IFA-2
INSTRUCTION MANUAL

BENCHMARK MEDIA SYSTEMS INC.
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REVISIONS			
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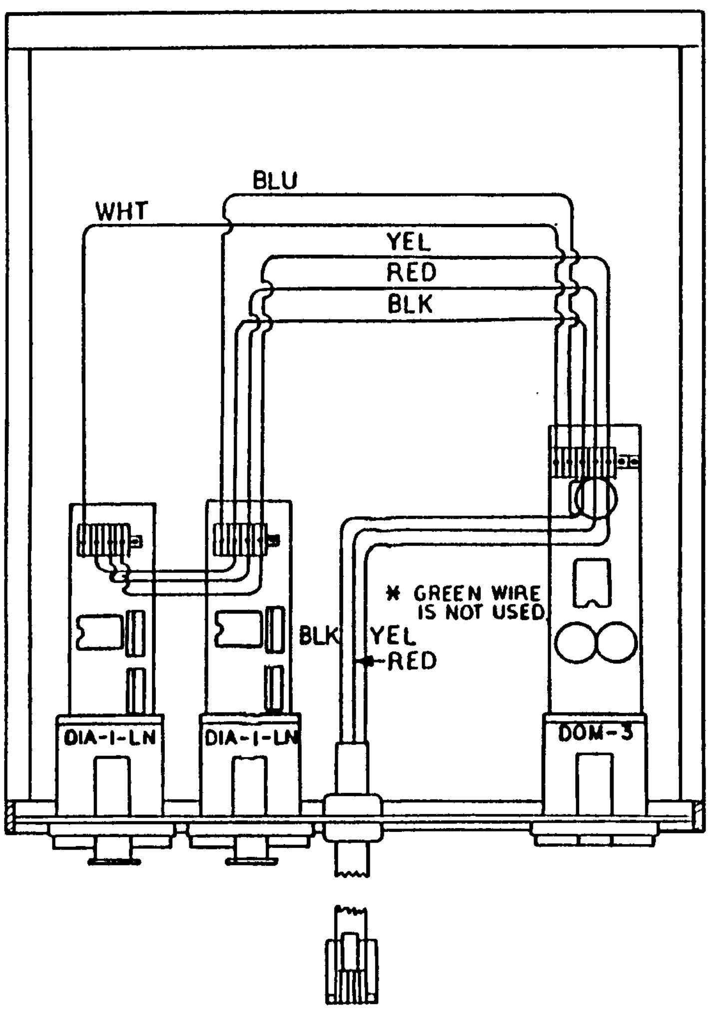

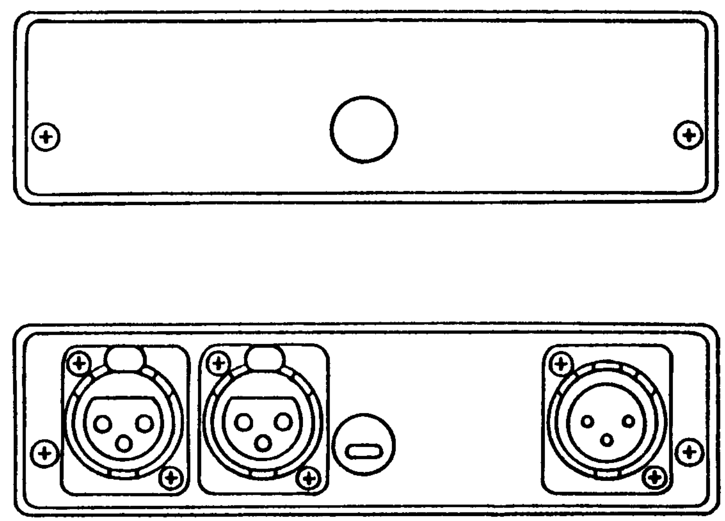

NOTES:

1. POWER CORD MAY PASS THROUGH EITHER END PLATE.

Benchmark Media Systems		
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BENCHMARK MEDIA SYSTEMS, INC.

DIA-1 and 2 Instruction Manual

Table of Contents

1.0 Introduction

The standard DIA-1 & 2 and the Low Noise DIA-1-LN & 2-LN Differential Input Amplifiers are universal input devices designed to provide both a balanced input and the gain reduction necessary to interface consumer and semi-professional audio equipment to the professional environment.

2.0 General Features

The DIA-1&2 balanced input devices have fixed gain that must be selected at the time of order, an input impedance of 100 k Ω with the standard series and 10 kΩ with the low noise series, and an output impedance of 47 Ω, single ended. This circuitry is on a small printed circuit board that may be mounted on either a 1/4" TRS jack or a female XLR type jack, both Switchcraft and Neutrik types, or the device may be used card only. The operational amplifiers used are either a TLO71 or 72 with the standard DIA series and a NE5534 or NE5532 in the low noise series.

The DIAs may be purchased with a choice of two connectors, a female XLR type or a 1/4" Tip Ring Sleeve type. The DIAs may also be purchased with no connector. The gain options that are available are; unity, -6 dB, and -12 dB. Additional gain structures may be purchased on a custom basis with surcharge added.

2.1 Gain Structures

Most of the applications of the DIAs will be in converting Semi-Pro or High Fidelity equipment to operate in the professional environment. Therefore a loss in amplification is most commonly needed. The choice of gain directly effects the input headroom of the device. All DIAs operating at the power voltage limits, will have an <u>output</u> clip point of approximately +22 dBu. (The dBu is a voltage reference of 0.7746 volts without an impedance reference) The input clip point of a unity gain DIA, operating at the power voltage limit, will be equal to its output clip point. A DIA with 6 dB of loss, however, will have an input clip point that is 6 dB higher than its output clip point, +28 dBu, and a DIA with 12 dB of loss will have an input clip point that is 12 dB higher than its output clip point, +34 dBu. Likewise any custom positive gain structures will directly <u>reduce</u> the input clip point (referenced to unity gain) by the amount of that gain.

In the professional environment, most equipment is capable of putting out +27 to +30 dBu. All of this is to say that if you want to maintain the system dynamic range, input clip points of +27 or higher should be considered necessary in your modified equipment. This necessitates that 6 dB loss be taken in the DIA, and this is what we recommend. If a direct drop from +4 dBu to -10 dBV (-8 dBu) is desired then the -12 dB gain structure may be chosen. In our opinion, however, the 6 dB loss is preferable. This is because most IHF type equipment has an input attenuation potentiometer directly after the RCA pin jack, and the additional loss necessary may be taken at this point. This preserves some gain capability, should it be necessary from time to time, without sacrificing the input clip point.

3.0 Unpacking and Installation

As with any delicate electronic equipment , care must be exercised in the handling of this board. Carefully unpack the DIA-1 or 2 and place it on the work table for installation in the intended equipment. Care has been taken during packing to assure the withstanding of normal shipping conditions. Examine the equipment carefully as it is unpacked. If the shipping carton appears to have been damaged during shipment check the equipment and notify the carrier and Benchmark immediately if there are signs of damage.

3.1 Physical Installation

The appropriate holes must be drilled or punched in the intended equipment chassis. For 1/4" jack installation a 3/8" hole should be drilled. From a practical standpoint it is well to start with a small drill size, such as a 1/8", to be used as a pilot hole, with a 1/4" intermediate hole also a genuine help before drilling the 3/8" final size. This will enable more precise location of the jack. If you no not have a deburring tool, a larger drill bit will work for that operation.

!!! Warning !!!

Be careful not to over tighten the nut on the plastic threads of the 1/4" jack. It is very possible to strip the threads on this connector.

Figure 3.1 shows the drill pattern for the Switchcraft D3F female XLR type connector.

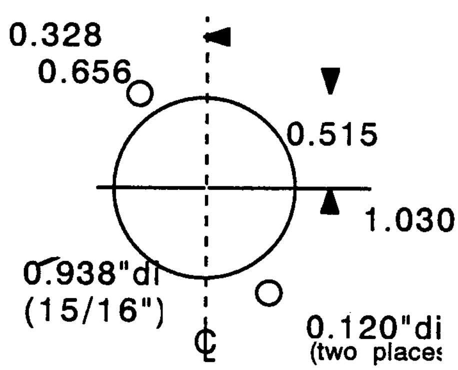

Fig 3.1 Switchcraft D3F Drill Template

You may find it convenient to have removed the inner portion of the D3F connector, with the board attached, while mounting the metal portion of the D3F.

3.2 Electrical Installation

The DIA-1 must be powered from bipolar supplies. The power voltage range is from ±9 to ±18 volts for the standard series, and to ±22 with the low noise series. If the devices need to be installed in equipment that have high voltage supplies only, such as in power amplifiers, on board zener regulation may be added. A group of three wires at the rear of the DIA-1 are used to bring power into the device. The red wire must connect to the positive supply, the blue wire to the negative supply, and the black wire ties to the power supply common point. See figure 3.2 for the correct pin assignments.

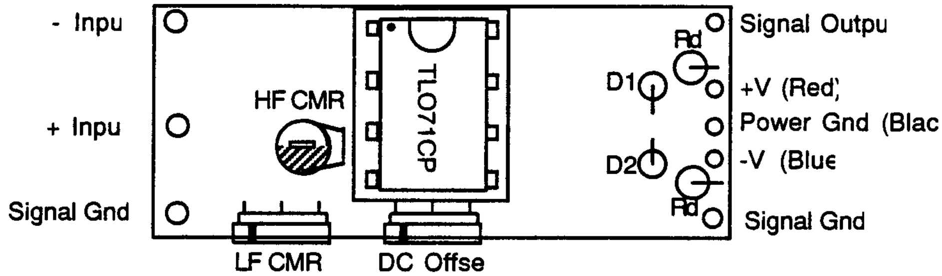

Fig 3.2 DIA-1 Connections and Controls

The DIA-2 must be powered from a single positive supply. The power voltage range is from +18 to +36 volts for the standard series, an to +44 volts for the low noise series. Two wires at the rear of the DIA-2 are used to bring power into the device. The red wire must be connected the supply's positive terminal and the black wire to the supplies negative terminal. See figure 3.3 for the correct pin assignments.

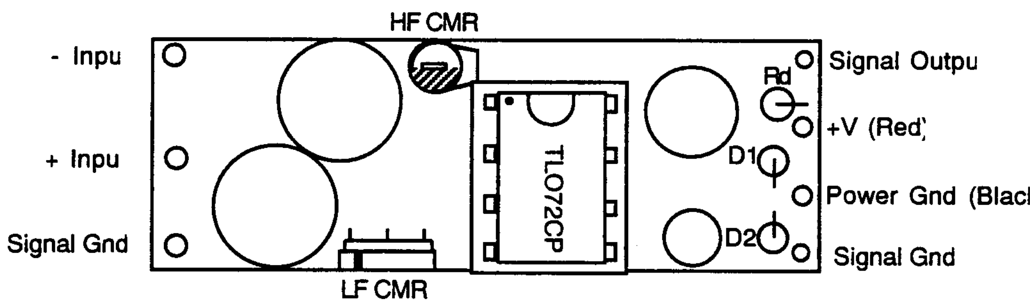

Fig 3.3 DIA-2 Connections and Controls

Output connections are made at the right end of the board. Output wires should be soldered to the two extreme outside holes. The output signal to the top hole and the ground to the bottom hole. The input connections, shown on the left end of the board are solder connections if you ordered "board only". The inputs, as identified on the pictorial, are correct for the board only, the 1/4" TRS jack, and for the XLR type connector.

3.2.1 Power Connections

Use the highest power supply voltage possible within the constraints of the op-amp limits. Often within a piece of equipment you will find both unregulated voltages of ± 15 to ± 18 volts as well as ± 9 to ± 12 volts regulated (+30 and +24 respectively for the DIA-2). It is sometimes possible to power the DIA-1 or 2 using the raw DC voltages, provided the ripple content is very low, but since the NE5532 and NE5534 do not have high power supply rejection ratios, caution must be exercised when doing this. Using the highest voltage available will give the best headroom, but high ripple content will degrade the signal to noise ratio, particularly in the annoying 120 Hz range. So use this option only if you can measure the results of your work.

Once again the maximum supply voltage that the TLO series op amps may use is ±18 volts (+36 on the DIA-2) and ±24 on the DIA-1-LN (+48 on the DIA-2-LN). Powering the amplifiers from higher voltages than these, must be accomplished using the optional on board zener regulation. When installing the DIA-1 or 2 in a power amplifier, it is preferable to power the device from the high voltage power supply by using this zener regulation. The ±10 volt supply that exists in many of the

CROWN power amplifiers will limit the headroom of the DIA-1 by approximately 3.5 dB.

There is no limitation to the maximum power supply voltage that may be used when using zener regulation. The physical space limitations necessary for the dropping resistors limit the maximum supply voltage to ±42 volts in the case of the DIA-1 and +58 volts in the case of the DIA-2. Higher supply voltages than these require the dropping resistors be mounted external to the DIA board. A convenient place to mount the external dropping resistors is directly at the power amplifiers filter capacitors. The chart on the schematic lists the appropriate resistor values for varying supply voltages. A set of dropping resistors is necessary for each DIA board to be installed within a power amplifier. The values for resistors not listed for the DIA-1 may be calculated by

$$R = \frac{V_{ps} - 18}{0.01} \ \Omega \qquad [3.1]$$

and the power rating of the resistor may be calculated by

$$P_r = (V_{ps} - 18) \times 0.02 \ \text{Watts}, \qquad [3.2]$$

rounded off to the next higher standard power rating. The formulas for the DIA-2 are

$$R = \frac{V_{ps} - 36}{0.01} \ \Omega \qquad [3.3]$$

and

$$P_r = (V_{ps} - 36) \times 0.02 \ \text{Watts}, \qquad [3.4]$$

again rounded to the next higher standard power rating.

For example, the DIA-1 will power from the following;

Bipolar Supplies	R_d	P_r
±60 Volt Supplies	4500 Ω	1 Watt
±70 Volt Supplies	5500 Ω	1 Watt
±80 Volt Supplies	6500 Ω	2 Watt
±90 Volt Supplies	7500 Ω	2 Watt

3.2.2 Input and Output Connections

If the DIA-1 or 2 was purchased with a connector attached, then of course no input connections need to be made to the board. If you purchased a board only, then the intended input wires must be soldered to the P.C. board according to figures 3.2. and 3.3 The unbalanced output connection must also be made. Use the Figure 3.2 and 3.3 to identify the correct hole locations.

!!! Warning !!!

> The DIA 1&2 are constructed on single sided printed circuit boards that may be easily damaged by excessive heat while soldering. It is very easy to "lift" a run from the board hence extreme caution must be exercised during the soldering process. We strongly recommend the use of a temperature controlled soldering station, set for a temperature of 600°. See the section on soldering in the Troubleshooting and Repair section 4.0

The DIA-1 is a DC coupled device, therefore you must be sure that no DC voltage is present at the output of the original equipment. If this is not done the DIA-1 will amplify this DC voltage. If DC is present, 100 µF aluminum electrolytic capacitors should be installed between the signal source and the input of the DIA-1. This large a capacitor is necessary to preserve the common mode rejection ratio of the DIA-1. Even larger capacitors are needed for the DOA-1-LN, and 330 µF, or larger, capacitors are recommended. The DIA-2 has no need for further isolation, as it already is an AC coupled device. Connect the existing input lead (original input in equipment) to the signal output of the DIA board.

When connecting the power and signal wires of the DIA-1 to their respective points, you should be aware of the jumper strap that ties the power ground and the signal ground together. This jumper offers an option for the installer. While there is normally no problem, it is possible to separate the power and signal grounds as a means of achieving hum free audio. It is our experience that this option is rarely needed since there is very little current flowing in the ground lead, unless the zener option is installed on the card, and then only to the amount allowed by the combined tolerance limits of those components.

The "ground" lead is the signal reference, therefore it is important where this lead is connected. We have found that some bipolar power supply common points are not necessarily a clean audio reference, whereas, the signal ground originally used with the equipment is almost always a good reference point. Care at this point is necessary in order to achieve the noise floor as a system, to which the DIA is capable. Perform close noise measurements and/or careful listening tests under high gain, to determine the result of your work.

3.2.2.1 Equipment Interconnection

Connect the output of the equipment that is feeding the newly modified piece (in which the DIAs were installed) in the following fashion. Balanced outputs are connected using both the black wire as the inverting and red wire as the non-inverting signal path in normal foil shielded audio cable. Connect the non-inverting output to non-inverting input and inverting output to inverting input. The shield of the interconnecting cable should be connected at only one end, either the output end or the input end. Additionally a separate insulated wire should tie the pieces of equipment together. See the Benchmark Media application note, "A Clean Audio Installation Guide" by Allen H. Burdick for the particulars as to how this external wire should be connected.

Unbalanced feeds should be connected to the input of the DIA in a similar fashion with the exception of the black wire (inverting input), which should connect to the signal reference (usually chassis ground) of the sending equipment. This is known as forward referencing. It allows the DIA to reject voltage differences between the two pieces of equipment. Again see the "Clean Audio Installation Guide".

!!! Notice !!!

> It is not uncommon for the manufacturers of high fidelity and semi-professional equipment to place a series resistor between the output of the internal amplifier and the RCA connector, whose value may be as high as 10 kΩ. The purpose of this resistor is to protect against those who would "mix" two outputs via a "Y" connector. This resistor will destroy the exceptional common mode rejection expected from the DIA and hence it should be removed.

3.2.3 Output Impedance

The output impedance of the DIAs is 47 Ω resistive. The purpose of this resistor is to isolate cable capacitance from the operational amplifiers output and thus preserve its phase margin. These devices are designed to work into input impedances not lower than 2 kΩ. If you intend to drive a long line, from 10' to 300' with your input unit, you will need to use a DOA line driver. If you have to drive a line longer than 300' then a CBO-1, with its high current output capability is the appropriate line driving device. This is due to the current requirements that are necessary to feed the cables capacitance at high frequencies. Further information on this may be found in "A Clean Audio Installation Guide".

3.2.4 Trim Adjustments

All of the variable controls on the DIAs are for factory presets, and are not user adjustments.

!!! Warning !!!

> The factory sealed adjustments must not be adjusted by the installer or user without precise measuring equipment and a knowledge of the circuit parameters affected. These are not gain controls.

The DIA-1 has three controls that are sealed. Two of these are the common mode rejection adjustments and the third is a DC offset null. The DIA-2 has only the two common mode rejection adjustments.

If you have strong reason to believe that any of the factory presets have been changed or are not correct then the following procedure may be used to correct these settings.

3.2.4.1 DC Offset Adjustment

The DC offset control, shown in figure 3.2, allows the "no signal" DC voltage at the output of the DIA-1 to be adjusted to near zero volts. To perform this adjustment a 4&1/2 digit DVM, with 0.05% accuracy or better, is necessary. We recommend the Fluke 8050A voltmeter.

1. With no signal present, connect the voltmeter to the output of the DIA-1

2. Measure the output voltage and adjust it as close to zero as possible. This should be at least lower than 1.0 millivolt and in many cases may be adjusted to less than 10 microvolts. The resolution of the 8050A is 10 μV. The DIA should not be expected to maintain this low an offset voltage under varying temperature conditions. Op-amp thermal instabilities will prevent the tight maintenance of this setting over temperature. Therefore, if it is possible, adjust the offset voltage at or near the temperature the device will see in actual use.

3.2.4.2 Common Mode Rejection Adjustment.

Common mode rejection adjustment must be performed using an oscillator with a "single ended" output (ground referenced), a function generator will work very well and a sensitive, wideband analog, AC type voltmeter. The voltmeters found in distortion analyzers with sensitivities down to -100 dBu or better are good. A digital voltmeter is not a proper choice for this measurement. Most preferable, however, is a logarithmic type voltmeter, such as those formerly made by **dbx** and Valley People. Unfortunately these are no longer available, except perhaps on the used market. Additionally an oscilloscope is very advantageous in this test setup. The oscilloscope should receive its signal from the output of the voltmeter, where the voltmeter is acting as a preamplifier for the scope. The scope should be triggered from the output of the function generator.

Connect the test equipment to the Differential Input Amplifier as shown in figure 3.4

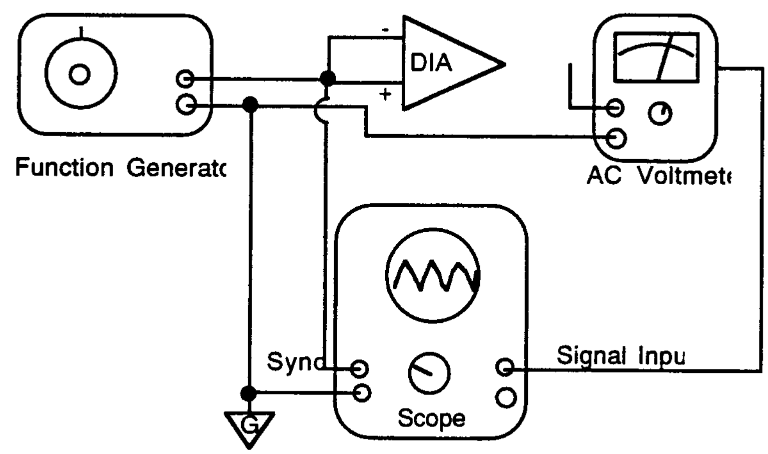

Fig 3.4 CMR Test Setup

The common mode rejection adjustment is actually a series of iterative adjustments between the resistive portion of the bridge and the capacitive portion. This adjustment should be performed at a frequency of 2 kHz.

Adjust the trim resistor for the best null possible at the output of the DIA while observing the voltmeter. If you have an oscilloscope as a part of your test setup, observe the phase shift of the remnant signal as you pass through a voltage minimum. The phase change is a more easily observable parameter when near the voltage minimum than is the voltage itself. Set the potentiometer for the center of the phase shift, and then proceed to the capacitive adjustment and adjust for a further reduction in output voltage. You will most likely need to switch the voltmeter to progressively lower ranges during this process. You will find the adjustments progressively more sensitive. Observing the oscilloscope will allow a significantly faster achievement of the desired null.

The common mode adjustment involves passive components that form a bridge around the active operational amplifier and this adjustment is independent of the operational amplifier. If an amplifier integrated circuit ever needs replacing, the common mode rejection adjustments will not need to be performed. The only possible exception to this would be the equivalent of a lightning strike that would take out or change the values of these passive components, in which case those parts would also need to be changed.

4.0 Troubleshooting and Repair

The DIA-1&2 are carefully constructed of very high quality components and therefore will probably never need servicing. Should a problem occur with your device, the following will aid in locating the problem.

The first step in troubleshooting, is to check for solder shorts and other mechanical problems that may have occurred during the installation. Many of the problems with electronic circuits may be solved by close visual inspection. We heartily recommend the use of an "OptiVISOR", manufactured by Donegan Optical Co., or an equivalent stereo optical magnifier.

If after inspection you have determined that no solder bridges were created during installation, the DC operating voltages should be checked. First determine that the proper power voltages exist at the pins of the operational amplifier, pins 4 and 7 on the DIA-1 and pins 4 and 8 on the DIA-2. With the DIA-1 a positive voltage, referenced to ground, at pin 7 (the full power supply voltage) should be present. Likewise a negative voltage at pin 4 should be present. In the case of the DIA-2, pin 4 is ground and pin 8 should have the full power voltage present. The output pins of the amplifier should be checked next, that is, pin 6 on the DIA-1 and pin and 7 on the DIA-2. The DIA-1 should have less than 5 mV at its output, and in reality 100 μV or less, should be typical. These measurements should be made with no audio signal present. The DIA-2, on the other hand, should have a voltage that is nearly one half that of the power voltage present at its outputs. If the output voltages are not correct, under no signal conditions, the replacement of the operational amplifier will in most cases fix the device.

On extremely rare occasions a faulty passive component may exist. If you are unable to locate the problem, a reasonable amount of troubleshooting assistance is available, via telephone, from the customer service department at Benchmark Media Systems.

4.1 Soldering Technique

Once the faulty component is isolated extreme caution must be exercised when removing the component and soldering in a replacement. Benchmark strongly recommends the use of a vacuum de-soldering station such as the Pace MBT-100.

The proper technique is to apply the de-soldering iron tip to the area to be de-soldered and wait for the solder to liquefy. As the solder becomes liquid the vacuum is applied while moving the tip of the iron and rotating the lead of the component coming through the circuit board. Rotate the lead without applying pressure to the pad. If this procedure is correctly applied the component will often drop from the circuit board.

The following is a soldering technique that was developed by NASA to ensure highly reliable solder joints.

> The component lead is heated first since it usually has the larger mass and has little chance of being damaged by excess heat. This is done by applying a small amount of solder to the tip of the soldering iron while simultaneously applying the iron to the component lead. This allows some flux to make it to the component lead. The iron should be slightly above the circuit board. When the lead reaches temperature it liquefies the solder adjacent to it and has good wetting. Slide the soldering iron down the lead and heat the printed circuit board pad while applying a controlled amount of solder to the joint. All of this should take no longer than as couple of seconds.

The component to be mounted on the circuit board may have leads that are oxidized. Clean them with a "Scotch Bright" abrasive pad, a fine bristle fiberglass brush or equivalent method.

This completes the DIA-1&2 instruction manual. 030392

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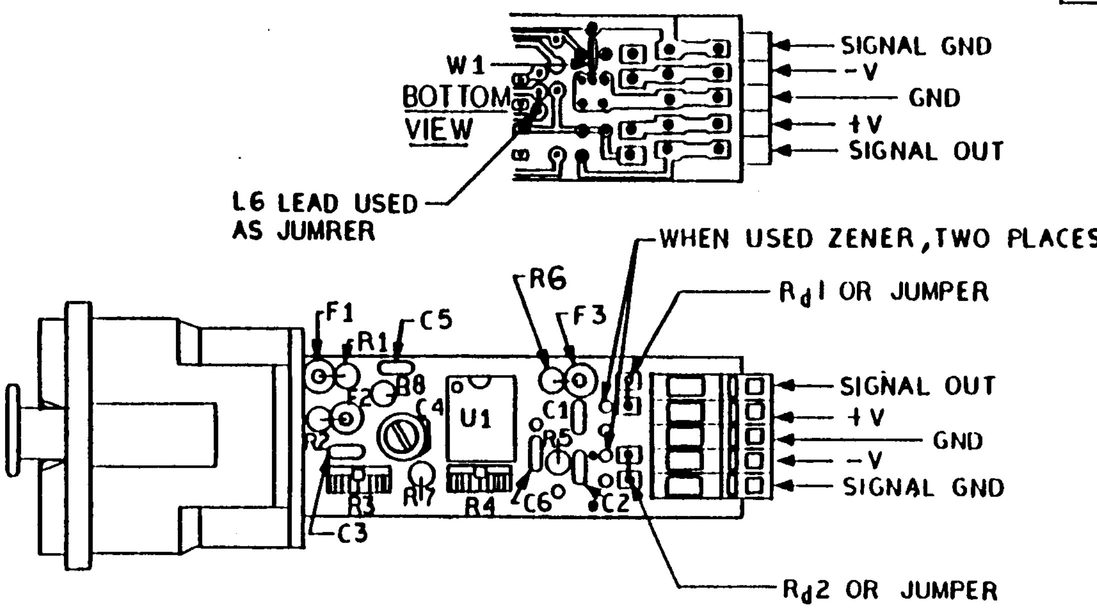

Benchmark Media Systems		
DIA-1-LN		
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BENCHMARK MEDIA SYSTEMS, INC.

DOM-3 Instruction Manual

Contents

1.0 Introduction

The DOM-3 Differential Output Mixer is a universal output devices similar in design and function to the DOA-3 Differential Output Amplifiers but with the ability to mix input signals. This ability to mix signals at the output provides the optimal answer for deriving a mono sum from discrete stereo, mixing microphone preamplifiers and numerous other mix applications.

2.0 General Features

The DOM-3 are balanced output device that has variable amplification from full Off to +12 dB, two 10 kΩ inputs, an output impedance of 60 Ω. The DOM-3 is an AC coupled output device that has no DC offset adjustments and thus is the ideal device for use with front panel "gain" controls. All circuitry is on a small printed circuit 0.65" wide by 2.00" long that is mounted on an XLR type jack. The operational amplifier used is a NE5532 for outstanding aural performance.

3.0 Unpacking and Installation

As with any delicate electronic equipment, care must be exercised in the handling of this board. Carefully unpack the DOM-3 and place it on the work table for installation in the intended equipment. Care has been taken during packing to assure the withstanding of normal shipping conditions. Examine the equipment carefully as it is unpacked. If the shipping carton appears to have been damaged during shipment check the equipment and notify the carrier and Benchmark immediately if there are signs of damage.

3.1 Physical Installation

The appropriate holes must be drilled or punched in the intended equipment chassis. From a practical standpoint it is well to start with a small drill size, such as a 1/8", to be used as a pilot hole, with a 1/4" intermediate hole also a genuine help before drilling the final size. This will enable more precise location of the connector.

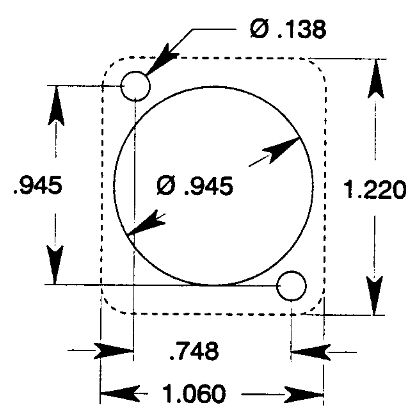

Fig 3.1 Neutrik "D Series" Drill Template

Figure 3.1 shows the drill pattern for the Neutrik D Series connector. Your device was shipped with an XLR connector. Drill and punch the appropriate holes and mount the DOM-3. It is possible to remove the inside of the D series connector and the PCB from the connector shell and thus mount the shell from the outside of the chassis and then insert the PCB and connector center back into the shell from inside the chassis. This is done by using a small green Xcelite® screwdriver that has been ground down (narrow) so that it will fit into the latching mechanism between the pins of the connector. Alternately, you can use a jewelers screwdriver. When reinserting the center of the connector and PCB, be sure to securely latch the device.

3.2 Electrical Installation

The DOM-3 must be powered from bipolar supplies. The power voltage range is from ±9 to ±24 volts. A group of three pins in the header strip at the rear of the DOM-3 are used to bring power into the device. See figure 3.2 for the correct pin assignments.

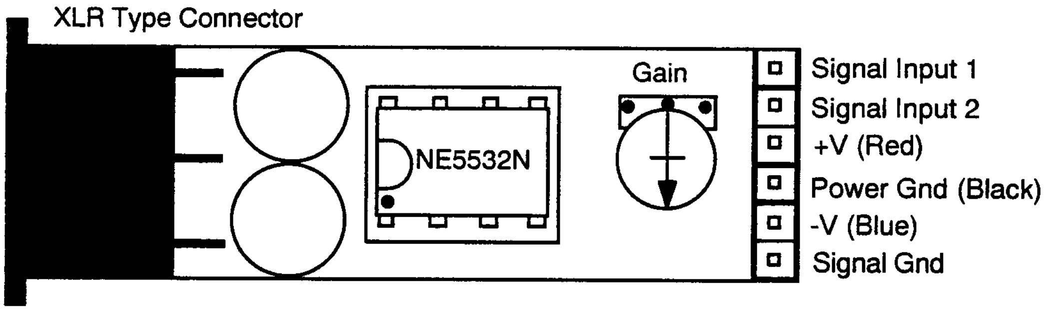

Fig 3.2 DOM-3 Connections and Controls

All connections at the right end of the board should be made with either the supplied plug-on female header or with Molex SL connectors (not supplied).

3.2.1 Power Connections

Use the highest power supply voltage possible within the constraints of the op-amp limits. Often within a piece of equipment you will find both unregulated voltages of ± 15 to ± 18 volts as well as ± 9 to ± 12 volts regulated. It is sometimes quite possible to use the raw DC voltages to power the DOM-3 since the op-amp has a relatively high power supply rejection ratio at this frequency. This option will give the best headroom but may degrade the signal to noise ratio slightly, particularly in the annoying 120 Hz range. So use this option only if you can measure the results of your work.

The maximum power supply voltage allowed with the DOM-3 is ± 22 volts. This is set by the published limits from the manufacturer of the op-amp. The use of ± 22 volt supply rails results in an increase in quiescent current drawn by the op-amps. The resultant heating of the chip increases the input bias currents. As the chip gets hot, the output current limit point is reduced, and if the device actually should have a 600 load (not at all recommended) the maximum output power capability is actually LOWER than if the power supply voltage were at ± 18 volts. On the other hand, with voltage sourced systems, maximum output voltage rather than power is the most desirable feature. Our experience shows that ± 24 V, often found in audio consoles of older vintage, is safe for the NE5532 provided there is no additional ripple content, even though this is beyond the stated maximum limit given by the manufacturer of the operational amplifier.

3.2.2 Input and Output Connections

The unbalanced input connections must be made via the supplied female header strip. Use the Figure 3.2 to identify the correct pins.

3.2.3 Output Impedance

The output impedance of the DOM-3 is 60 Ω balanced, 30 Ω unbalanced. This is achieved with 1% metal film build-out resistors. A 60 Ω output impedance has been found to be the optimum drive Z for today's foil shielded cables. This allows the longest possible cable runs to be made without excessive high frequency roll-off and without significant high frequency response peaking.

If the shielded pair being used has 32 pF/foot capacitance between conductors (not shield) then for a system high frequency cutoff of say 30 kHz, the maximum length of cable that may be used is 2947 feet, or approximately 900 meters. This is ten times the length possible, under the same constraints, if the output impedance were 600 Ω.

The total C is determined by:

$$C = \frac{1}{2 \pi F_C R} \qquad [3.1]$$

where;

C is the maximum allowable cable capacitance
R is the output impedance (60 Ω)
F_C is the lowest system high frequency cutoff that we can tolerate.

Obviously using low capacitance cable will further improve the limits.

The total number of feet of whatever cable chosen is found by:

$$\text{Feet}_{\text{max}} = \frac{C}{\text{Cable pF/ft}} \qquad [3.2]$$

Another benefit of the 60 Ω output impedance is that there is only 0.8 dB amplitude difference between a bridging input and a 600 Ω loaded input. See "A Clean Audio Installation Guide" by Allen H. Burdick, a Benchmark Media Systems application note.

If significant high frequency material will be sent over the interconnect pair, cable lengths will need to be limited to less than that calculated above. This due to the current limit of the operational amplifier, and this is because more current is drawn by the cables capacitance with increasing frequency. Again see the "Clean Audio Installation Guide".

3.2.4 Balanced or Single Ended Outputs

The DOM-3 can be used either as a balanced or as a single ended output. When using the DOM-3 as a balanced output device, both of the outputs, inverting and non-inverting will be utilized. When using the DOM-3 as a single ended output, be sure to use *only one* of the two outputs, either the inverting or the noninverting. Under no circumstances should the unused output be tied to ground as would be done with a transformer output. The active balanced output is already ground referenced, unlike the transformer type outputs.

!!! Warning !!!

Tying one of the outputs to ground will cause a large amount of distortion to occur as well as overheating of the operational amplifier.

3.2.5 Terminations and Output Amplitude

The impedance matched audio interconnect system developed in the days of tube amplifiers is now passé for anything but *extremely* long cable runs. With modern operational amplifier technology it is no longer necessary nor even desirable to terminate audio lines with a "matched" low impedance, unless you are the Phone Co. with miles of cable, the length of which approaches 1/10 wavelength at the highest frequency of interest. For us, that is 3000' to 5000' at 20 kHz. One exception might be in a high RF environment where the line becomes a high impedance at the receive end with respect to the RF. Here a 600Ω or 150Ω termination will present a low impedance to the offending RF power between the two wires of the pair. But this is rather "iffy" in that it requires different levels of RF to appear on the two different wires of the balanced pair, an uncommon problem. And the balanced input still needs good ability to reject common mode RF, the more significant problem.

Today the voltage sourced interconnect system is becoming universally used. The voltage sourced system features a low source impedance of approximately 50 to 60 Ω, and a high input impedance of 10 kΩ or higher. The advantages are:

1. Less power drawn from the source equipment, therefor less heat generated.

2. Lower distortion generated by the output stage doing the driving.

3. 14 dB lower noise pickup by the interconnect lines due to the lower source impedance.

The DOM-3 was designed with this in mind and while it will drive a 600 Ω load, it does so with reduced headroom (lower clip amplitude) due to the internal current limiting of the op-amp used. Therefore, for the best headroom in your system, DON'T put a 600 Ω resistor at the receiving end of the cable being driven by the DOM-3.

PS Voltage	Ques I	Max Out, Bal Unterm.	Max out, Bal 600 Ω
±22 Volts @	±12.0 mA	+30 dBu	Overheats
±18 Volts @	±9.50 mA	+28 dBu	+26 dBu
±15 Volts @	±8.60 mA	+26 dBu	+25 dBu
±12 Volts @	±7.75 mA	+24 dBu	+23 dBu
±10 Volts @	±7.50 mA	+22 dBu	+21 dBu
±09 Volts @	±7.50 mA	+21 dBu	+20 dBu

Fig 3.3 DOM-3 Output Limits and Quiescent Current

The maximum output from the DOM-3 operating as an unbalanced output is always 6 dB lower than when operating as a balanced output because only one half of the available output swing is being utilized.

3.2.6 Virtual Ground Summing

The DOM-3 as shipped will mix only two inputs. However because the amplification control potentiometer is the feedback resistor, the inverting input of the operational amplifier is available to be used as a summing node with a virtually unlimited number of input summing resistors. These input resistors must be external to the PC board. To use the DOM-3 in this mode we suggest that you remove one of the 10 kΩ input resistors, and replace it with a 33 Ω input resistor. This 33Ω resistor is used to isolate the summing node from any shielded cable capacitance. It is well to keep the wire that ties all of the input resistors together as short and as close to the summing node as possible. This is because the summing node is a *very* sensitive point and long wires will pick up stray 50 or 60 Hz magnetic fields. If a long wire is unavoidable then a *low capacitance* shielded cable should be used.

If shielded cable is used to protect the summing node, then the same total capacitance that the shield presents to the summing node should be added to the feedback circuit, to maintain circuit stability. That is if the shielded cable itself has 200 pF of capacitance, then a 200 pF capacitor should be added in parallel to the existing feedback capacitor.

It should be remembered that whenever the outputs of various amplifier circuits are summed in a mixing circuit, the noise floors of these amplifiers are also summed. Therefore the output noise of the DOM-3 will increase with every additional amplifier stage that is added to the summing circuit. If the noise floors of each piece of equipment that feeds the DOM-3 is the same, then the noise will add as the square root of two. That is every time you double the number of inputs there will be a 3 dB increase in noise.

In addition, the "noise" amplification of the DOM-3 itself is a function of the input resistance and hence is directly related to the number of inputs that are summed. The noise generated by the DOM-3 will have a 6 dB increase every time the number of inputs is doubled. This is because the various input resistors are technically in parallel and tie to the low impedance that may be modeled as ground. Thus the noise amplification of the DOM is set by the ratio of the feedback resistor to the new parallel equivalent input resistor;

$$A\ (\text{noise}) = \frac{R_f}{R_i\ \text{equivalent}} \qquad [3.3]$$

This self noise source is in addition to the summation of the noise of the various amplifier sources.

Lets suppose the unity amplification, single input noise floor of the DOM-3 is -102 dBu. And it is our intent to sum 16 different signals. Immediately the noise floor will jump up 24 dB without any input signals (even noise signals) being sent to the inputs. Therefore, the self noise of the DOM-3 under these conditions will be -78 dBu. Now if the noise floors of all 16 inputs are also -102 dBu then the sum of their noise contributions will be 12 dB or -90 dBu total. In this case the self noise of the DOM-3 will be dominant and indeed will be the measured output noise of the system.

If you will be summing signals that have a large amount of common material (coherent signals) such as when creating a mono sum from stereo, you will experience a resultant 6 dB increase in amplitude. This may compromise the headroom of the system. On the other hand taking a 6 dB loss at the output to protect against the potential signal addition will cause the average output to be to low since the summation of totally unrelated signal sources that are of equal amplitude will result in a 3 dB signal increase. Therefore you should take a 3 dB loss at the DOM-3 to compensate for this signal increase. In practice adjusting amplification for the correct output level with actual program material rather than tones will yield the most satisfying results, and will account for the differences in program material.

3.2.7 Amplification Control

The amplification of the DOM-3 is adjustable from full Off to +12 dB balanced or +6 dB unbalanced.

When using the DOM-3 as a summing amplifier with many inputs, it is well to operate the device with no more than 6 dB of amplification. This is due to the difficulty of electrically performing the summing function at high frequencies, and that is because the increase in noise amplification directly causes the gain-bandwidth product of the operational amplifier to be reduced. Less amplification is available at high frequencies to be placed into feedback for the reduction of distortion.

On occasion it may be desirable to remove the 20 kΩ linear trim potentiometer and replace it with a panel potentiometer for continuous control. A DOM-3 is the correct device for this application. Use a linear panel potentiometer of the same value or a log (audio) taper potentiometer of up to 100 kΩ. A log taper potentiometer of 100 kΩ will provide an amplification of up to +26 dB. The wires that make the connection to the potentiometer should be kept as short as possible to reduce any stray hum pick-up.

4.0 DOM-3 Servicing

The DOM-3 is the simplest of circuits. The only component that has any reasonable probability of failure is the dual operational amplifier, and since it is socket mounted it is easiest to remove it and try another if problems in the operation of the device occur. Barring a lightening strike, the passive components will in all probability never fail.

4.1 Circuit Board De-Soldering

Printed circuit boards are *very* easy to damage by excessive heat. Unless you have developed the specialized skills necessary to remove and replace components, we suggest that you leave the task to someone skilled in these techniques.

When servicing printed circuit boards we strongly recommend the use of a vacuum de-soldering station, such as the Hakko 470. 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. *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 against the board, but *without* applying pressure to the pad, you are able to most thoroughly remove solder from around the hole. In turn the component will often drop out of the board when you are finished.

4.2 Circuit Board Re-soldering

NASA has developed an effective technique that ensures highly reliable solder joints. It involves first heating 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. This will allow some flux to make it 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 and has good wetting, slide the soldering iron down the lead and heat the printed circuit board pad while applying a controlled amount of solder to the joint. All of this should take no more than a couple of seconds. If the component that is to be installed has leads that are oxidized, it will be necessary to clean them. This may be done with either a Scotch Bright® abrasive pad or fine bristle fiberglass brush, among other methods.

This completes the DOM-3 instruction manual.

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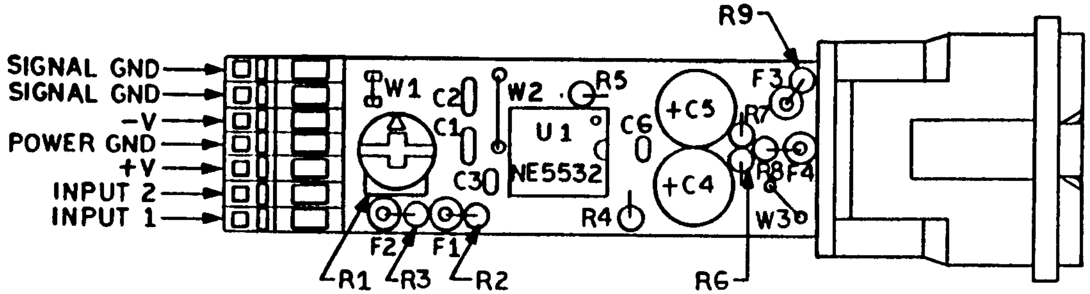

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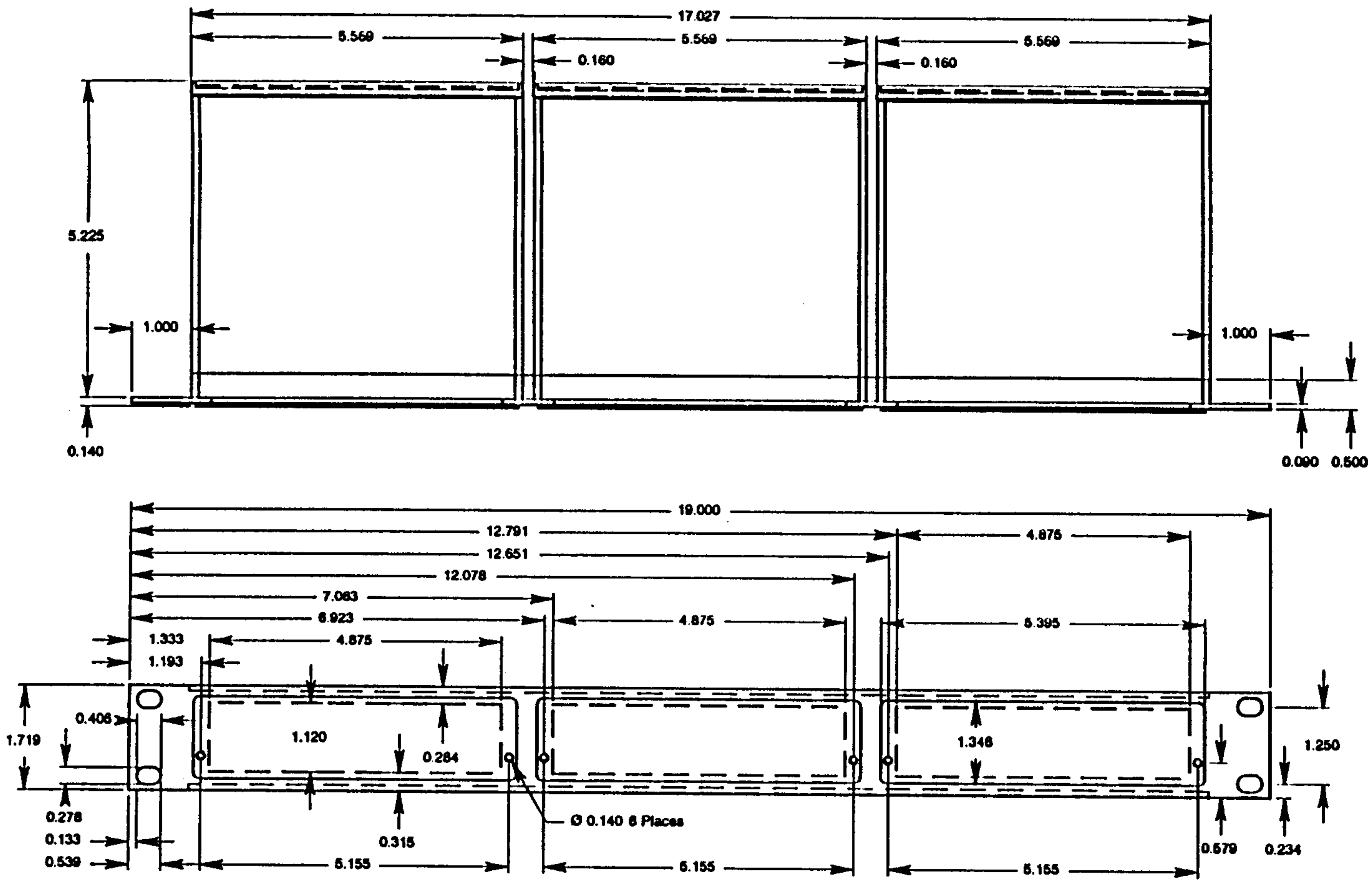

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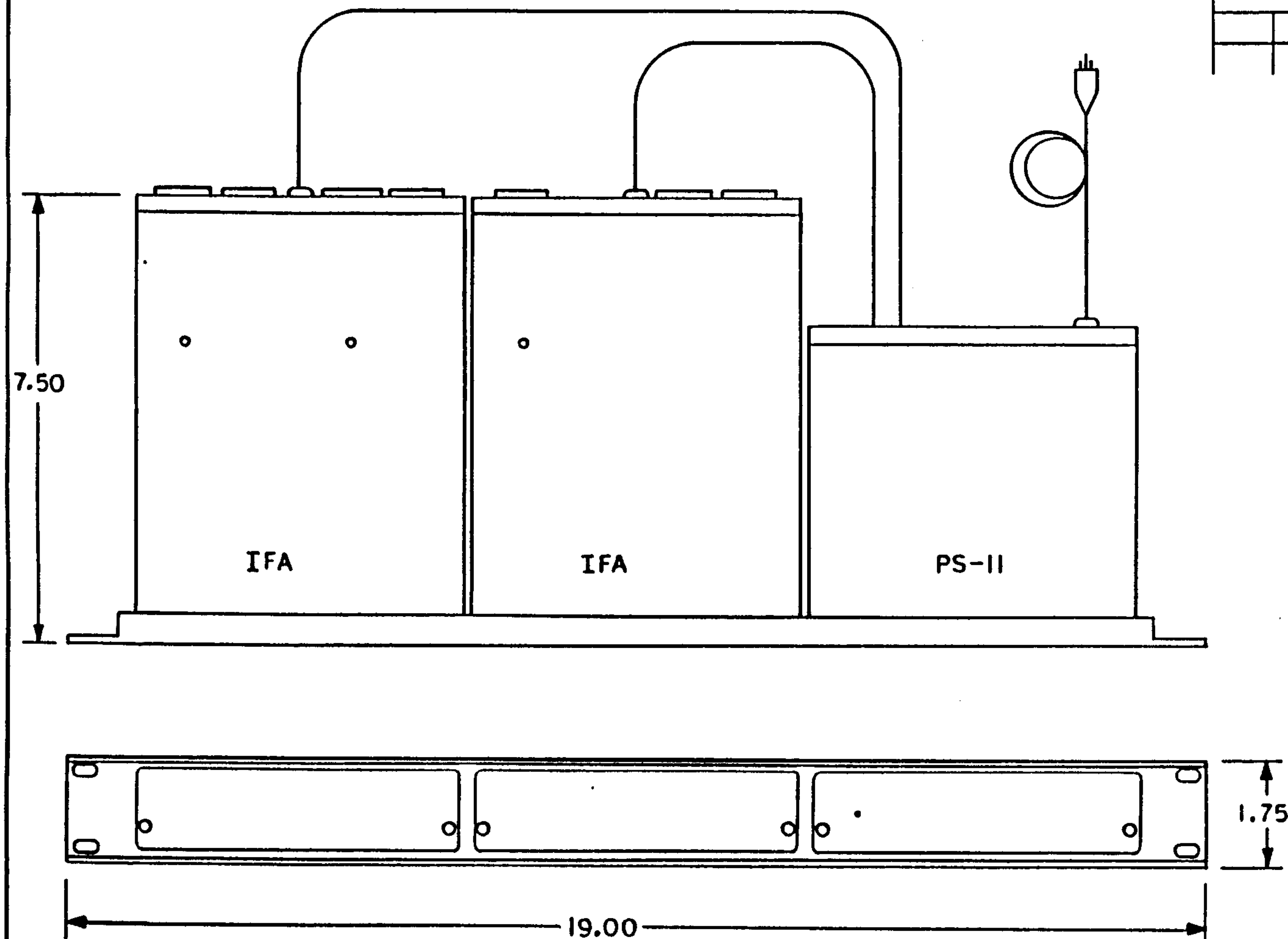

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