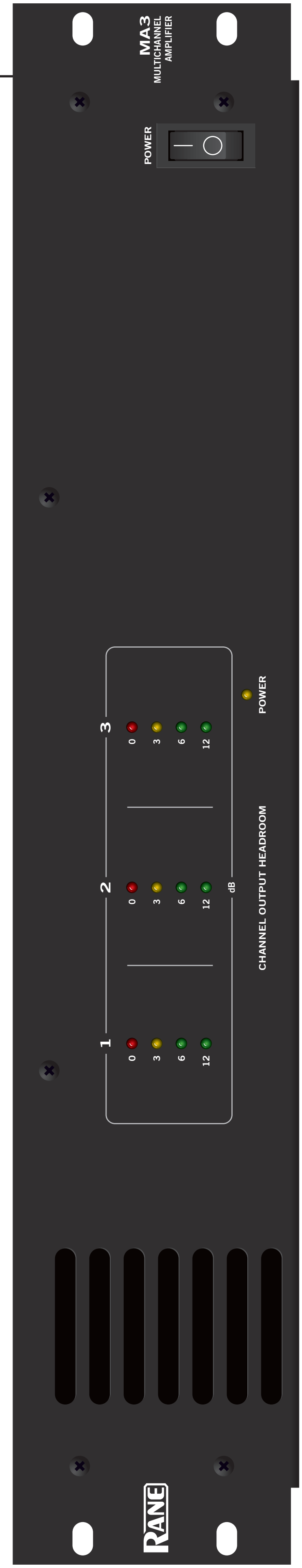
MA3

MULTICHANNEL AMPLIFIER



CONTENTS *(in order of appearance)*

22472

IMPORTANT SAFETY INSTRUCTIONS

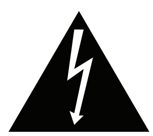
1. Read these instructions.
2. Keep these instructions.
3. Heed all warnings.
4. Follow all instructions.
5. Do not use this apparatus near water.
6. Clean only with a dry cloth.
7. Do not block any ventilation openings. Install in accordance with manufacturer's instructions.
8. Do not install near any heat sources such as radiators, registers, stoves, or other apparatus (including amplifiers) that produce heat.
9. Do not defeat the safety purpose of the polarized or grounding-type plug. A polarized plug has two blades with one wider than the other. A grounding-type plug has two blades and a third grounding prong. The wide blade or third prong is provided for your safety. If the provided plug does not fit into your outlet, consult an electrician for replacement of the obsolete outlet.
10. Protect the power cord and plug from being walked on or pinched particularly at plugs, convenience receptacles, and the point where it exits from the apparatus.
11. Only use attachments and accessories specified by Rane.
12. Use only with the cart, stand, tripod, bracket, or table specified by the manufacturer, or sold with the apparatus. When a cart is used, use caution when moving the cart/apparatus combination to avoid injury from tip-over.
13. Unplug this apparatus during lightning storms or when unused for long periods of time.
14. Refer all servicing to qualified service personnel. Servicing is required when the apparatus has been damaged in any way, such as power supply cord or plug is damaged, liquid has been spilled or objects have fallen into the apparatus, the apparatus has been exposed to rain or moisture, does not operate normally, or has been dropped.
15. The plug on the power cord is the AC mains disconnect device and must remain readily operable. To completely disconnect this apparatus from the AC mains, disconnect the power supply cord plug from the AC receptacle.
16. This apparatus shall be connected to a mains socket outlet with a protective earthing connection.
17. When permanently connected, an all-pole mains switch with a contact separation of at least 3 mm in each pole shall be incorporated in the electrical installation of the building.
18. If rackmounting, provide adequate ventilation. Equipment may be located above or below this apparatus, but some equipment (like large power amplifiers) may cause an unacceptable amount of hum or may generate too much heat and degrade the performance of this apparatus.
19. This apparatus may be installed in an industry standard equipment rack. Use screws through all mounting holes to provide the best support.

WARNING: To reduce the risk of fire or electric shock, do not expose this apparatus to rain or moisture. Apparatus shall not be exposed to dripping or splashing and no objects filled with liquids, such as vases, shall be placed on the apparatus.

WARNING

To reduce the risk of electrical shock, do not open the unit. No user serviceable parts inside. Refer servicing to qualified service personnel.

The symbols shown below are internationally accepted symbols that warn of potential hazards with electrical products.



This symbol indicates that a dangerous voltage constituting a risk of electric shock is present within this unit.

This symbol indicates that there are important operating and maintenance instructions in the literature accompanying this unit.

WARNING: This product may contain chemicals known to the State of California to cause cancer, or birth defects or other reproductive harm.

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

CAUTION: Changes or modifications not expressly approved by Rane Corporation could void the user's authority to operate the equipment.

CAN ICES-3 (B)/NMB-3(B)

INSTRUCTIONS DE SÉCURITÉ

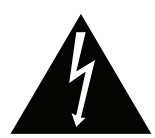
1. Lisez ces instructions.
2. Gardez précieusement ces instructions.
3. Respectez les avertissements.
4. Suivez toutes les instructions.
5. Ne pas utiliser près d’une source d’eau.
6. Ne nettoyer qu’avec un chiffon doux.
7. N’obstruer aucune évacuation d’air. Effectuez l’installation en suivant les instructions du fabricant.
8. Ne pas disposer près d’une source de chaleur, c-à-d tout appareil produisant de la chaleur sans exception.
9. Ne pas modifier le cordon d’alimentation. Un cordon polarisé possède 2 lames, l’une plus large que l’autre. Un cordon avec tresse de masse possède 2 lames plus une 3è pour la terre. La lame large ou la tresse de masse assurent votre sécurité. Si le cordon fourni ne correspond pas à votre prise, contactez votre électricien.
10. Faites en sorte que le cordon ne soit pas piétiné, ni au niveau du fil, ni au niveau de ses broches, ni au niveau des connecteurs de vos appareils.
11. N’utilisez que des accessoires recommandés par Rane.
12. N’utilisez que les éléments de transport, stands, pieds ou tables spécifiés par le fabricant ou vendu avec l’appareil. Quand vous utlisez une valise de transport, prenez soin de vous déplacer avec cet équipement avec prudence afin d’éviter tout risque de blessure.
13. Débranchez cet appareil pendant un orage ou si vous ne l’utilisez pas pendant un certain temps.
14. Adressez-vous à du personnel qualifié pour tout service après vente. Celui-ci est nécessaire dans n’importe quel cas où l’appareil est abimé : si le cordon ou les fiches sont endommagés, si du liquide a été renversé ou si des objets sont tombés sur l’appareil, si celui-ci a été exposé à la pluie ou l’humidité, s’il ne fonctionne pas correctement ou est tombé.
15. La fiche du cordon d’alimentation sert à brancher le courant alternatif AC et doit absolument rester accessible. Pour déconnecter totalement l’appareil du secteur, débranchez le câble d’alimentation de la prise secteur.
16. Cet appareil doit être branché à une prise terre avec protection.
17. Quand il est branché de manière permanente, un disjoncteur tripolaire normalisé doit être incorporé dans l’installation électrique de l’immeuble.
18. En cas de montage en rack, laissez un espace suffisant pour la ventilation. Vous pouvez disposer d’autres appareils au-dessus ou en-dessous de celui-ci, mais certains (tels que de gros amplificateurs) peuvent provoquer un buzz ou générer trop de chaleur au risque d’endommager votre appareil et dégrader ses performances.
19. Cet appareil peut-être installé dans une baie standard ou un chassis normalisé pour un montage en rack. Visser chaque trou de chaque oreille de rack pour une meilleure fixation et sécurité.

ATTENTION: afin d’éviter tout risque de feu ou de choc électrique, gardez cet appareil éloigné de toute source d’humidité et d’éclaboussures quelles qu’elles soient. L’appareil doit également être éloigné de tout objet possédant du liquide (boisson en bouteilles, vases,…).

ATTENTION

Afin d’éviter tout risque de choc électrique, ne pas ouvrir l’appareil. Aucune pièce ne peut être changée par l’utilisateur. Contactez un SAV qualifié pour toute intervention.

Les symboles ci-dessous sont reconnus internationalement comme prévenant tout risque électrique.



Ce symbole indique que cette unité utilise un voltage élevé constituant un risque de choc électrique.

Ce symbole indique la présence d’instructions d’utilisation et de maintenance importantes dans le document fourni.

REMARQUE: Cet équipement a été testé et approuvé conforme aux limites pour un appareil numérique de classe B, conformément au chapitre 15 des règles de la FCC. Ces limites sont établis pour fournir une protection raisonnable contre tout risque d’interférences et peuvent provoquer une énergie de radiofréquence s'il n'est pas installé et utilisé conformément aux instructions, peut également provoquer des interférences aux niveaux des équipements de communication. Cependant, il n'existe aucune garantie que de telles interférences ne se produiront pas dans une installation particulière. Si cet équipement provoque des interférences en réception radio ou télévision, ceci peut être detecté en mettant l'équipement sous/hors tension, l'utilisateur est encouragé à essayer de corriger cette interférence par une ou plusieurs des mesures suivantes:

- Réorienter ou déplacer l'antenne de réception.
- Augmenter la distance entre l'équipement et le récepteur.
- Connecter l'équipement à une sortie sur un circuit différent de celui sur lequel le récepteur est branché.
- Consulter un revendeur ou un technicien radio / TV expérimenté.

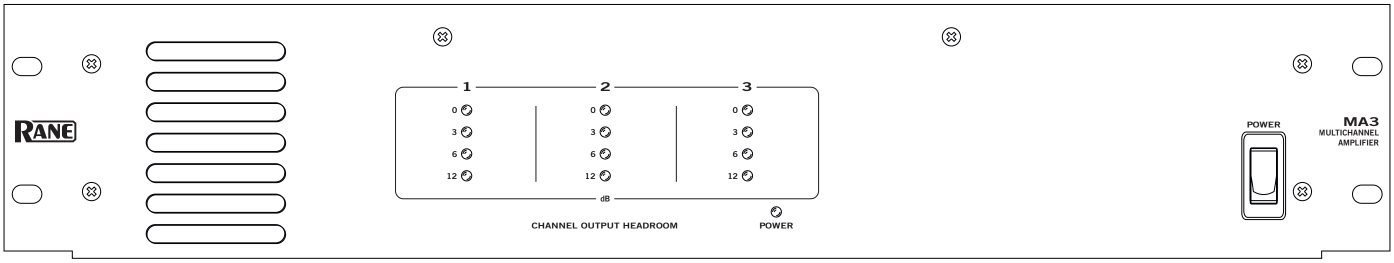
ATTENTION: Les changements ou modifications non expressément approuvés par Rane Corporation peuvent annuler l'autorité de l'utilisateur à manipuler cet équipement et rendre ainsi nulles toutes les conditions de garantie.

CAN ICES-3 (B)/NMB-3(B)

Cartons et papier à recycler.

OPERATORS MANUAL MA3

MULTICHANNEL AMPLIFIER



Quick Start

Sure, you say, "it's just a three channel amp, I'm in a hurry — I don't need to read the manual." But at least read this little section so you really know what to expect, and your installation can go even faster.

Be sure the amplifier is ***off*** before making any connections. Euroblocks make amplifier connection easy. They are just like "snap on" terminal blocks that take up to 12 guage wire.

Driving the MA3 from a balanced source is recommended. If you must drive the MA3 Input with an unbalanced source, we recommend using a cable that has two conductors plus a shield, and be sure to keep cable lengths as short as possible (under 10 feet [3 meters]). See the RaneNote, "Sound System Interconnection" (contained in this booklet).

Nominal speaker loads should be no lower than 4Ω per output. If you are running series or parallel combinations, be sure and *check your total load impedance*.

For constant-voltage distribution, consider using the optional TF410 or TF407 transformers with the MT6 rack panel. Transformers may be used on any number of output channels required, and one MT6 can be used with two MA3s. If you intend to use constant-voltage distribution transformers, you may want to read the RaneNote "Constant-Voltage Audio Distribution Systems" (contained in this booklet).

If you are using small speakers that could overload with bass, you may want to activate an internal 80 Hz Filter on each channel. The MA3 is shipped from the factory with the jumpers in the "no filter" position, as shown in the diagram on page 4.

Once Input and Output connections are completed, be sure all rear panel **LEVEL** controls are all the way counterclockwise. Now flip the **POWER** switch on. After a couple of seconds, slowly turn up each channels' **LEVEL** control to the desired gain. Maximum yields the most effective dynamic range control for the built-in Limiter). If all is well, you will hear something pleasant. If not, re-check connections, put on a better CD, and read more of this manual.

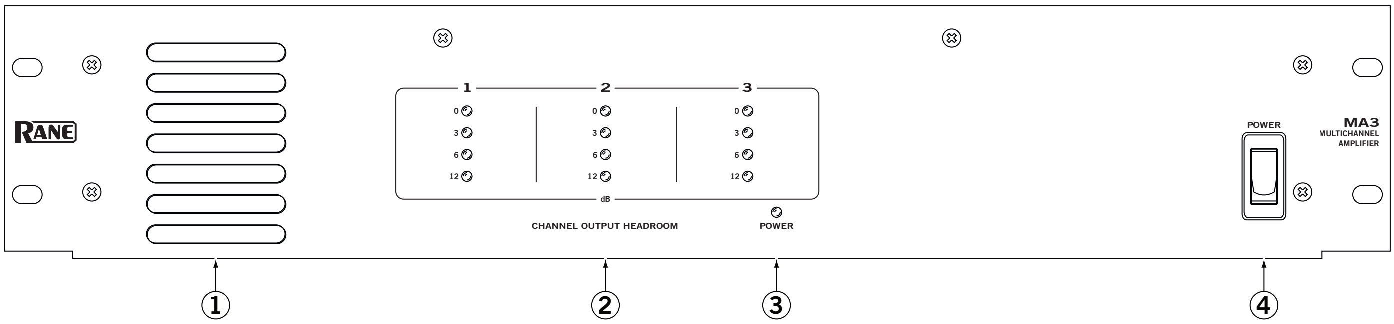
Speaker Connection

To reduce the risk of fire, follow these instructions:

- Connect speaker wires with the amplifier off.
- Use approved Class 2 wiring to connect speakers to the output terminals.
- The recommended wire gauge is 12-18 AWG.
- Do not use damaged wires, and protect wires from damage.
- Strip wire 0.25 inch (about 6.3 mm).
- Twist the strands together.
- Fully insert the wire into the Euroblock connector.
- Tighten the screw.
- Make certain there are no loose wire strands.
- Use speakers with a power rating equal to or greater than the rating of the amplifier.
- Connection at the speaker depends on the type of connector. Follow the instructions provided by the speaker manufacturer.

WEAR PARTS: This product contains no wear parts.

Front Panel Description



① **Heat tunnel exhaust vents** are located on the left of the unit. Large aperture vent slots are used for low noise. Air is taken in at the back of the unit and exhausts out the front. When installed in a rack, make sure there is ample room for air to exit. The sealed heat tunnel design does not require the use of an air filter.

② **CHANNEL OUTPUT HEADROOM meters** indicate the amount of remaining headroom (how much more signal can be applied before Limiting occurs).

0 dB remaining is indicated by a red indicator. When lit, any additional signal causes the Limiter to operate. It is possible to "compress" the signal as much as 20 dB with very little effect on sound quality. This gives the MA3 the overload characteristics of a much larger amplifier, without the use of external compressors. The MA3 was designed to be driven hard (heavily compressed signal) so it is not necessary to buy extra power to obtain the headroom required to prevent overload.

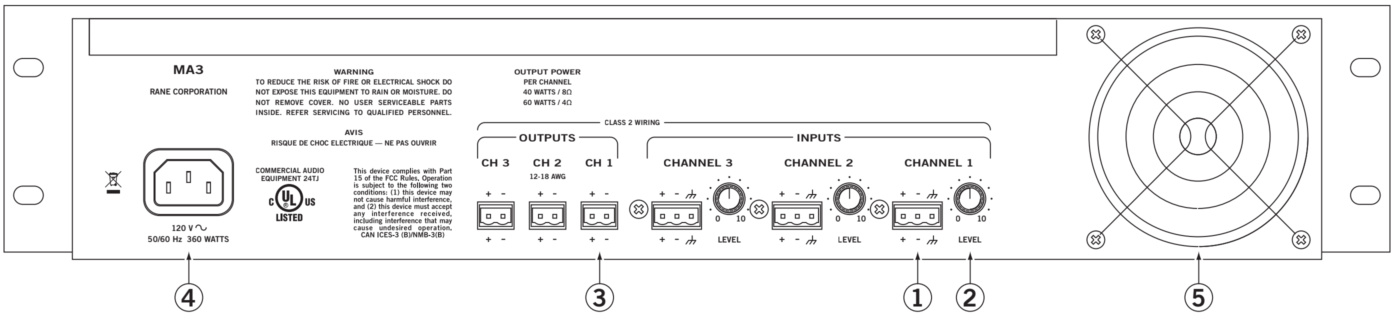
3 dB remaining is indicated by a yellow indicator. When lit, 3 dB of additional signal may be applied before Limiting.

6 dB remaining is indicated by a green indicator. When lit, 6 dB of additional signal may be applied before Limiting.

12 dB remaining is indicated by a green indicator. When lit, 12 dB of additional signal may be applied before Limiting.

③ **POWER:** This yellow indicator lights when power is applied to the unit. See ④ below.

④ **POWER switch:** This control obediently turns the MA3 on and off every time you poke it with your finger. Poking the top half of the switch turns the unit *on* when it is off. Poking the bottom portion of the switch turns the unit *off* when it it on. All three channels have turn-on and turn-off muting to reduce switching transients.



① **INPUTS** are balanced Euroblock connectors, one for each channel. We recommend the use of at least 18 AWG wire for reliability. Driving the MA3 from a balanced source is recommended. If you must drive the MA3 Input with an unbalanced source, use a cable that has two conductors plus a shield. Connect the (+) or “hot” source to the MA3 (+) Input, the ground to the MA3 (–) Input and connect the shield to the MA3 shield input. Do ***not*** connect the shield on the source end. Shield connections go directly to chassis ground and should not be used as signal ground. Shield connection to chassis occurs via the screw found between the Input and Output connectors—keep this screw tight for improved EMI protection. When operating the MA3 with unbalanced Inputs, be sure to keep cable lengths as short as possible. Refer to the RaneNote *“Sound System Interconnection”* (included in this booklet) for additional information.

② **LEVEL** controls adjust the input sensitivity for each of the three Amplifiers. The internal Limiters have maximum operating range (most amount of limiting before input overload) when the LEVEL controls are set to maximum. For best *system* noise performance, the input sensitivity may be reduced to send a “hotter” signal to the Amplifier. Here we go again! You get nothing for free. There are always tradeoffs to be made (better overdrive capability *or* lower system noise). The choice depends on your application. For additional information see the RaneNote *“Setting Sound System Level Controls”* available in the Library on our website.

③ **OUTPUTS:** Connect the speaker(s) or transformer(s) to each of the three channels by means of the Euroblock connectors with 12 to 18 AWG wire. See Speaker Connection on page Manual-1.

④ **IEC cord socket:** This connector accepts a standard IEC 3-conductor line cord (included with 120V units). Plug this into a *grounded* 3-prong AC outlet of 120 VAC (or 230 VAC if the MA3 is internally wired for 230V operation).

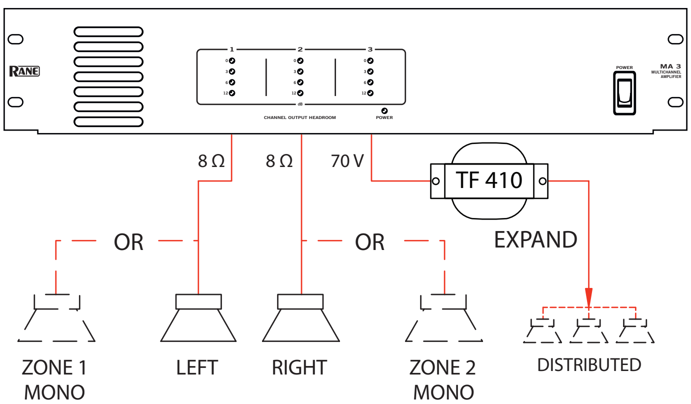
⑤ **Heat tunnel air intake:** The fan draws air in through the finger guard on the rear of the unit. The air flow is directed down a sealed heat tunnel and exhausts through front panel vents. No filter is required as air flow is directed through an unobstructed sealed tunnel and will not contaminate internal circuitry.

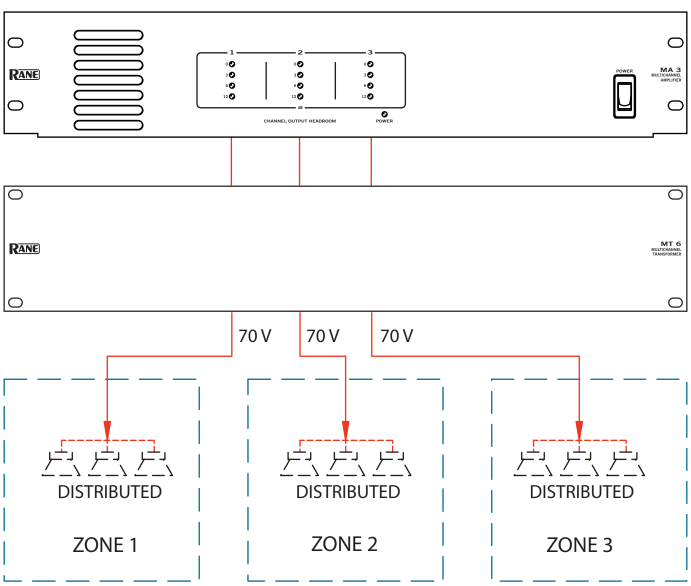
TF410 & TF407 Transformers

The MT6 rack panel holds up to six transformers installed on the back, in any combination. Transformers are sold individually:

- The **TF407** is a 40W, **70.7 V** transformer with 0.5 dB insertion loss at rated power and a frequency response of 50 Hz to 15 kHz, ±1 dB.

- The **TF410** is a 40W, **100 V** transformer with 0.5 dB insertion loss at rated power and a frequency response of 50 Hz to 15 kHz, ±1 dB.

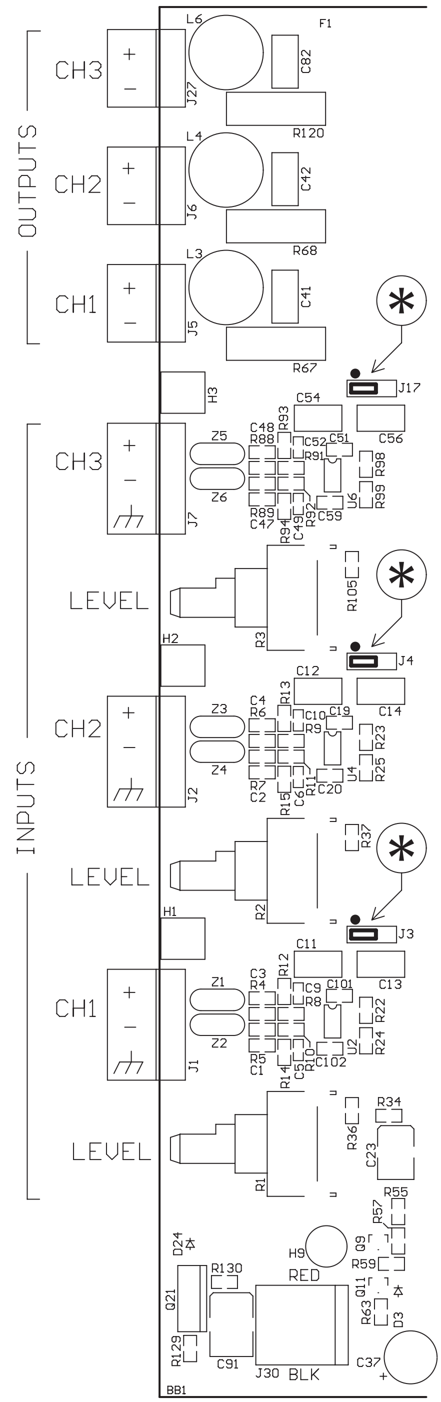




80 Hz Highpass Filters

Internal jumpers allow independently selecting 80 Hz, 2nd-order Butterworth Filters for each channel. These Filters are useful when using small bookshelf speakers or small constant-voltage distribution transformers.

The MA3 is shipped from the factory with the jumpers in the "no filter" position, as shown in the diagram below. Moving the jumper to the other position activates the 80 Hz filter. This operation requires removing the top cover and should only be done by qualified service personel with the unit unplugged.



The MA3 is shipped with the internal 80 Hz High-pass filters in the bypassed position.

DATA SHEET MA3

MULTICHANNEL AMPLIFIER

General Description

The MA3 is a three-channel amplifier designed to operate reliably in commercial environments. The MA3 was specifically designed for use in:

- Paging
- Foreground Music
- Background Music Distribution

The MA3 is an ideal amplifier with Rane's paging and music products, the Rane CP52S, CP64S, CP66 and DA26S.

The MA3 uses a conventional linear power supply with a toroidal transformer. This configuration minimizes the emissions associated with switching supplies and noisier transformer designs. The power supply features *independent secondary supplies for each channel*, minimizing load regulation interaction and crosstalk.

Thermal management is accomplished with a sealed heat-tunnel design incorporating *low velocity* forced-air and large aperture openings. This design minimizes the noise usually associated with forced-air cooling and *eliminates the need for an air filter.* Forced-air cooling allows the amplifier to operate reliably in harsh environments and *avoid the buildup of heat in unventilated racks associated with passive convection cooling*.

The combination of a solid, conservative power supply and forced-air cooling allows the MA3 to *simultaneously* deliver 40 watts of *continuous* average power into 8Ω and 60 watts into 4Ω.

SPiKe®* *dynamic* protection circuitry completely safeguards each channel against over-voltage, under-voltage, overloads, transients from inductive loads, thermal runaway and *instantaneous* temperature peaks. Biasing is not allowed to occur when an under-voltage condition exists, reducing turn on and turn off transients.

Fast-response limiters allow the MA3 to tolerate up to 20 dB of overdrive into 8Ω and 4Ω loads while holding THD below 1%. This means no loss of speech intelligibility or harsh clipping. This feature greatly *increases the dynamic range* of the system without external limiters.

Peak-responding, load-adaptive meters accurately indicate the remaining headroom. The meters are helpful in setting system levels and indicating signal compression.

Balanced inputs with Euroblock connectors are provided. Euroblock output connectors to speakers accept up to 12 gauge wire. Rear panel Level controls allow amplifier sensitivity adjustment. Internally selectable 80 Hz highpass filters for each channel offer protection against over excursion of small bookshelf speakers and saturation of distribution transformers at low frequencies. These filters are shipped in the "off" position from the factory.

Features

- 3 Independent Amplifiers
- 60W per Channel Continuous Average Power into 4Ω, 20-20k Hz
- 40W per Channel Continuous Average Power into 8Ω, 20-20k Hz
- Load Sensitive Dynamic Limiters and Headroom Meters
- SPiKe® Protection Circuitry
- High Capacity Linear Power Supply
- Sealed Heat-Tunnel Forced Air Cooling
- Input Level Controls (on rear panel)
- 80 Hz High-Pass Filter Selection
- Euroblock Connectors

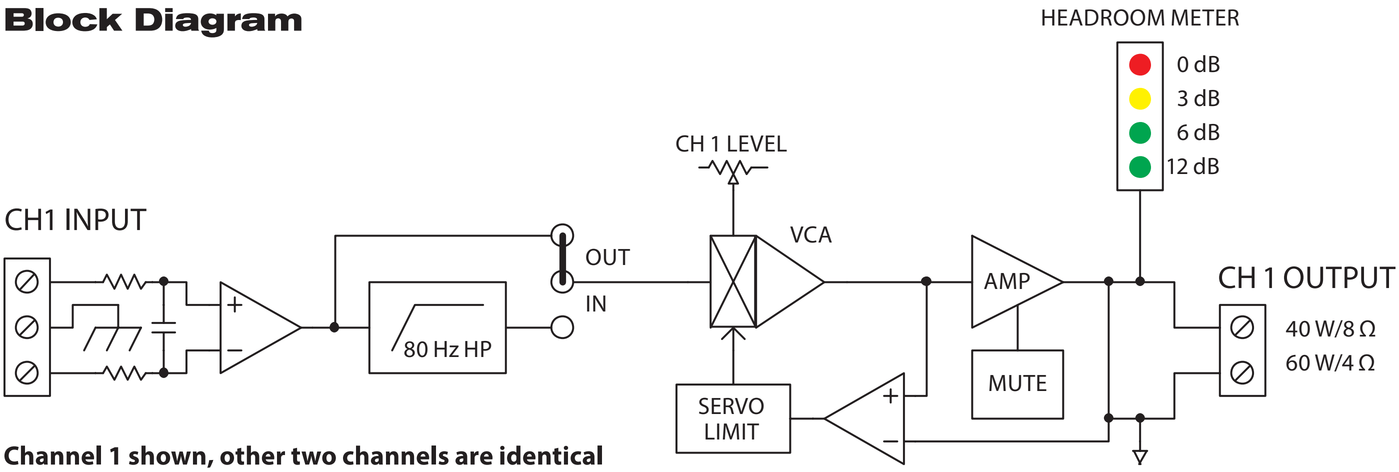
**SPiKe is a registered trademark of National Semiconductor Corporation.*

Features and Specifications

Parameter	Specification	Limit	Units	Conditions/Comments
Input:	Euroblock Connector			
Impedance	20k	min.	Ω	Each leg
Maximum Input Level	+20	min.	dBu	
Sensitivity	Off to 0		dBu	Input required for full power; 8Ω
CMR	40	min.	dB	20 Hz to 20 kHz
Highpass Filter	80 Hz (factory default is “off”)	±2.5%	Hz	2nd-order butterworth
Amplifier: Gain	27	±0.5	dB	1 kHz
Power Output	40/60	min.	watts	8/4 Ω cont. avg. power, all channels driven
Frequency Response	20 - 20k		Hz	+0, -.5 dB
S/N	90	min.	dBr	re: 40W, 8Ω, A-weighted
Crosstalk	-60	max.	dB	1 kHz, 4Ω, all channels driven
THD+N	0.05%	typ.		1 kHz, 40 W, 8Ω, 80 kHz BW
	0.1%	typ.		1 kHz, 60 W, 4Ω, 80 kHz BW
	0.2%	typ.		20 Hz-20 kHz, 35W, 8Ω, 80 kHz BW
Slew Rate	10	min.	V/µs	
Damping Factor	80	min.		8Ω, 1 kHz
On/Off Transient Muting	Active			Drop out 85 VAC (120 VAC unit)
Fan Cooling	Active Constant-Current			Sealed tunnel
Fan Noise	45.2	dB		A-weighted, 6 inches from front of fan grate
Tunnel Power Dissipation	120W; 410 Btu/hr			60W / channel; 4Ω load; all channels driven
SOA	SPiKe*			Safe Operating Area
Limiter: Attack Time	10	typ.	ms	10 dB step
Decay Time	3000	typ.	ms	10 dB step
Threshold	0.1% THD+N	typ.		@1 kHz
Action	1% THD+N	max.		15 dB overdrive (max. level) @ 1 kHz
Meter: Attack Time	20	typ.	ms	10 dB step
Decay Time	500	typ.	ms	10 dB step
Indicators	0, 3, 6 ,12	+0, -2	dB	20log (Vmax/Vout) or 10log (Pmax/Pout)
Power Supply: Type	Linear; Toroidal Transformer			Independent secondaries for each channel
..........Input	100 to 240 VAC	±10%	VAC	C14 inlet uses C13 cord
..........Consumption	33.6W; 115 Btu/hr			No load (idle)
..........Total Load & Unit	360W; 1200 Btu/hr			60 W/channel; 4Ω load; all channels driven
Unit: Conformity	FCC, cULus			
..........Construction	All Steel			
..........Size	3.5"H x 19"W x 9"D (2U)			(8.9 cm x 48.3 cm x 22.9 cm)
..........Weight	26 lb			(11.8 kg)
Shipping: Size	4.25" x 20.3" x 13.75"			(11 cm x 52 cm x 35 cm)
..........Weight	30 lb			(13.6 kg)

Note: 0 dBu = 0.775 Vrms. *SPiKe is an acronym for Self Peak Instantaneous temperature (Ke) protection circuitry.

Block Diagram



Channel 1 shown, other two channels are identical

Features

Built to be driven hard

The MA3 Amplifier drives all three channels at the continuous average rated power, indefinitely. It is specifically designed to operate in demanding commercial applications. Very low emissions allow the amplifier to operate in close proximity to signal processing equipment without causing excessive interference. The CP52S, CP64S, CP66 and DA26S may all operate next to the MA3 in a rack. The high efficiency "heat tunnel" design allows the amplifier to process severely compressed signals reliably even when installed in a rack with elevated ambient temperatures. Forced-air cooling keeps heat away from other equipment.

You won't hear the other Zones

The MA3 is designed to deliver foreground music, background music and paging signals to three different Zones without annoying crosstalk. A quiet office, for example, with a paging signal only, will not hear foreground music playing in the lounge. The high capacity linear power supply incorporates three independent secondary supplies with independent bridge rectifiers and filters. The result is exceptionally good crosstalk figures even with multiple channels driving full power into 4Ω loads.

No bad "spikes"

The MA3 is designed to operate without interruption of signal with as little as 85 VAC available (120 VAC unit). Even if the Amplifier is operating at full power, the signal will not breakup as the AC line voltage drops to 85 VAC. If the AC line drops lower than 85 VAC the signal mutes without "spikes." Once AC power is restored, the signal restarts quickly without "spikes" or signal breakup.

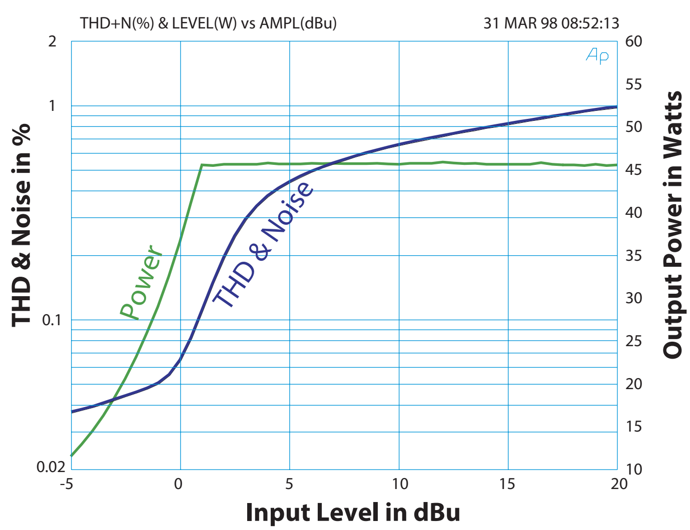
The good "SPiKe"

The power amplifiers in the MA3 are protected with National Semiconductors' proprietary SPiKe* protection circuitry. SPiKe protection offers a level of protection not available in conventional amplifiers. It has the ability to instantaneously monitor the temperature of the power device die, yielding a level of reliability not achievable with discrete designs.

It's OK to light the 0 dB Headroom indicator a *lot*

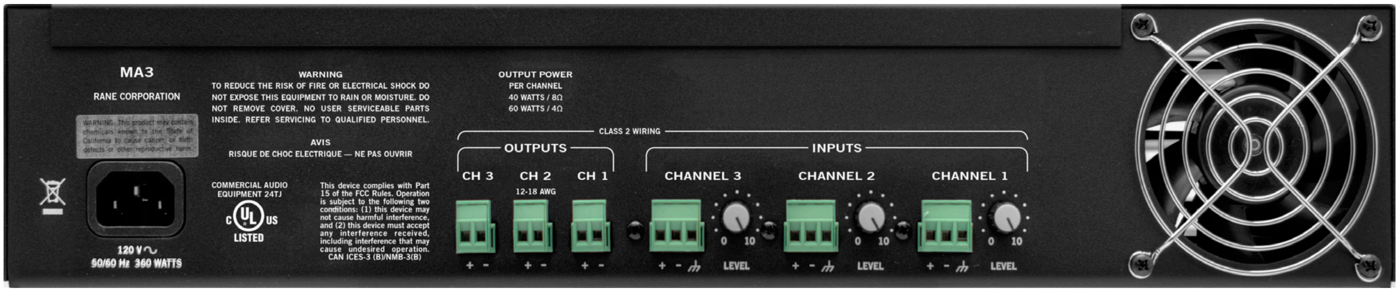
The high-performance limiter used in the MA3 means all the available power can be delivered to the load and not simply held in reserve to avoid overload. There is no need to buy up to *four times* the required power just to prevent occasional system overload. The MA3 can compress a signal with 9 dB of dynamic *power* range down to a signal with 3 dB of dynamic *power* without loss of speech intelligibility or excessive distortion.

With typical amplifiers, when 40 watts is needed to achieve a required average SPL of 80 dB, the contractor must buy an amplifier rated at no less than 160 watts just to maintain 6 dB of headroom. The figure below illustrates the performance of the MA3 limiter.



*Spike is a registered trademark of National Semiconductor Corporation. SPiKe is an acronym for **S**elf **P**eak **I**nstantaneous (**Ke**) protection circuitry.

Rear Panel



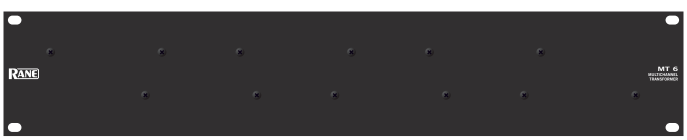
MT6 Transformer Panel

Constant-voltage transformers may be purchased individually, and up to six may be mounted in any combination on the back of a 2U high MT6 rack panel:

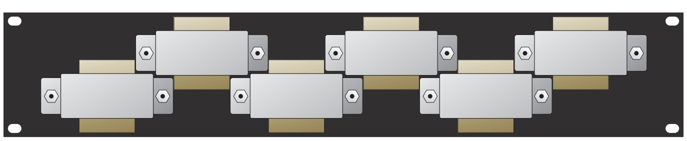
• TF407 is a 40W, 70.7V Distribution Transformer
• TF410 is a 40W, 100V Distribution Transformer

Both transformers rated at 40 watts, 50 Hz to 15k Hz ±1 dB, with 0.5 dB insertion loss. Each transformer comes with crimp-on tabs, wire nuts, and mounting screws.

For applications, see the RaneNote "Constant-Voltage Audio Distribution Systems: 25, 70.7 & 100 Volts."



MT6 front panel



MT6 rear panel with six transformers installed.

Architectural Specifications

The MA3 shall be a three channel amplifier. It shall deliver 40 watts continuous average power into 8 ohms and 60 watts continuous average power into 4 ohms. The amplifier shall have balanced inputs with Euroblock connectors and Euroblock output connectors capable of accepting 12 gauge wire. Input level controls shall allow adjustment of input sensitivity. An internal means of selecting 80 Hz highpass 2nd-order butterworth filters shall be provided. Load sensitive limiter circuits shall expand the dynamic range of the amplifiers and prevent clipping and the associated loss of speech intelligibility.

The power supply shall use a conventional linear supply with means of operating from 120 VAC 50/60 Hz or 230 VAC 50 Hz. An IEC connector with integral fuse and IEC cord shall be utilized. A front panel mounted power switch shall be provided with a "power-on" indicator.

Thermal management shall employ forced air cooling, allowing the amplifiers to operate reliable in unventilated racks at elevated ambient temperatures. The design shall incorporate a sealed heat tunnel with large aperture openings and low velocity air flow to minimize noise and eliminate the need for air filtering and the associated maintenance.

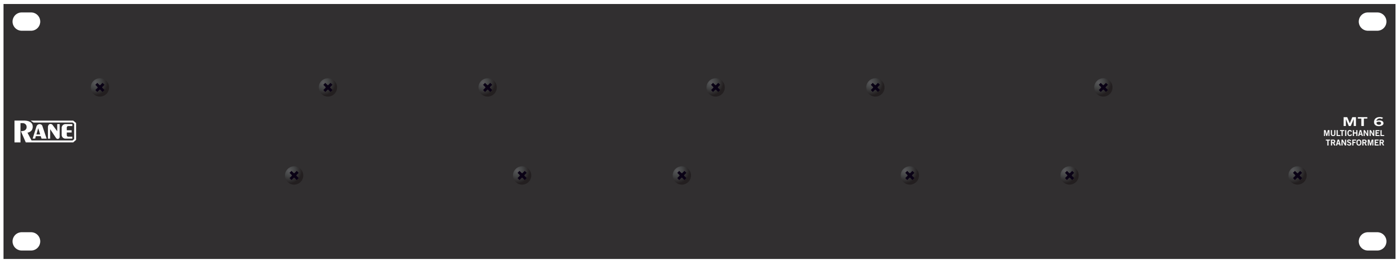
The design shall provide protection against overvoltage, undervoltage, overloads, transients from inductive loads, thermal runaway and *instantaneous* temperature peaks. Load sensitive headroom meters shall provide indication of 0, 3, 6 and 12 dB of remaining headroom.

The main chassis shall be constructed of 12 gauge, cold- rolled steel capable of reliably supporting rack mount applications. The unit shall be UL listed and cUL certified.

The unit shall be a Rane Corporation model MA3.

DATA SHEET MT6

MULTICHANNEL TRANSFORMER KIT



Front Panel

General Description

The MT6 is simply a 2U rack panel that can mount up to six distribution transformers for Rane MA3 amplifiers.

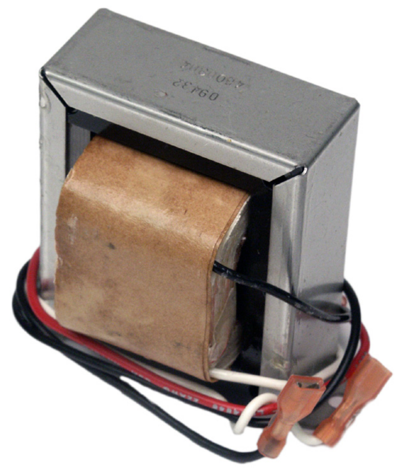
Constant-voltage transformers are purchased individually:

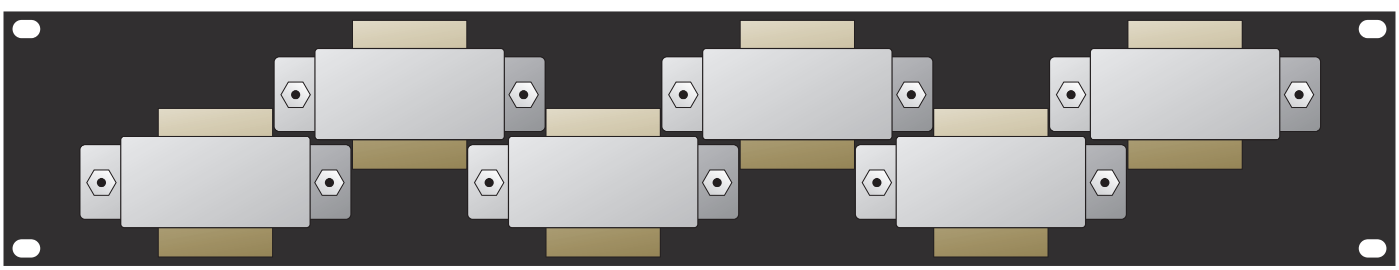
- TF407 is a 40W, 70.7V Distribution Transformer
- TF410 is a 40W, 100V Distribution Transformer

Both transformers rated at 40 watts, 50 Hz to 15k Hz ±1 dB, with 0.5 dB insertion loss. The transformer wires have insulated female tabs. To accomodate different installation preferences, each transformer includes:

- Four insulated crimp-on male tabs
- Four wire nuts
- Two mounting screws and nuts for the MT6 plate.

For applications, see the RaneNote "Constant-Voltage Audio Distribution Systems: 25, 70.7 & 100 Volts." available at rane.com.

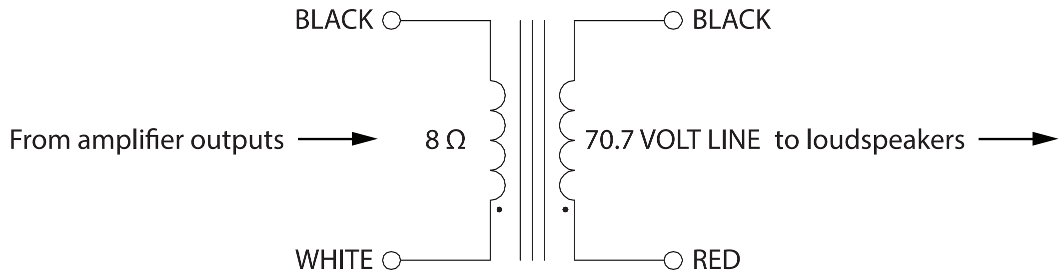




Rear Panel

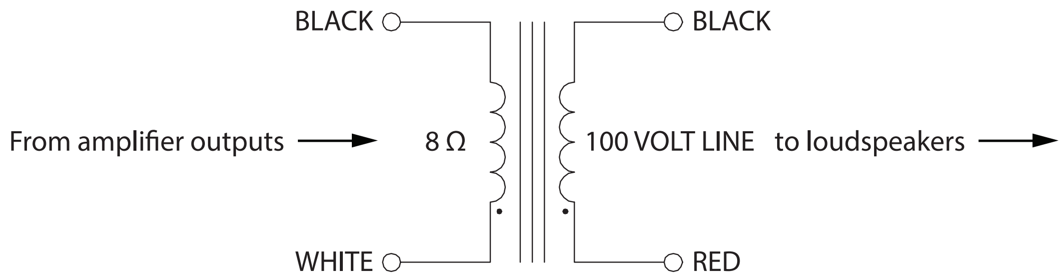
MT6 Specifications

Parameter	Specification	Limit	Units	Conditions/Comments
Unit: Panel Construction	12 gauge steel			
..........Size: 2U	3.5"H x 19"W			8.89 cm x 48.26 cm
Shipping Weight	3 lb			1.36 kg



TF407 Specifications

Parameter	Specification	Limit	Units	Conditions/Comments
Transformer Rating	40		Watts	Maximum average power
..........Connectors	0.187" Female Insulated Terminal			Includes male tabs and wire nuts
..........Wire	10" length		inch	U.L., C.S.A., 90C grade
Output Tap: Voltage	70.7		Vrms	
Frequency Response	50 Hz to 15 kHz	±1	dB	8Ω
Insertion Loss	.5	typ	dB	
Shipping Weight	3 lb			1.36 kg



TF410 Specifications

Parameter	Specification	Limit	Units	Conditions/Comments
Transformer Rating	40		Watts	Maximum average power
..........Connectors	0.187" Female Insulated Terminal			May be removed to use wire nuts
..........Wire	10" length		inch	U.L., C.S.A., 90C grade
Output Tap: Voltage	100		Vrms	
Frequency Response	50 Hz to 15 kHz	±1	dB	8Ω
Insertion Loss	.5	typ	dB	
Shipping Weight	3 lb			1.36 kg

WARNING: This product may contain chemicals known to the State of California to cause cancer, or birth defects or other reproductive harm.

Unwinding Distribution Transformers

- High Voltage Audio Distribution
- Transformers at the Power Amp End
  - Turns Ratio
  - Saturation
  - Insertion Loss
- Transformers at the Loudspeaker End
  - Impedance Matching
  - Isolation

Paul Mathews
Rane Corporation

Introduction

What could be more mundane than the transformers and autoformers that are the backbone of audio distribution systems? This article will show you that there is a lot more going on with these chunks of iron and copper than you ever suspected. Learn why **transformers are often the power bottleneck in distribution systems**, learn how to interpret datasheets, believe or disbelieve manufacturers' claims, how to specify HV components, and how to setup HV systems to deliver the best possible power, fidelity, and bandwidth.

High Voltage Audio Distribution Systems

Although the term *Constant Voltage* is still in common use, this article adopts the less confusing *High Voltage* (HV) terminology. HV systems are in widespread use for these principal reasons:

- HV systems minimize power losses in low-cost wiring.
- HV systems facilitate connection of multiple loudspeakers without careful consideration of impedance matching.
- Once an individual power adjustment on a loudspeaker has been made, the loudspeaker continually receives the same amount of power even when other loudspeakers are added or removed from the system, resulting in more constant and uniform coverage.
- Volume control by transformer tap at the loudspeaker end is more efficient than resistive pads.

Transformers at the Power Amp End
Boosting the Output Voltage

Solid state power amplifiers usually need a voltage boost to get to the 70.7 volt and 100 volt levels of most HV systems, and a transformer or autoformer will do the job. The differences between transformers and autoformers will be covered later (see the *To Isolate or Not to Isolate?* section). In the meantime, the term *transformer* will be used to refer to both types. The transformer boosts the amplifier output by a fixed ratio, called its *turns ratio.* The correct transformer will provide the right amount of boost, which is simply the desired HV system voltage, e.g., 70.7 volts, divided by the amplifier full power output voltage.

Here is the basic procedure for selecting an output transformer for an HV system where the amplifier power required P has been determined using suitable methods:

1. Determine TURNS RATIO to get proper HV level.

a) Measure the unclipped rms output voltage available from the power amplifier or calculate if from Ohm's Law:
   $V_{OUT} = \sqrt{P \times R}$
   For example, for an amplifier rated 100 watts at 8Ω:
   V_{OUT} = 28.3 Vrms

b) Calculate desired voltage boost ratio, aka *turns* ratio,
   $N = V_{HV} / V_{OUT}$, e.g., N = 70.7 / 28.3 = 2.5
   Select candidate transformers with turns ratio within 20% of calculated N and with datasheet power ratings similar to amplifier output wattage.

2. Determine TRANSFORMER SIZE to prevent *saturation*.

a) VERY IMPORTANT: Decide on the lowest system frequency f_{LC} for good fidelity and full power delivery.

b) Find datasheet ratings or conduct tests to determine voltage tolerance of candidate transformers at f_{LC}.

c) To qualify, a transformer must not saturate when driven with V_{OUT} at f_{LC}. You may or may not be able to determine this characteristic from datasheets. Read on.

The low frequency voltage capabilities of the transformer will be the primary limiting factor in system power delivery.

TURNS RATIO: Finding It on the Datasheet

Turns ratio does not show up on many datasheets, but you can usually calculate it from other specifications. From the information on a transformer datasheet, find any combination of specifications that relates primary voltage, or primary power and impedance, to secondary voltage. Use these equations, based on Ohm's Law and Joule's Law, to calculate the missing specification.

$$V_{PA} = \sqrt{P \times R} \qquad V_{HV} = N \times V_{PA} \qquad N = \frac{V_{HV}}{V_{PA}}$$

For example, from transformer datasheet specs showing "300 watts at 4Ω" (amplifier/primary side) and "70.7V output" (secondary), use the first equation to calculate power amp output voltage V_{PA} = 34.6V. Then, use the third equation to calculate
N = 2.04.

Some transformers have what their datasheets call *voltage taps*. For example, a transformer might have 25 volt, 35 volt, and 45 volt primary taps, along with 70.7 volt and 100 volt secondary taps. For any combination of primary and secondary taps, the effective turns ratio is simply the ratio of the secondary tap value to the primary tap value, as given in the third equation above.

Now that we have the Turns Ratio (Step 1 above), let's look at the other most important performance determining characteristic, which is voltage capability, usually determined by transformer size and weight.

SATURATION: What's All the Flux About?

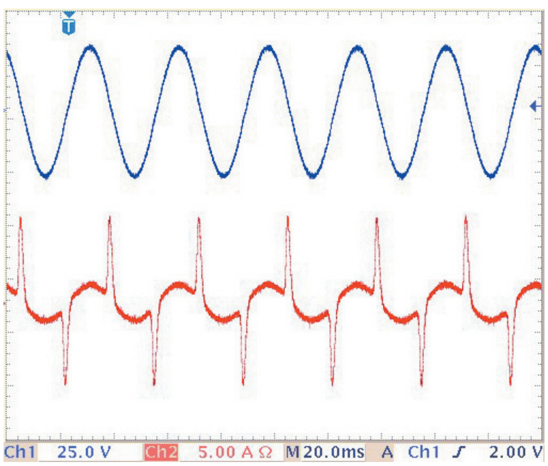
Transformers have *saturation* problems that limit their capabilities at low frequencies. In fact, a transformer that is doing a great job at 100 Hz can be an amplifier killer just an octave lower. What happens when a distribution transformer saturates? What does saturation sound like? Does this mean you have to high pass all your HV systems? These and other questions are answered here.

What Happens When a Transformer Saturates?

Transformers transfer power from winding to winding by coupling through mutual magnetic fields. This transfer of power is amazingly efficient, and it happens with or without a core. However, the iron core plays two essential roles:

1. The core *contains* the magnetic fields. Without a core, significant portions of the magnetic fields balloon out around the windings, reducing mutual coupling and potentially causing interference problems.
2. The magnetic field in the core itself *opposes uncoupled current flow in the primary.* This is why the transformer primary, even though it is made of heavy copper wire, does not normally act like a short.

Without a core, the primary **does** act like a short, and a **saturated** core is not much better than no core.

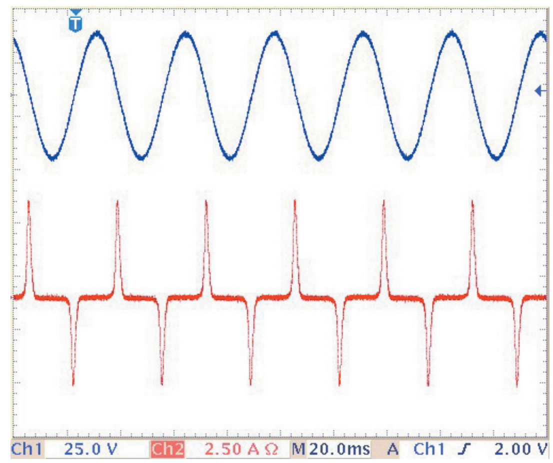


Here are the primary voltage (top) and current (bottom) oscilloscope traces for a distribution transformer entering saturation toward the end of each half cycle of input. Both waveforms should be sinusoidal, but the spikes on the current waveform are due to saturation. Notice that the power amplifier, in this case, is still doing a good job of delivering a sine wave, in spite of the current spikes. A less-robust power amplifier would show noticeable distortion coinciding with each spike. The coupling between primary and secondary is not much affected by core saturation. However, during saturation, the dc resistance of the primary suddenly appears in parallel. The power amplifier tries to maintain its output voltage, but the load impedance has taken a sudden dive.

Core saturation happens when the magnetic field in the core reaches its maximum possible density, which is what happens when the applied voltage polarity remains the same for too long.

Saturation has nothing to do with power delivery: the onset of saturation depends only on the voltage waveform applied to the primary.

To reinforce this point, the next graphic shows amplifier voltage and current with an unloaded (open circuit) secondary. The current waveform stays near zero until the volt-seconds limit of the primary is reached.



For audio signals, core saturation is more likely as you lower the frequency and raise the applied voltage. In the preceding photo, the input was 20 Vrms at 25 Hz. The onset of saturation depends on voltage and time, so expect to see a similar problem for 40 Vrms and 50 Hz.

The saturation **voltage** of a transformer rises linearly with frequency. This means that **power** handling capability declines with the inverse square of the frequency.

It should be no surprise that DC voltages are a serious problem for transformers, since DC is like zero frequency. Indeed, dc offsets of a few tens or hundreds of millivolts can asymmetrically saturate a transformer, meaning that saturation current spikes will occur primarily on one signal polarity. For this reason, some power amplifiers are a poor match to distribution transformers, This is also one reason why some manufacturers recommend installing resistors and capacitors in series with distribution transformers, further impacting low frequency response. Well-designed power amplifiers have low offsets, and well-designed transformers tolerate a reasonable level of offset.

The Sound of Saturation

When power amplifiers suddenly finds itself having to deliver massive amounts of current, most will protect themselves by throttling back their output voltage. On the better amplifiers, Safe Operating Area (SOA) circuitry kicks in. On less well-designed units, the internal power supply voltages collapse, and the amplifier circuitry is simply unable to continue to deliver a faithful signal. Some amplifiers may blow fuses or simply fail. The sound that you hear depends very much on how a particular amplifier responds to this type of overload. Most likely, you will hear badly distorted bass and/or signal drop-outs.

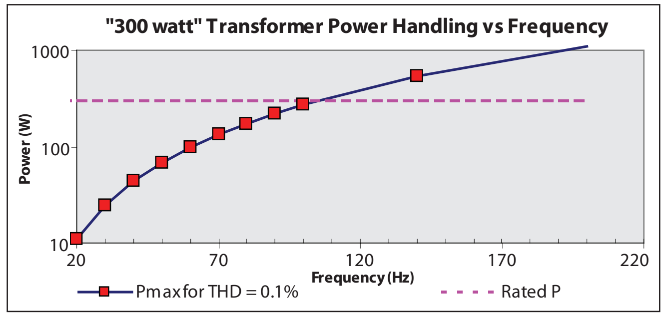
Size Matters

As with most things audio, you need larger components to handle lower frequencies, and the same is true for transformers. If other design elements are held constant, the larger cores can tolerate higher primary voltage levels, because magnetic fields produce lower flux densities over their larger cross-sectional areas. Another way to improve the voltage capability of a transformer is to increase the number of turns in each winding. However, unless the wire size is made smaller (resulting in higher resistive losses), the core may still have to be made larger to accommodate the additional turns of wire.

Many of the distribution transformers we tested would have much improved performance if their designers had simply added a few turns of wire to their design.

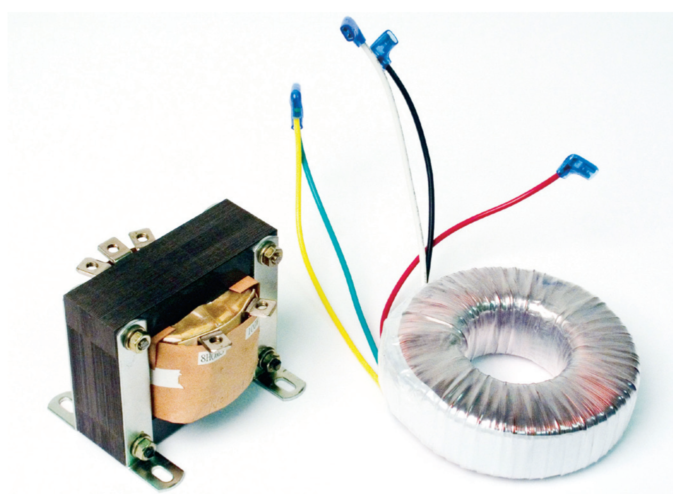
Where Does It Say *Saturation* on the Datasheet?

Unfortunately, most transformer datasheets are not much help in providing specifications for low frequency performance. Some provide a vague 'Frequency Response' range. Our tests indicate that this is usually hopelessly optimistic if not dishonest: the power bandwidth at the low end is generally much lower than the specification. Fortunately, since no secondary load is required to observe saturation, bench measurements are easy. Connect a sinewave source to the primary with a small-value resistor in series. Measure the rms voltage across the primary with a voltmeter or an oscilloscope. Similarly measure the voltage across the resistor. Start at 1 kHz and sweep downwards. Across the resistor, you should measure a small voltage (proportional to primary current) that increases slowly as you decrease frequency. At some frequency, you will observe an abrupt increase in resistor voltage, indicative of the onset of saturation. Change the drive voltage and repeat the sweep. You should be able to derive a graph like the one shown here. This particular '300 watt' transformer has a datasheet indicating "Frequency Response: 20 Hz to 20 kHz." How would you rate it?



What About High Frequencies?

From the discussion about low frequencies and saturation, you have probably guessed that saturation is not a problem at high frequencies. However, other non-ideal characteristics come into play. Stray magnetic fields, uncoupled between primary and secondary, show up as *leakage inductance* in series with the windings. Leakage inductance reduces the voltage available to the load at higher frequencies. Core losses are another phenomenon affecting high frequencies. The better cores use more expensive steels and thinner laminations. Datasheet specifications are reasonably reliable indicators of high frequency performance.



Toroidal (at right in photo) types of transformers tend to have lower leakage inductance and better high frequency performance than most E-core models (at left in photo). However, excellent performance is available from either type of core: it all depends on the details of the design.

What About Insertion Loss?

Insertion loss seems to be a mandatory specification for distribution transformers, although we find it difficult to understand why. Losses in loudspeakers themselves totally dominate most audio systems, and audio power is easy to find and cheap to buy. It is almost impossible to overheat even very lossy distribution transformers with audio program material: there is just too much iron, copper, and surface area in a transformer that is large enough to couple at low frequencies, and average audio power is so much lower than the peaks that the transformer must accommodate. Finally, the winding resistance that causes insertion loss can be a desirable feature, since it improves the transformer's tolerance for DC offsets.

Insertion loss is not useful as distribution transformer specification. Instead, focus on the a transformer's ability to deliver power at the highest and lowest required frequencies.

Transformers at the Loudspeaker End

On the secondary side of the power amplifier distribution transformer, we connect HV loudspeakers in parallel (each with its own step-down transformer), and adjust *power taps* as required to achieve required loudness in each area. System designers usually specify HV loudspeakers with integral transformers, so you might suppose that the drivers and transformers are well-matched, so why worry? It turns out that ten little 10 watt transformers in parallel can be just as troublesome as one big 100 watt transformer.

The transformer characteristics discussed above apply equally at the loudspeaker end.

Loudspeaker Step-down Transformers and Saturation

The transformers at the loudspeaker end are prone to saturation, just like their big cousins at the amplifier end. Imagine the effect of 10 or more transformers all reaching voltage saturation in parallel and at the same time. Moreover, since saturation depends only on voltage, each loudspeaker transformer should be able to withstand full HV voltage levels at the lowest system frequency, regardless of the amount of power allocated to it. This is why most HV loudspeaker modules include a series capacitor to reduce the likelihood of transformer saturation. Note, however, that these capacitors are perfectly suited to carrying saturation current spikes once those spikes begin to flow.

Is Impedance Matching Important?

For best results, adjust loudspeaker taps so that they sum to either the power amplifier output rating or to the power amplifier distribution transformer rating, whichever is smaller. This will present the proper rated load impedance to the power amplifier, allowing it to develop rated power, while minimizing saturation effects in the transformer at low frequencies.

If additional loudspeakers are added or power tap settings are increased beyond the amplifier or transformer rating, load impedance for the power amplifier will go down proportionately. However, a smaller but still linear load impedance is usually the preferred alternative to a highly nonlinear saturating transformer.

To Isolate or Not to Isolate?

Distribution transformers are available in both autoformer (non-isolating) and transformer (isolating configurations), so you have the option of isolating the loudspeaker wiring from the amplifier wiring. Here's a couple of reasons why you might want to.

Safety Isolation

Distribution transformers can provide an additional barrier between lethal mains power potentials and accessible loudspeaker terminals. HV lines from isolating transformers have no potential relationship with respect to earth ground, so that shocks are unlikely except in the event of contact with both lines at once. Some electrical inspectors require that HV lines be isolated from power amplifier outputs.

Isolation to Break Ground Loops

For the many types of audio equipment that have shielding potentials connected to safety ground, non-isolated HV loudspeaker lines occasionally provide a return path for ground loops with enormous extents. In this era of plastic loudspeaker enclosures, this is becoming more rare.

Summary

1. Selecting a Distribution Transformer at the Power Amp End:

a) Select **proper turns ratio** to boost to HV system level ***and*** to present an acceptable impedance to the power amplifier. You may have to derive turns ratio from other specs.

b) Select for adequate low frequency **voltage** capability to prevent saturation for **good low frequency power transfer**. You may have to make your own measurements.

c) Verify sufficiently low leakage inductance and low core losses for **good high frequency power transfer**. It's usually OK to use datasheet information.

2. Transformers at the Loudspeaker End:

a) Suffer from the same problems and can equally become the weak link in a system.

b) Are often 'matched' to and included with loudspeaker modules, so be aware of inherent characteristics.

3. Toroids versus E-cores: details are more important than shape.

4. Transformer isolation: can improve safety and eliminate ground loops.

Sound System Interconnection

- **Cause & prevention of ground loops**
- **Interfacing balanced & unbalanced**
- **Proper pin connections and wiring**
- **Chassis ground vs. signal ground**
- **Ground lift switches**

Rane Technical Staff

RaneNote 110

Introduction

This note, originally written in 1985, continues to be one of our most useful references. It's popularity stems from the continual and perpetual difficulty of hooking up audio equipment without suffering through all sorts of bizarre noises, hums, buzzes, whistles, etc.— not to mention the extreme financial, physical and psychological price. As technology progresses it is inevitable that electronic equipment and its wiring should be subject to constant improvement. Many things *have* improved in the audio industry since 1985, but unfortunately wiring isn't one of them. However, finally the Audio Engineering Society (AES) has issued a standards document for interconnection of pro audio equipment. It is AES48, titled *"AES48-2005: AES standard on interconnections —Grounding and EMC practices — Shields of connectors in audio equipment containing active circuitry."*

Rane's policy is to accommodate rather than dictate. However, this document contains suggestions for external wiring changes that should ideally only be implemented by trained technical personnel. Safety regulations require that all original grounding means provided from the factory be left intact for safe operation. No guarantee of responsibility for incidental or consequential damages can be provided. *(In other words, don't modify cables, or try your own version of grounding unless you really understand exactly what type of output and input you have to connect.)*

Ground Loops

Almost all cases of noise can be traced directly to ground loops, grounding or lack thereof. It is important to understand the mechanism that causes grounding noise in order to effectively eliminate it. Each component of a sound system produces its own ground internally. This ground is usually called the audio *signal* ground. Connecting devices together with the interconnecting cables can tie the signal grounds of the two units together in one place through the conductors in the cable. Ground loops occur when the grounds of the two units are also tied together in another place: via the third wire in the line cord, by tying the metal chassis together through the rack rails, etc. These situations create a circuit through which current may flow in a closed "loop" from one unit's ground out to a second unit and back to the first. It is not simply the presence of this current that creates the hum—it is when this current flows through a unit's audio signal ground that creates the hum. In fact, even without a ground loop, a little noise current always flows through every interconnecting cable (i.e., it is impossible to eliminate these currents entirely). The mere presence of this ground loop current is no cause for alarm if your system uses properly implemented and *completely* balanced interconnects, which are excellent at rejecting ground loop and other noise currents. Balanced interconnect was developed to be immune to these noise currents, which can never be entirely eliminated. What makes a ground loop current annoying is when the audio signal is affected. Unfortunately, many manufacturers of balanced audio equipment design the internal grounding system improperly, thus creating balanced equipment that is not immune to the cabling's noise currents. This is one reason for the bad reputation sometimes given to balanced interconnect.

A second reason for balanced interconnect's bad reputation comes from those who think connecting unbalanced equipment into "superior" balanced equipment should improve things. Sorry. Balanced interconnect is not compatible with unbalanced. The small physical nature and short cable runs of completely unbalanced systems (home audio) also contain these ground loop noise currents. However, the currents in unbalanced systems never get large enough to affect the audio to the point where it is a nuisance. Mixing balanced and unbalanced equipment, however, is an entirely different story, since balanced and unbalanced interconnect are truly *not compatible*. The rest of this note shows several recommended implementations for all of these interconnection schemes.

The potential or voltage which pushes these noise currents through the circuit is developed between the independent grounds of the two or more units in the system. The impedance of this circuit is low, and even though the voltage is low, the current is high, thanks to Mr. Ohm, without whose help we wouldn't have these problems. It would take a very high resolution ohm meter to measure the impedance of the steel chassis or the rack rails. We're talking thousandths of an ohm. So trying to measure this stuff won't necessarily help you. We just thought we'd warn you.

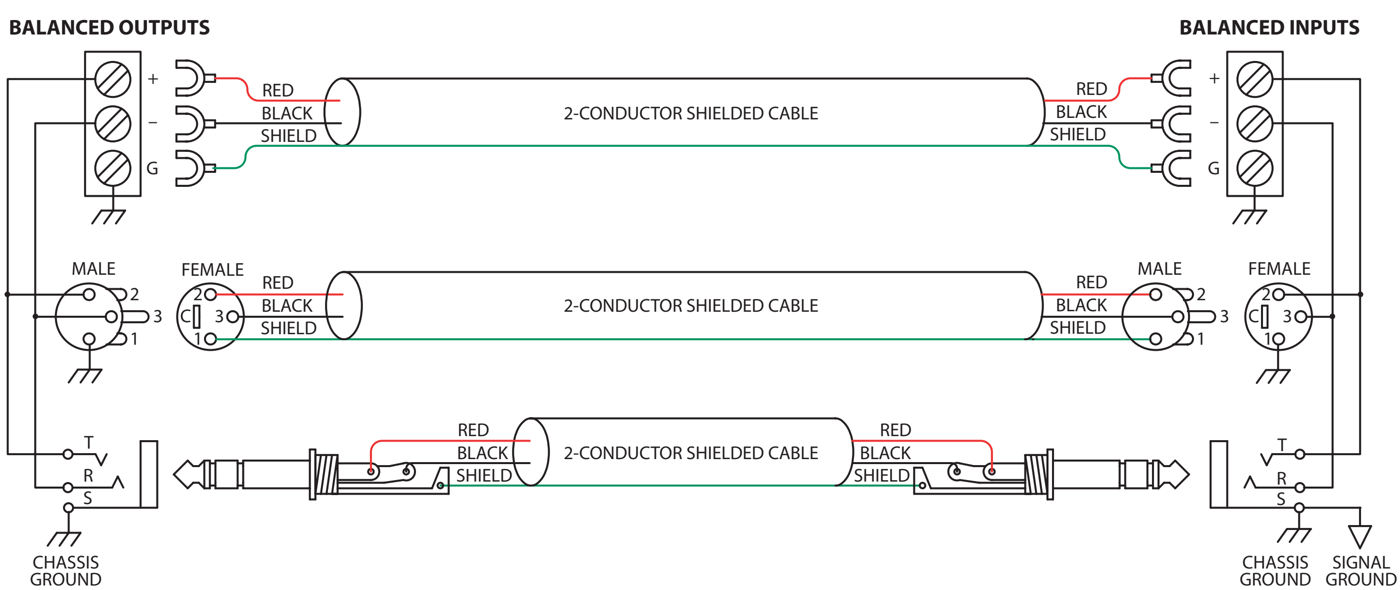


Figure 1a. The right way to do it.

The Absolute Best Right Way To Do It

The method specified by AES48 is to use balanced lines and *tie the cable shield to the metal chassis (right where it enters the chassis) at both ends of the cable.*

A balanced line requires three separate conductors, two of which are signal (+ and –) and one shield (see Figure 1a). The shield serves to guard the sensitive audio lines from interference. Only by using balanced line interconnects can you *guarantee* (yes, *guarantee*) hum-free results. Always use twisted pair cable. Chassis tying the shield at each end also *guarantees* the best possible protection from RFI [radio frequency interference] and other noises [neon signs, lighting dimmers].

Neil Muncy[1], an electroacoustic consultant and seasoned veteran of years of successful system design, chairs the AES Standards Committee (SC-05-05) working on this subject. He tirelessly tours the world giving seminars and dispensing information on how to successfully hook-up pro audio equipment[2]. He makes the simple point that it is absurd that you cannot go out and buy pro audio equipment from several different manufacturers, buy standard off-the-shelf cable assemblies, come home, hook it all up and have it work hum and noise free. *Plug and play.* Sadly, almost never is this the case, despite the science and rules of noise-free interconnect known and documented for over *60 years* (see References for complete information).

It all boils down to using balanced lines, only balanced lines, and nothing but balanced lines. This is why they were developed. Further, that you *tie the shield to the chassis, at the point it enters the chassis, and at both ends of the cable* (more on 'both ends' later).

Since standard XLR cables come with their shields tied to pin 1 at each end (the shells are not tied, nor need be), this means equipment using 3-pin, XLR-type connectors *must tie pin 1 to the chassis* (usually called chassis ground) — not the audio signal ground as is most common.

Not using *signal ground* is the most radical departure from common pro-audio practice. Not that there is any argument about its validity. There isn't. **This is the right way to do it**. So why doesn't audio equipment come wired this way? Well, some does, and since 1993, more of it does. That's when Rane started manufacturing some of its products with balanced inputs and outputs tying pin 1 to chassis. So why doesn't everyone do it this way? Because life is messy, some things are hard to change, and there will always be equipment in use that was made before proper grounding practices were in effect.

Unbalanced equipment is another problem: it is everwhere, easily available and inexpensive. All those RCA and ¼" TS connectors found on consumer equipment; effect-loops and insert-points on consoles; signal processing boxes; semi-pro digital and analog tape recorders; computer cards; mixing consoles; et cetera.

The next several pages give tips on how to successfully address hooking up unbalanced equipment. Unbalanced equipment when "blindly" connected with fully balanced units starts a pattern of hum and undesirable operation, requiring extra measures to correct the situation.

The Next Best Right Way To Do It

The quickest, quietest and most foolproof method to connect balanced and unbalanced is to **transformer isolate all unbalanced connections**. See Figure 2.

Many manufacturers provide several tools for this task, including Rane. Consult your audio dealer to explore the options available.

The goal of these adaptors is to allow the use of *standard cables.* With these transformer isolation boxes, modification of cable assemblies is unnecessary. Virtually any two pieces of audio equipment can be successfully interfaced without risk of unwanted hum and noise.

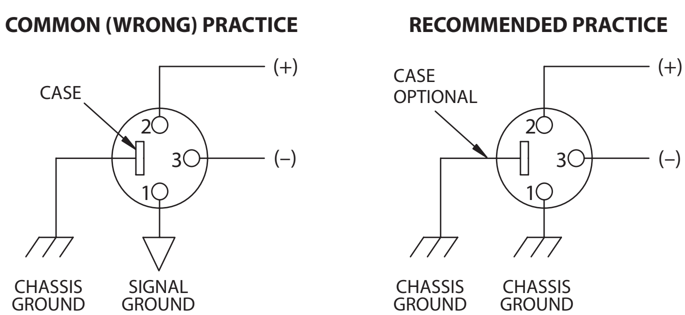


Figure 1b. Recommmended practice.

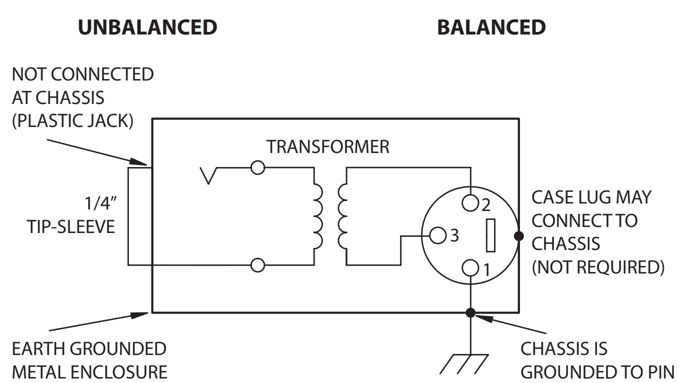


Figure 2. Transformer Isolation

Another way to create the necessary isolation is to use a *direct box.* Originally named for its use to convert the high impedance, high level output of an electric guitar to the low impedance, low level input of a recording console, it allowed the player to plug "directly" into the console. Now this term is commonly used to describe any box used to convert unbalanced lines to balanced lines.

The Last Best Right Way To Do It

If transformer isolation is not an option, special cable assemblies are a last resort. The key here is to prevent the shield currents from flowing into a unit whose grounding scheme creates ground loops (hum) in the audio path (i.e., most audio equipment).

It is true that connecting both ends of the shield is theoretically the best way to interconnect equipment –though this assumes the interconnected equipment is internally grounded properly. Since most equipment is *not* internally grounded properly, connecting both ends of the shield is not often practiced, since doing so usually creates noisy interconnections.

A common solution to these noisy hum and buzz problems involves disconnecting one end of the shield, even though one can not buy off-the-shelf cables with the shield disconnected at one end. The best end to disconnect is the receiving end. If one end of the shield is disconnected, the noisy hum current stops flowing and away goes the hum — but only at low frequencies. A ground-sending-end-only shield connection minimizes the possibility of high frequency (radio) interference since it prevents the shield from acting as an antenna to the next input. Many reduce this potential RF interference by providing an RF path through a small capacitor (0.1 or 0.01 microfarad ceramic disc) connected from the lifted end of the shield to the chassis. (This is referred to as the "hybrid shield termination" where the sending end is bonded to the chassis and the receiving end is capacitively coupled. See Neutrik's EMC-XLR for example.) The fact that many modern day installers still follow this one-end-only rule with consistent success indicates this and other acceptable solutions to RF issues exist, though the increasing use of digital and wireless technology greatly increases the possibility of future RF problems.

If you've truly isolated your hum problem to a specific unit, chances are, even though the documentation indicates proper chassis grounded shields, the suspect unit is not internally grounded properly. Here is where special test cable assemblies, shown in Figure 3, really come in handy. These assemblies allow you to connect the shield to chassis ground *at the point of entry*, or to pin 1, or to lift one end of the shield. The task becomes more difficult when the unit you've isolated has multiple inputs and outputs. On a suspect unit with multiple cables, try various configurations on each connection to find out if special cable assemblies are needed at more than one point.

See Figure 4 for suggested cable assemblies for your particular interconnection needs. Find the appropriate output configuration (down the left side) and then match this with the correct input configuration (across the top of the page.) Then refer to the following pages for a recommended wiring diagram.

Ground Lifts

Many units come equipped with ground lift switches. In only a few cases can it be shown that a ground lift switch improves ground related noise. (Has a ground lift switch ever *really* worked for you?) In reality, the presence of a ground lift switch greatly reduces a unit's ability to be "properly" grounded and therefore immune to ground loop hums and buzzes. Ground lifts are simply another Band-Aid® to try in case of grounding problems. It is true that an entire system of properly grounded equipment, without ground lift switches, is guaranteed (yes *guaranteed*) to be hum free. The problem is most equipment is *not* (both internally and externally, AC system wise) grounded properly.

Most units with ground lifts are shipped so the unit is "grounded" — meaning the chassis is connected to audio signal ground. (This should be the best and is the "safest" position for a ground lift switch.) If after hooking up your system it exhibits excessive hum or

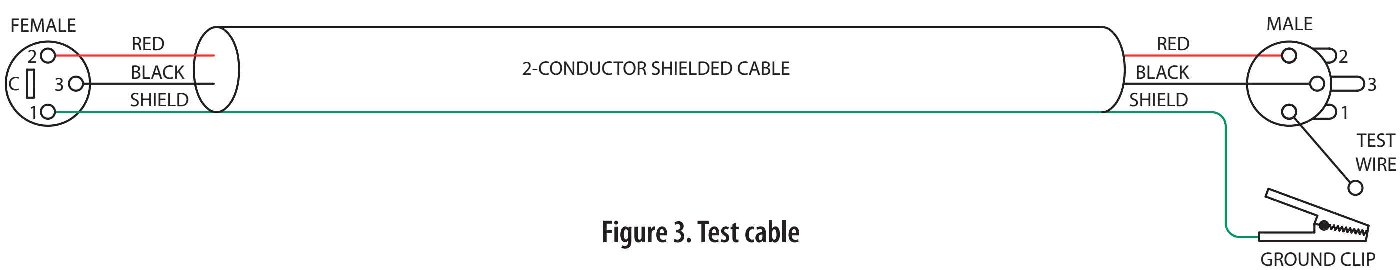


Figure 3. Test cable

buzzing, there is an incompatibility somewhere in the system's grounding configuration. In addition to these special cable assemblies that may help, here are some more things to try:

1. Try combinations of lifting grounds on units supplied with lift switches (or links). It is wise to do this with the power off!

2. If you have an entirely balanced system, verify all chassis are tied to a good earth ground, for safety's sake and hum protection. Completely unbalanced systems never earth ground anything (except cable TV, often a ground loop source). If you have a mixed balanced and unbalanced system, do yourself a favor and use isolation transformers or, if you can't do that, try the special cable assemblies described here and expect it to take many hours to get things quiet. May the Force be with you.

3. Balanced units with outboard power supplies (wall warts or "bumps" in the line cord) do *not* ground the chassis through the line cord. Make sure such units are solidly grounded by tying the chassis to an earth ground using a star washer for a reliable contact. (Rane always provides this chassis point as an external screw with a toothed washer.) Any device with a 3-prong AC plug, such as an amplifier, may serve as an earth ground point. Rack rails may or may not serve this purpose depending on screw locations and paint jobs.

Floating, Pseudo, and Quasi-Balancing

During inspection, you may run across a ¼" output called floating unbalanced, sometimes also called psuedo-balanced or quasi-balanced. In this configuration, the sleeve of the output stage is not connected inside the unit and the ring is connected (usually through a small resistor) to the audio signal ground. This allows the tip and ring to "appear" as an equal impedance, not-quite balanced output stage, even though the output circuitry is unbalanced.

Floating unbalanced often works to drive either a balanced or unbalanced input, depending if a TS or TRS standard cable is plugged into it. When it hums, a special cable is required. See drawings #11 and #12, and do not make the cross-coupled modification of tying the ring and sleeve together.

Winning the Wiring Wars

- Use balanced connections whenever possible, with the shield bonded to the metal chassis at both ends.
- Transformer isolate all unbalanced connections from balanced connections.
- Use special cable assemblies when unbalanced lines cannot be transformer isolated.
- Any unbalanced cable must be kept under 10 feet (3 m) in length. Lengths longer than this will amplify all the nasty side effects of unbalanced circuitry's ground loops.

Summary

If you are unable to do things correctly (i.e. use fully balanced wiring with shields tied to the *chassis* at both ends, or transformer isolate all unbalanced signals from balanced signals) then there is no guarantee that a hum-free interconnect can be achieved, nor is there a definite scheme that will assure noise-free operation in all configurations.

References

1. Neil A. Muncy, "Noise Susceptibility in Analog and Digital Signal Processing Systems," presented at the 97th AES Convention of Audio Engineering Society in San Francisco, CA, Nov. 1994.
2. *Grounding, Shielding, and Interconnections in Analog & Digital Signal Processing Systems: Understanding the Basics*; Workshops designed and presented by Neil Muncy and Cal Perkins, at the 97th AES Convention of Audio Engineering Society in San Francisco, CA, Nov. 1994.
3. The entire June 1995 AES Journal, Vol. 43, No. 6, available $6 members, $11 nonmembers from the Audio Engineering Society, 60 E. 42nd St., New York, NY, 10165-2520.
4. Phillip Giddings, *Audio System Design and Installation* (SAMS, Indiana, 1990).
5. Ralph Morrison, *Noise and Other Interfering Signals* (Wiley, New York, 1992).
6. Henry W. Ott, *Noise Reduction Techniques in Electronic Systems*, 2nd Edition (Wiley, New York, 1988).
7. Cal Perkins, "Measurement Techniques for Debugging Electronic Systems and Their Instrumentation," *The Proceedings of the 11th International AES Conference: Audio Test & Measurement,* Portland, OR, May 1992, pp. 82-92 (Audio Engineering Society, New York, 1992).
8. Macatee, *RaneNote*: "Grounding and Shielding Audio Devices," Rane Corporation, 1994.
9. Philip Giddings, "Grounding and Shielding for Sound and Video," *S&VC*, Sept. 20th, 1995.
10. AES48-2005: *AES standard on interconnections — Grounding and EMC practices — Shields of connectors in audio equipment containing active circuitry* (Audio Engineering Society, New York, 2005).

To Input

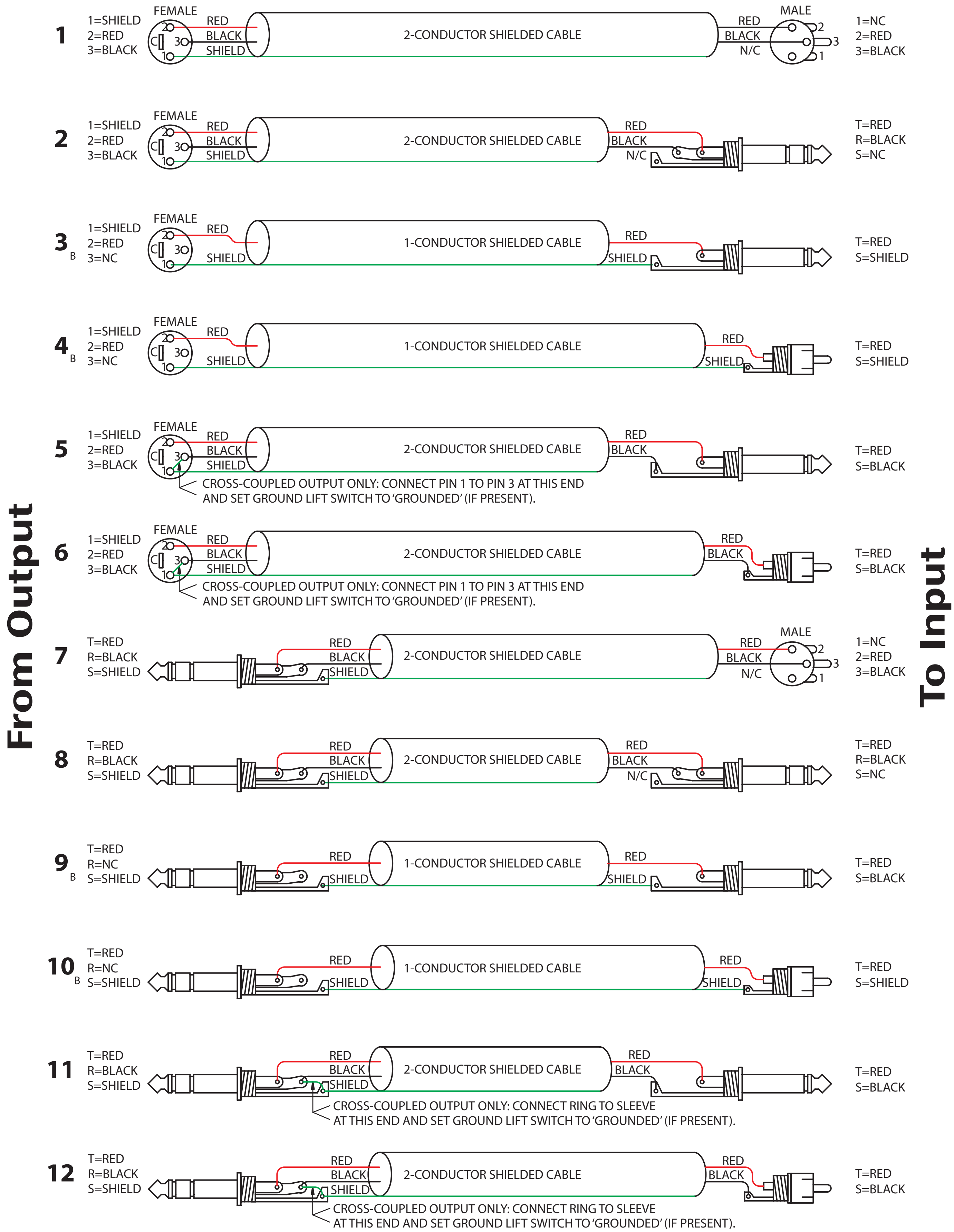
From Output

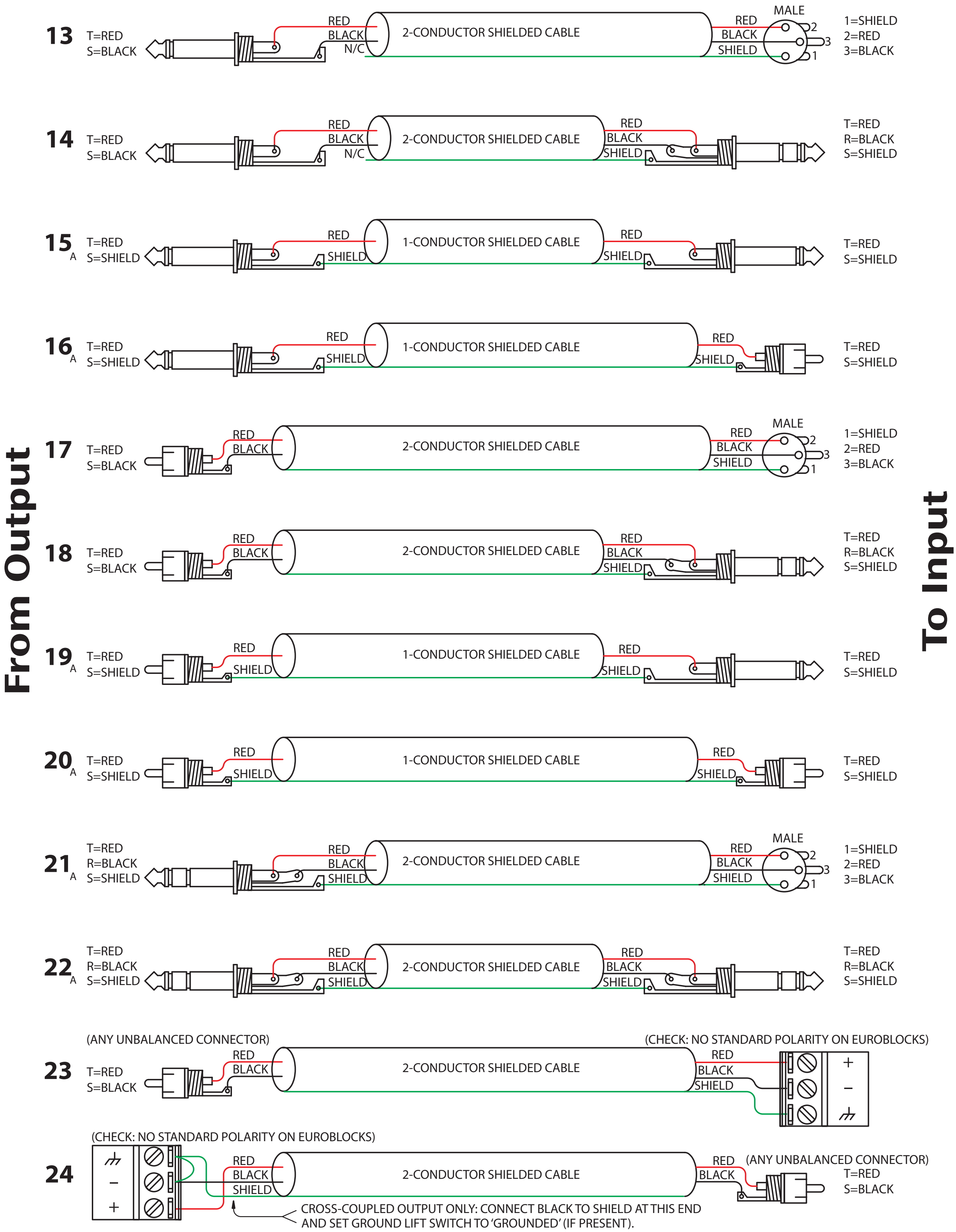
CABLE CONNECTORS	MALE BALANCED XLR	¼" BALANCED TRS (TIP-RING-SLEEVE)	¼" OR 3.5mm UNBALANCED TS (TIP-SLEEVE)	UNBALANCED RCA	BALANCED EUROBLOCK
FEMALE BALANCED XLR (NOT A TRANSFORMER, NOR A CROSS-COUPLED OUTPUT STAGE)	1	2	3[B]	4[B]	+ to + − to − SHIELD NC
FEMALE BALANCED XLR (EITHER A TRANSFORMER OR A CROSS-COUPLED OUTPUT STAGE)	1	2	5	6	+ to + − to − SHIELD NC
¼" BALANCED TRS (NOT A TRANSFORMER, NOR A CROSS-COUPLED OUTPUT STAGE)	7	8	9[B]	10[B]	+ to + − to − SHIELD ONLY TO EUROBLOCK
¼" BALANCED TRS (EITHER A TRANSFORMER OR A CROSS-COUPLED OUTPUT STAGE)	7	8	11	12	+ to + − to − SHIELD NC
¼" FLOATING UNBALANCED TRS (TIP-RING-SLEEVE) (SLEEVE IN UNIT = NC)	21[A]	22[A]	11	12	+ to + − to − GROUND to GROUND
¼" OR 3.5 mm UNBALANCED TS (TIP-SLEEVE)	13	14	15[A]	16[A]	23
UNBALANCED RCA (TIP-SLEEVE)	17	18	19[A]	20[A]	23
BALANCED EUROBLOCK	+ to + − to − SHIELD ONLY TO XLR PIN 1	+ to + − to − SHIELD ONLY TO TRS SLEEVE	24	24	+ to + − to − GROUND to GROUND

Figure 4. Interconnect chart for locating correct cable assemblies on the following pages.

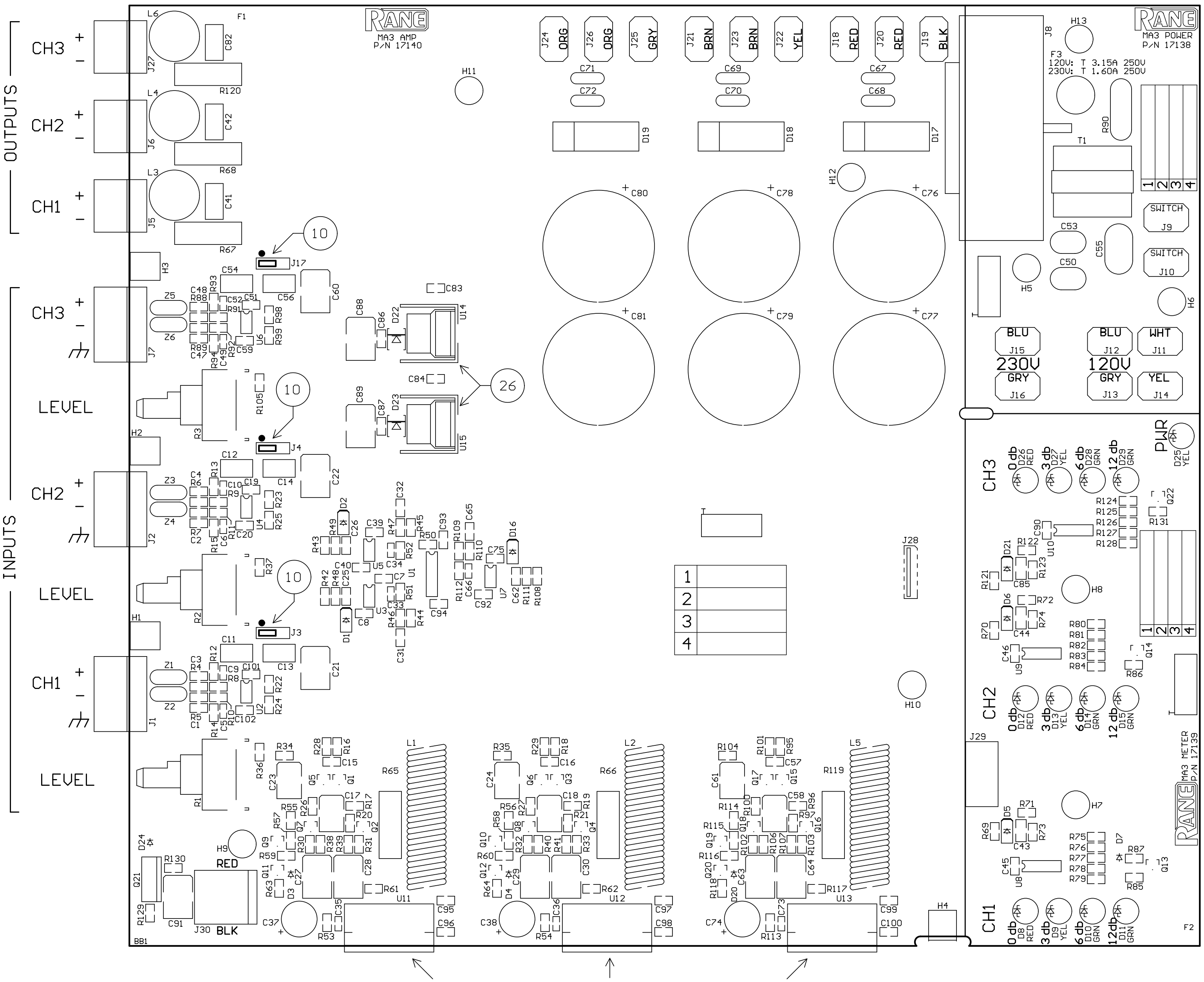
Note: (A) This configuration uses an “off-the-shelf” cable.

Note: (B) This configuration causes a 6 dB signal loss. Compensate by “turning the system up” 6 dB.

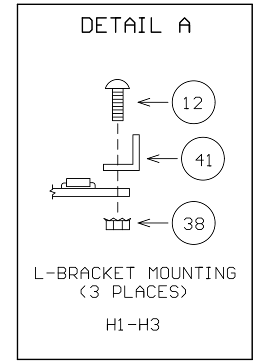

From Output
To Input
1
1=SHIELD
2=RED
3=BLACK
FEMALE
RED
BLACK
SHIELD
2-CONDUCTOR SHIELDED CABLE
RED
BLACK
N/C
MALE
1=NC
2=RED
3=BLACK
2
1=SHIELD
2=RED
3=BLACK
FEMALE
RED
BLACK
SHIELD
2-CONDUCTOR SHIELDED CABLE
RED
BLACK
N/C
T=RED
R=BLACK
S=NC
3 B
1=SHIELD
2=RED
3=NC
FEMALE
RED
SHIELD
1-CONDUCTOR SHIELDED CABLE
RED
SHIELD
T=RED
S=SHIELD
4 B
1=SHIELD
2=RED
3=NC
FEMALE
RED
SHIELD
1-CONDUCTOR SHIELDED CABLE
RED
SHIELD
T=RED
S=SHIELD
5
1=SHIELD
2=RED
3=BLACK
FEMALE
RED
BLACK
SHIELD
2-CONDUCTOR SHIELDED CABLE
RED
BLACK
CROSS-COUPLED OUTPUT ONLY: CONNECT PIN 1 TO PIN 3 AT THIS END
AND SET GROUND LIFT SWITCH TO 'GROUNDED' (IF PRESENT).
T=RED
S=BLACK
6
1=SHIELD
2=RED
3=BLACK
FEMALE
RED
BLACK
SHIELD
2-CONDUCTOR SHIELDED CABLE
RED
BLACK
CROSS-COUPLED OUTPUT ONLY: CONNECT PIN 1 TO PIN 3 AT THIS END
AND SET GROUND LIFT SWITCH TO 'GROUNDED' (IF PRESENT).
T=RED
S=BLACK
7
T=RED
R=BLACK
S=SHIELD
RED
BLACK
SHIELD
2-CONDUCTOR SHIELDED CABLE
RED
BLACK
N/C
MALE
1=NC
2=RED
3=BLACK
8
T=RED
R=BLACK
S=SHIELD
RED
BLACK
SHIELD
2-CONDUCTOR SHIELDED CABLE
RED
BLACK
N/C
T=RED
R=BLACK
S=NC
9 B
T=RED
R=NC
S=SHIELD
RED
SHIELD
1-CONDUCTOR SHIELDED CABLE
RED
SHIELD
T=RED
S=BLACK
10 B
T=RED
R=NC
S=SHIELD
RED
SHIELD
1-CONDUCTOR SHIELDED CABLE
RED
SHIELD
T=RED
S=SHIELD
11
T=RED
R=BLACK
S=SHIELD
RED
BLACK
SHIELD
2-CONDUCTOR SHIELDED CABLE
RED
BLACK
CROSS-COUPLED OUTPUT ONLY: CONNECT RING TO SLEEVE
AT THIS END AND SET GROUND LIFT SWITCH TO 'GROUNDED' (IF PRESENT).
T=RED
S=BLACK
12
T=RED
R=BLACK
S=SHIELD
RED
BLACK
SHIELD
2-CONDUCTOR SHIELDED CABLE
RED
BLACK
CROSS-COUPLED OUTPUT ONLY: CONNECT RING TO SLEEVE
AT THIS END AND SET GROUND LIFT SWITCH TO 'GROUNDED' (IF PRESENT).
T=RED
S=BLACK

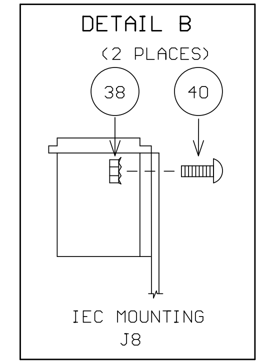

From Output
To Input
13
T=RED
S=BLACK
RED
BLACK
N/C
2-CONDUCTOR SHIELDED CABLE
RED
BLACK
SHIELD
MALE
1=SHIELD
2=RED
3=BLACK
14
T=RED
S=BLACK
RED
BLACK
N/C
2-CONDUCTOR SHIELDED CABLE
RED
BLACK
SHIELD
T=RED
R=BLACK
S=SHIELD
15 A
T=RED
S=SHIELD
RED
SHIELD
1-CONDUCTOR SHIELDED CABLE
RED
SHIELD
T=RED
S=SHIELD
16 A
T=RED
S=SHIELD
RED
SHIELD
1-CONDUCTOR SHIELDED CABLE
RED
SHIELD
T=RED
S=SHIELD
17
T=RED
S=BLACK
RED
BLACK
2-CONDUCTOR SHIELDED CABLE
RED
BLACK
SHIELD
MALE
1=SHIELD
2=RED
3=BLACK
18
T=RED
S=BLACK
RED
BLACK
2-CONDUCTOR SHIELDED CABLE
RED
BLACK
SHIELD
T=RED
R=BLACK
S=SHIELD
19 A
T=RED
S=SHIELD
RED
SHIELD
1-CONDUCTOR SHIELDED CABLE
RED
SHIELD
T=RED
S=SHIELD
20 A
T=RED
S=SHIELD
RED
SHIELD
1-CONDUCTOR SHIELDED CABLE
RED
SHIELD
T=RED
S=SHIELD
21 A
T=RED
R=BLACK
S=SHIELD
RED
BLACK
SHIELD
2-CONDUCTOR SHIELDED CABLE
RED
BLACK
SHIELD
MALE
1=SHIELD
2=RED
3=BLACK
22 A
T=RED
R=BLACK
S=SHIELD
RED
BLACK
SHIELD
2-CONDUCTOR SHIELDED CABLE
RED
BLACK
SHIELD
T=RED
R=BLACK
S=SHIELD
23
(ANY UNBALANCED CONNECTOR)
T=RED
S=BLACK
RED
BLACK
2-CONDUCTOR SHIELDED CABLE
(CHECK: NO STANDARD POLARITY ON EUROBLOCKS)
RED
BLACK
SHIELD
+
−
24
(CHECK: NO STANDARD POLARITY ON EUROBLOCKS)
−
+
RED
BLACK
SHIELD
2-CONDUCTOR SHIELDED CABLE
RED
BLACK
(ANY UNBALANCED CONNECTOR)
T=RED
S=BLACK
CROSS-COUPLED OUTPUT ONLY: CONNECT BLACK TO SHIELD AT THIS END
AND SET GROUND LIFT SWITCH TO 'GROUNDED' (IF PRESENT).

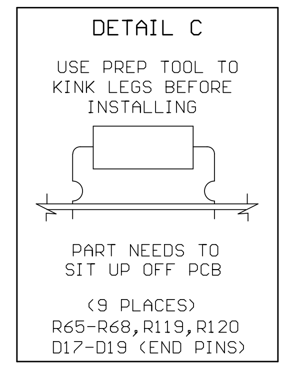
110686 FILM 1 OF 5 TOP SILKSCREEN MA3



NOTE: USE JIG TO INSTALL U11,U12,U13







NOTE:
NO MASK REQUIRED
FOR PREP

Rane Corp. (425)355-6000
110687 DES MA3
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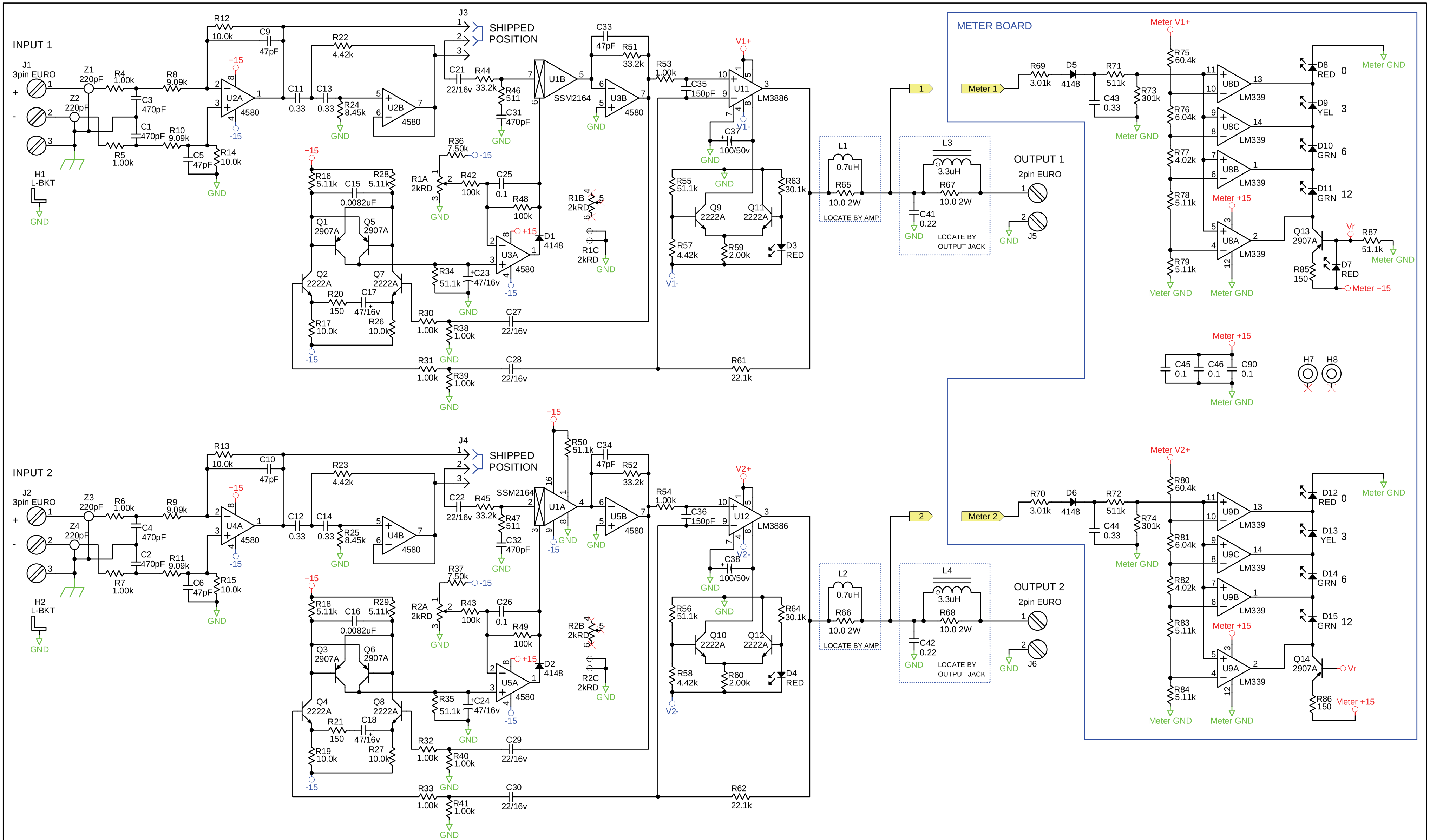

ACTION:

DRAWN BY:

CHECKED BY:

RANE
10802 47th Avenue West
Mukilteo WA 98275-5098

MA3 - CH 1 & CH 2

SHEET: 1 of 2

110689

6/27/2007
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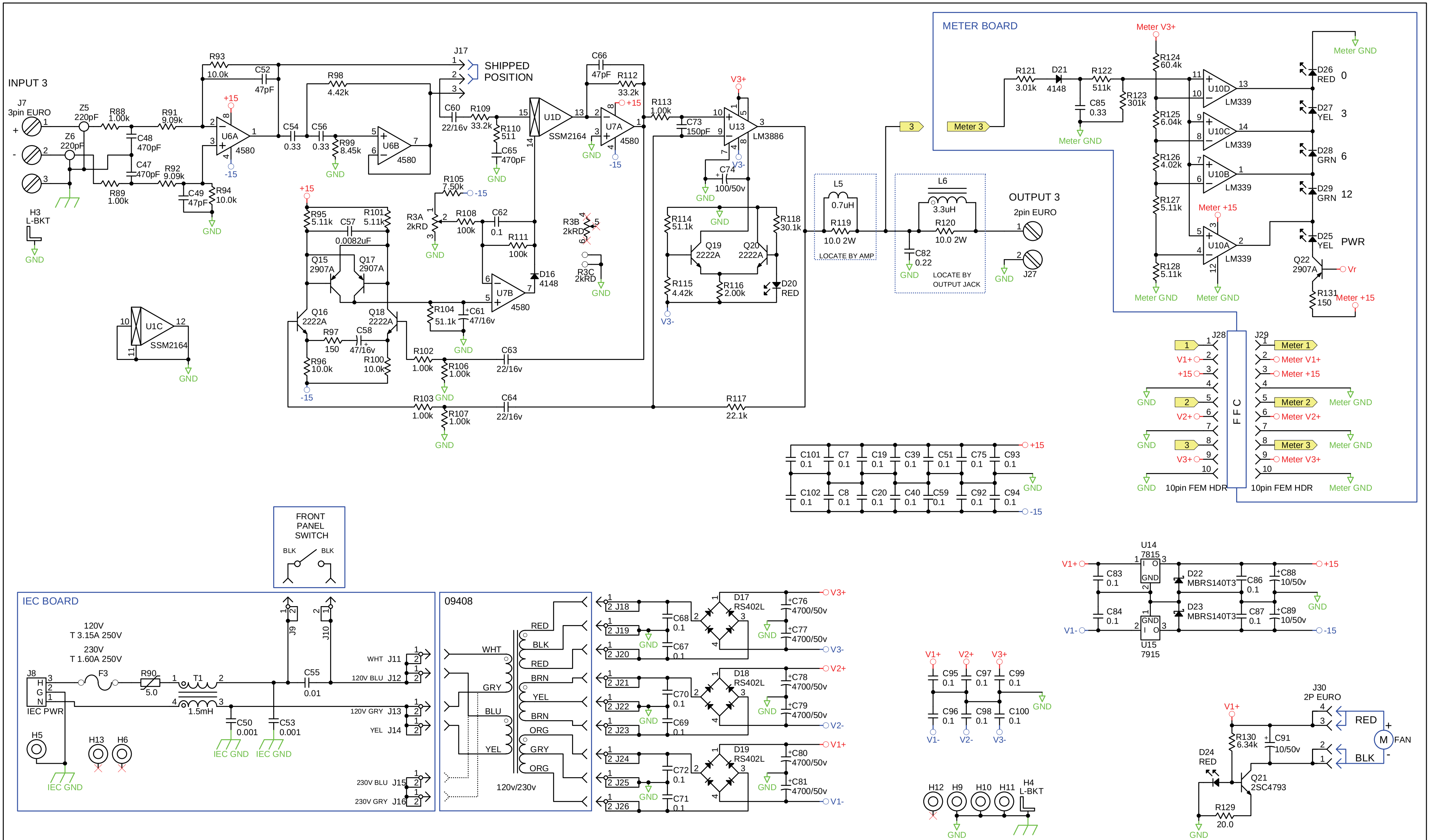

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RANE
10802 47th Avenue West
Mukilteo WA 98275-5098

MA3 - CH 3 & PWR SUPPLY

SHEET: 2 of 2

110689

Declaration of Conformity

Application of Council directive(s):

2002/96/EC
2004/108/EC
2011/65/EU

Standard(s) to which conformity is declared:

EN60065:2002 / A1:2006
EN55103-1:2009
EN55103-2:2009
EN50581:2012
ENVIRONMENT E2
SERIAL NUMBERS: 900000 - 999999

Manufacturer:

Rane Corporation
10802 47th Avenue West
Mukilteo WA 98275-5000 USA

This equipment has been tested and found to be in compliance with all applicable standards and regulations applying to the Electromagnetic Compatibility (EMC) directive 2004/108/EC. In order for the customer to maintain compliance with this regulation, high quality shielded cable must be used for interconnection to other equipment. Modification of the equipment, other than that expressly outlined by the manufacturer, is not allowed under this directive. The user of this equipment shall accept full responsibility for compliance with the EMC directive in the event that the equipment is modified without written consent of the manufacturer. This declaration of conformity is issued under the sole responsibility of Rane Corporation.

Type of Equipment: **Professional Audio Signal Processing**

Brand: **Rane**

Model: **MA3**

Immunity Results:

THD+N re: 5W/8Ω, 400 Hz sine, BW: 20-20 kHz, Baseline: -66 dBr

Test Description	Results	Conditions
RF Electromagnetic Fields Immunity		
80 MHz -1000 MHz, 1 kHz AM, 80% depth, 3V/m	< -66 dBr	80 Mhz -200 MHz
	< -50 dBr	200-1000 Mhz
Conducted RF Disturbances Immunity		
150 kHz - 80 MHz, 1 kHz AM, 80% depth, 3V RMS	< -66 dBr	Power Lines
150 kHz - 80 MHz, 1 kHz AM, 80% depth, 3V RMS	< -66 dBr	Signal Lines
Magnetic Fields Immunity		
50Hz - 10kHz, 4.0 - 0.4 A/m	< -66 dBr	50 Hz - 10 kHz

I, the undersigned, hereby declare that the equipment specified above conforms to the Directive(s) and Standard(s) shown above.

(Signature)

Michaël Rollins
(Full Name)

Compliance Engineer
(Position)

March 19, 2007
(Date)

Mukilteo WA USA
(Place)

MA3

MULTICHANNEL AMPLIFIER