GREEN REPORT

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Radial Engineering Ltd.
1588 Kebet Way
Port Coquitlam BC V3C 5M5

Tel: 604-942-1001
Fax: 604-942-1010

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

INTRODUCTION

The Radial Green Report is a comparison report that looks at four popular direct boxes in professional touring, studio and broadcast. This was originally done on our behalf by Ron 'Obvious' Vermulen, former chief technical director at Bryan Adam's world class Warehouse Studios in Vancouver, BC. These tests were performed using an Audio Precision System-1 Analyzer and the results are provided here as a reference for the more demanding audio engineer.

It is important to note that the competitive DI boxes used in this report are among the most popular in the industry and are certainly very good quality. This report is in no way designed to cause offense to these manufacturers, but merely here to provide technical data for those that care to compare.

Another aspect of this report is that unlike the others that are all active, the Radial JDI is in fact 100% passive. What this means is that while the others incorporate buffers and require 48V phantom powering as part of their signal flow, the JDI does not. The point here is that a well designed passive direct box with a high quality engine – in this case a Jensen Transformer – can often be as good if not better than an active one.

Enjoy the read. I think you will be impressed with the results.

Peter Janis

President,
Radial Engineering Ltd.

Green Report General DI Comparison

This first section is basically a summary for those that do not want to read through all of the details. Here we highlight the most critical issues regarding performance and circuit design.

Test Conditions	Radial JDI	Klark-Teknik DN-100	Countryman Type-85	Brook Siren BSS-133
All tests were performed under these conditions: Audio Precision SYSTEM-2622 CASCADE+ DSP **Level:** 0dbU (774.6 mV RMS) **Source impedance:** 600 ohms **Load:** 1,200 ohms (300 ft. of twisted pair cable) **Capacitance:** 10,000 pfd (.01µF) of total capacity. **Bandwidth:** 22Hz - 22kHz - not weighted				
Type of circuit:	Passive	Active	Active	Active
Noise:	-116.8dBu	-111.6dBu	-74.64dBu	-81.48dBu
Distortion at 20Hz:	0.059	0.290	0.264	0.693
Linearity 20Hz~20kHz:	0.22dBr	-1.78dBr	-1.93dBr	-0.41dBr
Inter-modulation:	0.0028%	0.123%	0.299%	0.106%
Phase deviation 20Hz:	-4.3º	-19.8º	-17.1º	-36.4º

Noise floor:
Noise floor is basically the residual noise of the device when inserted into a test circuit. The Radial JDI measures a noise floor that is 5dB lower than the nearest rival. This is not surprising as the JDI is passive. The advantage of a low noise floor is mostly noticed in the studio when recording with today's high sample rate digital recorders.

Distortion – THD:
Most folks have heard of THD or total harmonic distortion, but few understand the relevance of this spec and how to read it. Here's the deal: most circuits have very little distortion at 1kHz but manufacturers tend to use it as it hides the reality while making their box look as good as the rest. When it comes to distortion, what really matters is how well a circuit will handle powerful low frequencies. For instance at 20Hz, the Radial JDI delivers extremely low distortion: a mere 0.06% or one quarter of the nearest rival. This would indicate the JDI being particularly adept at handling high output devices that have lots of low frequency content.

Linearity:
This test shows how well the direct box retains the signal balance from 20Hz to 20kHz. A 'perfect' device would exhibit 0dB fluctuation and be ruler flat. In practice this is impossible as the wire, connectors and each resister will inevitably have some capacitive effect on the signal path. Here the Radial JDI delivers amazing linearity with less than 1/5th a dB of variation.

Inter-modulation:
IMD or inter-modulation is basically a test that listens for dissonance. Think of it as playing two notes on a piano that are harmonically 'weird' such as playing a C with a C#. On a 'bad' piano, this sounds terrible… on a good piano, we call this jazz! The JDI's inter-modulation distortion is so low at 0.003%, it can barely be measured.

Phase deviation:
Think of phase deviation as playing a three note chord where all notes are played simultaneously but upon playback, they are come out at different times. Phase deviation is most audible in the low frequencies as is often sited for making bass sound indistinct. The Radial JDI delivers amazing phase accuracy at just over 4º while the others smear the bottom end by anywhere from 20º to 40º.

Conclusion:
The Radial JDI is a simple passive device that at once converts the impedance and balances the signal. It does so without the use of any powering whatsoever. Instead, it employs a high performance transformer as the engine to perform these tasks. This also benefits the transmission by eliminating nasty ground loops. These tests prove that the Radial JDI is quieter, has less distortion, is able to handle more signal, will have less impact on the original sound and will deliver a more accurate picture of the instrument. The Radial JDI is quite simply the world's finest passive direct box.

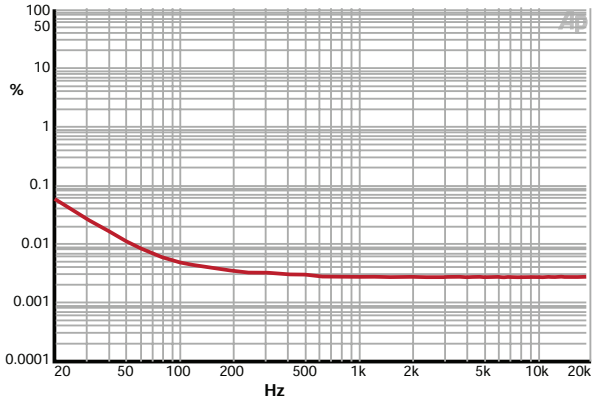
Distortion THD - detailed test results

In this test, the Radial JDI exhibited 1/4th to 1/10Th the distortion of the others. This should not be surprising as transformers are for the most part capable of handling tremendous levels without distortion. But this does not mean that the JDI does not distort. High quality transformers like the Jensen used in the JDI will saturate when they are subjected to abnormal levels. This has the pleasing effect of sounding 'vintage' which of course makes sense as most old equipment employs transformers at either their input or output stages.

Frequency:	JDI	Countryman	Klark-Technik	BSS
20Hz	0.0599	0.2900	0.2640	0.6930
250Hz	0.0035	0.0967	0.1890	0.1340
500Hz	0.0029	0.0615	0.1870	0.1320
1KhHz	0.0025	0.0360	0.1840	0.1330
2.5kHz	0.0028	0.0297	0.1710	0.1340
5kHz	0.0028	0.0292	0.1660	0.1310
10kHz	0.0028	0.0270	0.1790	0.1260
20Hz	0.0029	0.0080	0.2230	0.1120
25kHz	0.0035	0.0052	0.2440	0.1090

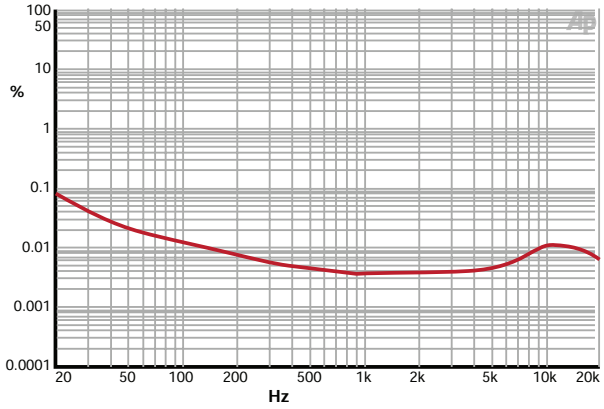
The JDI's exceptionally low distortion at all frequencies makes it an ideal candidate for digital pianos and active bass guitars that tend to overload most DI boxes. The warm sounding Bessel curve further enhances their performance by introducing a very soft limiting effect.

RADIAL JDI - THD vs FREQUENCY



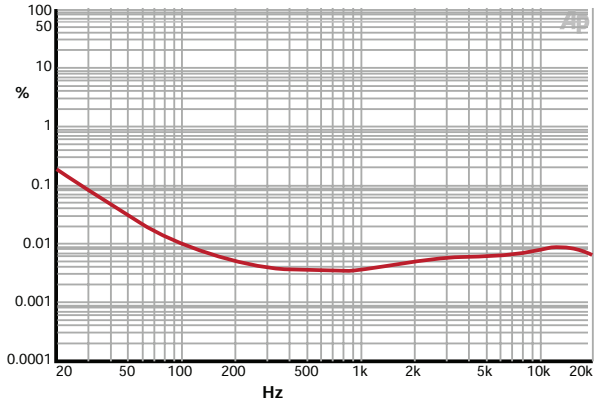
The Radial JDI measures less than 0.01% distortion in the all important bass region and remains stable throughout the full frequency range. The JDI compares very favourably against all others tested.

BSS AR-133 - THD vs FREQUENCY



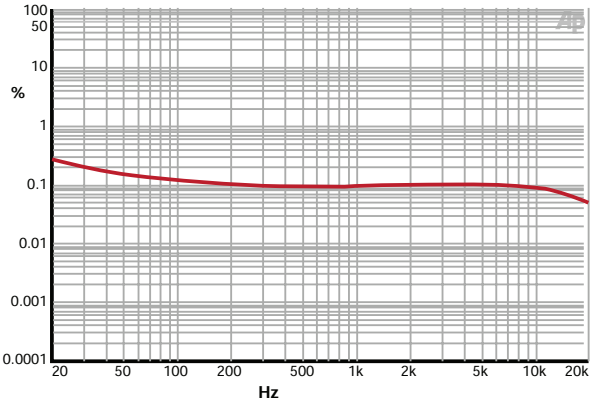
The BSS begins at just under 0.1% distortion at 20Hz - almost double that of the JDI. As predicted, it drops to below 0.01% the 1kHz region, but rises again at 10kHz.

KT DN100 - THD vs FREQUENCY



The Klark-Teknik DN200 does not fare well in the low bass region measuring 0.2% at 20Hz. It does however improve dramatically in the 500Hz to 1kHz region and only rises slightly above 2kHz.

COUNTRYMAN T85 - THD vs FREQUENCY



The Countryman shows significantly more distortion than all others at all frequencies measuring 0.3% at 20Hz and a less than impressive 0.1% at 1kHz

Linearity - detailed test results

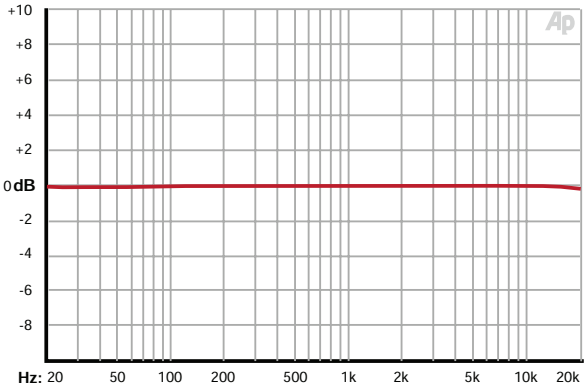
The most natural sounding direct box will be one that delivers a linear response or more precisely, one that does not introduce an increase or decrease at any particular frequency.

Frequency / Deviation	Radial JDI	Countryman	Klark Technik	BSS
20Hz	-0.12	-0.14	-0.46	-0.93
50Hz	-0.07	-0.04	-0.19	-0.41
250Hz	-0.03	-0.04	-0.08	-0.14
500Hz	-0.01	-0.02	-0.04	-0.04
1kHz	-0.01	0.00	0.00	-0.01
2.5kHz	-0.01	-0.01	+0.01	-0.01
5kHz	0.00	-0.07	+0.11	0.00
10kHz	-0.05	-0.36	+0.55	+0.04
20kHz	-0.22	-1.78	+1.93	+0.25
25kHz	-0.35	-2.97	+2.74	+0.46
40kHz	-0.85	-7.52	+5.14	+1.54
50kHz	-1.23	-10.60	+6.83	+2.50
80kHz	-2.57	-18.40	+8.89	+5.73

It is important to note that although all DIs did well at 1kHz, this spec is somewhat meaningless as most audio devices will test well in this region. Where you can really see how well a device is made is when you look at the extremes where demands are greatest. In this test, the JDI faired best with about 0.2dB fluctuation from 20hz to 20kHz while the Countryman and Klark-Technik exhibited close to 2dB fluctuation and the BSS near 1dB.

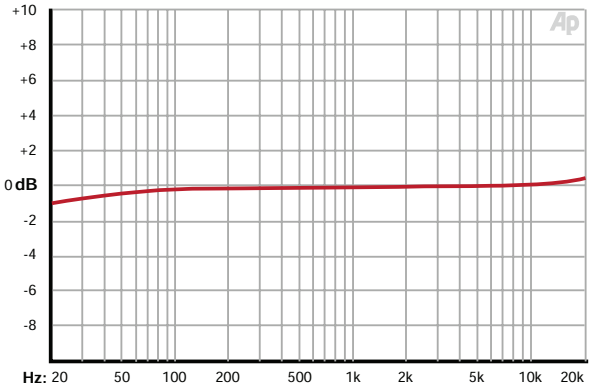
	JDI	Countryman	Klark -Teknik	BSS
Deviation 20Hz to 80kHz	-2.47dBr	-18.4dBr	-8. 89dBr	-5.73dBr
Deviation 50Hz to 20kHz	0.22dBr	-1.78dBr	-1.93dBr	-0.41dBr

RADIAL JDI - FREQUENCY RESPONSE - 22Hz TO 22kHz



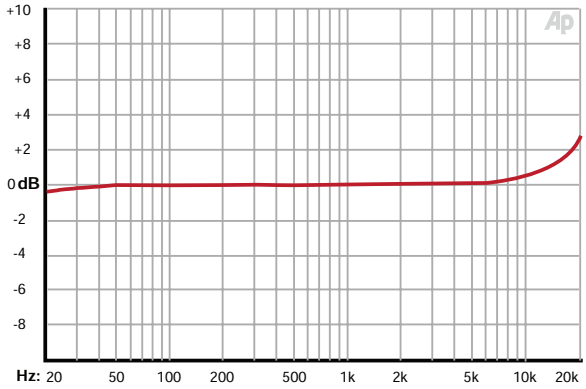
The Radial JDI is exceptionally linear from 20Hz to 20kHz showing less than <0.1dB of variation throughout the entire audible range. A slight top end drop is due to capacitive effect of the 300ft of cable.

BSS AR-133 - FREQUENCY RESPONSE - 22Hz TO 22kHz



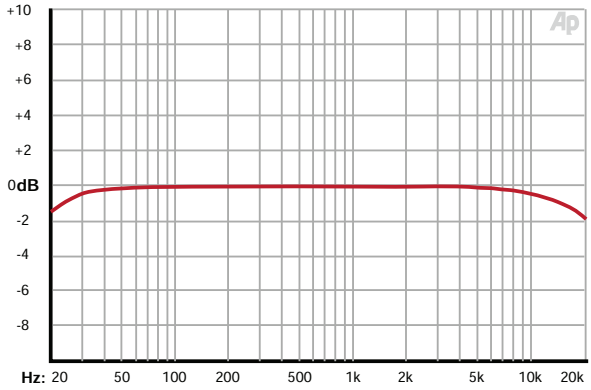
The BSS AR-133 has a significant 1dB drop in the low end along with a 0.4dB rise that begins at 2kHz and really climbs above 10kHz, attributable to the output transformer.

KT DN-100 - FREQUENCY RESPONSE - 22Hz TO 22kHz



The Klark-Teknik DN-100 does not fare as well with a 0.5dB drop in the low end and a significant 3dB rise that begins at 3kHz and really climbs above 10kHz. This rise is attributed to the output transformer.

COUNTRYMAN T85 - FREQUENCY RESPONSE - 22Hz TO 22kHz



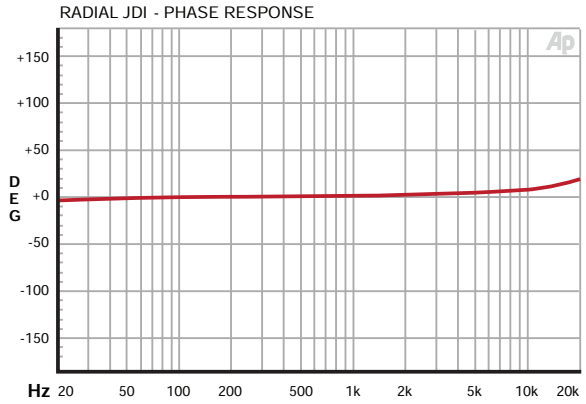
The countryman Type-85 shows a reasonably solid bottom end right down to 20Hz but shows a disappointing top end with severe roll-off above 10kHz.

Phase response – detailed test results

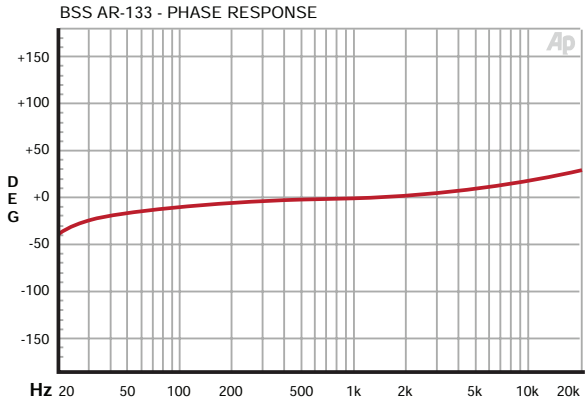
Many engineers believe that phase deviation is one of the single most important factors in achieving 'good sound' from a direct box. The human ear is extremely phase conscious. The brain constantly monitors phase relationships via the ears to localize sound. Phase provides indicators such as 'depth of field' and 'imaging', key ingredients that position the instrument in a mix.

Deviation°	JDI	Countryman	Klark-T	BSS
20Hz	-4.3°	-19.8°	-17.1°	-38.5°
31.5Hz	-3.1°	-14.8°	-12.2°	-25.7°
63Hz	-1.9°	-10.2°	-6.7°	-14.4°
125Hz	-1.2°	-7.7°	-3.7°	-8.2°
250Hz	-0.7°	-5.4°	-1.7°	-4.9°
500Hz	-0.3°	-2.0°	-0.4°	-2.5°
1kHz	0.3°	1.3°	1.2°	-0.4°
2.5kH z	2.0°	7.5°	5.4°	2.5°
5kHz	4.6°	16.7°	11.9°	6.4°
10kHz	9.8°	34.6°	24.2°	10.8°
20kHz	20.0°	69.8°	44.9°	28.9°
25kHz	25.0°	87.7°	53.6°	36.4°
40kHz	39.3°	>90°	73.5°	57.9°
50kHz	48.4°	>90°	83.3°	70.4°
80kHz	73.8°	>90°	>90°	>90°

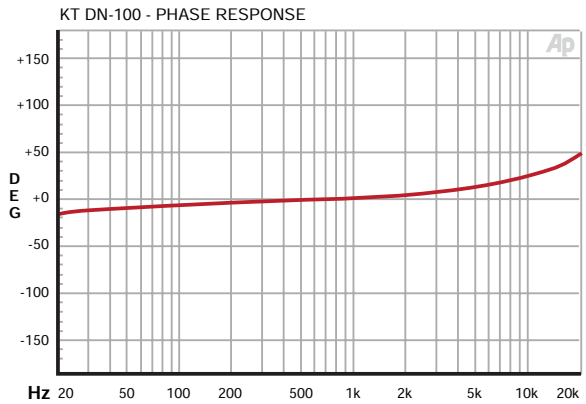
As shown above, most direct boxes fair well in the mid range, particularly at 1kHz. But this does not tell the full story. We humans are most sensitive to phase shift in the low end bass region. This is due to the longer wavelengths. One can hear the effect of phase cancellation in the bass by simply taking two loudspeakers and positioning them face to face with their wires inversed. The bass will simply vanish. The Radial JDI delivers spectacular low frequency phase accuracy with a mere 4° of shift while the others shift the low register by anywhere from 17° to almost 40°. Think of it as if someone turned a speaker away from you by a 45° angle. The sound will change dramatically! What is particularly surprising is how well the JDI also performed in the high registers. At 10kHz it is only 10° off while the others fair as poorly as 35° off scale.



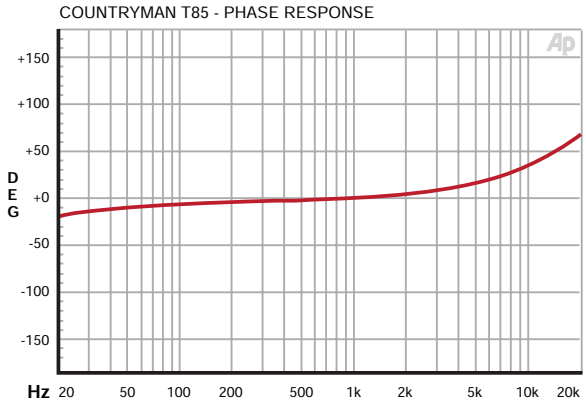
The Radial JDI exhibits only -4.3° phase shift at 20Hz and virtually zero° phase shift from 100Hz to 2kHz. At the high end, the JDI again tops the group with ionly 20.0° of shift at 20kHz.



The BSS AR-133 measures a disappointing -38.5° out of phase at 20Hz and reaches 28.5° at 20kHz. It only shows a somewhat stable phase response between 450Hz and 2kHz.



The Klark-Teknik fares a bit better than the Countryman on the low end with -17.1 phase shift at 20Hz but only third best at the top end with 44.9° off at 20kHz. Stability is reached between 250Hz and 1.5kHz.



The Countryman shows a semi-respectable -18.5° of shift at 20Hz but only reaches stability between 500Hz and 1.5kHz. top-end is already out by 16.7° at 5kHz and -69.8° out at 20kHz.

Noise floor & gain structure

One of the single biggest areas of misconception with a direct box is the gain structure. If for instance you plug in the JDI and compare the output with an active unit such as the Klark-Teknik, you will notice that the Klark-Teknik will be louder. This is obviously due to the battery inside 'amplifying or buffering' the signal. The 'assumption' by the uninformed is that louder is better. A 'real world' result that can be derived from this specification is, however, loudness versus residual noise or signal to noise. The following shows how to clearly define the 'specmanship' and see 'behind the smoke' to get the real answer..

Model:	JDI	Countryman	Klark-Teknik	BSS
Noise floor:	-116dB	-111.6dB	-74dB	-81.48dB
Gain JDI reference:	0dB	+11.81dB	+17.13dB	+21.96dB

We first take the unit noise or residual noise and then add the maximum gain from the DI's output. The JDI being passive has no gain. The resulting specification gives a true picture of how the unit will sound. Opening the pad on the input of the console to achieve unity gain will offset any discrepancies and the final result will be a usable signal with a residual noise floor. As clearly demonstrated in this exercise, the Radial JDI and the Countryman show significantly superior signal to noise over the Klark-Teknik and the BSS. By reducing the effect of the pad on the console, you actually allow the console to breathe and work better. This of course is only applicable to high quality consoles with clean pre-amp sections. If the mixer shows a 'real' signal to noise of 106dB, then having a DI with 115dB signal to noise will obviously not produce any discernible advantage.

Feature set

The folowing chard compares the features included that make a DI of greater or leser use to the professional sound technician or engineer for a particular application. Obviously, the more features that allow the DI to adapt to variables, such as system phase or grounding, the better it is suited to that application. As shown here, the Radial JDI goes well beyond the basic functionality offered by the others. in this comparison.

	JDI	Countryman	Klark-Teknik	BSS
Inputs:	Dual ¼"	Dual ¼"	Dual ¼"	Dual ¼"
Mix to mono:	Yes, merge function	No	No	No
Input Pad:	Yes, 15dB	Yes, 20dB	Yes, 20dB	Yes, 20dB
Speaker circuit:	Yes, bandpass	No	No	No
Output:	XLR-M	XLR-M	XLR-M	XLR-M
Ground Lift:	Yes	No	No	No
Polarity reverse:	Yes - 180º	No	No	No
Requires power:	No	Yes, 48V	Yes, 48V	Yes, 48V
Uses batteries:	No	yes	yes	yes

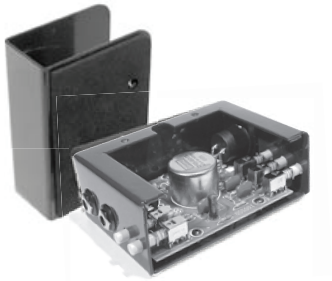
Waranty

The Radial 3-year transferable warranty on the JDI also goes far beyond that offered by the Countryman, Klark-Teknik and BSS Di's 1-year non-transferable warranty.

CONSTRUCTION

All four direct boxes presented provide a good external metal box and shielding against magnetic fields.

Radial JDI



Radial DI's feature steel I-beam internal construction for maximum strength. The outer metal wrapper uses bookend design which creates an overhang that protects the switches and jacks. The PCB is supported with four welded stand-offs to reduces stress on the PCB. A rubber pad covers the bottom for electrical isolation and helps the DI 'stay put' on top of amps.

BSS AR-133

Front and back panels screw to an aluminum channel. The PCB is supported by the jacks. A hit to the panels is transferred directed to the PCB. The switch and jacks are unprotected.

KT DN100

Similar construction to the BSS. Panels screw to an aluminum channel with the jacks supporting the PCB. The switch and jacks are unprotected. This build process unprotected. This build process does have one advantage, it reduces cost during manufacturing.

Countryman T85

Front and back panels are integrated to a slide-in-frame. Switch and jacks are recessed for protection. PCB is encased in epoxy making repair impossible.

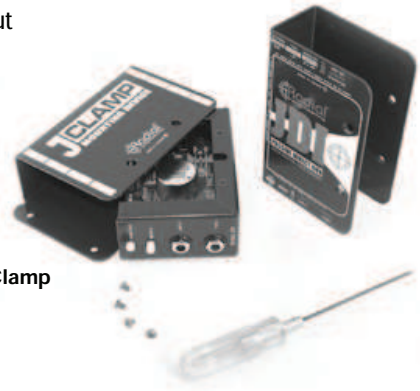
Built tough for the road...

The image to the right is an actual photo of a Radial DI taken in front of the Radial Engineering facility. Proof you 'can' drive a truck over it! We are serious when we say "built tough for the road". Fourteen gauge steel combined with I-beam construction and a heavy-duty baked enamel finish make the J48 indestructible. The outer shell features bookend design and creates a protective zone around the jacks and switches.

Mounting options:

Radial DIs are easily rackmountable using the **J-Rak**. As many as eight Radial J-class products can be fitted into just 2RU with your choice of input or output facing the front. For secure mounting of a single J-class DI in covert locations, like inside podiums or racks, the **J-Clamp** is available.

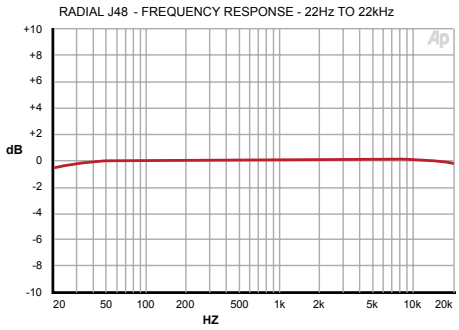
J-Rak

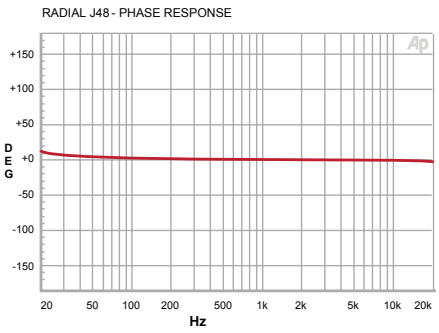


J-Clamp

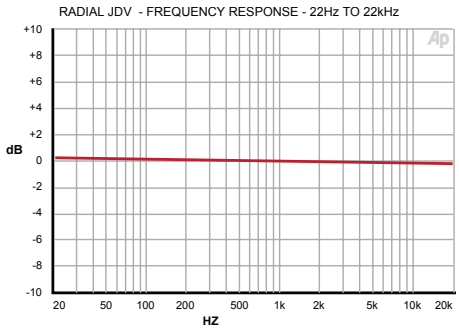
OTHER RADIAL DIRECT BOXES

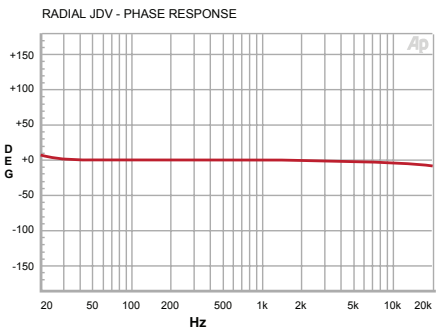
J48 PASSIVE DI



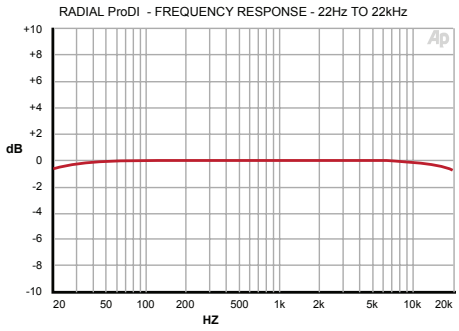


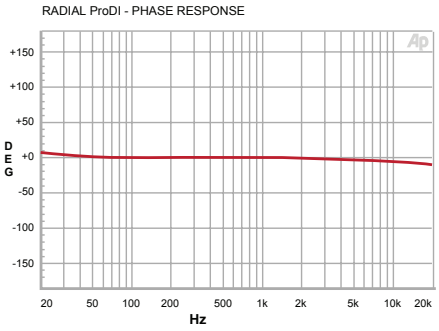
JDV ACTIVE STUDIO DI



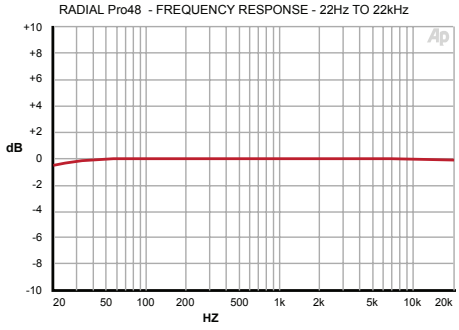


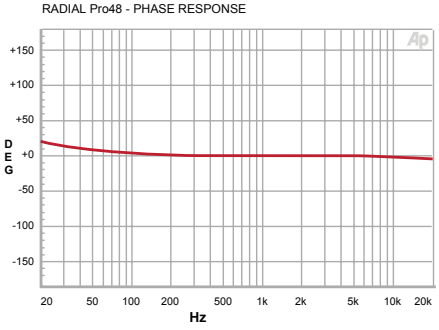
PRO DI PASSIVE DI





PRO 48 ACTIVE DI





Test conditions for above charts;

Audio Precision:	*SYSTEM-2622 CASCADE+ DSP*	*Source impedance:*	*600 ohms*
Test Frequency:	*1KHz*	*Test Load:*	*1,200 ohms*
Bandwidth:	*22Hz - 22KHz not weighted*		*(through 3 ft of twisted pair cable*
Level:	*0dbU (774.6 mV RMS)*		*having 100 pfd approximate of total capacity)*