The New Family of Precision Low Profile Single-Oven OCXOs Based on Universal Design for Wide Range of Application

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Abstract— The new family of precision low profile single-oven OCXOs was developed to meet the trend of rapidly increasing needs for those. The additional specific is the same one ("universal") internal design covering wide range of different applications. The subject universal design allows to realize for appropriate 10 MHz crystals the following combination of technical parameters:

1. Stability vs. temperature in operating temperature range of - 20…+70 °C: <1E-9 (peak-to-peak);
2. Low phase noise: -105 dBc/Hz @ 1 Hz,
   -155 dBc/Hz @ 100 Hz,
   -162 dBc/Hz @ 10 kHz;
3. Very good short-term stability of <1E-12 for 1 s;
4. Long-term stability up to (2…3)E-8/year;
5. High level of output signal with almost no variations of 10±1 dBm;
6. Internal frequency multiplications, if needed, fx2 or fx4;
7. Different power supply voltage options in range of 5…15 V;
8. "Oven alarm" output.

Important is that appropriate cold-welded crystals in both HC43 and HC37 packages were developed and are being manufactured "in house" too.

Despite its low height (see b. m.) the subject design provides low thermal sensitivity. For instance the thermal shock of 30 °C causes a temporary frequency change of about 5E-10.

The subject OCXO's design may be performed in versions with height of 10…16 mm. It can be mounted on the bases with standard sizes of 2''x2'', 51x41 mm, and 36x27 mm. It's originally developed for crystals' frequencies range 5…20 MHz.

We have started large quantity manufacturing of being presented OCXOs' family.

I. Technical characteristics

The new family of precision low profile single-oven OCXOs was developed to meet the trend of rapidly increasing needs for those. The additional specific is the same one ("universal") internal design, covering wide range of different applications.

The oscillators have three different types of cases: 36x27, 51x41, 51x51 mm. All three types are of homogeneous design and similar circuit technique. Some options are not available in compact cases: for instance, 51x41 mm case does not have Oven Alarm, and frequency multiplication is not available in 36x27 mm case.

The following parameters are inherent for a standard oscillator version:

- frequency	5…20 MHz without multiplication to 40 MHZ with multiplication
- long-term instability (for 10 MHz)	$\pm (3…5)\cdot 10^{-8}$ /year $\pm (3…5)\cdot 10^{-10}$ /24 hours
- Allan deviation	$< 5\cdot 10^{-12}$
- stability vs. temperature	$\pm (1…3)\cdot 10^{-9}$
- output signal	HCMOS Sin > 350 mV (Us = 5 B) > 500 mV (Us = 12 B)
- power	5 V 12 V
- Phase noise (for Sin 10 MHz)	1 Hz - 95 dBc/Hz 10 Hz - 125 dBc/Hz 100 Hz - 145 dBc/Hz 1000 Hz - 150 dBc/Hz 10000 Hz - 155 dBc/Hz

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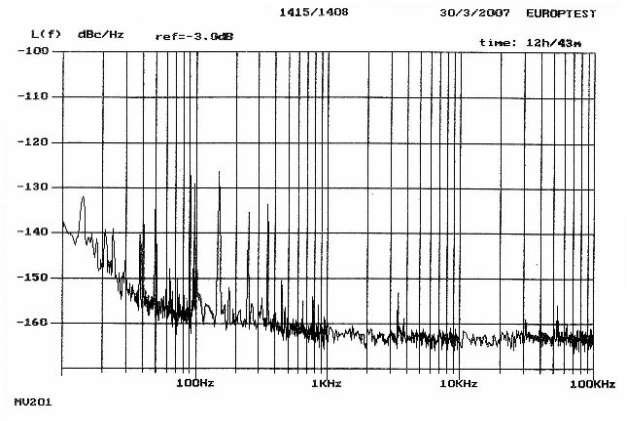
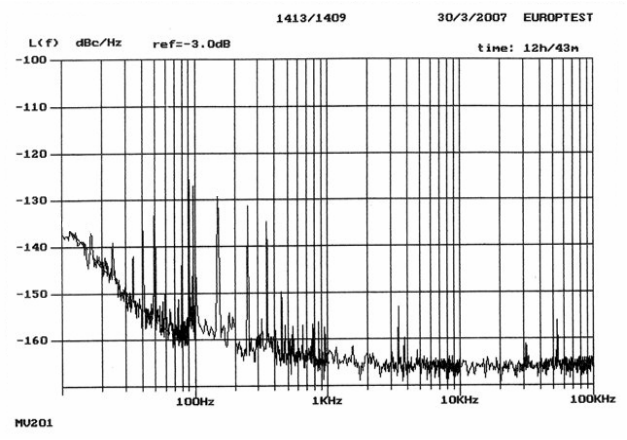
The said parameters permit the oscillator manufacture with minimum adjustment and parameter control costs.

Finer parameters realization is possible for special applications:

1. Low noise. (Fig.1.) For 10.0 MHz, 12 V, Sin
   - 1 Hz - 105 dBc/Hz
   - 10 Hz - 135 dBc/Hz
   - 100 Hz - 153 dBc/Hz
   - 1000 Hz - 160 dBc/Hz
   - 10000 Hz - 163 dBc/Hz

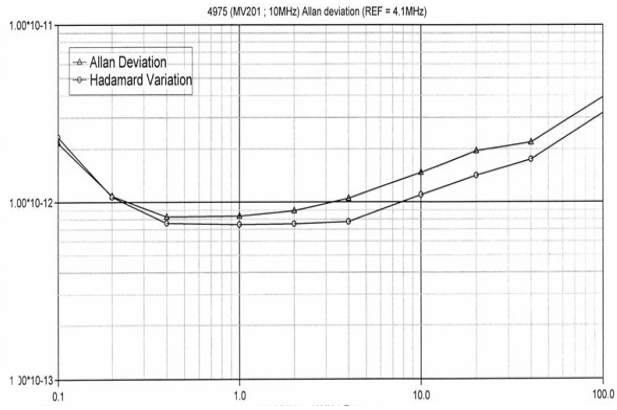


Low noise option



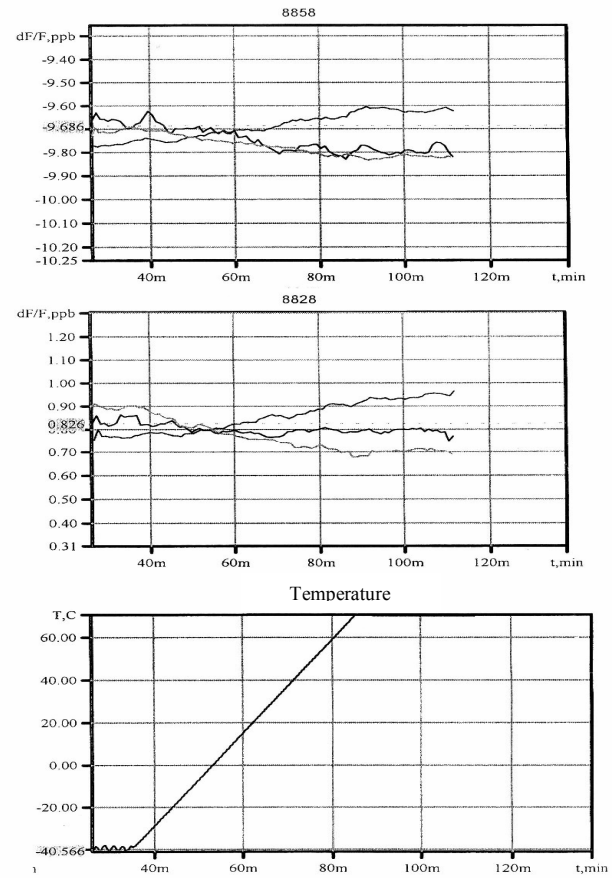
Ultra low noise option.
Fig. 1.

2. Low level of harmonics, < -50 dBc.
3. Output Sin signal of large amplitude, up to > 1.2 V.
4. Output Sin signal of increased stability, ±1dB and better.
5. Low Allan deviation, to < $1 \cdot 10^{-12}$. (Fig. 2.)



Allan deviation.
Fig. 2.

6. Temperature stability up to $\pm 5 \cdot 10^{-10}$. (Fig. 3.)



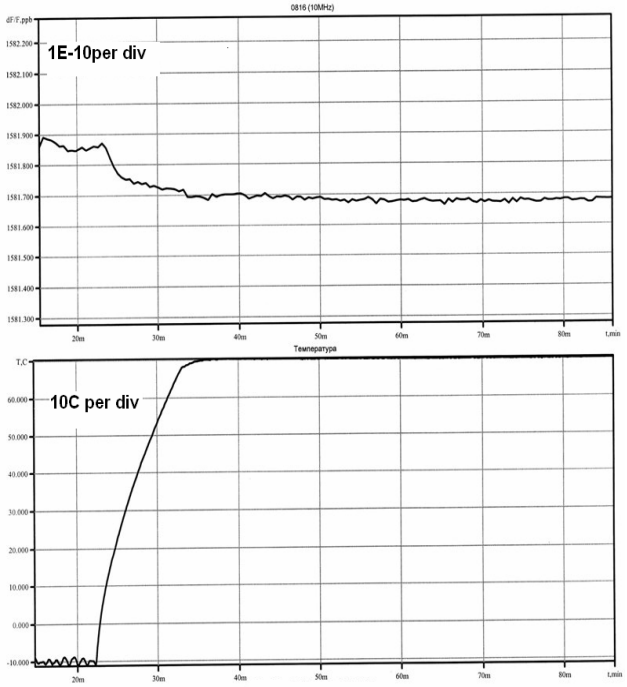
Frequency stability vs. temperature at 0, 2.5, 5V control voltage.
Fig.3.

7. Short startup time – up to 1 min.
8. Power supply expanded range, for instance, 9…14V. At this, the oscillator retains all inherent parameters, including the warming-up power within the said range of power supply voltages.
9. Wide temperature range, up to - 40… + 90°C.

All the above parameters, while keeping the oscillator design intact, are ensured through changing the circuit elements configuration and mode of operation.

At the development of single oven OCXOs with frequency stability vs. temperature of better than $\pm 1 \cdot 10^{-9}$ the following factors became of vital importance: change of temperature characteristic slope due to control voltage changes, frequency drifts due to wide range changes of environment temperature (especially important for low-profile oscillators), frequency jumps due to thermal shocks (fast change of temperature or air flow change at the start-up of operation of fans). The necessity of solving these problems required use of special design and circuit technique solutions.

Hot zone warming-up optimization and temperature gradient decrease have received much attention. As a result, an extremely low thermal shock reaction was received for oscillators with 12.7 mm height (Fig.4).

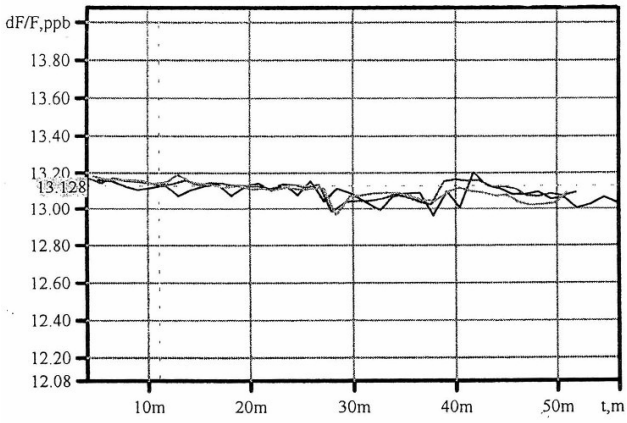


Thermal shock reaction
Fig. 4.

Organization of Morion's own high-quality resonators production has been vital for phase noise and Allan deviation improvement.

As one of the tasks was to create a cheaper oscillator, all the oscillators are of a single-board design that requires minimum manual labor at assembly. In some configurations only a resonator is manually installed.

Speeded-up development became an important result of using homogeneous design and similar circuit technique in three oscillators of different sizes that became possible due to the realized technical solutions tested with one type of oscillators per the whole family. Other options are easy to introduce for a customer familiar with one of the oscillator types due to a similar oscillator behavior.



Frequency stability vs. power supply deviation ±5%
Fig. 5.

I I. CONCLUSIONS:

High technical characteristics (stability up to $\pm 5 \cdot 10^{-10}$ vs. temp., Allan deviation $<1 \cdot 10^{-12}$, phase noise <-160dBc/Hz) and universality for a wide range of various applications have been achieved. These OCXOs full-scale production confirms the found solutions high efficiency.