

WORKHORSE™

500 Series Rack & Mixer



Order No. R700 0100

USER GUIDE

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Made in Canada 

Radial Workhorse™

500 Series Rack and Mixer

Congratulations and thank you for purchasing the Radial Workhorse, an innovative eight channel card frame and mixer designed to take full advantage of 500 series modules. This manual covers installation and operation of the Workhorse. We recommend that you take a few minutes to read through this manual in order to familiarize yourself with the many innovative features incorporated into the Workhorse. Inside, you will find important safety features along with tips on how to get the most out of your 500 modules while using the Radial Workhorse.

To make the manual as easy to understand as possible, we have divided it into several sections. It begins with an overview, then descriptions of each function, ending with some real world applications. Should you have any questions, comments or concerns not covered in these pages, we invite you to log onto the Radial web site at www.radialeng.com and visit the Workhorse FAQ section. This is where we post the latest details and applications. If you do not find what you need, feel free to send us an email at info@radialeng.com and we will do our best to answer your question as quickly as possible. Get ready to Plug in, Turn on and Tune in your 500 modules with the Radial Workhorse.

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IMPORTANT SAFETY & USER NOTICE - FOR PROFESSIONAL USE ONLY

The Radial Workhorse is specifically designed for use by qualified professional audio engineers. The open frame design is not intended for use by consumers or those unfamiliar with this format. Even though the current and voltage levels are relatively low, we recommend that all slots be filled with a module or covers be placed over unfilled slots. This will help protect you from electrical shock.

The Workhorse™ rack frame and mixer is designed to be used with 500 series or what are commonly known as Lunchbox™ modules. The Workhorse has been designed following the framework as outlined by the VPR Alliance as described on the API™ website. Although some manufacturers build modules that are not VPR compliant, they may in fact work with the Workhorse. Please consult those specific manufacturers for details regarding their compatibility. The Radial Workhorse Open Source Document outlines the required technical specifications for manufacturers that intend to have their modules used in the Workhorse. Compatibility of any modules other than a module made by Radial Engineering Ltd. is the sole responsibility of the user. Please read the Limited Radial Warranty for details. There are no replacement or user serviceable parts inside.

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FRONT PANEL FEATURE SET

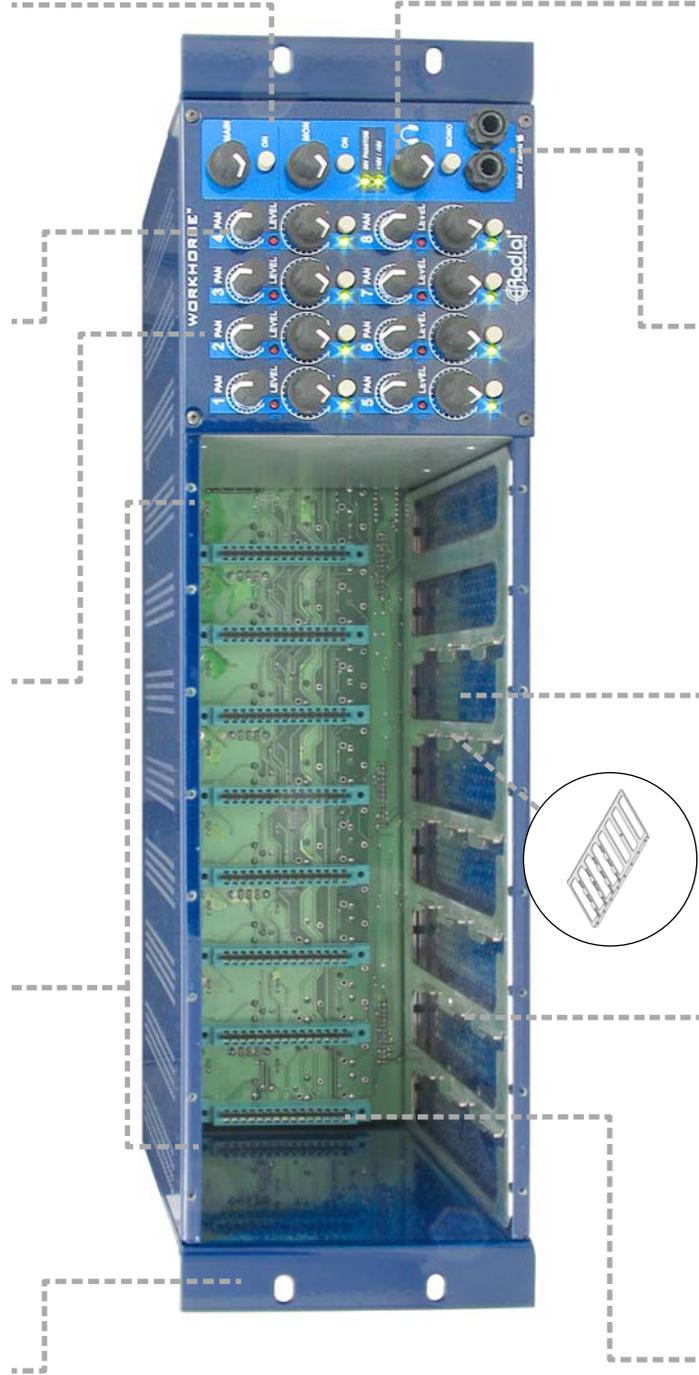
STEEL CASE: The Workhorse chassis is made from heavy steel to provide extra shielding against stray magnetic fields and RF.

EIGHT CARD SLOTS: Up to eight 500 series compatible modules may be loaded into the Workhorse and connected via standard card edge receptacle.

MIXER SECTION: Ultra quiet built-in mixer lets you tap signals from each module and mix them to the main, monitor or headphones.

MIXER CHANNEL INPUTS: Each Workhorse channel is equipped with volume control, left-right pan, LED overload indicator and channel on-off for muting.

OUTPUT SECTION: Separate stereo controls for main, monitors and headphones make it easy to adjust levels or mute signals when needed.



DEEP CURRENT POOL: Modules can draw as much current as they need from a shared pool. Up to 1200mA total current is available.

EASY-GLIDE TRAY: Slide-in platform for modules makes connecting to back plane easy by properly aligning card edge height.

FITS ALL MODULE SIZES: Both single and double wide modules will fit in the Workhorse. Removable tray for non-standard modules.

DUAL HEADPHONES: Super high output dual headphone amp with level control to ensure you can mix in any environment. Mono check switch.

LED INDICATORS: Provide visual power status for the +/- 16 volt module rails and 48V phantom power.

REAR PANEL FEATURE SET

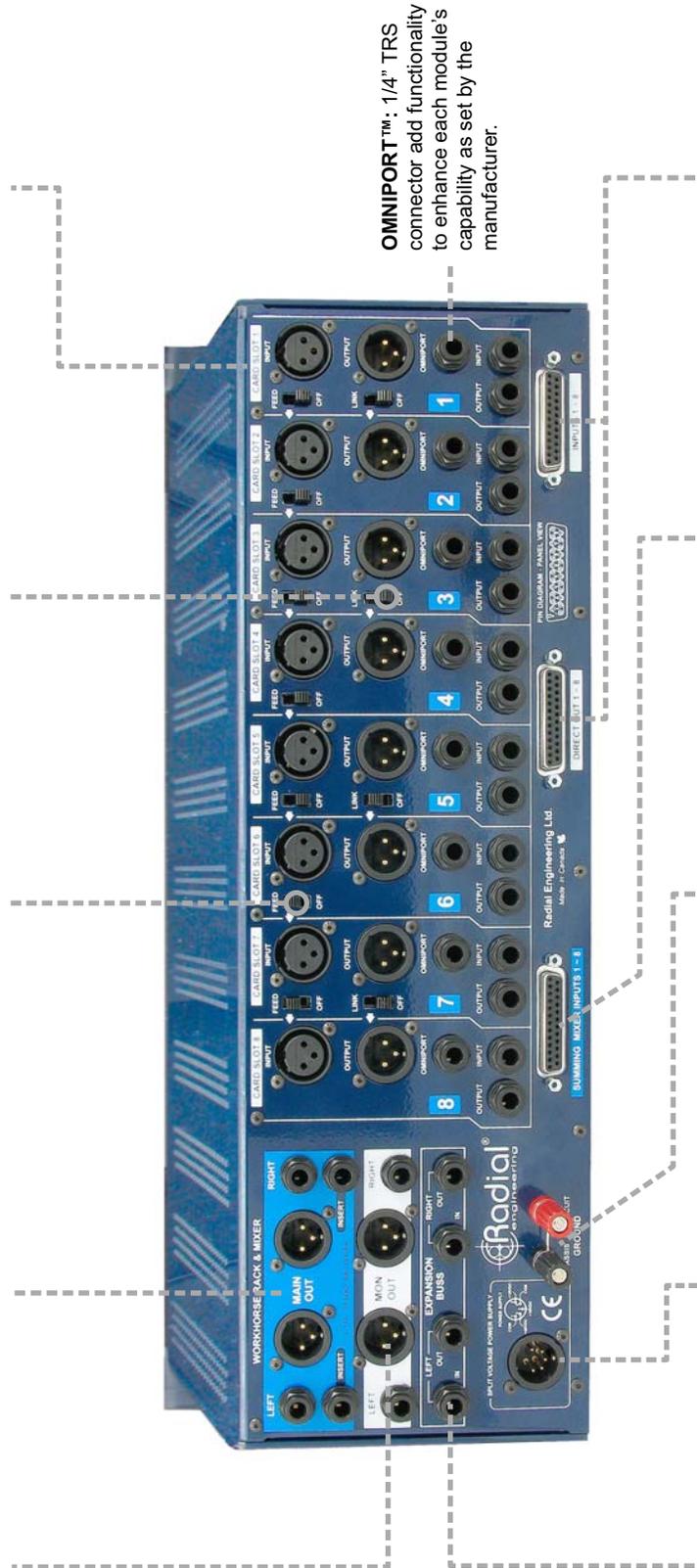
MONITOR OUTPUTS: Used to send signal to your nearfield monitors with choice of XLR and 1/4" TRS jacks. Features independent level control.

MAIN OUTPUTS: Jensen transformer isolated to eliminate noise and add warmth. Equipped with TRS insert jacks for effects.

FEED FUNCTION: Lets you connect one module into the next to set up elaborate channel strips without having to hard patch with cables.

STEREO LINK: Makes it easy to pair up modules equipped with a stereo link function in standard API master slave configuration.

CARD SLOT CONNECTORS: Follows original XLR I/O format and adds parallel 1/4" TRS jacks for easy connectivity to workstations.



OMNIPORT™: 1/4" TRS connector add functionality to enhance each module's capability as set by the manufacturer.

EXPANSION BUSS: Expand the workhorse to 16x2 or larger by connecting one Workhorse into another. Simple 1/4" connections makes it easy.

EXTERNAL POWER: High current external switching supply delivers 1600mA to the Workhorse plus separate 48V phantom feed for mic preamps.

STUDIO GROUNDING: External grounding lugs makes it easy to set up star grounding schemes for high-end studio wiring.

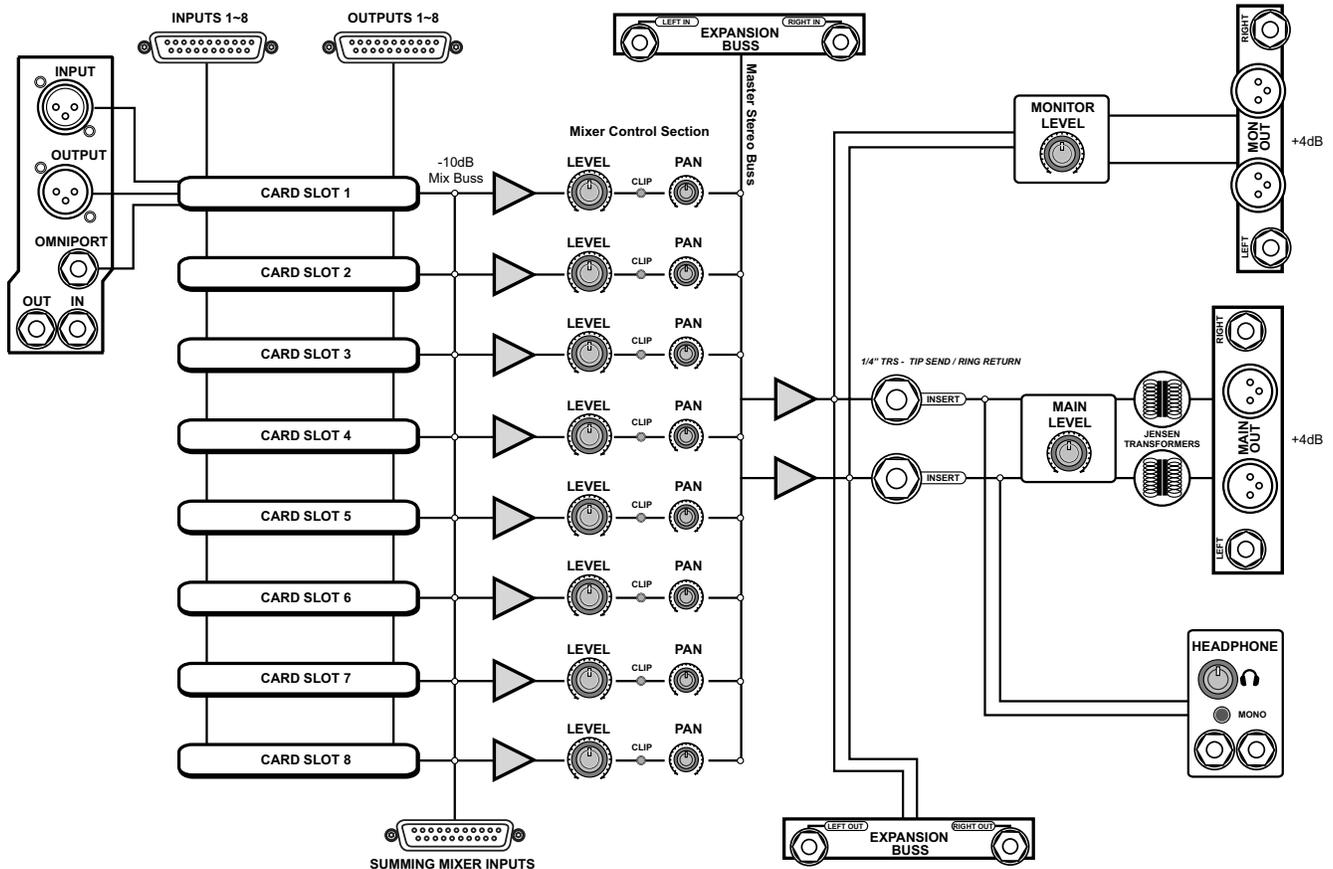
SUMMING MIXER: Built-in eight channel summing mixer lets you mix 'outside the box' in the analogue domain for added warmth and character.

BALANCED 25-PIN D-SUBS: Eight channel D-Subs follow Pro Tools standard for easy connectivity to workstations. Wired in parallel to XLR inputs and outputs.

INTRODUCTION

The Workhorse is an eight channel card frame and mixer designed for 500 series modules. Up to eight modules may be used at any one time. Once 'plugged in', the Workhorse automatically routes the module's signal to the XLR, ¼" and D-sub connectors on the rear panel via a 15-pin card-edge connector and receptacle. Radial modules and those that have been designed by other manufacturers

to take advantage of the Workhorse's extra features will enjoy the added convenience of having the signal sent to the internal mix buss and the built-in 8x2 stereo summing mixer. For older generation modules, the individual channel outputs can be routed to the summing mixer using a D-sub cable affording them much the same functionality as newer Radial designs.



SIGNAL FLOW

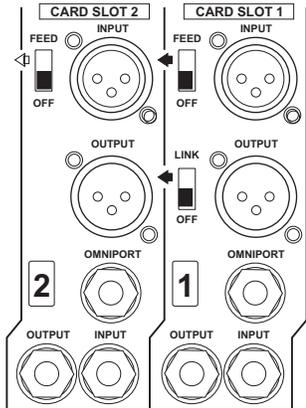
The signal flow chart above shows the basic signal routing that the Workhorse provides. Flowing from left to right, the signal comes into the Workhorse provides. Flowing from left to right, the signal comes into the Workhorse via the rear panel XLR female and ¼" TRS connector. Once the signal goes into a module, it is then sent back out after it is processed to the male XLR and ¼" TRS. This of course happens on all eight channels. Simultaneously, Radial modules send the signal to the internal mix buss which feeds the mixer.

After the signal has been panned left or right, it can go to the expansion buss if feeding a second Workhorse. It is then fed into the master output stage where it is once again buffered and sent to the main, monitors and headphones. Note the main outputs are Jensen transformer isolated. The next section in this manual discusses each feature in detail following the signal flow.

FEATURE SET

Card Slot I/O Connections

Each of the Workhorse card slots is equipped with XLR, 1/4" TRS and D-sub inputs and outputs. The input sensitivity will be dependant on the type of module being used. For instance if you are using a microphone preamplifier, the input will of course be suited for a low level microphone. If you are using a dynamic processor like a limiter or an EQ, then the input will usually be set to handle a professional +4dB balanced signal.



Because the Workhorse is equipped with an internal mix buss most Radial modules are equipped with an internal buffer so that the output can be sent along the buss to the mixer section. As such, the XLR male and TRS outputs will usually follow suit with a +4dB balanced line level signal that is able to feed a professional recording system or line level mixing console. This may sound a bit complex, but as we look into applications later in this document, it will become very clear.

Put simply, the input level is determined by the type of module being used while the output level will typically be a balanced +4dB line level signal. If you use 1/4" mono cables you will unbalance the signal. This will reduce the level by about -6dB but everything will still remain completely functional. Simply adjust the levels to compensate.

Omniport

Omniport™ is a special 1/4" TRS jack located on the rear panel that has been left 'open' to allow the module to perform a unique task. In other words, depending on the type of module, the manufacturer can assign the Omniport to perform a function that may be most appropriate. This could be a key input on a gate, a footswitch on a guitar effect or maybe an instrument input on a mic preamp.

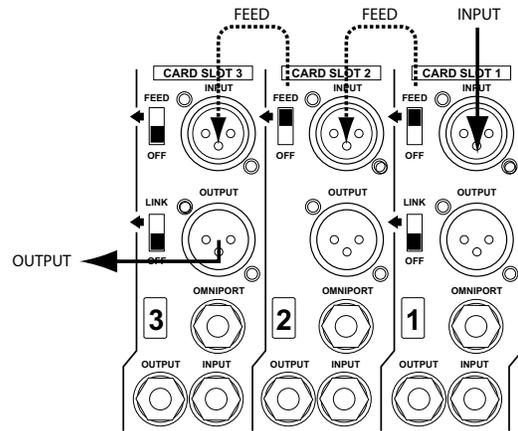
The card-edge pins 7 and 9 (unused in the original spec) have been assigned to the Omniport™ TRS connector. The application here is only limited to one's imagination as to the function that best relates to a given module. As the Omniport function is determined by the module, you will need to consult the module manufacturer's specification for details on how it was designed to be used.

Radial Omniport Assignment:

| Module | Omniport function |
|----------|--|
| PowerPre | Instrument input |
| JDV | Direct box output (low Z out for live touring) |
| X-Amp | Instrument input |
| Phazer | Balanced direct out (original dry signal out) |
| JDJ | Direct box output (low Z out for live touring) |
| EXTC | TRS insert for patch bay |
| Komit | Compressor key input |

Feed Switch

As you delve further into the functionality of the 500 series, you will find that the modular format allows all kinds of connectivity options. With older 500 series racks, connections between modules were done using an XLR cable whereby the output from one module would plug into the input of another. The Workhorse simplifies the process by introducing a Feed switch on the rear panel. This connects the balanced output of one module to the balanced input of the adjacent module to the immediate right. The Feed switch allows you to daisy chain a series of adjacent modules making it easy to create 'customized' channel strips whereby a mic preamp could feed an EQ which in turn could feed a compressor. Changing the order is simply a matter of relocating the modules or patching using an XLR cable. The UP position turns the Feed connection on.

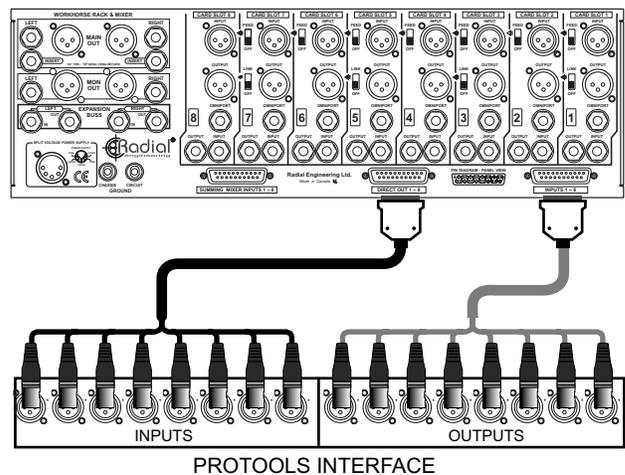


Stereo Link Switch

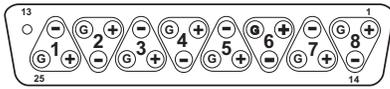
Every second card slot is equipped with a Link switch. The Link function allows modules that are 'stereo ready' to be linked together. A typical example would be using two limiters on a stereo track where you want the dynamics to be the same for both channels. Pin-6 on the card edge connector is designated for this function and used to send control voltage from one module to the other. One module will take on the master role while the second will act as the slave. This is a 'standard' function on all API Lunchbox™ generations.

D-Sub I/O Connectors

To add flexibility, all eight balanced card-slot input and output connections are duplicated on two 25-pin D-Subs wired to the Tascam™/ProTools™ pin-out standard. These parallel connections are designed to make it easy to integrate the Workhorse with recording systems that employ this industry standard.



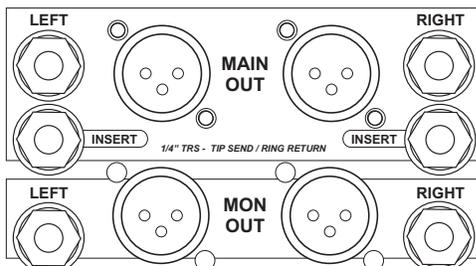
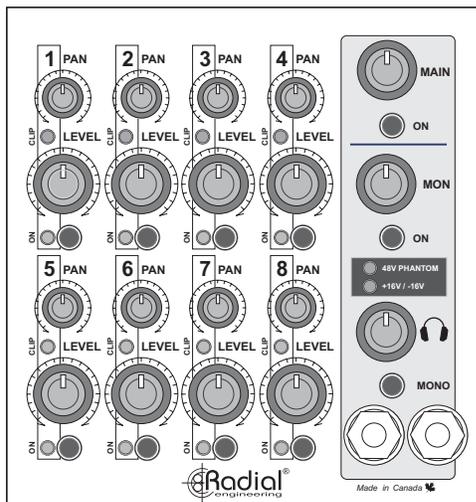
The D-sub pin configuration is printed on the back panel so you can ensure the cable that is being used is properly wired. The good news is that today, most music shops carry these types of cables and they are usually wired correctly.



| Pin # | | Pin # | |
|-------|------------------|-------|------------------|
| 1 | Channel 8 Hot | 14 | Channel 8 Cold |
| 2 | Channel 8 Ground | 15 | Channel 7 Hot |
| 3 | Channel 7 Cold | 16 | Channel 7 Ground |
| 4 | Channel 6 Hot | 17 | Channel 6 Cold |
| 5 | Channel 6 Ground | 18 | Channel 5 Hot |
| 6 | Channel 5 Cold | 19 | Channel 5 Ground |
| 7 | Channel 4 Hot | 20 | Channel 4 Cold |
| 8 | Channel 4 Ground | 21 | Channel 3 Hot |
| 9 | Channel 3 Cold | 22 | Channel 3 Ground |
| 10 | Channel 2 Hot | 23 | Channel 2 Cold |
| 11 | Channel 2 Ground | 24 | Channel 1 Hot |
| 12 | Channel 1 Cold | 25 | Channel 1 Ground |
| 13 | Not Used | | |

Mixer Section

The mixer section in the Workhorse features an eight channel summing mixer with stereo outputs. It derives its signal via pin-11 from the slot card-edge connector or from the D-sub summing mixer input connector. Each channel features an ON-OFF switch that enables you to select or mute the signal from the designated card slot. Individual channel gain controls are used to adjust the mix level while the pan control lets you position the signal across the stereo spectrum. To assign a channel to a left or right output, one simply hard-pans the module using the pan control. A channel-on LED lets you know when a channel is activated plus an overload peak indicator lets you monitor signal levels to ensure you are not overloading the summing mixer's input.



Mixer Master Section and Outputs

The mixer's master section features three stereo outputs: main, monitor and headphones, each with individual level control. The main stereo output is equipped with TRS insert jacks for connecting effects or equalizers and Jensen transformers that isolate the output to reduce the hum and buzz caused by ground loops. This is particularly useful in live recording environments where control over the electrical system is often compromised. These also play an important role by introducing the warm 'Jensen sound' at the mixers main output. Jensen transformers are legendary in their ability to withstand huge transients without distortion while delivering a smooth articulated sound.

The monitor output provides a second stereo pair that can be used in the studio for monitoring, as a direct output for recording or to feed a PA system in a live environment. Both the main and monitor outputs are equipped with individual on-off switches and outfitted with balanced XLR-male and 1/4" TRS connectors. Although both the main and monitor outputs are balanced +4dB line level, you can use an unbalanced 1/4" cable if need be. This will of course unbalance the signal and reduce the output by about -6dB.

Headphone Amplifier

The Workhorse is equipped with a high-output stereo headphone amplifier with two standard 1/4" TRS headphone connections. This enables the engineer to share the mix and discuss the situation with the producer while both are listening. To use, simply plug in and adjust the level to suit.

The headphone buss is equipped with a switch that sums the stereo image to mono. This switch only affects the headphone out and is intended to provide the engineer with a quick reference to hear how the mix correlates when sent as a mono broadcast. This handy feature also helps identify stereo pairs that may be out of phase. When set to mono, instead of summing together and getting louder, they will get quieter and sound thin.

It is important to note that the Workhorse is intended for professional use in high Sound Pressure Level (SPL) environments and the headphone amplifier is capable of producing very high audio volume levels with most headphones. In fact, the maximum sound level is much louder than what battery operated portable music players can produce. Care and attention must be paid to ensure you do not damage your hearing by setting the signal too loud. Always test signals at a low volume before increasing the listening level.

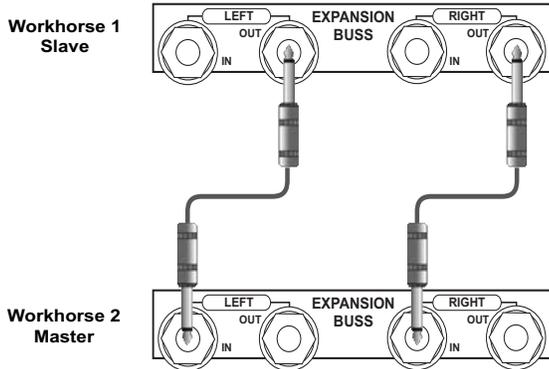


Headphone Safety Warning Caution: Very Loud Amplifier

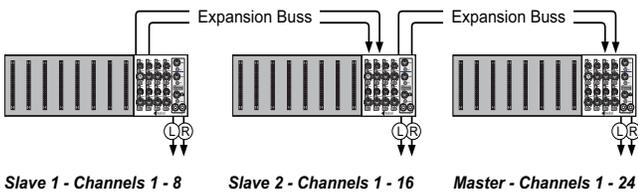
As with all products capable of producing high Sound Pressure Levels (SPL) users must be very careful to avoid the hearing damage that may occur from prolonged exposure. This is particularly important as it applies to headphones. Prolonged listening at high SPLs will eventually cause tinnitus and can lead to partial or complete loss of hearing. Please be aware of the recommended exposure limits within your legal jurisdiction and follow them very closely. The user agrees that Radial Engineering Ltd. remains harmless from any health effects resulting from the use of this product and the user clearly understands that he or she is entirely responsible for the safe and proper use of this product. Please consult the Radial Limited Warranty for further details.

Expansion Buss

The Workhorse stereo expansion buss is designed to allow multiple Workhorses to be used together to create larger mixing systems. This also lets you create 'sub-zones' and 'group' mixes. Standard unbalanced 1/4" cables are used to connect between units with choice of input or output depending on which Workhorse will be set as the 'master' and which will be designated as the 'slave'. All you do to link one to the other is connect two cables (left and right). The output from the 'slave' will now feed the input on the 'master' essentially combining the two to create a 16x2 mixer.



You can take things a step or two further by adding more Workhorses with the each subsequent unit delivering more and more channels. This could for instance be used in a live scenario where channels 1-8 from the first Workhorse are vocals with the output being treated like a sub-group sent to a wedge monitor system while the full mix from the master (1-16 or 1-24 channels) is sent to the PA and recording system.



Keep in mind that the Workhorse's modular flexibility also enables you to use the individual XLR or 1/4" outputs from each module card slot to feed a recorder should this be desired. Once you get to know the Workhorse the creative options are almost endless!



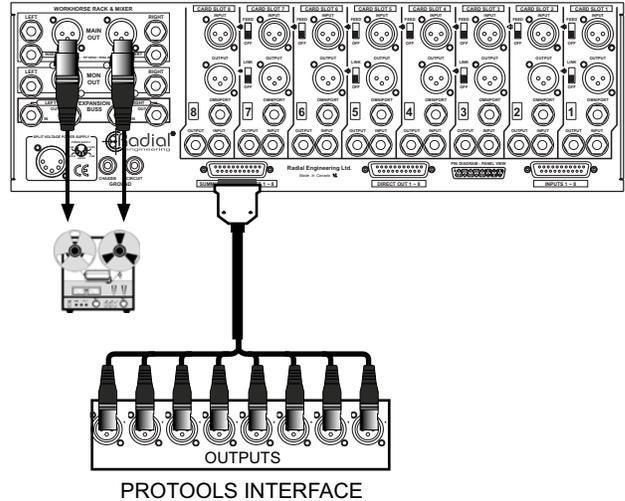
Radial Tech Note: Expansion Buss

The Radial 'open source' approach also enables the expansion buss to be interfaced with other manufacturer's electronic equipment that is equipped with similar functionality such as products made by Rupert Neve Designs™. The expansion buss is essentially the inverting (virtual earth) input of an op-amp in the mixer section of the rack with a 4.75K Ohm resistor in series for unity gain connectivity. This can be used by an external device so long as it can operate into a 4.75K Ohm load. There is no DC blocking. This means that if there is any DC on the output of the external device, the clipping response of this stage will be non-symmetrical and headroom will be reduced.

D-Sub Summing Mixer Input

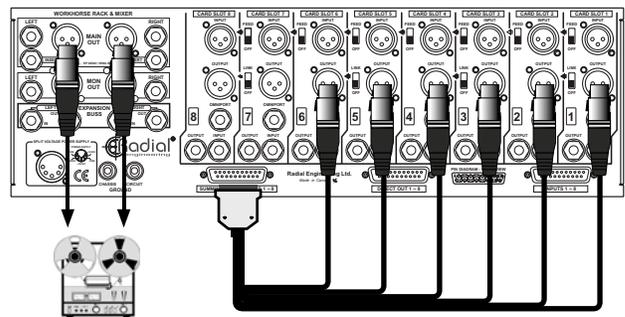
One of the cool extras built into the Workhorse is the ability to use it as a stand-alone eight channel analog summing mixer. This feature also enables older 500 series modules to be hard wired into the Workhorse mix buss. A dedicated unbalanced 25-pin D-Sub input on the rear panel provides access to the eight mixer inputs and accepts both +4dB and -10dB line level sources.

For instance, if you prefer the sound of analog summing, and want to mix eight channels from your ProTools™ rig, you simply connect the output of your recording interface to the Workhorse summing mixer D-Sub input and you can now mix using the eight front panel level and pan controls.



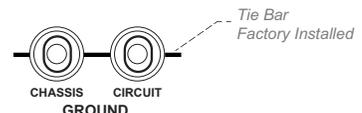
Using The Summing Mixer Input To Mix Older Modules

If you have a bunch of older API™ preamps and want to mix their outputs using the built-in mixer, simply connect the individual card-slot outputs to the summing mixer input using a D-Sub cable and you are all set. The modules output signal will appear at the corresponding mixer channel.



Grounding Posts

The connection between chassis and circuit (analog) ground is made between the binding posts on the rear panel (factory set). Opening this connection will separate these grounds in the Workhorse itself so the only connection point between them is in the power supply. Further separation is not allowed by electrical safety authorities. It will only be in rare and unusual circumstances these grounds will need to be separated.



Power Supply and Capacity

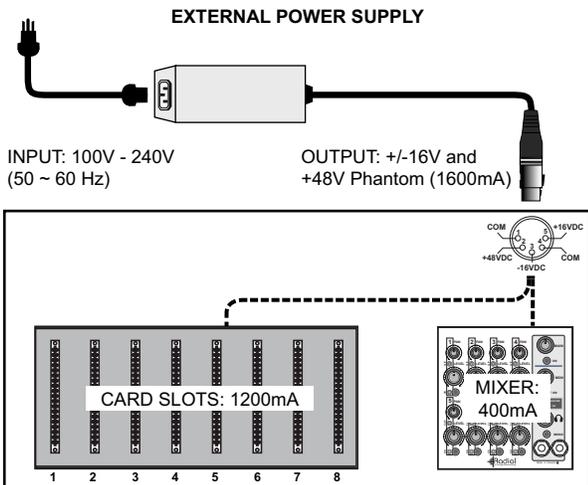
The Workhorse employs a universal power supply that will automatically convert the various voltages used around the world and regulate them before sending the power to the Workhorse. A standard male IEC/EIN power input connector makes it easy to travel as you need only change the cable to suit the local power connector type.

The Workhorse does not have a power switch. As soon as you connect the 5-pin XLR from the external supply to the Workhorse it will be activated. Two front panel LEDs in the master section will illuminate as soon as power is established. These indicate 48V Phantom power is available and the +/-16V power supply for the modules is active.



The Workhorse power supply is a 1600 milliamps (mA) external 'brick' that provides 48 volts for phantom power and the required +/-16 volts to supply each module. Pin-15 on the card-edge connector provides phantom power. Turning phantom power on or off is module dependent. So for instance if you plug in a mic preamp, it will normally be set up to feed the phantom power from the Workhorse supply to the microphone input thus enabling you to send +48V phantom power to a condenser microphone or active DI. For modules such as dynamic processors or EQs that do not use phantom power, the module simply ignores pin-15 as if it were not there.

Unlike some 500 series racks that are 'power limited', the Workhorse pools the available current so that the user can configure the system based on his or her requirements. The 1600 milliamps are first divided whereby 400 milliamps are reserved for the master mix section. This leaves 1200 milliamps that can be shared among the 8 module slots and supplied via pins 12, 13 and 14.

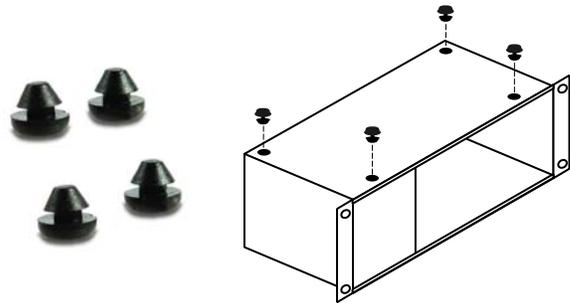


So for instance if you have a couple of power-hungry tube preamps in slots 1 and 2 that require 250 milliamps of current, you still have 700 milliamps of current left to power the other six slots. Considering most 500 series modules use between 40 and 80 milliamps of current, it is unlikely you will ever exceed the Workhorse's available power. *Note: The original API spec calls for 130mA on each slot. The Workhorse not only exceeds this (150mA when current draw is divided equally between eight card slots) but allows you to distribute the available power as needed.*

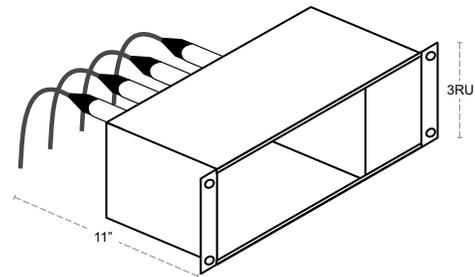
| Single Slot Modules | | | Double Slot Modules | | |
|---------------------|-------------------|--------------|---------------------|-------------------|---------------|
| 1 | Mic Preamp | 80mA | 1 | Tube Mic Pre | 250mA |
| 2 | Equalizer | 60mA | 2 | | |
| 3 | Compressor | 60mA | 3 | Tube Limiter | 250mA |
| 4 | Gate | 60mA | 4 | | |
| 5 | Mic Preamp | 80mA | 5 | Tube Mic Pre | 250mA |
| 6 | Equalizer | 60mA | 6 | | |
| 7 | Compressor | 60mA | 7 | Tube Limiter | 250mA |
| 8 | Gate | 60mA | 8 | | |
| | TOTAL DRAW | 520mA | | TOTAL DRAW | 1000mA |

Installing The Workhorse

The Workhorse can be either mounted in a standard IEC 19 inch rack system or placed on the desktop with the user installed rubber feet that are included in the packaging.

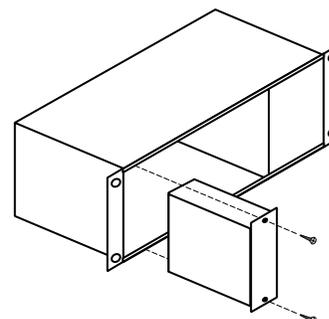


The Workhorse is 19" wide, 7" deep and uses three standard vertical rack spaces or 5.25". The total rack depth needed for installation is 11" (280mm) to accommodate rear panel cable connectors. It is a good idea to provide some means of support and strain relief for the cable bundle connecting to the rear panel.



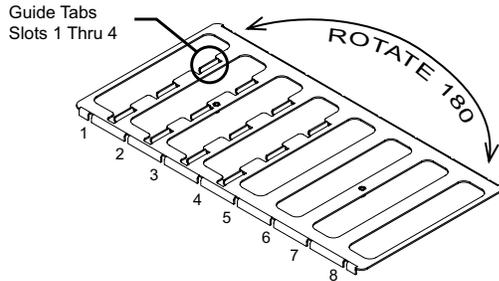
Installing Modules In The Workhorse

Modules slide into the Workhorse card slots and make contact with the card edge connector on the inside rear plane. Once in place, modules are fastened using two 4/40 thread machine screws.



Slide-In Card Slot Tray

Another innovative feature in the Workhorse is the slide-in tray for the card slots. The tray is designed to make sliding modules in and out easier while lessening the frustration of trying to line up the card-edge connectors. The tray is equipped with a series of guide tabs to help align single and dual width modules. The tray comes factory installed with slots 1 ~ 4 set up for single wide modules, and then 5/6 and 7/8 set up for double wide modules. The tray can also be rotated 180° so that the double wide modules can be installed in the first four slots.



The workhorse is designed to accept modules that adhere to the 4.5" height dimensions outlined by the VPR Alliance. Compliant modules will easily slide in and out of the Workhorse card slots with the slide-in tray in place. However there are some modules that are in violation of the height specification. To accommodate non-compliant modules, the slide-in tray may have to be removed.



Two Phillips screws on the bottom of the Workhorse allow the slide-in tray to be taken out. To remove, turn the workhorse upside down and locate the two Phillips head screws on the bottom chassis. Remove the two screws and lift out the tray. Replacing the two screws back into the slide-in tray will help keep them handy if the tray is to be re-installed.

Exchanging Modules

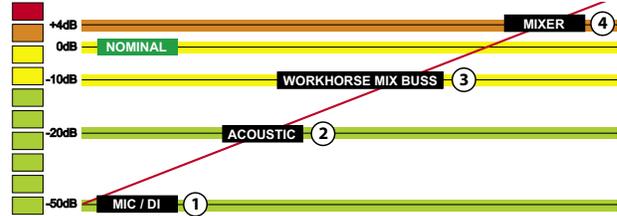
When making any electrical connection, it is always safer to do so with the power disconnected. The Workhorse power supply is equipped with internal protective measures intended to provide a margin of safety should a module exchange be performed in error with the power on. However, the Workhorse is not designed to allow repeated insertion and removal of modules while the power supply is active. Always disconnect the power from the Workhorse before exchanging modules.

! SAFETY NOTICE - NO HOT SWAPPING

"Hot Swapping", or exchanging modules while the power is on is not covered under the Radial Limited Warranty. The user is responsible for any damage to the Workhorse or module arising out of hot swapping and the user shall save Radial Engineering Ltd. harmless should any damage occur. Please consult the Radial Limited Warranty for further details.

Signal Flow And Levels

Because the Workhorse is modular, it can accept a multitude of different devices. This also means that you need to understand the signal flow so that you can be sure what you want to do will work. In the world of audio there are basically four low level signal groups to contend with before you get to high power output levels such as those produced by power amplifiers to drive loudspeakers.



- MIC LEVEL RANGE:** Microphones and direct boxes produce the weakest signals. These typically range from -60dB to -40dB depending on type. Some such as ribbon microphones can be as low as -70dB while condenser mics will generally be at the top end of this range. With a Workhorse, one would connect a microphone to a preamp like the PowerPre™. This would elevate the signal to either -10dB to feed the internal mix buss or produce +4dB at the XLR direct out.
- INSTRUMENT LEVEL RANGE:** The output levels produced by instruments can range widely. A single coil electric guitar can produce as little as -40dB while an electronic keyboard, sampler or digital piano is capable of producing as much as -10dB. For low level instruments, 500 series modules like the JDV™ amplify the signal to -10dB for the internal buss while also producing +4dB at the XLR output for direct recording. High output keyboards can also be connected directly to the Workhorse summing input and mixer as this is set at -10dB (nominal).
- UNBALANCED -10dB LINE LEVEL RANGE:** Unbalanced outputs from CD players, keyboards, mixers and home hi-fi components are usually specified at -10dB and are often referred to as consumer line level. The internal mix buss inside the Workhorse is designed to accept an unbalanced -10dB signal. (In fact it can handle more.) Once a microphone signal has been amplified using, for instance, the Radial PowerPre™, the preamp output will feed the Workhorse mix buss. And when a +4dB balanced line level signal is brought into the Workhorse via a device like the Radial Komit™ compressor-limiter, the Workhorse will unbalance the signal before it is sent to the internal buss which in turn will feed the mixer. The D-Sub summing mixer input is also a -10dB unbalanced input.
- BALANCED +4dB LINE LEVEL RANGE:** Most electronic devices process unbalanced audio signals. In other words, after the balanced signal arrives at the input, it is usually unbalanced inside, processed and then balanced again to deal with the outside world. This is how most 500 series modules work and is why the direct output is balanced line level. After it is unbalanced, the Workhorse internal buss follows the same architecture whereby the signal is first mixed, then the Workhorse mixer output steps up the level and balances the signal to a full +4dB professional balanced output. Depending on how much signal the mixer gets, this can increase to as much as +22dB before distortion.

Matching the output level of one device to the input of the next will help you avoid distortion and maximize signal-to-noise. For instance, using a +4dB output to drive a -10dB input could overload the input and cause distortion. Conversely, a -10dB output may not have enough gain to drive the input of a +4dB device resulting in a higher noise floor.

With this in mind let's track the signal flow and level as it passes through the Workhorse. The diagram below shows the signal chain starting with a microphone.



The mic is connected to a mic preamp like the PowerPre™ that boosts the signal from -50dB to line level. The preamp direct output increases the signal to +4dB so that it can feed a recorder or another processor such as a compressor or EQ. While this is happening, Radial modules and others compatible with the Workhorse have a special buffer to unbalance the signal and drive it on to the internal -10dB mix buss where it flows to one of the mixer channels. The mixer then amplifies and balances the signal at the main outputs to deliver a +4dB (nominal) level.

Because each of the Workhorse module slots is equipped with a balanced line level input and a balanced line level direct output (depending on the module), you are free to interconnect modules or route signals to other devices using standard XLR patch cables. Once you start working with your Workhorse, you will quickly come to understand all of the capabilities and how easy it is to use.

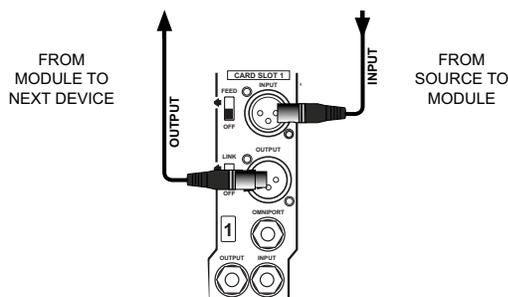
USING THE WORKHORSE

Because the Workhorse is a modular device, there are practically no limits as to what kind of signal chain you can create. For instance it can be used as an analog effects router for your workstation, as a customizable channel strip, a multi-channel preamp for live recording or as part of a play-back and overdub system. The magic is the simplicity that manages to bring unlimited flexibility together.

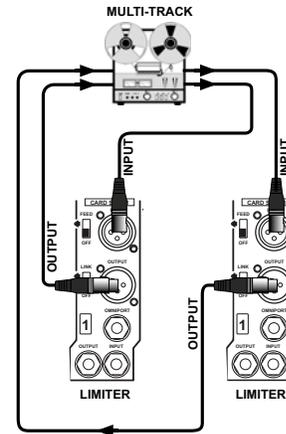
As with all electronic equipment, **turn off the power and turn down levels** before making connections. This will avoid the loud on-off transient that can damage equipment or blow speakers. Plugging in a module is merely a matter of sliding it into the Workhorse and carefully aligning the 15-pin card edge connector. Once plugged in, secure the module in place using the supplied Phillips screws. After the module is connected, it will automatically route the signal from the rear panel connectors to and from the module. If you are using a Radial 500 series module or one that has been designed to take advantage of the internal mix buss and Omniport features, these too will automatically be routed.

Old School Lunchbox

The first step in approaching the Workhorse is going back to the original API lunchbox. This device was basically a steel enclosure that fed power to a number of modules. Connecting to and from modules was done using the XLR connector that was associated with each card slot. The Workhorse retains all of this connectivity while adding the convenience of 1/4" TRS and 25-in D-sub connectors.



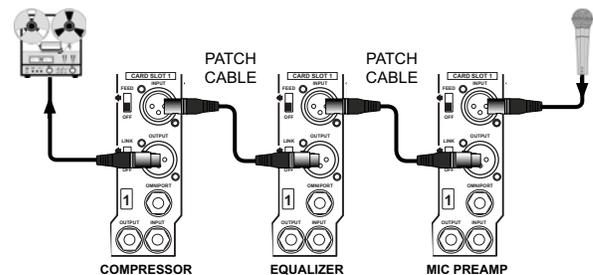
An example here could be connecting two limiters to tame a stereo drum track during mix down. Take the output from your recording system; plug it into the Workhorse XLR inputs and then take the direct output back from the same card slots. Adjust the limiter to suit. This is the most basic function.



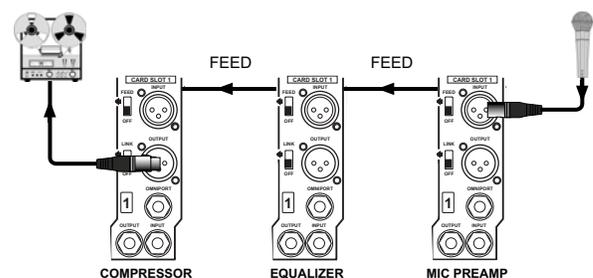
Setting Up A Channel Strip

The next stage is using several modules together to create a channel strip. For instance, when recording a vocal track, you may want to run a mic preamp into an EQ to add some presence and then into a limiter so that the track stays out of the 'red'.

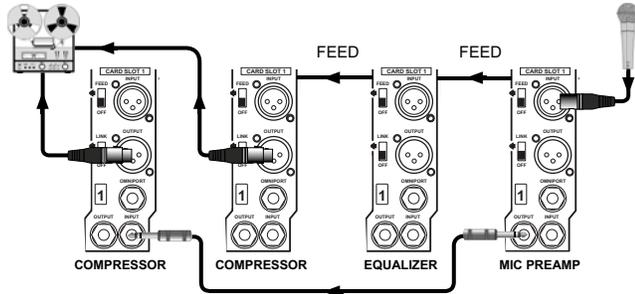
Using the old API system, you would connect the microphone to the mic preamp using a standard XLR cable. The mic preamp output would then connect to the EQ which in turn would connect to the limiter. The direct XLR output from the limiter would then be sent to the recording system.



The Workhorse simplifies the process with a FEED function. This basically replaces inter-module patch cables. Instead of using an XLR cable, you simply push the FEED switch into the UP position and it routes the signal to the adjoining module. When engaged, the FEED function always sends the signal to the next module working from left to right (front view). Because the FEED function is tied to the XLR connector, it will work with new Radial modules and older 500 series modules.



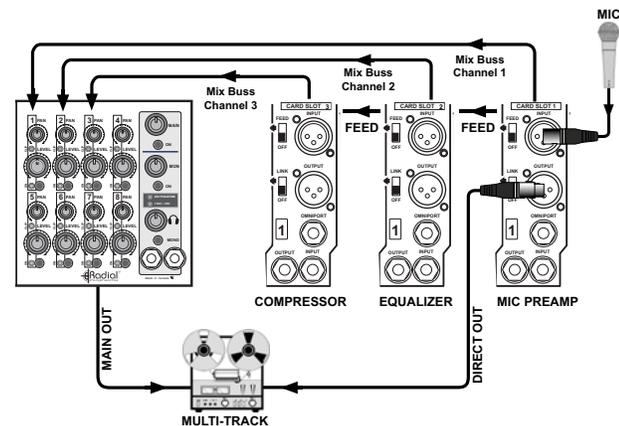
Now consider another variation that uses both a patch cable and the FEED function to split the signal and route it to a fourth module. The image below shows how this is done by connecting a patch from the first module to the fourth module while the FEED function routes the signal to the second and third modules. The mic signal has been split into two signal paths that can be processed separately.



Using Modules In Series And Parallel

When you are using Radial modules, the signal will automatically be sent to the Workhorse's internal mix buss while still making the output available at each card slot. The way this works is quite simple; each module output is sent to the Workhorse mixer where it can be turned on, panned left or right and be adjusted. This is where things can really get wild.

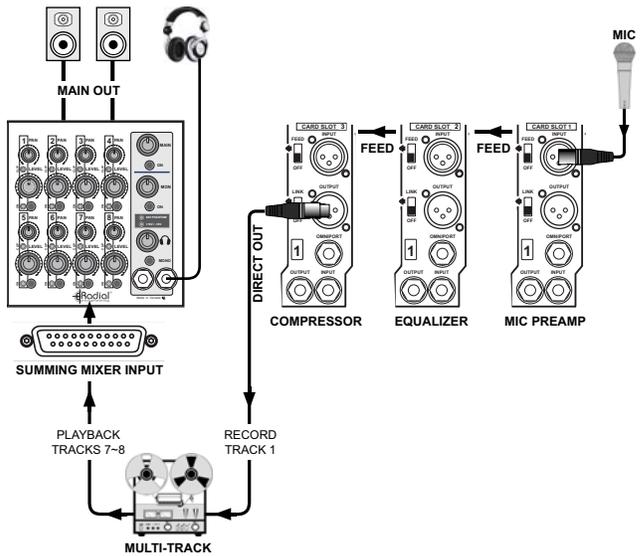
Using the same 'channel strip' example as above, you can set up a mic preamp to connect to an EQ which then feeds a compressor. The signal will not only be available at the direct output of the compressor module, but each of the module outputs will also be routed to the individual mixer channels 1~3. This means that you can turn on or off each module at the mixer and listen to the signal before it goes into the next module. This lets you optimize the signal flow for distortion and sonic character. You can record the combined signal via the warm sounding Jensen transformers on the main outputs, while still capturing the sound of the original unprocessed signal using the mic preamp's direct output at the card slot I/O.



Using The Workhorse For Overdubs

Begin by setting up a channel strip using a mic preamp, EQ and limiter. These are plugged into slots 1, 2 and 3. Set the FEED switch in the up position on modules 1 and 2 so that the signal is routed in series. Plug your mic in turn on the phantom power on the mic preamp if you are using a condenser microphone. Take the XLR output from card-slot 3 (limiter) and send this to your recorder. Turn on channel-3 on the Workhorse mixer to monitor the level via the monitor outputs or headphones.

To overdub, send the stereo playback tracks into the Workhorse using mixer channels 7 and 8 via the summing input D-Sub. Pan channel-7 left, and channel-8 right. Adjust the relative signals between the channel strip on mixer channel-3 and the stereo program on channels 7 and 8. Hit record!

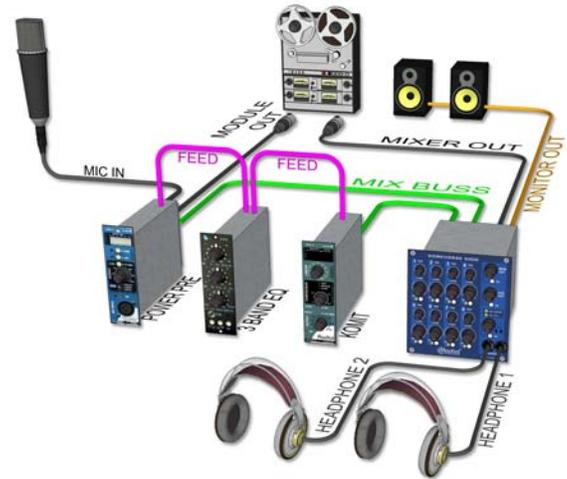


VARIOUS SETUPS USING THE WORKHORSE

The following setups show how the Workhorse can be used in the studio or in a live recording environment. There are of course an unlimited number of possibilities... but these will give you some ideas of how you can use your Workhorse to create simple recording channels to advanced reamping systems as you mix and match various 500 series modules.

Standard setup for a vocal track

This setup uses a microphone, EQ and compressor. The microphone feeds the PowerPre™ mic preamplifier which simultaneously sends a dry, unprocessed track to the recording system. This track is saved in case further reamping will be required. The PowerPre™ feeds the EQ which in turn, feeds the Komit™ compressor-limiter where the signal is sent to the Workhorse's internal mix buss. The main output is used to record the track while the monitor out feeds the near-field playback system.



Eight Channel Live Recording

This example discusses recording a small jazz ensemble using eight microphones. For this set up, Radial PowerPre™ mic preamps are used. Each module's direct output is connected to an eight channel recording system so that the each instrument can be recorded individually and properly mixed back in the studio. The main outputs are used to feed the PA system. As these are transformer isolated, ground loops will not pose a problem. The monitor out is connected to a two channel field recorder. This will enable the engineer to give the band a reference recording right after the show. Back at the studio, the recorder output will feed the Workhorse D-Sub summing input where the mix will be finalized.



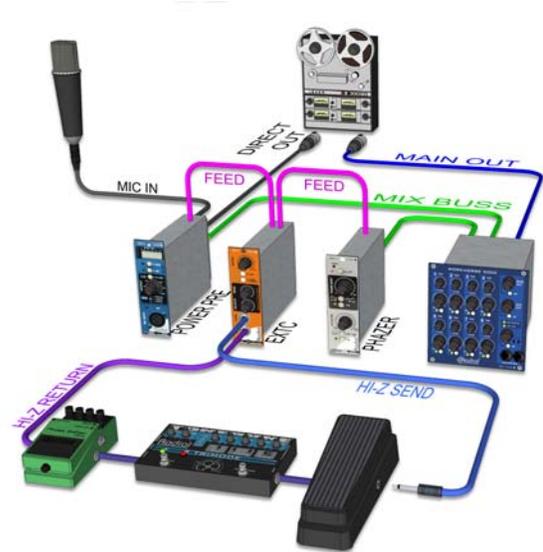
Stereo Channel Strip

This setup is used to record a solo acoustic instrument such as an acoustic guitar, viola or piano using two microphones by creating two high-performance recording channels using the Workhorse FEED function. Two PowerPre™ mic preamplifiers feed equalizer modules like the Radial Q3™ coil EQ. The output of the equalizers feed the Komit™ compressor-limiters. The output of the Komit™ compressor-limiters are routed to the mixer through the Workhorse internal mix buss. The Workhorse main output sends the mix to the recorder taking advantage of the added warmth afforded by the Jensen™ transformers. On 'recording channel #2' we have added a Radial Phazer™ module to the setup. This enables us to focus the two microphone signals by bringing the fundamentals into phase. Phase aligning the fundamentals creates for greater realism which can produce astonishingly clear results. We have turned off the output of most modules going to the mix buss, choosing instead to only capture the signal at the end of each chain. At any time, you can audition the signal from any of the modules going into the mixer section to compare or if you like, mix it in by adjusting the level to suit.



Crazy Sounding Vocal Track

This is an example of how one can create a weird, wonderful, extreme vocal track by inserting guitar pedals into the mix and then creating a radical EQ curve using the Phazer™. This is done 'live' by connecting a mic into the PowerPre™ and feeding the signal using the feed function into the EXTC™ and Phazer™. The effects send from the EXTC is used to feed various pedals such as a tube distortion for added grit or maybe a warm sounding analog chorus instead of the usual digital plug-in. Notice that only the outputs from the PowerPre and the Phazer feed the Workhorse mix buss. This allows you to mix in the Phazer's effect for radical EQ by either phase cancelling or phase adding certain frequencies.

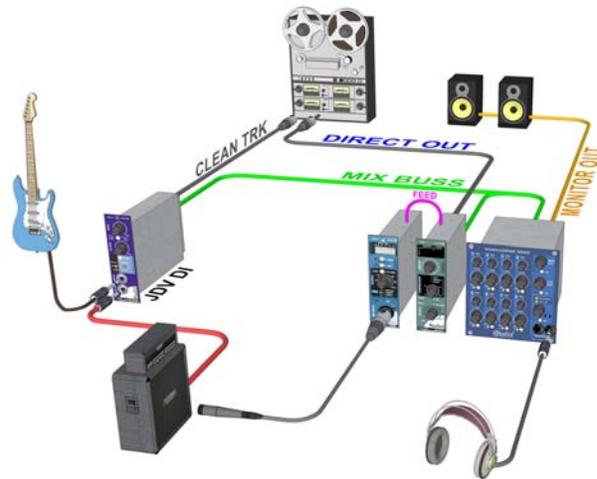


Reamping Using The Workhorse

The Workhorse is ideally suited for reamping. This is a two-stage process whereby you start by recording a dry track and then once recorded, you send the dry track back from the recorder to the effects and amplifiers. Reamping allows the engineer to change tones and position microphones to optimize the sounds during the recording process.

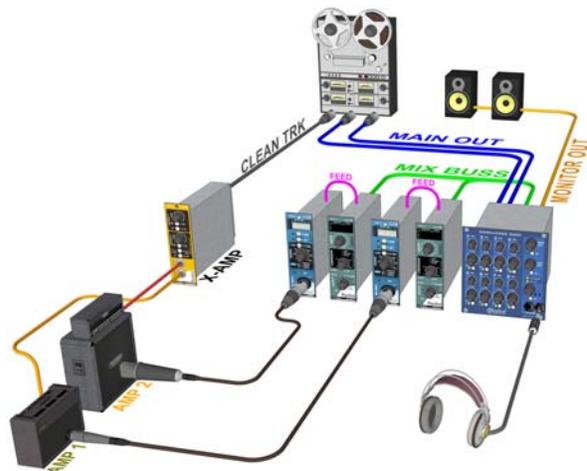
Part-1 Recording

The guitar is connected to the JDV™ where the signal is split to feed the guitarist's amplifier using the front panel aux out (you can take this a step further by adding a Radial X-Amp™ module which would then allow the guitarist to audition two amps at the same time). While the guitarist is playing, you are also capturing a clean track directly from the JDV's balanced XLR output. This feeds a spare track on your recording system. You could also put some mics up in front of the amps to capture the guitarist's performance. This may be used later to thicken up tracks. Once the magical performance is recorded, you can send the guitar player home. You are now set for part-2 and Reamping. You can monitor the whole process using headphones or by connecting your monitors to the Workhorse mixer outputs.



Part-2 Reamping

Send the clean recorded track back into the Radial X-Amp™. The signal will then be converted to high impedance and sent to two amplifiers. You can also introduce effects. Both guitar amplifier outputs are transformer isolated to eliminate ground loops. The amps are captured using microphones that connect to two PowerPre™ mic preamps. The output from each PowerPre FEEDs the Komit™ compressors limiters to keep the levels under control. The stereo signal is sent to the Workhorse mix buss. Best part here is that you can take your time to move the microphones around the room to find the best tone (alternately, if you do not want to use a 'live' amp, you can send the signal into the Radial EXTC™ which can feed a bunch of pedals. Then bring the signal back and process the tone using the Radial JDV guitar cabinet emulator. This will produce a much more 'natural sounding recording').



FREQUENTLY ASKED QUESTIONS

Q: How do I turn the Workhorse phantom power off?

A: There is no reason to turn the phantom power off. Only modules such as mic preamps will connect to the phantom power supply on the edge card connector pins. Turning on or off phantom is usually done on the mic preamp module.

Q: How do I know that there is sufficient power for all my modules?

A: Most manufacturers specify the draw required to properly run their modules. The Workhorse has 1200mA of current available. Simply add up the draw and make sure you do not exceed 1200mA.

Q: What happens if I exceed 1200mA?

A: Sometimes nothing will happen as most times you will not be running the modules to their fullest. But when they are run hard, starving the module will result in distortion and reduced signal handling.

Q: Can I damage a module due to under-powering?

A: No. It just won't sound as good.

Q: Why is there no power switch on the Workhorse?

A: Mostly because there is no more space. We recommend that all studio equipment be routed to a central power strip. These are usually equipped with an on-off switch that would enable you to turn on or off all your gear at one time. For safety, always turn the speakers on after other equipment. This will avoid turn-on transients from damaging your speakers.

Q: I find that putting in and pulling modules is difficult. Is this normal?

A: Yes. Most modules are designed to fit snugly. Just patiently wiggle them in and out. Be careful when putting them in so that they align properly with the card edge connector. Once you have done this a few times it will become easier.

Q: I find some non-Radial modules very tight. Is this normal?

A: Unfortunately, due to lack of standards, you may find this to be the case. You can usually wiggle them in. In some cases, you will have to remove the bottom tray. This is why we have created the Workhorse Open Source Document. Hopefully most manufacturers will adopt this standard as we move forth.

Q: Can I hurt myself by touching the back plane PC board?

A: This is a low power device so getting a shock is unlikely. Due to legal liability, we cannot recommend the practice. This is why the Workhorse comes with a protective plastic cover that can be cut as needed to keep dust and roaming hands out.

Q: Can I damage the card edge connector?

A: Although unlikely, you can damage anything if you are not careful. The Workhorse employs high-quality EDAC connectors that are designed for many insertions. Just take it easy when plugging in or out. Always disconnect the power before inserting or removing modules.

Q: What happens if I use a 1/4" mono connector instead of a 1/4" TRS?

A: You will unbalance the signal and the level will drop by around 6dB. This means it will not be as loud and, if you are running cables beyond 20 feet, you are more likely to pick up noise. Otherwise, it should work fine.

Q: The headphone out is very loud. Can this damage some headphones?

A: Yes. Always set the headphone level down low and increase until comfortable. The extra loud headphone out is designed to accommodate all types of headphones and enable the Workhorse to be used in very loud environments such as in night clubs. Read the warnings in the manual for safe use.

Q: Do I need to worry about the red and black ground lugs on the back panel?

A: No. These are coupled together from the factory. These are only made available for professional studios that have special grounding requirements.

Q: What is the difference between the XLR and 1/4" TRS jacks?

A: There is no difference. They are wired in parallel and there for convenience.

Q: I notice that there are air vents on the top. Will covering these pose a problem?

A: Air vents are designed to allow modules to cool down. Try to leave a space above for ventilation. Most modules will not run so hot as to be a concern. Simply touch the module to see if it runs hot.

Q: Can I plug a keyboard directly into the Workhorse summing mixer?

A: Yes. There is plenty of gain in the mixer to handle most buffered instruments.

Q: Why is the power supply external?

A: The main reason for an external power supply is to free up space inside the chassis for the Workhorse mixer section. Additional benefits include reduced electromagnetic interference (EMI) and easy adaptability to international AC power standards.

Q: Will the FEED function work on old API modules?

A: Yes, the FEED switch connects the card slot's output jack to the input of the next card slot.

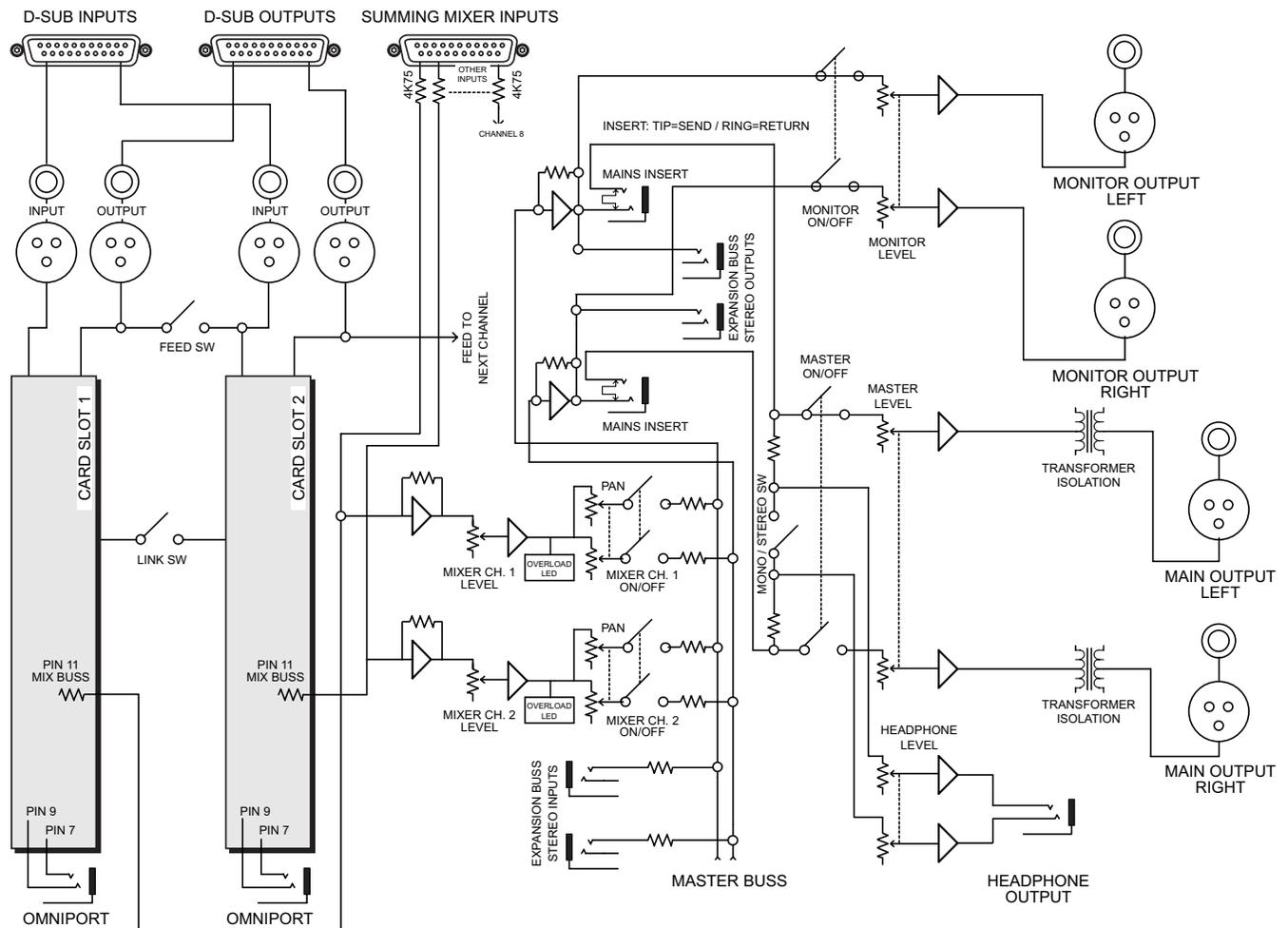
TROUBLE SHOOTING

1. No Power:
 - Check the power 5-pin XLR connection on the rear panel.
 - Ensure the power supply is plugged into a working outlet.
2. No sound at individual XLR outputs outputs:
 - Check the front panel LED Power indicators and ensure the Workhorse is powered up.
 - Check that all modules are seated properly and secured.
 - Check audio cable connecting to and from the Workhorse.
 - If you are using the mixer section, ensure the it is setup correctly and the channel is on. Also check the level and pan settings.
 - Check that the eight FEED switches are set to the proper setting for your setup.
3. No sound at mixer outputs:
 - Ensure the correct mixer channels are active and their LED indicators are illuminated.
 - Check that the level controls are set to a nominal level and the pan controls are positioned at the center mark.
 - Ensure the main and monitor master level controls are set to a nominal level and that the 'ON' switch is depressed.
 - If you are using the main outputs check the insert jack and any equipment connected there.
3. A loud humming noise is audible in the system:
 - Check the source device for proper connections and settings.
 - If the module(s) you are working with allow it you can try lifting the signal ground.
 - Plug all your equipment into the same power source to minimize ground loops.
 - Use the Workhorse Main outputs. These are transformer isolated to eliminate hum and buzz caused by ground loops.
4. Some modules are louder than others:
 - Use the mixer section to amplify a low output module and bring it up to par with other modules.
5. Sound is distorted when using the Summing Mixer input:
 - Although the 25-pin D-Sub input for the summing mixer is based on the Tascam™ analog audio pin-out it unbalances the signal by grounding the cold (-) lead. Most devices with a balanced 25-pin D-Sub output will work fine driving the unbalanced summing mixer input. However, in the remote chance that the source device creates distortion with this arrangement you can solve the issue with a custom 25-pin D-Sub to XLR cable wherein the XLRs pin-3 (cold) is left unconnected inside the shell.
6. Sound from one module is appearing on different output:
 - Check the FEED switch on the rear panel. It may be mistakenly engage causing the signal from one module to be routed to the next.

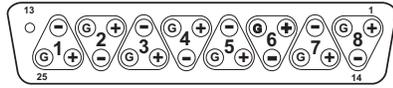
SPECIFICATIONS

| | | | |
|----------------------|--|----------------------|---|
| Circuit type: | Virtual earth mix buss integrated operational amplifier - Class AB | Main Output: | +4dB balanced stereo XLR and 1/4" TRS outputs; Jensen™ transformer isolated |
| Max output level: | +22dB (20Hz to 20kHz) | Main Inserts: | 1/4" TRS - tip = send; ring = return |
| Voltage Gain: | Up to +23dB on the main output | Monitor Output: | +4dB balanced stereo XLR and 1/4" TRS outputs; transformerless; +4dB balanced |
| Distortion: | 0.007% @ 1kHz with 10dB in and 10dB out 0.05% @ 20Hz with 10dB in and 10dB out | Headphone Out: | 1/4" TRS Stereo - 2.8VRMS @ 8 Ohms (up to 7VRMS depending on headphone impedance) |
| Signal to Noise: | -91dB with +20dB output | Ground: | Red: audio, Black: chassis |
| Card Slot Inputs: | 8 x balanced XLR, 1/4" TRS, D-SUB | Power Supply Input: | 100V - 240V AC (50~60Hz) |
| Card Slot Outputs: | 8 x balanced XLR, 1/4" TRS, D-SUB | Power Supply Output: | 1600mA - External switching type with 5-pin XLR, +/-16 VDC; 48V phantom |
| Card Slot Impedance: | Depends on modules used | Dimensions: | 19" wide x 5.25" tall x 7.44" deep 482.6 wide x 134 tall x 189mm deep |
| Internal Mix Buss: | 4.75k Ohms input coupling resistor | Weight: | 22lbs / 10kg |
| Summing Mixer Input: | DB-25, Unbalanced +4dB/-10dB with up to +20dB capacity; input impedance = 4.75K Ohms | | |

WORKHORSE BLOCK DIAGRAM

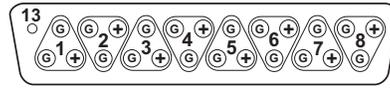


D-SUB CONNECTOR FOR CARD SLOT I/O



| Pin # | | Pin # | |
|-------|------------------|-------|------------------|
| 1 | Channel 8 Hot | 14 | Channel 8 Cold |
| 2 | Channel 8 Ground | 15 | Channel 7 Hot |
| 3 | Channel 7 Cold | 16 | Channel 7 Ground |
| 4 | Channel 6 Hot | 17 | Channel 6 Cold |
| 5 | Channel 6 Ground | 18 | Channel 5 Hot |
| 6 | Channel 5 Cold | 19 | Channel 5 Ground |
| 7 | Channel 4 Hot | 20 | Channel 4 Cold |
| 8 | Channel 4 Ground | 21 | Channel 3 Hot |
| 9 | Channel 3 Cold | 22 | Channel 3 Ground |
| 10 | Channel 2 Hot | 23 | Channel 2 Cold |
| 11 | Channel 2 Ground | 24 | Channel 1 Hot |
| 12 | Channel 1 Cold | 25 | Channel 1 Ground |
| 13 | Not Used | | |

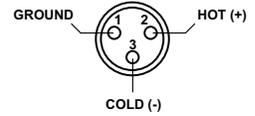
D-SUB CONNECTOR FOR UNBALANCED SUMMING MIXER INPUT



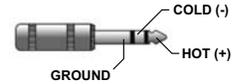
| Pin # | | Pin # | |
|-------|------------------|-------|------------------|
| 1 | Channel 8 Hot | 14 | Channel 8 Ground |
| 2 | Channel 8 Ground | 15 | Channel 7 Hot |
| 3 | Channel 7 Ground | 16 | Channel 7 Ground |
| 4 | Channel 6 Hot | 17 | Channel 6 Ground |
| 5 | Channel 6 Ground | 18 | Channel 5 Hot |
| 6 | Channel 5 Ground | 19 | Channel 5 Ground |
| 7 | Channel 4 Hot | 20 | Channel 4 Ground |
| 8 | Channel 4 Ground | 21 | Channel 3 Hot |
| 9 | Channel 3 Ground | 22 | Channel 3 Ground |
| 10 | Channel 2 Hot | 23 | Channel 2 Ground |
| 11 | Channel 2 Ground | 24 | Channel 1 Hot |
| 12 | Channel 1 Ground | 25 | Channel 1 Ground |
| 13 | Not Used | | |

CONNECTOR WIRING

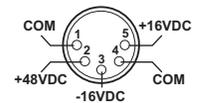
XLR Connector



TRS 1/4" Phone Connector



5-Pin XLR Power Connector



CARD-EDGE CONNECTOR SPECIFICATIONS

The following details the pin configuration as used in the Workhorse. The 'Old' refers to the published API/VPR specifications. The 'Current' refers to the various racks we have investigated on the market. The 'New' is the Radial standard as outlined in the Workhorse Open Source Document.

| Pin # | Old API Specification | Current use in market | New Radial Specification |
|-------|-----------------------|-----------------------|--------------------------|
| 1 | Chassis Ground | Chassis Ground | Chassis Ground |
| 2 | Output +4dB Hot | Output +4dB Hot | Output +4dB + Phase |
| 3 | Output -2 Hot | --- | --- |
| 4 | Output Cold | Output Cold | Output +4db - Phase |
| 5 | A- Ground | A- Ground | Analog Ground |
| 6 | Stereo link | Stereo link | Stereo link |
| 7 | Input -2 Cold | --- | 1/4" TRS Omniport - Ring |
| 8 | Input +4dB Cold | Input +4dB Cold | Input +4dB - Phase |
| 9 | Input -2 Hot | --- | 1/4" TRS Omniport - Tip |
| 10 | Input +4dB Hot | Input +4dB Hot | Input +4dB + Phase |
| 11 | Gain adjustment | --- | Radial Buss feed |
| 12 | +16VDC supply | +16VDC supply | +16VDC supply |
| 13 | Power Ground - 0V ref | Power Ground - 0V ref | Power Ground - 0V ref |
| 14 | -16VDC supply | -16VDC supply | -16VDC supply |
| 15 | +48VDC Phantom | +48VDC Phantom | +48VDC Phantom |

Due to the lack of clear standards, we have worked within the limitations of keeping the old standards while making the Workhorse as flexible as possible. For instance Pin-3 has been left open because sometimes (on some modules) it is paralleled with Pin-2. This arrangement eliminates problems between other modules. We also discovered that sometimes Pin-7 and Pin-9 can be paralleled with Pin-8 and Pin-10, so the Omniport™ jack will not interfere.

The BUSS FEED (Pin-11) is simply whatever signal the designer will want to send to the buss (main out of module typically) and is essentially an amplifier feeding a 4K7 resistor to Pin-11. That is connected to the inverting (virtual earth) input of an op-amp (in the mix section of the rack) with a 4K75 feedback resistor. This is called

a 'Virtual Earth Mix Buss'. It is low noise and less prone to problems. We chose 4K7 because it is lower noise than a higher value and because the Rupert Neve Designs Portico series has a 4K7 Mix Buss on all of their modules. This provides cross-compatibility between Radial and Rupert Neve Designs.

The BUSS output on Pin-11 of each Radial module connects to a level and pan control in the master mixer area. By being able to mix together the output of what may be several modules in series various new effects may be created. For example if the Phazer phase adjustment tool is in a series chain of modules, it can be used as a radical EQ to phase cancel the tone by creating a nulling effect.

THREE YEAR TRANSFERABLE LIMITED WARRANTY

RADIAL ENGINEERING LTD. ("Radial") warrants this product to be free from defects in material and workmanship and will remedy any such defects free of charge according to the terms of this warranty. Radial will repair or replace (at its option) any defective component(s) of this product (excluding finish and wear and tear on components under normal use) for a period of three (3) years from the original date of purchase. In the event that a particular product is no longer available, Radial reserves the right to replace the product with a similar product of equal or greater value. In the unlikely event that a defect is uncovered, please call 604-942-1001 or email service@radialeng.com to obtain an RA number (Return Authorization number) before the 3 year warranty period expires. The product must be returned prepaid in the original shipping container (or equivalent) to Radial or to an authorized Radial repair center and you must assume the risk of loss or damage. A copy of the original invoice showing date of purchase and the dealer name must accompany any request for work to be performed under this limited and transferable warranty. This warranty shall not apply if the product has been damaged due to abuse, misuse, misapplication, accident or as a result of service or modification by any other than an authorized Radial repair center.

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