Guidelines for use of Mercury Miniature OCXOs in Network Timing Applications

This application note gives best practice advice on how to optimise the performance of Rakon's Miniature Mercury OCXOs in network timing and synchronisation applications – date of issue: 2011-04-27.

Introduction

In a conventional OCXO, to improve frequency stability, the effect of ambient temperature is virtually eliminated by enclosing the entire oscillator within an 'oven' maintained at a constant high temperature. As conventional OCXOs tend to be bulky, high in price and power-hungry, Rakon developed the Mercury series of Miniature OCXOs.

In a Miniature OCXO a miniature oven keeps a crystal oscillator at an approximately constant temperature slightly above the specified operating temperature range, for example at ≈ 90° for an operating temperature range of –40° to +85°C. The whole assembly is then treated as a TCXO and a temperature sweep is performed at the factory and each device is programmed with a correction curve. This results in an oscillator with a typical stability of better than ±50 ppb over –40° to +85°C. This means that every device has been tested over the full operating temperature range in a temperature chamber. The operating temperature specified in our data sheets is that of the air in the vicinity of the OCXO. Because the oven does not have the strict temperature requirements demanded by a conventional OCXO, it can be implemented at lower cost and in a smaller package.

Please note that heat sources near the OCXO may lift the board temperature above that of the air. If the internal temperature of the OCXO rises above its specified maximum operating temperature as a result of convection heating within the customer's module, the OCXO will no longer maintain its stability. This can occur even if the air temperature external to the OCXO is still below the OCXO's maximum operating temperature.

It is important to realise that heat, although usually considered an unwanted by-product, is what gives an OCXO its stability. Provided the board temperature stays below the maximum operating temperature there is no strict need to cool the device – in fact cooling can be detrimental to its short and medium term stability.

General Guidelines

Consult the manufacturer from the start of the program and continue the engagement throughout the development. Apply standard RF practice, keep tracks short and place the oscillator near the timing circuitry.

Power Supply Considerations

It is recommended to use a local power supply regulator to isolate the device from external power noise sources. The local supply must be dimensioned in such a way that it can handle the warm-up current of the device. The warm-up power consumption of the Miniature OCXOs is limited as per the following table:

	Warm-up	Steady-state at 25°C
Mercury –20° to +70°C	800 mW	350 mW
Mercury –40° to +85°C	1000 mW	400 mW

It is recommended to decouple the supply of the OCXO with a 10 uF capacitor close to the device.

Voltage Control

In case voltage control has been specified it is important to realise that typical sensitivity is +8 ppm/V and a small error in the control voltage may result in a considerable frequency error. Because of this the ground of the control voltage needs to be connected close to the ground of the OCXO as ground lead impedance may introduce a voltage (= frequency) error caused by the relatively large current flowing through it.

Thermal Guidelines

Under steady state conditions the OCXOs will perform as per the specification. A steady state is reached after a "warm-up" period which includes the oscillator and the circuit board on which it is mounted, under conditions of constant temperature and airflow. For wander compliance testing it is recommended to power-up the board for at least 24 hours before commencing the measurements and to keep the temperature variation within ±1°C (unless otherwise stated in relevant standard).

A change in the temperature external to the OCXO will result in an increase or decrease of current to the heater as the oven is trying to maintain its temperature. This is a critically damped closed loop system and its response will lag the external stimulus resulting in phase and frequency variations (i.e. frequency wander).

For this reason it is best to keep the external temperature fluctuations to a minimum. The main cause of temperature fluctuation is variation in the amount of airflow when fans run at varying speeds or are used intermittently.

As there is no need to cool the OCXO as such, its short and medium term stability can be greatly improved by shielding it from airflow. Place the oscillator where air flow is low. It may be possible to use tall components or mechanical parts to shield the oscillator locally. If this is not possible or shielding is not sufficient a plastic or metal cover may be placed over the OCXO. It is recommended that the cover leaves an air-gap of a least several mm above and around the oscillator. Figure 1 shows Mercury performance without shielding with airflow 1 m/s. Figure 2 shows the performance of the same device with a draught cover at airflow 1 m/s.

Figure 1

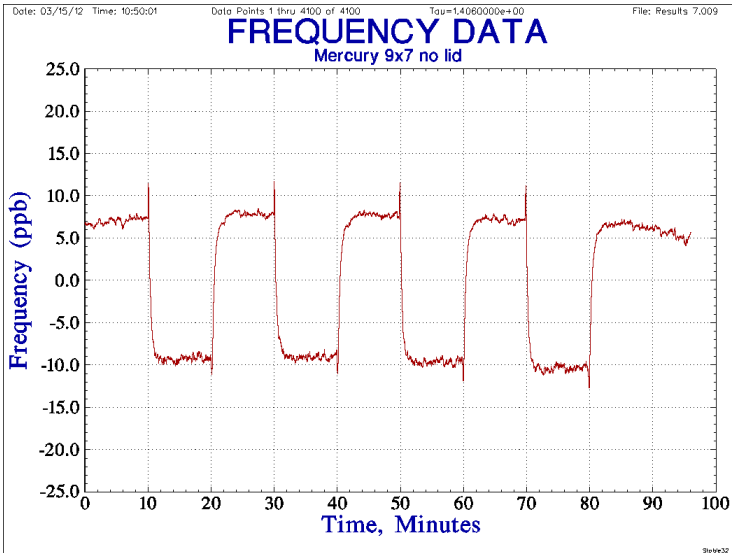
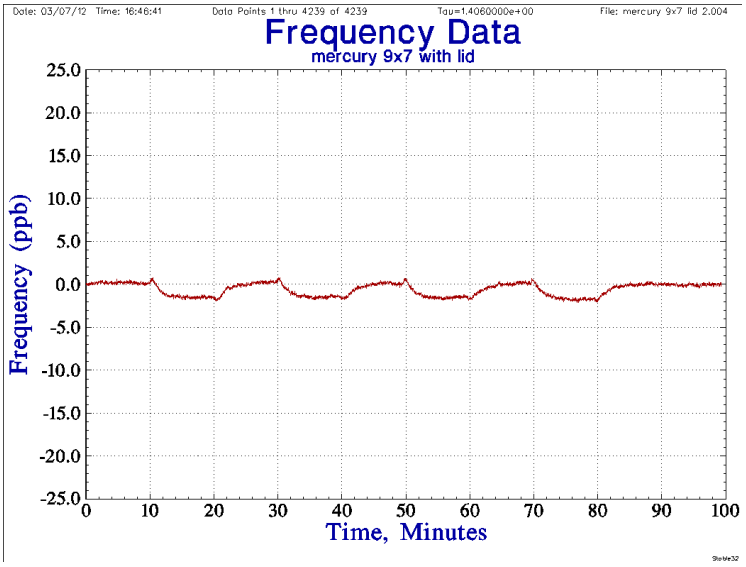


Figure 2



Rakon can provide draught covers to shield the device from air flow. The part no. for draught covers for 9x7 Mercury: PCV00018AA3. The part no. for draught covers for 14x9 Mercury: PCV00018AA4.

Figure 3: Shows how the cover can be placed on the pcb with a 9x7 device; Figure 4 shows how the cover can be placed on the pcb with a 14x9 device.

Figure 3

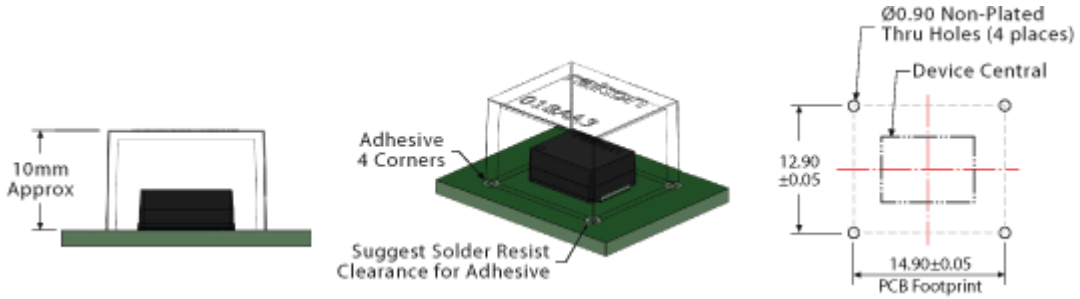
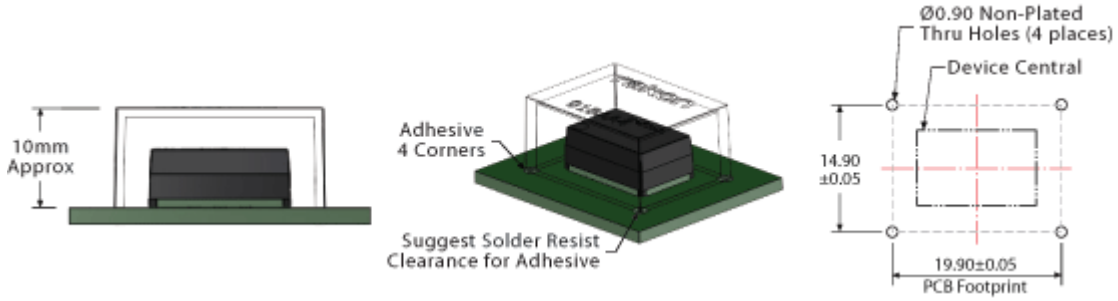


Figure 4: Another source of temperature variation is when certain circuitry is switched on intermittently. This could generate enough heat to disturb the thermal balance. It is best to keep such circuitry away from the oscillator.

Figure 4



Next step:

For more information email: info@rakon.co.uk