

Main Oscillator with sub-fs Resolution and High Performance Local Oscillator Generation in MicroTCA.4

KVG: Jiaoni Bai

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- 2. Quartz Crystal Products
- 3. Main Oscillator with high Power and sub-fs Resolution
- 4. High Performance Local Oscillator Generation



KVG Introduction

KVG Quartz Crystal Technology GmbH Location / Headquarter: Neckarbischofsheim, Germany

We provide

 state-of-the-art frequency control products for Science & Industry e.g., crystals, oscillators, filters, specific quartz crystal products, etc.
 Customized products, solution and excellent service
 Certification
 EN9100 and ISO14001











Quartz Crystal Products

Ultra-low Phase Noise OCXO Series

10 MHz

- Case: 36.1x27.2x15 mm
- Supply voltage: 12.0V
- Current consumption: Warm-up \leq 400 mA (4.8 W) Steady State ≤ 150 mA (1.8W max.
- > Frequency stability: $-20^{\circ}C \sim 70^{\circ}C \leq \pm 10 \text{ ppb}$
- Output power: > +8 dBm
 - sine wave, 50 Ohm

Mg in 00

O-30-ULPN

10.000 MHz

- Long-term stability (Low aging): 20 years $\leq \pm 400$ ppb
- > Phase noise:
 - \leq 120 dBc/Hz at 1 Hz
 - \leq 148 dBc/Hz at 10 Hz
 - \leq 160 dBc/Hz at 100 Hz
 - \leq 165 dBc/Hz at 1 kHz
 - \leq 168 dBc/Hz at 10 kHz
 - \leq 168 dBc/Hz at 100 kHz

100 MHz

- **Case:** 25.8 x 25.8 x 14 mm
- > Supply voltage: 12.0V
- **Current consumption:** Warm-up \leq 350 mA (4.2 W max Steady State ≤ 150 mA (1.8W n
- > Frequency stability: $-20^{\circ}C \sim 70^{\circ}C \le \pm 300 \text{ ppb}$
- \blacktriangleright Output power: \geq +12 dBm, sine wave, 50 Ohm
- > Low aging: per year $\leq \pm 500$ ppb
- > Phase noise:
 - \leq 110 dBc/Hz at 10 Hz
 - \leq 140 dBc/Hz at 100 Hz
 - \leq 170 dBc/Hz at 1 kHz
 - \leq 180 dBc/Hz at 10 kHz
 - ≤ 182 dBc/Hz at 100 kHz
 - \leq 182 dBc/Hz at 1 MHz

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0-40-ULPN

100.000 MHz



Quartz Crystal Products

Ultra-low Phase Noise Reference Frequency Module

162.5 MHz, 325 MHz, 499.8 MHz, 1.0 GHz, 1.3 GHz, 2.6 GHz, 2.856 GHz etc.

1.3 GHz, 1.0 GHz

Phase noise:

≤ - 90, -88 dBc/Hz at 10 Hz
≤ -120, -118 dBc/Hz at 100 Hz
≤ -145, -157 dBc/Hz at 1 kHz
≤ -160, -162 dBc/Hz at 10 kHz
≤ -160, -162 dBc/Hz at 100 kHz
≤ -160, -162 dBc/Hz at 1MHz
≤ -170, -162 dBc/Hz at 10MHz

> RMS Jitter:

[1 kHz to 10 MHz] < 2 fs



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Main Oscillator (MO)

Technical Overview

- Custom designed 19" 600 mm 5U housing
- Excellent short-term phase noise and jitter <1fs</p>
- Frequency stability better than 10⁻¹² (hours-days)
- Support high power outputs \geq +46 dBm
- Provide different frequencies (optional)
- Support remote diagnostic for maintenance
- Tight operational reliability





Under license from DESY

> Typical Application:

Providing high-power and ultra-low phase noise RF-signals in modern accelerators



MO1300

Working Principle

MO synchronizes an ultra-low phase noise DRO output signal with a 1.3 GHz signal synthesized from an ultra-stable GPSDO 10 MHz signal.





MO1300

RF Performance



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Measurement result provided by Heinrich Pryschelski (DESY)

KVG Local Oscillator Generation (DeRTM-LOG)

Technical Overview

- > A multi-channel local oscillator, RF signal and clock generator
 - 9 REF, 9 LO and 9 CAL signals [400 MHz to 6 GHz]
 - 22 low-jitter, differential CLK signals up to 160 Msps
- Two double-width, full-height, MicroTCA.4 compliant extended Rear Transition Module (eRTM)
- LO residual phase noise < 5 fs (rms)
 [10 Hz to 1 MHz] at 1.354 GHz
- On/Off switching of output clocks and RF signals
- Temperature regulation for long-term stability of RF signals
- Diagnostic for RF power, DC voltage, temperature, humidity



Under license from DESY



Noise Spectrum

DeRTM-LOG

RF Performance

ICIrw PN Smth 1% Spur 6dB Offset -3dB ⊚2CIrw PN Offset -3dB

DeRTM-LOG 1.3 GHz:

REF 1.300 GHz
 LO 1.354 GHz
 CLK 81.25 MHz

RF Parameter	Measured Value (Worst Case)
Return Loss	>20 dB
LO Out Power	>29 dBm
Isolation	>80 dBc
Harmonics (2 nd , 3 rd)	<-80 dBc



Typical CLK (81.25 MHz) Absolute Phase Noise





DeRTM-LOG

Test-Stand

A fully automated test stand developed and provided by DESY to check possible production errors.

Measure:

- individual mezzanines
 (DC/DC mezz., RF mezz., ...)
- A fully assembled module

> Test:

- CLK frequency [1 MHz to 500 MHz]
- LO, REF and calibration signals [1 MHz to 6 GHz]







Production and Future Development

Under production: DeRTM-LOG 1.3 GHz and 1.5 GHz

Further developments by DESY with new architecture

- Cover various LO and CLK generation scenarios
- Cover more REF frequencies applications
- Residual phase noise of the LO and CLK generation
 - ≤ -165 dBc/Hz white noise

We provide DeRTM-LOG for your frequency application.



- Standard products
- Local Oscillator Generation (DeRTM-LOG) test stand
- Join us for visits at FLASH Main Oscillator MO1300





Thank you for your attention!

Thanks to DESY and WUT ISE colleagues for their support.

Further questions, please contact us.

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