



EOSC10KV3 USER MANUAL

Ultra-pure reference oscillator
(from AN67 from Linear-Technology)

EOSC10KV3_Manual.odt

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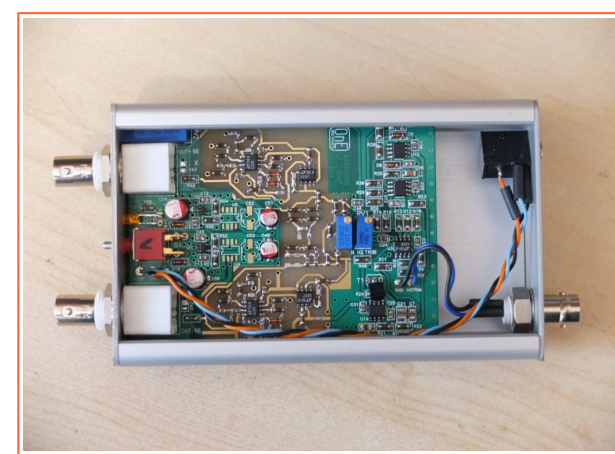
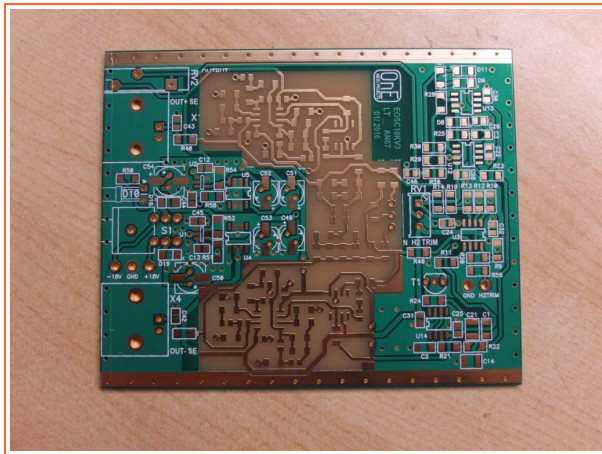
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EOSC10KV3 views



1) What is it ?

The EOSC10KV3 is an ultra low THD sine wave oscillator, used as a reference for audio testing purpose or evaluating high resolution/high performance ADC.

This design come from the AN67 Linear-Technology Application Note from Dale Eagar. The full explanation of the oscillator is described in this app note, please refer to it for more informations.

Some little improvements has been done to became the design note as a real PCB design.

As claimed by the original author, the THD level reached by the oscillator surpass all measurements equipments available from now. THD measurement is only possible using techniques to remove fundamental and then amplifying THD products for further FFT measurements.

So, the THD level has been measured with my own set-up* to be less than -136 dBc (H2). All others harmonics are much below and flooded in the noise floor ($V_{out} = 0 \text{ dBV} = 1 \text{ V}_{rms}$). Extended measurements made using Audio Precision SYS2722 (thanks to Samuel Groner) has confirmed these THD levels. (see chapter 5 for details).

(* : My measurement sertura is made with 10kHz passive notch filter with 40dB post gain, EADCAKMv1 AK5394A based ADC (from me) with 192kHz S/PDIF output and ESI juli@ PCI soundcard with 192kHz SPDIF input).

2) Operating outputs frequencies.

In the AN67 app note, the oscillator is made to operate at a frequency of 10 kHz. The choice of this frequency is very relevant because non-linearity of modern audio equipment are very low and so using 10kHz (instead of 1kHz often used as test frequency) ensure to reveal THD even for high-end equipments.

Nevertheless, the EOSC10KV3 can operate at others frequencies than 10kHz, as 1kHz for example. I built myself a 1kHz version of the oscillator, and checked with success same or better THD level than the 10kHz version.

In addition, i provide with the EOSC10KV3 design folder a full bill of material for each 1kHz and 10kHz oscillator version. There is only minors values change between us.

Of course operation at others frequencies are possible but not far above 10kHz, because loop gain will decrease and THD will rise.

3) Instrument operation.

1) power supply requirements.

The EOSC10KV3 need only an external power supply to operate. For optimal performance, low noise linear PSU is recommended (for example SSR01/SSR02 combo). Using batteries is also possible (4 x 6F22 9V batteries for +/-18V operation). Note that current consumption is about +/- 80mA, so batteries life time will not be high.

The EOSC10KV3 PCB have two internal voltage regulators options, and they have both their own limitations :

The low noise regulators LT1761/LT1964 (default BOM values).

→ Maximum input voltage must never excess +/-20VDC !

If this voltage is exceeded regulators will be damaged.

The standard adjustable regulators LM317/LM337 (less expensive regulators)

→ Maximum input voltage must never excess 20VDC or 32VDC if inputs capacitors of regulators (C50/C54 and C44/C45) are replaced by higher voltage rating.

(Regulators accept 32Vmax but inputs caps are 20V).

IMPORTANT NOTE :

In my design, input supply connector is a 3,5 stereo jack. The advantage is that you can use low cost standard jack cable where you cut one side to connect wires to your own supply.

Care must be taken because +/-15V on the male jack connector will be shorted during insertion inside the female connector ! You must avoid to insert the connector if you power supply is on, otherwise you risk to destroy the power supply if it is not short-circuit protected !

2) Using outputs

After a complete adjustment (see chapter 4), the oscillator can be used. The EOSC10KV3 provide two single-ended outputs .

Each of these outputs deliver same output voltage, but in opposite phase (180° shift).

This allow to get single ended signal using only one output, or differential one when using both and taking only "hot" signal of each outputs. Note that in differential mode the output voltage will be twice.

For convenience, the amplitude control trimmer has been put on the front panel to allow easiest control. The single-ended outputs amplitude can be adjusted using this trimmer between about 500mV to 3Vrms (1V to 6Vrms in differential mode).

3) Rear “H2 trim” output.

The “H2 trim” output is dedicated to set H2 to minimum value by using the RV1 trimmer. This trimming is not mandatory. Practical tests show very low sensitivity on H2 level to the trimming.

4) First power-up tests.

To avoid parts failure at start-up, it is important to make some tests to and verify that nothing is wrong. The first thing to do is to make a complete visual soldering inspection ! Check all polarized components (diodes, capacitors and of course IC !).

If not already done, clean meticulously the PCB to remove any soldering flux trace.

→ Note that flux trace can corrupt the oscillator to working.

Turn fully clockwise the trimmer RV3 (Gain) to disable oscillator.

Then, take a current limited variable power supply. Set the current limit to $\pm 100\text{mA}$ and the output voltage to 0V. Connect it to EOSC10KV3 and switch it ON.

(It is preferable that you could read current on both rails of the power supply when powering)

Now, increase slowly the symmetric voltage and verify that input current doesn't rise up more than few tenth of mA. You must also see the front Led becoming luminous.

Stop increasing the voltage when you arrive to $\pm 14\text{V}$, and verify that you have +12,4V on C49 and -12,4V on C51. (If you have used LM317/337 regulators, you must stop at $\pm 15\text{V}$).

The current consumption on each rail must be around + 60 mA(+14V) and – 60 mA (-14V).

Connect now one output to an oscilloscope.

Start to turn counter-clockwise RV3 (Gain) slowly until you look the oscillation appear an the output. Do not be surprised if the output change fast and clip to rail voltage !

Verify that you have the right oscillator frequency and also no high frequency (MHz) oscillation. (If you note HF oscillations, you may need to clean again the PCB).

Then now, go to next chapter (4) for complete adjustment procedure.

5) Adjustment procedure.

First, verify that RV1 is at middle position (It's H2 trim). Then :

Connect one output to a real time spectrum analyser (sound-card and FFT analysis software like Arta), or to an oscilloscope (you need to show amplitude change, choose fast FFT view with low bin count).

Turn RV3 slowly counter-clockwise until the amplitude start to increase.
As soon you see something on spectrum, let it increase to it's final value.

If the gain is sufficient , you must clearly see the low frequency damping loop with output voltage converging to it's final value (That can take some time).

If not, continue to turn RV3 very slowly counter-clockwise to add a little more loop gain.

After the oscillator start to oscillate WITHOUT saturate (excessive loop gain), verify that you can change the output amplitude using RV2 on the front panel.

If yes, you have closed the control loop right !

So now, with RV2 (at front) set the output level to desired value .

Then, verify by powering on,off and on again if the unit start OK again and reach the previous setted output. If the oscillator do not restart, you need to increase a little the gain again.

OPTIONAL and only if you can read H2 level with accurate setup :

I noted that H2 level could be reduced using lowest loop gain of RV3.

So, you could try after to turn very slowly RV3 clockwise to reduce gain and see if it affect H2 level (while maintaining output level of course).

SUMMARY OF IMPORTANT POINTS TO REMEMBER :

This is RV3 that control global gain loop (to start the oscillator), but NOT control the output amplitude. If control loop gain is too big, the output saturate, if too low there is nothing on output.

Is there a short range where the oscillator work, with output settling to the adjusted amplitude (with RV2).

After the oscillator start to oscillate WITHOUT saturate (excessive loop gain), then we use RV2 on the front panel to set the output level to desired value.

NOTE :

Because of the very narrow adjustment gain band to make the oscillator working stable, it is possible after a correct adjustment to have the oscillator not working properly after some time of no use or when temperature gradient occur. Note that the operating voltage can also affect stability, it is recommended to always supply the oscillator with same input voltage.

If this problem occur, it can be necessary to repeat the adjustment procedure.

If the oscillator work properly, you must have output voltage corresponding to your previous setting.

That's all !

6) Technical specifications.

1) General parameters

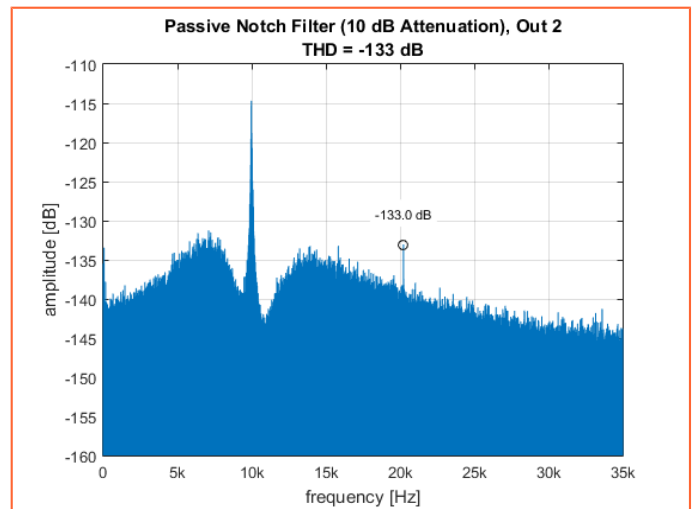
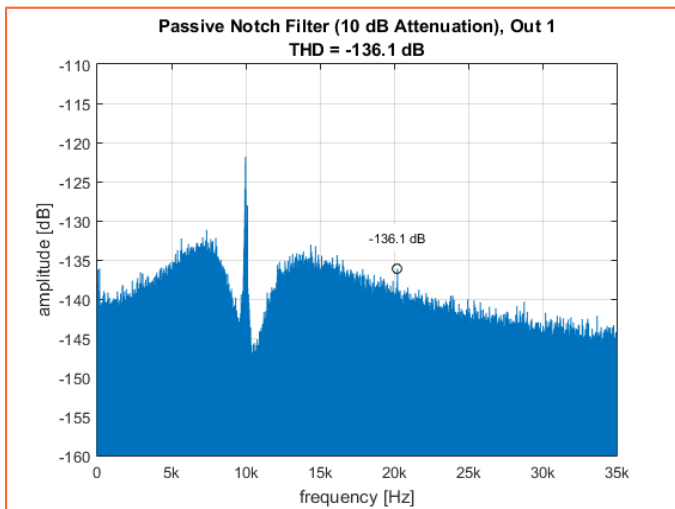
Parameter	Min	Typ	Max	Unit
Power supply voltage range	13*	15	20**	Vdc
Current consumption (outputs unloaded).		60		mA
Output amplitude adjustment range (single ended)	0,5	-	4	Vrms
Output amplitude adjustment range (differential)	1	-	4	Vrms
Total harmonics distortion (Vo= 1 Vrms). Rload= 10 KOhms		< -130 0,000016		dBV %

* : Only for LT1761/LT1964 regulators, otherwise 14,5V min.

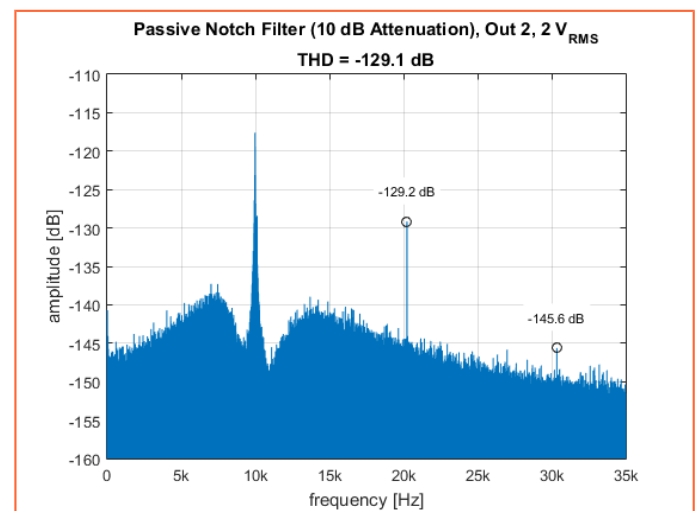
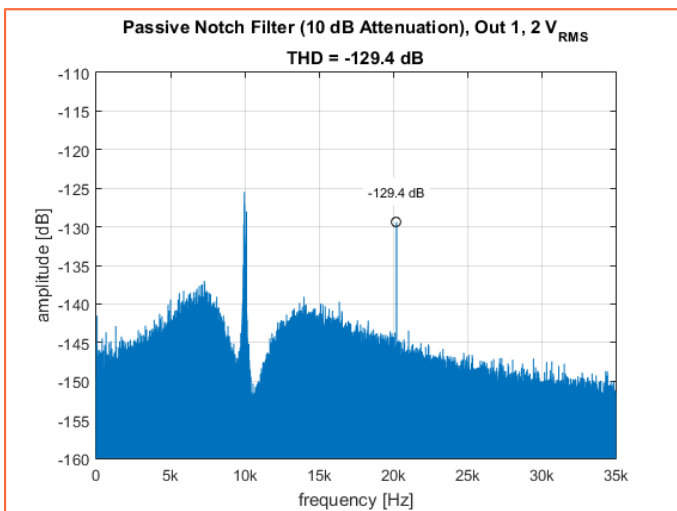
** : See chapter 2.1 "Powering it".

2) THD figures @ 10kHz with SYS2722 using high depth notch filter)

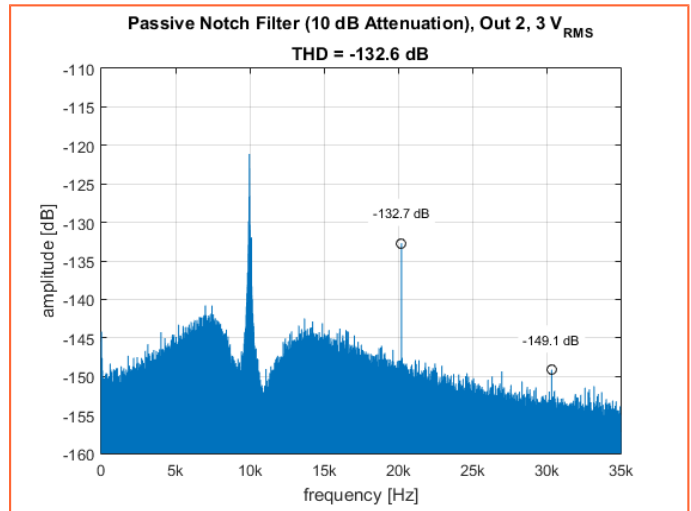
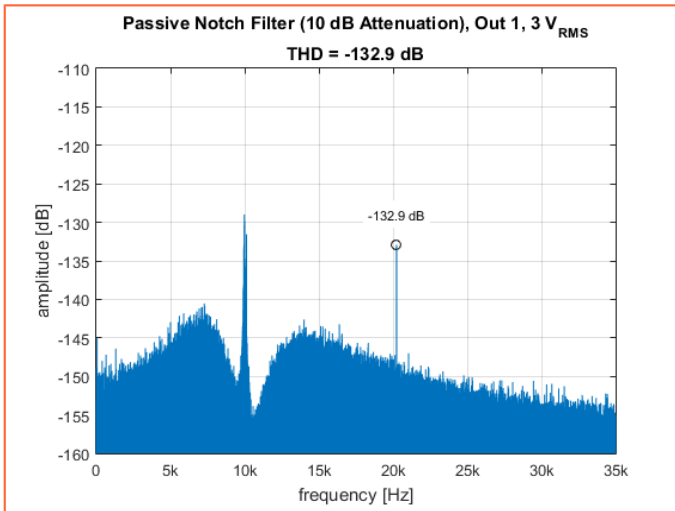
1) THD @ Vout = 1 Vrms (0 dBV / 2,8 Vpp), OUT1 and OUT2



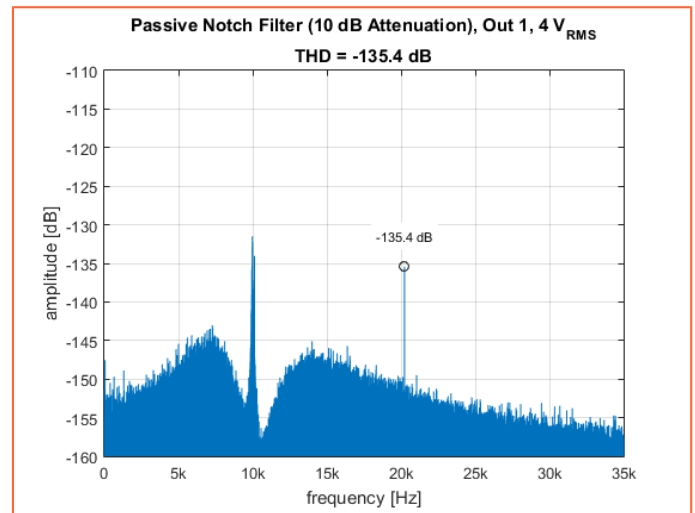
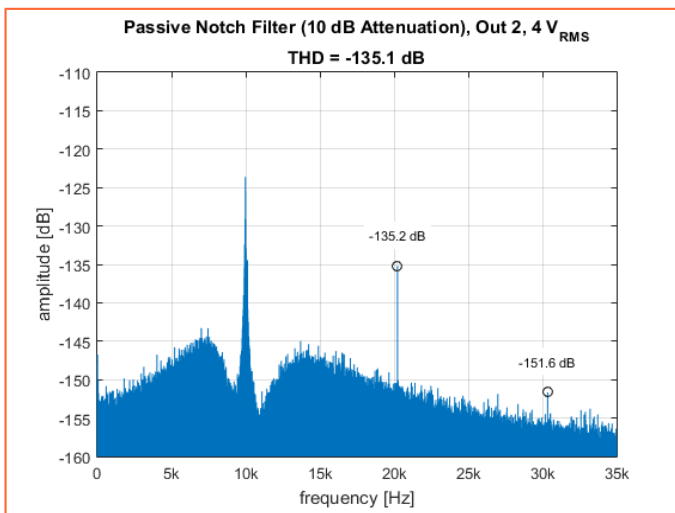
2) THD @ Vout = 2 Vrms (+6 dBV / 5,7 Vpp), OUT1 and OUT2



3) THD @ $V_{out} = 3 V_{rms}$ (+9,5 dBV / 8,5 Vpp), OUT1 and OUT2



4) THD @ $V_{out} = 4 V_{rms}$ (+12 dBV / 11,3V pp), OUT1 and OUT2

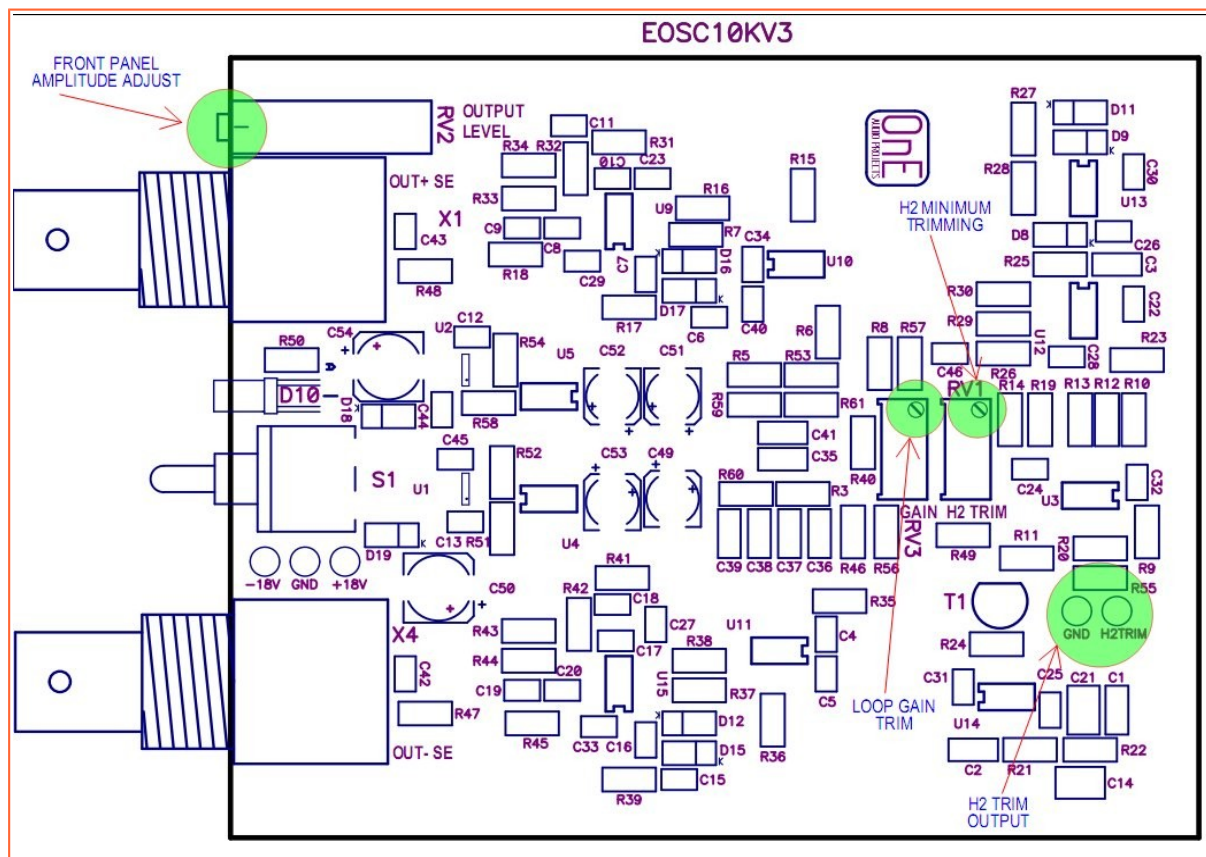


Note:

THD level measured by connecting directly oscillator to the Audio-Precision SYS-2722 input give same level as the residual THD of the analyser. So, for this reason a 10 kHz passive notch-filter is added between the EOSC10KV3 and the analyser input to avoid THD coming from the analyser itself.

The notch-filter attenuation at the harmonics frequencies is taken into account in measurements by the SYS2722 to show a real amplitude of harmonics (all FFT plots above). (Many thanks to Samuel Groner for all these measurements and his patience !).

3) Circuit board adjustment trimmers placement.



END OF MANUAL

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

Others OnE Audio Designs :

- ★ **ERMSDCV2**, DC-1MHz RMS voltmeter & 80dB 10Hz-100kHz Ultra low noise amplifier.
- ★ **EOSC10KV3**, ultra low THD 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.