Airflow Considerations on Synchronisation Testing

Technical Note

Introduction

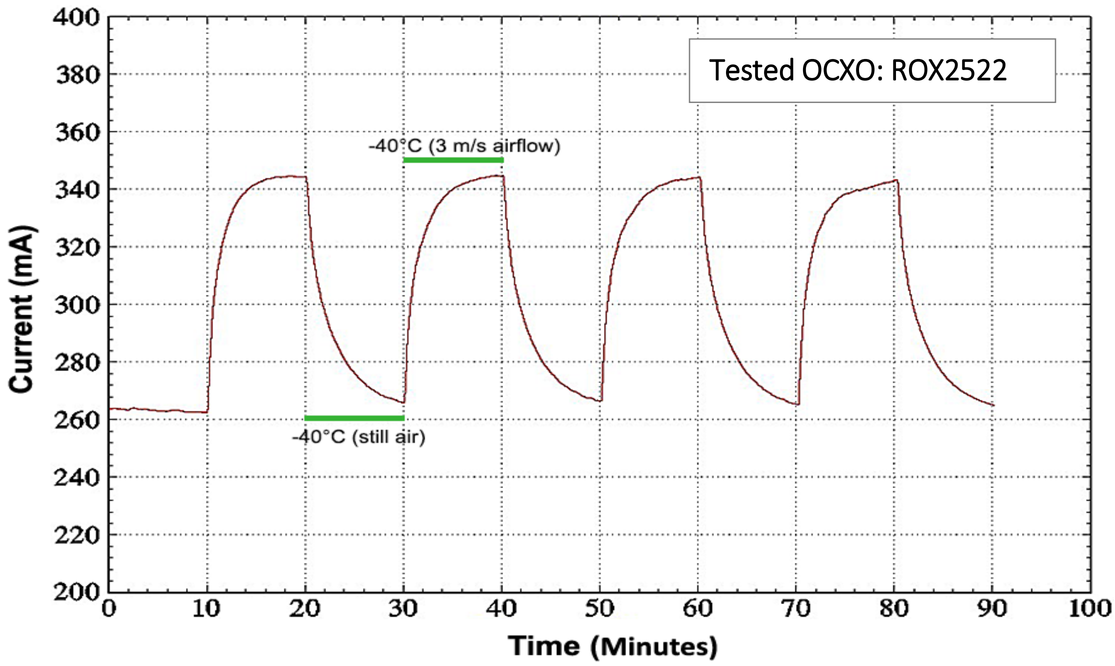
Synchronisation testing is carried out in test chambers, where thermal conditions are varied by forcing cool or hot air into the chamber. Since quartz crystal ovenised oscillators are sensitive to airflow, this test method might give anomalous results for the oscillator in question. This paper recommends procedures for reducing the effect of airflow on synchronisation testing. Adoption of these procedures helps ensure that the unwanted effect on the results of the test environment used (e.g. the test chamber or the airflow) is minimised. These procedures help the systems to uniformly test the effects of temperature variation. N.B. If airflow effects are to be tested, separate test methods are to be used.

Impact of Airflow on OCXOs

Crystal based oscillators are used as local references in most of today's synchronisation implementations. Oven controlled oscillators are used for highly stable clock references. Ovenised crystals are held at a constant temperature, supported by thermo mechanical constructions to protect the device performance from external effects. The oscillators are highly sensitive to the airflow around them, as the airflow can cause a change in temperature of the crystal, thus leading to a change in device frequency.

An OCXO tested at -40°C in still air would not necessarily perform the same as when tested at the same temperature but under an airflow of, say, 3 m/s. To illustrate the effects of airflow, the following graph (Fig. 1) shows the power supply current variation in an OCXO (which in turn is an indication of the temperature change experienced by the OCXO) in still air and under airflow. The airflow impacts the OCXO causing a temperature change.

Fig. 1: Effect of Airflow on Current Supply



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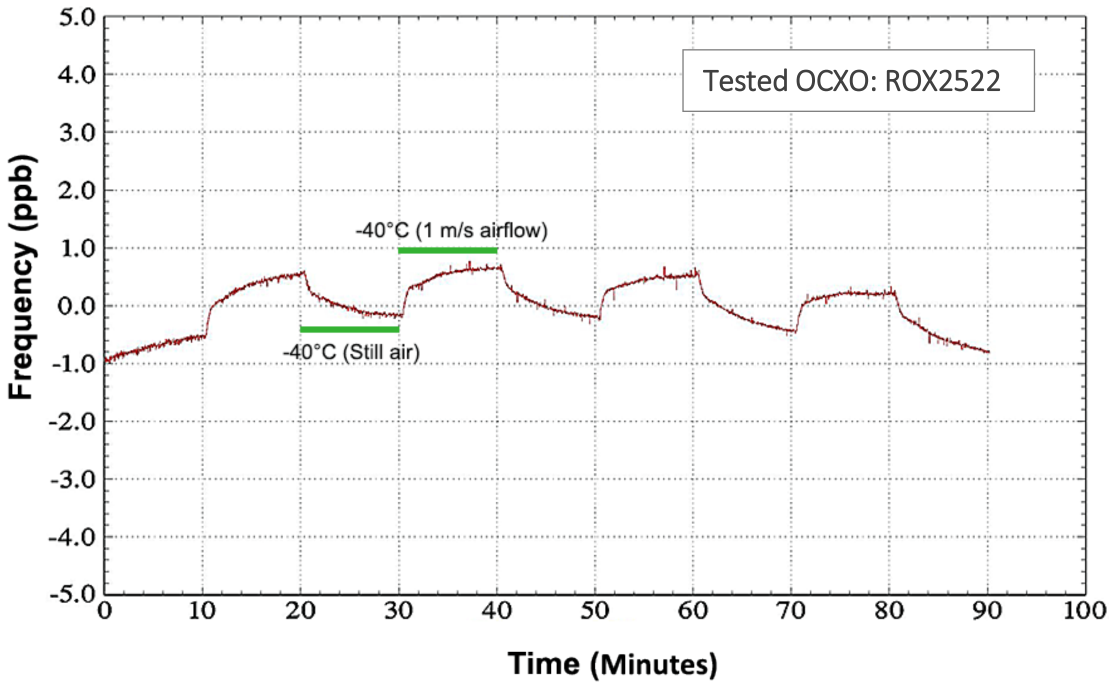
The results shown are from testing a Stratum 3E level of OCXO 'ROX2522' in a 25 x 22 x 23 mm package. The graphs show that the airflow varied from 0 to 1 m/s, 10 minutes on and 10 minutes off. Over this rest period, the change is frequency is about 1 ppb and the change in current is about 80 mA. This equates to about a 2°C change in temperature.

The equivalent frequency change of the device is illustrated in the graph below (Fig. 2).

Fig. 2: Effect of Airflow on Frequency



The IEC standard 60679-1 specifies the methods of test and general requirements for quartz crystal oven controlled oscillators (OCXOs) of assessed quality, using either capability approval or qualification approval procedures.

In the 5.2.3 of this standard, it states "If heat loss due to forced air circulation affects the performance of the oscillator, still air conditions shall be simulated by enclosing the oscillator in a draught shield consisting of a thermally conducting box, having internal dimensions so that a 20 ± 5 mm clearance is maintained from all surfaces. The temperature at which measurements should be taken under these conditions is the reference point temperature on the surface of the draught shield."

OCXOs are generally specified with their performances in still air. If the OCXOs are to be used in applications where airflows are present, then the environmental conditions need to be characterised and the correct OCXO devices need to be selected for the application requirement. Reference [1] describes an oscillator temperature calibration in still air.

Best design considerations for OCXOs also need to include the positioning of the OCXO. It is recommended that the OCXO be placed at a location where airflow is absent or at least minimised.

If such a situation is not possible, a plastic or metal cover may be placed over the OCXO. It is recommended that the cover leaves an air-gap of at least several mm above and around the oscillator. The enclosure acts as a shield and the temperature that is being tested should be "the surface temperature of a thin, highly conductive isothermal enclosure surrounding the device with known dimensions."[2] The isothermal surface provides a medium to conduct the heat into the device under test without direct airflow. The isothermal surface may be dimensioned to reflect the dimensions of the customer's enclosure if this is known.

"Such a procedure will ensure that the synchronisation testing is done under uniform environments and results obtained are under common test conditions."[2]

References

[1] Guidelines for use of Mercury Miniature OCXOs in Network Timing Applications; Application Note, Rakon

[2] OCXO Temperature Calibration in Still Air, Engineering Note, Rakon.

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