

*/'rū-bri-kōm/*, proper noun

A reference, a frequency ruler for precision measurements, a standard for turnkey and reliable optical frequency combs.



You want an optical frequency comb that keeps your experiment or in-the-field solution running smoothly and efficiently. Frequency combs have a reputation for being complicated instruments that cause downtime at the worst times—that era has now ended with the RUBRIComb<sup>®</sup>. Redefine reliability with a laser that never lets you down.

The RUBRIComb<sup>®</sup> from Vescent is a fully stabilized optical frequency comb with precise control over the repetition rate ( $f_{\text{rep}}$ ), the carrier-envelope offset frequency ( $f_{\text{CEO}}$ ), and the optical reference beat ( $f_{\text{opt}}$ ). At its core is a passively mode-locked erbium-doped fiber oscillator. Our unique approach reduces the system size, weight, and power (SWaP). The complete RUBRIComb<sup>®</sup> frequency comb is designed and built to ensure stable, low-phase-noise operation, with Allan Deviations supporting the next generation of optical atomic clocks.

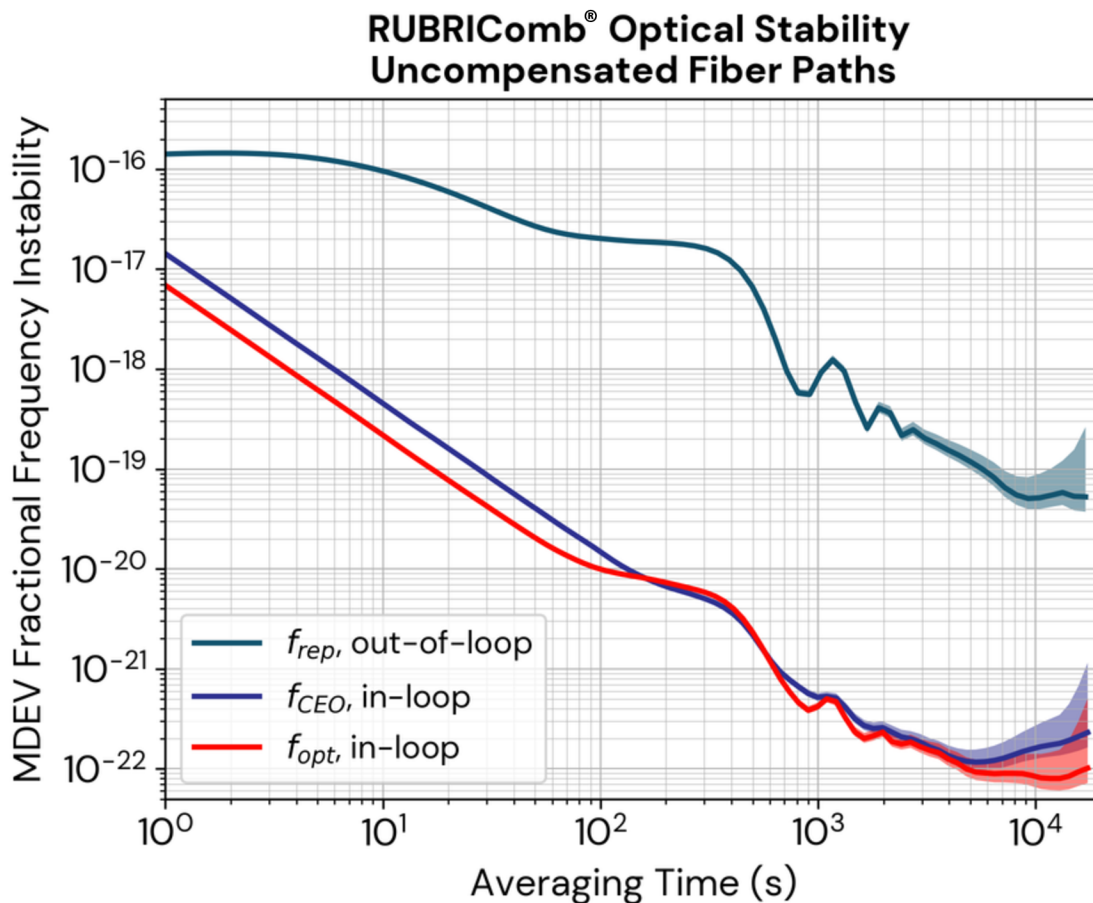
The entire laser, including self and external referencing modules, is contained in a single 2U 19" rack mount chassis. The laser mode-locks at startup every time and is specially designed for a robust, long life. Our unique oscillator design also makes it easy to precisely factory-match the repetition rate of several RUBRIComb<sup>®</sup> combs for multi-comb spectroscopy experiments.

### Leading Application Solutions

- Atomic Clocks and Time Transfer
- Quantum Computing
- Dual Comb Spectroscopy

### Features

- Turnkey Operation: up and running in 30 minutes
- Low Noise: supports the best optical clocks and more
- Robust: passes demanding shake, vibe, and thermal tests
- Stable: remains locked for months
- Color Support: lock many lasers with additional options
- Deliver: low noise to every laser in your system



### RUBRIComb<sup>®</sup> : Exceptional Stability

This plot highlights the stability of the RUBRIComb optical frequency comb, as measured by the Modified Allan Deviation (MDEV). The log-log axes show the stability between 1 and 10,000 seconds, demonstrating fractional frequency stability that averages below the  $10^{-18}$  level. The out-of-loop trace was measured from the beat note between two RUBRICombs phase-locked to the same optical reference (Stabilaser 1542E) and demonstrates the low-noise of independent comb systems.

The in-loop traces of  $f_{CEO}$  (blue) and  $f_{rep}$  (green) showcase the comb's intrinsic noise floor, enabling it to support cutting-edge applications like optical clocks and low-phase-noise microwave generation.

# RUBRIComb<sup>®</sup> Specifications

Parameter	Min	Typical	Max	Comments
Center Wavelength		1560 nm		
Repetition Rate		100 MHz (for -100) 200 MHz (for -200)		
<b>Optical Outputs</b> - All connectors are PM FC/APC				
Oscillator Average Output Power	0.01 mW			
Oscillator Optical Bandwidth	18 nm	35 nm (for -100) 25 nm (for -200)		FWHM
Amplifier Average Output Power	4 mW			
Amplifier Optical Bandwidth	40 nm	70 nm		-10 dB full width
<b>RF Outputs</b> - All connectors are SMA				
$f_{\text{CEO}}$ Signal-to-Noise Ratio	35 dB			100 kHz RBW
$f_{\text{CEO}}$ Integrated Phase Noise		400 mrad	1000 mrad	10 Hz-1 MHz
$f_{\text{CEO}}$ Frequency Stability <sup>1</sup>			$5 \times 10^{-17}$	At 1 s, In-loop Modified Allan Deviation
$f_{\text{opt}}$ Optical Input Power	0.1 mW		0.6 mW	
$f_{\text{opt}}$ Signal-to-Noise Ratio <sup>2</sup>		40 dB		100 kHz RBW
$f_{\text{opt}}$ Integrated Phase Noise <sup>2</sup>	200 mrad			10 Hz-1 MHz
$f_{\text{opt}}$ Frequency Stability <sup>1,2</sup>			$5 \times 10^{-17}$	At 1 s, In-loop Modified Allan Deviation
$f_{\text{rep}}$ Output Power Level	-10 dBm	0 dBm	5 dBm	

<sup>1</sup> Allan Deviation from zero-dead-time lambda counter with 1 s gate time.

<sup>2</sup> Depends on user-supplied optical reference. Data given for 1kHz 1560 nm reference laser with >0.1 mW input power when phase locked with a SLICE-FPGA.



# RUBRIComb<sup>®</sup> Specifications Continued...

Parameter	Min	Typical	Max	Comments
<b>Frequency Transducers</b>				
$f_{CEO}$ Tuning Range	100 MHz (for -100) 200 MHz (for -200)			Pump Current Tuning
$f_{CEO}$ Input Voltage Tuning Range	-5 V		5 V	SMA Input
$f_{rep}$ PZT Tuning Range	30 Hz	60 Hz (for -100) 240 Hz (for -200)		Depends on Repetition Rate. Temperature tuning spec allows for larger changes in $f_{rep}$ .
$f_{rep}$ Input Voltage Tuning Range	0 V		6 V	SMA Input
$f_{rep}$ Temperature Tuning Range		25 kHz (for -100) 50 kHz (for -200)		Cavity temperature between 20 and 45 °C
$f_{rep}$ Temperature Tuning Sensitivity		1 kHz/°C (for -100) 2 kHz/°C (for -200)		Depends on Repetition Rate
<b>Size, Weight, and Power</b>				
Line Voltage	100 VAC		230 VAC	50/60 Hz
Power Consumption			40 W	
Weight		7.3 kg		
Chassis Volume		17 L		
Dimensions (in)		19 x 19 x 3.875 W x D x H		2U 19" rack mount
Dimensions (cm)		48.3 x 48.3 x 9.8 W x D x H		2U 19" rack mount
<b>Environmental</b>				
Operating Temperature	15 °C		35 °C	Minimum temp must be above dew point
Storage Temperature	-10 °C		70 °C	

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