Multi-branch laser station (MLS)

Metrological system for long-distance coherent optical frequency transfer in star topology

Exail Quantum Systems presents a new generation of repeater laser station dedicated to the dissemination of an ultra-stable optical frequency through fiber links from one point to multiple distant users. The station allows to evaluate the stability and accuracy of the transferred metrological signal in each branch.
The MLS relies on the proven fiber noise compensation technology developed for Exail RLS but exceeds those in the long-term noise floor [1].

[1] [1] E. Cantin et al. (2021). An accurate and robust metrological network for coherent optical frequency dissemination New J. Phys.

General architecture

The MLS is a stand-alone system that actively compensates the phase noise introduced by the fiber links and provides an ultra-stable output frequency equivalent to the input reference.
The station compensates the fiber noise of up to 6 parallel branches and collects the incoming down-link signal to assess the round-trip residual instability.
To this purpose, the MLS includes a multi-channel ultra-low-noise optical interferometer, the electronics for noise compensation of 6 links (or 2 or 4 links on demand) and the electronics for round-trip heterodyne detection. The station is fully compatible with Exail RLS and allows to extend the capabilities of a metrological fiber network to star topologies.

Features

- Versatile and modular system
- Up to 6 phase-coherent optical output pairs for simultaneous signal dissemination and stability assessment
- Noise correction electronics for up to 6 links with fully automated phase-locking
- Stability assessment electronics for up to 5 links compatible with commercial frequency counters via RF outputs
- Low-phase-noise laser system
- Automatic polarization control
- Compliant with DWDM Telecom network infrastructures
- Intelligent and autonomous system with remote control of all physical parameters

Wide variety of configurations available

The MLS is available in different configurations depending on the customer need.
The system can be provided with an architecture allowing for internal RF oscillator noise rejection which is suited for non-metrological network nodes such as NREN nodes.
Alternatively, the MLS applies a simpler lay-out without RF noise rejection which may match installation in an NMI-type node where a metrological RF reference is available.

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OPTICAL CHARACTERISTICS

Operating Wavelength	Channel 44 of the ITU grid: 1542.14 nm [1]
Output power	< 2 mW per branch
Laser class	3B
Laser linewidth	< 5 kHz
Output noise figure	< 5 dB
Operating mode	CW
Input power range	between 1 nW and 100 µW
Frequency tunability	50 pm

[1] Other wavelengths available on request (e.g. in L-band)

PHYSICAL CHARACTERISTICS

Dimensions	19'' rack, 545 mm depth, from 11 to 13U depending on the configuration
Weight	55 Kg maximum
Material	Aluminium
Supply voltage	100-240 VAC, 50-60 Hz
Electrical consumption	150 W
Operating temperature	15° C to 35° C
Storage temperature	5° C to 30° C
Humidity	Maximum relative humidity 80 % for temperatures up to 31° C decreasing linearly to 50 % at 40° C.

INTERFACES

Ethernet	RJ45
Radio Frequency	SMA
Optical	LC/APC
Communication protocols	IP, SSH, SNMP

PERFORMANCES

Relative short-term frequency stability	$< 3 \times 10^{-17}$ @1 s
Relative long-term frequency stability	$< 2 \times 10^{-21}$ @103 s
Temperature sensitivity of the interferometer	< 0.1 fs/K

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