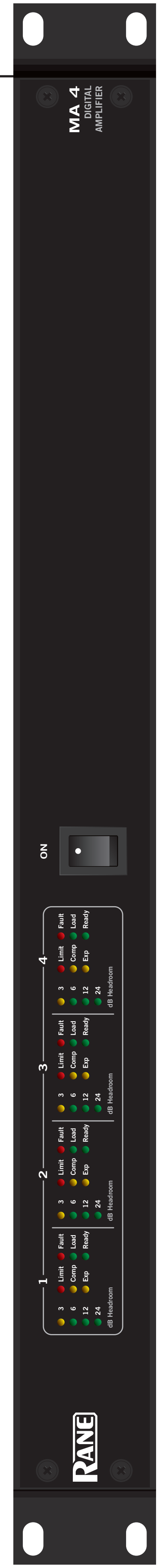
MA 4

MULTICHANNEL AMPLIFIER



CONTENTS *(in order of appearance)*

21583

IMPORTANT SAFETY INSTRUCTIONS

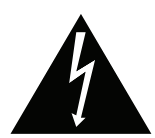
1. Read these instructions.
2. Keep these instructions.
3. Heed all warnings.
4. Follow all instructions.
5. Do not use this apparatus near water.
6. Clean only with a dry cloth.
7. Do not block any ventilation openings. Install in accordance with manufacturer's instructions.
8. Do not install near any 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

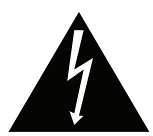
1. Lisez ces instructions.
2. Gardez précieusement ces instructions.
3. Respectez les avertissements.
4. Suivez toutes les instructions.
5. Ne pas utiliser près d'une source d'eau.
6. Ne nettoyer qu'avec un chiffon doux.
7. N'obstruer aucune évacuation d'air. Effectuez l'installation en suivant les instructions 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.

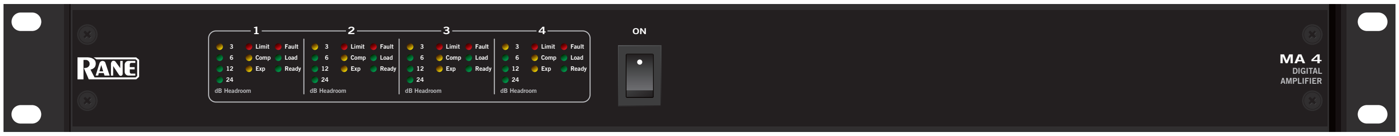
ATTENTION: Les changements ou modifications non expressément approuvés par Rane Corporation peuvent annuler l'autorité de l'utilisateur à manipuler cet équipement et rendre ainsi nulles toutes les conditions de garantie.

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

Cartons et papier à recycler.

OPERATORS MANUAL MA 4

MULTICHANNEL AMPLIFIER



Quick Start

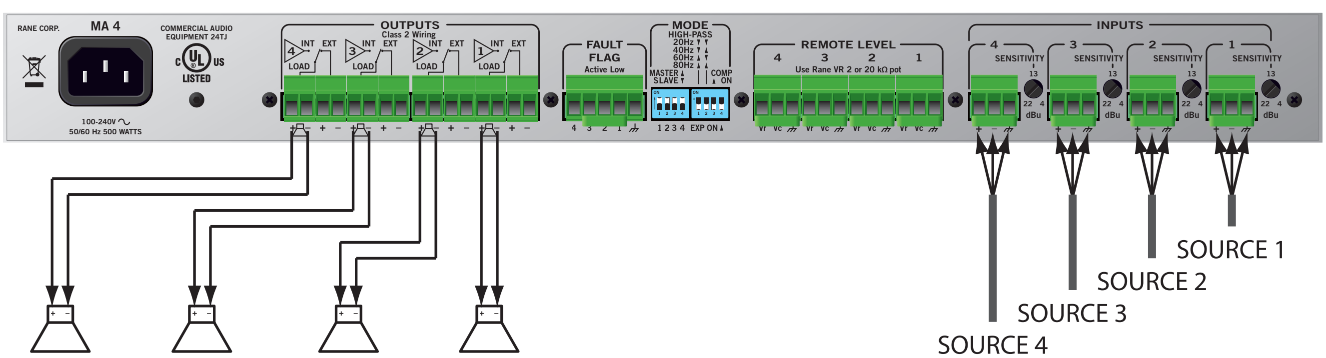
Basic MA 4 operation is straightforward:

1. The universal switching power supply works with 100 to 240 VAC, 50/60 Hz.
2. Make sure the front panel power switch is *off* (the unit consumes 5 watts in standby mode).
3. Connect balanced inputs (rear panel).
4. Set SENSITIVITY controls to +22 (see why on page Manual-2) (rear panel).
5. Turn the Downward EXPander ON (rear panel).
6. Set COMPressor to 10 dB (rear panel).
7. Select the appropriate HIGH PASS filter frequency (20, 40, 60 or 80 Hz on rear panel).
8. Connect speaker loads (rear panel).
9. Make sure you have adequate ventilation around the unit – see Safety Instructions.
10. Turn ON the front panel power switch. You're good to go!

Metering shows the status of the amplifier at a glance (see page Manual-3). Headroom (with any load), dynamics control, Fault status and Load status are indicated for each channel.

Extra Credit

For remote turn-on, fault reporting and back-up amplifier operations, and remote level control wiring, see page Manual-4.
For FAULT FLAG operation (applications and reported faults), see page Manual-3.



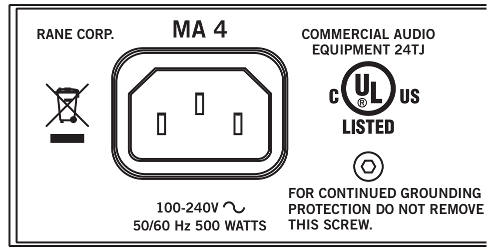
Installation

- No rear mounting hardware required.
- Allow adequate ventilation to keep ambient temperature around the amplifier below 104˚F (40˚C).
- Fan cooled with inset intake on left side and inset exhaust on right side (no filter)
- Amplifier heat load in Btu/hr at 100/240 VAC
  - 10.2 / 13.3 Btu/hr All amplifiers in standby
  - 112.3 / 95.5 Btu/hr All amplifiers on, no signal
  - 167 / 139 Btu/hr All amplifiers driven, pink noise, 12 watts avg. 4:1 crest
  - *Note: 1 watt x 3.413 = 1 Btu/hr.*

WEAR PARTS: This product contains no wear parts.

Description & Operation

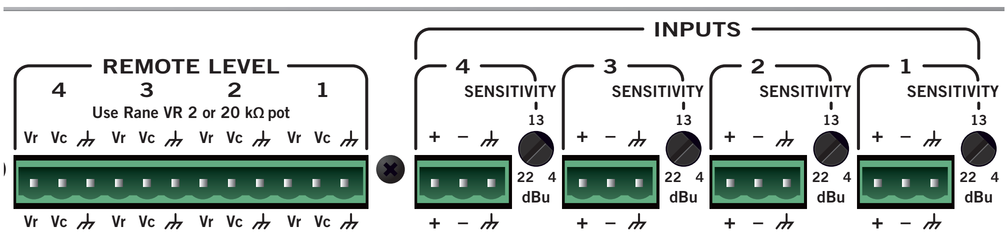
- Each channel delivers **100 watts of power** into a 4 ***or*** 8Ω load (constant power).
  - Average load impedance is estimated, then used to set the limiter to confine the maximum average power to 100 watts.



- **Universal voltage**, power-factor-corrected power supply (see figure on data sheet).
  - Switch-mode power supply operates 100 to 240 VAC, 50 Hz or 60 Hz.
  - Under- and over-voltage protection with inrush current management.
  - The power supply features an IEC appliance inlet.
  - Must be connected to a grounded mains socket-outlet.

- **Class D amplifiers** operate at up to 85% efficiency.
  - Amplifiers operate in floating Bridged configuration.
  - Channels are **not bridgeable**.
  - Balanced Inputs accept +22 dBu maximum.

- Rear panel **SENSITIVITY controls** allow continuous adjustment from +22 dBu to +4 dBu.
  - Integrated Limiter prevents clipping regardless of input level and sensitivity setting with input levels up to +22 dBu.
  - The best dynamic range is achieved when all stages in a system clip at the same time. If the signal processing in front of the amplifier clips at +22 dBu, and the amplifier sensitivity is set so that it clips at + 4 dBu, you loose 18 dB of headroom.



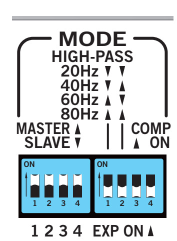
- **REMOTE DC LEVEL control inputs** are provided for each channel.
  - Audio taper attenuation with external linear pot (0 dB to –80 dB, –16 dB at center position).
  - Clickless mute with switch (use SPST switch; connect Vc to GND to mute).
  - Euroblock connector with strain relief (Vref, Vcontrol, GND).
  - One pot may control all four channels by daisy-chaining the Vc of the used port to the other three ports.

- The **Load-dependent Limiter** eliminates voltage and current clipping, ensuring signal integrity and uninterrupted service.
  - The peak signal detector for the Limiter is oversampled to insure accuracy at any frequency.
  - Instantaneous attack and 3 dB per second decay.

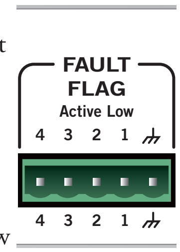
- Average load impedance is estimated and used to determine the **Limiter threshold** setting.
  - The front panel Load indicator (see metering) indicates the load status.
  - The normal impedance range is 2 to 16 Ω. (green Load indicator *on*).
  - Average load impedance is estimated over 180 ms and requires a minimum of 3.3 watts **averaged over 180 ms**.

- A s**oft-knee COMPressor** is enabled (*down*) or disabled (*up*) for all channels using the rear panel dipswitch.
  - The rms threshold is 10 dB below the Limiter threshold.
    - Allows full uncompressed operation of typical program material while reducing continuous sine wave power.
    - Soft knee span is 10 dB; Ratio is 3:1; Attack is 1.5 seconds; Decay is 3 dB per second.
  - If the internal amplifier temperature goes above 65° C, the compressor is automatically set to the 10 dB setting until the temperature drops below 55° C. At normal operating temperatures, the threshold setting follows the dipswitch setting.

- **Downward EXPander** reduces noise in the absence of signal.
  - The expander is enabled (*down*) or disabled (*up*) for all channels using the rear panel dipswitch.
  - Threshold is –70 dBFS; Ratio is 3:1; Attack time is 50 ms; Gain reduction 10 dB per second.

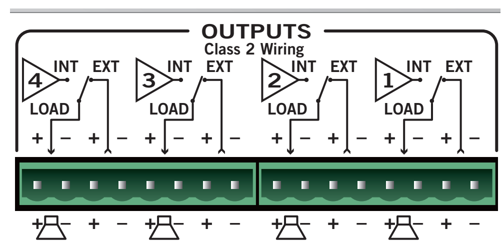


- **20, 40, 60 or 80 Hz HIGH-PASS filters** are selected using the rear panel dipswitch.
  - Setting affects all channels.
  - Filters are 12 dB per octave, Butterworth alignment.



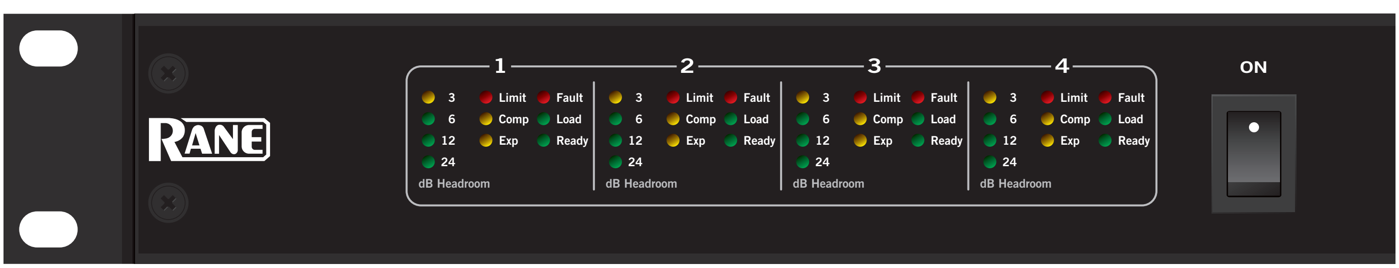
- **Individual FAULT FLAG ports** are provided for each channel.
  - When a fault is detected on power up, the channel or channels affected are not enabled, and the appropriate front panel fault indicators are lit. A detected fault is re-tested every 10 seconds.
  - When a channel develops a fault while operating, the channel shuts down and the output relay is turned OFF. A detected fault is re-tested every 10 seconds.
  - Possible faults include: supply under-voltage, over-voltage, voltage imbalance, output short to ground, output short to supply, output short to output, clock not running, over safe temperature.
  - Channels set to Master, drive the fault flag high when no fault is present. Passive pull down pulls the fault flag low when a fault occurs or power is lost. Slave channels read the status of the fault flag (see Master/Slave below).
  - The fault flag uses 5 volt logic with high-side active drive and passive pull down. No fault = +5V. Fault = 0V.

- Each channel is set for **MASTER (*up*) or SLAVE (*down*) operation** using the rear panel dipswitch.
  - Master channels write fault flag status.
  - Slave channels read fault flag status.
  - The Master setting is used for remote fault reporting and/or automatic redundancy switching control.
  - The Slave setting is used for individual channel remote power sequencing or automatic redundancy switching.



- Internal **automatic redundancy switching** is provided (see page Manual-4).
  - The primary amplifier channel is set to Master. The backup amplifier channel is set to Slave. The Master fault flag is wired to the Slave fault flag. If two different MA 4 amplifiers are involved (recommended), also wire the fault flag grounds together. Drive Master and Slave audio inputs from the same source, and set the SENSITIVITY controls the same. Master and Slave front panel power switches must be ON.
  - When a fault is detected on a Master amplifier channel, that channel is shut down, the output relay is switched to off, internally connecting the load to the EXTernal amplifier input. The front panel fault indicator is then lit.
  - The Slave channel remains in low-power standby (Ready indicator flashing) until a fault is detected (fault flag no longer driven high by the Master channel). When a fault is detected, the Slave channel performs a self test, switches to run mode, and closes the output relay (takes about 500 ms). The output of the Slave channel is connected to the EXTernal amplifier input on the Master channel.

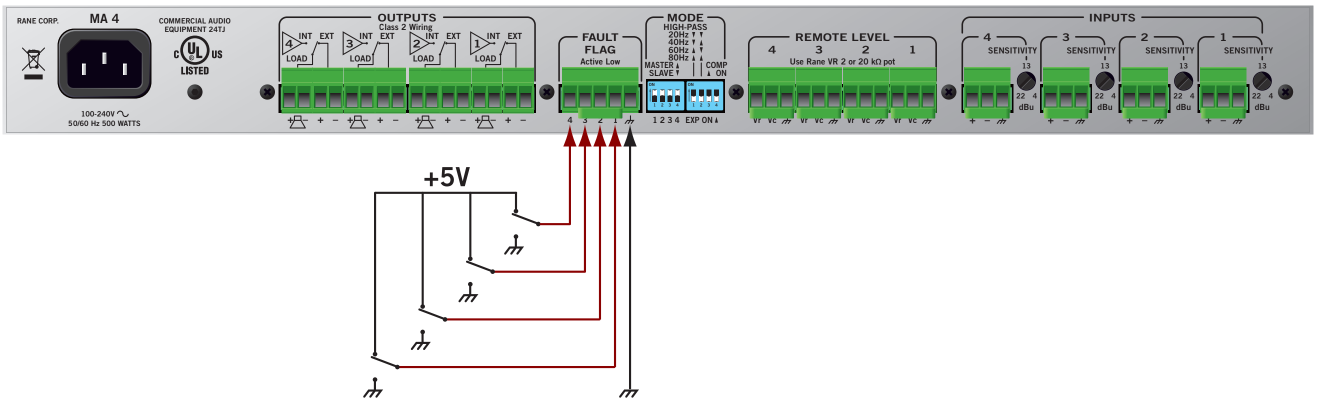
- **Comprehensive front panel metering** is included for each channel:
  - Headroom meters are four-segment. The peak signal level is compared to the limit threshold and the difference in dB is displayed as remaining headroom. The limiter threshold is adjusted to account for the average load impedance, resulting in load compensated headroom indication.
  - Red Limiter, yellow Compressor and yellow Expander indicators light when the associated dynamics control is active.
  - A red Fault indicator lights when a fault is detected
  - The green Load indicator is *off* when impedance is above 16 Ω, *on* when impedance is between 2 and 16 Ω and *flashing* when the impedance is below 2 Ω.
  - The green Ready indicator is *off* when the power switch is off, *flashing* when the power switch is on and the unit is in standby (Slave channel with high fault flag) and *on* when the channel is active.



Advanced Applications

Remote Turn-on

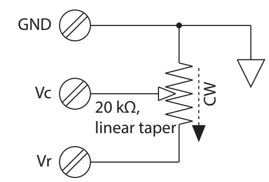
To operate an amplifier channel in low power standby with remote turn-on, set its rear panel switch to SLAVE. External +5 volts connected to the FAULT FLAG holds the amplifier in standby. Floating the FAULT FLAG or connecting it to ground turns the channel on.

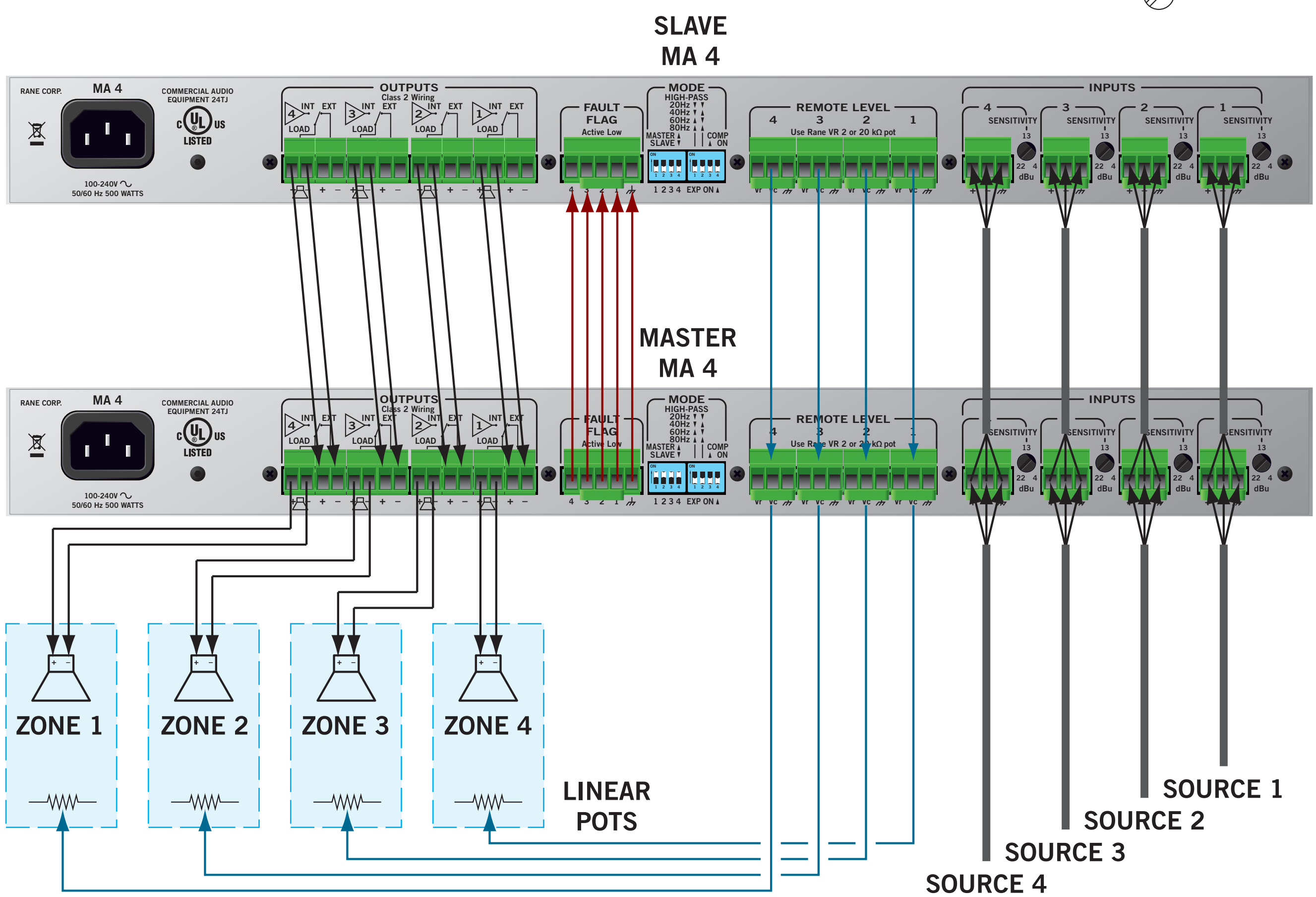


Fault Reporting

To have an amplifier channel report a fault to a control system or back up amplifier, set it to Master. The Fault Flag is held high (+5 volts) during normal operation and goes low (passive pull down) when a fault occurs. For details on Fault Flag operation, see page Manual-3.

Remote Level Control inputs are provided for each channel. Any linear potentiometer 10k to 100k Ω may be connected to these inputs (diagram at right).

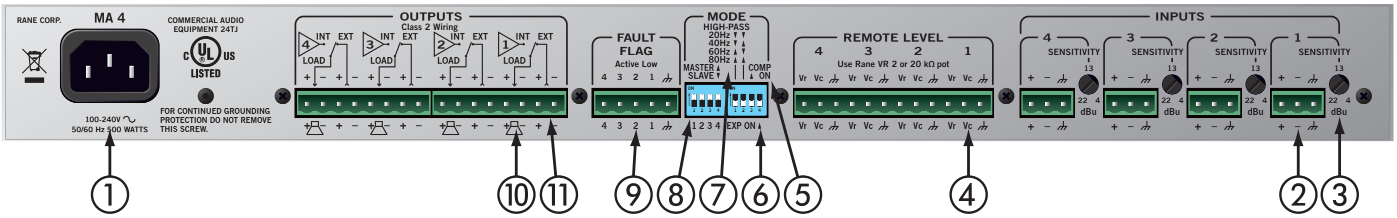




Specifications

Parameter	Specification	Conditions/Comments
Input impedance	10 kΩ	Each leg, differential, 1 kHz
Maximum input	+22 dBu	
Sensitivity range/resolution	+22 to +4 dBu	256 steps
Remote level control range/resolution	Attenuate only; 0 dB to –80 dB	Audio taper response, 256 steps
Fault flag in/out	Active 5V high-side drive, passive pull down.	NO Fault = +5V; Fault = 0V
Limiter	Oversampled instantaneous attack	3 dB per second decay
..........Load compensated	Limit set for 7.5 amps peak	Based on load Z
Compressor	50 ms rms detector	Threshold relative to limiter
..........Threshold	10 dB re peak dBFS	Rear panel dipswitch on/off
..........Attack	1.5 second	
..........Decay	3 dB per second	
..........Knee Span	10 dB	
Expander	Select on rear panel	rms detector
..........Threshold	-70 dBFS	
..........Attack	50 ms	Gain reduction release time constant
..........Decay	10 dB per second	Rate of gain reduction
High-pass filter	12 dB per octave, Butterworth	20, 40, 60, 80 Hz dipswitch select
Load sensing	2 to 16Ω normal	Green Load indicator *on*
..........Low load detect	Below 2Ω is low	Green Load indicator *flashing*
..........High load detect	Above 16Ω is high	Green Load indicator *off*
..........Min average power	3.3 watts average required for good load estimate	
Output		
..........Power	100 watts	3 to 8 Ω
..........Frequency response	20 Hz to 20 kHz	+0, -3 dB
..........Dynamic range	>90 dB	A-weighted, typical
..........THD+N	0.1% typ	100 watts into 4Ω, 20-20 kHz
..........Clock fundamental	310 kHz	<10 mV residual
..........Relay switching	Turn on mute, fault protection, redundancy switching	
Fan cooling	Temperature controlled, variable speed	Intake left side, exhaust right side
Heat load in Btu/hr		100 / 240 volts AC 50/60 Hz
..........Standby	10.2 / 13.3	
..........Run mode, no signal	112.3 / 95.5	
..........All channels driven	167 / 139	pink noise, average ⅛th power, 4:1 crest
AC Mains	100 to 240 VAC	±10%, 50 or 60 Hz
PFC	100 kHz boost	
DC/DC	200 kHz forward	
Unit: Conformity	FCC, cULus	
..........Construction	All Steel	
..........Size	1.75"H x 19"W x 9.25"D	(4.4 cm x 48.3 cm x 23.5 cm)
..........Weight:	8 lb	(3.6 kg)
Shipping: Size	4.5" x 20.3" x 13.75"	(11.5 cm x 52 cm x 35 cm)
..........Weight:	11 lb	(5 kg)

All specifications typical unless otherwise noted.

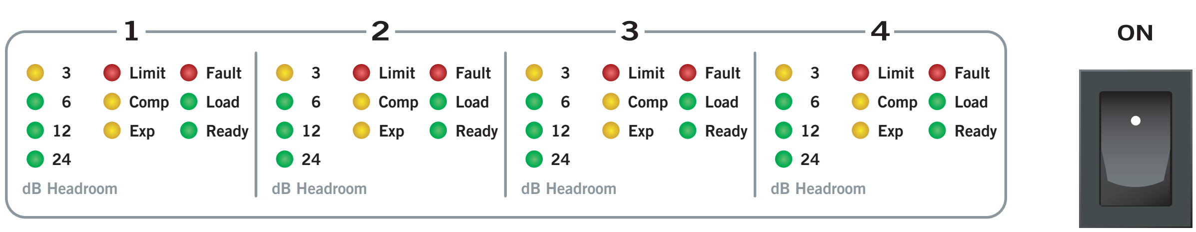


① Universal voltage, power-factor corrected, switch mode power supply operates 85 to 260 VAC, 50 Hz or 60 Hz. The supply features under and over voltage protection, low inrush current and operates with up to 85% efficiency.
② INPUTS are balanced and accept up to +22 dBu via Euroblock connectors with strain-relief.
③ SENSITIVITY controls allow continuous adjustment from +22 dBu to +4 dBu. Integrated limiter prevents clipping regardless of input level and sensitivity setting.
④ REMOTE DC LEVEL control ports with Euroblock strain-relief connectors allow audio taper attenuation using 10k to 100k Ω linear pots. Clickless muting may be implemented using a switch, connecting Vr to Vc.
⑤ A soft knee COMPressor is provided with rms threshold relative to the limit threshold. ON/off setting affects all channels. This allows uncompressed operation with typical program material while reducing continuous sine-wave power. Ratio is 3:1; Attack is 1.5 seconds; Decay is 3 dB per second; Soft knee span is 10 dB.
⑥ Downward EXPander reduces noise in the absence of signal. ON/off setting effects all channels.
  - Threshold: –70 dBFS; Ratio: 3:1; Attack: 50 ms; Gain reduction: 10dB/sec.

⑦ Selectable 20 Hz, 40 Hz, 60 Hz or 80 Hz HIGH-PASS filters are provided. The setting affects all channels. Filters are 12 dB per octave, Butterworth alignment.
⑧ Each channel is set for MASTER or SLAVE operation. Master channels write Fault Flag status. Slave channels read Fault Flag status.
  - The Master setting is used for remote fault reporting and/or automatic redundancy switching control.
  - The Slave setting is used for individual channel remote power sequencing or automatic redundancy switching.

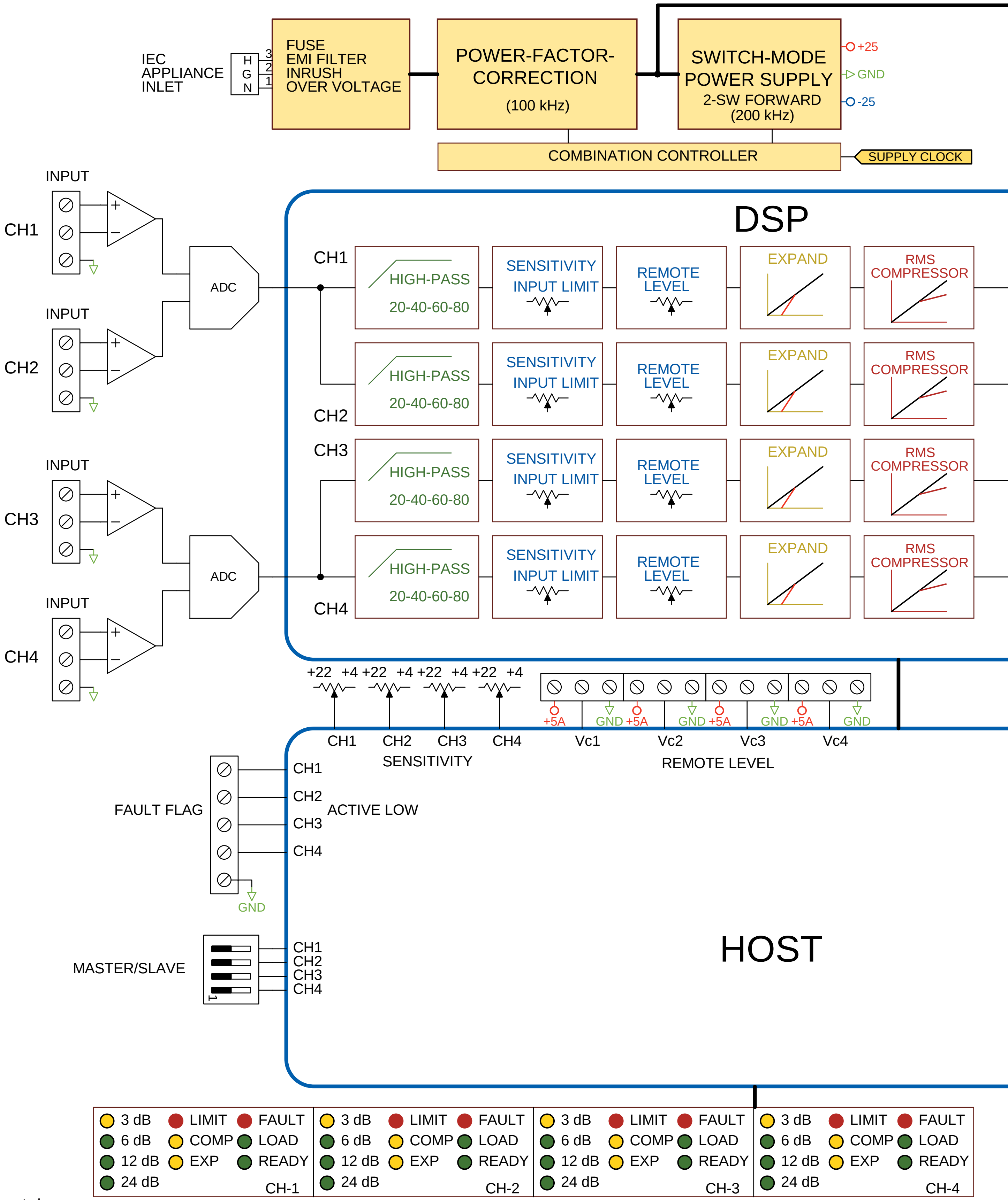
⑨ Individual FAULT FLAG ports are provided for each channel.
  - The Fault Flag uses high-side active drive and passive pull down. No fault = +5 volts. Fault = 0 volts.
  - Channels set to Master drive the Fault Flag high when no fault is present. Passive pull down pulls the Fault Flag low when a fault occurs or power is lost.
  - Slave channels read the status of the Fault Flag.

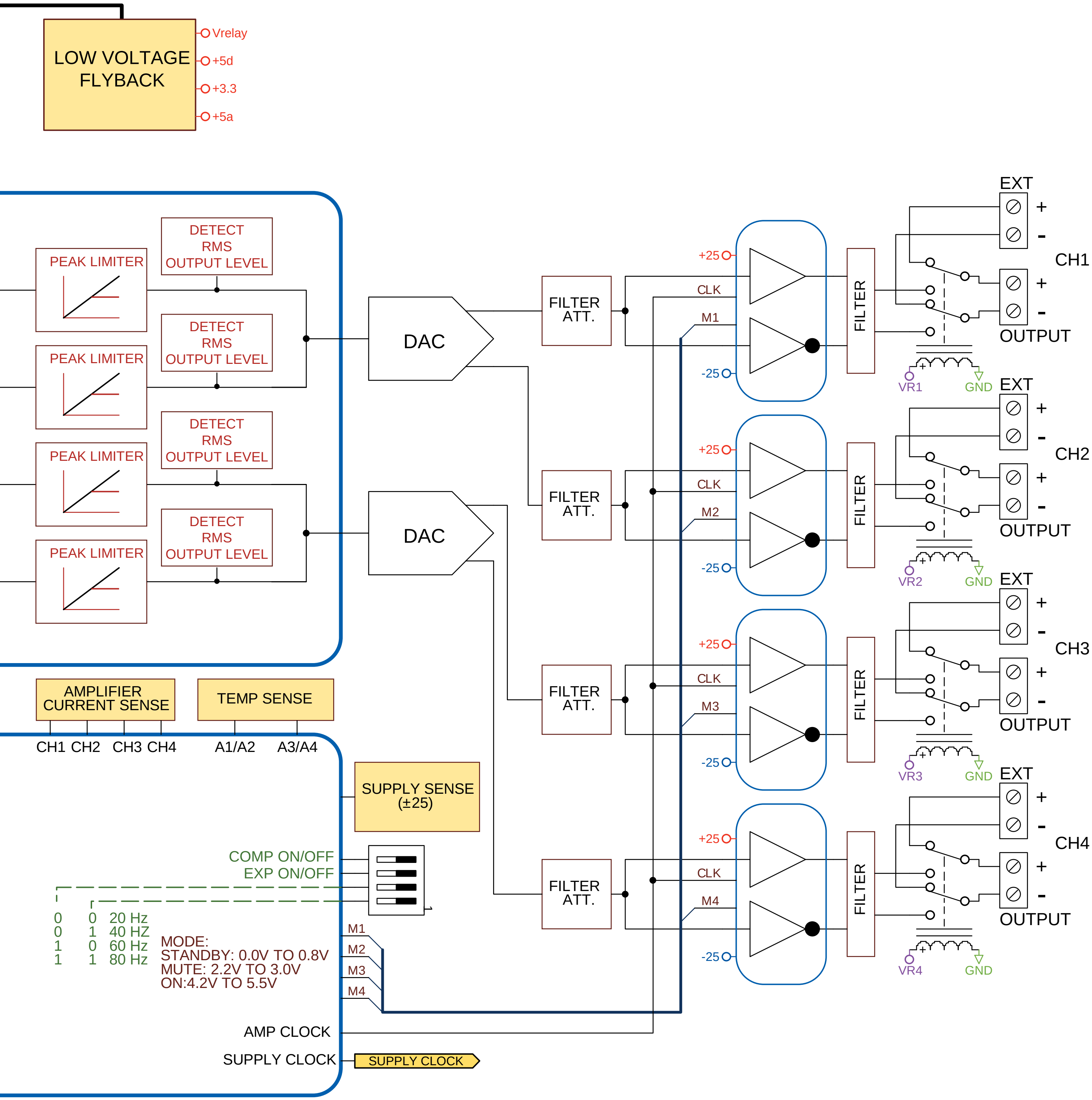
⑩ Amplifier outputs are floating (not ground referenced) and are **not** bridgeable. Each channel delivers 100 watts into a 4 or 8Ω load. Average load impedance is estimated then used to determine the limiter threshold required to limit maximum power to 100 watts and peak current to less than 7.5 amps. Impedance estimation requires a minimum of 3.3 watts and is averaged over 180 ms.
⑪ External amplifier input is used for Internal, automatic redundancy switching.
⑫ Comprehensive front panel metering is included for each channel:
  - Four segment, load sensitive headroom meter shows remaining headroom.
  - Limiter, Compressor and Expander indicators light when the associated dynamics control is active.
  - The Fault indicator lights when a fault is detected
  - The Load indicator if *off* when impedance is above 16Ω, *on* when impedance is between 2 and 16Ω and *flashing* when the impedance is below 2Ω.
  - The Ready indicator is *off* when the power switch is off, *flashing* when the power is switch is ON and the unit is in standby (Slave channel with high fault flag) and *on* when the channel is active.

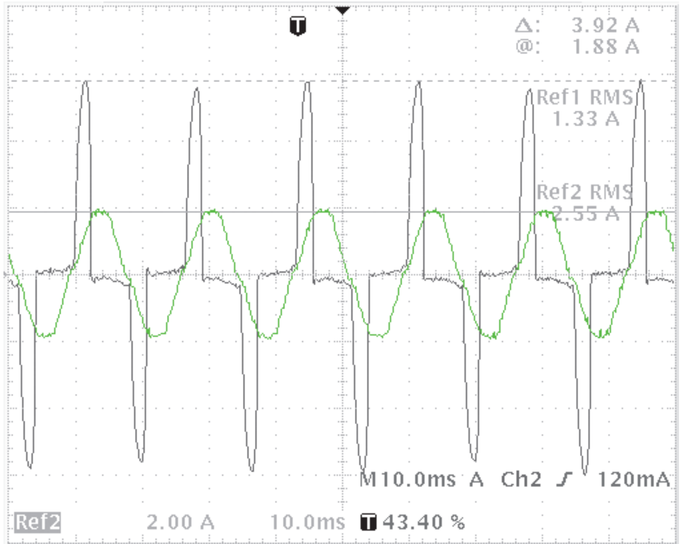


⑫

Block Diagram

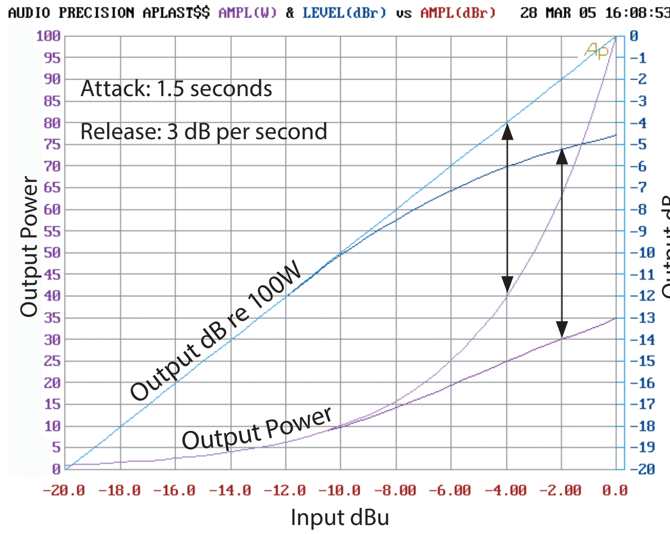



LOW VOLTAGE FLYBACK
Vrelay
+5d
+3.3
+5a
PEAK LIMITER
DETECT RMS OUTPUT LEVEL
DAC
FILTER ATT.
+25
CLK
M1
M2
M3
M4
-25
FILTER
EXT
+
-
CH1
CH2
CH3
CH4
OUTPUT
VR1
VR2
VR3
VR4
GND
AMPLIFIER CURRENT SENSE
TEMP SENSE
CH1 CH2 CH3 CH4
A1/A2 A3/A4
SUPPLY SENSE (±25)
COMP ON/OFF
EXP ON/OFF
0 0 20 Hz
0 1 40 HZ
1 0 60 Hz
1 1 80 Hz
MODE:
STANDBY: 0.0V TO 0.8V
MUTE: 2.2V TO 3.0V
ON:4.2V TO 5.5V
AMP CLOCK
SUPPLY CLOCK
SUPPLY CLOCK



Power-Factor-Correction (PFC)

Near perfect Power-Factor with ⅓ the peak current and ½ the average current (green) compared to non power-factor-corrected supply with conduction of 3 ms (black). The response is measured at 100 watts.



Compressor Response

Architectural Specifications

The unit shall be a four channel amplifier. It shall deliver 100 watts of power per channel into a 4 to 8 ohm load. The amplifier shall incorporate load sensing with normal operation in the range of 2 to 16 ohms. Front panel indicators shall alert presence of a channel load outside of this range.

The amplifier shall have balanced inputs with Euroblock connectors and Euroblock output connectors capable of accepting 12 gauge wire. Sensitivity controls with a range of +22 to +4 dBu shall be provided for each input on the rear panel by means of screwdriver adjustment. Load sensitive headroom meters shall provide indication of 3, 6, 12 and 24 dB of remaining headroom.

Euroblock connectors shall be provided as a means of connecting remote DC level potentiometers or switches to attenuate the input level of each channel.

Automatic redundancy switching shall be provided in the event of a fault of any amplifier channel. Euroblock connectors shall provide a means of connecting additional amplifier outputs for automatic backup purposes. Each channel shall have master or slave operation determined by a rear panel dipswitch. Master channels shall write fault flag status, and Slave channels shall read fault flag status.

A rear panel dipswitch shall provide a selection of 20, 40, 60 or 80 Hz highpass 2nd-order Butterworth filters. Load sensitive limiter circuits shall prevent clipping and the associated loss of speech intelligibility. A front panel LED shall indicate limiter activity within each channel.

Built-in compressors shall be provided with a 10 dB threshold. A rear panel dipswitch shall activate or deactive the compressors. A front panel LED shall indicate compressor activity within each channel.

Built-in expanders shall be provided with a -70 dBFS threshold. A rear panel dipswitch shall activate or deactive the expanders. A front panel LED shall indicate expander activity within each channel.

Euroblock connectors on the rear panel shall provide a means of transmitting or receiving fault flag information to other amplifiers or indicators with an active 5 volt drive. A front panel LED shall indicate a fault flag condition within each channel.

Thermal management shall employ forced air cooling, allowing the amplifiers to operate reliable in ventilated racks at 40°C ambient temperature. The fan speed air flow shall be controlled by temperature. Intake shall be on the left side of the chassis and exhaust on the right side, incorporating low velocity air flow to minimize noise within a rack cabinet.

The universal internal switch-mode power supply shall operate from 100 to 240 VAC, 50 or 60 Hz. The power supply design shall provide power-factor-correction with very low inrush current and overvoltage protection. An IEC connector and IEC cord shall be utilized. A front panel mounted power switch shall be provided.

The unit shall be a Rane Corporation Model MA 4.

DATA SHEET — MT 4

MULTICHANNEL TRANSFORMER

General Description

The MT 4 four-channel distribution transformer is packaged in a space saving 1U, 19-inch rack-mount tray. The fully isolated, high-performance toroid transformers provide flat frequency response within 1 dB from 40 Hz to 20 kHz. Each transformer is designed for an 8Ω 100 watt input, and 100 watt 70 volt or 100 watt 100 volt output. The recommended load for the 70 volt tap is 50 Ω. The recommended load for the 100 volt tap is 100 Ω. Convenient Euroblock connectors are provided on the rear of the chassis.

The MT 4 comes ready-to-use with four mounted transformers and strain-relief Euro connectors. The tray with Euroblock connectors (model KT 4) and individual transformers with mounting hardware (model TF 4) are available separately, allowing the installer to build a tray with just the number of channels required. (see the mounting in Figure 4, next page). This makes this ideal for any rack system where high-performance 100 watt, 100 / 70 volt, isolated distribution transformers are required.

For 25 volt audio distribution systems, the TF 4 can be used by connecting the 25V loads between its 70V and 100V taps (green and yellow wires). Thermal resistance of the TF 4 is only 1C/W and is lower when mounted in a MT 4 chassis.

Other creative combinations are possible. For example, the yellow/green pair can drive 8Ω loads near to the amplifier, with the red/yellow pair being simultaneously used for a 70 V system. Depending on loading of the 70 V system, this arrangement presents an impedance between 4 and 8Ω to the amplifier.

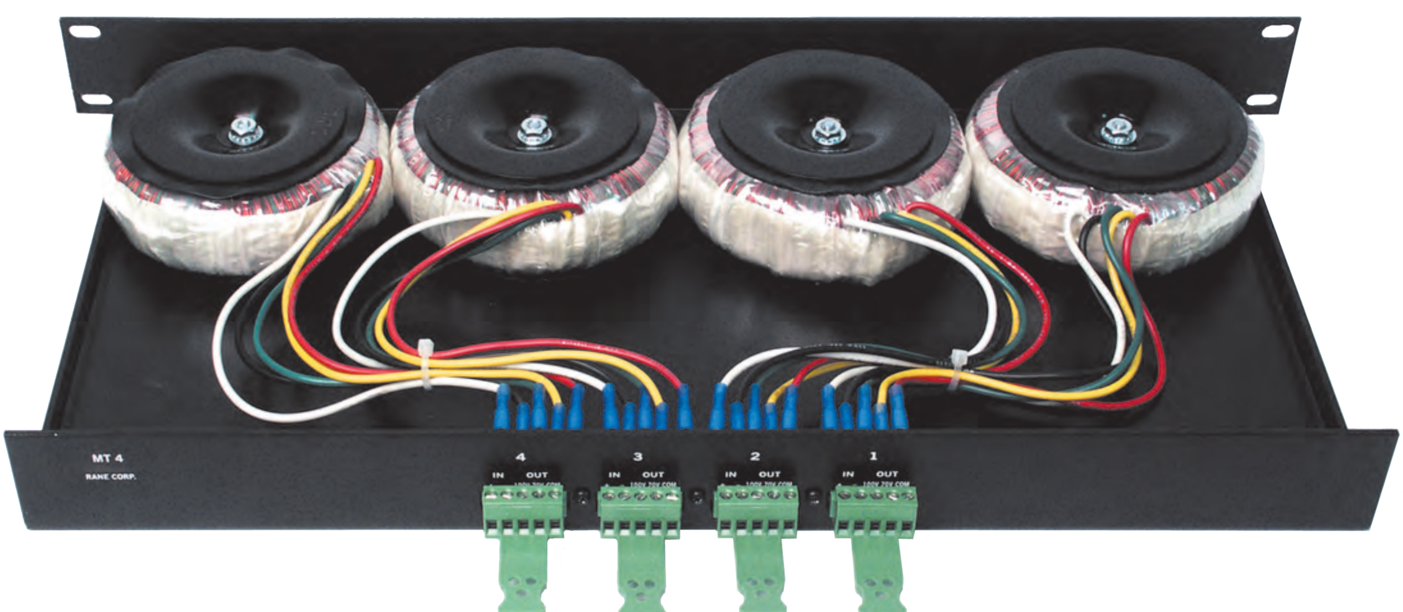
TF 4 can be used at power ratings much higher than 100 W, provided that the low-cut frequency is moved up accordingly. Since voltage capability doubles with each octave, power capability quadruples each octave. See the RaneNote "Constant-Voltage Audio Distribution Systems: 25, 70.7 & 100 Volts" available at rane.com.

Features

- Four channels, 100 watts, 100 / 70 volt
- Input 8Ω, 100 watts
- Euroblock strain-relief connectors
- 1U, 19 inch rackmount tray
- Frequency response 40 Hz to 20 kHz +0, -1 dB
- Separate mounting tray and individual transformers available

Options

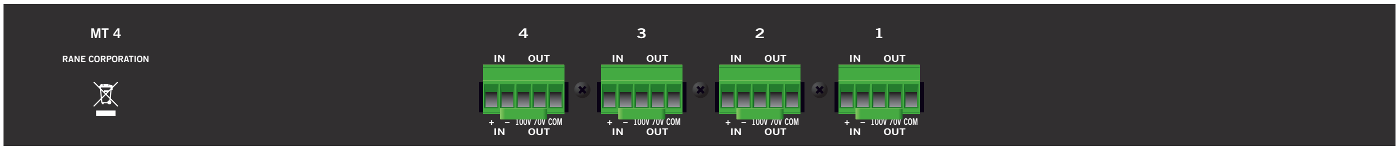
- MT 4 rackmount tray with four transformers (shown below)
- KT 4 rackmount tray only
- TF 4 individual transformers



MT 4

MULTICHANNEL TRANSFORMER

Rear Panel



Parameter	Specification	Limit	Units	Conditions/Comments
Transformer Rating	100		Watts	Maximum average power
	30		Watts	Maximum continuous average power
..........Connectors	Chassis mounted Euroblock			Strain relief
..........Chassis	1U rack-mount tray			
Input voltage	28.28		Vrms	100 watts / 8 Ω
Output Tap 1: Voltage	70.7		Vrms	50 Ω load
Output Tap 2: Voltage	100		Vrms	100 Ω load
Frequency Response	40 to 20 kHz	+0, -1	dB	100 watts with specified load
THD	0.1	typ	%	1 kHz, 100 watts
THD	0.2	typ	%	40 Hz to 20 kHz, 100 watts
Unit: Panel Construction	12 gauge steel			
..........Size: 1U	1.75"H x 19"W x 9"D			4.45 cm x 48.26 cm x 22.86 cm
..........Weight	18 lb			8.2 kg

TF 4 Transformer, 100 V / 100 W

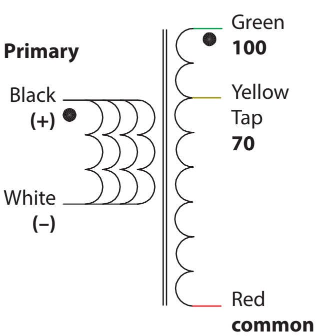


Figure 1. Schematic

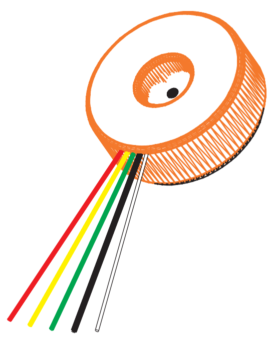


Figure 2. Perspective

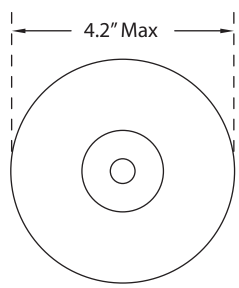


Figure 3. Top View

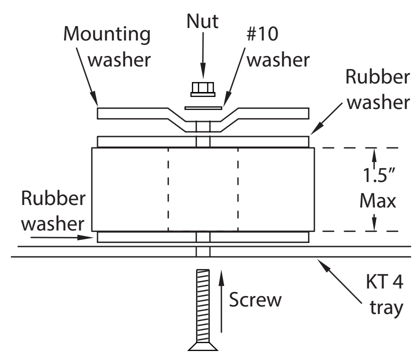


Figure 4. Mounting, Side View

Insulation & Flammability

1. Insulation materials compatible with surface operating tempertaures > 60°C.
2. All materials flammability rated UL94V0.

Electrical

1. Primary DC resistance: Black-White < 500 mΩ
2. Secondary DC resistance: Red-Yellow < 4Ω, Red-Green < 6Ω.
3. Magnetizing Inductance: Primary: > 1H (1V, 100 Hz)
4. Leakage Inductance: Primary (secondaries shorted): 20 µH.

Performance Specifications

1. Max Output Power: 100 Vrms @ 1 Arms.
2. Average Input Power (for thermal dissapation): 30 W.
3. Maximum Power Loss: <20 W @ 100 W Output (8Ω load).

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

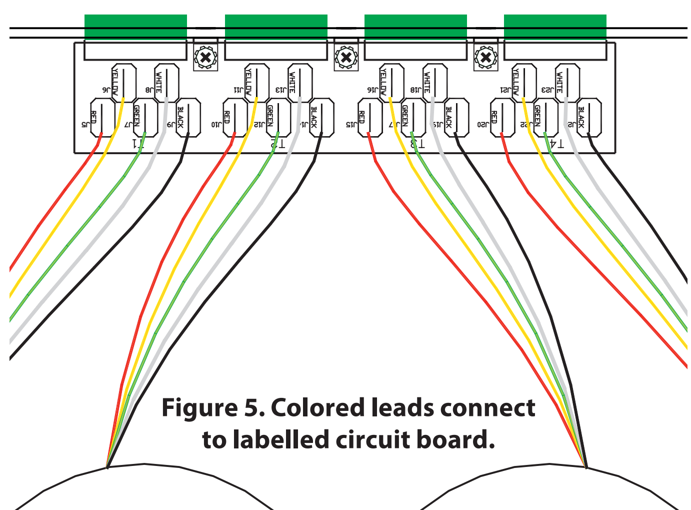


Figure 5. Colored leads connect to labelled circuit board.

All features & specifications subject to change without notice. PN 15178 DOC 108152

Constant-Voltage Audio Distribution Systems: 25, 70.7 & 100 Volts

- Background — Wellspring
- U.S. Standards — Who Says?
- Basics — What is "Constant" Anyway?
- Voltage Variations — Make Up Your Mind
- Calculating Losses — Chasing Your Tail
- Wire Size — How Big is Big Enough?
- Rane Constant-Voltage Transformers

Dennis Bohn
Rane Corporation

RaneNote 136

Background — Wellspring

Constant-voltage is the common name given to a general practice begun in the late 1920s and early 1930s (becoming a U.S. standard in 1949) governing the interface between power amplifiers and loudspeakers used in *distributed sound systems*. Installations employing ceiling-mounted loudspeakers, such as offices, restaurants and schools are examples of distributed sound systems. Other examples include installations requiring long cable runs, such as stadiums, factories and convention centers. The need to do it differently than you would in your living room arose the first time someone needed to route audio to several places over long distances. It became an economic and physical necessity. Copper was too expensive and large cable too cumbersome to do things the home hi-fi way.

Stemming from this need to minimize cost, maximize efficiency, and simplify the design of complex audio systems, thus was born constant-voltage. The key to the solution came from understanding the electric company cross-country power distribution practices. They elegantly solved the same distribution problems by understanding that what they were distributing was *power*, not voltage. Further they knew that power was voltage times current, and that power was conserved. This meant that you could change the *mix* of voltage and current so long as you maintained the same *ratio*: 100 watts was 100 watts – whether you received it by having 10 volts and 10 amps, or 100 volts and 1 amp. The idea bulb was lit. By stepping-up the voltage, you stepped-down the current, and vice-versa. Therefore to distribute 1 megawatt of power from the generator to the user, the power company steps the voltage up to 200,000 volts, runs just 5 amps through relatively small wire, and then steps it back down again at, say, 1000 different customer sites, giving each 1 kilowatt. In this manner large gauge cable is only necessary for the short direct run to each house. Very clever.

Applied to audio, this means using a transformer to step-up the power amplifier's output voltage (gaining the corresponding decrease in output current), use this higher voltage to drive the (now smaller gauge wire due to smaller current) long lines to the loudspeakers, and then using another transformer to step-down the voltage at each loudspeaker. Nothing to it.

U.S. Standards— Who Says?

This scheme became known as the *constant-voltage distribution method*. Early mention is found in *Radio Engineering, 3rd Ed.* (McGraw-Hill, 1947), and it was standardized by the American Radio Manufacturer's Association as SE-101-A & SE-106, issued in July 1949[1]. Later it was adopted as a standard by the EIA (Electronic Industries Association), and today is covered also by the *National Electric Code (NEC)*[2].

Basics — What is "Constant" Anyway?

The term "constant-voltage" is quite misleading and causes much confusion until understood. In electronics, two terms exist to describe two very different power sources: "constant-current" and "constant-voltage." Constant-current is a power source that supplies a fixed amount of current regardless of the load; so the output voltage varies, but the current remains constant. Constant-voltage is just the opposite: the voltage stays constant regardless of the load; so the output current varies but not the voltage. Applied to distributed sound systems, the term is used to describe the action of the system *at full power only*. This is the key point in understanding. *At full power the voltage on the system is constant and does not vary as a function of the number of loudspeakers driven*, that is, you may add or remove (subject to the maximum power limits) any number of loudspeakers and the voltage will remain the same, i.e., constant.

The other thing that is "constant" is the amplifier's output voltage at rated power – and *it is the same voltage for all power ratings*. Several voltages are used, but the most common in the U.S. is 70.7 volts rms. The standard specifies that all power amplifiers put out 70.7 volts at their rated power. So, whether it is a 100 watt, or 500 watt or 10 watt power amplifier, the maximum output voltage of each must be the same (constant) value of 70.7 volts.

Figure 1 diagrams the alternative series-parallel method, where, for example, nine loudspeakers are wired such that the net impedance seen by the amplifier is 8 ohms. The wiring must be selected sufficiently large to drive this low-impedance value. Applying constant-voltage principles results in Figure 2. Here is seen an output transformer connected to the power amplifier which steps-up the full-power output voltage to a value of 70.7 volts (or 100 volts for Europe), then each loudspeaker has integrally mounted step-down transformers, converting the 70.7 volts to the correct low-voltage (high current) level required by the actual 8 ohm speaker coil. It is common, although not universal, to find power (think loudness) taps at each speaker driver. These are used to allow different loudness levels in different coverage zones. With this scheme, the wire size is reduced considerably from that required in Figure 1 for the 70.7 volt connections.

Becoming more popular are various *direct-drive* 70.7 volt options as depicted in Figure 3. The output transformer shown in Figure 2 is either mounted directly onto (or inside of) the power amplifier, or it is mounted externally. In either case, its necessity adds cost, weight and bulk to the installation. An alternative is the direct-drive approach, where the power amplifier is designed from the get-go (I always wanted to use that phrase, and I sincerely apologize to all non-American readers from having done so) to put out 70.7 volts at full power. An amplifier designed in this manner does not have the current capacity to drive 8 ohm low-impedance loads; instead it has the high voltage output necessary for constant-voltage use — same power; different priorities. Quite often direct-drive designs use bridge techniques which is why two amplifier sections are shown, although single-ended designs exist. The obvious advantage of direct-drive is that the cost, weight and bulk of the output transformer are gone. The one disadvantage is that also gone is the isolation offered by a real transformer. Some installations require this isolation.

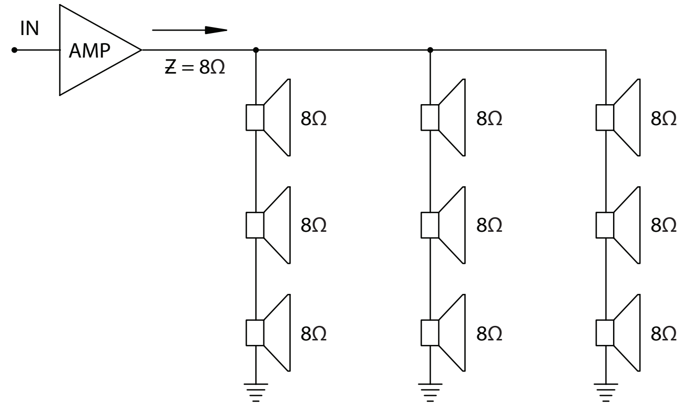


Figure 1. Low-Inpedance Series-Parallel 8Ω Direct Drive

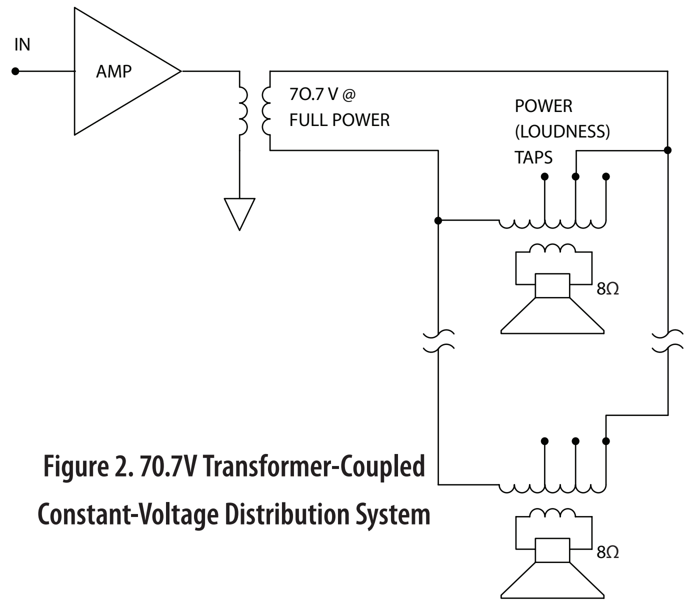


Figure 2. 70.7V Transformer-Coupled Constant-Voltage Distribution System

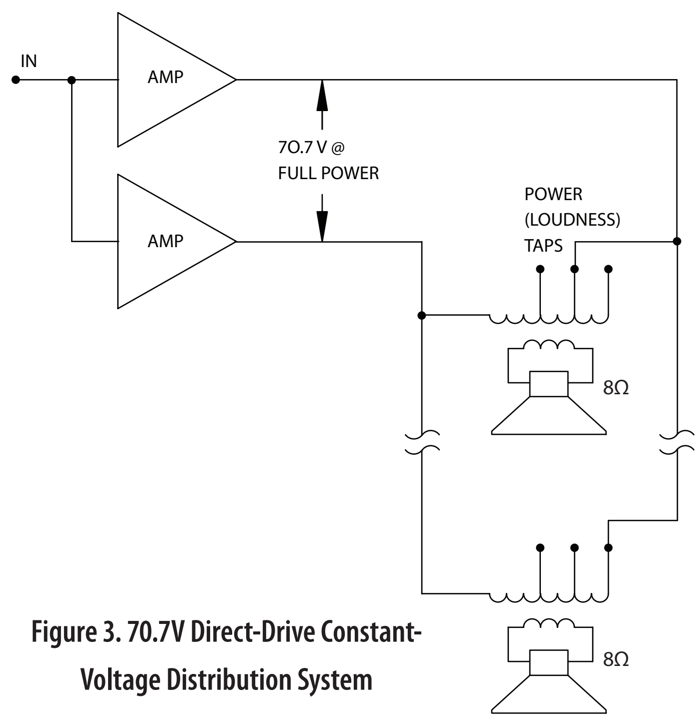


Figure 3. 70.7V Direct-Drive Constant-Voltage Distribution System

Voltage Variations — Make Up Your Mind

The particular number of *70.7* volts originally came about from the second way that constant-voltage distribution reduced costs: Back in the late '40s, UL safety code specified that all voltages above 100 volts peak ("max open-circuit value") created a "shock hazard," and subsequently *must be placed in conduit* – expensive – bad. Therefore working backward from a maximum of 100 volts peak (conduit not required), you get a maximum rms value of 70.7 volts (Vrms = 0.707 Vpeak). [It is common to see/hear/read "70.7 volts" shortened to just "70 volts" – it's sloppy; it's wrong; but it's common – accept it.] In Europe, and now in the U.S., 100 volts rms is popular. This allows use of even smaller wire. Some large U.S. installations have used as high as 210 volts rms, with wire runs of over one mile! Remember: the higher the voltage, the lower the current, the smaller the cable, the longer the line. [For the very astute reader: The wire-gauge benefits of a reduction in current exceeds the power loss increases due to the higher impedance caused by the smaller wire, due to the current-squared nature of power.] In some parts of the U.S., safety regulations regarding conduit use became stricter, forcing distributed systems to adopt a 25 volt rms standard. This saves conduit, but adds considerable copper cost (lower voltage = higher current = bigger wire), so its use is restricted to small installations.

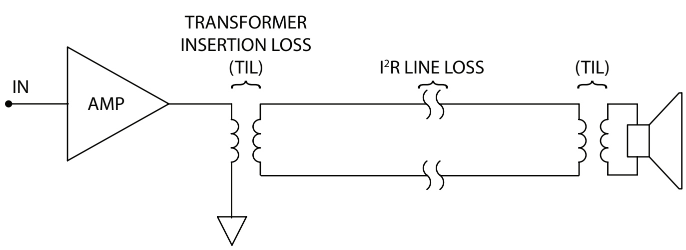


Figure 4. Transformer & Line Insertion Losses

Calculating Losses — Chasing Your Tail

As previously stated, modern constant-voltage amplifiers either integrate the step-up transformer into the same chassis, or employ a high voltage design to direct-drive the line. Similarly, constant-voltage loudspeakers have the step-down transformers built-in as diagrammed in Figures 2 and 3. The constant-voltage concept specifies that amplifiers and loudspeakers need only be rated in watts. For example, an amplifier is rated for so many watts output at 70.7 volts, and a loudspeaker is rated for so many watts input (producing a certain SPL). Designing a system becomes a relatively simple matter of selecting speakers that will achieve the target SPL (quieter zones use lower wattage speakers, or ones with taps, etc.), and then adding up the total to obtain the required amplifier power.

For example, say you need (10) 25 watt, (5) 50 watt and (15) 10 watt loudspeakers to create the coverage and loudness required. Adding this up says you need 650 watts of amplifier power – simple enough – but alas, life in audioland is never easy. Because of real-world losses, you will need about 1000 watts!

Figure 4 shows the losses associated with each transformer in the system (another vote for direct-drive), plus the very real problem of line-losses. *Insertion loss* is the term used to describe the power dissipated or lost due to heat and voltage-drops across the internal transformer wiring. This lost power often is referred to as I^2R losses, since power (in watts) is current-squared (abbreviated I^2) times the wire resistance, *R*. This same mechanism describes line-losses, since long lines add substantial total resistance and can be a significant source of power loss due to I^2R effects. These losses occur physically as heat along the length of the wire.

You can go to a lot of trouble to calculate and/or measure each of these losses to determine exactly how much power is required[3], however there is a Catch-22 involved: Direct calculation turns out to be extremely difficult and unreliable due to the lack of published insertion loss information, thus measurement is the only truly reliable source of data. The Catch-22 is that in order to measure it, you must wait until you have built it, but in order to build it, you must have your amplifiers, which you cannot order until you measure it, after you have built it!

The alternative is to apply a very seasoned rule of thumb: *Use 1.5 times the value found by summing all of the loudspeaker powers.* Thus for our example, 1.5 times 650 watts tells us we need 975 watts.

Table 1: 70.7V Loudspeaker Cable Lengths and Gauges for 1.5 dB Power Loss

	Wire Gauge >	22	20	18	16	14	12	10	8
	Max Current (A) >	5	7.5	10	13	15	20	30	45
	Max Power (W) >	350	530	700	920	1060	1400	2100	3100
Load Power	**Load Ohms**	**Maximum Distance in Feet**							
1000	5	0	0	0	0	185	295	471	725
500	10	0	93	147	236	370	589	943	1450
400	12.5	0	116	184	295	462	736	1178	1813
250	20	117	186	295	471	739	1178	1885	2900
200	25	146	232	368	589	924	1473	2356	3625
150	33.3	194	309	490	785	1231	1962	3139	4829
100	50	292	464	736	1178	1848	2945	4713	7250
75	66.6	389	618	981	1569	2462	3923	6277	9657
60	83.3	486	774	1227	1963	3079	4907	7851	12079
50	100	584	929	1473	2356	3696	5891	9425	14500
40	125	729	1161	1841	2945	4620	7363	11781	18125
25	200	1167	1857	2945	4713	7392	11781	18850	29000

Wire Size – How Big Is Big Enough?

Since the whole point of using constant-voltage distribution techniques is to optimize installation costs, proper wire sizing becomes a major factor. Due to wire resistance (usually expressed as ohms per foot, or meter) there can be a great deal of engineering involved to calculate the correct wire size. The major factors considered are the maximum current flowing through the wire, the distance covered by the wire, and the resistance of the wire. The type of wire also must be selected. Generally, constant-voltage wiring consists of a twisted pair of solid or stranded conductors with or without a jacket.

For those who like to keep it simple, the job is relatively easy. For example, say the installation requires delivering 1000 watts to 100 loudspeakers. Calculating that 1000 watts at 70.7 volts is 14.14 amps, you then select a wire gauge that will carry 14.14 amps (plus some headroom for I^2R wire losses) and wire up all 100 loudspeakers. This works, but it may be unnecessarily expensive and wasteful.

Really meticulous calculators make the job of selecting wire size a lot more interesting. For the above example, looked at another way, the task is not to deliver 1000 watts to 100 loudspeakers, but rather to distribute 10 watts each to 100 loudspeakers. These are different things. Wire size now becomes a function of the geometry involved. For example, if all 100 loudspeakers are connected up daisy-chain fashion in a continuous line, then 14.14 amps flows to the first speaker where only 0.1414 amps are used to create the necessary 10 watts; from here 14.00 amps flows on to the next speaker where another 0.1414 amps are used; then 13.86 amps continues on to the next loudspeaker, and so on, until the final 0.1414 amps is delivered to the last speaker. Well, obviously the wire size necessary to connect the last speaker doesn't need to be rated for 14.14 amps! For this example, the fanatical installer would use a different wire size for each speaker, narrowing the gauge as he went. And the problem gets ever more complicated if the speakers are arranged in an array of, say, 10 x 10, for instance.

Luckily tables exist to make our lives easier. Some of the most useful appear in Giddings[3] as Tables 14-1 and Table 14-2 on pp. 332-333. These provide cable lengths and gauges for 0.5 dB and 1.5 dB power loss, along with power, ohms, and current info. Great book. Table 1 above reproduces much of Gidding's Table 14-2[4].

Rane Constant Voltage Transformers

Rane offers several models of constant-voltage transformers. The design of each is a true transformer with separate primary and secondary windings – not a single-winding autotransformer as is sometimes encountered.

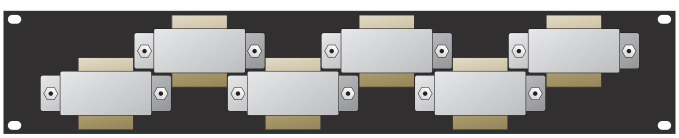
MA3 Transformers

The MA3 had a design change in February 2007 affecting whether the transformers are mounted internally or externally.

For MA3 amplifiers manufactured *after* February 2007, use the MT 6 rack panel, which can hold up to six transformers.

For MA3 amplifiers manufactured *before* February 2007, transformers are mounted internally. If you aren't sure, the older MA3 has six transformer mounting holes above the input jacks. TF 410 transformers are sold individually for either rack-mounting or direct mounting inside the MA3 chassis.

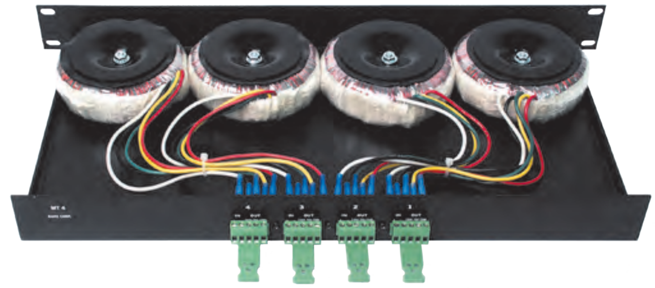
TF 410 rated 40 watts, 100 volts.



MT 6 rack panel, rear view, with six transormers installed.

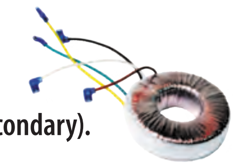
MT 4 Transformers

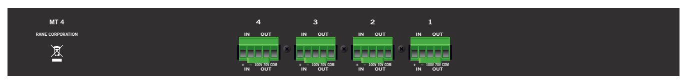
The MT 4 high performance toroidal transformers set a new standard for wideband frequency response and small size. MT 4 transformers come assembled in a 1U rack-mount open tray chassis or individually as follows:



MT 4 Four channels: 100W, 100V or 70.7V (tapped sec).

TF 4 Rated 100W, 100V or 70.7V (tapped secondary).





KT 4 Open 1U tray chassis with connectors, mounts four TF 4 transformers.

Use MT 4 transformers with *any* standard power amplifier and *any* combination of constant voltage loads up to 100 watts to improve frequency response and power handling. MT 4 transformers use premium toroidal cores and windings to deliver excellent full-power bass and a flat frequency response well above the audio range. Distributions systems noticeably deliver better audio fidelity. MT 4 transformers are also smaller and lighter than other distribution transformers.

For 25 volt audio distribution, the TF 4 can be used by connecting the 25V loads between its 70V and 100V taps. See the MT 4 Multichannel Transformer Data Sheet.

References

[1] Langford-Smith, F., Ed. *Radiotron Designer's Handbook, 4th Ed.* (RCA, 1953), p. 21.2.

[2] Earley, Sheehan & Caloggero, Eds. *National Electrical Code Handbook*, 5th Ed. (NFPA, 1999).

[3] See: Giddings, Phillip *Audio System Design and Installation* (Sams, 1990) for an excellent treatment of constant-voltage system designs criteria; also Davis, D. & C. *Sound System Engineering, 2nd Ed.* (Sams, 1987) provides a through treatment of the potential interface problems.

[4]Reproduced by permission of the author and Howard W. Sams & Co.

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.

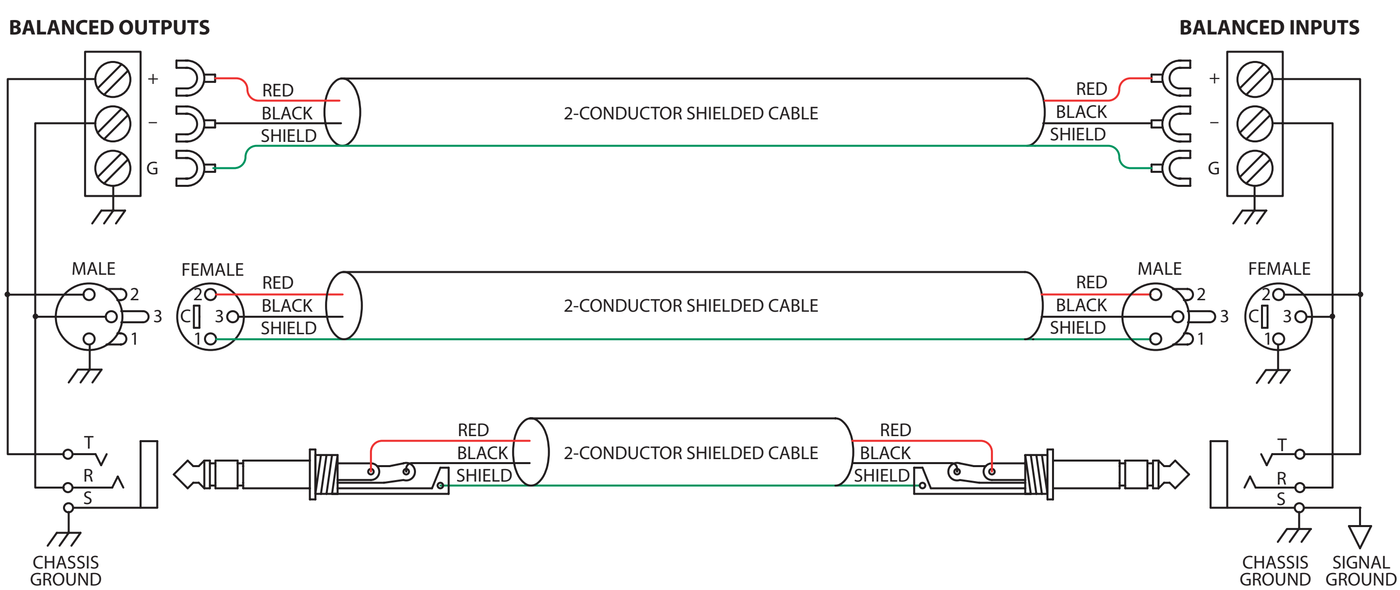


Figure 1a. The right way to do it.

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.

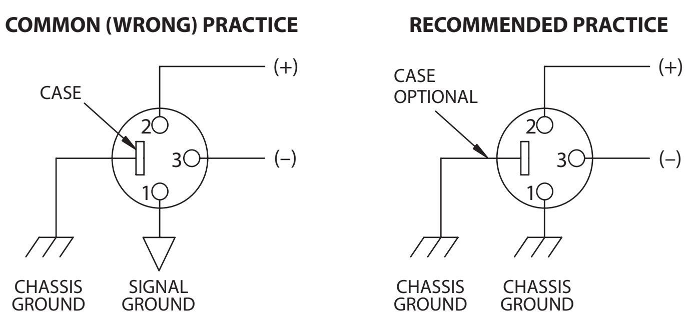


Figure 1b. Recommmended practice.

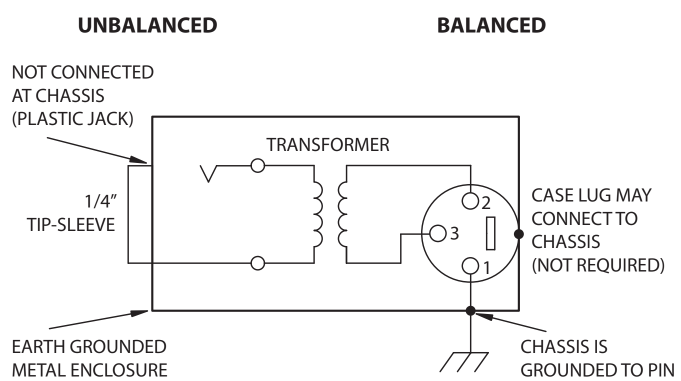


Figure 2. Transformer Isolation

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

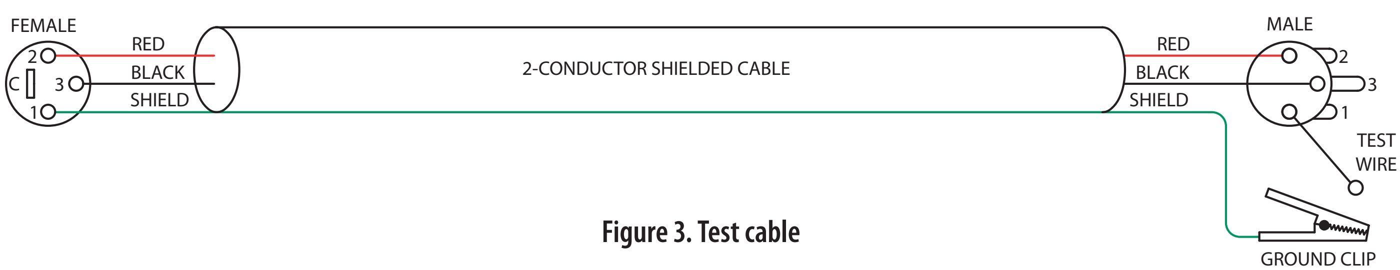


Figure 3. Test cable

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

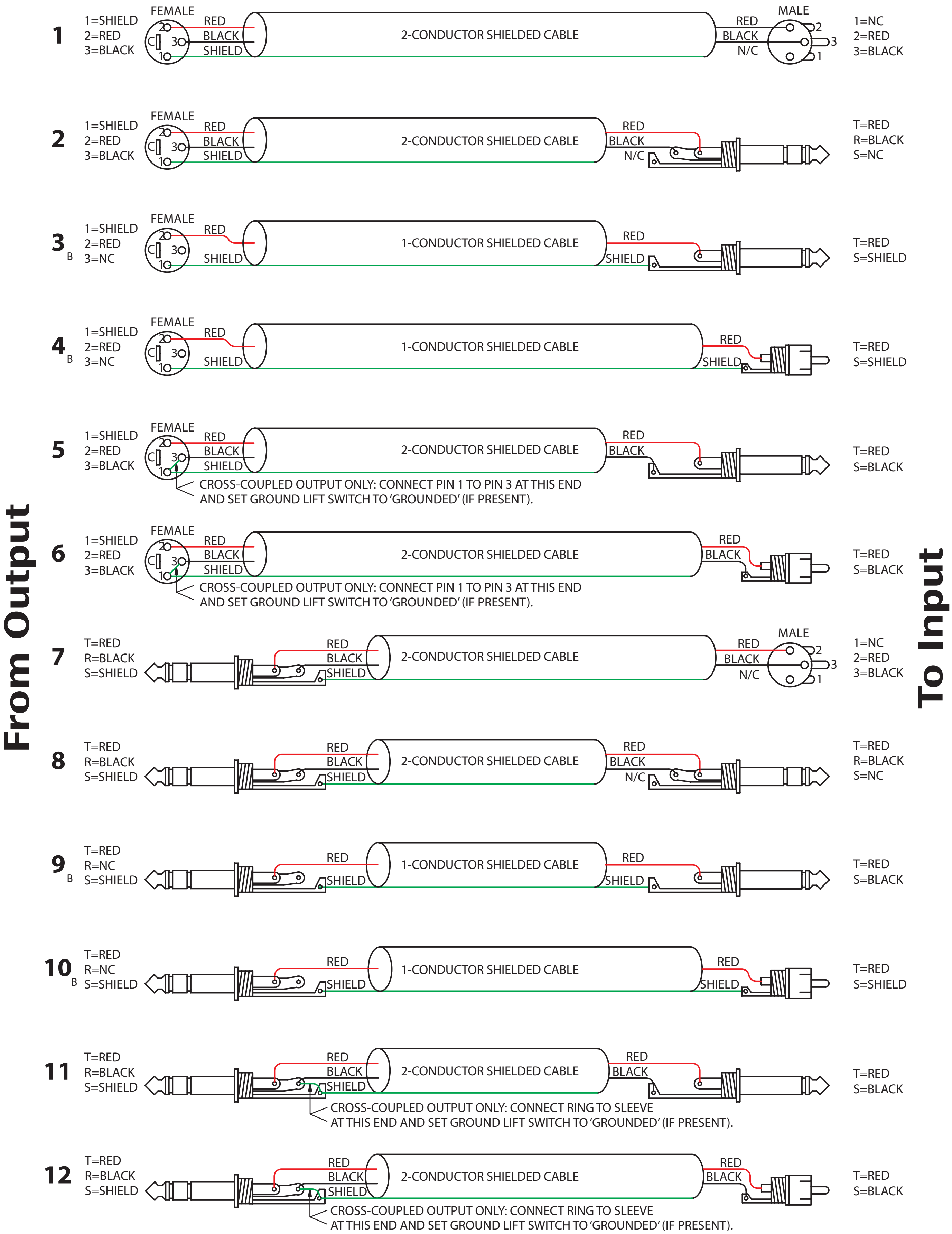
From Output

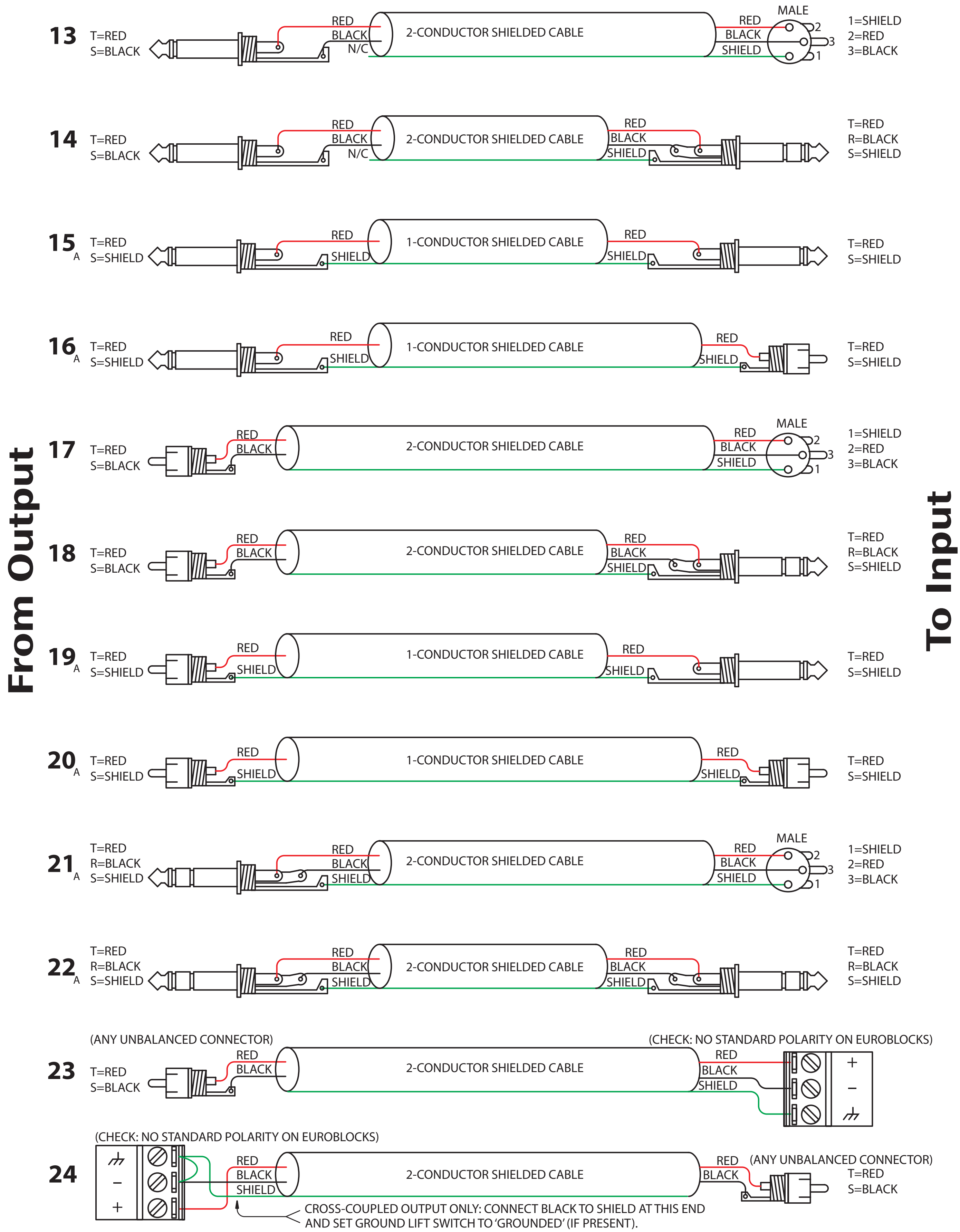
CABLE CONNECTORS	MALE BALANCED XLR	¼" BALANCED TRS (TIP-RING-SLEEVE)	¼" OR 3.5mm UNBALANCED TS (TIP-SLEEVE)	UNBALANCED RCA	BALANCED EUROBLOCK
FEMALE BALANCED XLR (NOT A TRANSFORMER, NOR A CROSS-COUPLED OUTPUT STAGE)	**1**	**2**	**3** B	**4** B	+ to + – to – SHIELD NC
FEMALE BALANCED XLR (EITHER A TRANSFORMER 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
T=RED
S=BLACK
CROSS-COUPLED OUTPUT ONLY: CONNECT PIN 1 TO PIN 3 AT THIS END
AND SET GROUND LIFT SWITCH TO 'GROUNDED' (IF PRESENT).
6
1=SHIELD
2=RED
3=BLACK
FEMALE
RED
BLACK
SHIELD
2-CONDUCTOR SHIELDED CABLE
RED
BLACK
T=RED
S=BLACK
CROSS-COUPLED OUTPUT ONLY: CONNECT PIN 1 TO PIN 3 AT THIS END
AND SET GROUND LIFT SWITCH TO 'GROUNDED' (IF PRESENT).
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
T=RED
S=BLACK
CROSS-COUPLED OUTPUT ONLY: CONNECT RING TO SLEEVE
AT THIS END AND SET GROUND LIFT SWITCH TO 'GROUNDED' (IF PRESENT).
12
T=RED
R=BLACK
S=SHIELD
RED
BLACK
SHIELD
2-CONDUCTOR SHIELDED CABLE
RED
BLACK
T=RED
S=BLACK
CROSS-COUPLED OUTPUT ONLY: CONNECT RING TO SLEEVE
AT THIS END AND SET GROUND LIFT SWITCH TO 'GROUNDED' (IF PRESENT).


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).

FACTORY AUTHORIZED SERVICE

Your unit may someday need to be serviced by the Rane Factory if you live in the USA. International customers should contact your dealer or distributor for service. You must call the Rane factory before shipping. Please do not return your unit to Rane without prior authorization.

Rane Corporation

To obtain service or a Return Authorization in the USA, please phone 425-355-6000

or Fax 425-347-7757

LIMITED DOMESTIC WARRANTY

RANE CORPORATION WARRANTS ALL RANE PRODUCTS (EXCEPT THOSE ITEMS CLASSIFIED AS *WEAR PARTS*, AND LISTED ON THE MANUAL-1 PAGE OF EACH OPERATORS MANUAL) PURCHASED IN THE U.S. AGAINST DEFECTS IN MATERIAL OR WORKMANSHIP FOR A PERIOD OF TWO (2) YEARS. *WEAR PARTS* ARE LIMITED TO A PERIOD OF NINETY (90) DAYS FROM THE INITIAL DATE OF RETAIL PURCHASE FROM AN AUTHORIZED RANE DEALER—WEAR PARTS REQUIRE PROOF OF PURCHASE DATE. This limited warranty extends to all purchasers or owners of the product during the warranty period beginning with the original retail purchase. Rane Corporation does not, however, warrant its products against any and all defects: 1) arising out of material or workmanship not provided or furnished by Rane, or 2) resulting from abnormal use of the product or use in violation of instructions, or 3) in products repaired or serviced by other than the Rane Factory, or 4) in products with removed or defaced serial numbers, or 5) in components or parts or products expressly warranted by another manufacturer. Rane agrees to supply all parts and labor to repair or replace defects covered by this limited warranty with parts or products of original or improved design, at its option in each respect, if the defective product is shipped prior to the end of the warranty period to the Rane Factory in the original packaging or a replacement supplied by Rane, with all transportation costs and full insurance paid each way by the purchaser or owner.

LIMITED WARRANTY OUTSIDE THE U.S.A.

RANE PRODUCTS ARE WARRANTED ONLY IN THE COUNTRY WHERE PURCHASED, THROUGH THE AUTHORIZED RANE DISTRIBUTOR IN THAT COUNTRY, AGAINST DEFECTS IN MATERIAL OR WORKMANSHIP, THE SPECIFIC PERIOD OF THIS LIMITED WARRANTY SHALL BE THAT WHICH IS DESCRIBED TO THE ORIGINAL RETAIL PURCHASER BY THE AUTHORIZED RANE DEALER OR DISTRIBUTOR AT THE TIME OF PURCHASE. Rane Corporation does not, however, warrant its products against any and all defects: 1) arising out of materials or workmanship not provided or furnished by Rane, or 2) resulting from abnormal use of the product or use in violation of instructions, or 3) in products repaired or serviced by other than authorized Rane repair facilities, or 4) in products with removed or defaced serial numbers, or 5) in components or parts or products expressly warranted by another manufacturer. Rane agrees, through the applicable authorized distributor, to repair or replace defects covered by this limited warranty with parts or products of original or improved design, at its option in each respect, if the defective product is shipped prior to the end of the warranty period to the designated authorized Rane warranty repair facility in the country where purchased, or to the Rane factory in the U.S., in the original packaging or a replacement supplied by Rane, with all transportation costs and full insurance paid each way by the purchaser or owner.

ALL REMEDIES AND THE MEASURE OF DAMAGES ARE LIMITED TO THE ABOVE SERVICES, IT IS POSSIBLE THAT ECONOMIC LOSS OR INJURY TO PERSON OR PROPERTY MAY RESULT FROM THE FAILURE OF THE PRODUCT; HOWEVER, EVEN IF RANE HAS BEEN ADVISED OF THIS POSSIBILITY, THIS LIMITED WARRANTY DOES NOT COVER ANY SUCH CONSEQUENTIAL OR INCIDENTAL DAMAGES. SOME STATES OR COUNTRIES DO NOT ALLOW THE LIMITATIONS OR EXCLUSION OF INCIDENTAL OR CONSEQUENTIAL DAMAGES, SO THE ABOVE LIMITATION MAY NOT APPLY TO YOU.

ANY AND ALL WARRANTIES, EXPRESS OR IMPLIED, ARISING BY LAW, COURSE OF DEALING, COURSE OF PERFORMANCE, USAGE OF TRADE, OR OTHERWISE, INCLUDING BUT NOT LIMITED TO IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, ARE LIMITED TO A PERIOD OF TWO (2) YEARS FROM EITHER THE DATE OF ORIGINAL RETAIL PURCHASE OR, IN THE EVENT NO PROOF OF PURCHASE DATE IS AVAILABLE, THE DATE OF MANUFACTURE, SOME STATES OR COUNTRIES DO NOT ALLOW LIMITATIONS ON HOW LONG AN IMPLIED WARRANTY LASTS, SO THE ABOVE LIMITATIONS MAY NOT APPLY TO YOU. THIS LIMITED WARRANTY GIVES YOU SPECIFIC LEGAL RIGHTS, AND YOU MAY ALSO HAVE OTHER RIGHTS WHICH VARY FROM STATE TO STATE, COUNTRY TO COUNTRY.

WARRANTY PROCEDURE - Valid in USA only

NOTICE! You must complete and return the warranty card or register your product online to extend the Warranty from 2 years to 3 years!

TO VALIDATE YOUR EXTENDED WARRANTY: Use the postcard that came in the box with your unit, or go to *www.rane.com* and click on **New Product Registration**. Fill out the warranty completely, being sure to include the model and serial number of the unit since this is how warranties are tracked. If your Rane product was purchased in the U.S.A., mail the completed card or register online with to Rane Corporation within 10 days from the date of purchase. **If you purchased the product outside the U.S.A. you must file your warranty registration with the Rane Distributor in that country.** It is advised that you keep your bill of sale as proof of purchase, should any difficulties arise concerning the registration of the warranty card. **NOTICE:** IT IS NOT NECESSARY TO REGISTER IN ORDER TO RECEIVE RANE CORPORATION'S STANDARD TWO YEAR LIMITED WARRANTY.

WARRANTY REGISTRATION is made and tracked by MODEL AND SERIAL NUMBERS ONLY, not by the purchaser's or owner's name. Therefore any warranty correspondence or inquires MUST include the model and serial number of the product in question. Be sure to fill in the model and serial number in the space provided below and keep this in a safe place for future reference.

WARRANTY SERVICE MUST BE PERFORMED ONLY BY AN AUTHORIZED RANE SERVICE FACILITY LOCATED IN THE COUNTRY WHERE THE UNIT WAS PURCHASED, OR (if product was purchased in the U.S.) AT THE RANE FACTORY IN THE U.S.. If the product is being sent to Rane for repair, please call the factory for a Return Authorization number. We recommend advance notice be given to the repair facility to avoid possible needless shipment in case the problem can be solved over the phone. UNAUTHORIZED SERVICE PERFORMED ON ANY RANE PRODUCT WILL VOID ITS EXISTING FACTORY WARRANTY.

FACTORY SERVICE: If you wish your Rane product to be serviced at the factory, it must be shipped FULLY INSURED, IN THE ORIGINAL PACKING OR EQUIVALENT. This warranty will NOT cover repairs on products damaged through improper packaging. If possible, avoid sending products through the mail. Be sure to include in the package:

1. Complete return street shipping address (P.O. Box numbers are NOT acceptable).
2. A detailed description of any problems experienced, including the make and model numbers of any other system equipment.
3. Remote power supply, if applicable.

Repaired products purchased in the U.S. will be returned prepaid freight via the same method they were sent to Rane. Products purchased in the U.S., but sent to the factory from outside the U.S. MUST include return freight funds, and the sender is fully responsible for all customs procedures, duties, tariffs and deposits.

In order to qualify for Rane's one year extended warranty (for a total of 3 years parts and labor), the warranty must be completely filled out and sent to us immediately. Valid in USA only.

We recommend you write your serial number here in your owners manual and on your sales receipt for your records.

SERIAL NUMBER:______________________________ **PURCHASE DATE:**_______________________

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/A11:2008
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: **MA 4**

Immunity Results:

THD+N re: 12.5W/8Ω, 400 Hz sine, BW: 20-20 kHz, Baseline: -72 dBr

Test Description	Results	Conditions
RF Electromagnetic Fields Immunity		
80 MHz -1000 MHz, 1 kHz AM, 80% depth, 3V/m	< -70 dBr	80 Mhz -1,000 MHz
	< -68 dBr	235 Mhz
Conducted RF Disturbances Immunity		
150 kHz - 80 MHz, 1 kHz AM, 80% depth, 3V RMS	< -72 dBr	Power Lines, 150-750 kHz, 850 kHz - 80 MHz
150 kHz - 80 MHz, 1 kHz AM, 80% depth, 3V RMS	< -49 dBr	Power Lines, 800 kHz
150 kHz - 80 MHz, 1 kHz AM, 80% depth, 3V RMS	< -72 dBr	Signal and Control Lines, 150 kHz - 80 MHz
Magnetic Fields Immunity		
50Hz - 10kHz, 4.0 - 0.4 A/m	< -72 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)

Greg Frederick
(Full Name)

Compliance Engineer
(Position)

June 29, 2010
(Date)

Mukilteo WA USA
(Place)

105225

MA 4

MULTICHANNEL AMPLIFIER