BENCHMARK MEDIA SYSTEMS, INC.

MP-3 Installation Guide

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INTRODUCTION

The MP-3 was designed to achieve excellent performance in microphone and other signal amplification. The MP-3 is ideal for the recordist that wants high performance from analog or digital recorders using the superior microphone technologies that have emerged over the past few years. With the MP-3 at or close to the microphone, additional performance benefits are realized, as opposed to long Mic cable runs to a console. By immediately raising the microphone signal amplitude to line level longer lines may be driven and minimum interference is allowed to enter the system from power lines, SCR stage lighting, etc.

Besides the obvious use as a microphone preamplifier, the module may be used wherever amplification is needed and minimum noise is desired. One application that is finding increased acceptance is to bring up low Telco levels without adversely affecting the noise floor. With the overall amplification range of 26 to +73 dB, and the input clip point equal to the output clip point minus the amplification, the MP-3 becomes a universal gain block with very good performance. In this manual, we reference all voltage amplitudes to 0 dBu. 0 dBu is a voltage reference of 0.7746 volts; the voltage that is found in a 600-ohm power matched system operating at 0 dBm.

INSTALLATION

A correct understanding of the proper installation is necessary to achieve the capabilities built into the MP-3. It is desirable that Benchmark application note, "A Clean Audio Installation Guide," be read, digested and applied, as a part of the installation of MP-3.

Mechanical Installation

Drill or punch the holes for the connector and the gain control potentiometer. The following diagram shows the connector mounting hole arraignment. The gain control potentiometer requires a single 3/8" round hold within a 3" maximum radius from the connector. The method for assembly is to remove the preamp circuit board and the center portion of the connector from the connector shell. This is done by turning the locking key located inside plastic portion of the connector and accessed by a small flat blade screwdriver such as an Xcelite Green handle #R3324.

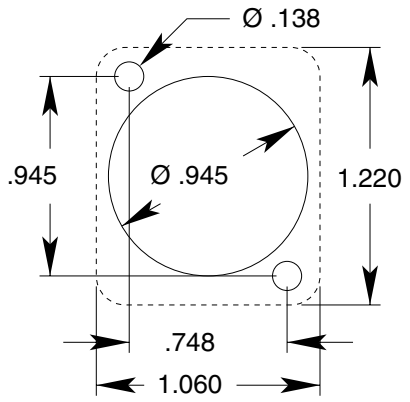


Fig 1. Cutout for Neutrik NC3FD

It has been our experience that shaving the width of the screwdriver slightly with a flat file will facilitate fitting the blade into the key. Install the connector shell from the front of the chassis. When this step is complete install the center, molded plastic portion of the connector, with its attached printed circuit board, into the shell from the rear of the panel.

Module Location

Care must be taken at installation to prevent stray electromagnetic fields from affecting the noise floor of the preamp. Magnetic leakage from a power transformer can cause problems, and we recommend the use of a toroidal power transformer with its inherent low magnetic field leakage. A "core band" is often available from the manufacturer of the transformer that slips over the outside of the transformer to provide additional magnetic field

isolation. Using outboard power supplies or battery power, where possible, will eliminate internally generated EMI. Battery power can also eliminate ground loop induced hum.

Sound Reinforcement

The MP-3 will especially find favor among those with sound reinforcement needs. The module may be mounted in a quad box at a remote location such as in a conference room. The input connector may have to be removed and the module mounted sideways. Bipolar (±) power may be brought to the module on one audio pair, using the shield as power ground, and balanced audio returned on a second pair.

Power Requirements

The power requirements for the MP-3 are a split (dual) power supply with output voltages of ±15 (recommended) to ±22 volts. This supply should be well regulated with low ripple and noise, and while the quiescent current drain is ≈20 mA, the supply should be capable of an output current of ±50 mA for peak current drive.

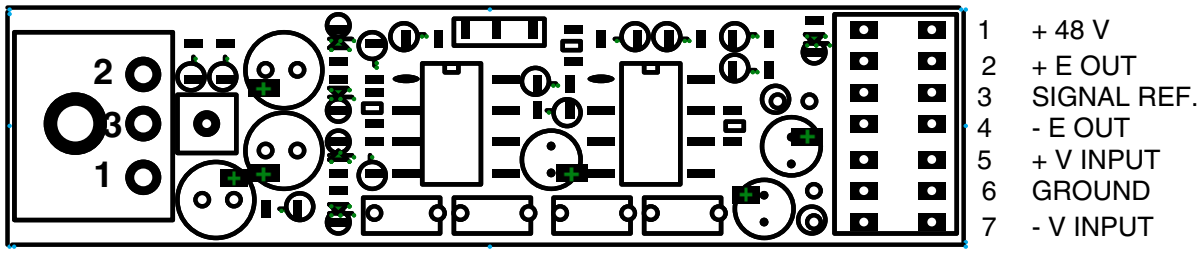
If phantom power is to be used with condenser microphones, then a +48 volt supply will be needed. It will also need to be a supply with low ripple and noise, and capable of a 10 mA load. The power ground is common for both the low voltage ± supply and the high voltage phantom supply.

For portable use, two 9-volt batteries can provide ± 9-volt operation with reduced headroom as the price to be paid. Four 9-volt alkaline batteries will provide ± 18-volt operation with 6-dB better headroom. Doing this yields a maximum output amplitude of about +28 dBu, and is highly recommended. Current drain from the module is approximately 20 mA, thereby yielding approximately 20 hours of battery power operation. This assumes a 500 mA-hour capacity, a relatively small capacitive load and a bridging input at the receiving end.

The use of four additional 9 volt alkaline batteries will provide 36 volts that may be added to the + 18 volt supply to create a phantom power source. Since the current drain of the phantom supply is 1/10 or less that of the module, you may expect the battery life to be that much longer than for the main batteries.

Power, Audio Input and Output Connections

All power and some signal connections are made through a nine-position 0.025" square post connector strip. Orient the module so that the input connector and gain pot are on your left, the power and output connector strip is on your right. The pins, numbered 1-7 from top to bottom are as follows:



Pin 1. = + 48 volts DC. (Phantom Power)
Pin 2. = + E Signal Out
Pin 3. = Signal Ground
Pin 4. = –E Signal Out
Pin 5. = +V Input (+9 to +22V)
Pin 6. = Power Ground
Pin 7. = –V Input (–9 to –22V)

Figure 1, MP-3 Connections

You will notice that both the output and the low voltage supply can be interconnected with standard Benchmark shielded pair pigtails if desired, or the entire set of wires may be soldered to the female mating connector that is supplied with the module. The +,G,– configuration is standard on all Benchmark Media Systems products as it facilitates simple polarity inversion with signal cabling, should it be necessary. It is important to note that phantom

power shares the same power ground with the low voltage supply. That is, the common (or return) of the + 48 V supply must be connected to pin 6 as must the common of the bipolar supply.

Input Connection

The input connection is made directly through the XLR type connector that is mounted to the module.

Setting Levels

It is very important that you carefully set up your system. Set it so that all the gain settings allow the various pieces of equipment and, indeed, every stage within every piece of equipment to reach their clip points at the same time. This is accomplished by taking most of the gain needed from the amplifier stage that has the lowest noise-figure, in this case the MP-3. This is the way to maximize the system's dynamic range. As simple as this sounds, the key to an outstanding system is a setup where *all* points in the chain reach clip at the same time, assuming the rest of the installation is correct.

OPERATION

Once the system has been installed and levels properly set, the only place gain levels should be adjusted is at the MP-3. An exception may be where you would like to "fade to off" between various recording segments, since the MP-3 will not go to a full off condition. In such a case, the gain control of the recorder can be used to fade to "off" and then returned to its original preset position at the beginning of the subsequent recording. Actual level adjustments, however, need to be made at the mic-preamp to ensure optimum dynamic range.

Performance Curves

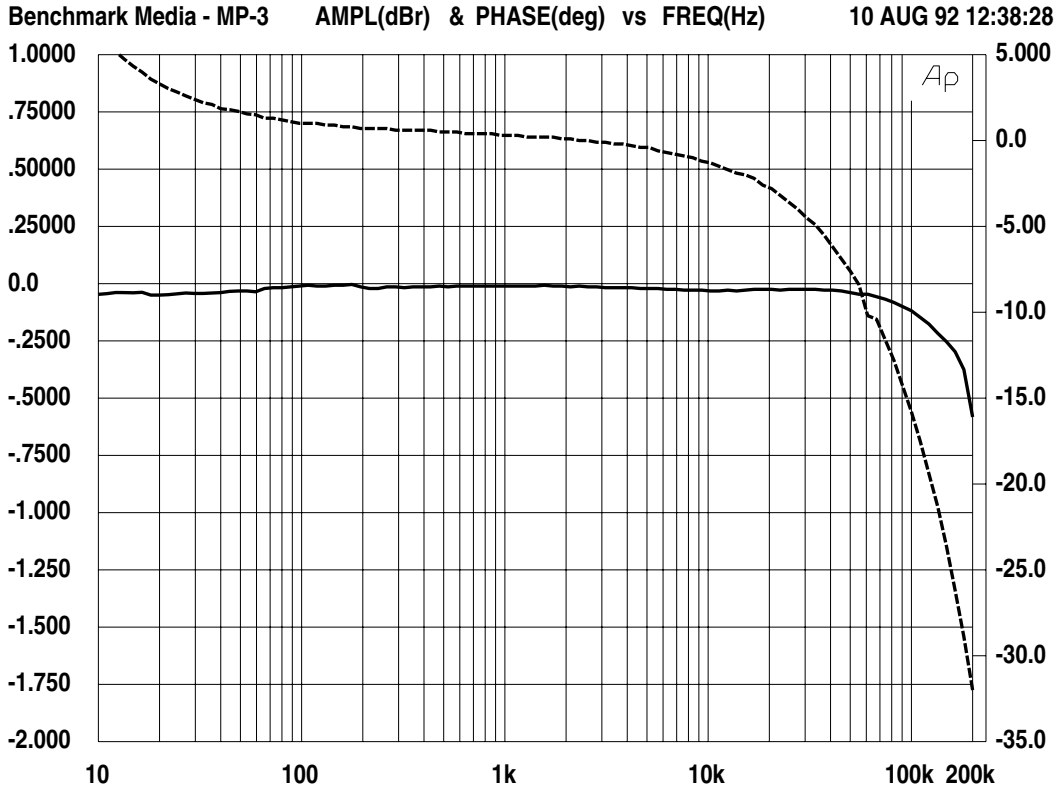


FIGURE 2, MP-3 AMPLITUDE BANDWIDTH

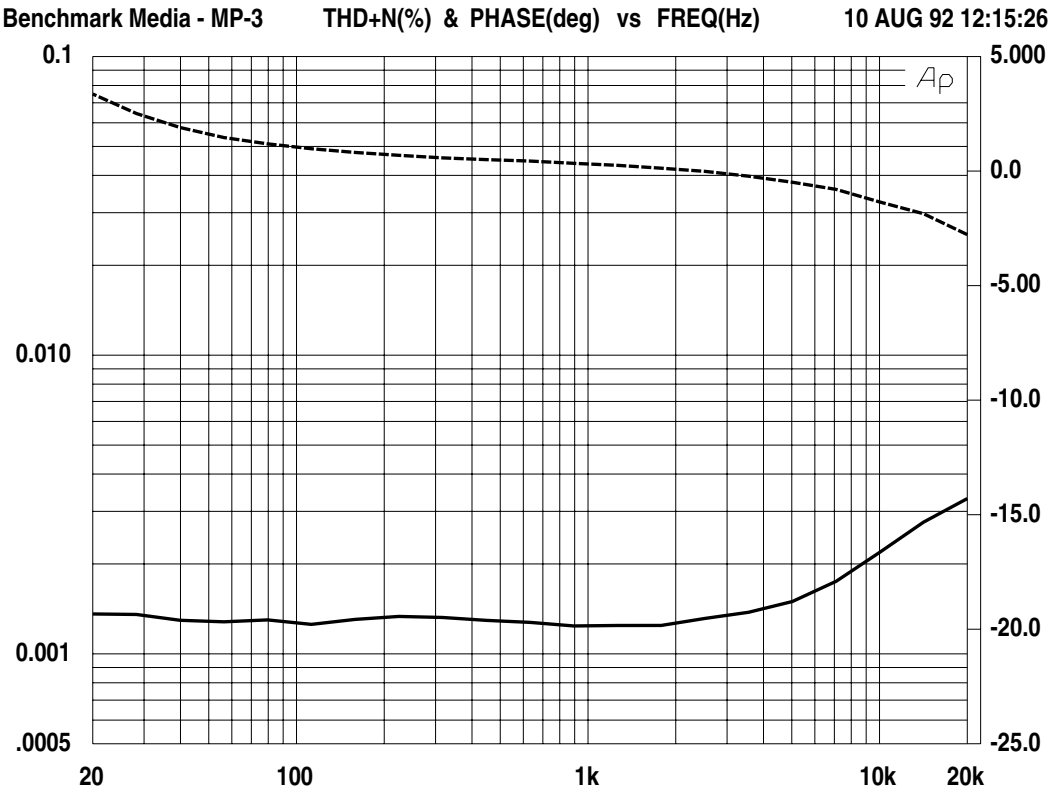


FIGURE 3, TOTAL HARMONIC DISTORTION (80 KHZ MEASUREMENT BANDWIDTH)

NOISE PERFORMANCE EVALUATION

Source Impedance

Specific procedures are necessary for the proper evaluation of noise performance. To obtain the correct noise level measurements, two specific criteria must be met.

[1.] A 150 Ω source impedance and

[2.] A 20 kHz measurement bandwidth.

The preamplifier must have the proper source impedance at its input. If the input of the preamplifier does not "see" the normal source impedance, it will amplify the noise of the parallel combination of the internal 10 kΩ bias resistors and the 6.81 kΩ phantom power resistors. An input termination can be made up with an XLR type connector and the appropriate resistor. Be sure to use a carbon film or a metal film resistor, not a carbon composition resistor. Carbon composition resistors have a phenomenon known as "excess noise," and this will yield a noise figure that is misleading. The noise specifications of the MP-3 are made referenced to a 150Ω source.

Noise Bandwidth

The second criterion that must be met for correct noise evaluation is the limitation of the measurement instrument's bandwidth to 20 kHz, as all the Benchmark noise specifications are 20 kHz bandwidth measurements. If the test instrument that you are using does not have an internal filter for that purpose, you will need to construct a device that will give the same results as a 20 kHz "brick wall" filter. We have available, upon request, an article by Deane Jensen entitled, "A 20 kHz Low Pass Filter for Audio Noise Measurements." If you should need to construct such a filter, this would be a good circuit to follow.

When measuring noise, remember that the output noise of the preamplifier (for gains of ≈45 dB and higher) will be the 20 kHz bandwidth Johnson noise of the source impedance (-130 dBu for a 150Ω source over 20 kHz), plus the amplification of the preamplifier, plus the noise figure of the preamplifier. Therefore, the expected noise floor of a preamp operating @ 50 dB of amplification would be -130 dBu, +50 dB, plus the noise figure of the preamp, which in this case is 1 dB, or = -80 dBu. The only way to achieve lower noise performance is to operate both the microphone (source impedance) and the

amplifier at much lower temperatures, and since we are talking temperatures in degrees Kelvin, the implication is a move toward cryogenic temperatures.

Potentiometer Gain Range

Limiting the gain range of the front panel potentiometer to less than its maximum of +73 dB improves the "setability" of the potentiometer. The 2.7Ω end stop limit resistor may be changed to a higher value. 10 Ω will limit the gain to 60 dB max., and higher values will further limit the gain of the preamplifier.

Additional Points to Note

Whenever phantom power is to be used, it is well to turn it on one half to one hour ahead of time. This allows the full formation of the coupling capacitor's dielectric, which reduces a small noise source that would be generated by leakage currents.

The amplifier, as noted above, may be used for boosting marginal line amplitude signals with minimum output noise. For example, when operated at 30 dB of amplification, the noise output of the module is still -92 dBu (150-ohm source).

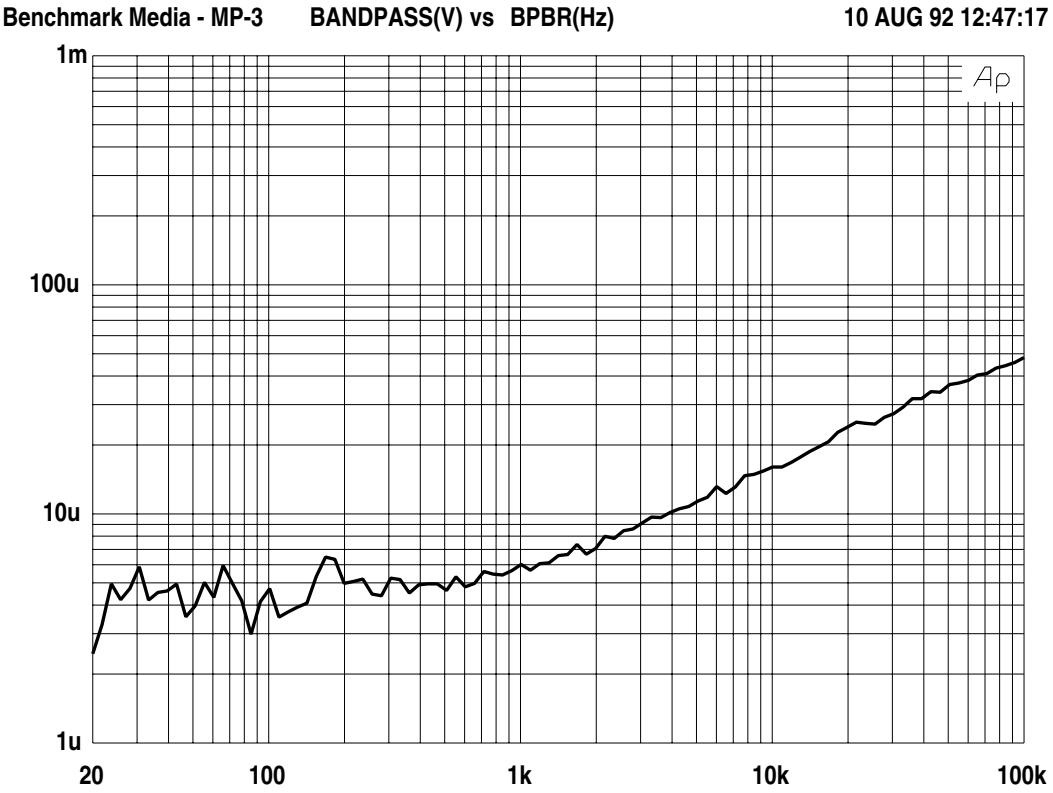


Figure 4, MP-3 Noise Spectra

Since the output impedance of the module is 60 ohms, the length of line that may be driven is three to four times longer than can be driven with a 150 to 200 ohm microphone drive impedance for the same small signal, high frequency cutoff point. For example, almost 2800' of foil shielded cable may be driven with a *small signal*, high frequency cutoff of 30 kHz. Since the output device has a current limit of 40 mA., cable capacitance will be the limiting factor in the actual slew rate at the receiving end of the cable being driven by the MP-3. For this reason, we recommend the use of very low capacitance cable, such as the Mogami 2574. It has a capacitance of 6 to 7 pF/ft between conductors, versus the 30 to 32 pF/ft to be found in most foil shielded cables. Mogami cable is normally available from stock at Benchmark Media. Alternately, Belden makes a data cable that has only 12 pF/ft, and is certainly a better choice than the standard "Audio" cables. See the "Clean Audio Installation Guide" for more information on slew rate limiting due to cable capacitance.

Conclusion

The amplification required for most microphones will typically be 35 dB or greater, and the preamp section will most often be the limiting factor in the output noise of a console or other electronics, before any recording or transmission medium. Therefore, the majority of amplification needed, consistent with desired headroom should be taken from the MP-3, since it has the lowest noise figure of any of the amplifying stages.

CIRCUIT DESCRIPTION

General

The very good performance of the MP-3 is due to careful attention to detail in the circuit design. THD @ A=40 dB, 20 kHz ≈ 0.0035%. The differential bandwidth is >200 kHz at any amplification, thus insuring low phase shift @ 20 kHz and good transient performance. The EIN of the module is approximately -130 dBu, when operated at a minimum A=40 to 43 dB. This is a noise figure of less than one dB.

Input Stage

Following the signal flow through the preamplifier, the input signal first encounters the phantom power circuit, which consists of a pair of 6.81K ohm resistors that feed power to the microphone line. This power is brought in on pin 1 of the 0.025" square post connector strip. Next in line are the input coupling capacitors and the 10 kΩ input bias resistors.

Next we encounter four zener diodes, two on each input leg. The voltages of these diodes are chosen such that the sum of the forward drop and zener voltage is less than the zener turn-on voltage of the low noise input transistors in the SSM-2017. If we are to protect these low noise transistors, then we must prevent them from ever going into their emitter-base zener mode, which destroys their low noise capability and makes the devices more prone to failure.

Next is the low noise active diff-amp, the SSM-2017. This device has an internal topology that is an emitter feedback differential amplifier using ultra low noise transistors. The noise figure of the transistors is ≈ 1 dB, referenced to 150 ohms. Low noise performance is obtained because no series input resistors are used before this device. By coupling the input signal directly to the bases of the input transistors, the only noise producer in the signal path is the intrinsic base resistance of the transistors. The source resistance of the transducer becomes the major noise producer. The variable resistor between the transistor's emitters and internal feedback resistors set the amplification of this stage

Output Stage

The output uses a dual op-amp, the NE5532. The inverting amplifiers provide the lowest common mode distortion. The 22 pF feedback capacitor allows the amplifier to maintain a high degree of RF immunity while providing for minimal additional phase shift.

The DC offset voltage from the output amplifiers of the MP-3 is typically less than 2 millivolts. Additionally, if the amplifiers will never be used with condenser microphones where phantom power is needed, then the phantom voltage isolating caps may be bypassed. However, the capacitor that couples the first IC to the output chip may not be bypassed, as there will always be a DC voltage across it, ranging from between just a few millivolts to 0.2 Volts.

This completes the MP-3 circuit description. 062502

1) Low Noise Electronic Design, C.D. Mothchenbacher & Fitcher, 1973, John Wiley & Sons, Inc., ISBN 0-471-61950-7

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