AT2380V2 USER MANUAL

0 to -127.5dB 2 channels digitally controlled stepped attenuator with amplitude tracking

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Document Revision	Date	Modifications	Author
A01	26/11/17	Beta release for PCB V2	ON
A01.1	25/01/18	Update for new CPLD firmware 0.23	ON

Contents

AT2380v1 front & rear views

1) What is it ?

The AT2380 is a dual channels digitally controlled passive stepped attenuator. It can be used to reduce the signal level in order to fit with the range of the target device.

It has been designed to doesn't introduce any significant distortion and noise by using fully passive attenuation network with high performance resistors. To avoid any noise contamination from all on-board digital control circuitry, all clocks can be disable keeping the attenuator to it's current state (frizzed value).

One of the main purpose of this attenuator is to help performing signals measurements (when testing audio devices for example) with analysis hardware such an audio sound-card.
Anyway, it can be of course used for any purpose where signal level control is needed.

For ease of use, the attenuation setting is made by a single rotary encoder and it's value is displayed directly on a four digits seven-segment LEDs display.

In addition, if some optional parts are mounted, an auto-track mode is available.
The auto track mode allow user to select directly in dBV the desired output voltage level wanted at the output of the attenuator (servo control loop). The output voltage level can be controlled in a 95dB dynamic range (+10 to -85 dBV).

For some users, it is sometimes useful to control the attenuation value by a computer, so it is possible to connect directly a BlueTooth uart board module (HC06 type) to allow direct setting control by a virtual serial Comport. The serial link provide both attenuation control (Tx) and output dBV level reading (Rx).(Only available with CPLD firmware greater than v0.23).

The entire design fit in a small aluminum enclosure and the PCB panel include the main board and also front and rear panel already drilled and engraved.
So, there is no need to make any drilling to get a very clean and beautiful DIY instrument!

2) Operating modes.

1) Normal mode

In normal mode, the AT2380 work as a dual channels attenuator with manual selection.
By default, the rotary encoder allow to set the actual attenuation with a step size of 0,5dB.

Pressing shortly the encoder allow to switch sequentially between five different steps size :
0,5dB ➔ 1 dB ➔ 3dB ➔ 6dB ➔ 10dB ➔ Back to 0,5dB.

For each step size , the new step value is displayed for ~1s.

When rotating the encoder to choose the attenuator value, the display follow instantaneously each encoder increments.

To avoid very fast relays switching during moving value, by default the relays states are only refreshed each 2s. If a faster response is required (used as audio volume control for example) it is possible to enable a faster control mode by mounting the "fast mode" jumper (see § 4.2).

Note : The selected attenuation value is the same for both channels.

2) Track level mode

Note : The tracking level mode is only available if needed parts has been mounted on the PCB ! (See bom details) and work only on the channel that has been connected to rms/log detector.

This mode allow to control automatically the attenuator to get a settled level at the output.
Changing the normal to track-mode can be done by pressing the encoder button about 2s.
When enabled, the message "AUto" is displayed for 1s.
(Back to normal mode is done by a new 2s press, and then message "MAnu" appear for 1s).

Now, the LEDs display doesn't show attenuation level, but the **desired** output voltage level in dBV.
The encoder allow the adjustment of this level in the range of -85dBV to +10dBV (56µV to 3,2Vrms).
The default level setting is the minimum value (-85dBV).

The front panel LED D1 (bottom) allow to follow the control loop state, by indicating by it's color if error is positive (red), negative (green) or off when error is canceled.

Note that the level can only be tracked if the input signal level is equal or above the level set (there is only attenuation !).To avoid fast relay switching when input level is changing, the attenuation value is refreshed only each 2s.

3) dBV output display mode

On the tracked channel, in any mode it is possible to use the display for dBV measurement of output. It must be noted that in tracking mode , the default display is the dBV setting, NOT the measurement ! values are same only when error is nulled .

So for both mode (Normal and Track), a 5 s push on the encoder will set upper "red" to indicated dBV measurement mode. The 7 segments leds display will show the effective dBV level at the output of the attenuator. The dBV measurement can be disable by another 5s push on the encoder button.

⇨ *Note that the dBV display mode is only available if the parts for tracking mode option are mounted !*

3) Instrument operation.

1) power supply requirements.

A single 12Vdc 400mA power supply is required for the AT2380 operation.
If it is used for very low noise measurement, an ultra low noise PSU (as SSR01/02) or battery pack/cells is recommended. In any case, the input voltage mustn't excess 16Vdc(see specs).
(For the best noise performance, use battery pack in a shielded case with short connection as possible to AT2380).

2) Front panel

1. Inputs 1 & 2

Inputs 1 & 2 of each attenuator channel. Signal level at input must not excess 10 Vrms*.
(* if the VDR protective device is installed).

2. Upper & lower LEDS

The upper Led indicate the display mode, normal (green) or output level in dBV (red).

The lower LED indicated the operation mode ;
→ Orange for Manual mode operation
→ In Auto mode, control loop error status : positive =Red / Negative =Green / error nulled =OFF

If the quiet mode switch is active, all leds and the display are switched off and relays last position is freezed. So, there is no attenuator control possible until quiet mode is disable.

Table1 :LEDs status summary

MODE	LED 2 (lower)	LED1 (upper)
Quiet mode	OFF	OFF
Manual mode → Setting display	ORANGE	GREEN
Manual Mode → dBV measurement display	ORANGE	RED
Auto track Mode → Setting display	RED OFF GREEN	GREEN
Auto track Mode → dBV measurent display	RED OFF GREEN	RED

3. 4 digits LEDs display

In default display mode, the 4 digits LED display allow to show actual dB attenuation in normal mode (0 to 127,5 dB), and the settled dBV output voltage in auto tracking mode (+10,0 to -85,0 dBV).

NOTE : In both mode, the user can switch the display to show the dBV output measurement by pressing the push button for more than 5s. When this display mode is enable, the upper led become red.

When step size or mode is changed, it also display new selected value for 1s.
When quiet mode is active (OSC STOP), the LED display is off.

3) Rear panel

1. Outputs 1 & 2

Outputs 1 & 2 of each attenuators channel.

Note : The output impedance of the attenuator vary with the selected attenuation from ~0 to about 300Ω. For accurate attenuation level, output load impedance must be high.

2. OSC STOP switch

The OSC STOP switch allow to disable CPLD internal clock that stop leds display and freeze all relays positions. In this mode, there isn't any clock signal that could corrupt signal integrity, particularly when very low level measurements are made.

3. DCIN jack input

DC input jack connector. A clean 12V >400mA DC power source must be provided to this input. Note: The positive wire is connected to center point of the jack axial connector.(reverse polarity protected). For the lowest noise operation and no ground loop issue, a 12V battery pack is recommended.

4. Rotary encoder with button

The rotary encoder with it's push-button allow to select modes and settings :

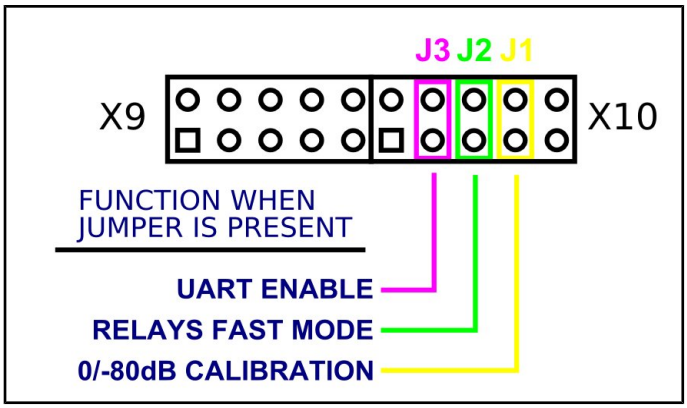
- ➔ dB attenuation (manual mode) or dBV level (Auto mode) by rotating left (-) or right (+).
- ➔ dB step by crank , by pressing shortly the button (0.5, 1, 3, 6 or 10dB).
- ➔ Manual/Auto mode operation by pressing button for 2 s
- ➔ Attenuation level (default) or dBV measurement display by pressing button for 5 s

It must be noted that for *dB step and Auto/Manu mode selection*, the encoder push-button operation functions is made when releasing it**.**

The encoder operation is fully disable when quiet mode is active (osc stop switch is on).

4) Jumpers modes settings

There is 3 mode jumpers on X10 connector.



1) Calibration Mode enable (J1)

The calibration mode jumper is to be used when we need to calibrate the dBV measurement of the AT2380. When this jumper is mounted, the CPLD control the attenuator sequentially to set 0 and -80dB attenuation about each 10s.
These two levels are required to perform the gain/offset calibration of the AT2380v2.
The jumper must be removed when calibration is done.
See more details about calibration procedure in the "AT2380_Build_instructions" document.

2) Fast Mode enable (J2)

When the fast mode jumper is mounted, the refresh rate of the relay is much more faster.
"Default" refresh rate : 0,5 Hz (no jumper)
"Fast Mode" refresh rate : 8 Hz (jumper mounted).

The fast mode is useful for audio volume control application to avoid large step increment caused by a slow update of the relays.

Note: The fast mode work only for Manual control, refresh still always 0,5Hz in tracking mode.

3) UART Mode enable (J3)

If an UART module is connected (to the X16 connector) for uart communication mode, the uart mode must be enabled by connecting the "UART mode enable" jumper.
Otherwise, the uart block will not send/receive data.

5) BlueTooth connection mode.

If needed, it is possible to use Bluetooth UART* link to control the attenuator.
The AT2380v2 provide to Rx/TX line that can be connected directly to a HC-06 low cost Bluetooth uart.

The serial link provided by the UART allow :

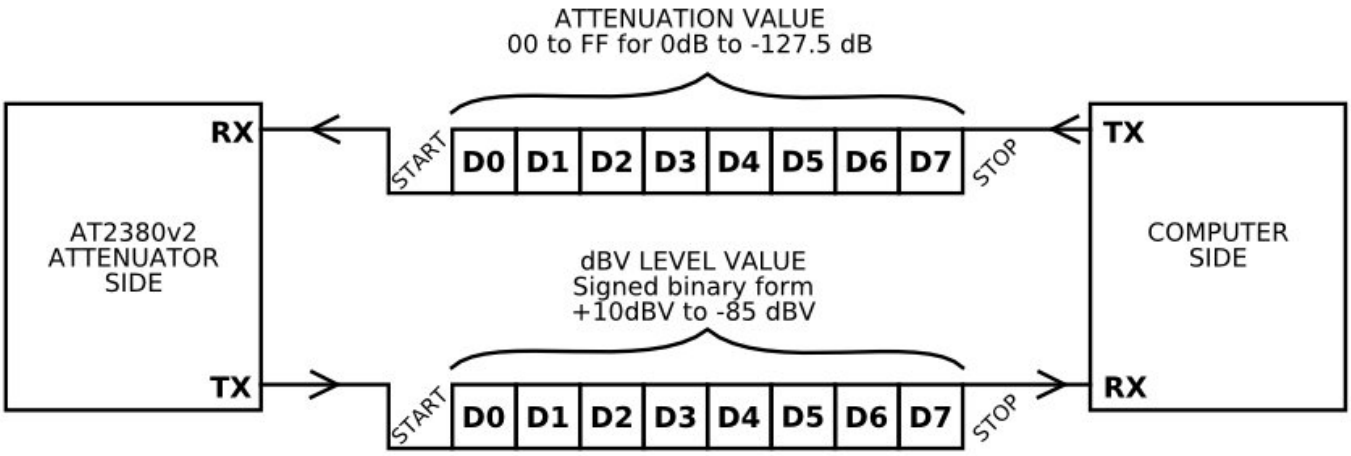
- Computer send attenuation value of attenuator (between 0 to -127,5 dB).
- Computer receive output dBV value (between +10 to -85 dBV in signed binary form with 1dB resolution).

The serial link configuration is :

Baud Rate : **9600 Bauds/s**
Parity : **None**
Stop Bit : **1**
Data length : **8 Bits**

To avoid noise coming from BT communication, the dBV value is not periodically sent to computer, but only initiated when an RX frame is read on the AT2380v2 side (attenuator value set).
So to read only dBV value, the computer must send same value as previous.
Note that the dBV value is refreshed in the CPLD at about 8 Hz rate.
The attenuation value send to the AT2380 is still read at a 0,5Hz rate.

The data link between the AT2380v2 and the Uart is show below :



Please, note that to be enable, the jumper "UART mode enable" MUST be mounted !

6) CPLD firmware version.

To know easily what is the CPLD firmware version in your device, the version number is displayed at startup for a few seconds. ("uXXX" were the three "X" are version number)

7) Technical specifications.

1) General parameters

Parameter	Min	Typ	Max	Unit
Power supply voltage range	9,5	12	16	Vdc
Current consumption (normal mode, all relays “on”) Vin=12V			400	mA
Current consumption (quiet mode, all relays “off”) Vin =12V	40			mA

2) Attenuator specs (both channels)

Parameter	Min	Typ	Max	Unit
Attenuation range	0	-	-127,5	dB
dB setting accuracy * (load ≥ 5 kΩ, f=10Hz to 100kHz)		± 0,25		dB
Maximum continuous input voltage **			10	Vrms
1dB bandwidth (12 %) @ Attenuation = - 40 dB		9		MHz
Channel to channel crosstalk (Fin= 10 kHz 1Vrms). (Worst case on attenuator setting)		-135		dB
Attenuator input impedance *** (constant Zin type)		600		Ω
Attenuator output impedance *** constant Zin type)	0,4	--	300	Ω

** : Depending on ladder resistors accuracy, R= 1% .*
*** : Limited by VDR protection to 16Vdc.*
**** : The input and output impedance of the attenuator ladder depend on ladder type choose.*
It can be build with constant input resistance or constant output resistance.
For more information about ladder network type and calculation please see :
http://www.eijndhoven.net/jos/attenuator-calculator/index.html

3) Tracking mode specs (only channel with tracking)

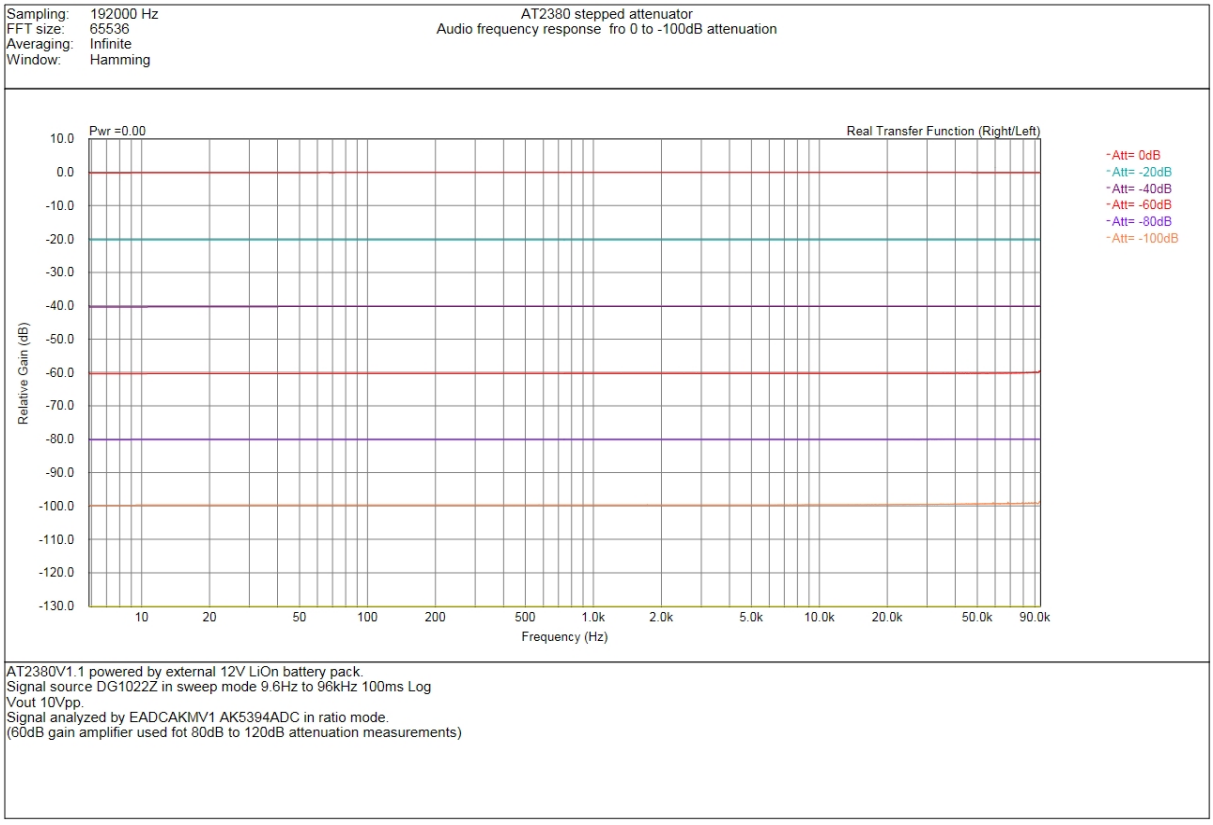
Parameter	Min	Typ	Max	Unit
Tracking voltage range	-85 0,00005		+10 3,2	dBV V rms
Tracking update rate *		0,5		Hz
dBV level set accuracy (10Hz..100kHz , +10 to -80 dBV, calibrated)		±1		dB
Lower cutoff bandwidth (-3dB)**		10		Hz
High cutoff bandwidth (-3dB)**		350		kHz

* : Relay drive refresh only
** : FDA and AD8310 Input filter parameters, can be extended if required).

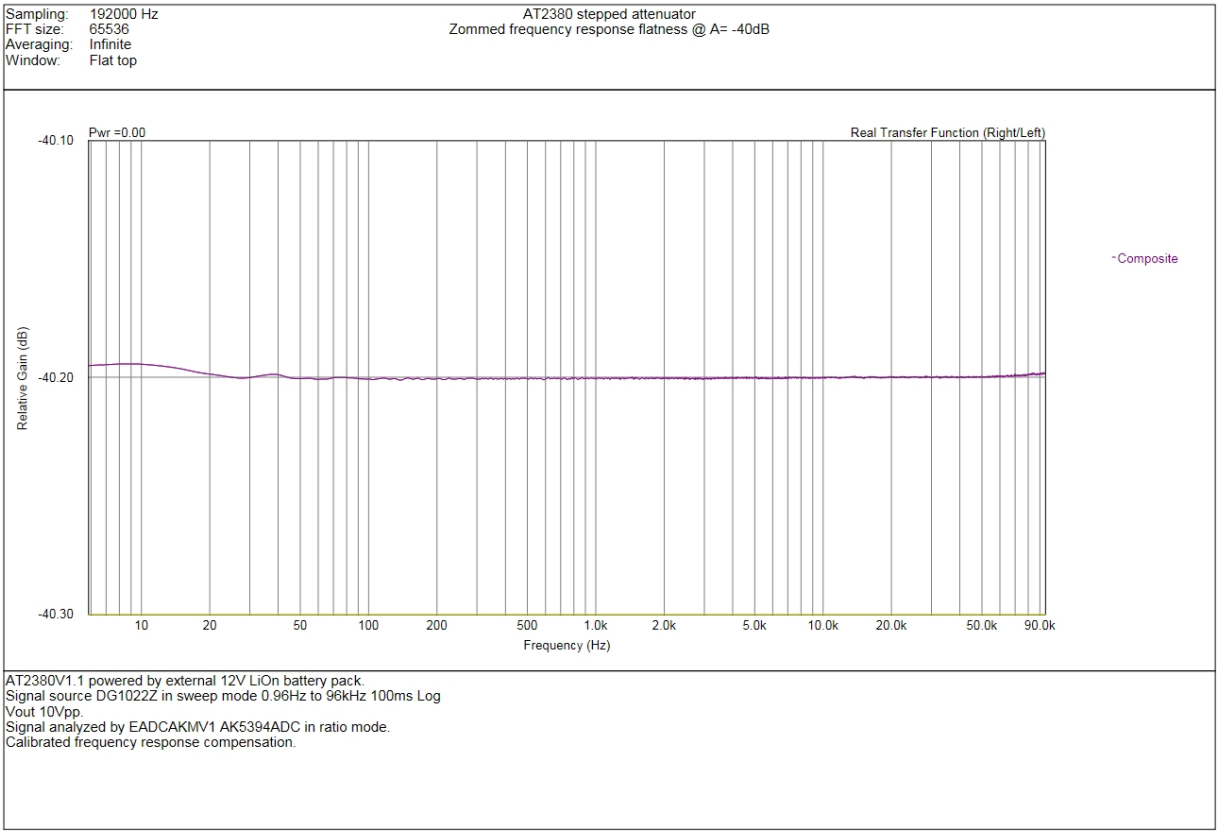
Note : The tracking mode require absolute monotonicity of the attenuator for proper operation.
So, all ladder resistors MUST have 1% accuracy or better.

4) Measurements results.

1) 0 to -100dB attenuation audio frequency response (20dB steps).

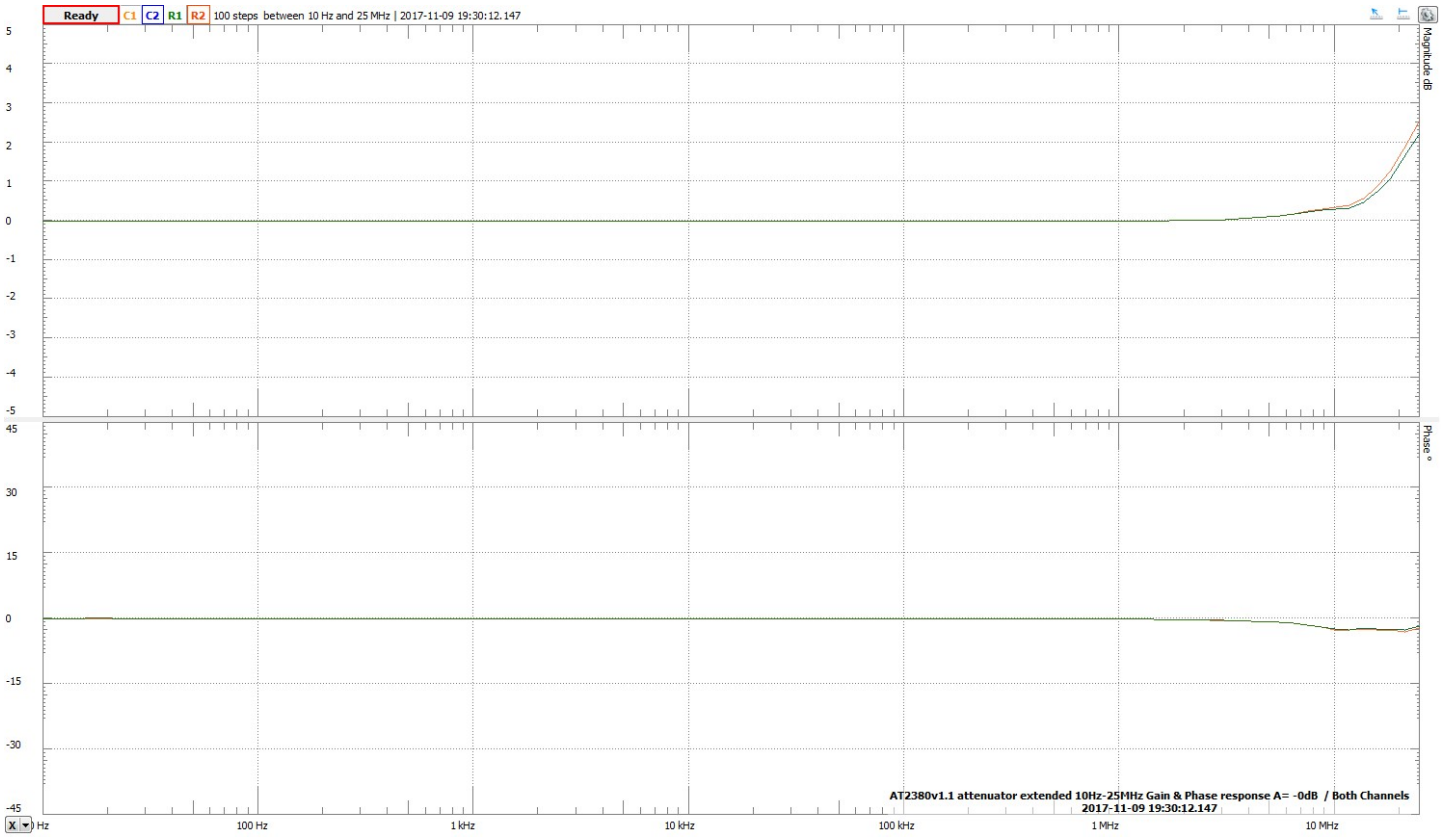


2) -40dB ±0,1dB zoomed audio frequency response flatness.

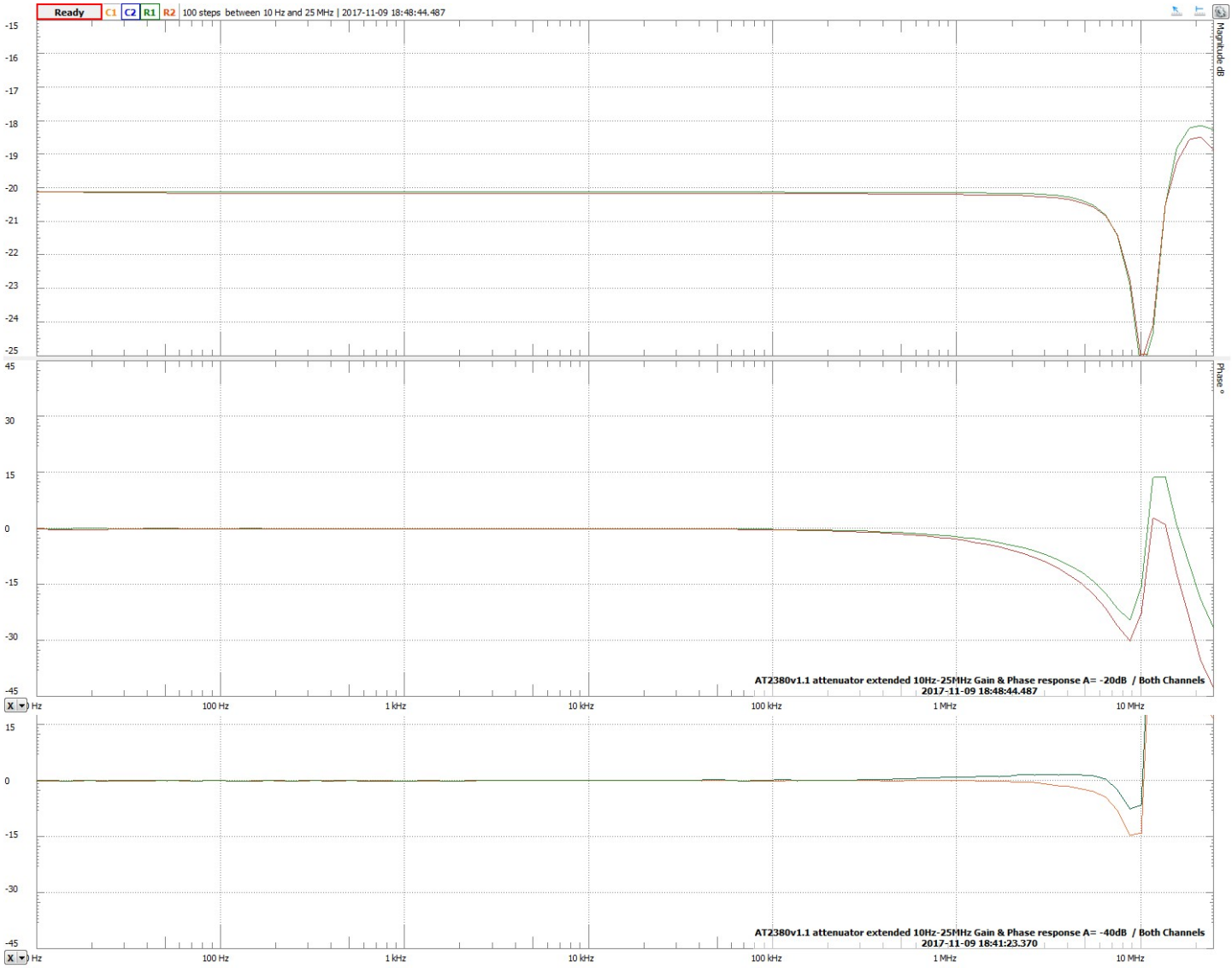


Otherwise specified, power supply is 12V battery pack.

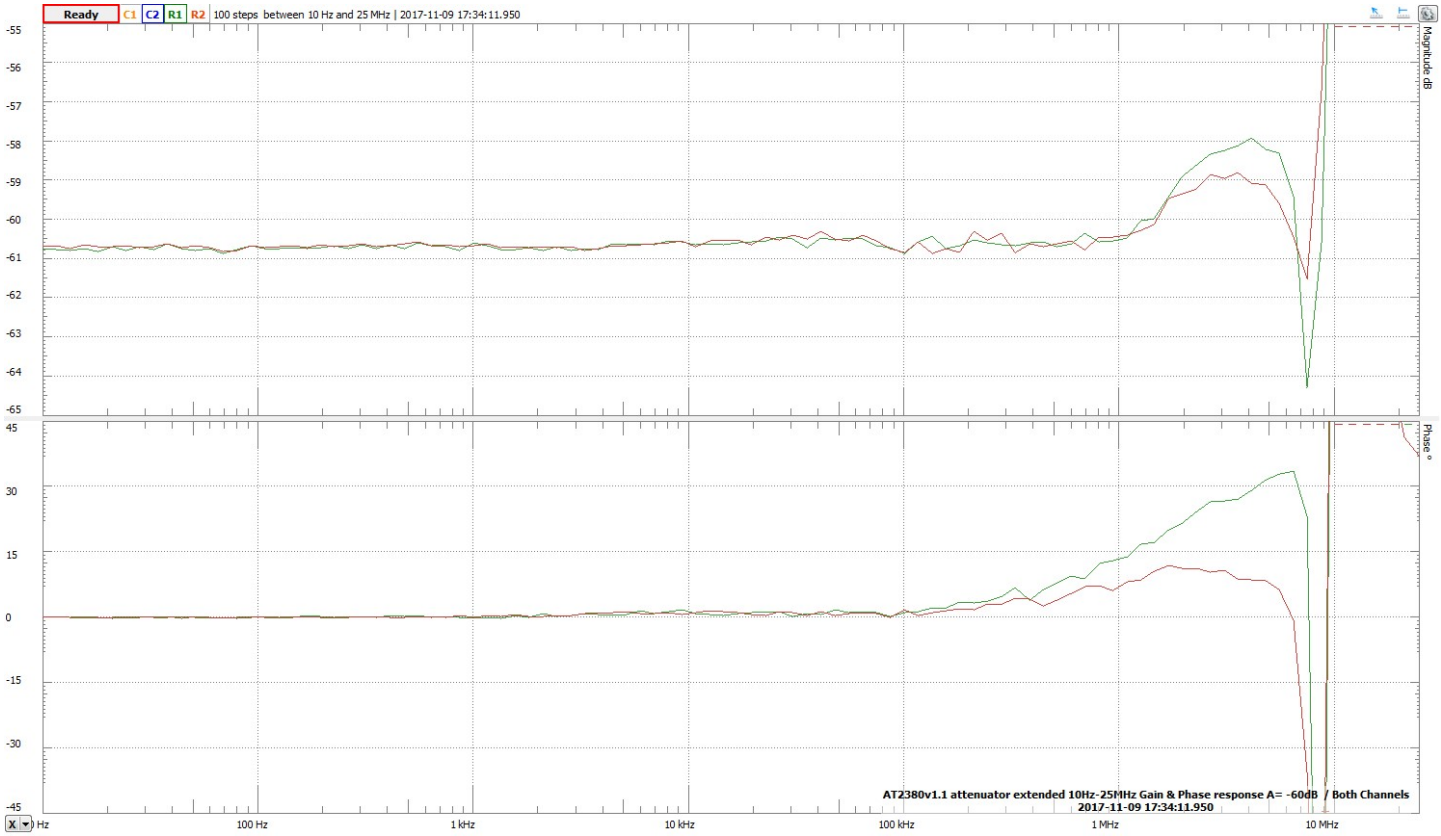
3) Gain & Phase response 10 Hz,,,25 MHz Att = 0 dB both channels



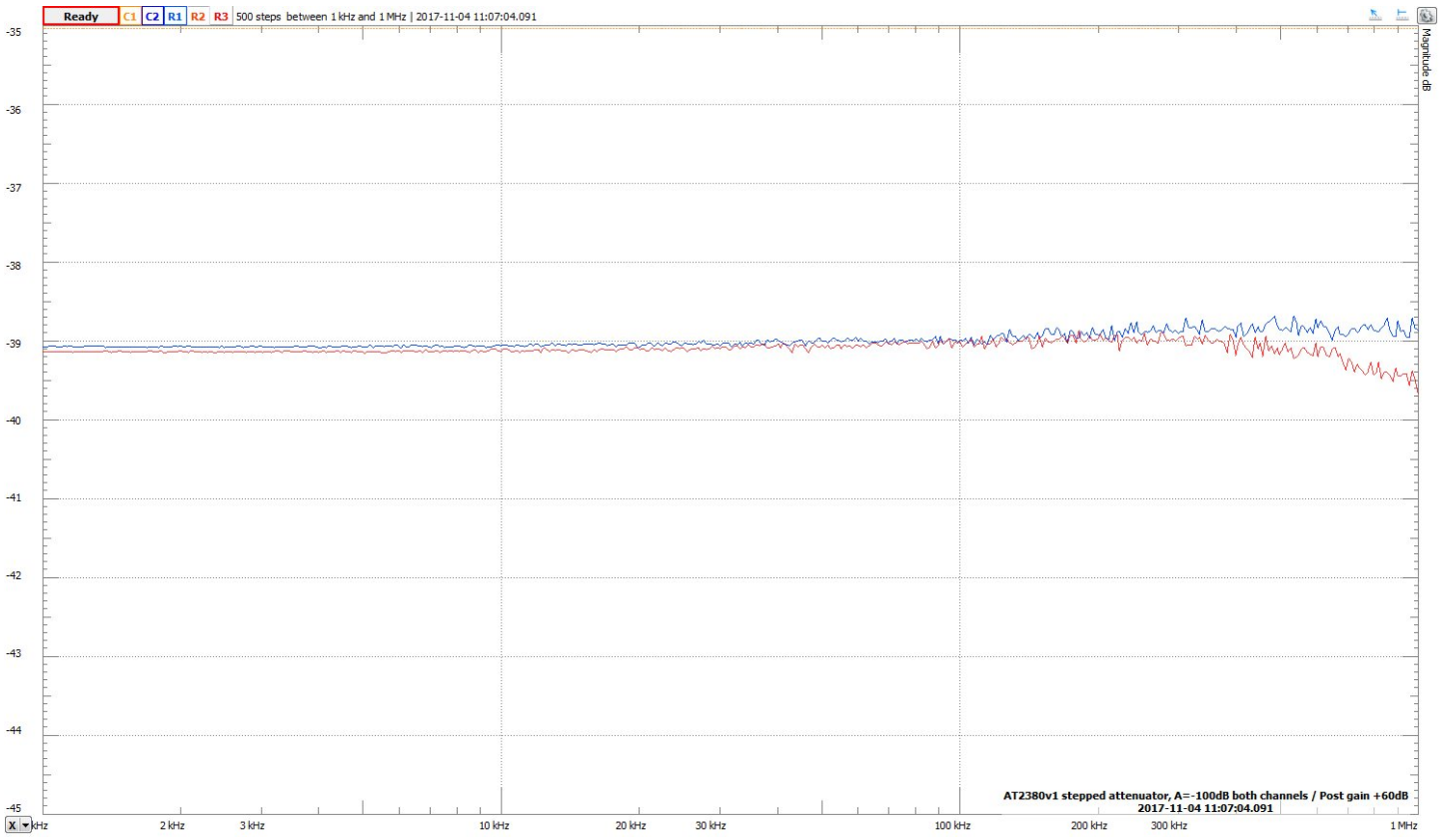
4) Gain & Phase response 10 Hz,,,25 MHz Att = -20 dB both channels



6) Gain & Phase response 10 Hz,,,25 MHz Att = -60 dB both channels

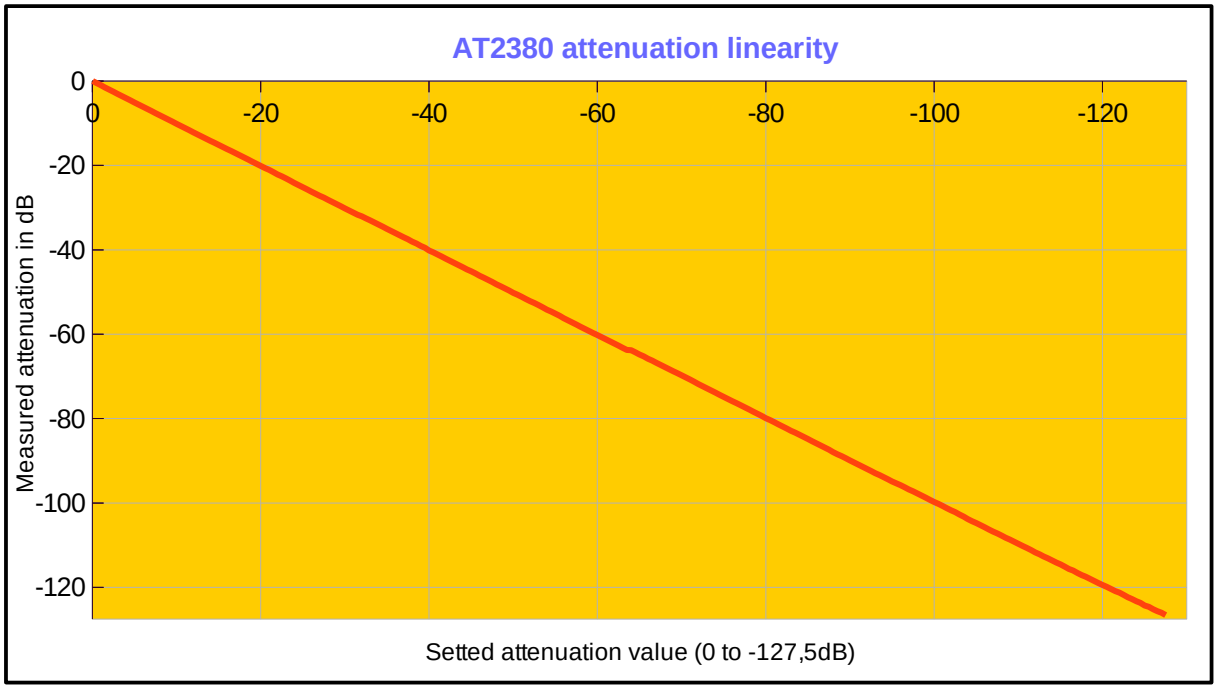


7) CH1/CH2 -100dB attenuation extended frequency response



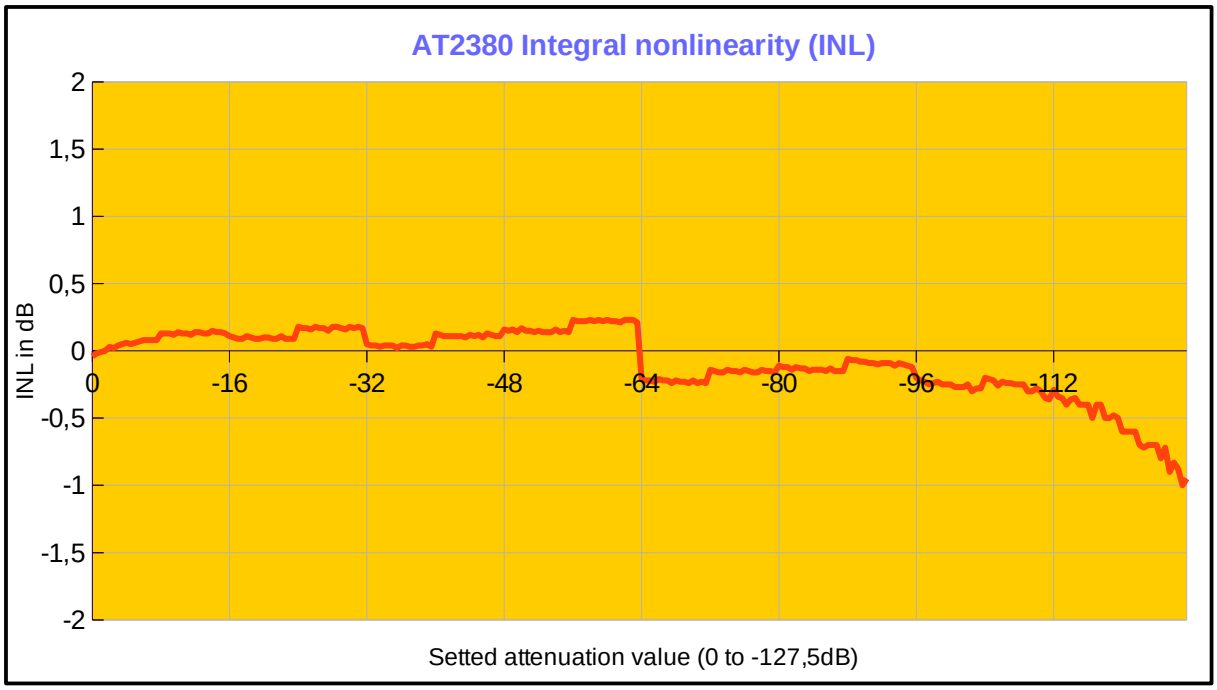
Notes : +60dB gain block at the output of attenuator for -100 +40= -60 dB
Scale is : Vertical 1dB/div , Horizontal LOG 1kHz to 1MHz.
Blue=CH1 / Red=CH2.

8) Attenuator Linearity



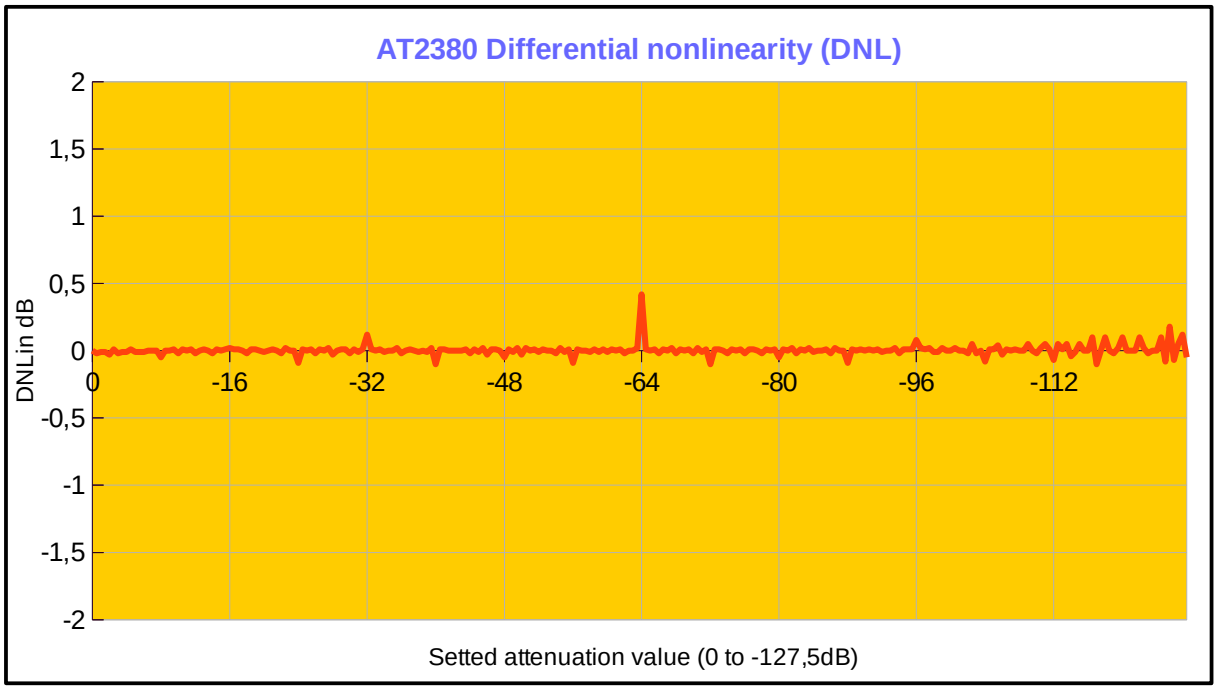
(see note 1)

9) Attenuator INL



(see note 1)

10) Attenuator DNL



NOTE 1 :

DNL and INL measured with 1kHz sine signal source and EADCAKMv1 (AK5394A ADC) as signal analyzer, calibrated in amplitude.

END OF MANUAL

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The full thread describing the project construction can be find on DIYaudio.com forum.
DIY bare printed circuit board with full project design folder are available for sale.
"Frex" member.

Others OnE Audio Designs (bare PCB available):

- **AT2380V2,** 0..-127.5dB 2 ch digital stepped attenuator with amplitude track.
- **ERMSDCV2**, DC-1MHz RMS voltmeter & 80dB 10Hz-100kHz Ultra low noise amplifier.
- **EOSC10KV3**, AN67 ultra low THD 1/10 kHz reference sine oscillator.
- **AA5381V1**, 24bits/192kHz stand alone high performance Analog to Digital converter CS5381CZZ based.
- **EHAMP08**, Remote controlled TPA6120 based headphone amplifier.
- **EXDAC**, Fully symmetric outputs dual PCM1792A high performance audio DAC with headphone amplifier.