

# **Design and test results for frequency controlled DOCXO for 5G equipment.**

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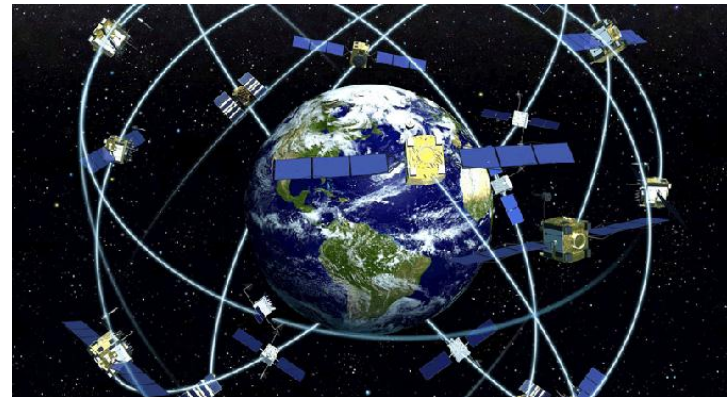
# 5G

Holdover 1–1.5 $\mu$ s over 24 hrs

ULTRA STABLE OSCILLATOR

OCXO or Rb?

10 MHz DOCXO



# DOCXO

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## Strict requirements:

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

# 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 <sup>3</sup>	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



# Long-term stability

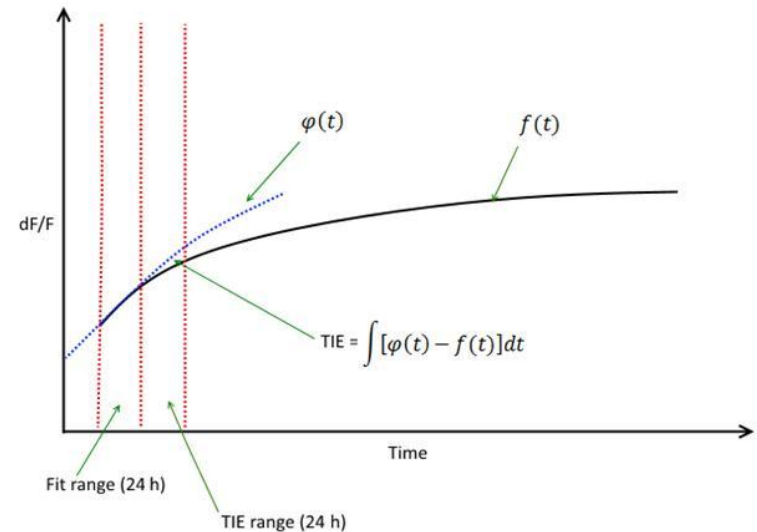
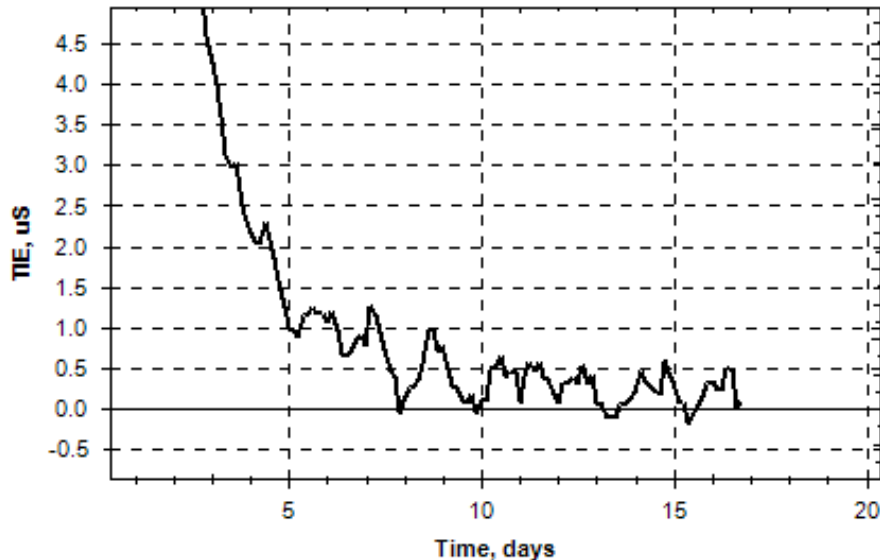
## Change rate

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### Learning systems

- Compensate long-term stability in holdover mode
- Very low change rate should be  $\leq 1..2E-11/\text{day}$

# 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.

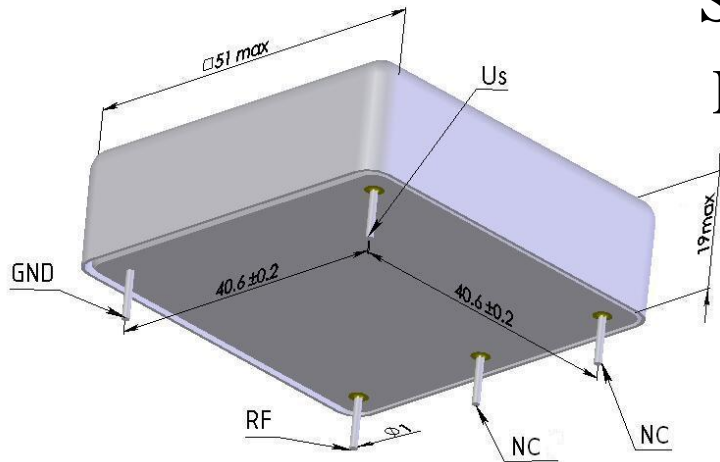
For the determination of subject time error, the readings situated inside of the next window are being used (TIE range).

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



# MV360

## Dimensions and key parameters



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

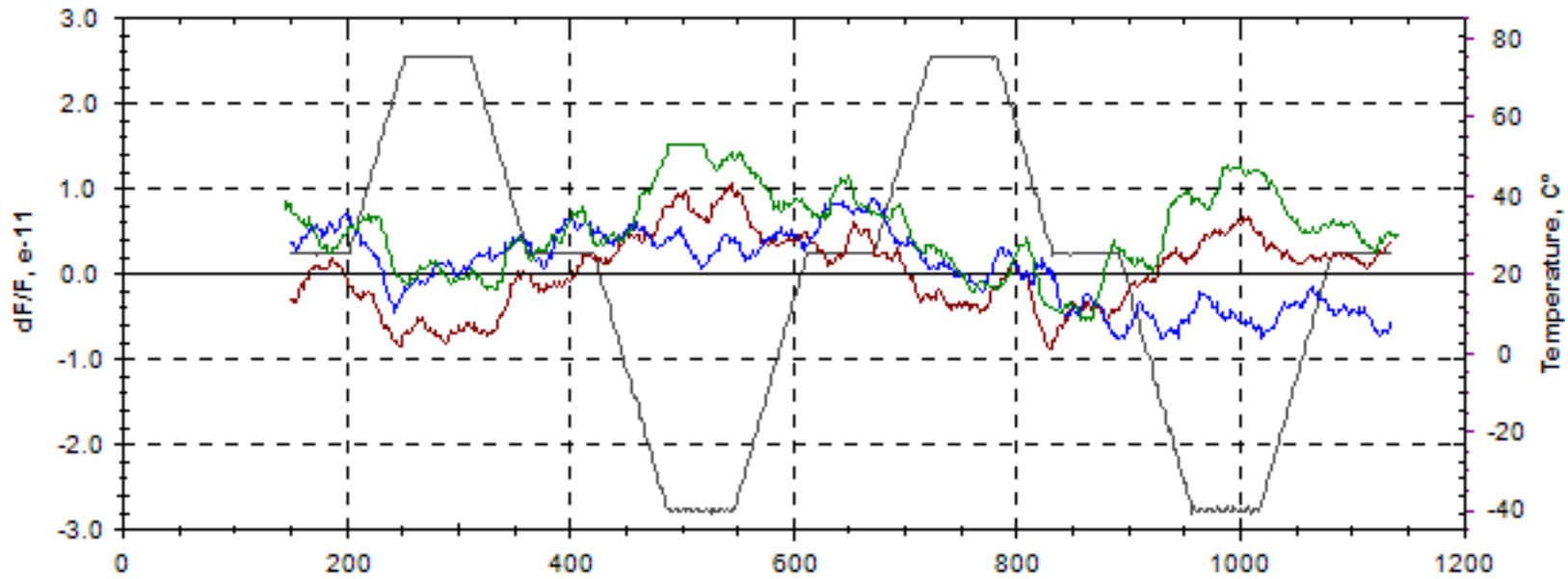
Long-term stability: up to  $\pm 1 \cdot 10^{-8}$ /year

Power supply: 5 or 12 V

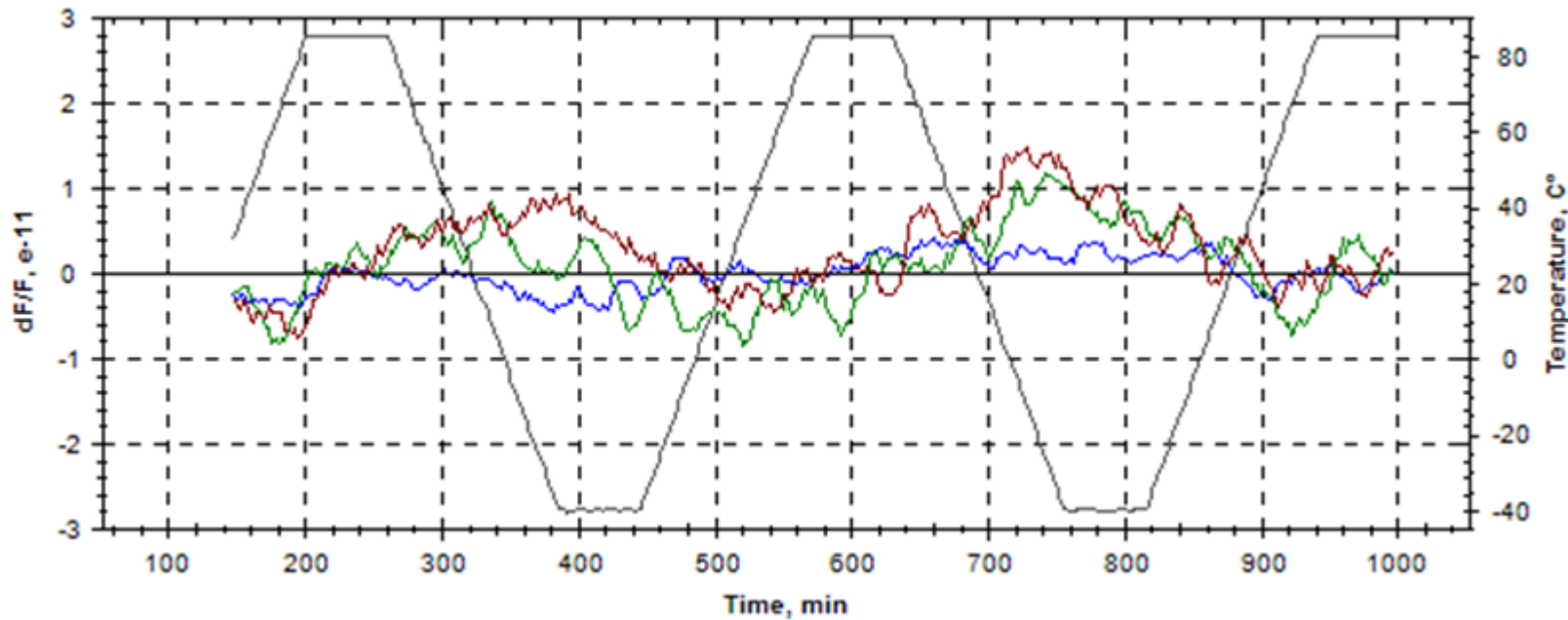
Package size: 51\*51\*19 mm



# Test results. MV360 Frequency stability vs. temperature



MV360  
12V

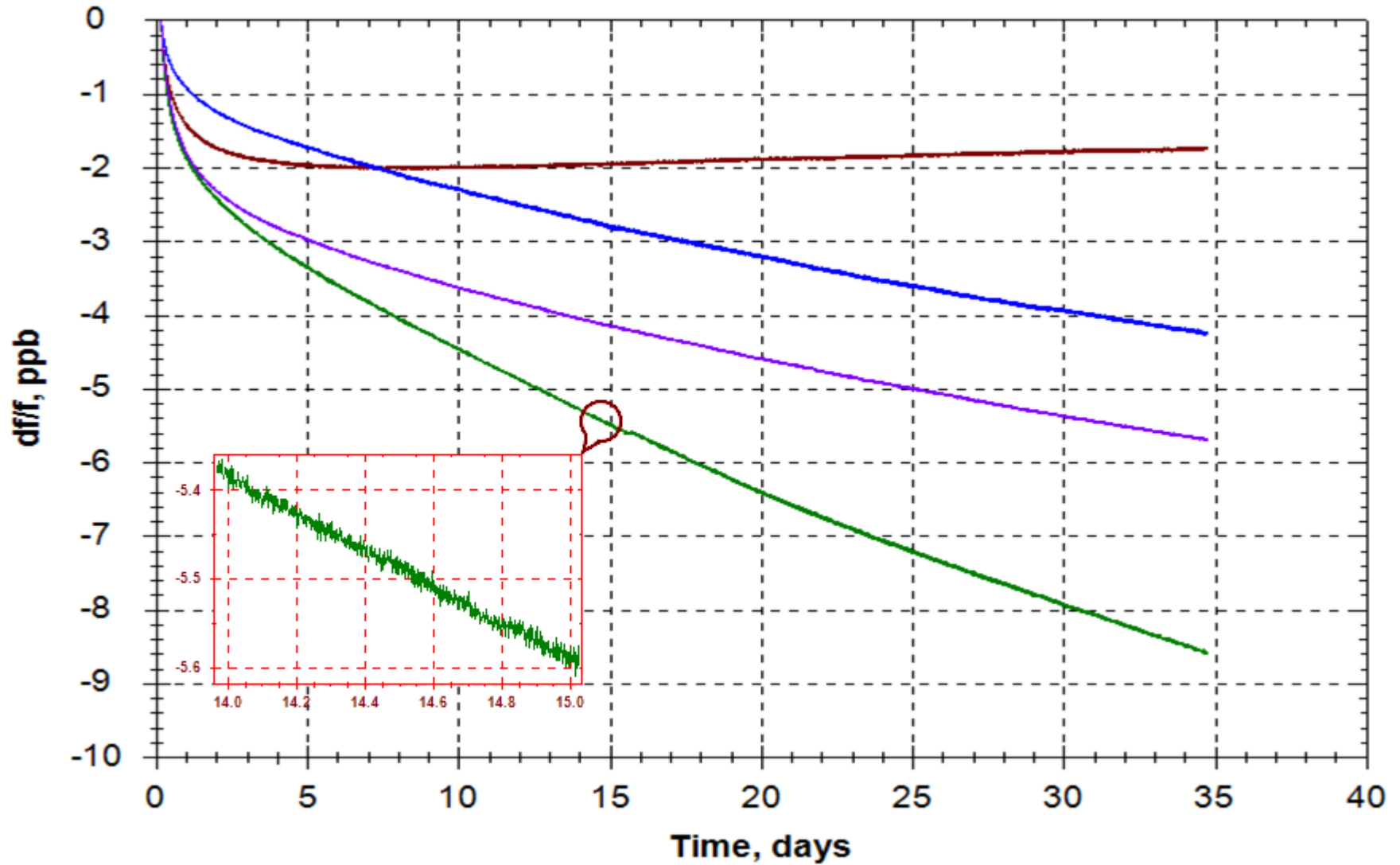


MV360  
5V



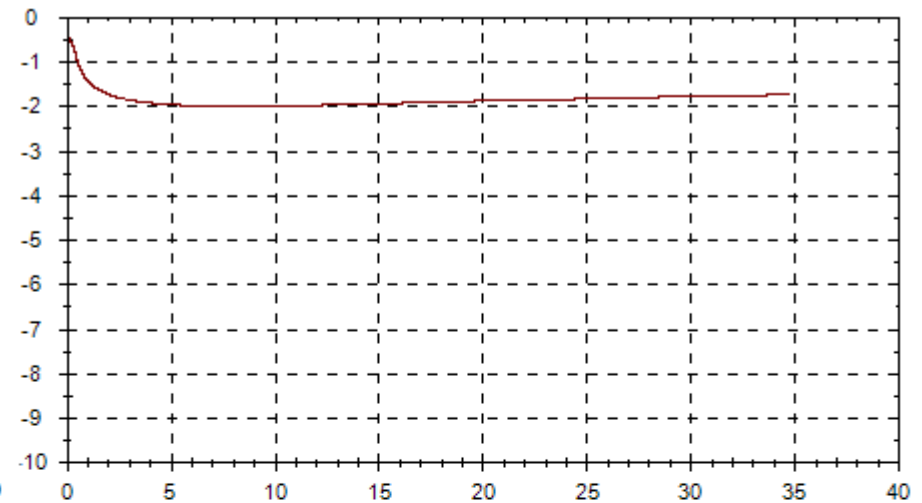
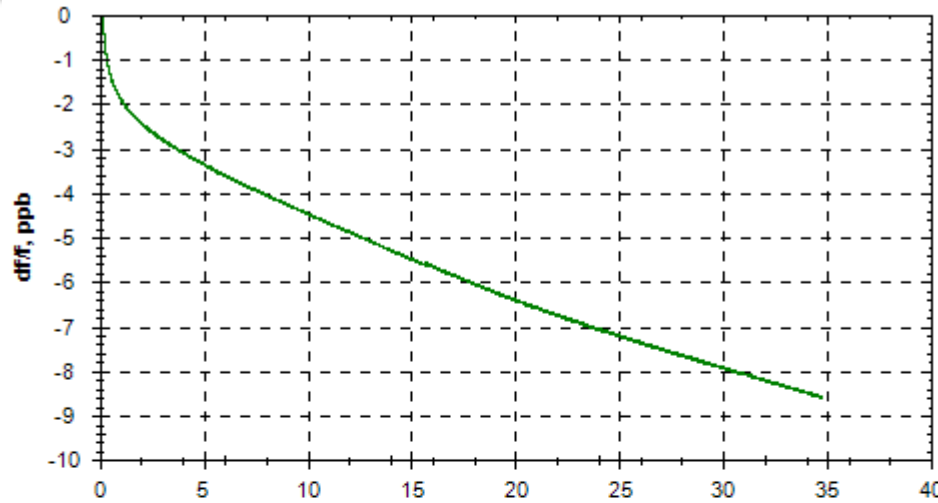
# Test results

## MV360 Long-term stability

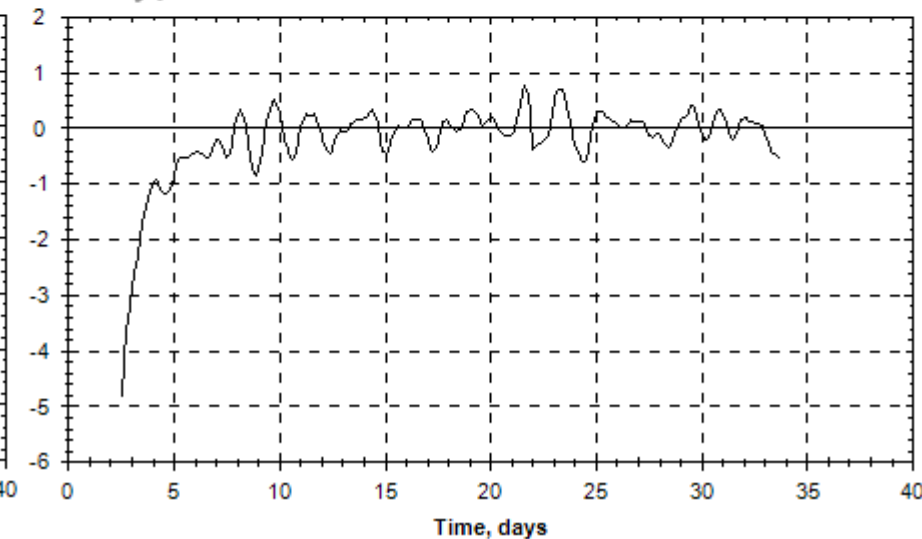
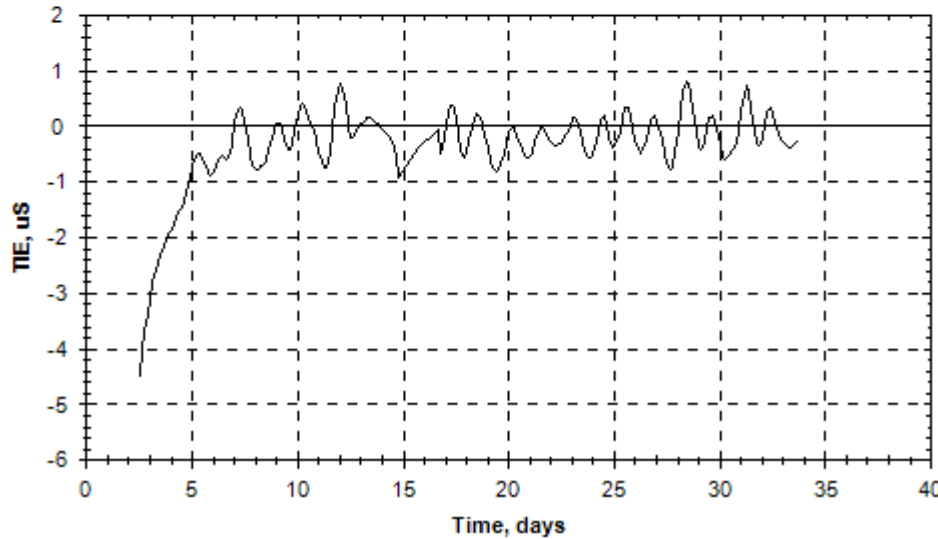


# Test results

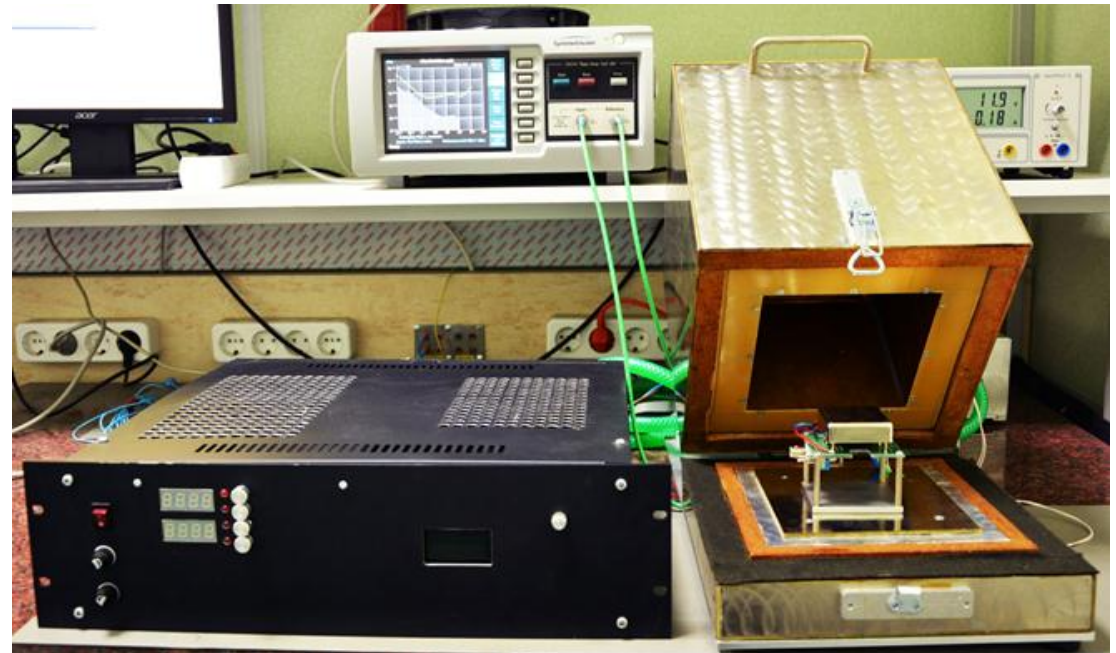
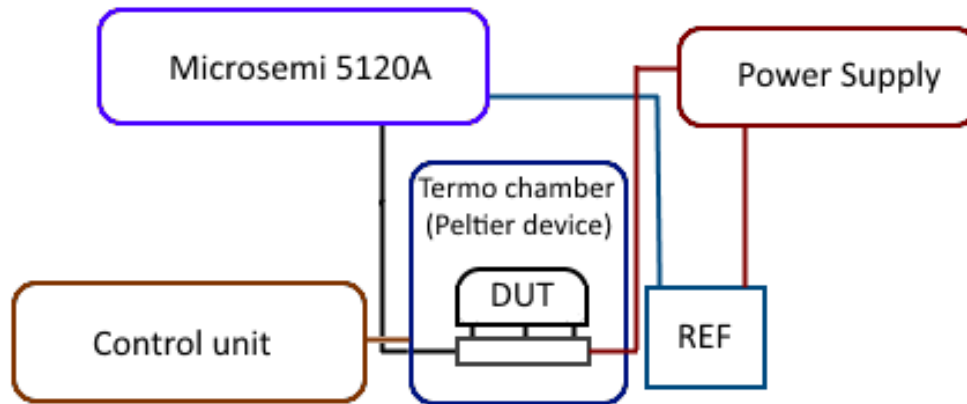
## MV360 24 hrs Holdover monitoring



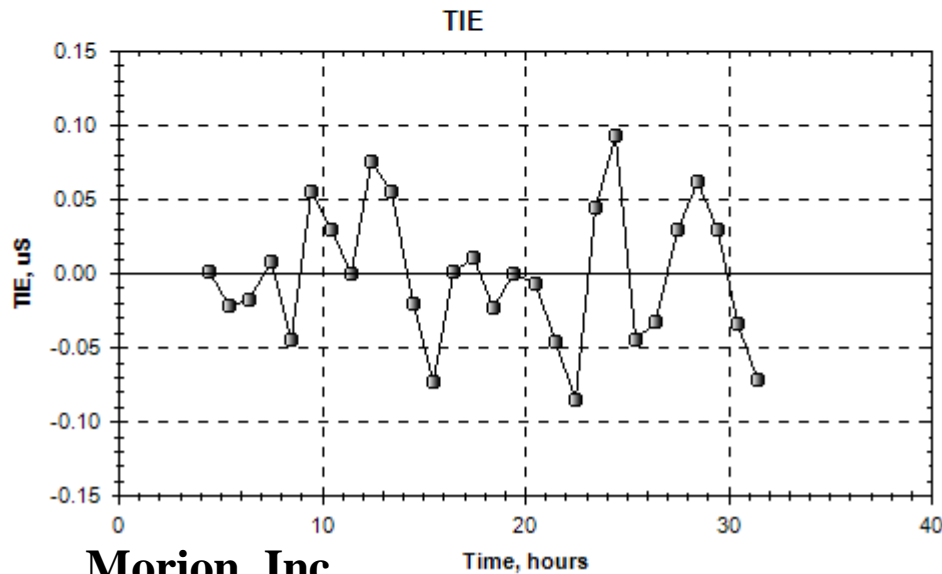
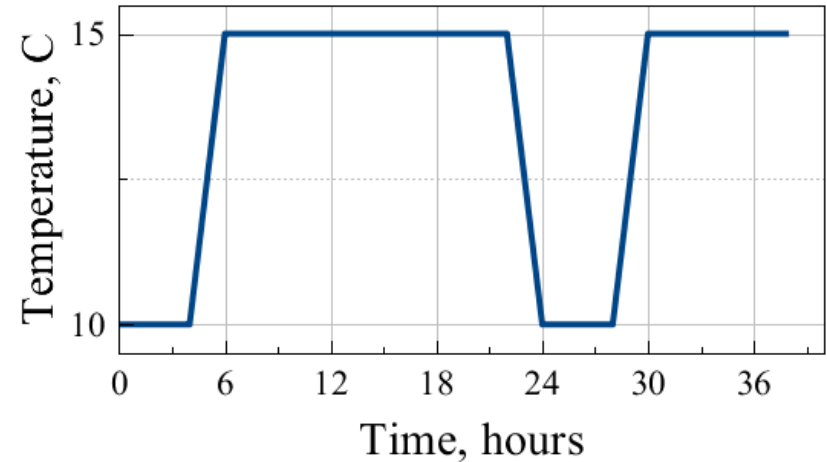
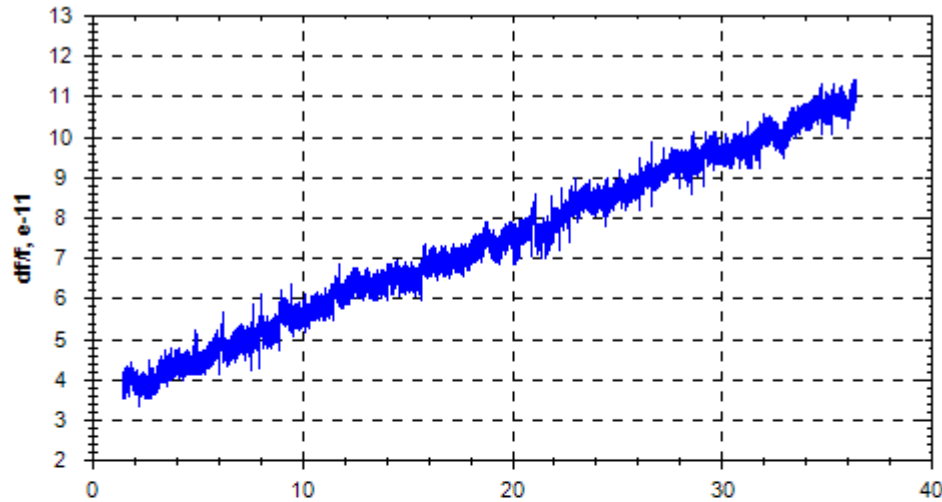
Time uncertainty



# MV360 4 hrs Holdover test with 5°C temperature change. Equipment.



# MV360 4 hrs Holdover test with 5°C temperature change. Test results.



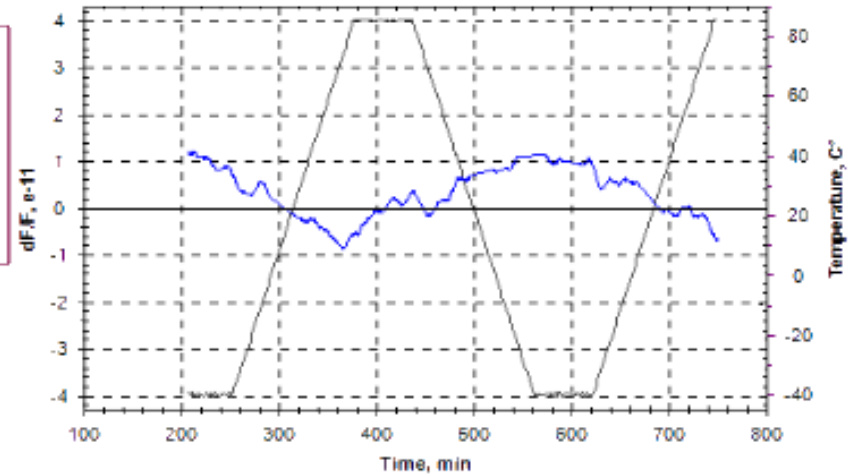
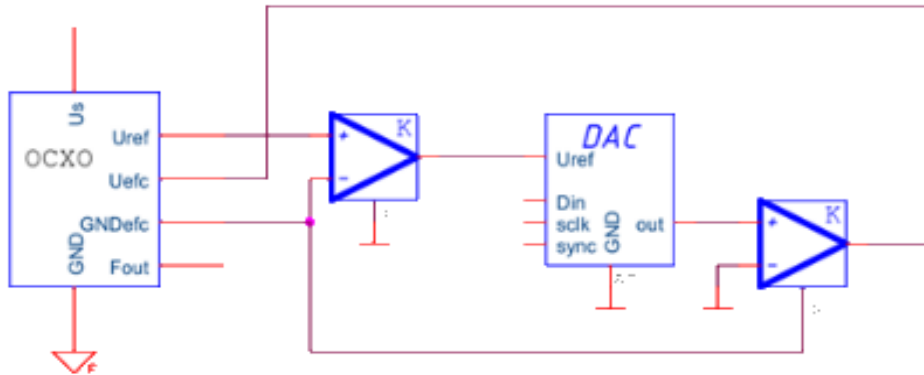
**TIE < 100 nS over 4 hrs**



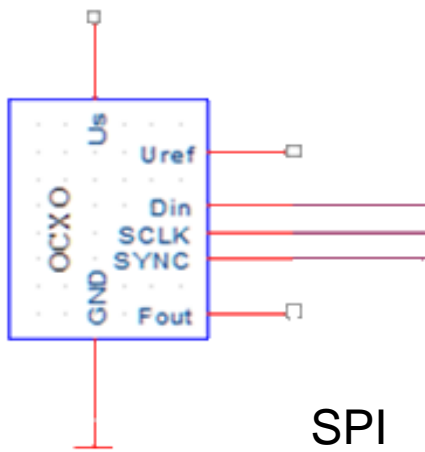
# MV360M

$MV360M = MV360 + \text{electrical frequency control}$

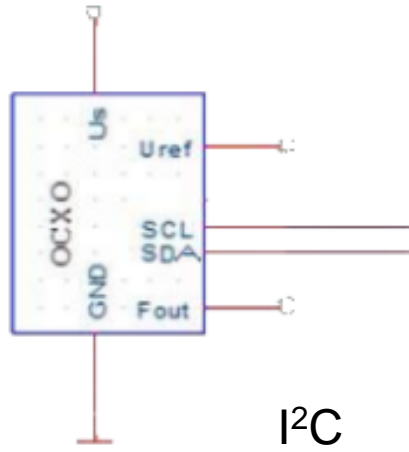
## Analog EFC



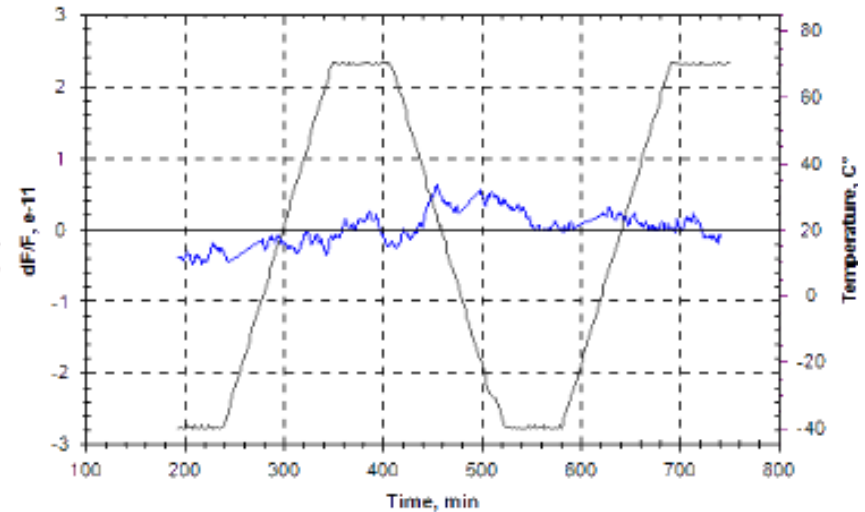
## Digital EFC



SPI

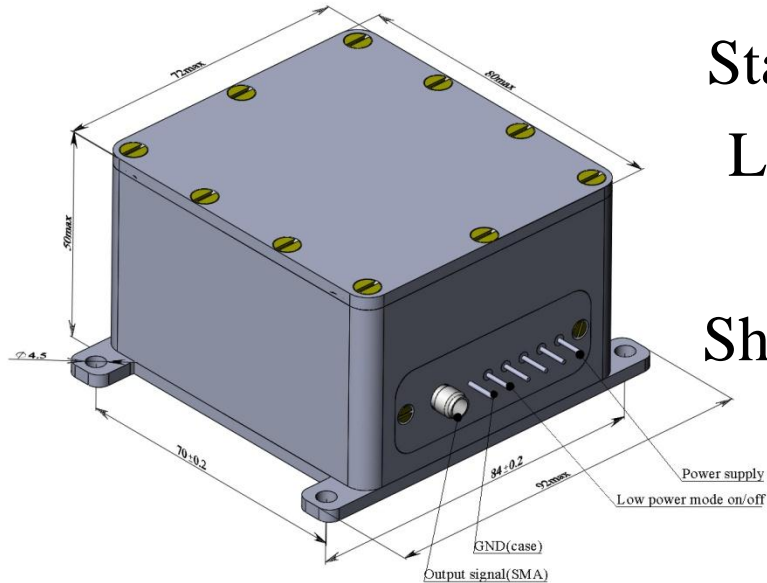


I<sup>2</sup>C



# 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

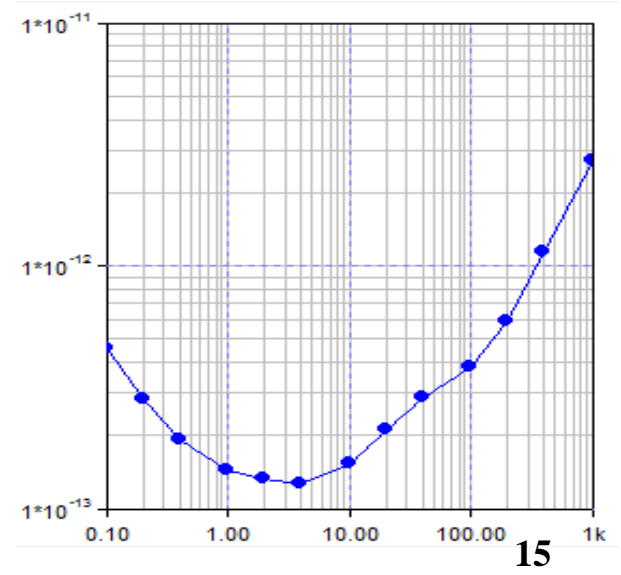
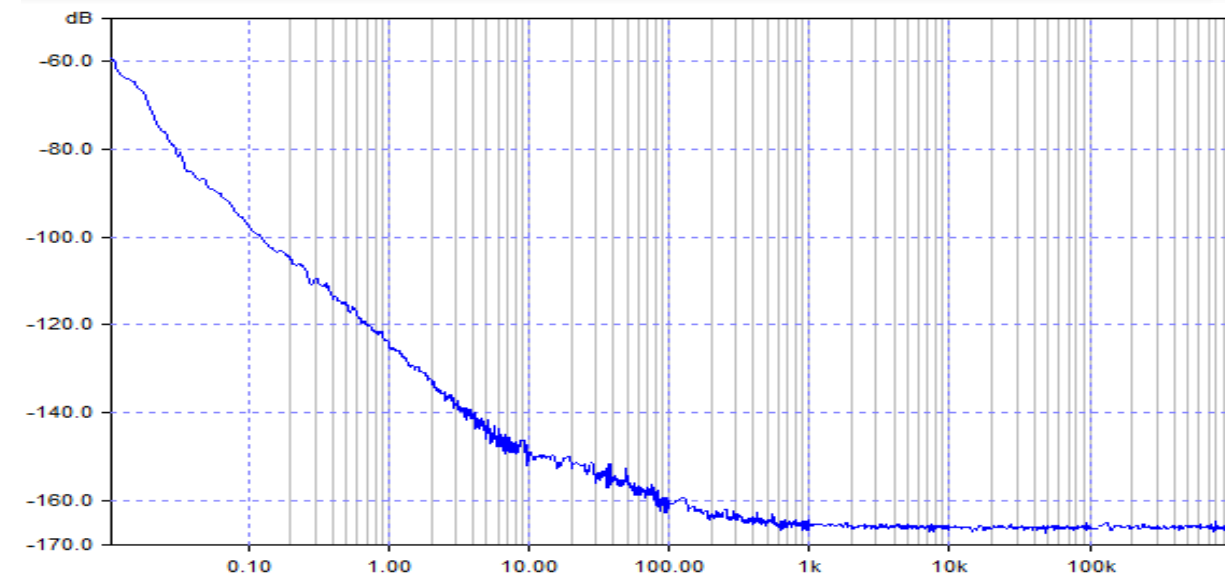
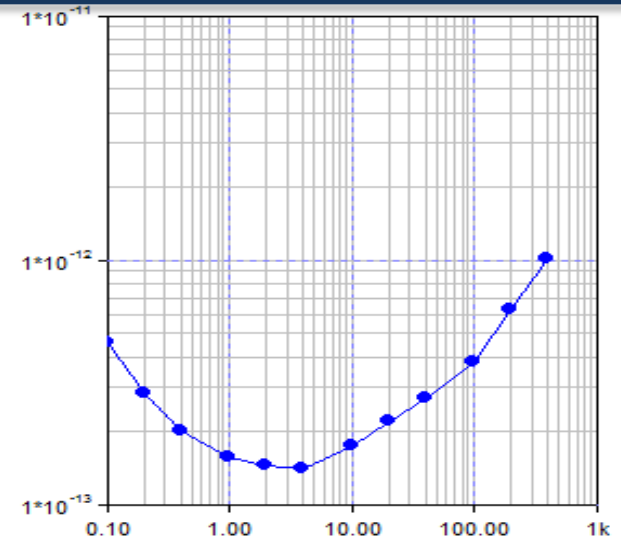
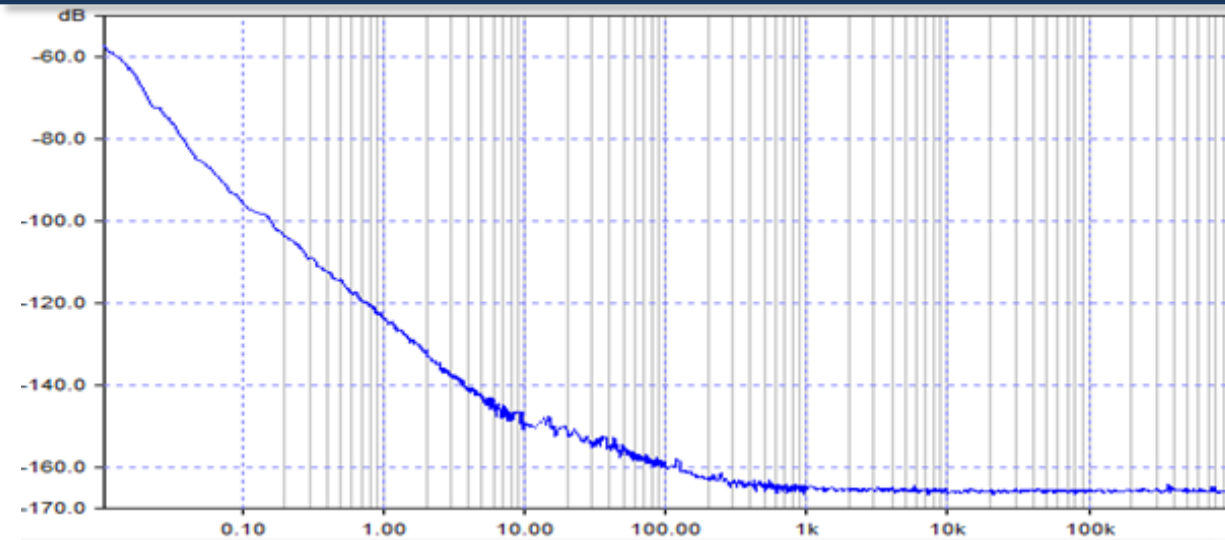
N.B. : version with EFC in final stage



# Test results

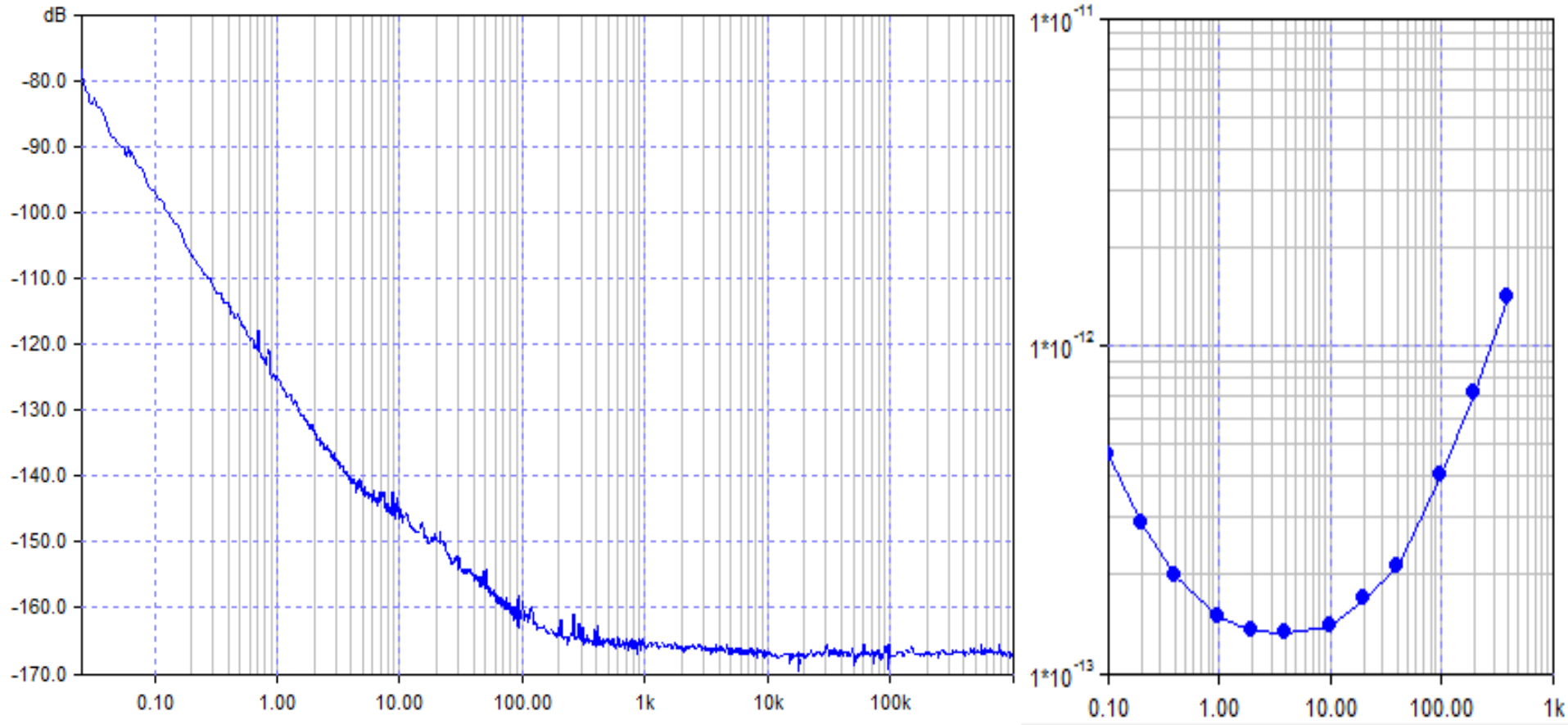
## MV336

### Phase noise and short-term stability



# MV336

## Typical phase noise and short-term stability





**Thanks for your  
attention!**



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