Concept, design and key test results of ultraprecise quartz oscillator meeting tight timekeeping requirements of 5G equipment. Further development

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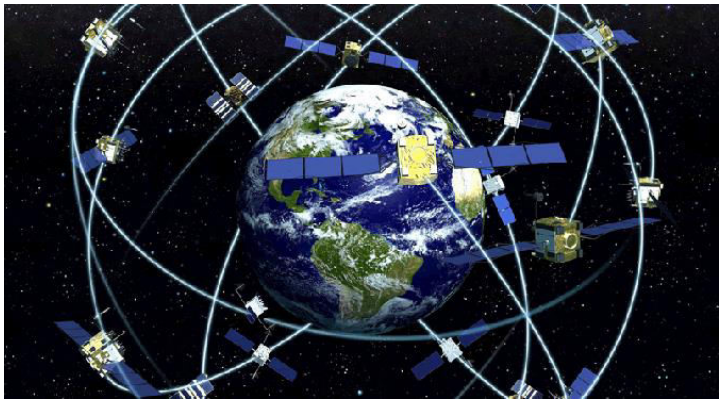
5G

Holdover 1–1.5µs over 24 hrs

ULTRA STABLE OSCILLATOR

OCXO or Rb?

10 MHz DOCXO



DOCXO

Strict requirements:

- Temperature stability
- Long-term stability (incl. “learning ability” for instability compensation, very low change rate)

Temperature stability

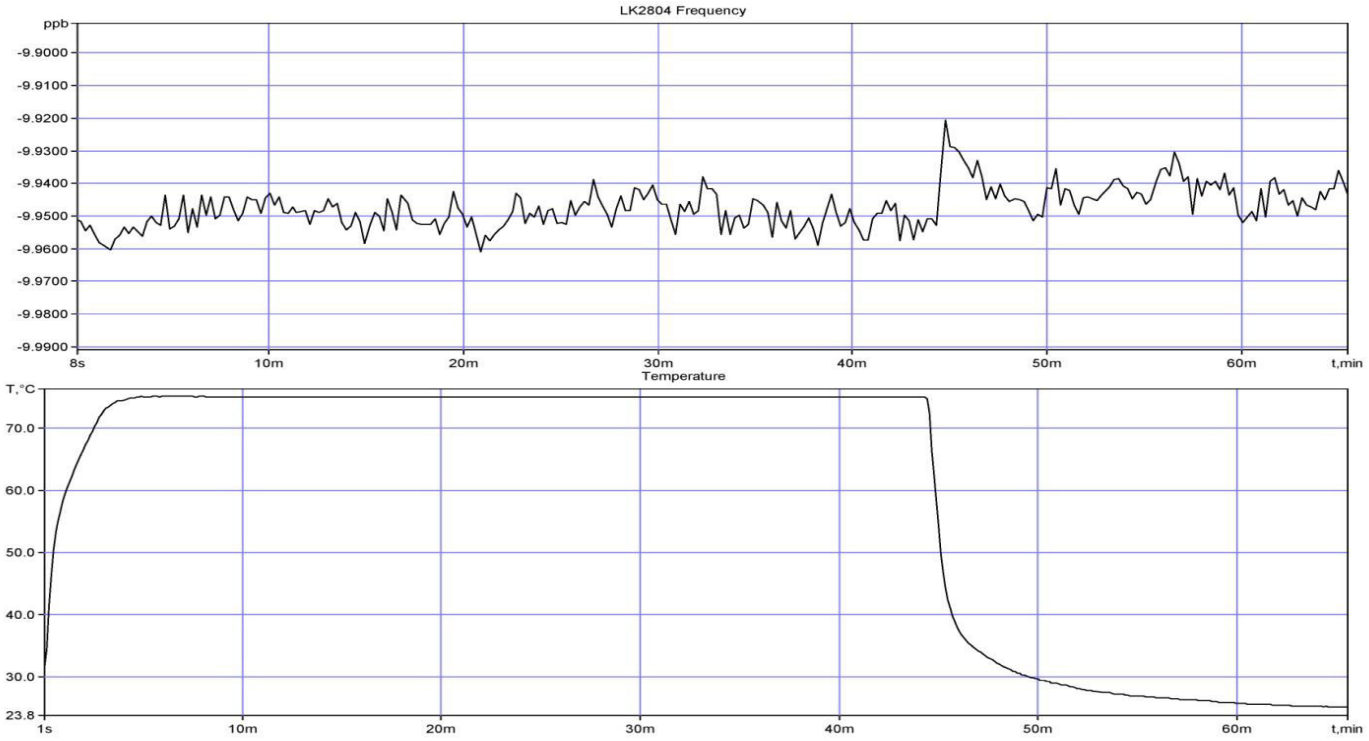
- Design of internal stage of ovenizing
- Precise reference voltage
- Precise temperature of internal stage
- Low load sensitivity

Old and new design of DOCXO

Parameter	Old design		New design MV360	New ultra low noisy design MV336
	MV180	MV89		
Dimensions, mm	51.0*51.0*19.0	51.0*51.0*38.0	51.0*51.0*19.0	92.0*80.0*50.0
Volume, cm^3	49.5	98.8	49.5	368
Supply voltage, V	12.0 or 5.0	12.0	12.0 or 5.0	12.0
Frequency stability vs. operating temperature	-40…+70 °C <±2E-10	-40…+70 °C <±1E-10	-40…+75 °C <±1E-11	-10…+60 °C <±2E-11
Frequency stability vs. -40…+85 °C	Not available	Not available	<±1E-11 (only for 5 V)	Not available
Short-term stability (Allan Deviation) per 1 s	<2E-12	<2E-12	<2E-12	<1E-13

Thermal shock

Temperature changes for about 40°C in 2 minutes



Very small overshoot;
Very small undershoot.

Long-term stability
Crystal

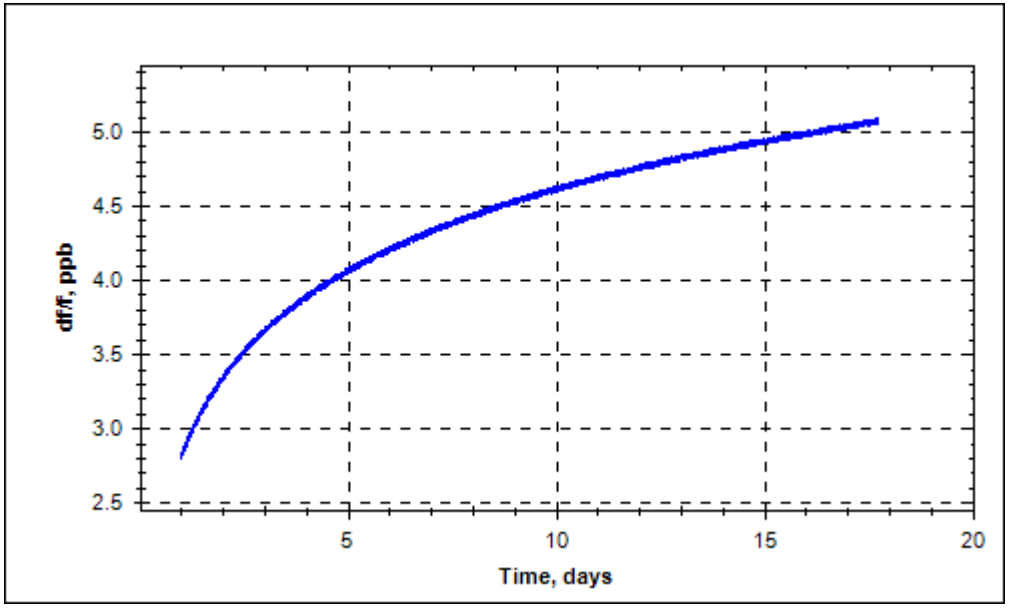
- ISO 6 class clean room
- High quality quartz
- Well established manufacturing processes
- “intensive aging“

Long-term stability
Change rate

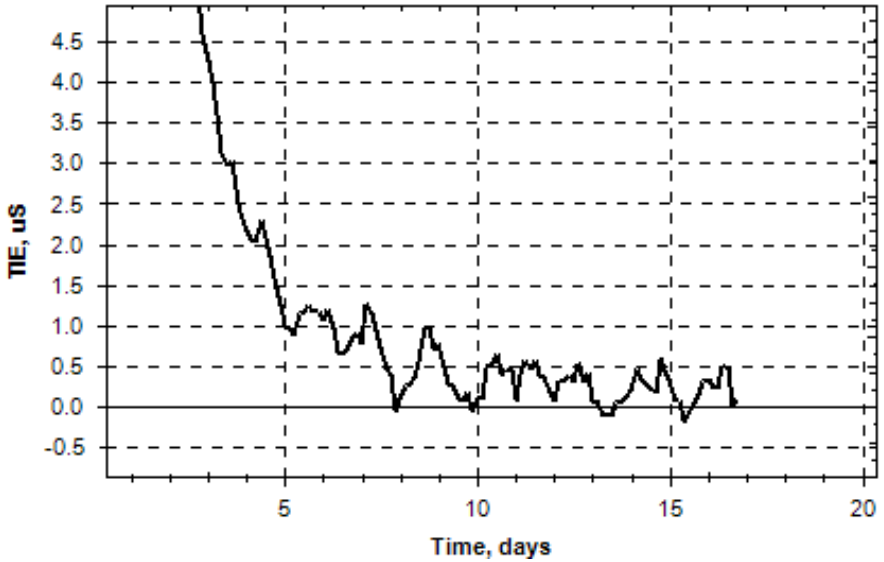
Learning systems

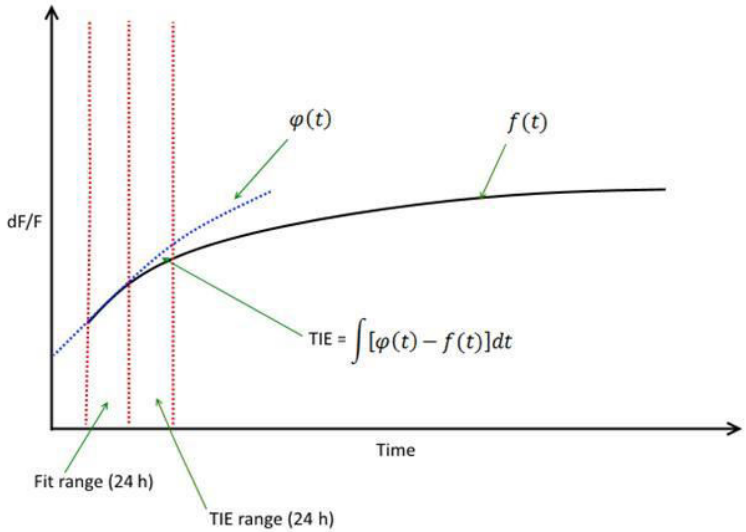
- Compensate long-term stability in holdover mode
- Very low change rate should be ≤1..2E-11/day

Long-term stability Monitoring. Stations



Long-term stability Monitoring





The «sliding» time window lasting 24 hrs and moving with 3 hrs step is applied to the data of long-term frequency stability .

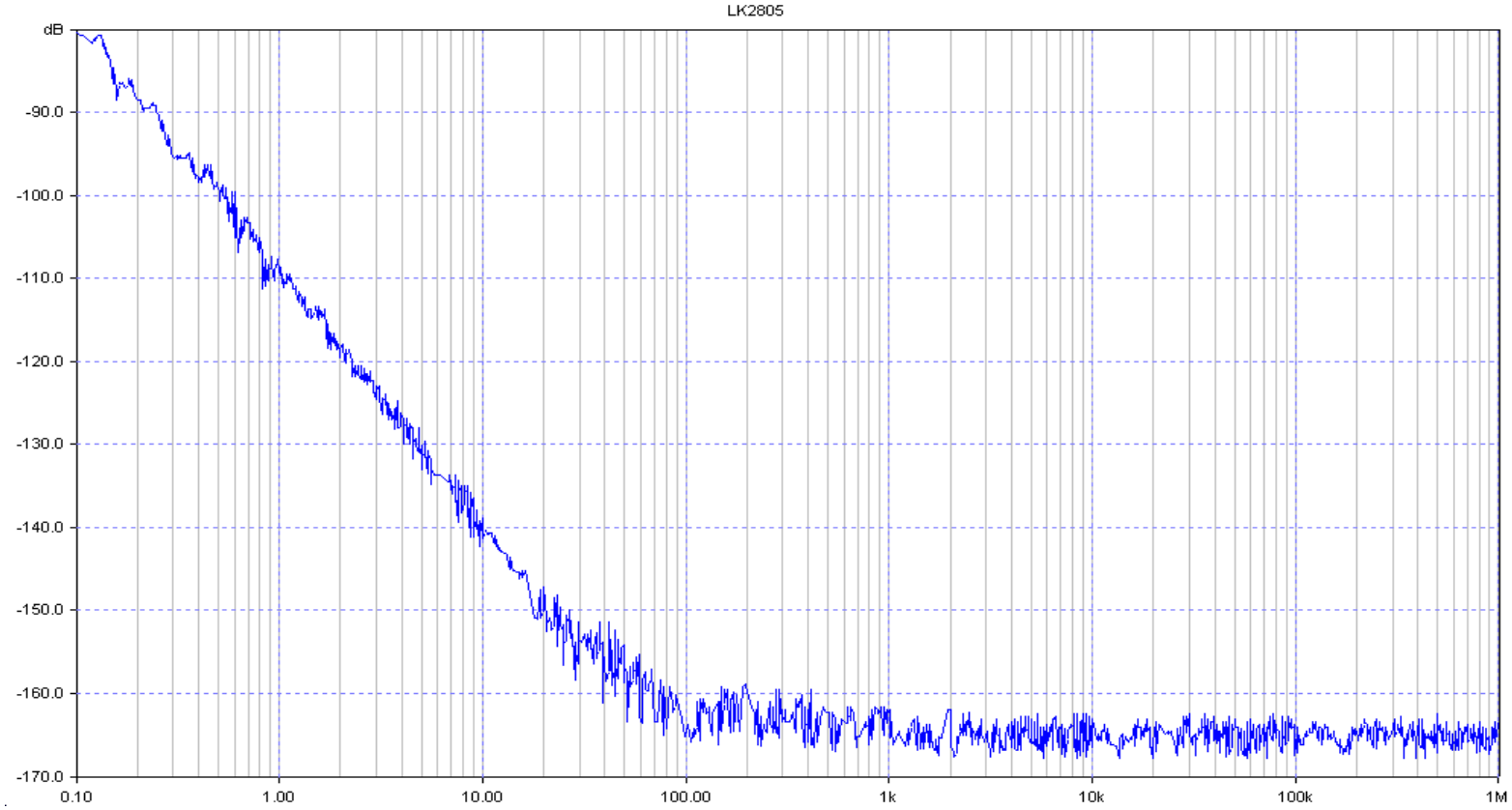
On each step based on readings situated inside of subject window (Fit Range) the approximation is being built.

For the determination of subject time error, the readings situated inside of the next window are being used (TIE range).

Certain metric for analysis of OCXO's timekeeping capability has been worked out like a "Time Uncertainity" metric.

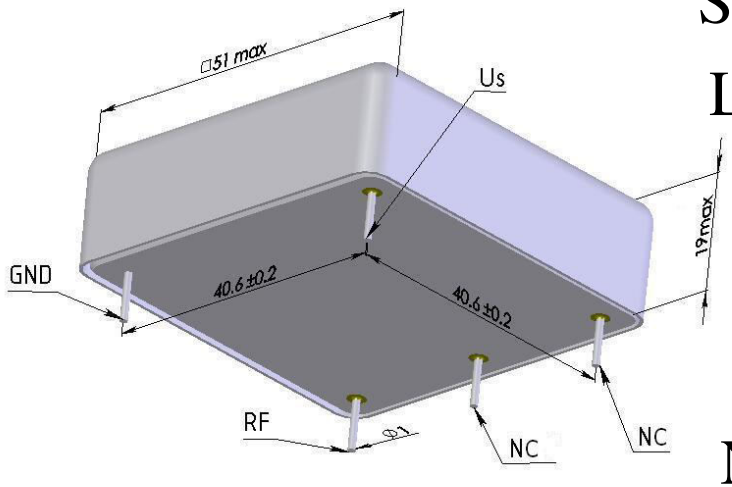
Typical phase noise of MV360

10 MHz



MV360

Dimensions and key parameters



Stability vs temperature : up to $\pm 1 \cdot 10^{-11}$

Long-term stability: up to $\pm 1 \cdot 10^{-8}$/year

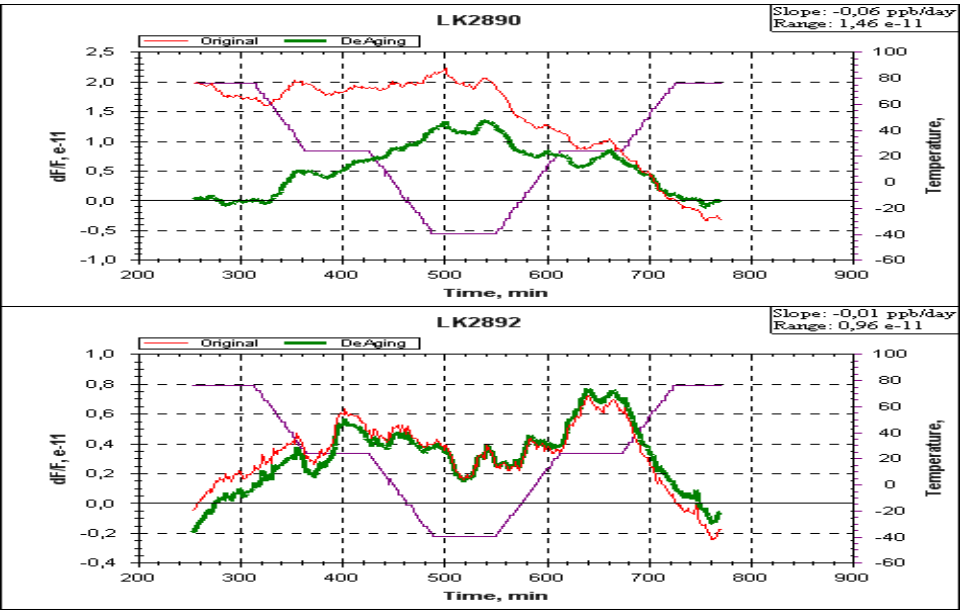
Power supply: 5 or 12 V

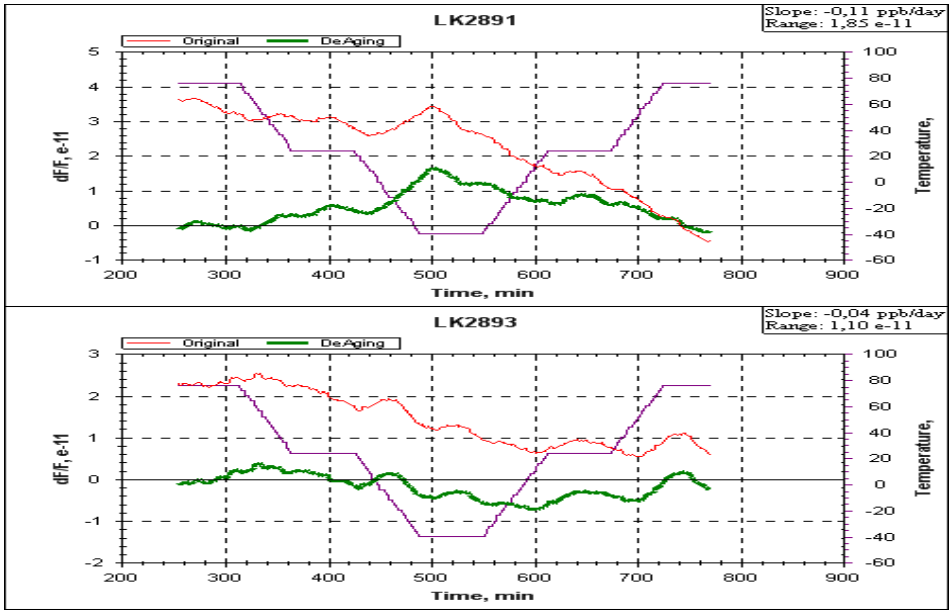
Package size: 51*51*19 mm

N.B. : version with EFC in final stage

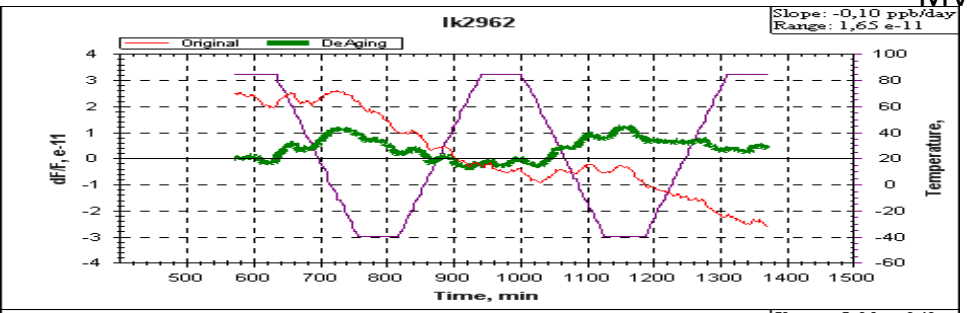
Test results. Frequency stability vs. temperature

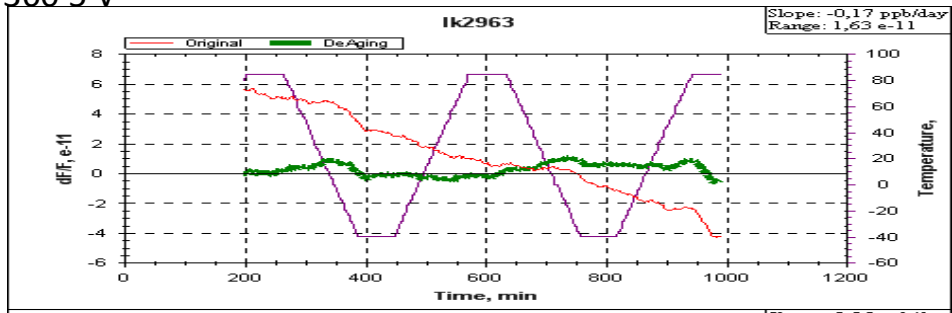
MV360 12 V

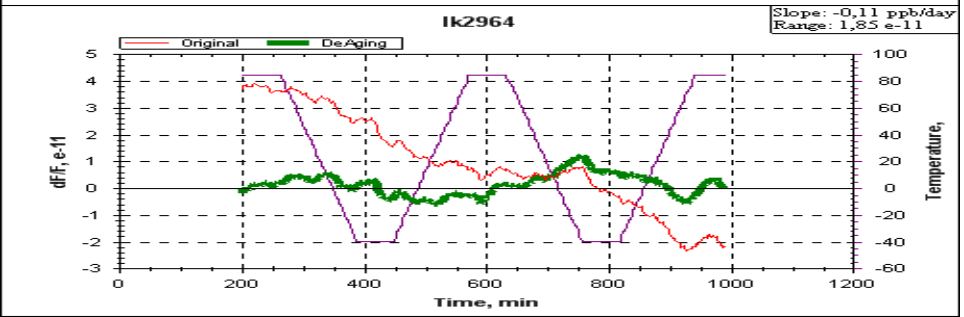


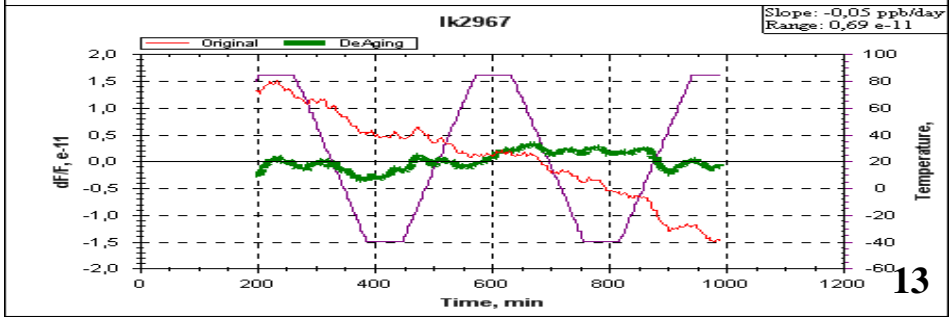


MV360 5 V

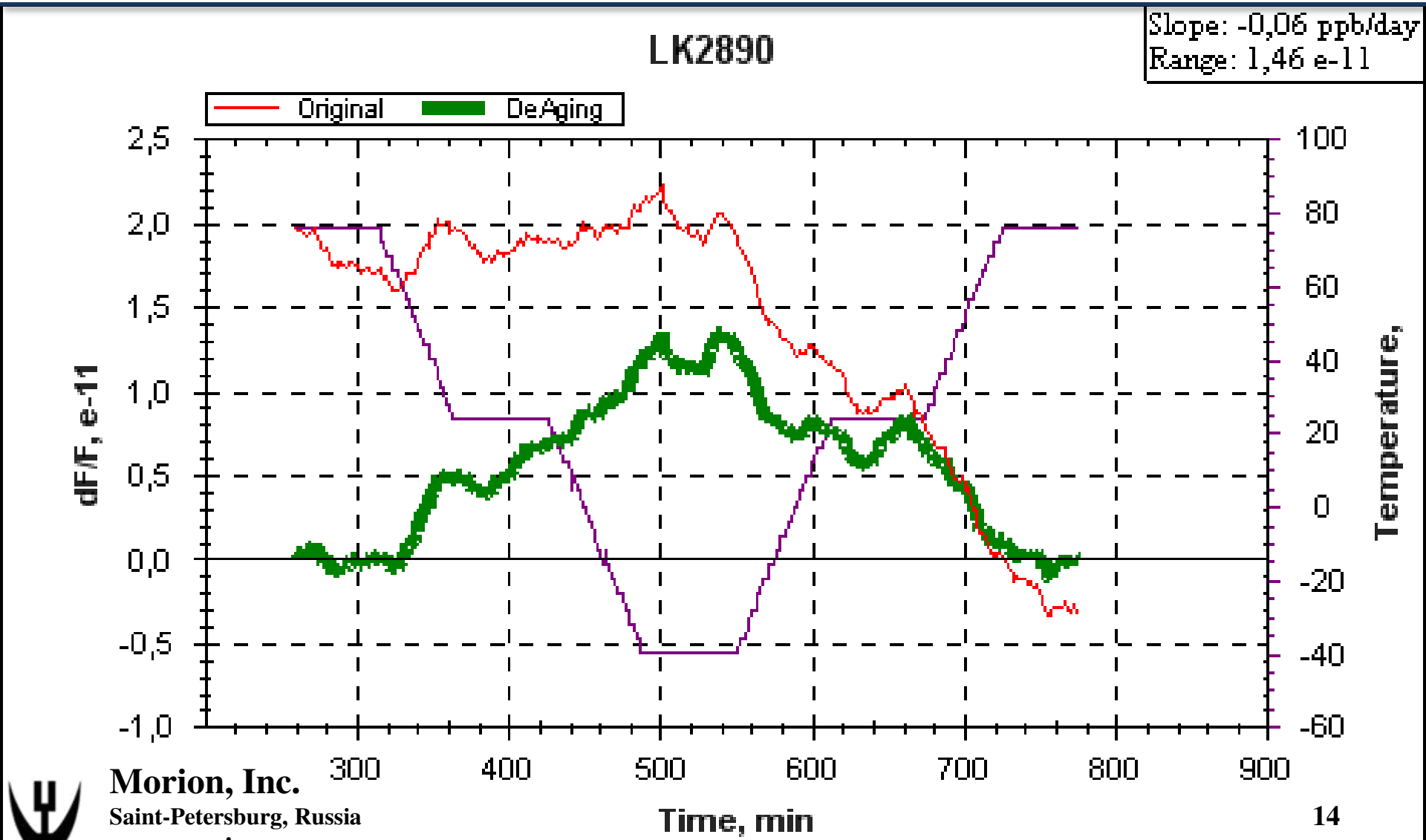




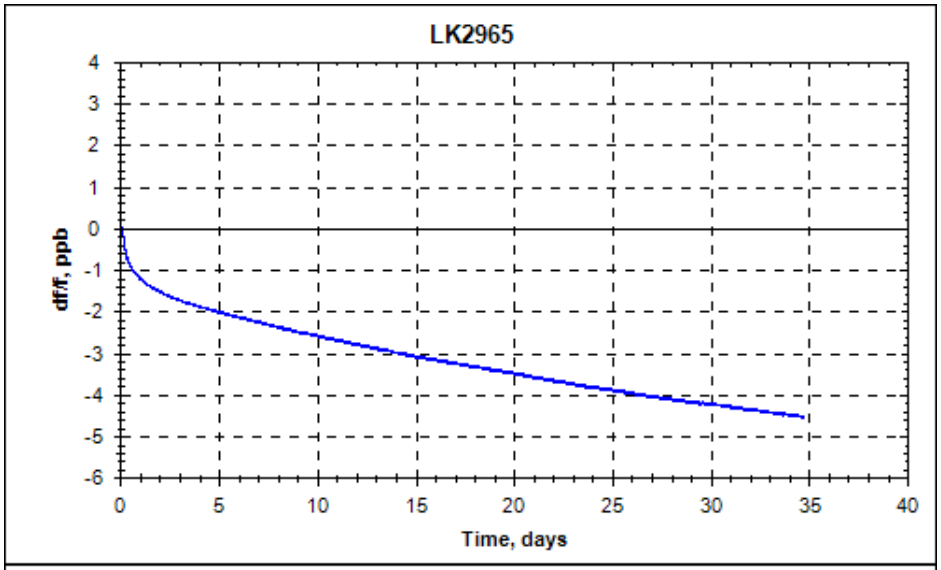


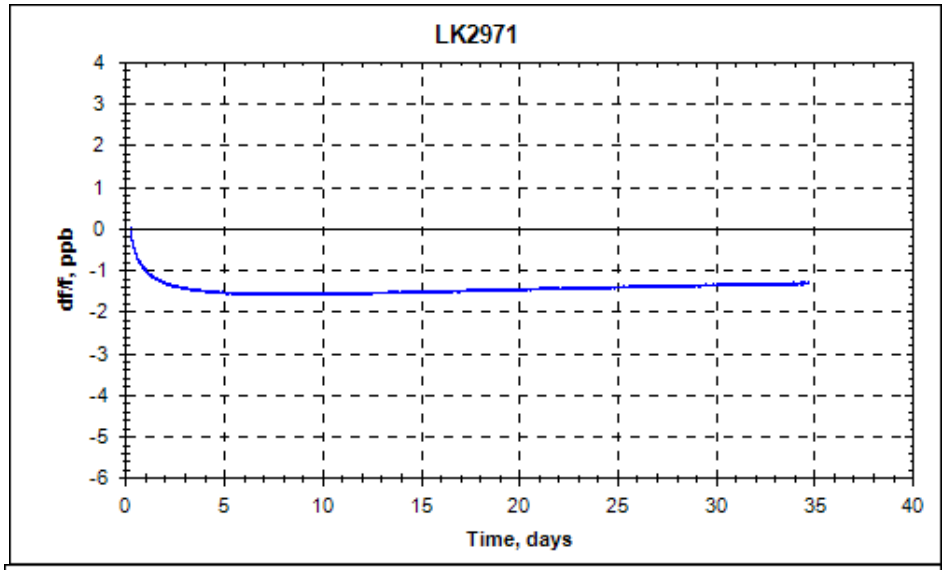


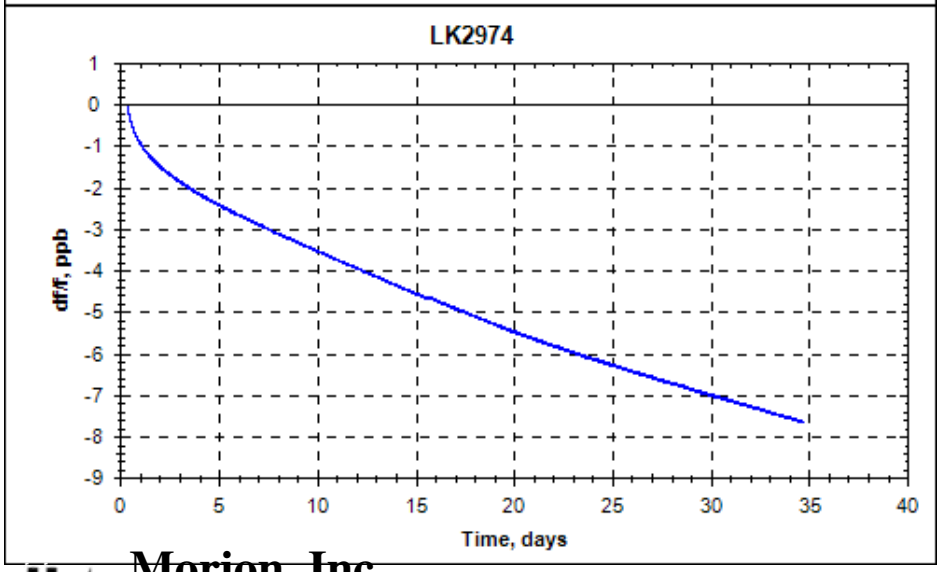
Typical frequency stability vs. temperature of MV360

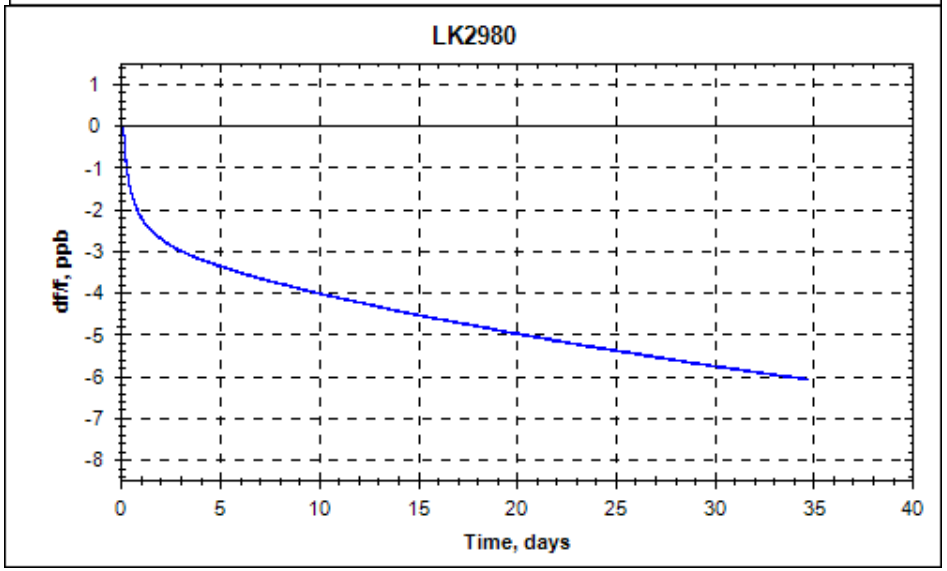


Test results
MV360 Long-term stability

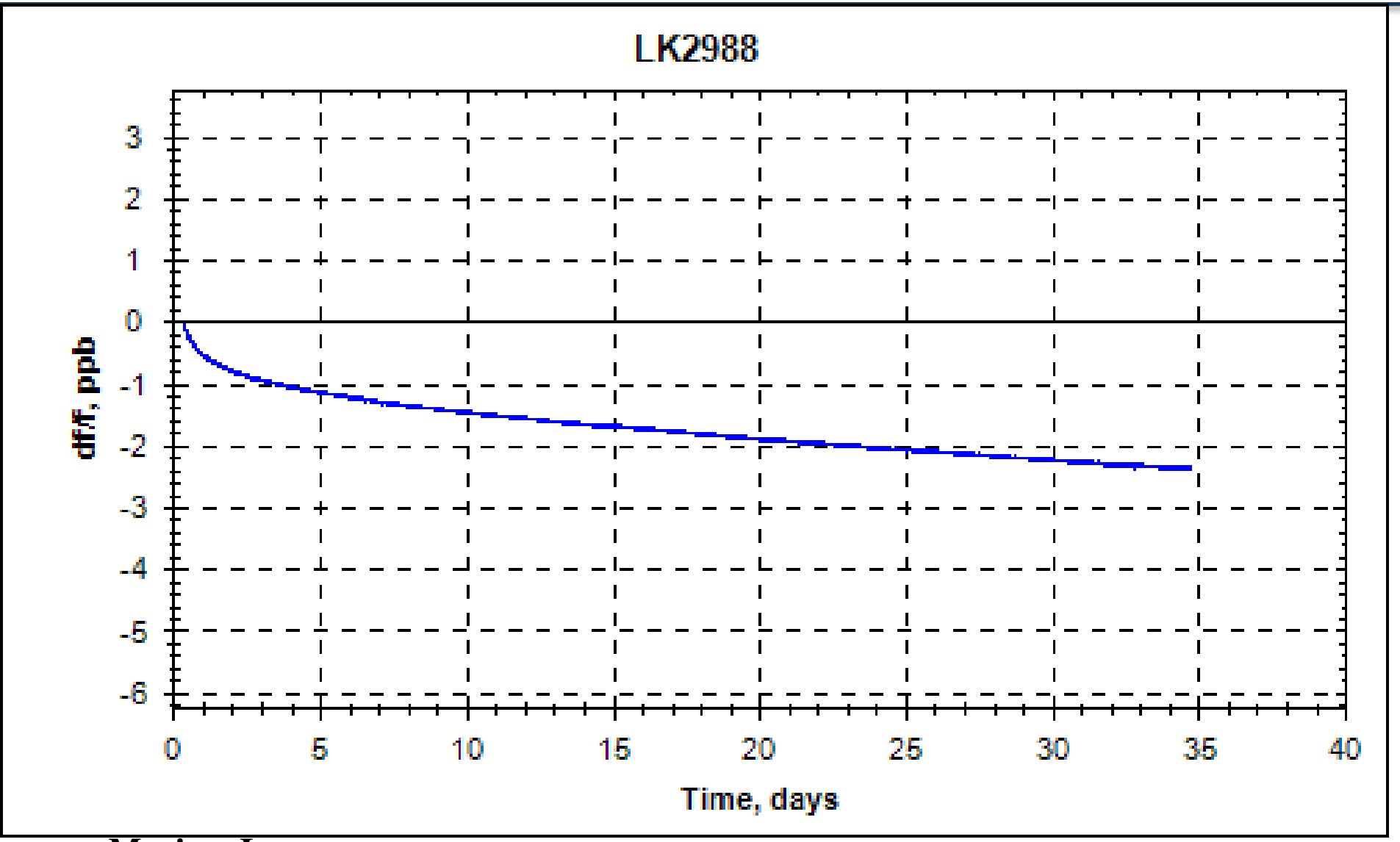




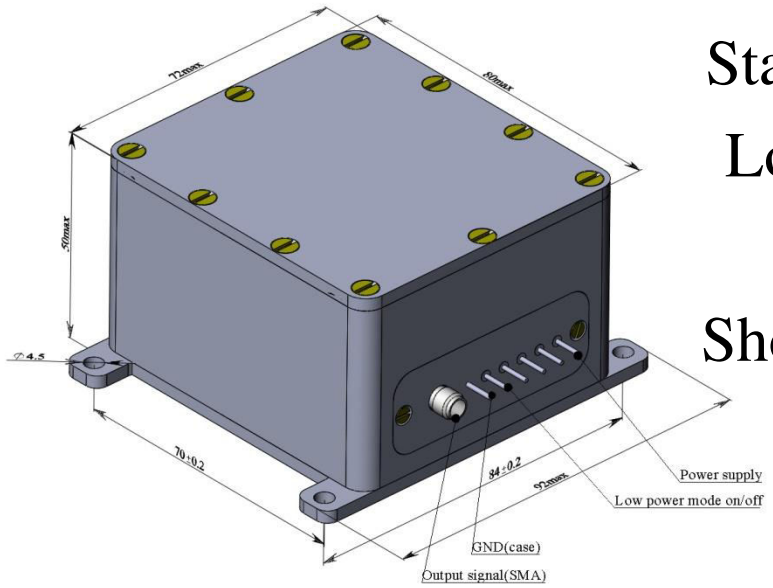




Typical
Long-term stability of MV360



Ultra low noisy DOCXO MV336
Dimensions and key parameters



Stability vs. temperature : up to $\pm 2 \cdot 10^{-11}$

Long-term stability: up to $\pm 1 \cdot 10^{-8}$/year

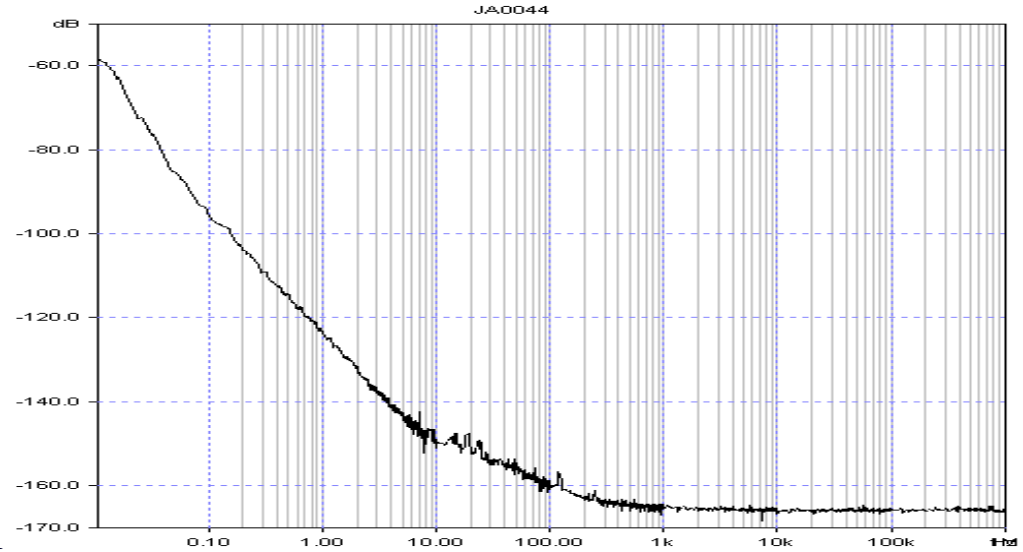
Power supply: 12 V

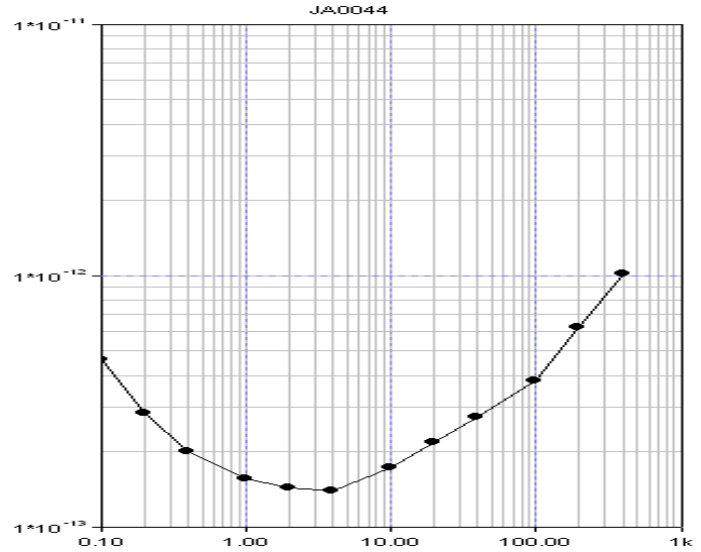
Short-term stability per 1 s: up to $1 \cdot 10^{-13}$

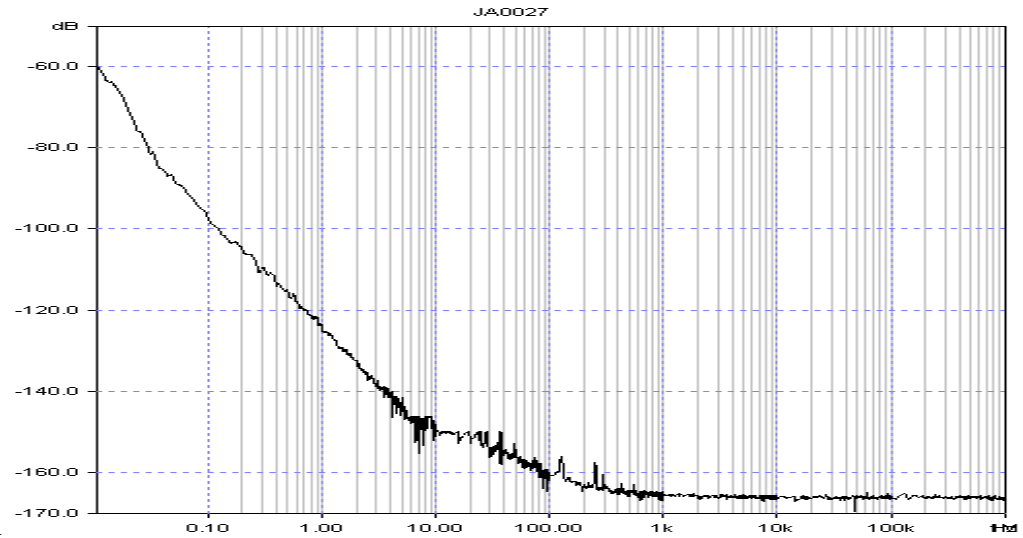
Package size: 92*80*50 mm

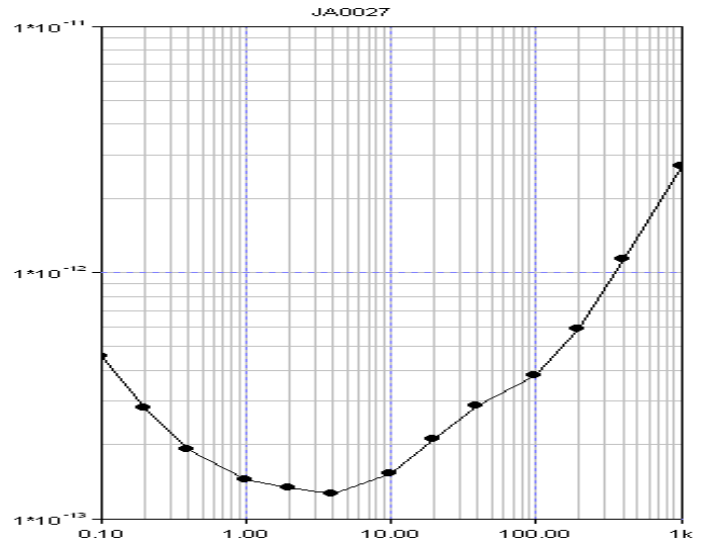
N.B. : version with EFC in final stage

Test results
MV336
Phase noise and short-term stability

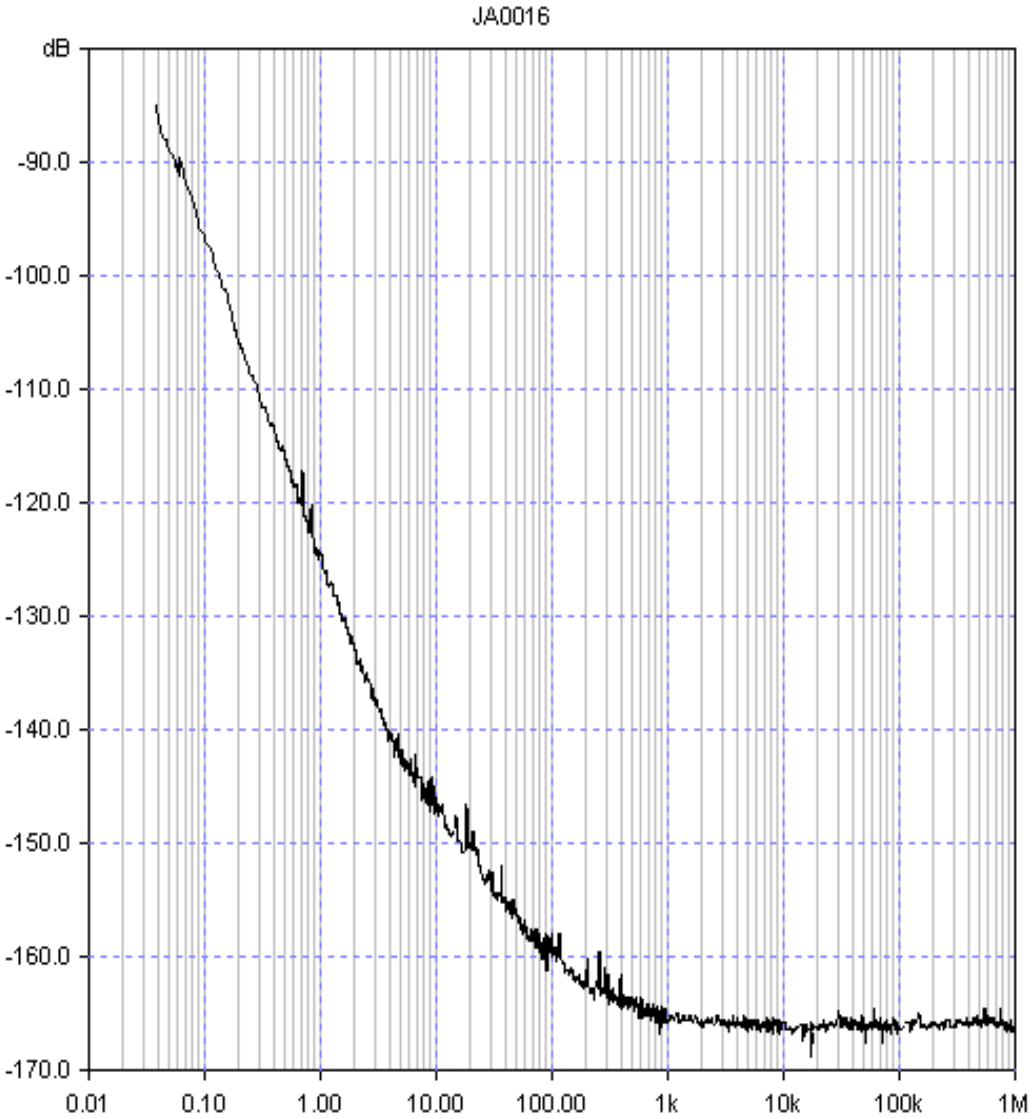


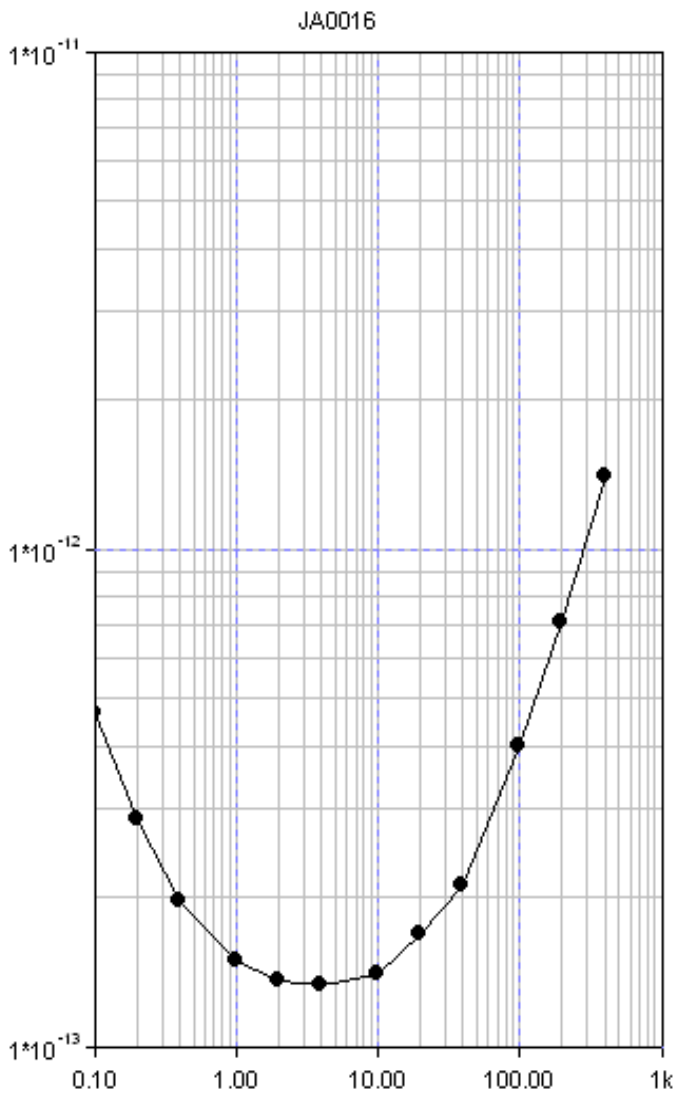






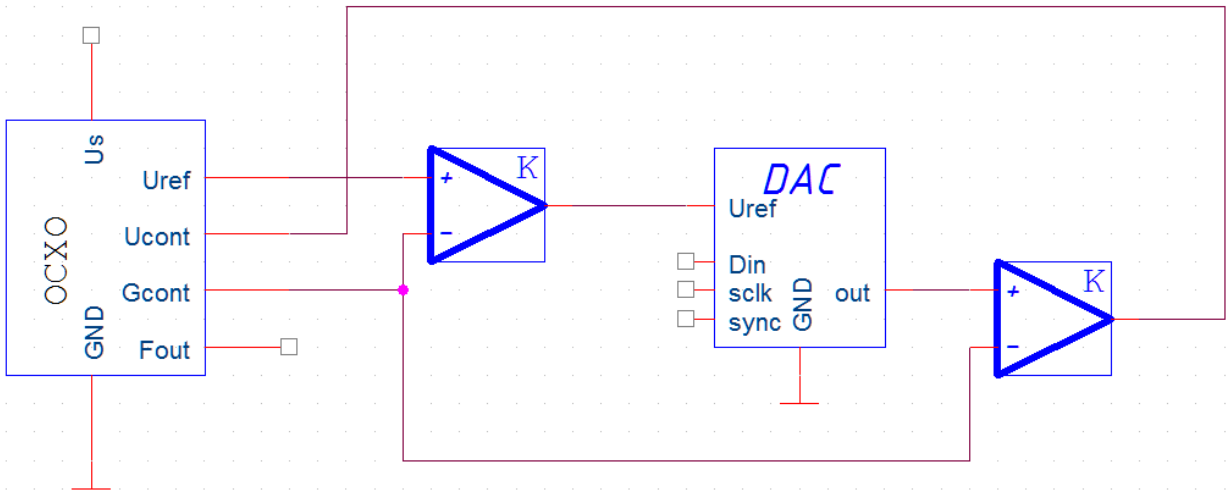
MV336
Typical phase noise and short-term stability





What's Next?

Implementation of electrical frequency control and widening of applications:



Thanks for your attention!

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