



J48

User Guide

Radial Engineering

1638 Kebet Way, Port Coquitlam BC V3C 5W9 tel: 604-942-1001 • fax: 604-942-1010

email: info@radialeng.com • web: www.radialeng.com

Radial Engineering is a division of C•TEC (JP CableTek Electronics Ltd.)

RADIAL J48 MK2 USER GUIDE

TABLE OF CONTENTS	PAGE
Introduction.....	1
Input & output panel feature set	2
J48 - Quick start for pros	4
Direct box basics	5
Features and functions	8
Frequently asked questions	13
Block diagram and specifications	15
Warranty	Back cover



Radial Engineering
1638 Kebet Way, Port Coquitlam BC V3C 5W9
tel: 604-942-1001 • fax: 604-942-1010
email: info@radialeng.com • web: www.radialeng.com

Radial Engineering Ltd. is a division of c-TEC (JP CableTek Electronics Ltd.)

Features and specifications are subject to change without notice.
J48 MK2 - Manual V3.1 05/20/05 part #: R800-9616-00

INTRODUCTION

Congratulations on your purchase of the Radial J48™ direct box. Three years in the making, the J48™ is a unique direct box that has been designed to handle the new generation of active battery-equipped acoustic guitars and basses that often overload typical direct boxes and cause distortion. Best of all, the J48 does so without the use of batteries.

The secret is the J48's internal digital switching power supply that converts 48V-DC phantom power to produce a higher internal rail voltage. This allows the J48 to handle transients of up to 9 Volts without choking. More dynamic headroom results in less square wave distortion. In fact, every aspect of the J48™ design has been optimized for maximum headroom while introducing minimal phase, harmonic and inter-modulation distortion.

But this is not all: the Radial J48 features a transformer that isolates 48V phantom power to help eliminate ground loops while removing hash and system noise. This ensures that what you put in - you get out. Nothing altered, nothing changed: just the pure and natural tone of the instrument.

We invite you to read through this manual before using your Radial J48 so that you can maximize it's potential. Please log onto www.radialeng.com for further details and updates. We also invite you to forward any comments, questions or suggestions to info@radialeng.com. We love to hear from you!

Enjoy.



INPUT AND OUTPUT PANEL FEATURE SET



1. -15dB pad switch

A provisional -15dB pad reduces the input signal to the circuit to ensure a clean and distortion-free signal is obtained.

2. 48V check LED

Used in conjunction with the low-cut filter switch to check for phantom power.

3. Left-right merge switch

A unique 'merge' function turns the input and thru-put connectors into a pair of left-right inputs with mono output at the XLR.

4. 1/4" input and thru-put jacks

These are used to connect the instrument to the direct box and the direct box to the instrument amplifier.

5. Protective bookend cover

The innovative bookend cover provides protection to switches and connectors against damage during hectic stage set-ups.



6. XLR male output

This male XLR output connector is wired to the AES standard with pin-1 ground and pin-2 hot and puts out a 600-ohm mic level signal.

7. Polarity reverse 180°

This toggles the XLR pin-2 and pin-3 to interface with older equipment. Also used when combining two sources (mic & DI) on the same instrument to avoid phase cancellation.

8. Low-cut filter (-6dB down at 80Hz)

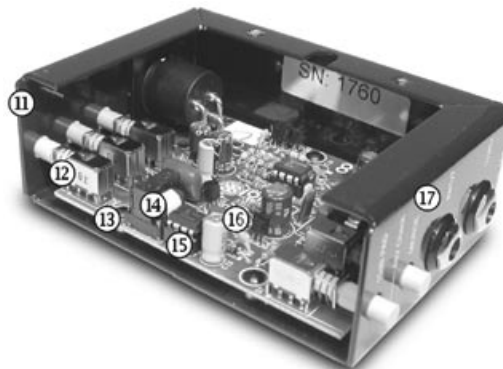
Gently rolls off bass to reduce rumble and acoustic resonance. Dual function switch also used to check presence of 48V phantom power.

9. Ground-lift switch

This ground-lift switch breaks the ground between the input & the output to eliminate hum and noise caused by ground loops.

10. Full bottom no-slip pad

Provides mechanical isolation to reduce slipping and electrical isolation from amplifier frames and handles.



11. **Welded I beam construction**

For maximum durability, a 14 gauge steel welded I-beam construction for a lifetime of trouble free performance.

12. **Silent, high cycle switches**

Super high repetition switches withstand heavy use and heavy fingers. “Make before break” design eliminates pops and clicks when toggling switch positions.

13. **Double sided PC board**

The military grade double-sided PC board provides maximum durability and added resistance against cold solder joints.

14. **Power supply transformer**

The transformer in the power supply helps eliminate ground loops by isolating the power coming in from the XLR's 48V phantom feed.

15. **Digital DC to DC switching power supply**

Steps up phantom power to produce higher internal rail voltage. This provides more headroom and results in less distortion and a more natural sound.

16. **Oversized capacitors**

Oversized capacitors produce maximum headroom.

17. **Baked-on enamel finish**

Great looks on stage or in the studio for years to come.

THE J48 QUICK START

This section is for advanced users. It provides a quick set of instructions for those that are familiar with direct boxes. For up and coming engineers, we suggest that you read through the manual before using your Radial J48.

Caution! *When connecting or disconnecting any audio device always ensure the power is off or all levels are set to zero. This practice will reduce the probability of noise, such as a capacitor discharge, from being sent through the amplifier to the speakers, which could cause a big “bang” in your sound system or even cause a speaker to blow. This is especially true with phantom powered equipment.*

The Radial J48 is an active direct box and as such requires standard 48V phantom for powering as found on most consoles and pre-amps. Before you start, make sure the phantom power has been turned on at the console. You can check for the presence of 48V phantom by depressing the low-cut filter switch. If phantom is present, the LED on the front panel will illuminate for a moment.

Now, make sure all switches are set in the ‘out’ position. Plug the instrument into the INPUT. Connect the THRU to the guitar amplifier or keyboard mixer, and the XLR OUTPUT to the PA or recording mixing console.

With the PAD set to 0dB (out position), slowly turn up the input level at the mixer and listen. The J48 should be able to handle most instrument levels without any problems. For exceptionally high signal levels such as from digital pianos, samplers and high-output basses, inserting the –15dB pad will reduce the input level to the active circuit. If you hear distortion, simply depress the –15dB pad. To reduce low frequency mud and run-away acoustic resonance, the J48 is equipped with a low-cut filter that gently rolls off bass (-6db at 80Hz). This has the added benefit of increasing the dynamic range when depressed.

Since the Radial J48 employs a transformer in the power supply, you are actually isolating the input and the output electrical connection. This will eliminate most buzz and hum caused by so-called ground loops. If you encounter 60-cycle hum or noise, it is likely that you have a different ground potential at the input and output of the J48. Depressing the ground lift (break) switch will generally solve the problem.

The J48 also features a polarity reverse. This reverses pin-2 and pin-3 at the XLR. As the J48 is set following the AES standard with pin-2 hot, reversing the polarity is generally not required unless the instrument is being both DI'd and mic'd. If so, the polarity reverse switch would allow both the mic and the J48 to be set ‘in-phase’ should these be reversed.

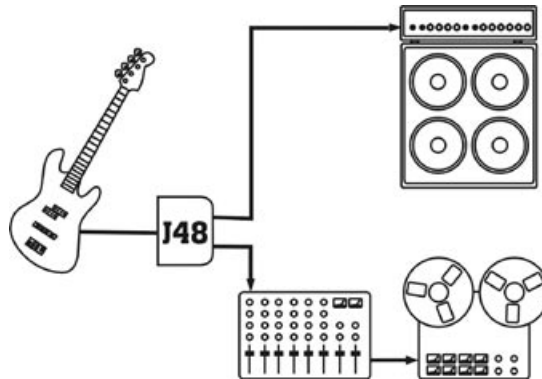
You are now ready to go! Now, close your eyes and listen. The J48 is without a doubt one of the most musical DI boxes manufactured today.

DIRECT BOX BASICS

What is a direct box anyway?

The name 'direct box' comes from direct insert box. This is why these marvelous contraptions are also called DI's. 'Direct Insertion' means exactly that: *To insert a signal directly or take an audio signal from the source and send it **directly** to a mix point or recorder.* We take this very seriously with all our direct boxes and as such, have designed these to reproduce the most accurate 'picture' of the source signal no matter what the instrument.

Direct boxes perform several important functions: they are designed as impedance matching and signal balancing devices. This means that they take the high impedance of a guitar or keyboard and 'transform' it to the low impedance used in balanced sound systems. Balanced signals inherently cancel noise and, due to their lower impedance, are capable of very long cable runs. Balanced signals are the norm in professional recording, broadcast and live sound. By properly matching the impedance you will enjoy better sound, less noise and an extended frequency response.



Typical DI box setup

Getting to know your Radial J48

As a rule, all direct boxes follow the same basic procedures when connecting them to a sound system. The instrument plugs into the IN, the musicians' instrument amplifier connects to the THRU, while the mixer or recorder is connected from the XLR 'OUTPUT'. Since the XLR output connection to the mixer taps the signal **before** it goes to the musician's amplifier, this allows the mixing engineer to 'capture' the signal **before** it is modified by the musician, thus resulting in the purest source possible. *It is important to note that what may sound good on stage may not necessarily sound good in the venue.*

By sending an unaltered signal to the front of house mix position (FOH), the engineer is able to get the sound he is looking for with minimal phase and harmonic distortion. This is likely the main reason why Radial direct boxes are so popular. Radial DI's do not alter the sound in any way before it gets to the mix position.

High to low impedance conversion and balancing

The Radial J48 features a 220kOhm input impedance for the instrument. As the signal passes through the J48 to the XLR output, it is converted to a balanced 600-Ohm low impedance signal. This allows long cable runs without introducing noise into the audio signal path. It is important to note that the output of the Radial J48 is mic level. This allows the J48 to be used alongside microphone signals without introducing cross-talk or causing saturation when driving the signal through the mic-bridging transformers of a splitter snake.

Phantom powering

The Radial J48 is an active direct box. This means that it employs a powered circuit to convert the impedance and balance the signal. The J48 derives its power from the mixing console using remote phantom power. Phantom power is a clever 48V-DC supply that comes from the mixer and runs on top of the audio through the XLR mic cable without affecting the audio. It was originally designed to provide power to capacitive or condenser microphones.

When direct boxes first appeared they used batteries. The problem with batteries is that when they run low, they cause the circuit to distort. It's pretty simple: less power – less headroom. Phantom power solved the problem by providing a remote power source that could eliminate the battery. Eureka! Phantom power gave us a stable power supply and no batteries to worry about.

Dynamic headroom

Years ago when the first phantom powered active direct boxes came around, the “instrument” of the day was a passive Fender Bass. These instruments would typically generate 1 or 2 peak volts at best. This seemed to work well. Then all of a sudden, someone decided to put a battery powered pre-amp in the instrument and the output levels increased. Today basses and acoustic guitars will easily output voltages as high as 7 volts. The result: overload!

With more input voltage, you need more dynamic handling to handle the transients. This means you need a higher internal rail voltage. The Radial J48 converts the 48V phantom using a similar approach to today’s super-high output power amplifiers whereby a digital switching power supply is employed to raise the internal rail voltage from the typical 3 volts to 9 volts. Headroom!

Because the J48 is able to handle these transients without overloading, you eliminate square wave distortion. Because of larger internal capacitors, the circuit is not constantly working at its peak. Harmonic distortion is reduced, inter-modulation distortion goes down and phase distortion is minimized. The Radial J48 coasts along producing a less stressed and more musical sound.

Buzz and hum caused by ground loops

Probably the most challenging aspect when setting up a sound system is reducing system noise. The most common problem is buzz and hum due to ground loops. This is generally caused by two separate ground paths with different voltage potentials interacting together, such as an AC powered keyboard connected through a DI to a mixer. Although lifting the ground can help, this is often not sufficient. Often times, engineers will revert to passive direct boxes such as the Radial JDI just to avoid ground loops. The Radial J48 employs a transformer as part of the internal switching power supply design. The transformer isolates the current from the phantom power supply, eliminating the ground loop. Clever.

Plug and play easy

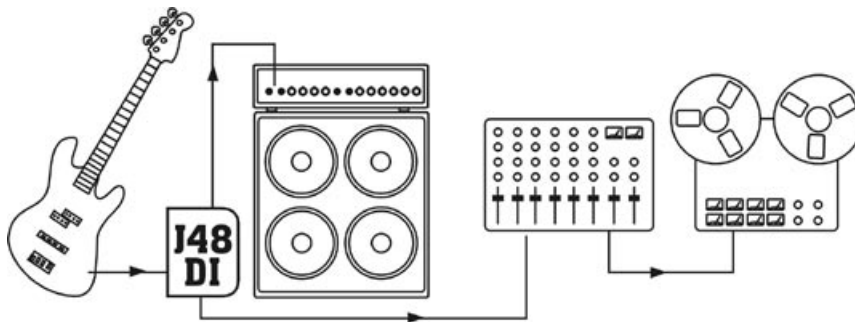
Ultimately, a good direct box should be plug and play easy to use. The J48 is a sophisticated device on the inside that is designed to be easy to use on the outside. By understanding the design, we feel that you can make better use of the features that are built into this marvelous direct box.

THE J48 FEATURES AND FUNCTIONS

The ¼" input and thru-put connectors

The J48 features two ¼" jacks on the input panel. These are designed to accept normal instrument input levels such as from basses, acoustic guitars, keyboards, and drum machines. The left ¼" input is normally connected to the source instrument. The second right-hand ¼" connector is normally used as a 'thru' connector and feeds the instrument signal to the musician's amplifier.

For instance, when using the J48 with a bass guitar, this set-up allows both the musician and the engineer to work with the original (direct) signal from the bass. This way, the musician can set up his sound on stage with his own EQ while the engineer can EQ the bass to better work in the hall.



Note: On live stages, it is common that instruments such as acoustic guitars would connect directly to a snake system and the signal would be split like the microphones to the stage monitors for fold-back. In these cases, the thru jack would not be connected.

High input impedance

The J48™ presents the instrument with a high input impedance to minimize pick-up loading. This means that low output instruments such as old Jazz or P-basses will not sound different when connected to the instrument amplifier. Note that the instrument is now feeding both the instrument amp and the direct box signal simultaneously. The J48's high input impedance only taps a minute amount of signal and then sends this signal through a pre-amp which then sends out a balanced signal to the mix position. For the most part, with today's high output instruments, loading is less of an issue. The big concern is overload distortion due to limited dynamic range.

Input distortion

A major concern today is input distortion and dynamic headroom. Just about every acoustic guitar (and many basses) incorporates a built-in active pre-amplifier that boosts the pick-up's output signal. Further, the musician turns the volume up and pushes his active EQ beyond the nominal (0dB) level. Since these high gain pre-amps often generate as much as 7 Volts, the high output signal saturates the input of most active direct boxes causing harsh square wave distortion. Even though the console may provide 48V phantom power, there is so little current available that most direct boxes are unable to produce enough peak-to-peak rail voltage to handle the signal. This is why acoustic guitars often sound 'thin' and 'scratchy'. It is all the more distressing with bass guitars and keyboards that have tremendous energy in the low end (bass frequencies). Once the signal is distorted, you cannot fix it in the mix. The J48 is designed to handle these signal levels without fear of overloading and is one of the main advantages you will enjoy with your J48.

Understanding input distortion and using the -15dB pad

Occasionally, you may encounter some devices with extremely high output levels than can overdrive the input circuit. The J48 is equipped with a pad to handle these situations. Engaging the -15dB pad steps down the input to ensure a clean and distortion-free signal is obtained. Typical devices that may require a pad include digital pianos, samplers, electronic drums, CD players, or the headphone output signal from a Walkman.

The merge switch

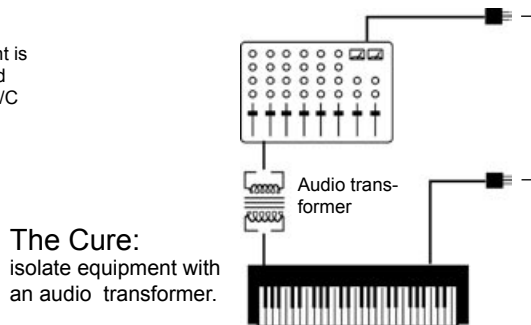
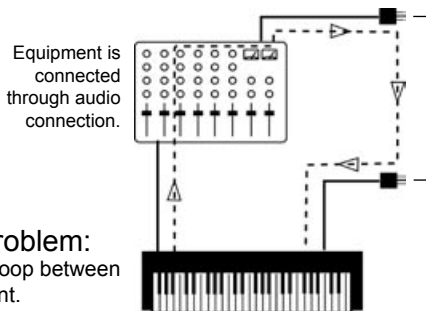
The J48 features a unique 'merge' function that turns the input and the thru-put into a 'left-right to mono' mix. Depressing the merge switch introduces a resistive mixer circuit that sums the two channels at the XLR output. This innovative function allows two sources such as a stereo keyboard or CD player to merge 'mono', saving valuable channels on the snake and on the mixer when you have more sources than available inputs. To 'merge' simply connect two instruments with similar output levels into the IN and THRU jacks, depress the MERGE switch to the ON position and you are set to go. The internal resistive mixer is set up to do this without posing any problems such as phase cancelling.

The ground lift switch

It is common practice to ground all electrical devices in a sound system. Proper grounding assures safe use and generally helps reduce system noise. As the Radial J48 is an interface, it is often placed between two grounded AC powered devices such as a keyboard and a mixer. Often, these two devices will be connected to different AC outlets or may have very different ground reference potentials. When connected together, these can sometimes cause 60-cycle hum or a loud system buzz. This noise is often referred to as a ground loop.

The Radial J48 features an isolation transformer in the power supply that will generally eliminate most of this type of noise. But in severe cases, depressing the ground lift switch can help. When lifted, you are actually breaking the internal ground path between the input and the output.

It should be noted that when you are 'going direct' or connecting a bass or acoustic guitar to the Radial J48 without using the thru-put, the ground switch should be set in the out position (grounded). If you are using the thru-put to your personal amp, then your amp and the mixer will have ground paths and breaking the ground would then be considered.



The balanced XLR output

The J48 features a mic level, balanced output jack that uses a standard XLR male connector. This jack is wired to the AES (Audio Engineering Society) standard with pin-1 ground, pin-2 hot and pin-3 cold. Today, pretty much all equipment is manufactured using this standard. Connection is made to the mic-level input of the mixing console or to a standard mic pre-amplifier. The J48 is ideally suited for interface with concert snake systems and splitters where mic and direct box signals are directed to several destinations at the same time such as recording, monitor, broadcast and front-of-house mix positions.

Phantom powering

The Radial J48 derives its power from the 48V phantom power supply, typically found on all mixers and mic preamplifier channels. This standard powering system will not harm dynamic microphones or other equipment that may be connected to the mixer.

The polarity reverse switch

A polarity reverse is provided that toggles the XLR pin-2 and pin-3 as the 'hot' or positive signal. This provides several operational benefits: interfacing with older mixing consoles that have pin-3 hot is simply a matter of depressing the polarity reverse. Also when combining a mic'd and direct signal from the same instrument, one sometimes encounters phase cancellation problems. Reversing the polarity on the J48 will often alleviate this. While recording, this same process provides the engineer with another 'tonal pallet' and experimenting with different settings can lead to some very pleasing results.

Mechanical attributes

One common feature you will find on all Radial products is our relentless pursuit of durability. Open up the J48 to look inside. You will note that the J48 is essentially two boxes in one. A heavy-duty welded I-beam steel frame houses the PC board, circuit and connectors. The PC board is two-sided which means that all components are soldered twice. Further, it is practically impossible to torque the PC board once installed. This ensures years of performance without failure.

An innovative 'book-end' construction features front and back recessed panels that protect the switches and connectors from being damaged during transport or from overzealous roadies. Five minutes before a show is no time for a switch to be broken. Worse yet, testing and sorting out noise and ground problems and doing sound checks can sometimes take hours. This can easily be hampered by a simple throw of a switch. ***You'll be glad our switches are tough to switch!***

The finish is a baked enamel that should provide years of performance and still look great! The J48 is also outfitted with a full bottom no-slip pad. This performs several important functions. To begin, it provides plenty of 'stay-put' on hectic stages. This keeps the DIs from falling off amplifiers or sliding around when they are stacked. The no-slip pad also works as an

electrical isolator when placed on guitar amplifiers. Most guitar amplifier chassis are bolted directly to the amp carry handles and these can sometimes be electrically charged. The isolation pad helps minimize shock hazards, especially with older amplifiers. If the pad ever wears down, it can be replaced by ordering a spare from the factory.

Using the J48 with batteries

The Radial J48 is designed with provisions for connecting typical 9V battery terminals to the PC board allowing it to be used with batteries. Please contact your Radial dealer for information to convert your J48 from 48V phantom operation to battery power.

J-Rak – 19” rack mount kit

You can rackmount the J48 using the J-Rak. This is a simple shelf that can rack-mount up to eight J48s, JDIs or any other similar sized Radial products in two RU spaces. These can be front or rear mounted allowing the system designer to have the XLRs on the front or rear of the rack, depending on the application.



Radial J-Rak

FREQUENTLY ASKED QUESTIONS

What is the difference between active & passive?

Active DI's have a built-in pre-amp requiring power to run while passive DI's use a transformer to convert the signal. Both transform or convert the instrument's high-impedance output to a low impedance balanced microphone level. This allows long cable runs without adding unwanted noise. Passive boxes have the advantage of providing isolation over typical DIs, which can reduce ground hum and noise in systems. The J48 features an isolation transformer in the power supply to address this problem.

Which is better - active or passive?

Both have their place just like dynamic and condenser microphones. Passive DIs are often easier to use because they do not require power while, active DIs tend to have more reach. As a rule, passive direct boxes are best suited for electrically powered devices like keyboards, while active boxes are often preferred for instruments like acoustic guitars and basses.

Can you explain loading?

Years ago, most bass guitars used low output pick-ups such as those found on Fender basses, while acoustic guitars used piezos. Musicians found that connecting the instrument 'thru' a passive direct box to their amplifier and then to a mixer caused the sound to change. Splitting the signal to the instrument amplifier and the mixer created the added second load. This of course would reduce the level going to the instrument amplifier and cause the sound to change. Active DIs like the Radial J48 buffer or pre-amplify the signal so that loading is never a problem.

What makes the Radial J48 so special?

Let's begin by understanding how active DI's work: active direct boxes are in fact preamplifiers. They boost the instrument's signal to a manageable level. This means that active direct boxes require power to run. As such, they must either get their power from batteries or phantom power from the console.

When using batteries, they must be fresh for the direct box to work properly. As soon as the power is low, the direct box will distort. This is why engineers hate batteries and prefer phantom power. But phantom has limitations; phantom power was originally developed to supply low-current condenser microphones. The AES specification for phantom is 48 volts with only a few milliamps of current. We tested a popular acoustic guitar with built-in pre-amp and found that when pushed to the max, the output peaked at 7 volts. Considering that most DI's can barely manage 3 volts, its no wonder guitars often sound harsh in a PA system. The Radial J48 was specifically designed to solve this problem by increasing the internal rail voltage so that these high output instruments would not overload the DI's input.

How does Radial increase the rail voltage?

We take the input voltage and drive it through a special custom made DC-to-DC transformer. The transformer is coupled to a timing chip that essentially drives the signal the same way as the newer switch mode or digital power amplifiers work. This brings the current up to a workable level and creates a higher internal rail voltage to handle the dynamics.

What is phantom power?

Phantom power is a 48 volt DC supply that comes from the mixing console that was originally designed to provide power to condenser microphones. The Radial J48 takes the phantom power and converts it using an internal switching power supply. This allows the J48 to handle higher transients without the distortion associated with most active direct boxes.

Why does the LED not stay on?

We felt that every milliwatt of power should be diverted to provide maximum sound quality. Phantom power is limited and LEDs require almost as much current as the whole J48 circuit. It will also save battery life if your Radial J48 is modified to use batteries.

What happens if I am not getting any sound?

Check to make sure the phantom power is on at the console. Then check all your cables. Nine out of ten times, cables are the culprits when it comes to no sound.

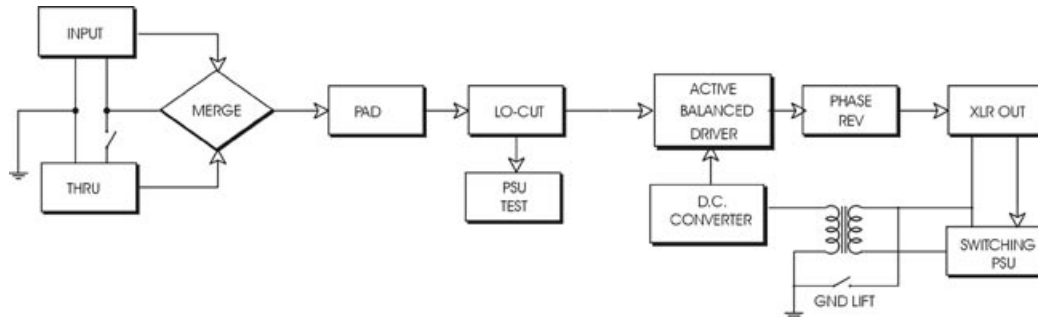
Is a flat frequency response better than a colored response?

This is a good question. When buying a large condenser microphone, you are not getting a flat mic, but getting a color or flavor for your sound palette. Most studios boast a selection of mics and the sign of a good engineer is one that knows which mic to use on what instrument in order to get a particular tone. With direct boxes, it is usually not the case. If the sound of the guitar is not right, one will usually change the guitar, not the direct box. Therefore, we believe the role of the direct box is to transport the original signal as faithfully as possible from the instrument to the destination and allow the engineer and producer to make the artistic choices. Here's more food for thought... should the direct box change the tone of the instrument? If it makes your Strat sound fat, will it make your Les Paul muddy? We think a properly designed DI should be faithful to the source. The Radial J48 direct box is natural and uncolored.

If my J48 ever fails, what do I do?

Simply contact your dealer or call Radial and we will issue a return authorization number and you can send it back to us for repair. We do suggest that before you do so, visit the dealer where you bought it and have them check it before sending it away. Often times, cables can be the problem.

BLOCK DIAGRAM AND SPECIFICATIONS



J48 MK2 Specifications

Type:	Active 48V with switching supply
Input impedance:	Unbalanced 220K-Ohms
Output impedance:	Balanced 600-Ohms
Frequency response:	10Hz to 80kHz
Linear performance:	+/- 0.12dB from 20Hz to 20kHz
Total harmonic distortion:	0.06% @ 20Hz, 0.005% @ 1kHz
Phase distortion:	0.02° at 1kHz
Maximum input voltage	3.12 Volts RMS (9V peak)
Size:	3.5" wide, 2" high, 5.5" deep
Weight:	1kg or 2lbs
Construction:	Welded 14-gauge steel
Finish:	Baked enamel coat

RADIAL ENGINEERING - 3 YEAR LIMITED WARRANTY

RADIAL ENGINEERING (a division of J.P Cabletek Electronics Ltd.) warrants this product to be free from defects in material and workmanship to the original owner 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 batteries, 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.

To make a request or claim under this limited warranty, 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 warranty. This limited 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.

THERE ARE NO EXPRESSED WARRANTIES OTHER THAN THOSE ON THE FACE HEREOF AND DESCRIBED ABOVE. NO WARRANTIES WHETHER EXPRESSED OR IMPLIED, INCLUDING BUT NOT LIMITED TO, ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE SHALL EXTEND BEYOND THE RESPECTIVE WARRANTY PERIOD DESCRIBED ABOVE OF THREE YEARS. RADIAL SHALL NOT BE RESPONSIBLE OR LIABLE FOR ANY SPECIAL, INCIDENTAL OR CONSEQUENTIAL DAMAGES OR LOSS ARISING FROM THE USE OF THIS PRODUCT. THIS WARRANTY GIVES YOU SPECIFIC LEGAL RIGHTS, AND YOU MAY ALSO HAVE OTHER RIGHTS, WHICH MAY VARY FROM STATE TO STATE OR PROVINCE TO PROVINCE.



Radial Engineering

1638 Kebet Way, Port Coquitlam BC V3C 5W9 tel: 604-942-1001 • fax: 604-942-1010

email: info@radialeng.com • web: www.radialeng.com

Radial Engineering is a division of C•TEC (JP CableTek Electronics Ltd.) J48 MK2 - Manual V3.1 05/20/05 part #: R800-9616-00

www.radialeng.com