BENCHMARK MEDIA SYSTEMS, INC.

The MicroFrame™ Series Instruction Manual

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1.0 Introduction

1.1 The MicroFrame™ Series

The MicroFrame™ Series consists of a modular rack mount chassis that is only 1 Rack Unit high. The rack mount chassis in turn houses 16 modular amplifiers, with front panel access, and two power supply electronics modules. The amplifier modules are ≈ 0.8" wide and the power supply modules are ≈ 2" Wide, providing a total of 18 modules in a 16.8" wide chassis that is only 13 inches deep. The very high density utilized with the MicroFrame™ Series provides for some of the most cost-effective use of real estate in the industry.

1.2 The MF-1

The MF-1, a single rack-unit modular frame, is designed to house two power supply modules, sixteen amplifier modules. This arrangement provides a redundant power configuration from a common power transformer and power entry module. The IEC type power entry device at the rear of the frame is a combination line filter, mains voltage selector (120-240 volt 50/60 Hz operation) and power plug, allowing all international power cords to be used.

Audio interconnect to the MF-1 is accomplished by one of two methods. If the frame was purchased with IO connectors at the rear of the frame, wiring and connecting the connectors to the frame achieves this goal. If the MF-1 was not purchased with IO connectors at the rear of the frame, the connector plate at the back of the frame is removed and connectorized audio wires are plugged directly onto the backplane/mother board. 0.025" sq. posts are provided on the backplane with three ports to each amplifier module position. Pre-Connectorized wire assemblies are available. These assemblies consist of latching and polarized three-position Molex® SL housing and pins attached to a length of #22 standard shielded pair, or #24 Mogami ultra flexible wire, ready for your multi-pin connector at the rear of the chassis.

The MF-1 is finished with a high quality, black powder-coat. The nylon card guides and the edge card connector, forming a secure arrangement suitable for mobile environments, hold the modules in place.

1.3 Modules

The plug-in modules have attached front panels that correspond to the module itself, and form a contiguous attractive front view of the frame. The finish on the panels is the same black paint with white silk-screen graphics. Each module has a small, extruded aluminum handle that has a bright anodize finish, and provides an ideal location for attaching labels as to the use of the module. Blank modules are available for unused amplifier positions. An extender board is also available.

1.3.1 The PS-2

The PS-2 is the power supply module for the MicroFrame™ Series. It provides a linearly regulated bipolar (±) 15 volts, at a maximum of 1.2 amps, to power the system. Linear regulators are used to ensure ultra low-noise amplifier performance. Two power supply modules are needed for each MF-1. The module has combining diodes at the output to the backplane allowing redundant regulator operation. The MF-1 uses a common power transformer and power entry module to feed the two PS-2 power supply modules. Individual voltage trim potentiometers are provided to allow for load balancing between the two supply modules. The power supply regulator modules have transformer secondary fuses to isolate them from the transformer, in the highly unlikely event of a catastrophic failure in one of the modules.

Operation of the MicroFrame™ Series should include forced air cooling, as 80 watts of power may be dissipated by the system. Operation without forced air is permitted for short time periods, but regular operation without forced air, is not recommended.

1.3.2 The LA-1 Line Amplifier

The LA-1 is one of a series of very high performance audio amplifier and processing modules, a product line known as the MicroFrame™ Series. It is characterized as a one in, two out line/distribution amplifier with front panel variable gain from + 20 to - 20 dB. Unity gain has a center detent position on the potentiometer. The input to the amplifier is a common mode filter that ensures very high rejection to common mode RF energy. The filter in turn feeds an instrumentation amplifier with a gain of -6 dB. Common mode rejection of the instrumentation is approximately 100 dB out to 3 kHz and 75 dB at 20 kHz. The variable gain stage follows and has active adjustment of the amplification for the most optimum noise performance. A trim potentiometer allows the detent position of the front panel gain potentiometer to be set precisely at Unity.

The module has a balanced output section that utilizes a new current boost integrated circuit, that in and of itself is almost totally free from crossover distortion. However when placed in the feedback loop of a NE5532, it provides all of the very desirable qualities of the op-amp but with 300 mA of output current capability. This is essential for driving long capacitive transmission lines. This high output current capability allows 150-Ω power matched transmission lines to be driven to + 26 dBm, or higher, at very low THD. Each LA-1 has two 60-Ω outputs (unless the module was ordered specifically with a different output impedance, such as 150-Ω). The output stage gain is +6 dB. Input and output clip points, at unity gain, are +26 dBu. The bandwidth is greater than 200 kHz for excellent transient and square wave response, without overshoot or ringing, low phase shift at 20 kHz (- 8°), and yet still providing outstanding RF immunity. On board fuses assure the continued operation of the system in the highly unlikely event of a catastrophic failure on an amplifier module.

A bi-colored signal indicating LED provides a green indication when a signal of a pre-determined threshold is present, usually the house reference level, and a flashing red/green indication when the module approaches overload at the output. The threshold for the peak indication is factory set to trip at +20 dBu, but may be set at any level from ≈ +16 to ≈ +26 dBu. The signal presence threshold is adjustable from - 10 dBu to +8 dBu, average, (-2 to +16 dBu peak) and is factory set at -10 dBu (-2 dBu peak).

2.0 Unpacking

Care has been taken in packing the LA-1 modules to assure that they will withstand normal shipping conditions. Examine the equipment carefully, as it is unpacked. If the shipping carton appears to have been damaged and there are signs of physical damage, check the equipment and immediately notify the carrier and Benchmark.

3.0 Installation

For basic installation concepts follow the “Clean Audio Installation Guide”, by Allen H. Burdick, a Benchmark Media Systems application note located at the back of this manual. Specifically, for the LA-1 module it is a simple matter of plugging the LA-1 into the MF-1 one RU modular frame, providing the desired connections at the backplane within the chassis, and finally powering the chassis.

3.1 Input Connections

Input to the board is made at the bottom three-pin header post on the backplane of the MF-1 labeled “Input”. The input impedance is 20-kΩ (balanced), or 10-kΩ unbalanced.

When feeding the inputs from an unbalanced source it is well to treat the signal as though it were in fact a fully balanced signal. This should include wiring, patch bays, etc., right up to the output of the unbalanced equipment. At that point the “low’ (black) wire is connected to the "ground" of an RCA type connector, for instance. The shield is not connected to ground at the receive end, but is connected at the send end. Additionally a star ground is used to tie all pieces of equipment together separately from the cables shield wires. See the sections that deal with Grounding and Forward Referencing in “A Clean Audio Installation Guide”. Wiring in this manner will reduce the common mode differences between pieces to a minimum and ensure that the excellent common mode rejection of the LA-1s input amplifier is able to reject residual power related differences between it and the send equipment. The only difference between this and a balanced output is that the “low” input side is tied to the “low” output of the balanced output.

Modules may be removed and inserted into the MF-1 while the frame is powered. When pulling a board while the frame is powered, there is usually no audible disturbance in the outputs of the other boards. However, when inserting a module into a hot frame, the inrush currents that charge the power supply filter caps may produce a small “tick”, much like a scratch on a record, that is generally not considered objectionable, and often not detectable in the presence of an audio signal.

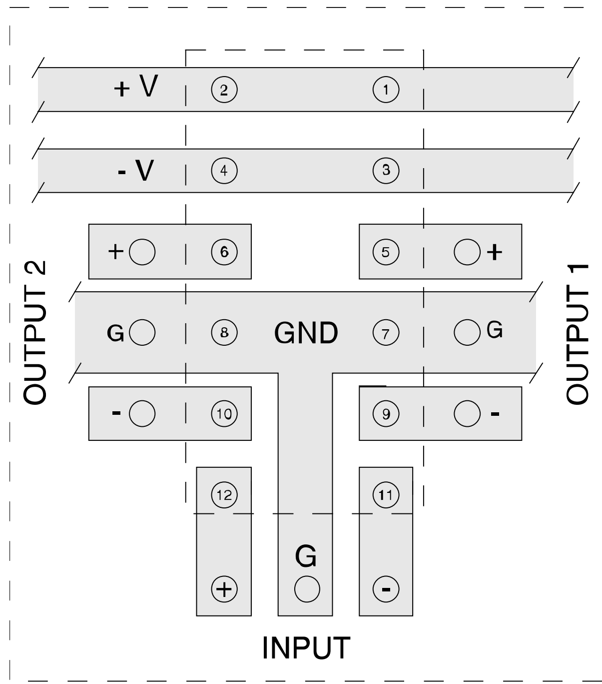

Figure 2.0, LA-1 Connector Pinout

3.2 Output Connections

As a distribution amplifier, the module has two sets of build out resistors that provide the two balanced outputs. When viewed from the back of the modular frame, the outputs are to the left and the right of the edge card connector, with the exception of module position one, (the extreme rightmost position when viewed from the rear of the chassis). It has one of its outputs in the center of the edge card connector. Feeding balanced inputs is done as normal. However when feeding an unbalanced input only one output leg and ground must be used. Do not use the second output pin. Care must be taken not to short one of the amplifier's outputs to ground. An output line shorted to ground will draw very high currents and produce overheating of the output amplifier. This will not cause catastrophic destruction of the output since current limiting is provided within the stage, but it will produce sever distortion at the chosen output.

!!! Warning !!!

Do not ground either side of a balanced output when feeding an unbalanced input. This active output does not have a transformer, nor is it of the quasi-transformer type active outputs. Grounding an output will cause severe distortion and overload of the amplifier module.

Three position Molex SL connectors should be used to mate with the 0.025" square posts on the backplane for all signal inputs and outputs. Alternately the connections may be made by wire wrapping to the 0.025" square posts.

3.3 Connector Assembly

In the assembly of connectors, be sure that the drain wire of the shielded pair is physically located as the center pin of the three-pin housing. Benchmark currently sells Molex® SL terminals and housings as well as the pre-connectorized cables. These assemblies are made up as three pin connectors. The three pin audio signal connectors with this wire arrangement, have the advantage of being able to be physically inverted, causing a polarity inversion of the signal. This of course is accomplished because ground (shield) has been specifically placed at the center pin of the assembly.

The following are part numbers for the recommended Molex connector parts.

2 pin housing	50-57-9002
3 pin housing	50-57-9003
Individual pins	16-02-0102
Crimp tool	11-01-0118

Follow the directions that came with the crimp tool you purchased for the specifics of the connector pins to be used.

4.0 Specifications

Input Section:

Type -	Instrumentation type Input with a Common Mode Filter
Com Mode Filter -	Differential mode bandwidth - >500 kHz, Common mode bandwidth - 26 kHz 2 pole LC filter > 60 dB attenuation @ 1 MHz
Input Impedance -	20 kΩ balanced, 10 kΩ unbalanced
CMRejection -	100 dB @ 2 kHz typ, 80 dB min, 75 dB @ 20 kHz typical, 60 dB min
Input Stage A = -6 dB	

Gain Stage:

Gain Range -	-20 dB to +20 dB with a center position detent at the unity gain position

Output Section:

Type -	Active balanced ground referenced output with current boost
Output Impedance -	60 Ω, 150 Ω or 600 Ω on special order
Output Current -	300-mA peak per output leg
Output Stage A -	+6 dB
Quantity -	Two (2) outputs per module
Differential Phase -	0.5° @ 20 kHz max, 0.35° typical

Metering:

Type -	Bi-color LED.
Signal Presence -	Green, threshold range = -2 to +16 dBu tone setup, -10 to +8 dBu with program material.
Peak Overload -	Flashing Red/Green, threshold Range = +16 to +26 dBu tone setup.

Overall:

Unity Gain THD -	0.005% 20 Hz - 20 kHz @ +24 dBm into 150 Ω max. 0.0015% typical (Measurement filters = 22 Hz and 80 kHz)
20 kHz Ø shift -	10° max, 8° typical
Bandwidth -	200 kHz min., 240 kHz typical
Unity Gain Noise -	-100 dBu max, -104 dBu typical
Noise @ A = 20 dB -	- 80 dBu max, -84 dBu typical
Supply Current -	60 mA Quiescent max, 55 mA typical, 70 mA max with LEDs flashing, 65 mA typical
Slew Rate:	8 V/µSec

5.0 Operation

Operation of the LA-1 is of the greatest simplicity. A signal is brought to the input of the module, and output audio is taken from one or both of the output ports. The amplification of the module is adjusted to yield proper levels at the equipment that is being feed. No further adjustments are necessary.

!!! Notice !!!

The LED "meter" signal pick off point is after the gain stage. This is for the easy detection of clip when excessive levels are at the output of the amplifier. Since up to 20 dB of amplification is available at the front panel of the LA-1, it is quite possible to reach clip levels when input levels are normal and high gain is taken. The flashing LED will prevent this condition, with the assistance of the operating engineer.

It is very possible to have input levels that will cause the input stage to clip (greater than + 26 dBu peak), and not see the problem with the flashing indicator. This will happen when the input levels are too high, the operator takes a reduction in amplification at the LA-1 to provide the proper levels to subsequent pieces of equipment. At this point the input stage will be clipping but the subsequent stages are not and there is no indication of clipping at the front panel of the LA-1.

Therefore, whenever large amounts of gain reduction are taken, (greater than 8 to 10 dB), care must be exercised to ensure a signal level at the input of the LA-1 whose peaks do not exceed +26 dBu. This is particularly true with live program material that has not had any compression or limiting. Doing this will ensure freedom from clipping in the input stage of the LA-1.

6.0 LA-1 Circuit Description

6.1 Overview

It will be helpful to refer to the module schematic and component assembly while reading the description of the module's circuitry.

The LA-1 consists of an instrumentation input stage, a gain stage, a signal detector with indicating LED, and a current boosted output stage with two sets of build out resistors.

6.2 Input Stage

The first element in the input stage is the capacitive input that isolates incoming residual DC from the remainder of the amplifier module. The sections of coupling caps have two devices in parallel, a single aluminum electrolytic that allows extremely low frequency response, and a large film capacitor that has very excellent high frequency characteristics. Together they serve the entire audio band and beyond without parasitic anomalies, such as dielectric absorption.

6.2.1 Common Mode Filter

The common mode filter, is the next section of the input stage. It virtually eliminates RF interference present on the balanced incoming audio. The common mode filter consists of a 38-mH common mode choke, two 1000 pF capacitors and two 10 kΩ terminating resistors. This yields an LC filter which provides the preamplifier with the ability to work in very high RF environments.

The common mode choke itself consists of a highly symmetrical dual winding on a common toroid core with an inductance of 38-millihenrys per leg. The operation of the choke is such that with a differential signal the magnetic fields created by the two highly symmetrical windings will cancel one another. This results in a net inductance of zero for differential signals, but a 38-mH inductance for common mode signals. The choke, the 1000 pF capacitors, and 10.0 kΩ termination resistors form a two pole Butterworth low pass filter whose corner frequency is 26 kHz with a 12 dB/octave roll off. Common mode signals are attenuated greater than 60 dB @ 1 MHz.

6.2.2 The Input Buffers

The next element in the chain are two unity gain buffer amplifiers. The 10-kΩ terminating resistors of the filter also serve as input bias current sources for the two buffer amplifiers that follow next.

6.2.3 The Differential Amplifier

The buffers drive a precision differential amplifier. The differential amplifier is configured to take a 6-dB loss to maximize the headroom that is available with the relatively low voltage power supplies. A unity gain operational amplifier will clip at ≈ +21 dBu out, (11.2 volts) using +/-15 volt power supplies. Since the input signal to the LA-1 is usually balanced with respect to ground, the pair of buffers, differentially, are capable of 6 dB more output than one amplifier by itself (with each input buffer handling the above mentioned +21 dBu). However, the differential stage is not capable of handling ≈ +27 dBu and, therefore, we must take a 6 dB loss at this point if we want the system input overload point to be +27 dBu and have all stages reach clip simultaneously. Simultaneous clip of all stages is necessary for optimum signal to noise ratio. The 6-dB loss works out fine because we pick up the 6-dB gain lost at the input with the balanced output stage configuration. What all this means is that, internal to the module, the operating signal level is 6 dB lower than at the input or at the output. I.e. with a balanced input level of +8 dBu, the operating level within the module is -2 dBu. When feeding the module from an unbalanced source, however, the input clip point is no longer +27 dBu because only one buffer amplifier is actually passing signal. All of the above assumes that the gain is set at the detent unity position. Signal to noise will degrade when gain or loss is taken at the front panel control.

The differential stage has trims that allow for a very high degree of common mode rejection. These trims are adjusted with an input signal level of +10 dBu. The resistive trim and the capacitive trim are both adjusted at an input frequency of 2 kHz. The typical null is a -100 dB out to 2 kHz rising to 75 dB at 20 kHz. This null can be expected to deteriorate by as much as 15 dB under temperature variations.

6.2.3.1 CMR Adjustment

The factory set common mode rejection trims should never need to be readjusted. This is a passive bridge, and normally the characteristics of the operational amplifier used do not affect the accuracy of balance on this bridge. When replacing the operational amplifier, therefore, we strongly recommend that you measure the common mode rejection before making any adjustments to those trims. Then if adjustment is necessary, it should be performed at, or as close as possible to, the actual ambient operating temperature.

The process of nulling the common mode rejection must be performed with the gain potentiometer set at its center unity (detent) position.

1. Feed an unbalanced signal with a level of +10 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, ties to ground.

2. Send a 2 kHz signal to the input and adjust the resistive portion of the Diff-amp Bridge for a minimum audio output from the LA-1. Use either a logarithmic level meter with sensitivity to below -100 dBu such as the Audio Precision System-One, System-Two, or some other sensitive linear meter. It is usually very helpful to watch the output of the meter 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 on the resistive trim has been achieved, null the capacitive trim. Two or three iterations between these trims should be sufficient to achieve the best broadband null possible. A null of better than 110 dB to 2 kHz, and better than 85 dB at 20 kHz is usually achievable, but most likely will not remain stable due to temperature drifts.

6.2.4 Common Mode Voltage Range

It is important to keep in mind that, while the input is a very high performance differential amplifier, but it is not a floating input; that is, it is ground referenced. This means that unlike a transformer input there is a relatively low limit on the amount of common mode voltage that the circuit can handle. Practically, we would suggest that a limit of two to three volts be the maximum common mode voltage allowed at the inputs. Also keep in mind that any common mode voltage will reduce the headroom by the difference between it and the maximum output level. For this reason, it is important to read and digest the Benchmark application note "A Clean Audio Installation Guide". In rare situations where the installer has no control over the common mode voltages present at the input of the amplifier, as with some Telco feeds, a high quality input transformer will need to be added to the installation. We recommend those manufactured by Jensen Transformers.

6.3 The Gain Stage

For normal operation, the gain stage is operated at the detent unity position. The gain of the LA-1 of course is variable, with its gain determined by front panel amplitude control. The front panel control allows an overall gain range for each module of from -20 to +20 dB. As mentioned before, for best system headroom and S/N ratios unity gain should be selected.

For the best system performance, each piece of equipment in the chain should be setup to operate at the chosen house reference level. The LA-1 should only be used to correct for occasional level anomalies. Operating the module with input levels that are higher than your system reference and taking a gain reduction at the variable gain stage will reduce your system headroom. Operating with input levels that are lower than your system reference and increasing the amplification will bring up the noise floor and thus reduce the possible signal to noise ratio of the system. For optimum system performance set up your system so that every stage of every piece of equipment reaches clip simultaneously.

6.3.1 Gain with Power Matched Systems

The LA-1 was designed to be use as a part of a voltage-sourced system. As such unity voltage gain is achieved with the front gain potentiometer in its center detent position, and the output of the amplifier feeding a high impedance input stage. Under these conditions the input and output clip points will be +26 dBu or slightly higher, where 0 dBu is 0.7746 AC volts (RMS). If the LA-1 modules were purchased with other than 60 Ω output impedance, i.e. 150Ω for use with a power matched system, the output voltage will not be the same under power matched conditions. When utilizing a 600 Ω or 150 Ω power matched system the output voltage at the unity gain position will be 6 dB lower that the input, that is +20 dBm output, yields a +26 dBm input, assuming a proper line terminations. This is due to the voltage divider effect that takes place between the output impedance of the LA-1 and the load or termination of the transmission line.

6.4 The Signal Indicating LED

The Signal indicating LED is a bi-colored LED 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 NE5532 are used as voltage comparators, and both have hysteresis built into their circuits.

The signal presence indicator uses one half of the NE5532 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. A single MMBD4148 small signal diode operates as a half wave rectifier. The turn-on threshold of the diode is precisely at the lowest DC voltage represented by the lowest signal level detection limit. This is serendipitous in that it permits implementation of a half wave rectification without the high parts count required by active circuits. 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 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 resistor string R, R, R, and D determine the trip point. When the inverting input signal rises above ground potential the comparator trips. R 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 non-inverting 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.

All of the circuitry of the signal indicators is high impedance and has no measurable effect on the audio signal quality.

6.5 The Output Amplifier

The output amplifier stage consists of a NE5532 dual operational amplifier, each half of which drives a current boost stage. The current boost stage is an LM6321 unity gain buffer amplifier that has a 50 MHz bandwidth, a 500 V/µSec slew rate, and a 300 mA output current capability. This performance provides a very low phase shift in the current boost stage, which in turn protects the phase margin of the op-amp driver once the loop is closed. The buffer itself has an excellent output stage design that is virtually free from crossover distortion, prior to being enclosed within a feedback loop, and has almost perfect performance when placed in a loop. Its high current capability allows two output splits to be taken from the low impedance point of the amplifier. The current boost buffer will run warm to the touch with out a load and with a heavy load it will be hot, that is over 135° F. This is not a problem, as the device will withstand temperatures up to 100° C and above.

This completes the LA-1 circuit description.

7.0 PS-2 Circuit Description

The PS-2 modular power supply unit is designed to provide 1.5 A of continuous current to the electronics of the MF-1. It is designed to operate with a second module of the same type in a semi-redundant configuration. The semi-redundant operation comes from the fact that these two modules use the same input power transformer, power entry module, and voltage select switch.

7.1 Input Section

The supply module consists of two secondary fuses to isolate the power module in the unlikely event of a catastrophic failure in one of the modules. These fuses are rated at 3 A, and have a "normal" blow time. A 1.5 A bridge rectifier follows the fuses for the conversion of the AC input voltage to a pulsating DC. 4700µF capacitors filter the voltage before it goes to the voltage regulators.

7.2 Regulators

The PS-2 uses TO-220 linear regulators. The LM317 is the positive voltage regulator and the LM337 is the negative regulator. Both of these regulators are adjustable. The output voltage is easily set with their respective trim resistors. The output voltage is set at ≈15.0 volts at the regulator or 14.3 volts after the combining diodes at the backplane. The 10 µF tantalum capacitor that connects from the control pin on each of the regulators filter the supply output further for low noise and ripple. These capacitors also help lower the output impedance of the regulator at high frequencies.

Diodes that connect from the output of each of the regulators to the input pins provide a discharge path for the capacitance of the entire MicroFrame™ Series in the event of a sudden loss of power to the regulators. Resistor R1101 and D1101 in the positive sup ply, and D2101 and R2101 in the negative supply make up the front panel indicator circuits. Capacitors C1204 and C1203 add to the stability of the regulator and further decrease the output impedance of the circuit. As previously mentioned, each of the power modules has combining diodes to allow the two regulators to operate in a semi-redundant configuration. These diodes isolate the supply in the event of a failure of one of the regulators. These combining diodes are D1201 and D1202.

7.3 Adjustment Procedure

Since the module is designed to operate with redundant regulators, it is well to adjust these regulators to force the two modules to share the load as equally as possible. The advantage of doing this is to reduce the operating temperature and subsequent stresses of the circuitry and thus increase its potential life.

This adjustment is very simple to perform. A 30 Ω load is necessary to force the supplies to operate at, or close to 1 A. Better than a 30 Ω load would be an adjustable active load that can be precisely set to operate at 1.0 A. The purpose of operating at 1 amp is to bring the voltage drop of the combining diodes into play and adjust the output with them in series. If the supplies are then adjusted to a precise 14.500 volts at the backplane, they will share the load very well. In practice the setability of the potentiometers prevents setting the outputs closer than ≈ ± 5 mV of the 14.5 volt figure.

Place the load directly between the ± outputs. If you are using an active load, adjust it for

1.00 amp current sink. Next adjust the positive regulator for precisely the 14.500-volt output. Check that the active load did not change its current sink value. Next adjust the negative regulator for precisely -14.500 volts. This completes the adjustment of the PS-2.

All of the PS-2s that leave the factory are adjusted for approximately ± 14.3.

This completes the PS-2 circuit description.

8.0 Service

During the normal warranty period, any defective unit may be returned to the factory for servicing. Any soldering or de-soldering to the printed circuit boards will void the warranty. The following information is provided for after warranty repairs only.

8.1 Troubleshooting Techniques

Armed with the knowledge of the circuit descriptions given above, standard trouble shooting techniques should be used to determine first the general area of a malfunction, and then more specifically the actual offending components. A review of the most basic of these techniques follows.

1. It is best to trouble shoot a module at a workbench using current-limited lab power supplies. Set the current limiting of the power supplies to 100 mA. This will protect the module and still allow the location of failures to be made.

2. Since most failures are catastrophic in nature rather than a gradual degradation of performance, make a close visual inspection of the module for any discoloration of components and possible shorts on the PC board itself. Discoloration would indicate excessive heat, most likely from a component failure. Remove any component that has obviously failed, i.e. carbonized resistors or IC packages that are cracked, etc. A stereo optical magnifier such as the "OptiVisor" will allow close inspection of the module and rapid identification of physical problems.

3. If fuses are blown, replace them and power up the module. If there are short circuits on the module the current limiting of the power supplies will prevent any further failures. The current limiting of the power supplies will show the presence of a short. If this occurs, allow the supplies to run at their preset current limit. Look for any components that are operating hot to the touch. This will show where the shorts are when there are no visual symptoms.

Typically one can just keep their hand on a surface at 130°-135° F. (≈ 40° C) When in the modular frame, no component should run with a temperature beyond which one can comfortably keep their finger. There is one exception, that of the output buffer amplifiers. However it should be operated on the test bench without a load, and thus at a relatively cool temperature.

4. Remove any components, i.e. transistors or integrated circuits that are experiencing overheating. Most often at this point the power supplies will come out of current limiting, and the module will function, at least in part. If further problems exist after the power supplies come out of current limiting, they can most often be found by performing voltage checks through the circuitry.

8.2 Through-Hole 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. 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 or by observing when the component lead moves about freely. 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 against the board, but without applying pressure to the pad, you are able to most thoroughly remove solder in the plated-through hole. In turn the component will often drop out of the board when you are finished. If you push the tip against the board, it will often rip the pad loose from the board.

!!! WARNING !!!

If the solder is not thoroughly removed from the plated-through hole, attempting to remove the component will bring with it plating from inside the hole. This may destroy the usefulness of the board. If you find that your attempt to completely remove the solder from the hole and pads has failed, do not attempt to re-heat the area with the de-soldering tool, as this will overheat the pad, and not 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.

8.3 Circuit Board Re-Soldering

NASA has developed an effective technique that ensures highly reliable hand 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 two or three 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.

9.0 Warranty

Benchmark Media Systems, Inc. warrants its products to be free from defects in material and workmanship under normal use and service for the period of five years from the date of delivery. This warranty extends only to the original purchaser. This warranty does not apply to fuses, lamps, or batteries, or any products or parts which have been subjected to misuse, neglect, accident, attempted owner or third party repair, modification or abnormal operating conditions.

In the event of failure of a product under this warranty, Benchmark Media Systems, Inc. will repair at no charge the product returned to its factory. Benchmark Media Systems, Inc., may, at its option, replace the product in lieu of repair. If the failure has been caused by misuse, neglect, accident, attempted owner or third party repair, modification or abnormal operating conditions, repairs will be billed at the normal shop rate. In such cases, an estimate will be submitted before work is started, if so requested by the customer.

The foregoing warranty is in lieu of all other warranties, expressed or implied, including but not limited to any implied warranty of merchantability, fitness or adequacy for any particular purpose or use. Benchmark Media Systems, Inc. shall not be liable for any special, incidental, or consequential damages.

A return authorization is required when sending products for repair. They must be shipped to Benchmark Media Systems, Inc. prepaid and preferably in their original shipping carton. A letter should be included addressed to the customer service department, giving full details of the difficulty.

This completes the MicroFrame™ Series service instructions.

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