USER MANUAL

ERMSDCV2

DC..1MHz RMS to DC converter, 85*dB Logarithmic output voltmeter & 80dB 10Hz...100kHz low Noise Amplifier*

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Document Revision	Date	Modifications	Author
A	03/2011	Initial manual	ON

Contents

ERMSDCV2 front and rear panel view

1) What is it ?

The ERMSDCV2 is a small box that includes some very useful functions for electronics design and test, especially in audio domain.

It's main function is a precise wide bandwidth RMS voltmeter. The RMS conversion is performed using state of the art RMS to DC converter IC, the LTC1968 from Linear Technology.

The second function is a high dynamic range logarithmic voltmeter. An analog output allows to display the measured AC voltage directly in dBV instead of Volts. What is useful when the dynamic signal level is high. The design use the AD8307 IC from Analog Devices to achieve it.

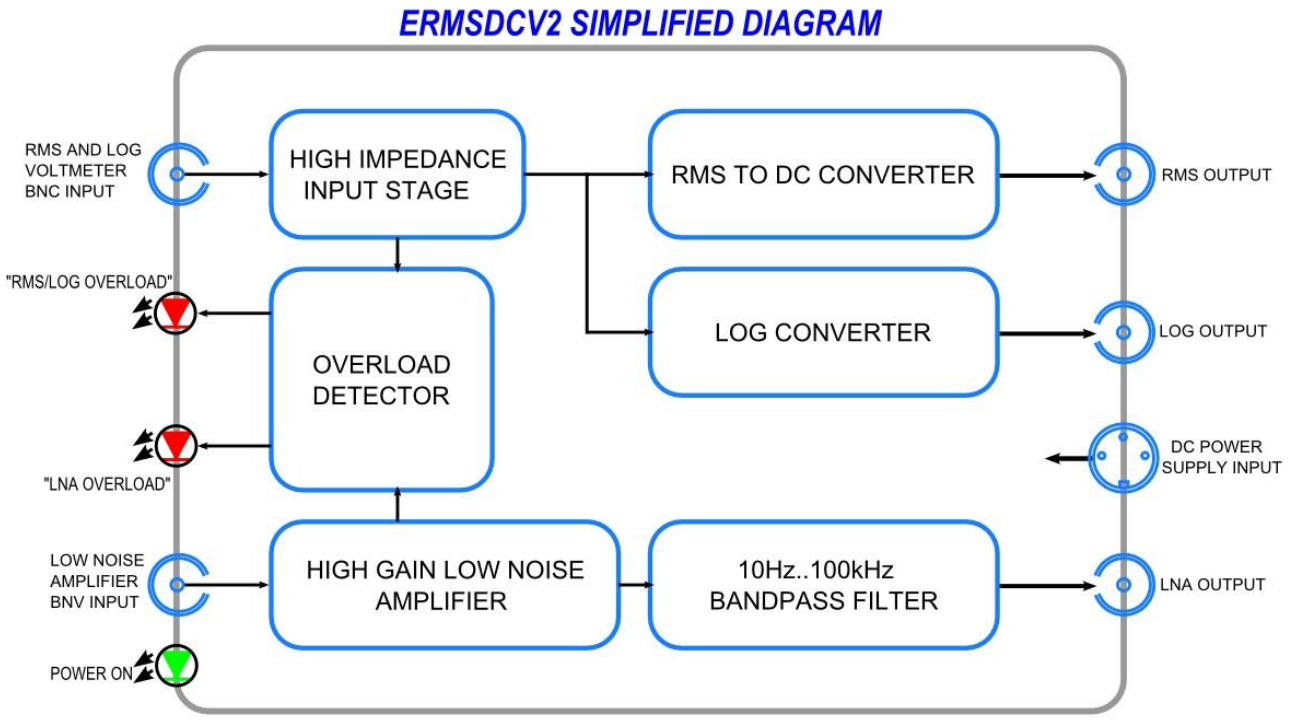
The third ERMSDCV2 function is a 80dB 10Hz..100kHz bandwidth low noise amplifier.
This amplifier allow to measure signal level down to micro-volt range, it has been intended to perform voltage regulators (such LM7805/LM317/TL431 and many others) comparative output noise measurements in audio band. Of course, it can be used in any application needing to extract low signal level without adding noise. The RTI noise of the amplifier is lower than 500nVrms...

2) Instrument overview

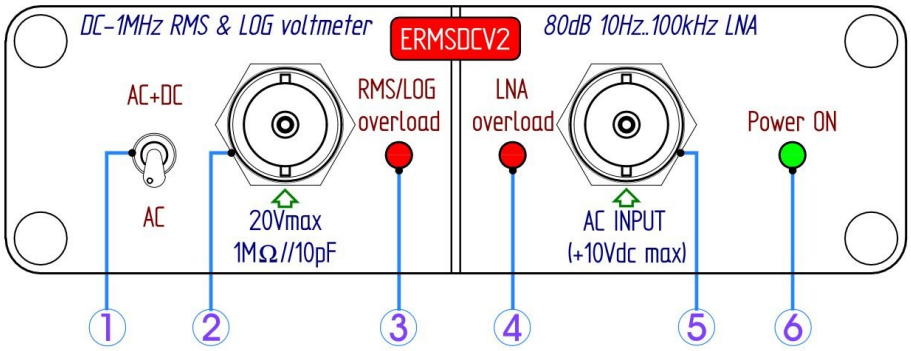
2.1) Functional diagram

The diagrams shows the main features of the ERMSDCV2 design.
Note the RMS and LOG voltmeter share the same high impedance input.

The LNA block is fully separated, it can be used independently of the voltmeter section.



2.2) Front panel description



(1) Input coupling switch:

The input coupling switch allow to select the type of voltage measurement.
In "AC" mode, only RMS value of the AC part is computed.
In "AC+DC" mode, it's the RMS value of the AC and DC part of the input voltage that is computed.

(2) RMS and logarithmic voltmeter input:

This is the common input of the RMS and Logarithmic voltmeter(BNC female connector).
This input has a 1MΩ//10pF input impedance. The high input impedance avoids loading the voltage source to perform precise measurements.

(3) RMS/LOG voltmeter input overload led indicator

This red led light on if the voltage of the RMS/LOG input exceed the upper measurement limit of +/-2Vpeak.
Note for RMS/DC converter, the peak input voltage must be less than +/-3V to perform correct measurement, and for the LOG converter this limit is +/-2Vpeak. So, when the red LED light is on, the measurement range of the LOG voltmeter has been reached, but not the limit of the RMS/DC voltmeter.
This input is protected for voltage up to +/-20V peak.

(4) LNA input overload led indicator

This red led light is on if the input voltage of the LNA input exceed +/-0.5 mVpeak.
Above this limit, the high gain the output make the LNA output saturate.
Note that the DC input voltage to the LNA must not exceed +10VDC.

(5) LNA input

This is the input of the low noise high gain amplifier (BNC female connector).
Because of the very high gain of the amplifier, it is strongly recommended to use coaxial link between LNA input and the source voltage measured.

(6) Power ON led indicator

This green LED light is on when the unit is powered by correct voltage(more than ~+/-7Vdc).
The pin-out of this connector is :

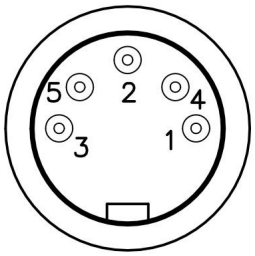
pin 1 → + V in (+7 to +12vdc)

pin 2 → Ground (0V)

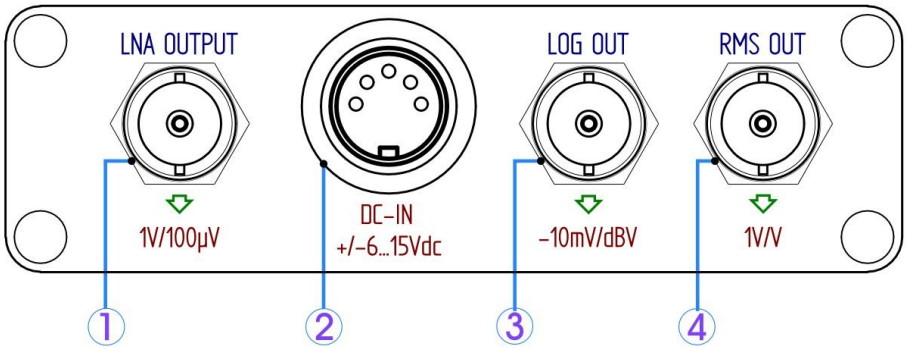
pin 3 → - Vin (-7 to -12Vdc)

pin 4 → Not connected

pin 5 → Not connected



2.3) Rear panel description



(1) LNA output

This is the low noise amplifier analog output(BNC female connector). Because of input AC coupling, no DC voltage appear at the output. The output sensitivity is 1Vrms for 100µVrms at the input (in bandpass frequency 10Hz to 100kHz). The maximum output voltage is about 3.5Vrms for 350µV at input.

(2) DC supply input

The symmetric DC power supply must be connected there.
The input voltage can be between +/-7V to +/-12V. The required minimum current for each rail is about 150mA.

It is recommended to use clean power supply for proper operation of the ERMSDCV2, especially for the LNA section that is noise sensitive. For this reason, switching mode power supplies (SMPS) should be avoided.

(3) Logarithmic voltmeter output

This is the logarithmic voltmeter output (BNC female connector).
The logarithmic output is a DC voltage matching directly voltage expressed in dBV.
For 1V at input you will get 0Vdc at output and for 100mV you will get -200mVdc at output.
This DC output voltage is 0Vdc=0dBV for 1V and -200mVdc=-20dBV for 100mV.
The output slope is -10mV/dB, so it is easy to to directly read voltage in log scale.

(4) RMS voltmeter output

This is the RMS to DC voltmeter output (BNC female connector).
The DC output represents the true RMS (Root-Mean-Square) value of the input signal.
The nominal output sensitivity is 1V/V, it means that for a signal of 1Vrms the output is 1Vdc.

3) RMS/DC and LOG voltmeter operation.

Simply connect a DC voltmeter on the RMS output and the signal to analyse to the BNC input. Choose the input coupling mode (AC or AC+DC), the DC voltmeter directly displays the RMS level.

The default nominal full scale input of the RMS voltmeter is 2.5V.But as the input stage of the RMS/LOG voltmeter is designed as an oscilloscope input, using oscilloscope probes can increase the input voltage range (just as oscilloscope inputs do).

You can use x10 or x100 scope probes can be used to get 10x or 100x input voltage range. This then gives a 25V or 250V range instead of 2.5V. This is possible because the internal probe resistor divider and the RMS input impedance (1MΩ) constitute a voltage divider.

The frequency response when probes are used is roughly the same as without probe, but it is necessary to trim the probe to obtain a good frequency flatness in all bandwidth.

Using probe has also the advantage to get an higher impedance than a direct connexion.

The probes impedance are :

- No probe (direct connexion) → 1MΩ
- x10 oscilloscope probe → 10MΩ
- x100 oscilloscope probe → 100MΩ

Using probe can avoid parasitic impedance disturbance.

4) Low noise amplifier (LNA) operation.

The LNA can be used for many purpose.
The design has been originally built to compare the noise of different linear voltage regulators.
The application note **AN83** from Linear Technology describing the test procedure with low noise amplifier can be read for further information.
The ERMSDCV2 is widely inspired from various schematics published in LT Applications notes.

The LNA can work together with the RMS/LOG voltmeter. The LNA output has to be connected to the RMS input. The RMS signal can then be measured to a level down to 1µV.

The resulting DC voltage value on the RMS output must be divided by the 10000 to obtain the real LNA RMS input voltage value. The one on the LOG output must be reduced by 80dB.

I'm sure that it will be an helpful toll in your lab for your DIY electronics & audio exploration !

5) Technical specifications

All tests performed with +/-9Vdc linear power supply.
Typical value measured on prototype board.

5.1) True RMS voltmeter

Parameter	Min	Typ	Max	Unit
Input impedance		1		MΩ
Input capacitance		15		pF
Linearity (250mV to 2.5V range f=1kHz)		0.5		%
Input voltage range (error<5%, No probe)	0.01 0.014	.. ..	2.5 3.5	Vrms Vpeak
Frequency bandwidth (error<5%) "AC+DC" mode. "AC" mode (no probe)	DC 0.01	..	1000 1000	Khz kHz
DC output settling time (1V step, 10% to 90%)		350		ms
RMS output sensitivity (trimmed)		1.000		V/V
Maximum input voltage limit (no probe)		..	20	Vpeak

5.2) Logarithmic voltmeter

Parameter	Min	Typ	Max	Unit
DC output logarithmic slope		-10		mV/dB
Linearity from 100µV(-80dBV) to 1V(0dBV) f=1kHz		0.5		dB
Noise floor (Input shorted to ground) (analog front-end with OPA627+AD817)		-85 56		dBV µVrms
Frequency bandwidth (error<3dB)	0.01	--	1800	kHz
Error between 0dBV to -80dBV (1V to 100µV)	-0.5	--	+0.5	dB

5.3) 80dB Low noise amplifier

Parameter	Min	Typ	Max	Unit
Nominal LNA Gain (f=1kHz, Vin=100µV, adjusted)		10000 80		V/V dB
AC input impedance (F=1kHz)		100		Ω
Input referred noise (10Hz..100kHz bandwidth)		500		nVrms
Frequency bandwidth (error<3dB)	0.01	--	100	kHz
Maximum input voltage (before saturate)		350 495		µVrms µVpeak
Maximum output voltage (before saturate)		3.5 4.95		Vrms Vpeak

END OF MANUAL

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Related OnE Audio Design :

- **EOSC10KV2**, ultra low THD (-120dBc) 10kHz reference oscillator.
- **AA5381V1**, 24bits/192kHz stand alone high performance Analog to Digital converter.
- **EHAMP08**, Remote controlled TPA6120 based headphone amplifier.
- **EXDAC**, Symmetric outputs high performance audio DAC with headphone amplifier.
