DOM-3
INSTRUCTION MANUAL

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DOM-3 Instruction Manual

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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.

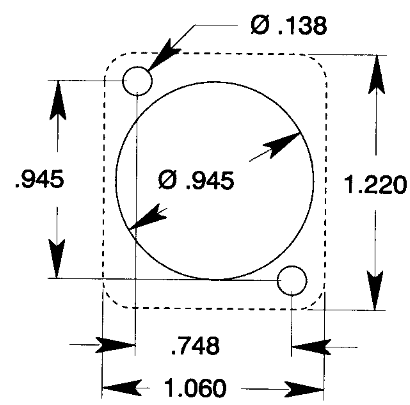

Fig 3.1 Neutrik "D Series" Drill Template

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.

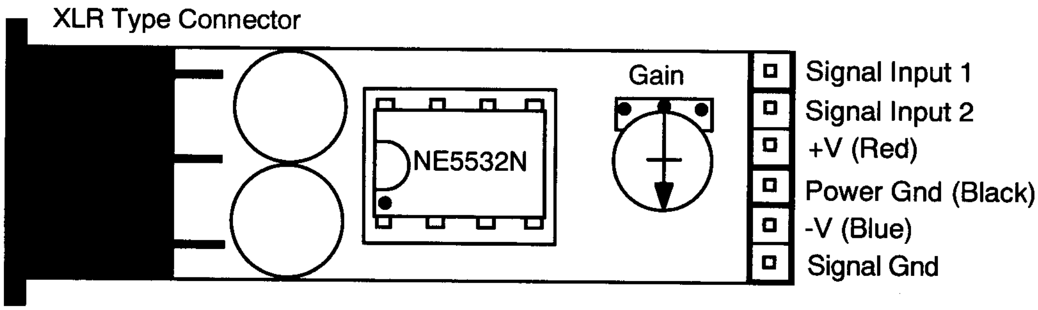

Fig 3.2 DOM-3 Connections and Controls

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:

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

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 un-balanced.

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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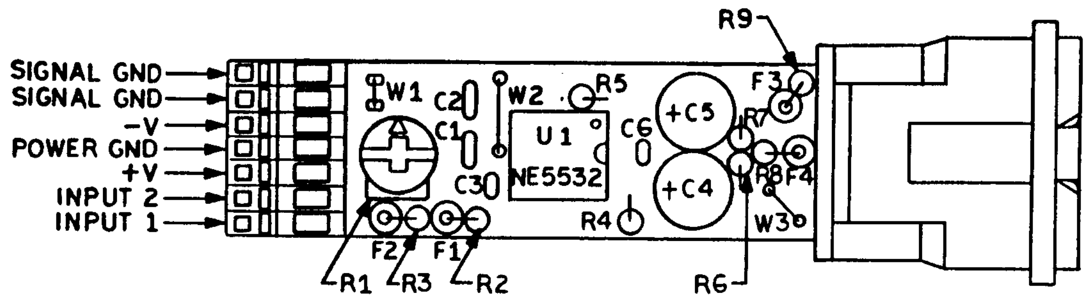

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