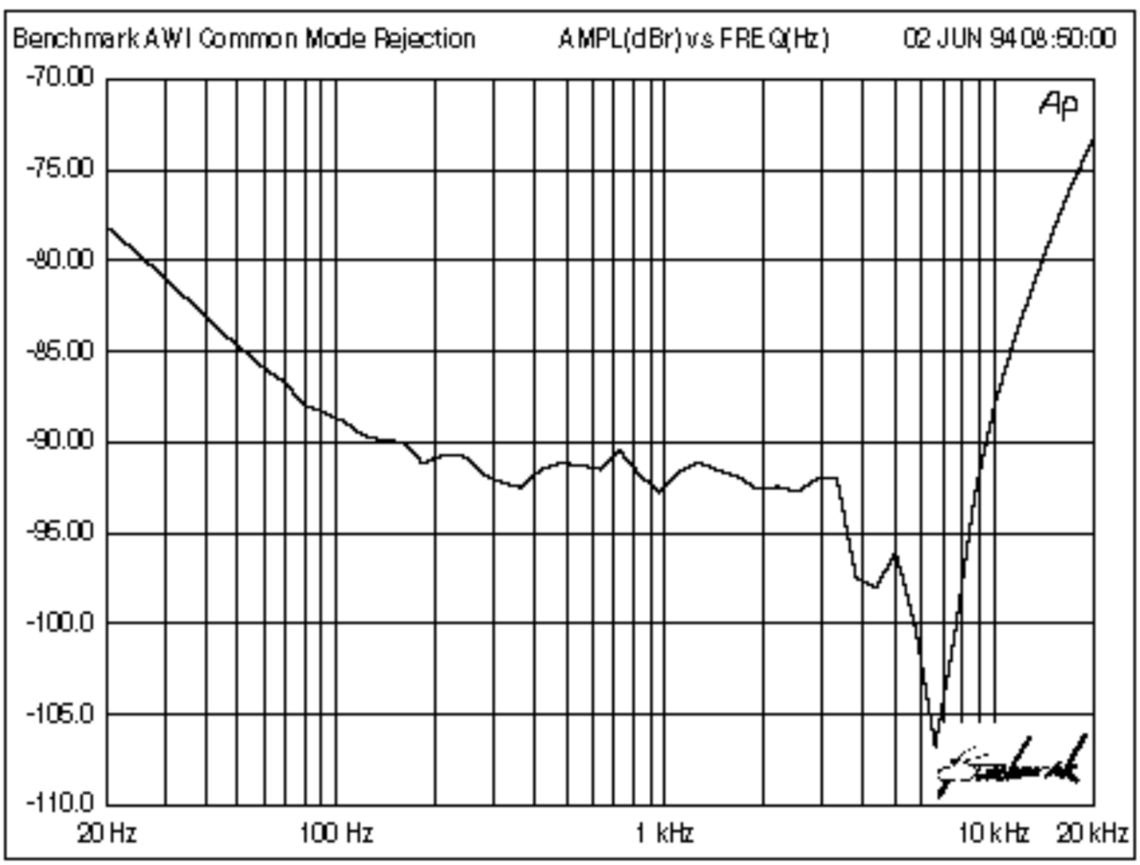

Figure 3. Typical Common Mode Rejection Performance

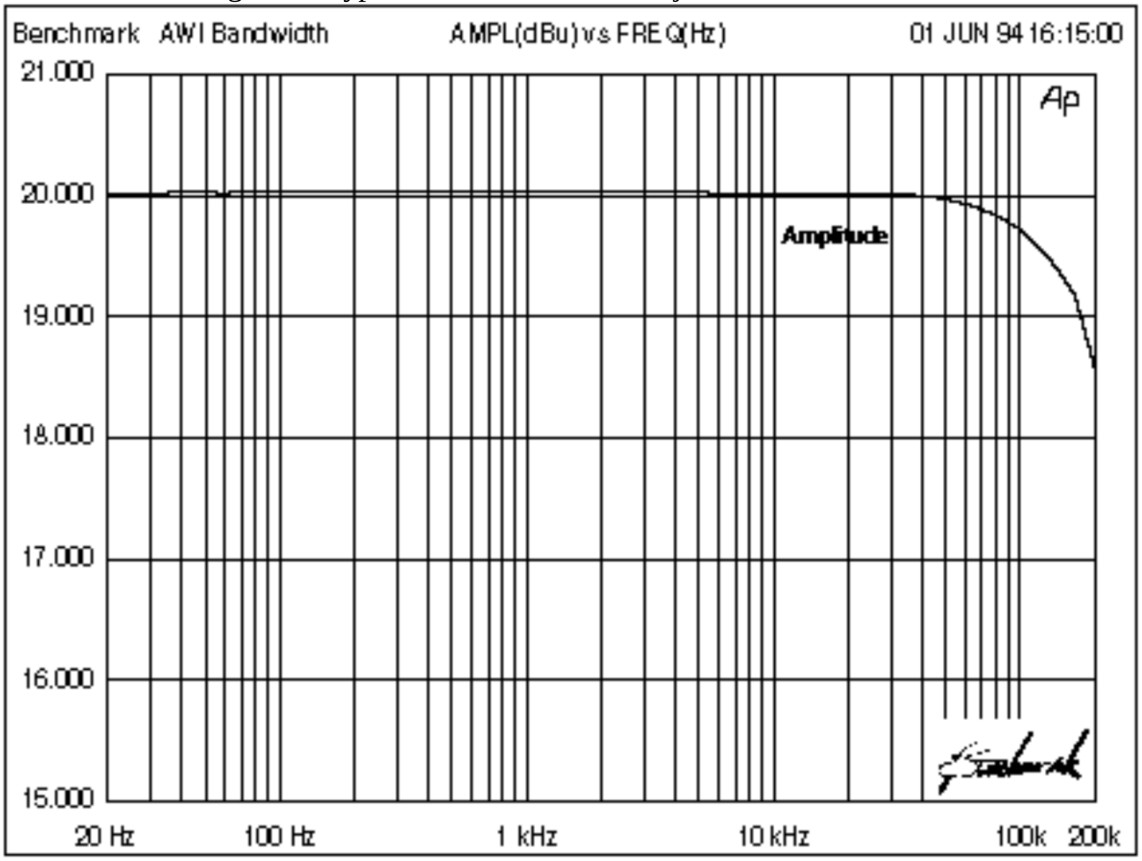

Figure 4. Amplitude Response

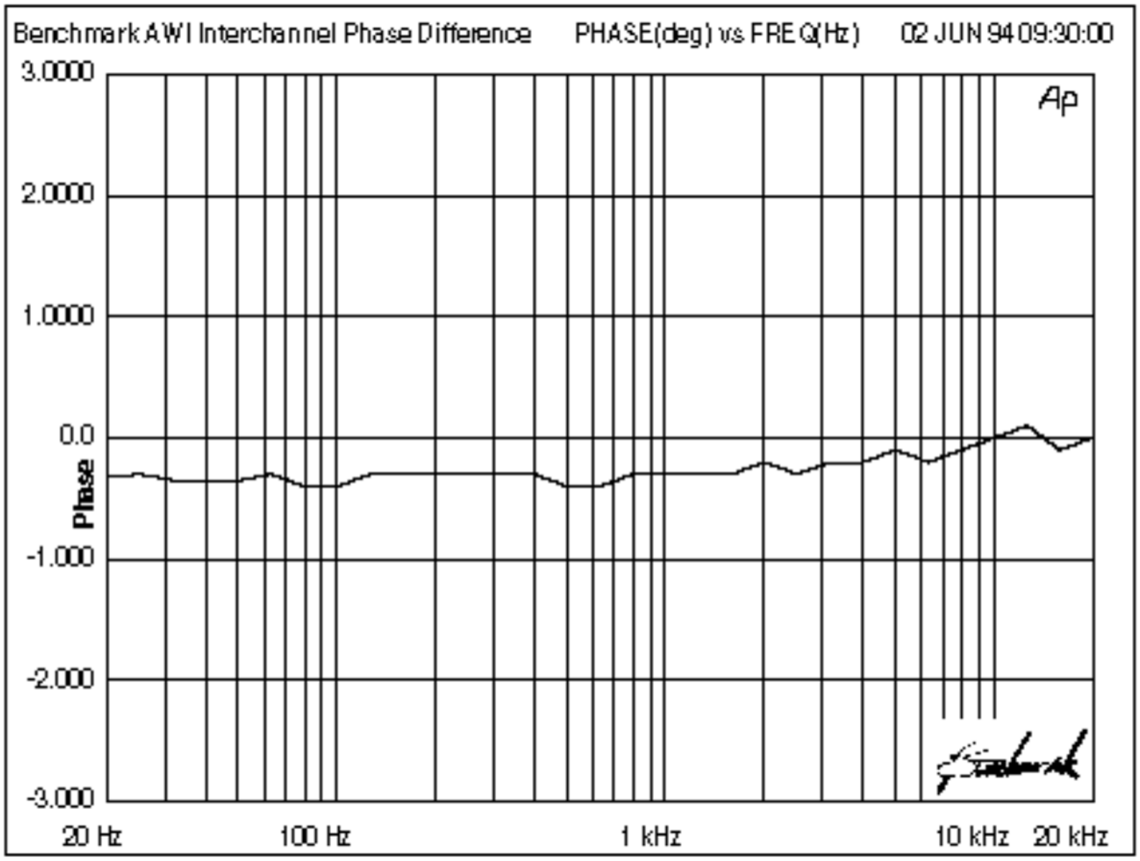

Figure 5. Differential Phase Response

2.1 Typical Specifications

Balanced Input Section

t 20 kΩ balanced input Z, with equal input impedances
t CMR >100 dB to 2 kHz, 75 dB @ 20 kHz
t 47 Ω unbalanced output Z

Balanced Output Section

t 10 kΩ unbalanced input Z
t 60 Ω balanced output Z
t Electronic Transformer balanced output

Overall

t Overall THD = 0.00075% @ 1 kHz, 0.0011% @ 20 kHz
t Overall absolute Ø @ 20 kHz = -7°0.. (line amp)
t Overall differential Ø ≈ ±0.25°, 20 to 20 kHz
t Bandwidth > 200 kHz
t Balanced input gain range = -18 to +6 dB
t Balanced output gain range = 0 to +20 dB
t Balanced input and output clip points = + 27 dBu
t Unbalanced input and output clip points = + 21 dBu
t Excellent RF immunity
t Switchable to line amp and mono mix.
t XLR and RCA type rear connectors
t Rack mountable with optional rack mount kit.

3.0 Installation and Operation

3.1 Mechanical Installation

The Audio World™ Interface may be operated stand alone on a desk or rack mounted If the unit is to be rack mounted, it is a simple matter to slip it into the panel and secure it with four screws (two black 4-40 x 1/4" pan head, and two black 4-40 x 1/4" flat head). No disassembly is necessary for installation into the rack mount panel.

3.2 Electrical Installation

Electrical installation is also very simple. Connect the various audio signals to and from the Audio World™ Interface. Power is supplied by the PS-1 wall mount supply included with the unit. Internally, balanced line shield grounds tie directly to the chassis. The unbalanced shield grounds tie to the analog signal reference. The analog signal reference does not tie directly to the chassis without the use of jumper W3, which provides a tie for the two grounds. Alternately, a 100 Ω resistor may be used instead of the jumper to provide isolation between the grounds and keep shield currents from flowing through the analog signal reference.

3.3 Setting Levels

Properly setting levels within the Audio World™ Interface is *very* important. It is quite possible, particularly when operating the unit as a line amplifier or as a mix amplifier, using both input and output level controls to incorrectly adjust the gains and severely compromise the headroom and the signal to noise ratio of the device.

While it is popularly believed that an interface device should translate the balanced lines level from +4 dBu to the nominal -10 dBV (-7.78 dBu) IHF reference, it is our experience that a reduction of only 6 dB is usually satisfactory. This is because many input circuits found in commercial and semi-professional equipment, have as their first element a potentiometer. See figure 3.

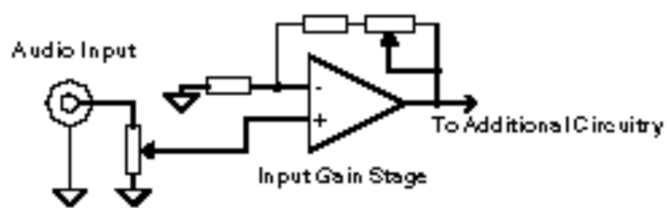

Figure 3 A Common Input Stage

The balanced input to unbalanced output section of the Audio World™ Interface should generally operate at or near a gain of -6 dB. This is found at approximately the 9 o'clock position of the input gain potentiometers. If additional gain reduction is necessary to avoid clipping in the equipment that receives the signal form the AWI, don't hesitate to take it. It is our experience, however, that this is seldom necessary.

The unbalanced input to balanced output section has been set at the factory to operate at + 6 dB, and this is also a setting of approximately 9 o'clock on the output gain potentiometers. This, however, will often not provide sufficient gain for the consumer device being interfaced. Adjust the balanced output so that it meets the expected + 4 dBu average as read by a standard volume indicator.

When using the device as a line amplifier or as a mixer the -6 and +6 dB gain settings are, indeed, the settings that should be used for the optimum headroom. See “A Clean Audio Installation Guide”, a Benchmark Media Systems application note, for more information on setting system levels.

4.0 Circuit Description

!!! Notice !!!

> The circuitry of the Audio World™ Interface is proprietary! While a schematic is included with the unit, please note that the design remains the exclusive property of Benchmark Media Systems, Inc.

The circuitry consists of the following major parts. There are two balanced-input to unbalanced-output amplifier sections, which include input gain adjustment. There are two unbalanced-input to balanced-output amplifier sections. At the junction of these two types of sections, there are two signal routing switches that allow device operation as a line amplifier and as a mixing amplifier. While reading the following description, it will be well to have the schematic along side.

4.1 Input Amplifiers

The instrumentation input amplifiers consist of two operational amplifiers that form a highly trimmed differential amplifier whose gain is variable from- 18 dB to +6 dB. The input to the instrumentation amplifier consists of paralleled input capacitors. The 100 µF aluminum electrolytic provides excellent low frequency response, while the paralleled 0.1 µF film capacitor overrides the ESR and inductive effects of the electrolytic at high frequencies. The input is resistive and as such it provides isolation between the source and the AWI in the case of loss of power to the AWI. This prevents distortion from being introduced onto the line from input amplifiers that are not powered and thus act as diodes.

4.1.1 Common Mode Rejection Null

The characteristics of the operational amplifier used do not affect the accuracy of the CMR null, that is, unless there is a malfunction with the op-amp. When replacing the operational amplifier, measure the common mode rejection *before* touching the trims.

Common mode adjustments are made for both low frequencies and high frequencies. R11 and R69 set the low frequency common mode performance, while R1 and R8 set the high frequency common mode performance.

The process of nulling the common mode rejection should be performed with the overall gain of the Audio World™ Interface set to unity. See Figure 4

Feed an unbalanced signal with a level of +20 dBu, referenced to ground, into both inputs of the module being adjusted. This signal must be *exactly* the same on both inputs. This is best achieved by using an oscillator with a single ended output, tying the ± inputs together and, in turn, to the single ended output of the generator. The ground side of the generator, of course, also ties to ground.

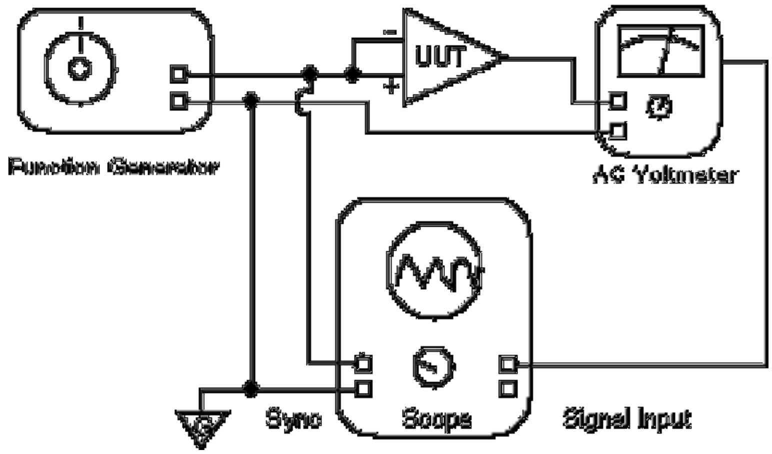

Figure 4 - Common Mode Rejection Adjustment

Send a 2 kHz signal to the input and adjust the low frequency portion of the differential amplifier CMR circuit for a minimum audio output from the Audio World™ Interface. Use either a logarithmic level meter with a sensitivity to below -100 dBu, such as the Audio Precision System One, or a very sensitive linear meter, such as the Amber 3501 distortion and noise meter. It is very helpful to watch the audio signal from the meter output on an oscilloscope, which in turn should be synchronized to the signal source. This will allow you to quickly see the phase/amplitude nulls as they take place. Once a minimum LF trim has been achieved, null the HF trim.

Two or three iterations between these controls should be sufficient to achieve the best broadband null possible. A null of better than 90 dB at 200 Hz, and better than 70 dB at 20 kHz, is achievable. Unfortunately, it is almost impossible to maintain this good a null over the operating temperature range. A degradation of up to 10 dB may be expected when the unit is returned to its working environment.

4.2 Signal Routing Switches and Mix Amplifier

The output of the input amplifier stage feeds the unbalanced RCA type output connector. Additionally, the outputs feed 10 kΩ resistors that are used for selecting the line amplifier mode and for mixing the two input channels.

The input to the mix amplifier is capacitivly isolated from both the outside world and the outputs of the balanced input amplifiers. Gain for the output stage is taken from the mix amplifier and has an overall range of 0 to + 20 dB for the mixer/output stage.

4.3 Electronic Transformer Output Amplifier

The output stage is an electronic “transformer”. While we will not discuss the design concepts of this stage, we will explain its operational characteristics and the output balance set-up.

Operationally, the stage acts similarly to a transformer, that is, you may ground one side of the balanced output and see the full signal level appear at the un-grounded output. This works well when the destination is an unknown in terms of its input type. The only problem with grounding one side is the loss of 6 dB of headroom, that is instead of having a peak clip point of +27 dBu, the unbalanced output will clip at +21 dBu. Also please remember that the output is ground referenced and is not floating, that is, the output does *not* offer galvanic isolation.

While it should never need adjusting since they were adjusted at the factory, the output stage has balance controls that must be set correctly for proper operation. Improperly set balance controls may result in an unstable or oscillating output section.

The adjustment procedure for the output balance is similar to adjusting a common mode null. Feed an input signal into the balanced output section, whether this is from the balanced input as a line amp, or from the unbalanced input RCA jack, is unimportant. Observe the signal at the output balance null test point and adjust the variable resistor, either R36 or R57 for a minimum signal. Proceed to the trim capacitor and adjust it also for a minimum signal. Two or three iterations of these controls should be sufficient for a minimum signal level null. The waveform of the null is of no consequence.

4.4 Signal Presence and Onset of Overload LED

The Signal indicating LED is bi-colored with red and green sections. The green section is used to indicate signal presence, and the red section is used to indicate the approach a of signal clip condition. Both halves of the FET input TLO72 are used as voltage comparators, and both have hysteresis built into their circuits.

The signal presence indicator uses one half of the TLO72 and associated components. The input audio is rectified and the DC voltage is compared with that of a preset (threshold) trimming resistor. This circuit yields a steady green indication when the desired signal threshold has been reached or exceeded.

The operation of the green signal presence LED is as follows. The 1N4148 small signal diodes operate as half wave rectifiers. The turn-on threshold of the diode is, fortuitously, precisely at the lowest DC voltage represented by the lowest signal level detection limit. DC from the diode is stored on the 0.1 µF film capacitor. Charge is held on the 0.1 µF capacitor to prevent a flashing condition with the quick absence of audio such as between words in dialog. The discharge time to an off condition will vary with the peak level of audio, and thus the peak voltage on the capacitor. Typically, however you will see a variation from 1 to 4 seconds to an off state. The 10 MΩ resistor provides a discharge path for the 0.1 µF capacitor as well as providing bias current source for the FET input operational amplifier.

The peak indicator is an oscillating half wave detecting comparator. When the audio input exceeds a predetermined level, the comparator trips and begins to oscillate. The factory calibration point is +20 dBu unless otherwise requested. The output of the comparator, in addition to driving the red portion of the LED, also drives a transistor that shunts the current from the green LED, causing an alternating red/green flash when the signal exceeds the trip point.

The peak comparator is an oscillating comparator by virtue of the fact that AC coupled hysteresis is applied around the device. Initially the output voltage of the comparator is near the + supply voltage, in the off state. The trip point is determined by the resistor string R80, R87, R72, and the input diodes D3, D4, D8 and D9. When the inverting input signal rises above ground potential the comparator trips. R87 is the calibration trim for the peak indicator. It has a range of approximately +16 to +26 dBu. The comparator is held in the off state by the bias that is applied to the inverting input until an input peak overcomes the preset bias. When the comparator trips the output voltage swings to the opposite supply rail. The 0.1 µF capacitor, in turn, pulls the noninverting input negative holding the comparator in the on state. The capacitor recharges with opposite polarity through the two 220 kΩ resistors and when the new threshold is passed the device turns off and is now held off, again by the charge on the capacitor, until the capacitor recharges to its original state. This action is that of a pulse stretcher which allows the operator to "see" very short peaks as they occur.

5.0 Troubleshooting and Repair

5.1 Servicing Techniques

Service and calibration can be easily performed at the test bench. Use current limited power supplies set for a current limit at ≈ ±100 mA, in lieu of the PS-1.

The first thing to do is to look for integrated circuits that are hot to the touch. Since most passive components are extremely reliable, usual circuit failures occur with the active semiconductors. Replace any extremely hot chips. Keep in mind that the NE5532 runs *very* warm to the touch. In fact, many people cannot keep a finger on a working NE5532 (approximately 135° F).

If you strongly suspect a passive component failure, replace it. Remember, however, printed circuit boards are *very* easy to damage with excessive heat. Unless you have developed the specialized skills necessary to remove and replace components, we strongly suggest that you leave the task to someone skilled in these techniques.

5.1.1 Circuit Board De-Soldering

When servicing printed circuit boards we strongly recommend the use of a vacuum de-soldering station, such as the Hako 470 or various Pace models. The proper technique with these stations is to apply the tip to the area to be de-soldered and wait for the solder to thoroughly melt. You can be sure of a thorough melt by observing the top side of the board. Only when the solder there has become liquid, apply the vacuum while moving the hollow tip with the component lead in a circular motion. By rotating the lead, with the tip *lightly* against the board, and *without* applying pressure to the pad, you are able to remove solder from the plated-through hole. When this procedure is performed correctly the component will often drop out of the board of its own weight. If the solder is not thoroughly removed from the plated-through hole do not pull the component. Attempting to force the component will bring with it plating from inside the hole. This, in turn, will require the repair of the hole with an eyelet. Also, if your attempt to completely remove the solder from the hole has failed, do not re-heat the area with the de-soldering tool. Doing so will overheat the pad, and will not heat the area that is in need. As a result, the board is usually damaged. Rather, re-solder the joint, and then go back and apply the proper technique, by allowing the solder in the joint to thoroughly melt before applying vacuum. This technique uses new solder as an efficient heat conductor to the total area, eliminating hot spots.

5.1.2 Circuit Board Re-Soldering

Here is an effective technique that ensures highly reliable solder joints. First, if the component that is to be installed has leads that are highly oxidized, it will be necessary to clean them. This may be done with a Scotch Bright® abrasive pad or fine bristle fiberglass brush, among other methods. After inserting the component, apply a small amount of liquid flux directly at the component leads and PCB with a needle bottle applicator or small brush. We prefer to use water soluble flux for ease of cleaning. The added flux is an immeasurable aid in achieving a good solder joint. Next, heat the component lead, since it usually has the higher mass, by applying a small amount of solder to the tip of the soldering iron at almost the same time as you apply the iron to the component lead. The iron should be approximately 1/8" above the board. When the lead has come up to temperature so that it melts the solder when placed against it, slide the soldering iron down the lead and heat the printed circuit board pad while applying a controlled amount of solder to the joint. The solder should flow into the joint with extreme ease and create an excellent fillet on the top of the PCB as well as on the bottom. The entire soldering portion of the procedure should take no more than a couple of seconds.

After replacing the components and soldering is complete, wash the board thoroughly. Water soluble flux is very conductive, and any residue left on the PCB will cause a lot of trouble. We recommend using de-ionized or distilled water to clean the board, however do not leave a board in clean de-ionized (or distilled) water for any length of time as it is very active and will attack the metals on the board. Thoroughly dry the board as well; do not power up a board in the presence of moisture.

This completes the Audio World™ Interface Instruction Manual 060394

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