BENCHMARK MEDIA SYSTEMS, INC.

RS-414 Mixing/Routing Switcher Module Instructions

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1.0 INTRODUCTION

The RS-414 Mixing/Routing Switcher, a module from the System 1000 series, provides a unique solution to the need for a small routing and mixing system. Quality materials, advanced circuit techniques, innovative design, and precise construction are combined in the RS-414 to provide the highest quality performance with maximum reliability.

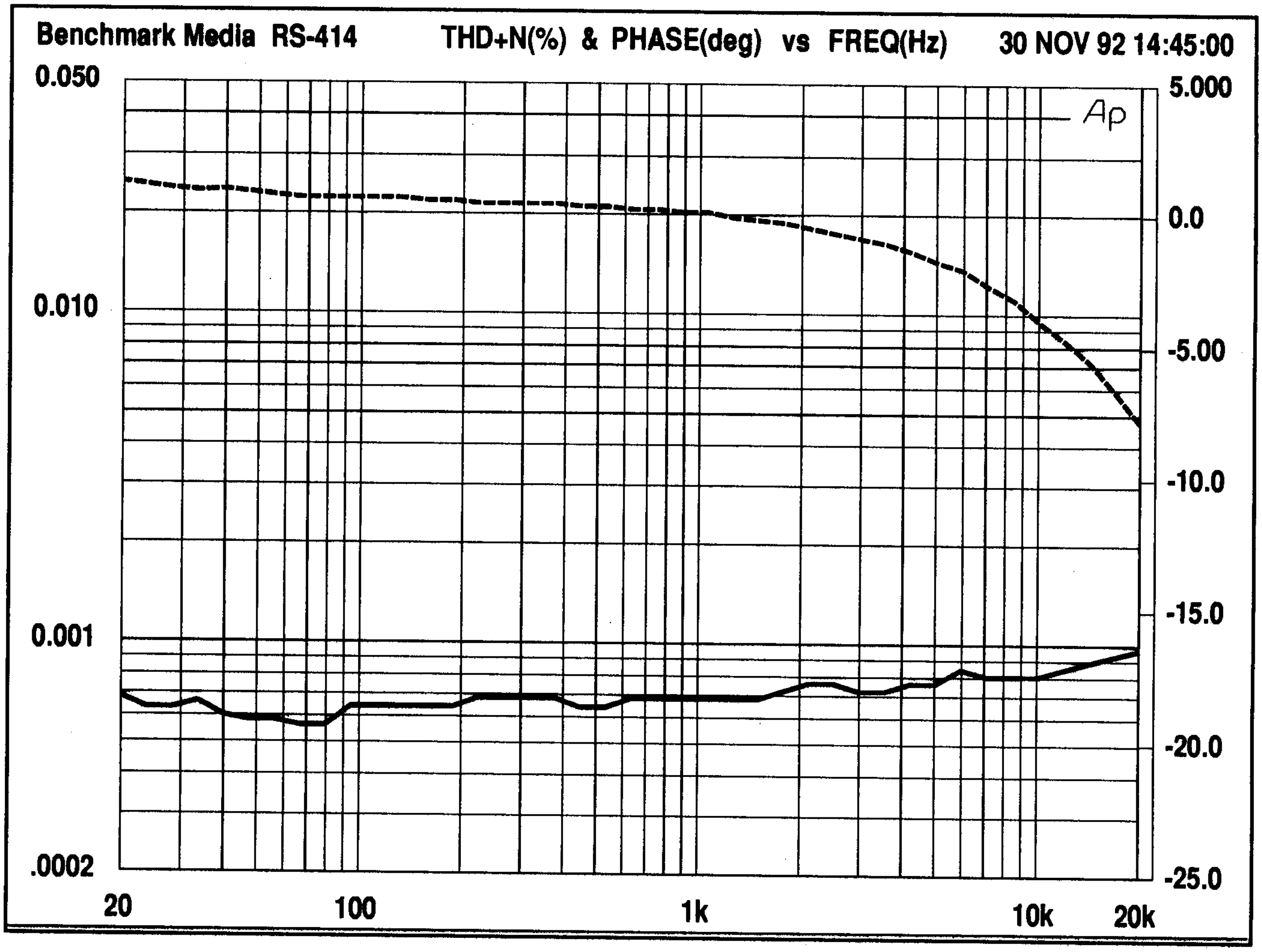


Fig. 1 - Typical RS-414 Total Harmonic Distortion and Phase

Innovative design makes the RS-414 a truly universal interface element. Modular construction allows the optimum combination of System 1000 modules to be determined by the user. As your needs expand, the System 1000 expands with you.

2.0 GENERAL DESCRIPTION

The RS-414 is highly flexible, with many applications that are not necessarily apparent. In order to obtain maximum benefit from your investment, it is strongly suggested that you first read the "Application Examples" section of this manual.

The RS-414 consists of four completely independent input sections, each with its own differential amplifier input stage. There are four output stages and 16 crosspoint switches. Each stage will now be described.

The RS-414 provides two active differential inputs with high common mode rejection. Due to the use of balanced inputs and input connectors that may be physically inverted, the polarity of one or all input channels may easily be reversed.

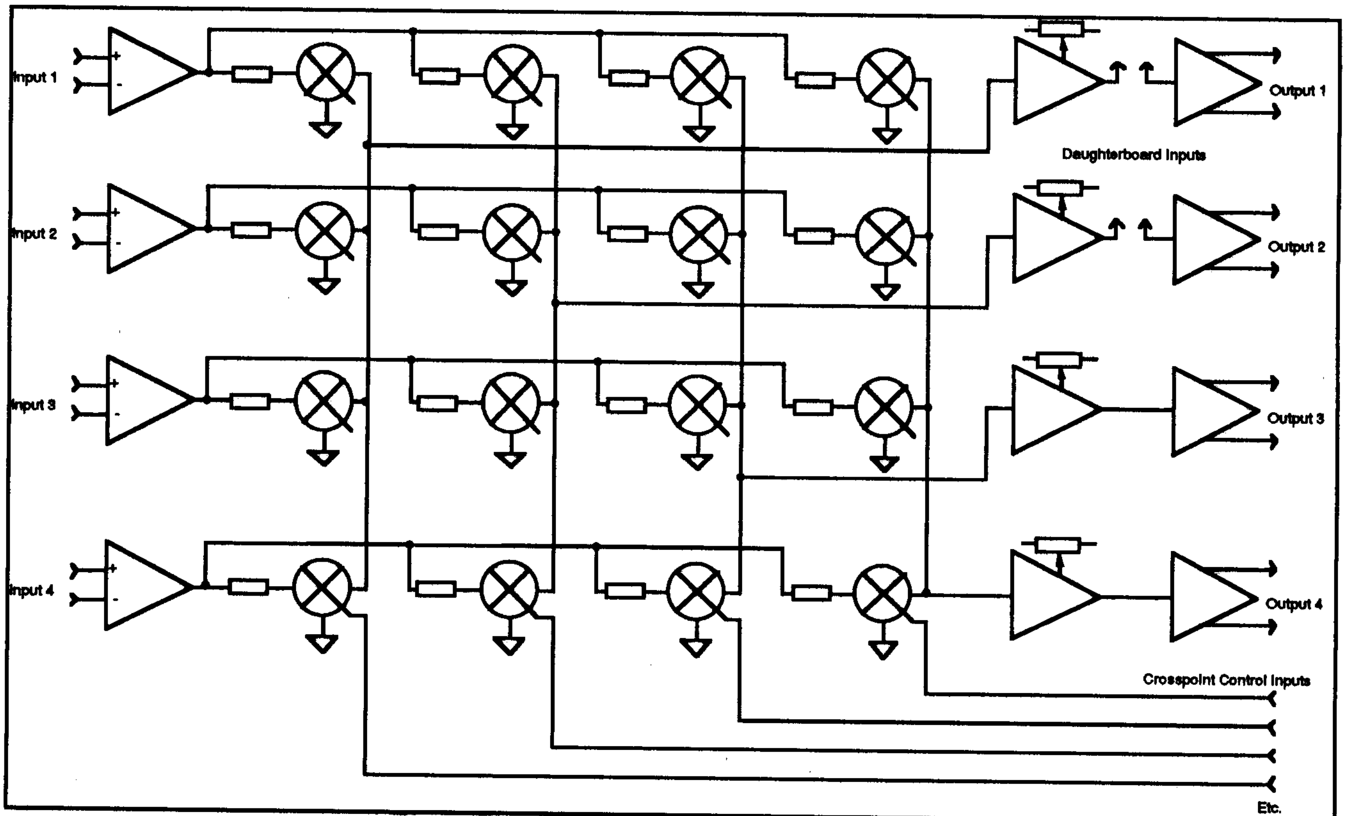


Fig. 2 - RS-414 Block Diagram

Each input stage directly feeds four 13.3 kΩ resistors at the input of the crosspoint switches. The switches act as a current switch, and are located at the summing node of an operational amplifier. The output of the crosspoint switches are tied together and form a current summing bus. This summing amplifier has variable gain to provide adjustment for the natural voltage addition that occurs with the summing of signals. The gain is adjustable from +0.5 dB to -9.5 dB

A 12 step green and yellow LED bargraph provides level indication of selectable measurement points within the RS-414. The calibration of the meter may be set at either 0, +4 or +8 dBu, depending on the house reference level. In addition to the bar graph display, a red

LED peak responding onset-of-overload indicator continuously monitors input and output levels for potential clipping. Its threshold is normally set at + 20 dBu, 7 dB below peak clip, but may be set over the range of +16 to + 26 dBu.

The RS-414 is designed to accept plug-on "daughter" boards for insertion of optional gain control or other processing at the input to output stages one and two. For additional information on daughter board connections, their application and availability, contact Benchmark Media Systems.

3.0 Unpacking

Care has been taken in packing the RS-414 modules to withstand normal shipping conditions. Examine the equipment carefully as it is unpacked. If the shipping carton appears to have been damaged or if there are other signs of physical damage, check the equipment and immediately notify the carrier and Benchmark Media Systems, Inc. Please check all portions of the packing material for installation accessories and manuals. Filler boxes are often used to ship interconnection pigtails, instruction manuals, rack mount accessories, and small tools and fuses.

4.0 Installation

The installation of the RS-414 is a simple matter of installing the System 1000 module frames in their proper location, inserting the RS-414 modules into their companion frames, making the audio input and output connections, adding the crosspoint control connections, and adjusting the variable mix gain for the conditions of use.

4.1 Input and Output Pin Assignments

Figure 2 details the RS-414 input and output connections to the System 1000 card frame. When installing the RS-414, observe the following:

Inputs to the board are made with the top four signal positions of the module edge connector labeled such in figure 3. Input 1 is considered the normal "left" channel input and input 2 the "right" channel. Inputs 3 and 4 are considered aux. inputs. While the differential input impedance is a relatively low 20 kΩ, any unused inputs should be back-terminated with 1k ohms or less to prevent the pickup of unwanted electromagnetic radiation.

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 produce a small "tick", much like a scratch on a record, that is generally not considered objectionable.

4.2 Output Connections

As mentioned above, outputs 1 and 2 are considered the "normal" stereo outputs. As such they are the two channels that have provision for remote control of gain or mode via optional daughter boards. Outputs 3 and 4 have no provision for daughterboard controllers. See the block diagram in Figure 2.0.

4.3 Connector Assembly

All input and output connections must be made with three pin Molex® SL™ pin and housing connectors or the new SIB-70 interface board. These connectors will be plugged onto the pins of the card edge connector at the rear of the card frame. All of the audio inputs and outputs must be oriented vertically. The crosspoint connections may be made in one of two possible arrangements. A single three pin housing may be used for crosspoints one and two, where the center pin position is left blank. The housing is connected by spanning horizontally across the pins of the card edge connector. Alternately, two pin housings may be used and oriented vertically, as with the audio inputs and outputs.

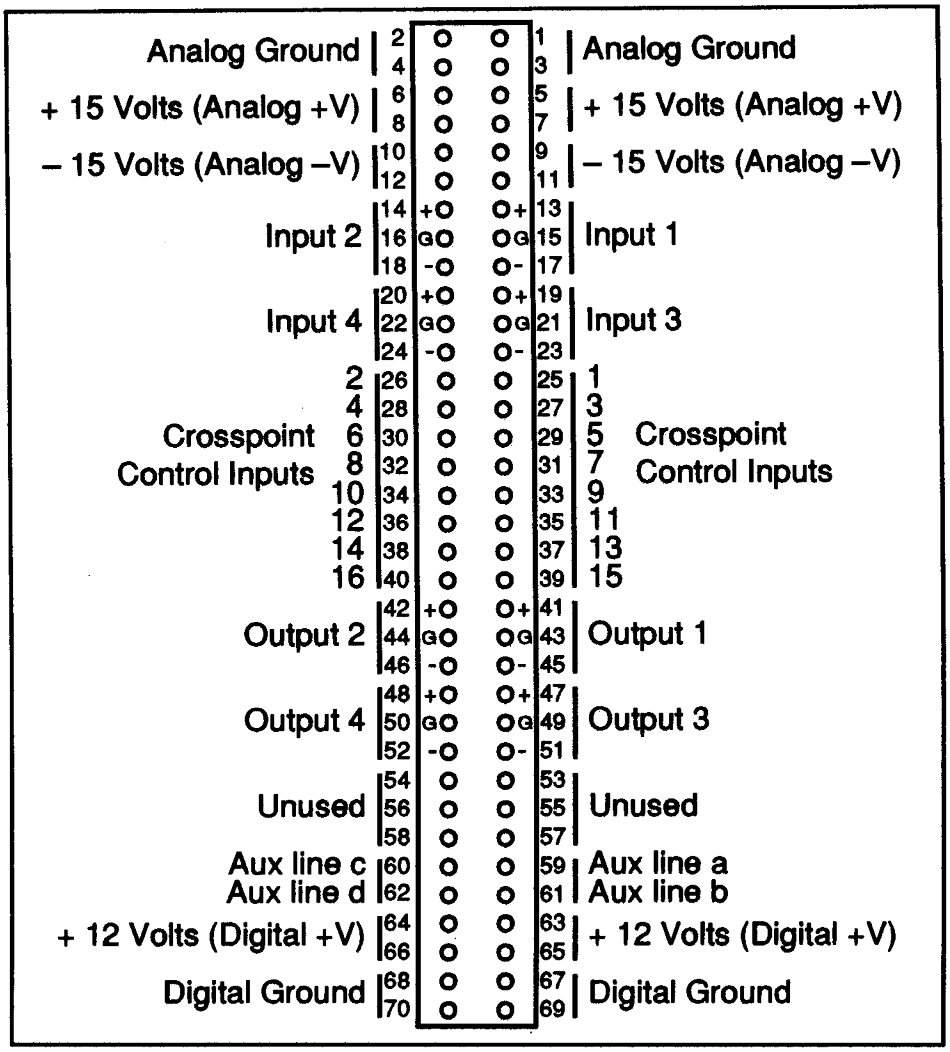


Fig. 3 - RS-414 Connector Pinout (View from Rear of Card Frame)

Molex housings and pins for the audio interconnect must be assembled in groups of three pins and one housing for a single shielded pair. Shield must be located in the center of the three pin row. With this arrangement, polarity inversions are achieved simply, should the need arise, by physically inverting the connector.

AMPMODU™ connectors may be used in lieu of the Molex pins and housings if you have them in your inventory. The major problem with the AMPMODU connectors is that they are thicker than the Molex devices and do not stack well when spanning horizontally; they interfere with one another. Molex housings and pins will work horizontally without interference.

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	11-01-011

If you use AMPMODU connectors, care should be taken when placing the connectors on the 0.025" square posts, that the connectors are not forced to travel further than what would be a *comfortable* seating. These connectors will not necessarily go all the way to the bottom of the wire wrap pins. Forcing them further than they were designed to travel may cause physical damage to them and result in intermittent connections. This problem is not as severe with the Molex SL pins and housings.

5.0 APPLICATION EXAMPLES

The RS-414 was designed to provide maximum flexibility. While the following applications do not specifically refer to it, external control of the crosspoint switches allows the possibility of computer control of the router module. With the addition of an RGC-04 daughterboard, full control over gain of output channels 1 and 2 is achieved. An RGC-02 provides gain control plus remote control of the following four modes; Stereo, Mono, Left Only, and Right Only. An MTX-02 daughterboard provides Left Only, Right Only, Mono, Stereo, Stereo Reversed, and Sum/Difference Matrix remote mode selections. A few applications will now be described.

5.1 Stereo and SAP Routing

The RS-414 provides an optimum answer to the need for assigning channels to the normal stereo and SAP inputs feeding a TV transmitter audio stereo generator. Often SAP is simply the mix of Left and Right channels. Occasionally SAP is used for a second language. By bringing all three sources into the RS-414, either decision is readily selected. Additionally, Left and Right channels may easily be reversed, should the need arise.

5.2 Four Channel Downlink Demod Routing

It is common to have four subcarrier demodulators on a video downlink channel. Unfortunately, each program origination source selects which subcarrier it wants to use for the various program audio sources. In other words, there is no standard channel assignments on the subcarriers. Selecting between the four channels of audio for stereo left and right is a simple push-button away, and it does not tie up the master routing switcher.

5.3 Four Channel VTR Mixing and Routing

With the advent of D2 and D3 VTRs, four channels of program audio are now available to the production department. How these channels are used will be a large variable. Some of the channels may be used conventionally as with two channel recorders, while the possibility of mixing or re-assigning channels is an ever present possibility. The RS-414 provides for these needs.

6.0 CIRCUIT DESCRIPTION

6.1 Overall

It will be helpful to refer to the RS-414 schematic while reading the description of the module's circuitry.

The RS-414 consists of four differential input amplifiers, sixteen crosspoint switches, and four variable gain mixing stages and four output amplifiers. See schematic diagram. The overall gain of the module is intended to operate at or close to unity.

A properly adjusted audio system should *not* have levels that vary from one piece of equipment to another. Levels should be brought to the house reference, (0, +4, or +8 dBu) at the *output* of all pieces of equipment, and then distributed at unity gain. Ever after, this level should not vary. If -10 dBV unbalanced outputs are to be used they will need an appropriate -10 dBV to + 4 dBu (or whatever the house reference) "interface box" to make the level transition. This should be located immediately adjacent to the program source. Do not change the amplification of the module to make the level transition.

Following this standard will facilitate equipment interconnection, and cross-connection through patch bays, without the need for additional interface amplifiers and gain adjustments.

6.2 Input Stage

The input stages are straightforward in design. The input stage consists of a precision differential amplifier with 6 dB of loss. This maximizes the available headroom with relatively low voltage power supplies. A unity-gain operational amplifier, operating from ±15 volt supplies, will clip at between +21 and +22 dBu, (12.3 and 13.8 volts peak), with reference to ground. Since the input signal is usually balanced with respect to ground and may have levels as high as +27 dBu, we must take a 6 dB loss at this point, if we want the system input overload to also be at the +27 dBu point. This loss works well, since with the balanced output stage configuration, we pick up the 6 dB gain lost at the input and differentially produce the desired +27 dB out. What this means is, internal to the module, the operating level is 6 dB lower than the input or the output. With a balanced input level of +4 dBu, the operating level after the first stage is -2 dB.

Unlike normal instrumentation amplifier inputs, when feeding the module from an unbalanced source, the input clip point is still +27 dBu. If the module is used as a single ended output device, then the overall gain through the module will be -6 dB.

The differential stage has trims that allow for a very high degree of common mode rejection. The trims are adjusted with an input signal level of +20 dBu. The resistive and capacitive trims are adjusted at a frequency of 2 kHz. The typical null is a -80 to -90 dBu, yielding a CMRR of 100 dB or better. The typical 20 kHz null values are -75 dB below the input level. It is important to keep in mind that, while the input is a high performance differential amplifier, it is *not* a floating input; 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 device can handle. Practically, we would suggest that a limit of two to three volts be the maximum common mode level. For this reason, it is very important to read and understand the Benchmark Media Systems, Inc. application note, "A Clean Audio Installation Guide". In very rare situations, where the installer has no control over common mode voltages present at the input of the amplifier, such as with some Telco feeds, a high quality transformer, such as those manufactured by Reichenbach Engineering, or Jensen Transformers, may need to be added to the installation.

6.3 The Crosspoint Routing Switch

The output voltages of the four input amplifiers are each brought to four of the sixteen crosspoint switches where a resistor, prior to the input, converts the output voltage to an output current. The switches are arranged in a series-shunt configuration. The input current to the switch is either shunted to ground, or is passed through the series switch element to the summing node of the variable gain mix stage. Which path the current takes is dependent upon the logic state of the switch. Since the control of the switch is external to the module, more than one switch at a time may be in the on position. This feature allows the currents from the four inputs to be mixed as well a simply routed to the various outputs.

The logic inputs to the CMOS switches are protected internal to the switch by diodes and by the external 5.1 kΩ input resistor. The inputs are pulled to a low (ground) state, in the absence of a logic input control voltage, by the 100 kΩ input shunt resistors. Ground, or low actuates an off condition, no signal is passed to the mix amplifier, for the switch, while a +12 volt input actuates an on condition.

6.4 The Variable Gain Mix Amp Stage

When turned on, the output of the switch feeds the variable gain mix amp. Since the input voltages have been converted to currents prior to the input of the switch, these currents must be converted back to a voltage output. This is accomplished by the variable gain mix amp. The output of four switches, from the four inputs, form a mix bus and then "sum" at this mix bus.

The current mix is presented to the summing node of this amplifier and is converted to an output voltage by this trans-impedance amplifier. The output level of this stage is determined by the total input current and the feedback resistance.

It is at this point that the general operation of this particular output should be determined. If this output will normally see only one input selection the output amplification may be set to a -3 dB gain. If a second input is selected from time to time for this output, then the maximum change in level is 6 dB, to an absolute output level of + 3 dB from the house reference, depending on the degree of correlation between the signals. If more than one input is expected to be selected on an ongoing basis, then the gain of this stage should be set accordingly.

The output of this stage in channels 1 and 2 is then routed to the header pins that feed a daughterboards audio input. Channel 1 feeds header pin # 9, and channel 2 feeds header pin # 17. If no daughterboard is present, a shorting jumper *must* be in place between pins 9 and 10, and also pins 17 and 18, to route the audio signal to the respective output stages.

The output of the mix amp stage for outputs 3 and 4 are wired directly to their output stages.

6.5 The Output Stage

The output stage is a NE5532 dual operational amplifier that is configured as a dual inverting follower. The first amplifier inverts the output of the mix amp and feeds its signal to a module output pin. The second half of the op-amp follows the first and provides the balanced output. 30.1 Ω build out resistors set the output impedance at a balanced 60 Ω. See "A Clean Audio Installation Guide" by Allen Burdick for further information on the use of 60 Ω as an output impedance.

6.6 Meter Operation

The meter consists of two basic sections. First, is the 12 segment LED meter with a scale factor of 3 dB/step. It is driven by the BA683A chip. Second, is the 13th segment peak overload indicator. The meter section has a four position DIP switch that allows the meter to monitor all four of the outputs. Since the input of the meter is a mix amplifier, more than one of the switch positions may be on at one time. Remember, however, that with all signal addition there is a respective increase in level, and meter calibration will be affected.

R2202 allows calibration of the meter to system references of 0, +4, and +8 dBu. Unless otherwise requested, the modules will be calibrated to a +4 dBu system reference at the factory. R2202 is adjusted so that, with the desired system reference level coming from the board, the first (bottom) yellow LED just turns on. R3207 sets the -27 dB LED for a correct turn on point. If the system reference level is +4 dBu, then the -27 dB calibration point would be -23 dBu.

The peak indicator is a pulse stretching comparator that indicates the module may be close to overload. It has the feature of being able to monitor the levels of a number of circuit points at once via a diode "or" circuit. This circuit topology is a half wave detecting comparator. When any one of these circuit input points exceeds a predetermined level, set by the resistor string R1105, R2103, and R2104, such that the inverting input rises above ground potential, then the comparator trips and the LED turns on. R2104 is the calibration trim for the P/OL indicator and it has a range of approximately +16 to +26 dBu. The factory calibration point is +20 dBu, unless otherwise requested.

6.7 Fusing

The RS-414 uses three power fuses. The fuses isolate the module from the rest of the System 1000 in the event of a failure on the module. The ±15 V analog power fuses are 1/2 Amp 3AG. F1801 and F1501 fuse the ± 15 V analog power. F4801 fuses the + 12 V digital supply and should also be rated at 1/2A.

7.0 SERVICE AND CALIBRATION

7.1 Servicing Techniques

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

7.1.1 Circuit Board De-Soldering

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

7.1.2 Circuit Board Re-Soldering

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

7.1.3 Module Extender

Service and calibration can be simplified with the use of the EX-370 Extender Board. Additionally, a 70 pin card edge connector made up with power wire pigtails is very useful for trouble shooting at the test bench. Be sure to use current limited power supplies set for a current limit at ±200 mA.

7.2 Common Mode Rejection Null

The common mode rejection trims on the input stages should never need to be readjusted, once they have been set at the factory. This is a passive bridge, and the characteristics of the operational amplifier used do not affect the accuracy of the balance on this bridge, that is, unless there is a malfunction with the op-amp. When replacing the operational amplifier, measure the common mode rejection *before* touching the trims.

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

Send a 2 kHz signal to the input and adjust the resistive portion of the differential amplifier bridge for a minimum audio output from the RS-414. Use either a logarithmic level meter with a sensitivity to below -100 dBu such as the Audio Precision System One, or a very sensitive linear meter, such as the Amber 3501 distortion and noise meter. It is very helpful to watch the audio signal from the meter output on an oscilloscope, which in turn should be synchronized to the signal source. This will allow you to quickly see the phase/amplitude nulls as they take place. Once a resistive null has been achieved, null the capacitive trim.

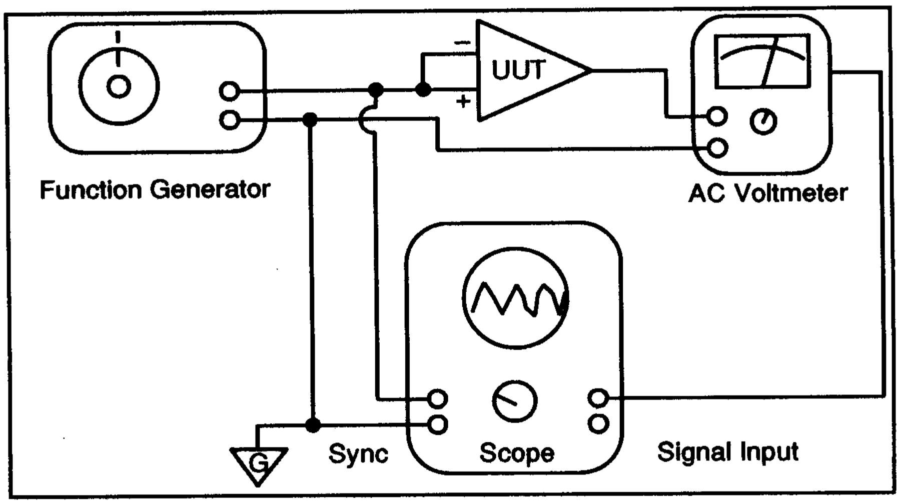


Fig. 4 - Common Mode Rejection Adjustment

Two or three iterations between these controls should be sufficient to achieve the best broadband null possible. A null of better than 100 dB at 200 Hz, and better than 75 dB at 20 kHz, is achievable with the current P.C. layout. Unfortunately, it is almost impossible to maintain this good a null over the operating temperature range. A degradation of up to 10 dB may be expected when the module is returned to its working environment.

7.3 Bar Graph Meter

Troubleshooting the bar graph meter is quite straightforward. The LEDs are arranged to work in groups of four. The LEDs are turned on by successive current sinks within the chip. The first LED's current sink turns on, then the second LED's sink turns on as the sink for LED 1 turns off, placing the two LEDs in series, thus reducing the internal power dissipation within the driver. This continues until a group of four have been turned on by the last current sink in the string and about 7.5 volts is developed across the LED string. Then, the next string starts with a similar process.

Troubleshooting the LED string is quite easy, once you recognize that a string of 4 LEDs is turned on by its last current sink activated. For example, if the middle four LEDs in the meter are extinguished when they should be on, it is safe to say that one of the four devices is open or the driver chip is defective. The first two LED strings (in ascending level) operate at about twice the current than that of the last string. Therefore, the last green LED and the three yellow LEDs have a slightly reduced light output, even though these positions use high efficiency LEDs. The 10 μF capacitor, C3202, and the 10 K ohm resistor, R3203, that are in parallel and are connected between pin 4 of the meter chip and ground, set the time constants to approximate a VU meter action. R3205, from pin 2 to ground, sets the current through the LEDs. Audio comes into the chip on pin number 3, along with a small amount of DC. offset to establish the -27 dB trip point. If re-calibration of the meter system is ever deemed necessary (such as after replacing a meter chip), this calibration should be performed after the 0 dB calibration is performed. With the proper input level, adjust the potentiometer until the first green (bottom most) LED just turns on.

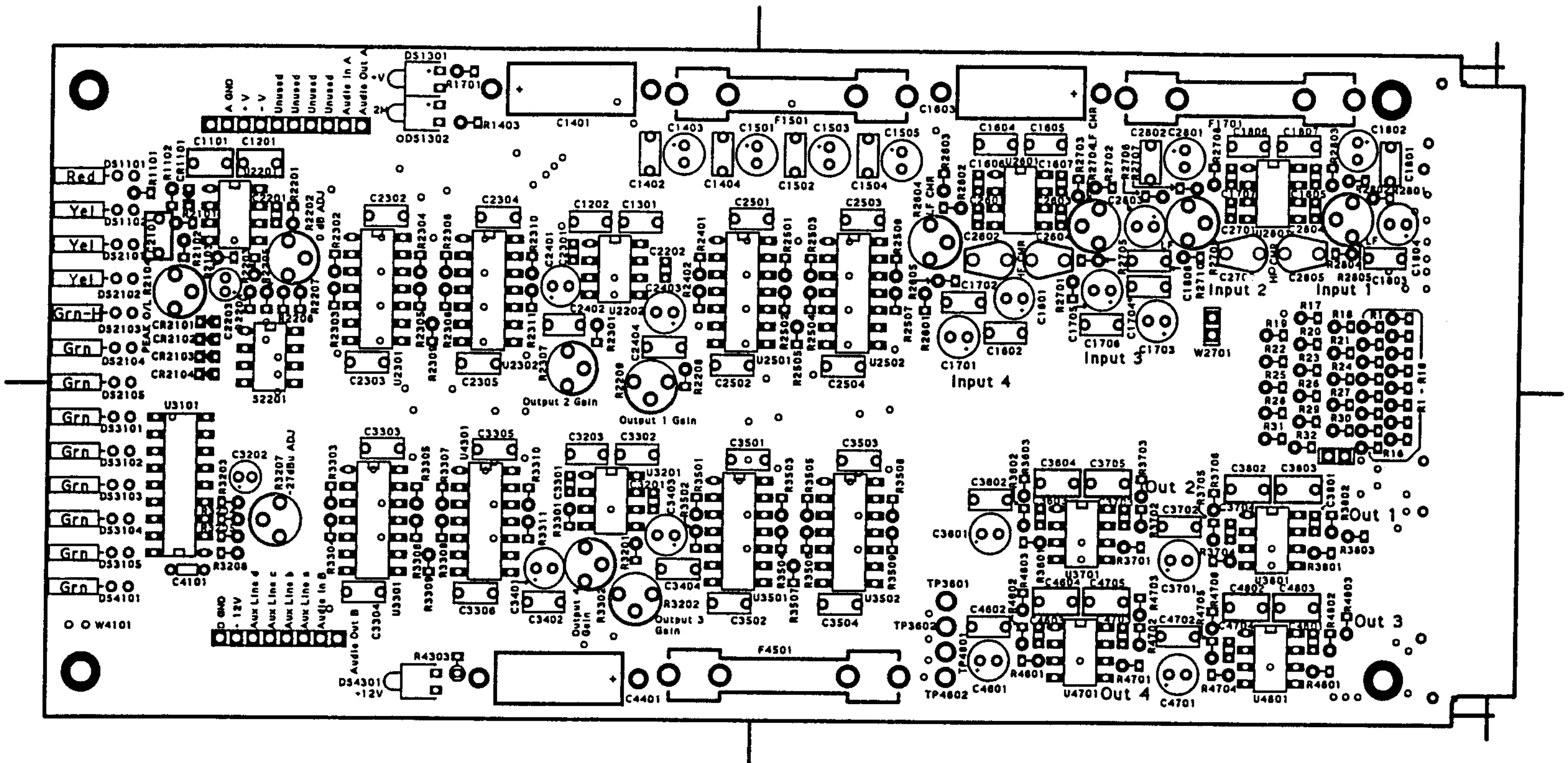
The meter amplifier, U2201B, is a standard inverting amplifier with R2201 and R2202 as a part of the feedback gain network. The calibration range is from ≈ -2 dB to ≈ +10 dB.

The peak overload comparator, as described above, is an oscillating comparator by virtue of the fact that A.C. coupled hysteresis is applied around the device. This assumes that the input signal does, in fact, drop below the threshold point, after seeing a peak overload, so as to allow it to reset. The diodes CR2101 through CR2204 form an analog "or" circuit; that is, any signal at any one of the input diodes may take the threshold point high enough to trip the comparator.

If further assistance is needed in trouble shooting the module, call for engineering support at the number listed below, between 9 AM and 5 PM EST.

This completes the RS-414 Instructions. 120792

BENCHMARK MEDIA SYSTEMS, INC.
5925 Court Street Road
Syracuse, NY 13206-1707
(315) 437-6300



SILKSCREEN

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BENCHMARK MEDIA SYSTEMS, INC.			
RS-414			
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DATE 1 / 9 / 92		ASSEMBLY # 500-03820-000	
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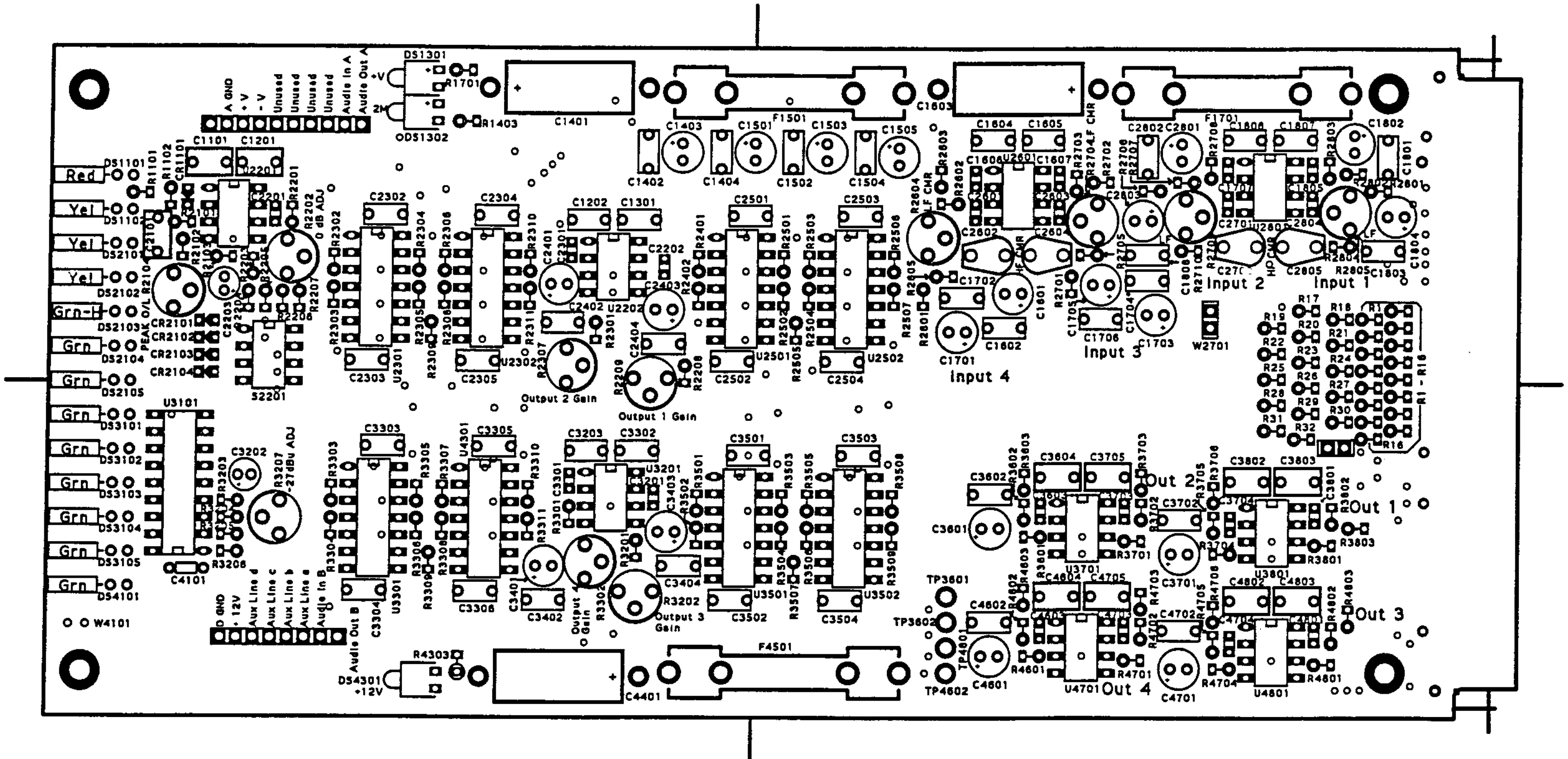

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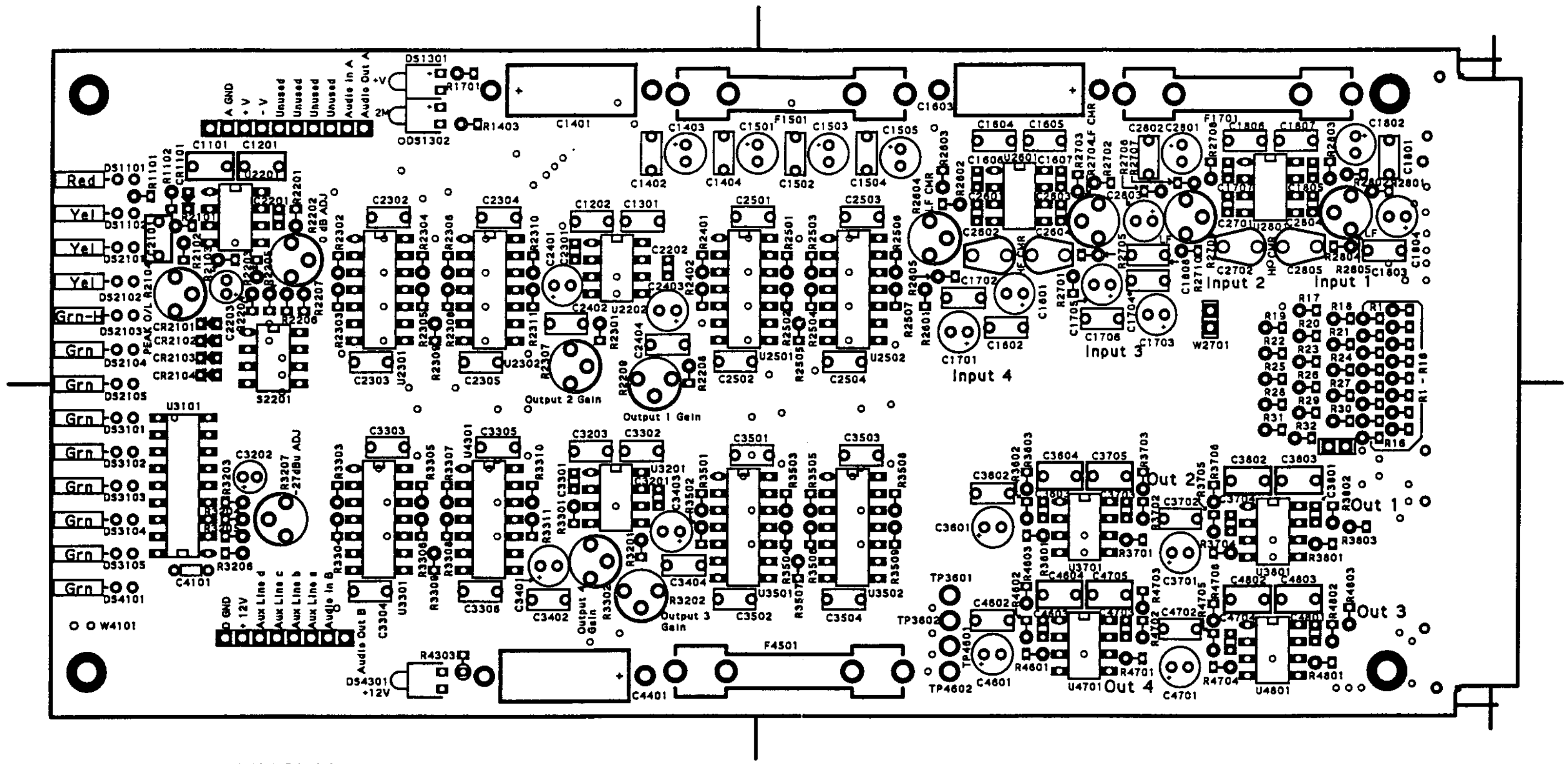

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