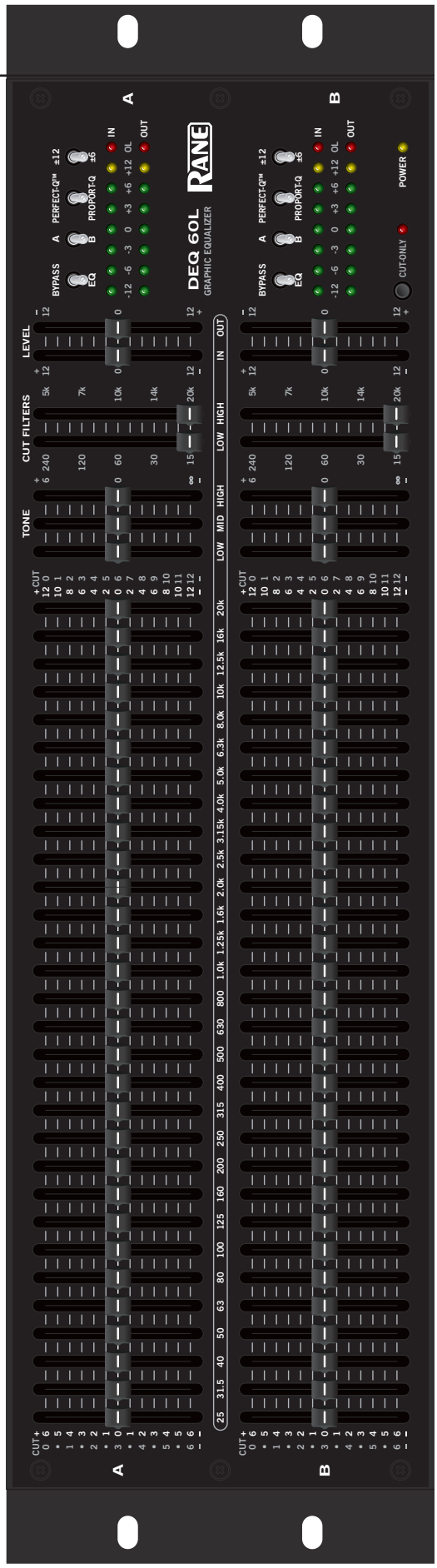
DEQ 60L

GRAPHIC EQUALIZER



CONTENTS *(in order of appearance)*

21600

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.

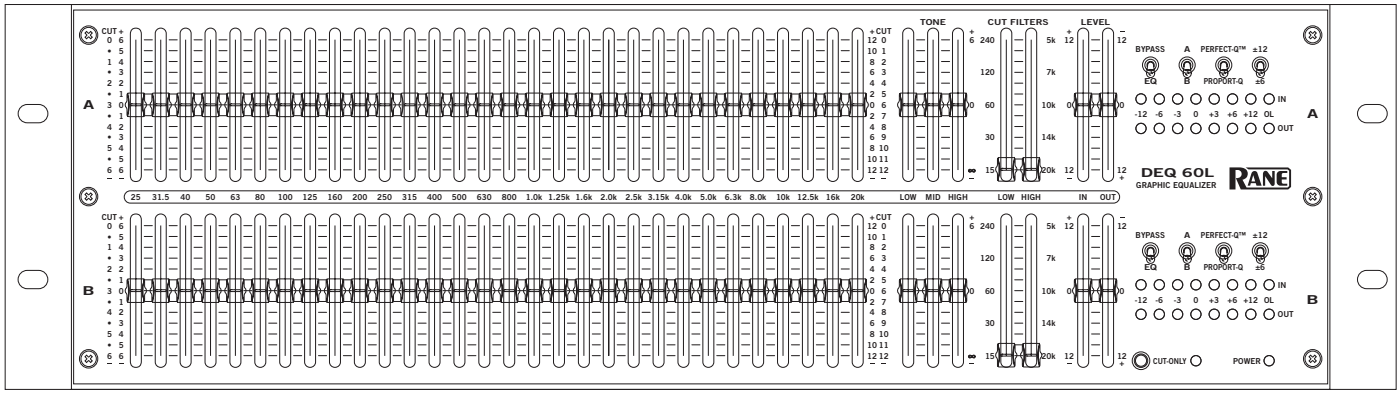
REMARQUE: Cet équipement a été testé et approuvé conforme aux limites pour un appareil numérique de classe B, conformément au chapitre 15 des règles de la FCC. Ces limites sont établis pour fournir une protection raisonnable contre tout risque d'interférences et peuvent provoquer une énergie de radiofréquence 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.



QUICK START

We know you know how to use an equalizer. Just read this section for the unique things to be aware of in the DEQ 60L.

We know you know how to use a realtime analyzer, but using **PERFECT-Q** mode will make that job a lot easier. Since there is no interaction between filters, the multiple adjustments through all the bands just to get the analyzer to read flat is a thing of the past. One pass should do the trick. Then use the **TONE** controls or **CUT FILTERS** for general sweetening. We know your sound is important and your time is valuable.

If you want to compare the sound of your old (non-Rane) EQ to this one, and you are used to the way the slider bands interact, then use **PROPORTIONAL-Q** mode.

Activating the **CUT-ONLY** switch puts both equalizer channels in the high resolution **CUT 0** to **-12 dB** (gray number scale). To prevent unwanted sudden volume shifts when switched, the outputs mute for a moment, then slowly increases in volume.

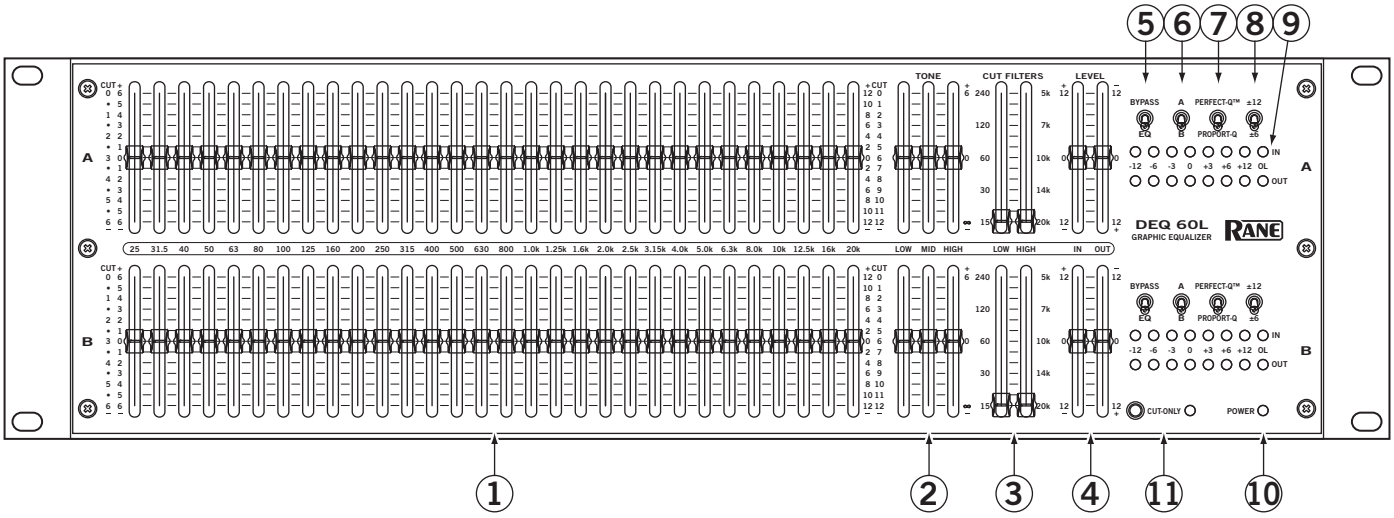
The **A** and **B** switches are like memories or control assigns. Normal stereo use would set the top row **A** (Left), and the bottom row to **B** (Right). But if you are running in stereo, and both sides use the same EQ curve, you can set both switches to **A**. Now the top EQ curve controls both left and right channels. Switching these to **B** will use the bottom EQ curve for both channels. This is great for switching EQ when a source changes. Just be aware of where these switches are, an unassigned EQ row will have no audible effect. These switches also affect the **CUT FILTERS**, **TONE CONTROLS**, and **LEVELS**.

The channel **BYPASS** switches have two modes, set by the rear panel switch. When set to **FILTERS**, the **BYPASS** switch only bypasses the **EQ**, **TONE** and **CUT FILTERS**. The **LEVEL** controls and other switches remain active. When set to **ALL**, the **BYPASS** switches ignore everything *including* the **LEVEL** controls.

You have several connector choices on the rear. However, use only *ONE* type of **INPUT** on each channel. *These Inputs do not sum*. But you may use any combination of **OUTPUTS** simultaneously if desired. Polarity convention on the XLR jacks is pin 2 positive, pin 3 negative and pin 1 shield (chassis ground).

WEAR PARTS: This product contains no wear parts.

FRONT PANEL DESCRIPTION



① **Graphic EQ controls**: Thirty bands are provided for each channel. Each EQ slider has a resolution of 256 steps. The center detent position guarantees a flat response. Slide control travel is 45mm with easy-to-read soft-touch handles.

② **LOW, MID, and HIGH TONE controls:** Independent, *Accelerated-slope*™, 3-band **TONE** controls allow easy, intuitive adjustment of tone response without the hassle of adjusting 30 bands. The **TONE** controls use 12 dB per octave Linkwitz-Riley filters. The Low/Mid crossover point is 300 Hz. The Mid/High crossover point is 4 kHz. As with the EQ sliders, center detent provides a guaranteed flat response. The range of control is +6 dB to *off*. Control resolution is 256 steps.

③ **LOW CUT and HIGH CUT FILTERS:** The **LOW** Cut Filter is adjustable over four octaves in 64 steps with a frequency range of 15 Hz to 240 Hz. The **HIGH** Cut Filter is adjustable over two octaves in 64 steps from 5 kHz to 20 kHz.

④ **LEVEL controls** serve two purposes, when used with the Meters (⑨):
1) Adjust the INPUT signal level to 0 dBu for good headroom and signal to noise.
2) Compensate for changes in signal level due to filter boost/cut settings by adjusting the OUTPUT signal level to 0 dBu.
The operation of the OUTPUT LEVEL control is reversed. Pushing the control up *reduces* gain. Pushing the control down *increases* the gain. This allows the user to easily adjust *sensitivity* without affecting the output signal level. Simply grasp both input and output controls and move together. The ranges of both controls is ±12 dB with a resolution of 256 steps.

⑤ **BYPASS switches** have two possible modes of operation. If the rear panel switch is set to BYPASS ALL, all filters and level controls are bypassed. If the rear panel switch is set to BYPASS FILTERS, only the filters are bypassed. Filters include EQ, TONE and CUT. Automatic relay bypass hardwires Inputs to Outputs in the event of a power failure.

⑥ **A / B switches** determine which set of controls is used by the A-channel or B-channel. Controls affected by the A / B switch are EQ, TONE, CUT FILTERS, LEVEL, Q switches and ±12 / ±6 dB switches. Bypass switches are not affected.

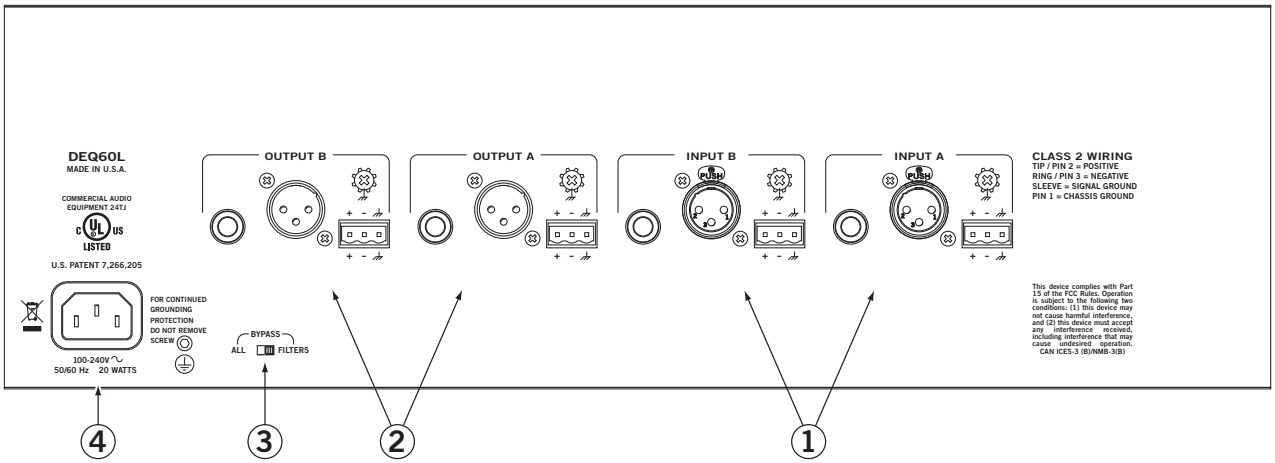
⑦ **PERFECT-Q**™: What you see is what you get. **PROPORTional-Q**: Classic smooth response. Most users will prefer the PERFECT-Q position. Some users may prefer the PROPORT-Q setting. See Graphic EQ Controls on page Manual-4.

⑧ **±12 / ±6 dB switch** changes the boost / cut of the Graphic EQ (①) for each channel. Use the ±6 dB unless you really need ±12 dB, the resolution is better.

⑨ **Input and Output Meters** are peak responding and indicate the signal level in dBu. Peak-dBu is held and displayed for 1.5 seconds. Attack is instantaneous. Decay is 500 ms for a 20 dB step.

⑩ When the **POWER indicator** is on, it indicates that power is turned on. This works with ④ on the Rear Panel (next page).

⑪ **CUT-ONLY** mode switch: when pressed in, as shown by the LED, sets the range of the EQ sliders **0** to **-12 dB** (gray number scale). When the switch is actuated, the output audio is muted and slowly increased to prevent volume surprises.



① **Channel A and B INPUTS:** Plug the outputs of the mixer or other source to these Inputs. *Choose between the XLR, the ¼" TRS, or the Euroblock Input jack—use only one—they do not sum.*

Rane adheres to the international and U.S. standard for balanced pin configurations: Pin 1 is chassis ground (neutral), pin 2 is hot (positive), and pin 3 is signal return (negative)**.**

Avoid the temptation to use unbalanced tip-sleeve ¼" TS plugs, but if you must, keep them short as possible, 10 feet (3 meters) maximum. Long unbalanced cables invite hum, noise and other undesirables. Balanced TRS ¼" are much better at rejecting noise.

The Euroblocks normally connect the cable shield to the ground terminal. For those installations where the internal shield-to-chassis connection causes interference, connect each shield directly to the chassis grounding screw located above each Euroblock connector, keeping the shield wrapped around the audio conductors as much as possible. For optimum Electromagnetic Interference (EMI) immunity, connect the shields at both ends of the cable to chassis ground.

See the RaneNote "Sound System Interconnection" for more information on system connections and proper grounding practices.

② **Channel A and B OUTPUTS:** Any Output can be used simultaneously with the others, take your pick. Same wiring as above... keep cables short, always wire balanced when possible, eat your vegetables, yadda yadda.

③ **BYPASS mode switch:** See ⑤ on the Front Panel, previous page.

④ **Power connector:** Uses the standard cord provided. Inside the DEQ 60L is a universal internal switching power supply that accepts 100 to 240 VAC at 50 to 60 Hz, allowing it to work in most countries.

Feature	Benefit
1) *Perfect-Q*™: What you see is what you get	1) ***No*** EQ filter interaction. Response matches slider settings.
2) Proportional-Q: Classic smooth response	2) Familiar response. Smooth tone contouring.
3) Independent *Accelerated-Slope*™ 3-band tone controls	3) Adjust Tone response without moving a dozen EQ sliders.
4) Low-cut and High-cut filters	4) Band limit for application: Voice, Music, Headphones, etc.
5) Input and Output level controls	5) Optimize dynamic range. Match the level after the EQ.
6) Eight segment metering for each input and output	6) Allows accurate use of the level controls.
7) Two Boost / Cut ranges: ± 6 dB or ± 12 dB	7) Select control resolution and range for the application.
8) Each audio channel may use A or B controls	8) Stereo Linking; Two "analog memories"; A-curve / B-curve comparison.
9) Analog controls	9) Quick control access with one control, one function, no confusion.
10) XLR, TRS and Euroblock Phoenix connectors	10) Connector matches your cables.
11) Bypass switch (DSP)	11) EQ in/out compare. Bypass Filters only or bypass Filters and Level controls.
12) Bypass relay (power failure)	12) No pops on turn-on or turn-off. Passes signal when power is off.
13) Exceptional RF and Magnetic immunity	13) Works in high RF environments. Works next to power amps.
14) Universal switching power supply	14) Works virtually anywhere in the world.
15) Cut-Only mode	15) Maximum level of precision.

Graphic EQ Controls

Control each of the thirty bands of EQ with high resolution, 256 step slide controls. The center detent position guarantees a flat response. *Perfect-Q*™ filters guarantee accurate graphic response and ***no*** band interaction.

The elimination of band interaction means the DEQ filters are suitable for "ringing out a room" and capable of the very subtle adjustments required by the most demanding user. Unlike previous designs that act upon a bandwidth of up to one octave when cut 12 dB, Perfect-Q only affects the intended 1/3 octave. For the first time, the user is able to adjust a single 1/3 octave band with no affect on adjacent bands. The lack of band interaction guarantees slider settings accurately indicate frequency response.

For full details and comparisons to previous EQs, see "Perfect-Q: The Next Step in EQ Design" included with this manual.

Control Surface

All graphics are screened on the reverse side of a durable Lexan surface. The graphics remain clear even after years of life on the road.

Universal Switching Power Supply

The DEQ 60L operates on any AC mains from 100 VAC to 240 VAC, 50 Hz or 60 Hz. The line cord attaches to a standard IEC appliance inlet, shipped with each unit.

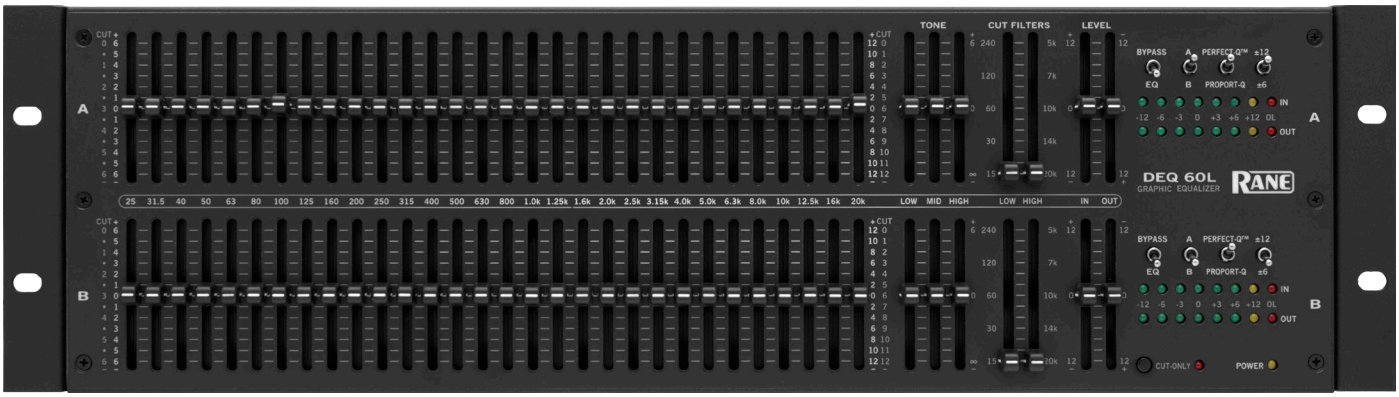
Security

An optional 5.2" security cover is available as an accessory for the DEQ 60L.

DATA SHEET

DEQ 60L

GRAPHIC EQUALIZER



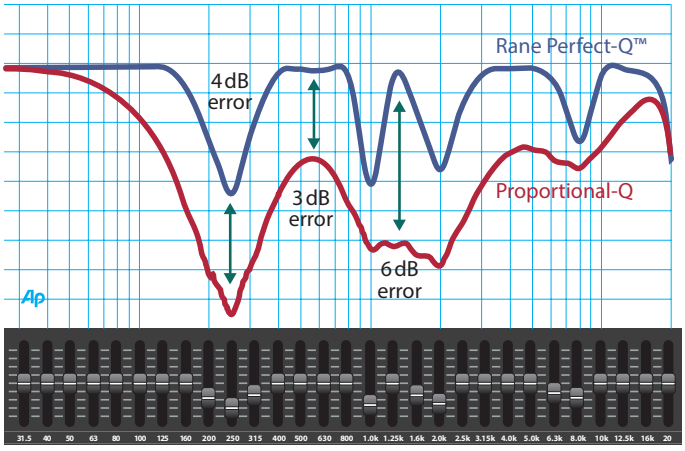
General Description

When the term "graphic equalizer" was first coined, the intent was to provide a device that allowed the user to "draw" the desired frequency response using slider controls on the unit's front panel. Thus, the Holy Grail of graphic equalizers is a device with a response that truly matches the slider settings. For years, this seemingly unobtainable goal resulted in products based on the fine art of compromise … until the DEQ 60L.

It's not Constant—not Proportional—It's Perfect! Digital Signal Processing (DSP) allows filter technology not possible with analog designs. Rane coined the term **Perfect-Q™** to describe the results (U.S. patent 7,266,205). The DEQ 60L is the first true graphic equalizer (i.e., one providing real mechanical front panel slide controls) whose output response precisely matches its front panel settings. Perfect-Q features virtually no band interaction and extremely low ripple between adjacent bands. To keep things flexible, fear not proportional-Q lovers, each channel of the DEQ 60L is selectable between Perfect-Q or Proportional-Q response.

For all the details, read the RaneNote "Perfect-Q, the Next Step in Graphic EQ Design" available at rane.com.

The DEQ 60L features 45 mm sliders, a switchable Cut-Only mode, additional Cut filters, and additional 3-band Tone controls. The DEQ 60L provides the most complete set of pure EQ functions ever offered in an analog controlled equalizer.



Typical PA adjustment showing the difference between Perfect-Q and Proportional-Q. Which curve matches the slider positions?

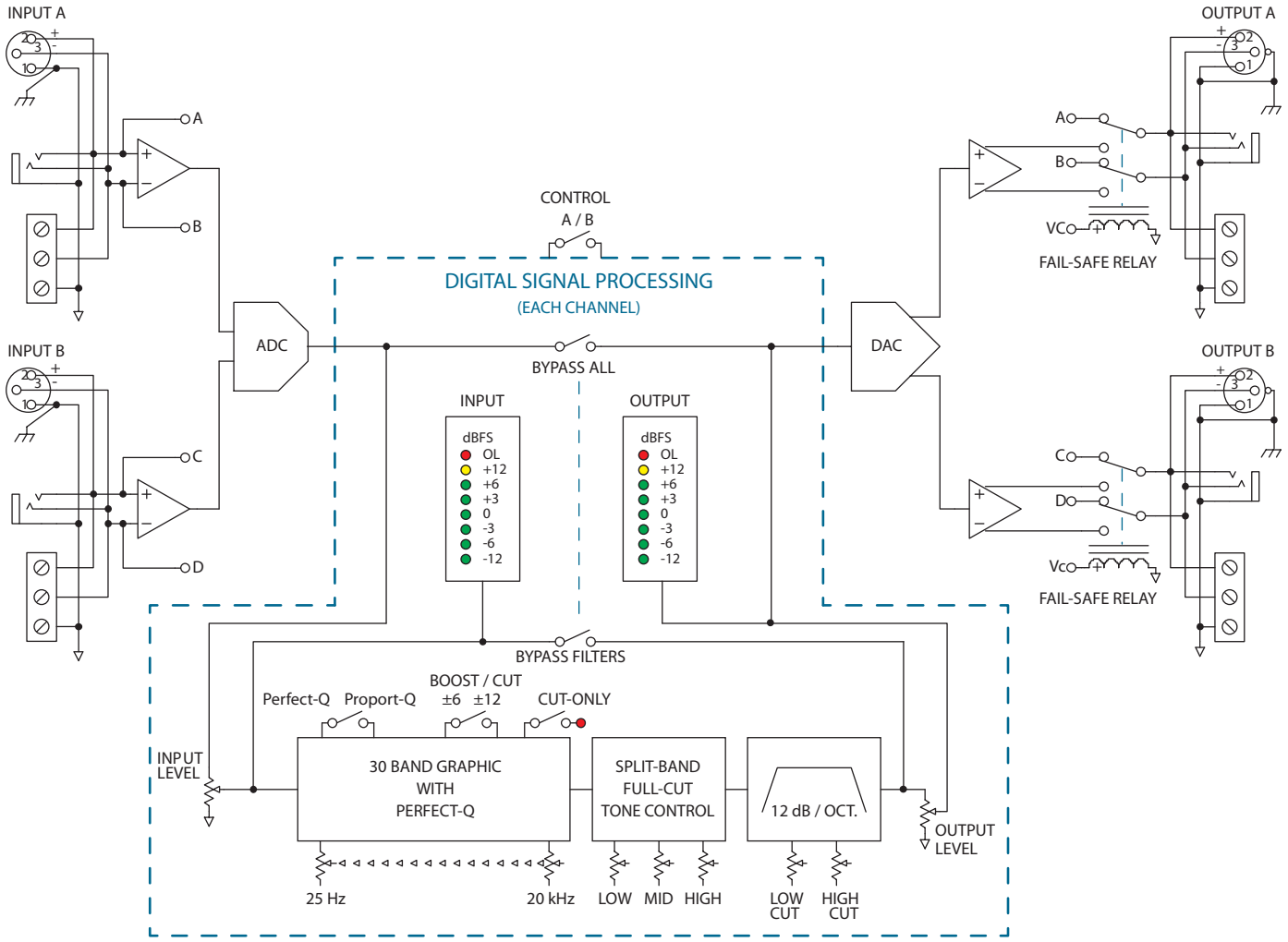
Features

- Perfect-Q™: What You See Is What You Get (**No** filter interaction)
- Proportional-Q: Classic smooth response
- Independent Accelerated-Slope™ 3-band full-cut tone controls
- Low-Cut and High-Cut Filters
- Input and Output Level controls
- Each channel may use A or B channel controls:
  - Stereo Linking
  - Two "analog memories"
  - A-curve / B-curve comparison
- 45 mm sliders with center detents
- Two Boost / Cut ranges: ±6 dB or ±12 dB
- Switchable Cut-Only mode
- Eight segment metering for each Input **and** Output
- Analog controlled DSP
- XLR, TRS and Euroblock connectors
- Bypass switch (DSP), Bypass relay (power failure)
- Exceptional RF and magnetic immunity
- Universal internal switching power supply (100-240 VAC)

Features and Specifications

Parameter	Specification	Limit	Units	Conditions/Comments
Inputs: Type	Active Balanced			
.....Connectors	XLR, ¼" TRS, Euroblock			XLR pin 2 hot per AES standards
.....Maximum Input	+22	1	dBu	1 kHz
.....Common Mode Rejection	60	typ.	dB	1 kHz
.....Impedance	14.6k	1%	Ω	Each leg to ground @ 1 kHz
DSP Block: Dynamic Range	106	typ.	dB	A-weighted (input to output); unity
24-bit Converters: Sample Rate	48		kHz	
Propagation Delay	1.29	typ.	ms	
Input Level: Range	±12		dB	
Output Level: Range	±12		dB	
Graphic EQ: Bands	30 ⅓-octave ISO spacing		Hz	25 Hz to 20 kHz
.....Type	Perfect-Q or Proportional-Q			Switchable, each channel
.....Range	±6 or ±12		dB	Switchable, each channel
.....Slider Travel	45		mm	Center detent = 0 dB
Tone Controls	3-band; Accelerated Slope™			2nd-order, phase 0° @ unity gain
.....Range	+6 to off		dB	Center detent = 0 dB
.....Low/Mid Crossover Point	300		Hz	
.....Mid/High Crossover Point	4		kHz	
Low-Cut Filter	15-240		Hz	
High-Cut Filter	5-20		kHz	
Meters	Input and Output			Each channel
.....Type	Peak responding		dBu	Peak-dBu is displayed for 1.5 sec
.....Attack/Decay	0/500	typ.	ms	per 20 dB step
Bypass: Power Failure	Automatic relay bypass			Input wired to Output
Bypass Switch Mode				Each channel
.....Rear switch: Bypass All	Filters and levels bypassed			By front panel bypass
.....Rear switch: Bypass Filters	Filters bypassed			By front panel bypass
A/B Switches	Determine controls to channel			Bypass and A/B not affected
Outputs:	Active Balanced			
.....Connectors	XLR, ¼" TRS, Euroblock			XLR pin 2 hot per AES standards
.....Impedance	100	1%	Ω	Each leg to ground
.....Maximum Output	+22	1	dBu	600 Ω or greater
EMI Filters	Yes			Inputs and Outputs
Frequency Response	15 Hz to 20 kHz	+0/-3	dB	
THD+Noise	.02	typ.	%	+4 dBu, 20-20 kHz, 20 kHz BW
THD+Noise	.006	typ.	%	+4 dBu, 1 kHz, 20 kHz BW
Crosstalk	<-100	typ.	dB	2 kHz
Power Supply Requirement	100 to 240 VAC			50/60 Hz, 20 W
Unit: Conformity	FCC, cULus			
Unit: Construction	All Steel			
.....Size	5.25" H x 19" W x 8.25" D (3U)			(13.3 cm x 48.3 cm x 21 cm)
.....Weight	11 lb			(5 kg)
.....Shipping: Size	11" x 23" x 16"			(27.9 cm x 58.4 cm x 40.6 cm)
.....Weight	18 lb			(8.1 kg)
Note: 0 dBu=0.775 Vrms				

Block Diagram



Architectural Specifications

The equalizer shall be analog-controlled, with all control provided on the front panel using 45 mm DEQ 60L linear sliders with dust dams. A detented and guaranteed 0 dB point shall be provided on these linear sliders. All signal processing shall be accomplished using high accuracy digital signal processing. The equalizer shall be a two channel model, and each channel shall have thirty (30) frequency bands located on standard ISO center frequencies. Each band shall have a bandwidth of 1/3-octave. The equalizer shall be front-panel switchable between two modes, Proportional-Q or Perfect-Q. The equalizer shall have a front panel switch selecting cut-only or boost/cut operation.

Low and high cut filters shall be provided with 12 dB/octave slopes and adjustable corner frequencies. Tone controls shall be provided for low, mid and high frequencies. The tone controls shall have a range of +6 dB to off.

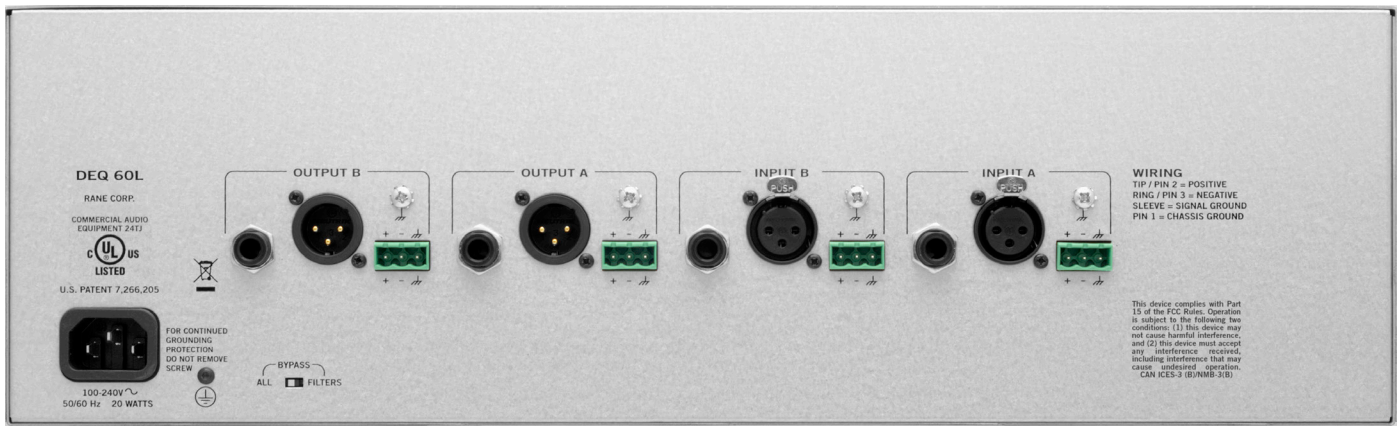
Input and output level controls shall be provided for each channel. Input and output peak dBu meters shall be provided. The unit shall provide an automatic passive bypass feature when power is not available, and active bypass switches for each channel when the unit is operating.

The inputs and outputs shall be active balanced/unbalanced designs terminated with XLR, 1/4" TRS (tip-ring-sleeve), and Euroblock terminals. The outputs shall have equal output impedances. RFI filters shall be provided.

The unit shall meet UL agency safety requirements and be powered from an internal universal power supply (100 to 240 VAC) via a rear panel IEC connector. The unit enclosure shall be constructed entirely from cold-rolled steel. The unit shall be supplied with ears for mounting into a standard 3U EIA rack.

The unit shall be a Rane DEQ 60L Graphic Equalizer.

Rear Panel



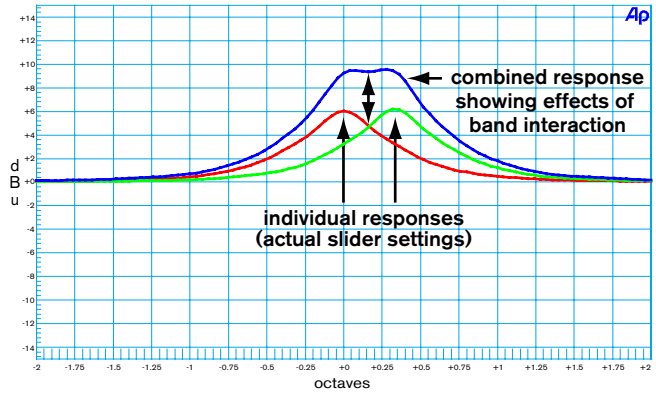


Figure 1. Band interaction of 1/3-octave Proportional-Q filters

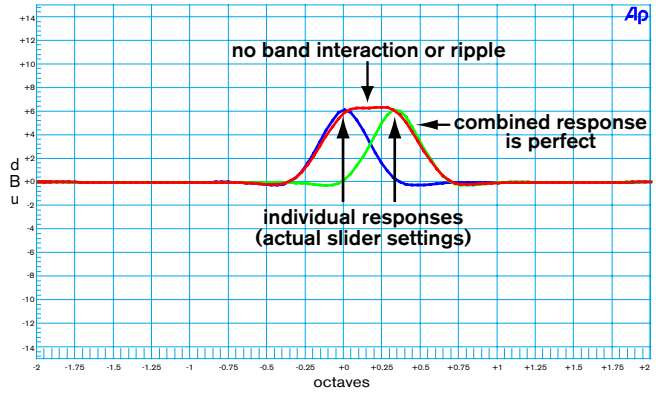


Figure 2. Graphic response of Perfect-Q filters

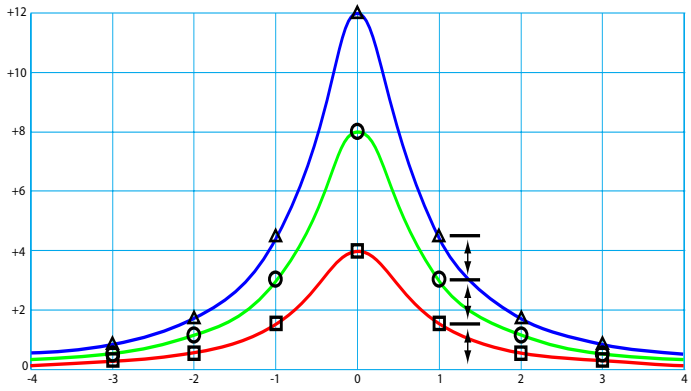


Figure 3. Phase response of Figures 1 and 2.

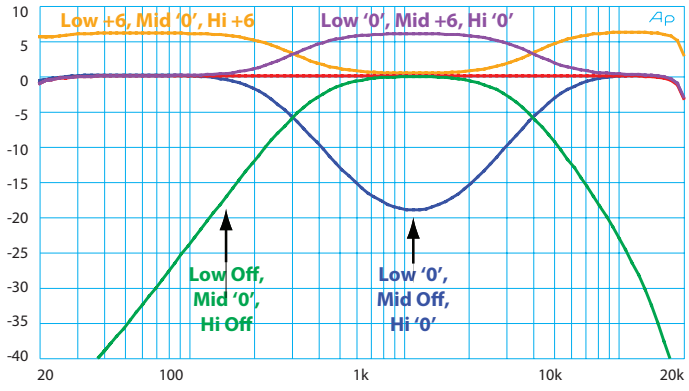


Figure 5. The interactive operation of the 3 Tone controls

References

1. R. Miller, R. Jeffs, S. Radford, D. Bohn, "Perfect-Q, the Next Step in Graphic EQ Design," *RaneNote,* (2003).

Accessory

The model **SC 5.2** Security Cover is available as an option.

Perfect-Q™, the Next Step in Graphic EQ Design

- **What You See Is (Really) What You Get**
- **Independent Band Adjustment**
- **Constant Bandwidth For All Sliders**
- **Minimum Phase Response**
- **Eliminates Band Interaction Overload**

Ray Miller
Rick Jeffs
Dennis Bohn

RaneNote 154

Pursuit of the Unreachable Star

The quest for absolute truth in graphic equalizer slider position has a long history and recently took a giant step forward. Using advanced DSP algorithms, Rane Corporation introduced an entirely new generation of graphic equalizers that realize the dream of having the output magnitude response correspond exactly to the front panel settings.* Extensive development resulted in this new technology trademarked “Perfect-Q,” because that is what it does: calculates the perfect Q required to create the exact response dictated by the front panel slider positions.

*Acknowledgement is given to the first products addressing this issue: the IEQ Smartcurve by ART and the TC 1128 by T.C. Electronics both introduced in 1987, and to the latest work achieving similar results by Lake Technology in 2002 as part of their proprietary loudspeaker processor designed for Clair Brothers, named Clair iO, and available now to the general public as the Lake Contour loudspeaker processor. This processor exhibits true arbitrary magnitude response for all equalizer types. Rane's unique technology is developed specifically for graphic equalizer use (i.e., one providing real mechanical front panel slide controls), to faithfully duplicate the front panel fixed-frequency slider positions.

There is irony in knowing that improving Rane's much praised constant-Q technology required switching to variable-Q technology to perfect the response vs. slider position problem. The popularity of Q-terminology is unfortunate since what is meant is bandwidth. In hindsight, naming the complementary technologies "constant bandwidth" and "proportional bandwidth" would have been better choices, because these terms identify the solutions more accurately.

Rane championed constant-Q designs beginning in 1982 as a better solution to the problem of slider-based graphic equalizers. Constant-Q gave a more honest front panel representation than proportional-Q. It minimized what Rane called "equalizing the equalizer," i.e., having to go back and readjust adjacent sliders to counteract the problem of interaction between bands. This is the phenomena where adjusting one band causes similar, but reduced, adjustment to adjacent (and even further out) bands. For example, if you boosted 800 Hz by a couple of dB, you would inadvertently boost the energy centered at 630 Hz and 1000 Hz. Constant-Q interacted less than proportional-Q and now Perfect-Q eliminates this problem.

Perfect-Q Advantages

The advantages of the Perfect-Q design go far beyond yielding a more accurate picture; it provides a degree of adjustment never before possible. Crucial subtle refinements of frequency response are for the first time possible, allowing for an unequaled ease of operation and clarity of sound reproduction. Changing a 1/3-octave setting changes ***only*** *that setting. This is unlike any other graphic EQ available (i.e., one providing real mechanical front panel slide controls as of January, 2003).*

DSP Provides the Solution

DSP allows more flexible processing than analog and permits delaying final filter parameters until the actual user settings are known – something not possible with analog. This gives the power to build an EQ that has an ideal response. The idea driving development of Perfect-Q is the same as constant-Q: constant bandwidth for each EQ band no matter what the setting, but DSP allows doing things that aren't practical (or in some cases even possible) in analog circuits, producing an even better outcome as demonstrated by these Perfect-Q characteristics:

- What you see is (really) what you get.
- Constant bandwidth for all slider settings.
- Adjusting one band does not change neighboring bands.
- Improved phase response due to eliminated interactions.
- No band interaction overload problems.

Graphic Details

Early EQs used passive analog networks resulting in a proportional-Q (also known as variable-Q; "Q" is inversely proportional to filter bandwidth) response, that is, the filter bandwidth became wider or narrower depending upon the slider setting. While producing smooth alteration of frequency response, proportional-Q designs have significant interaction between adjacent bands. For certain applications this interaction results in a "sound" some listeners grew to appreciate, even at the expense of poor correlation between overall response and slider position. Figure 1 shows two adjacent sliders boosted 6 dB, with the resultant proportional-Q response. As shown the proportional-Q graphic equalizer's front panel is a poor representation of the true frequency response curve. Front panel says +6 dB, but the real output is +9 dB.

By the 1970s it was clear that a constant-Q design would come a lot closer to the ideal. The use of active filters greatly increased the designer's ability to realize new filter topologies and, in 1981, three constant-Q, one-third-octave graphic equalizers were concurrently designed. While a significant improvement, the results were not ideal. Figure 2 shows the response of a constant-Q design with two adjacent sliders boosted 6 dB. While band interaction is significantly reduced, ripple between bands is increased.

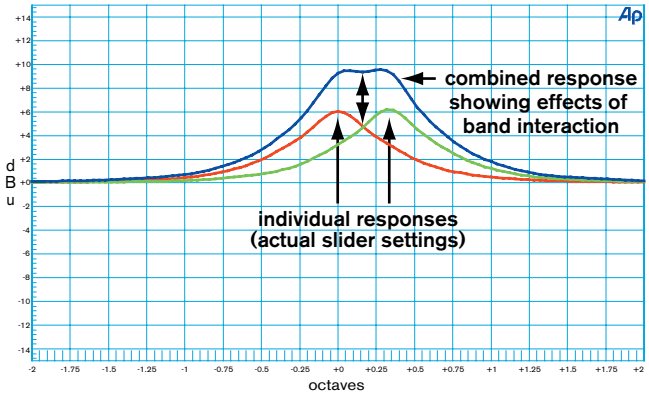


Figure 1. Band interaction of 1/3-octave Proportional-Q filters

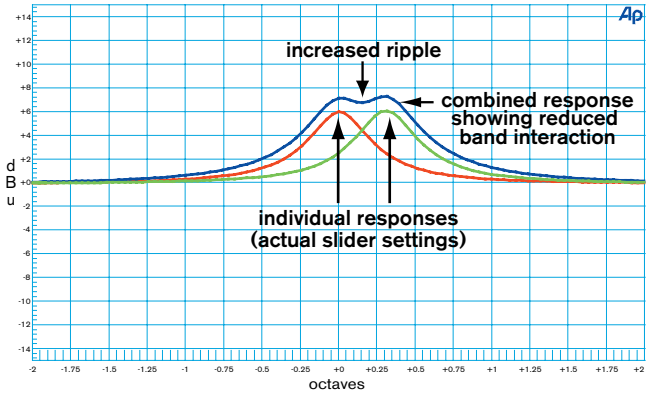


Figure 2. Band interaction of 1/3-octave Constant-Q filters

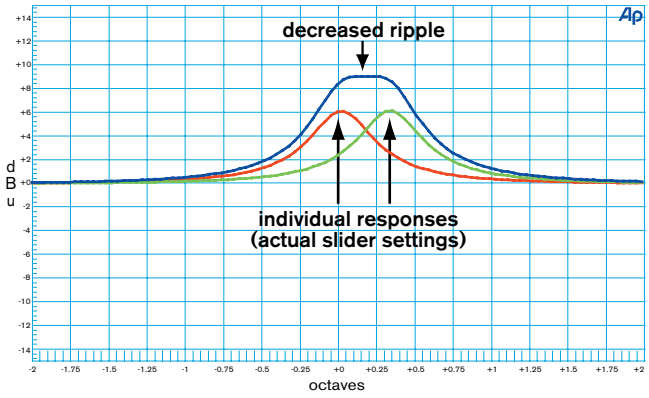


Figure 3. Band interaction of Interpolating Constant-Q filters

Interpolating Constant-Q, developed to reduce the ripple, works quite well, however band interaction is increased, and the overall output amplitude is nearly as bad as proportional-Q. Figure 3 shows it is narrower, more closely approximating the front panel's ⅔-octave width, but the amplitude is nearly +9 dB.

It's not Constant – It's not Proportional – It's Perfect!

As stated earlier, DSP allows filter technology not possible with analog designs. Ray Miller, one of Rane's distinguished DSP engineers extensively researched filter band interaction and developed new ways of preventing it.

Perfect-Q features virtually no band interaction and extremely low ripple between adjacent bands. The result: the world's first graphic equalizer whose output response precisely matches the front panel slider settings dramatically shown in Figures 4 and 6.

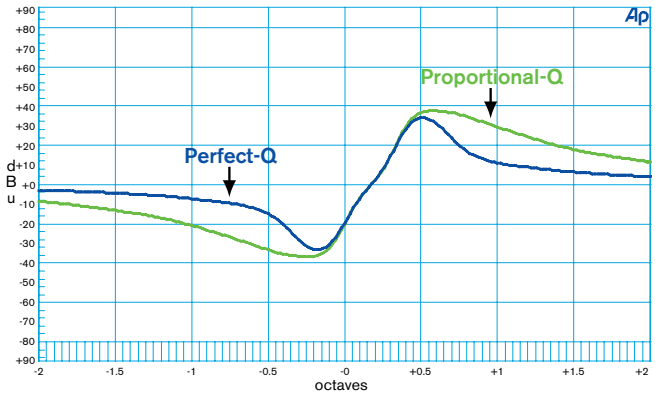


Figure 5. Phase response of Figures 1 and 4.

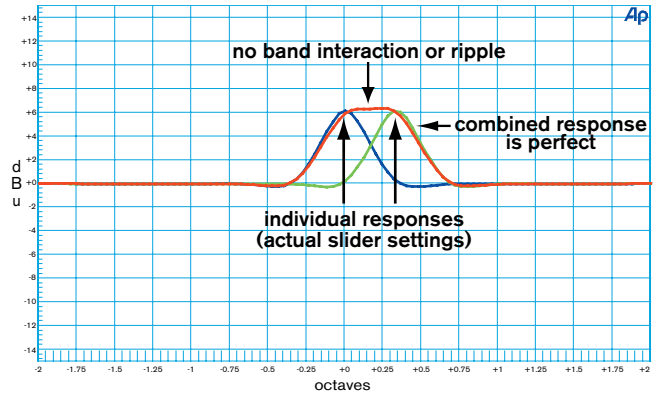


Figure 4. Graphic response of Perfect-Q filters

What you see is what you've cut... or boosted

If all that doesn't impress you, look at this example where DEQ 60 slider positions are lined up with the frequency responses corresponding to the Perfect-Q and Proportional-Q settings. There's a scoop around 250 Hz to remove some low-mid woof, a few notches around 1 kHz and 2 kHz for feedback control, and a dip in the 8 kHz region to tame a pesky high frequency hot spot. Note the difference between the two curves, especially the interactions between adjacent bands in the low-mids and the 6 dB offset at 1.25 kHz. Which EQ curve looks more like the front panel slider positions? Which one is perfect?

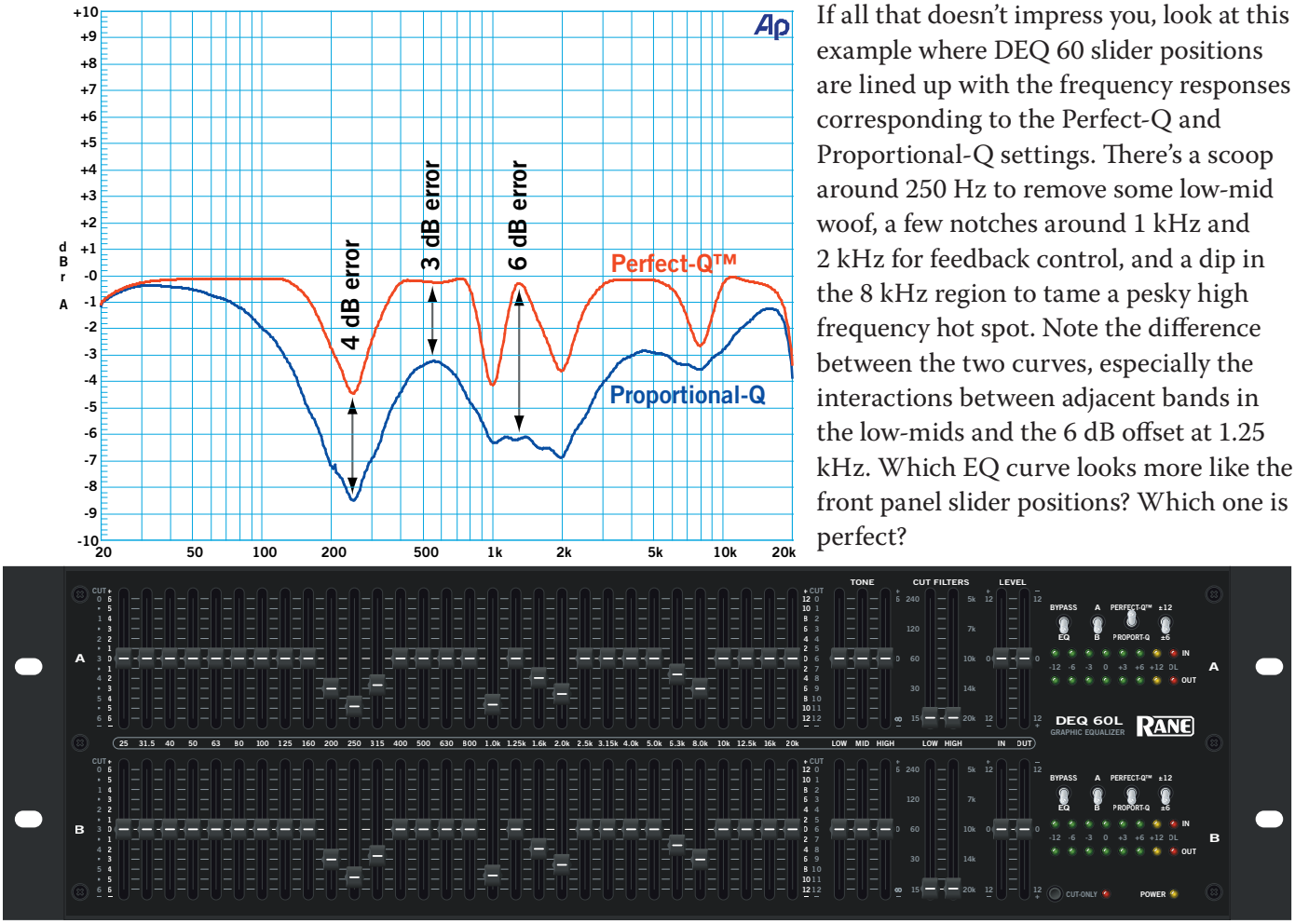


Figure 6. Perfect-Q versus Proportional-Q settings

Getting From There to Here

Condensed to its essence, Perfect-Q is a proprietary method for linearizing filter band interaction using variable-Q techniques, which makes getting from settings to response very accurate.

With that as the end, let's go back to the beginning and see how we got here:

Graphic equalizers are constructed from a set of filters evenly spaced on a logarithmic frequency scale, providing a relatively narrow-band adjustment of the audio spectrum. Typically there is a one-third-octave spacing. Each filter affects a band of frequencies centered about the specified center frequency, and is set flat, having no effect, or adjusted to boost or cut, amplifying or attenuating its frequency band.

Graphic equalizers suffer from overlapping band problems, where adjusting one band adjusts adjacent bands to a lesser, but significant extent, resulting in a frequency response not matching the settings. Creating a response matching the settings makes equalizers easier to use.

Various techniques exist to achieve this aim: you can use complex filters, which have negligible effect on adjacent bands, however narrow bandwidths require lots of expensive computing power. Alternatively, adding extra filters can compensate for the interaction. Or most commonly, adjusting the filter settings on the fly to approximately yield the desired response.

Several techniques can accomplish this last method. Different iterative methods exist, where adjustments are made, the error analyzed, then adjustments are made again and so forth, until the error is sufficiently small. This is what a person who could see the amplitude vs. frequency response would do. Although a computer does it much faster, this equalizing-the-equalizer procedure still results in an undesirable time lag between changing settings and the desired response.

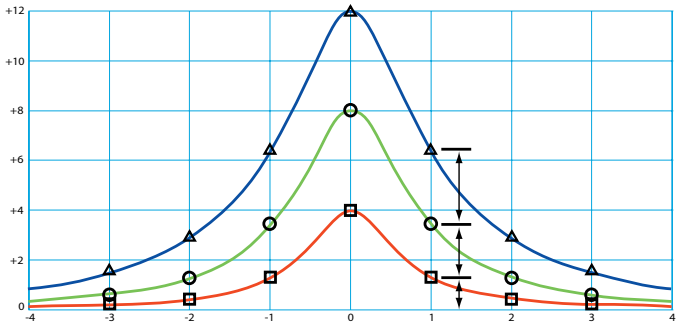


Figure 7. Constant-Q Nonlinear Response.
The setting is adjusted in linear steps: 4, 8, and 12 dB, and we see the resulting response curves. Symbols are shown at ⅓-octave intervals. For a constant-Q filter, the level ⅓-octave away (shown as 1) is not a linear function of the setting, as we see by the uneven spacing.

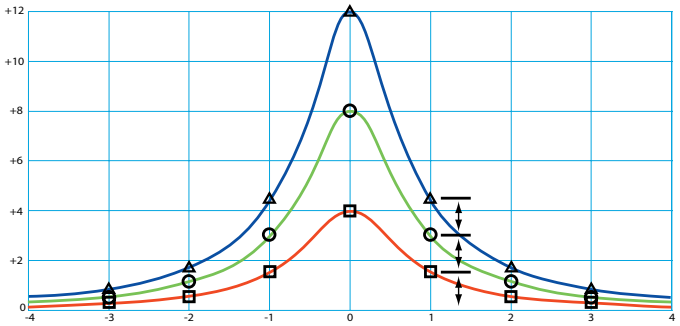


Figure 8. Perfect-Q Linear Response.
The Q has been adjusted such that the level ⅓-octave away (shown as 1) is a linear function of the setting.

Linear Response Changes

Although not particularly obvious, graphic equalizer bandpass response is, in general, not linear. This means that when the center frequency amplitude is changed, the filter skirts do not necessarily change in a linear manner. If it were a linear response then boosting the center frequency amplitude would result in a boosting of the skirts a known and predictable (key words) amount that was a linear factor of the amount of center boost. Figure 7 shows boosting the center in 4-dB steps results in points located ⅓-octave away being boosted, first around 1-dB, then about 2-dB and for the last 4-dB step nearly 3-dB. Contrast this with the Perfect-Q linear response shown in Figure 8, where the same points increase the same amount for each 4-dB increase.

In previous graphic equalizer designs the interaction acts like a linear system for small settings, but not for large ones. The results are good as long as the filters are not boosted or cut by large amounts; in that case the result is a compromise, but it is better than uncorrected. To linearize the system the filters must be cascaded. This results in the dB (logarithmic level) responses of the filters summing together to form the composite response; otherwise phase shifts between filter sections complicate things.

Perfect-Q takes a different approach. It adjusts the filter Q, or bandwidth, as a function of boost/cut amount, in such a way as to make the interaction linear, and thereby much easier to correct. The frequencies of the two filters directly adjacent to a given filter are given priority. The interactions at those two frequencies are made perfectly linear, which makes the interactions at more distant frequencies more nearly linear, and so on. Once the response is linear it is a straightforward, although complex, mathematical matter to check the user setting and subtract the resultant interaction so only the intended change is made.

Perfect-Q Availability

First use of this technology was the DEQ 60 Digital Graphic Equalizer — a 2-channel 30-band ⅓-octave design with conventional slider controls (part of Rane's analog-controlled digital series). Perfect-Q is employed in these fine products:

- DEQ 60L Graphic Equalizer
- Halogen software for the HAL Multiprocessors

Proprietary Rights

All techniques and algorithms discussed in this article are covered by U.S. Patent 7,266,205 granted to inventor Ray Miller and assigned to Rane Corporation. International patent pending.

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.

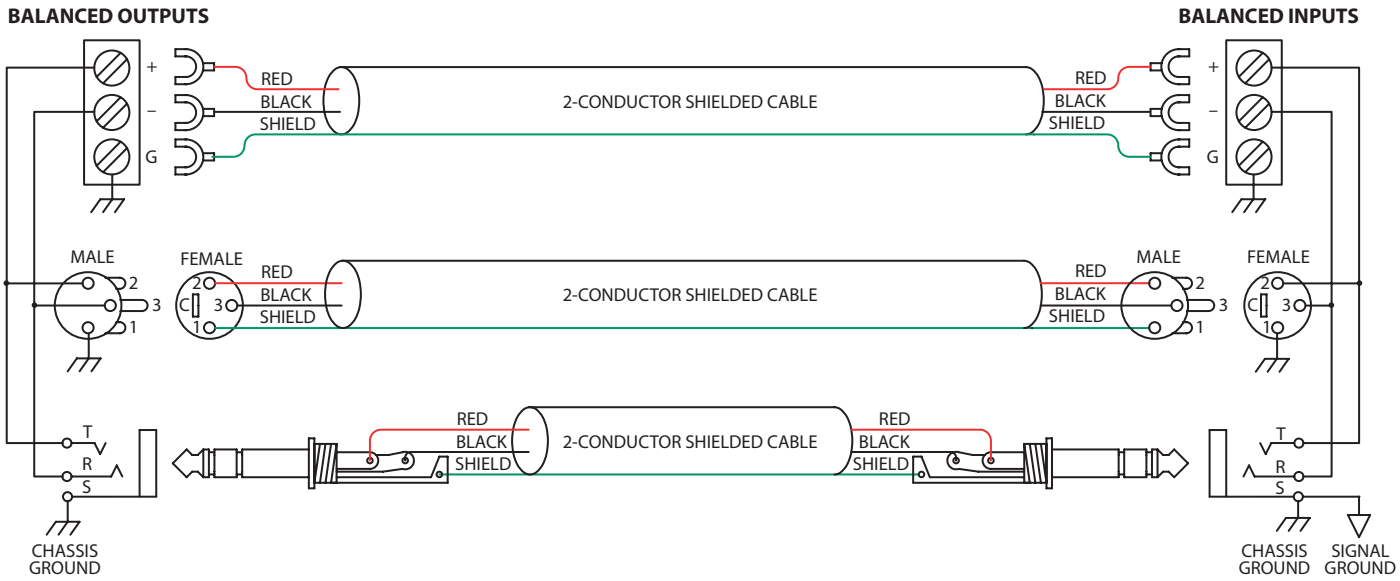


Figure 1a. The right way to do it.

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.

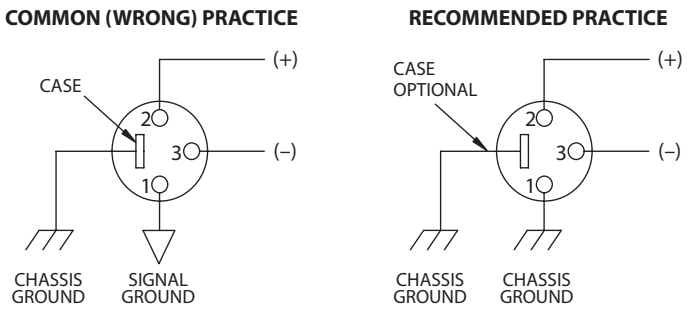


Figure 1b. Recommmended practice.

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.

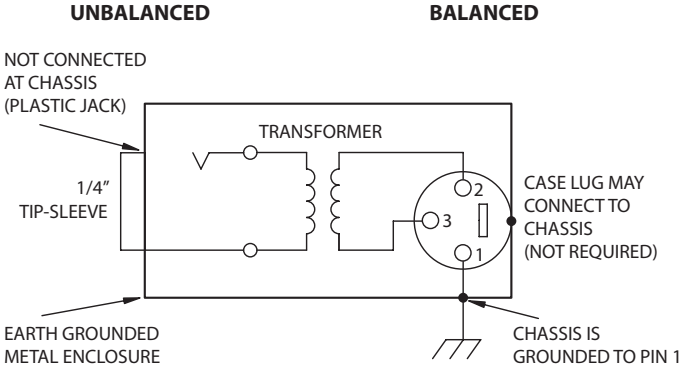


Figure 2. Transformer Isolation

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

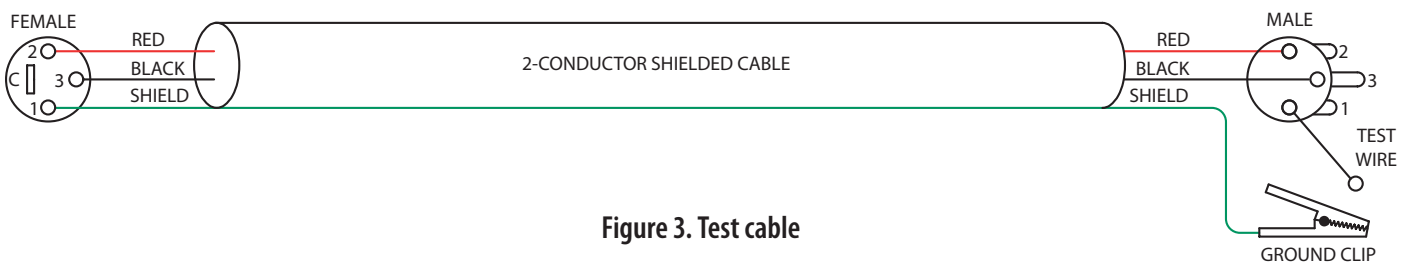


Figure 3. Test cable

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).

Band-Aid is a registered trademark of Johnson & Johnson

To Input

From Output

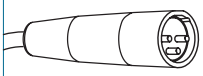
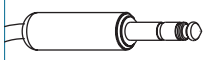
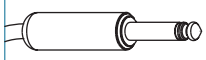
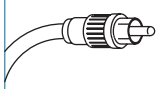
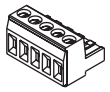
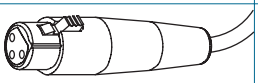
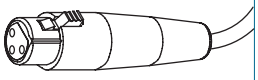
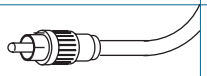
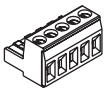
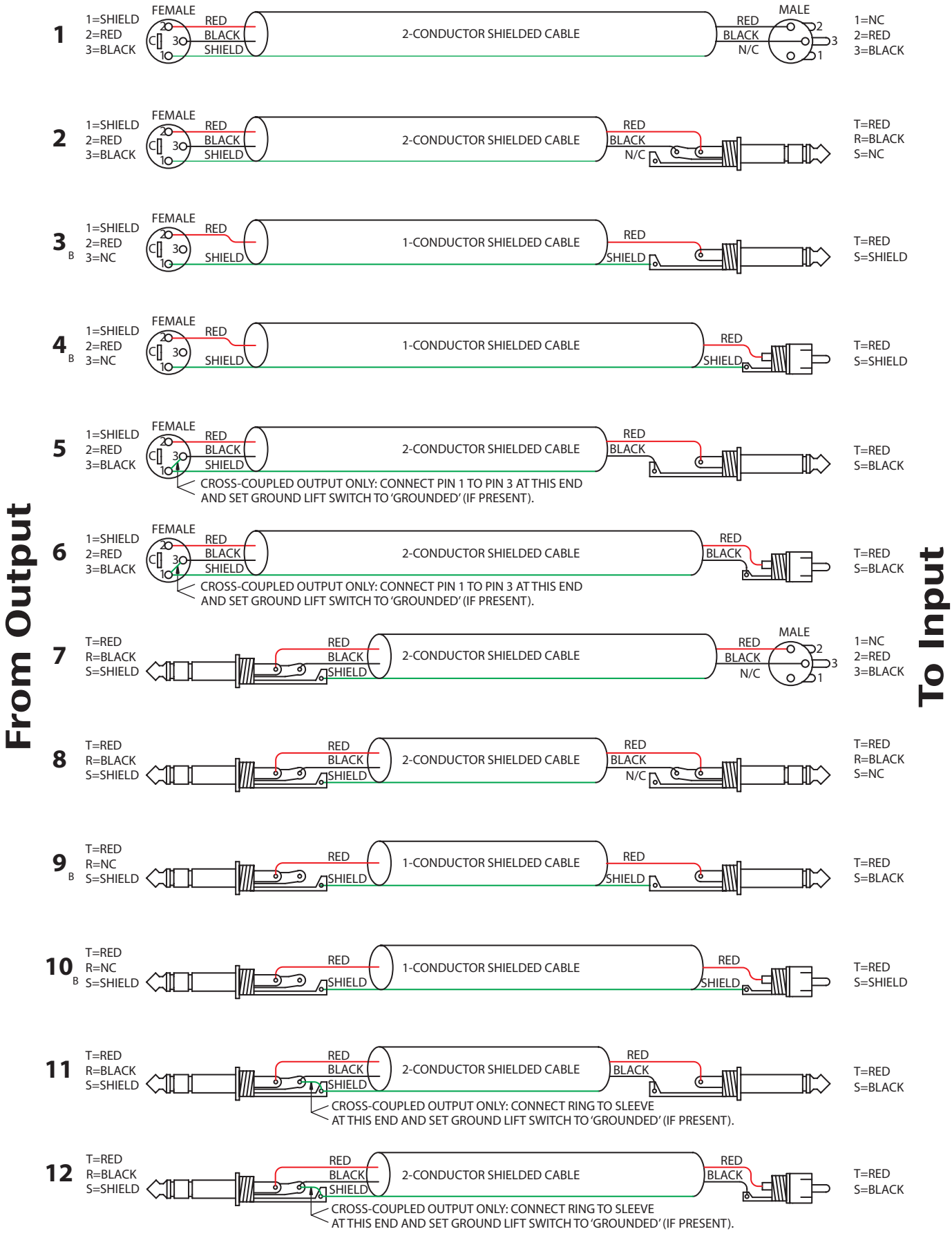
CABLE CONNECTORS	 MALE BALANCED XLR	 ¼" BALANCED TRS (TIP-RING-SLEEVE)	 ¼" OR 3.5mm UNBALANCED TS (TIP-SLEEVE)	 UNBALANCED RCA	 BALANCED EUROBLOCK
 FEMALE BALANCED XLR (NOT A TRANSFORMER, NOR A CROSS-COUPLED OUTPUT STAGE)	1	2	3 B	4 B	+ to + − to − SHIELD NC
 FEMALE BALANCED XLR (EITHER A TRANSFORMER 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

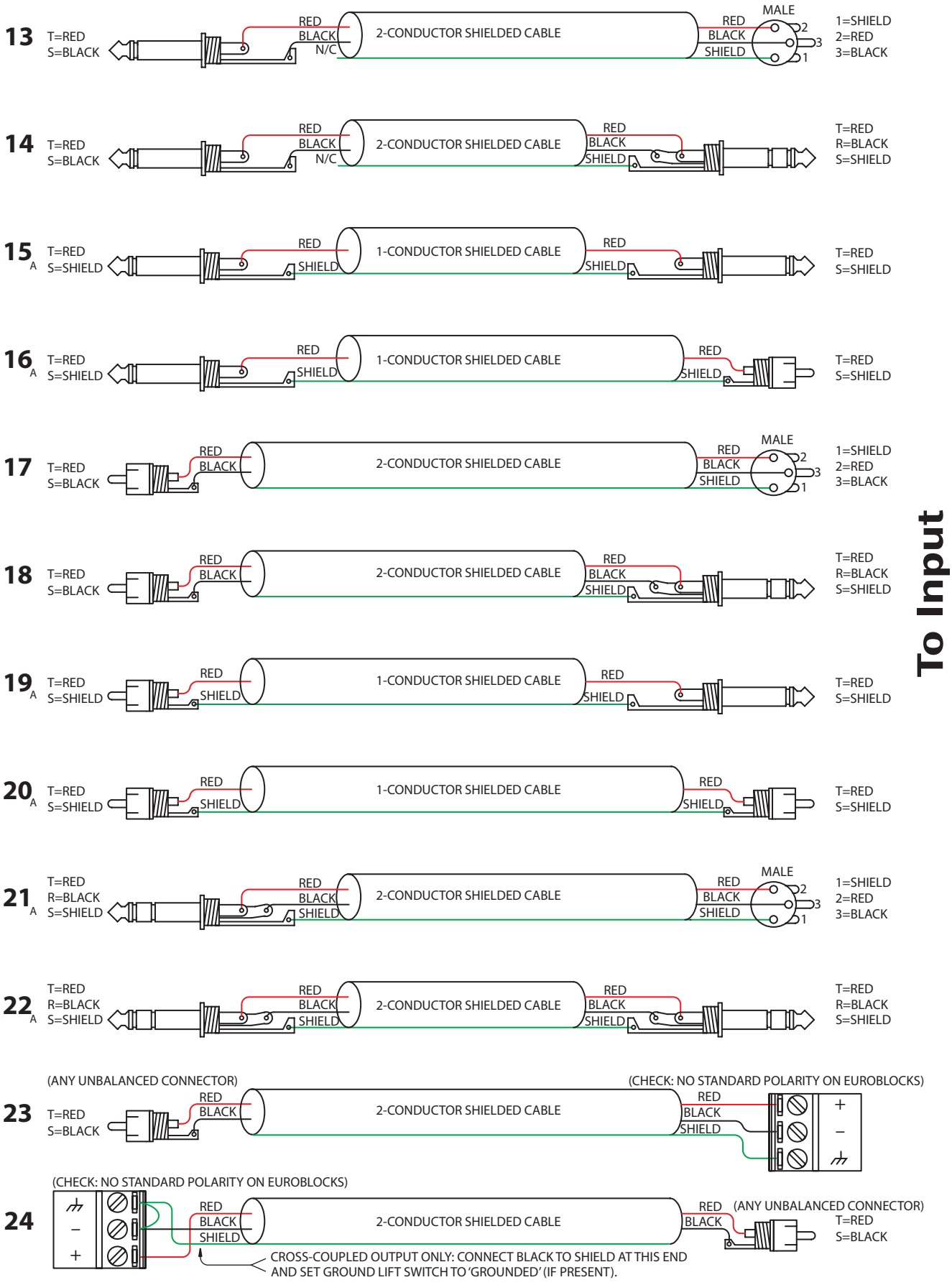
Figure 4. Interconnect chart for locating correct cable assemblies on the following pages.

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

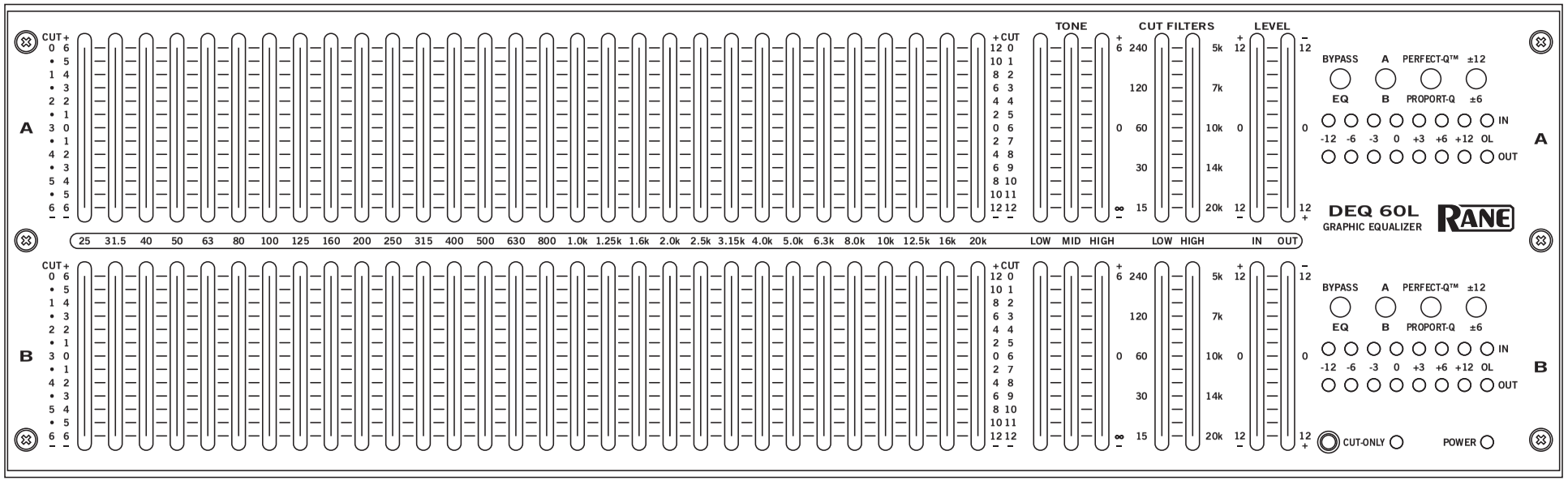
Note: (B) This configuration causes a 6 dB signal loss. Compensate by "turning the system up" 6 dB.

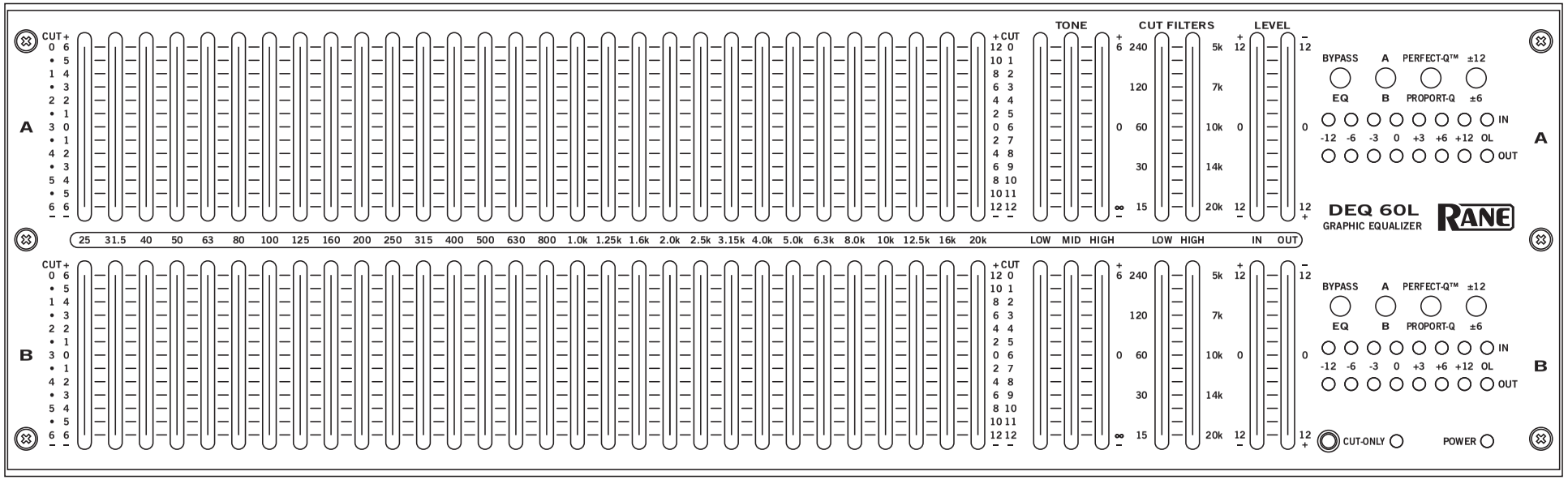

From Output
To Input
1
1=SHIELD
2=RED
3=BLACK
FEMALE
RED
BLACK
SHIELD
2-CONDUCTOR SHIELDED CABLE
RED
BLACK
N/C
MALE
1=NC
2=RED
3=BLACK
2
1=SHIELD
2=RED
3=BLACK
FEMALE
RED
BLACK
SHIELD
2-CONDUCTOR SHIELDED CABLE
RED
BLACK
N/C
T=RED
R=BLACK
S=NC
3 B
1=SHIELD
2=RED
3=NC
FEMALE
RED
SHIELD
1-CONDUCTOR SHIELDED 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


TONE
CUT FILTERS
LEVEL
A
B
CUT+
+CUT
25 31.5 40 50 63 80 100 125 160 200 250 315 400 500 630 800 1.0k 1.25k 1.6k 2.0k 2.5k 3.15k 4.0k 5.0k 6.3k 8.0k 10k 12.5k 16k 20k
LOW MID HIGH
LOW HIGH
IN OUT
BYPASS
A
PERFECT-Q™
±12
EQ
B
PROPORT-Q
±6
IN
OL
OUT
-12 -6 -3 0 +3 +6 +12
DEQ 60L
GRAPHIC EQUALIZER
RANE
CUT-ONLY
POWER


TONE
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+CUT
25 31.5 40 50 63 80 100 125 160 200 250 315 400 500 630 800 1.0k 1.25k 1.6k 2.0k 2.5k 3.15k 4.0k 5.0k 6.3k 8.0k 10k 12.5k 16k 20k
LOW MID HIGH
LOW HIGH
IN OUT
BYPASS
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PERFECT-Q™
±12
EQ
B
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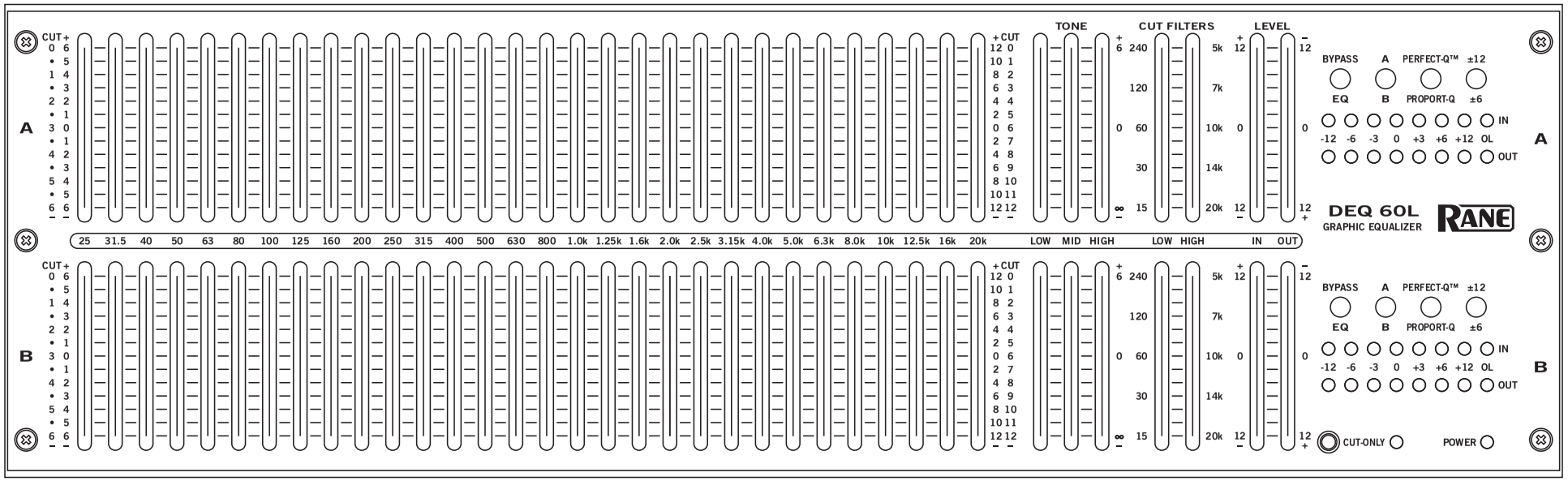
-12 -6 -3 0 +3 +6 +12
DEQ 60L
GRAPHIC EQUALIZER
RANE
CUT-ONLY
POWER


TONE
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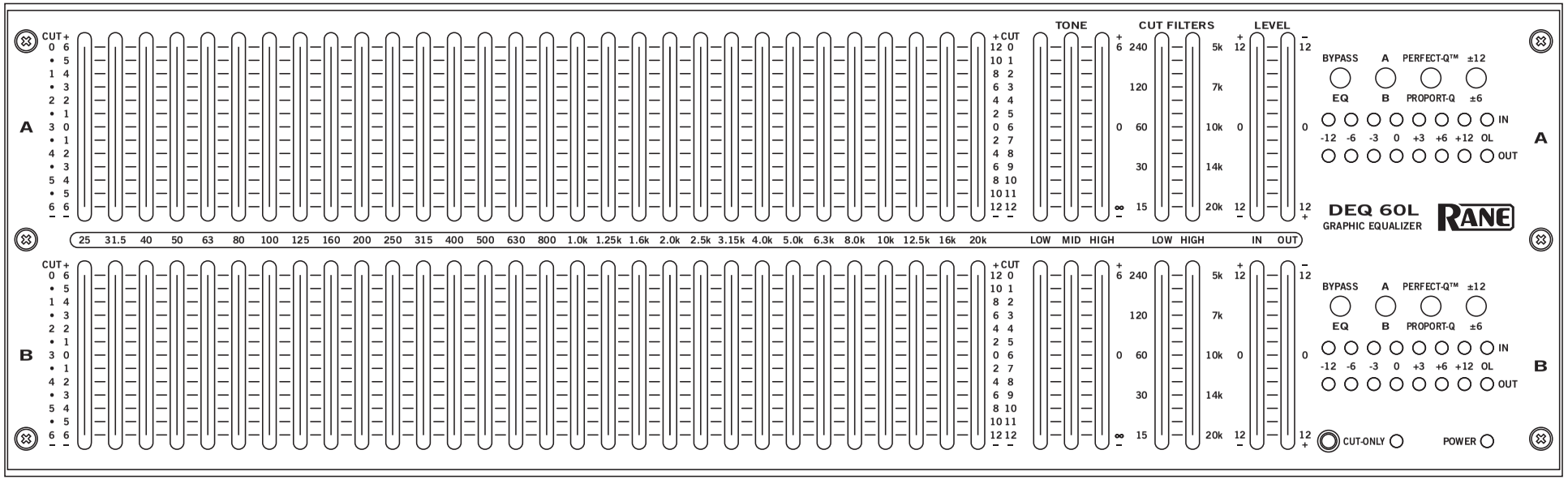
POWER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CUT+
+CUT
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LOW MID HIGH
LOW HIGH
IN OUT
BYPASS
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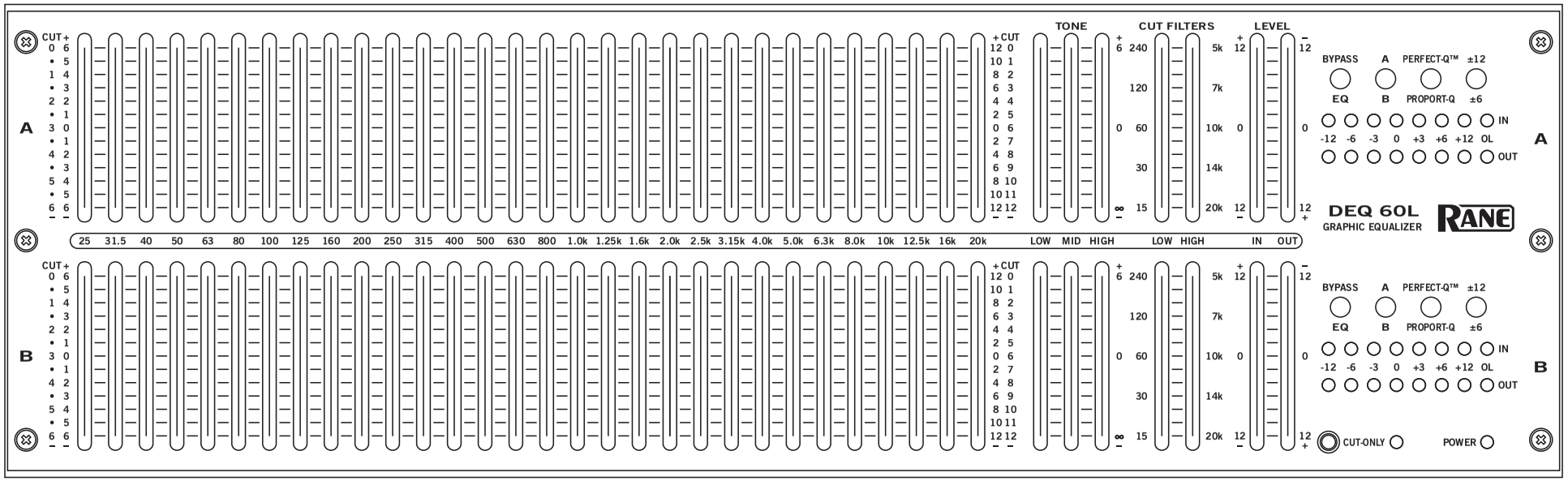
DEQ 60L
GRAPHIC EQUALIZER
RANE
CUT-ONLY
POWER


TONE
CUT FILTERS
LEVEL
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CUT+
+CUT
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LOW MID HIGH
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PERFECT-Q™
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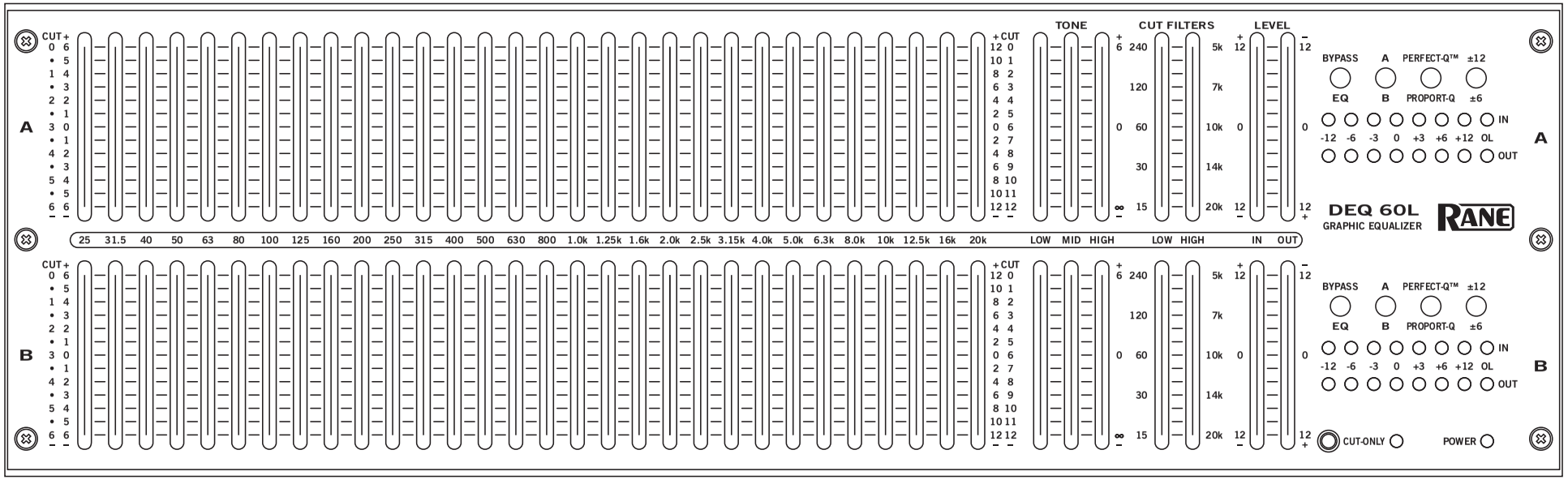
GRAPHIC EQUALIZER
RANE
CUT-ONLY
POWER


TONE
CUT FILTERS
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+CUT
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LOW MID HIGH
LOW HIGH
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BYPASS
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PERFECT-Q™
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PROPORT-Q
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OUT
-12 -6 -3 0 +3 +6 +12
DEQ 60L
GRAPHIC EQUALIZER
RANE
CUT-ONLY
POWER

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
2011/65/EU

Standard(s) to which conformity is declared:

EN60065:2002/A1:2006/A11:2008
EN50581:2012
SERIAL NUMBERS 900000 - 999999

Manufacturer:

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

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. This declaration of conformity is issued under the sole responsibility of Rane Corporation.

Type of Equipment: Professional Audio Signal Processing

Brand: Rane

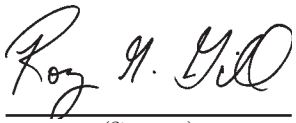
Model: DEQ 60L

Immunity Results:

A-weighted quasi-peak noise (AC 24 tested)

Test Description	Results	Conditions
RF Electromagnetic Fields Immunity		
80 MHz -1000 MHz, 1 kHz AM, 80% depth, 3V/m	< -70 dBu	80 Mhz -1000 MHz
Conducted RF Disturbances Immunity		
150 kHz - 80 MHz, 1 kHz AM, 80% depth, 3V RMS	< -67 dBu	Power Lines, 150 kHz - 80 MHz
	< -62 dBu	Signal & Control Lines, 80 MHz
Magnetic Fields Immunity		
50Hz - 10kHz, 4.0 - 0.4 A/m	< -68 dBu	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)

Roy G. Gill
(Full Name)

Compliance Engineer
(Position)

December 16, 2010
(Date)

Mukilteo WA USA
(Place)

DEQ 60L

GRAPHIC EQUALIZER