OPLL: Optical Phase Locked Loop with Tunable Frequency Offset

Preliminary Specification
January 2011

The new Digital Optical Phase Locked Loop (OPLL) product consists of two RIO high-performance narrow linewidth PLANEX™ lasers, high-speed phase lock loop circuitry and a microprocessor for easy setup, fast tuning and interactive control. It provides two optical signals precisely tuned and phase locked to a specified value of optical frequency difference.

OPLL's unique design is based on RIO's proprietary External Cavity Laser Planar Technology (PLANEX™). PLANEX laser cavity consists of a gain chip and a Planar Lightwave Circuit PLC) with waveguide Bragg grating. PLANEX laser has significant advantages, critical to OPLL performance:

- ✓ Low frequency noise, narrow linewidth
- ✓ Low relative intensity noise (RIN)
- ✓ Excellent wavelength stability
- ✓ Offset frequency tuning

The OPLL module is providing two optical signals with a tunable wavelength offset and locking wavelength difference. Performance and features OPLL module provides end users with a stable, self-contained, easy-to-use & cost-effective solution. This is the most reliable alternative to expensive custom OPLL modules, based on fiber lasers or other laser sources.

The OPLL module has optical and electrical I/O and standard data interfaces for external monitoring and control. The OPLL module is an integrated source solution for fiber optic sensing applications, such as Brillouin DTSS systems for oil & gas and infrastructure monitoring, LIDAR and microwave photonics.

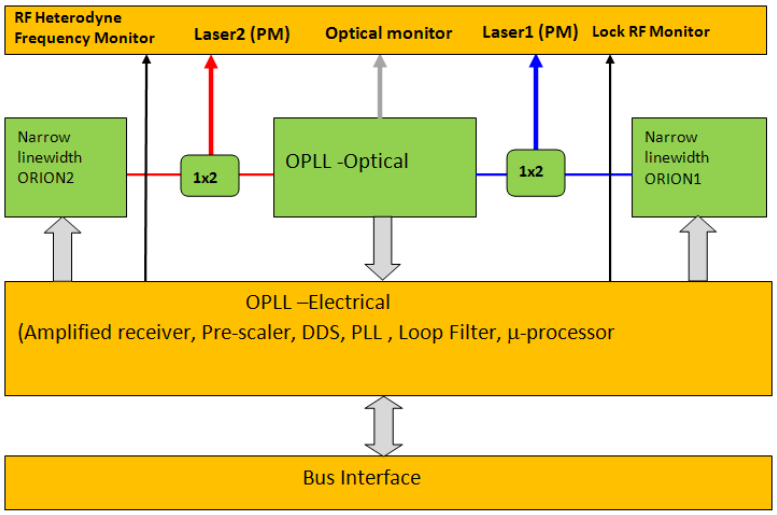
KEY FEATURES

- Two lasers outputs with specified wavelengths
- Selectable wavelength offset locking and monitoring
- PM output
- Option with optical amplifier for high output power
- Monitoring ports for optical signal, RF beat frequency and PLL lock signal
- Single longitudinal mode, narrow linewidth, long coherence length
- 1528nm-1565nm, ITU-T DWDM wavelength or custom
- Compact, low power dissipation
- Digital controller and firmware
- GUI, USB port and Data I/O

APPLICATIONS

- Brillouin (BOTDA/BOTDR) Distributed Temperature and Strain sensing (DTSS)
- Metrology
- Coherent Optical Communications
- Microwave photonic s
- RF over the fiber
- LIDAR
- Tunable heterodyne source
- Testing of high speed optical receivers

OPLL Block-diagram



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Absolute Maximum Ratings

Operation of the device beyond these maximum conditions may degrade device performance, lead to device failure, shorter lifetime, and will invalidate the device warranty.

Parameter	Min	Max	Unit
Storage temperature	- 40	+ 85	ºC
Supply voltage			V
ESD-susceptibility		500	V
Humidity (Non condensing)	5	95	**%**

Performance specifications

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Output Power	P_{out}	Ports L1, L2		5		mW
L_1 (port 1) wavelength [1]	λ_1			1550.12		nm
L_2 (port 2) wavelength [1]	λ_2			λ_1 + 0.09		nm
Lorentzian linewidth [2]	$\Delta\nu$	L1, L2, CW		10		kHz
Side mode suppression ration	SMSR		45	50		dB
Frequency noise under locking conditions,	$S^{1/2}(f)$	at 100 Hz		1000		Hz/√Hz
		at 1 kHz		200		
Relative Intensity Noise	RIN	> 10 kHz			-155	dB/Hz
Frequency locking range [3]	f_{lock}		8		14	GHz
Continuous locking tuning range	f_{sweep}				1	GHz
Reference locking offset frequency	f_{ref}			11		GHz
Frequency step tuning, GUI selectable	f_{step}		0.01		10	MHz
Locked step response time at 10 MHz step	τ_{10}			5		µsec
Locked step response time at 100 MHz step	τ_{100}			15		µsec
Locked step size	δ_f				300	MHz
Search for lock time outside of lock range	$\delta f/t$			50		MHz/sec
Phase noise at 100 kHz offset from the carrier	PSD				-65	dBc/Hz
Power variation (RMS) over 1 MHz offset tuning	$\delta P/P$				0.1	%
Sweep mode, continuous, numbers of step and step size are GUI selectable	$f_{stop} - f_{start}$				1	GHz
Operating case temperature			10		55	°C
Power Dissipation					12	W
AC power consumption					40	W
Dimensions			19" rack mountable, 2U			

[1] Custom wavelength is available, see ordering information
[2] Under locking condition Reference locking frequency difference
[3] GUI selectable ranges

Output ports and connectors

	Type	Function	Description
L1	Optical FC/APC PM	Laser 1 output	
L2	Optical FC/APC PM	Laser 2 output	
Beat frequency	Optical FC/APC PM	Lasers output L1 and L2	
Beat frequency	Electrical SMA		RF monitor (-20 to –30 dBm)
Lock monitor	Electrical BNC	Lock Monitor	• -5V to +5V into resistive load ≥1k if actively locking • In open loop, monitor is near 0
Data	USB	Control interface	interface, GUI
Power	AC		85 to 260 VAC
Fuse			US – single 1A, Europe dual 1A

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Ordering Information

R	I	O	2	1	3	5	-	1	-	X	X	-	1

Product family	
2	OPLL

Controller Interface	
3	USB

Fiber/Connector	
5	PM/FC-APC

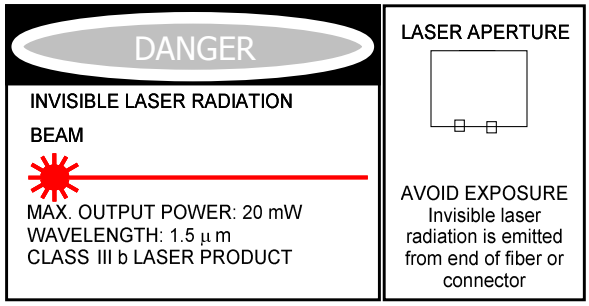
Output Power	
1	5 mW (typical)

Wavelength	
00	1550±10nm
01	custom
ITU	DWDM ITU channel

Linewidth	
1	<15 kHz

Laser Safety Information

Laser Modules are classified as FDA/CDRH Class IIIb laser products per CDRH, 21 CFR 1040 laser safety requirements.



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