Wavelength
REFERENCES

Clarity™
Precision Frequency Standard
Narrow Line Semiconductor Laser

The Wavelength References Clarity laser family locks a laser emission to a molecular absorption line. The instrument drives a semiconductor laser in a unique configuration that creates superb frequency stability traceable to a physical constant and thus forms a primary frequency standard. The Clarity can lock to several transitions and materials, check for availability.

The laser ships as one of two models:

1. The Clarity PFR series ships with SMF28e output and offers locking to the center wavelength of an absorption line (called Reference Mode). This provides excellent long term stability and an accurate traceable reference.
2. The Clarity NLL series ships with PM Panda output and offers Reference Mode as described plus an additional mode: Line Narrowed Mode. This mode uses the side of the absorption line as a frequency discriminator to reduce the linewidth down to as low as <50 kHz. This is an excellent choice for interferometric applications.

Both models have a 2 mW (LP) version and a 25 mW (HP) version.

Consult factory with any questions or application-specific configurations.

Specifications[1]	Performance	Notes
Wavelengths	1312nm, 1550nm regions	Consult factory for availability at other wavelengths
Lock Modes	Line Narrowing Reference	Locks to side of absorption line Locks to center of absorption line
Absolute Accuracy	<±0.1ppm <±0.02pm typical	< ± 0.3pm (expanded uncertainty)
Wavelength Short Term Stability	< 5 MHz, Reference < 1 MHz, Line Narrowed	RMS. 25 ˚C after 20 min. warm up, 1000 sec. with 0.01 sec gate.
Allan Deviation	$<1x10^{-9}$ $<5x10^{-10}$	Typical 100 seconds all modes Typical 1000 seconds Reference Lock
Wavelength Modulation Artifacts	None	No intentional wavelength modulation
Laser Linewidth (Line Narrowing Mode)	< 50 kHz <150 kHz	NLL Low Power (LP) NLL High Power (HP)
Laser Linewidth, nominal (Reference Mode)	1 MHz 5 MHz	NLL LP, NLL HP, PFR HP PFR LP
Side Mode Suppression	>35 dB	Typical
Output Power, nominal	2 mW 25 mW	Low Power (LP) High Power (HP)
FiberType	SMF28e PM Panda	PFR model NLL model
Fiber Interface	SCAPC	SCAPC-FCAPC jumpers available
External Interface	RS-232	
Operating Temperature	0˚C to +50 ˚C	
Power Requirements	90-250 VAC, 50/60 Hz, 0.5 amp	Module requirements +5V @ 2 amp

1. 25 °C; Specifications subject to change without notice

Features

- **Primary frequency standard**
- **Ultimate in stability and accuracy**
- **Low cost**
- **Low acoustic sensitivity**
- **Linewidths < 50 kHz available**
- **25mW "High Power" available**

Applications

- **Calibration of optical instrumentation**
- **Sensing**
- **Interferometry**
- **Coherent communications**

Ordering Information (example)

NLL-1550-LP

Model (see above)
PFR
NLL

Wavelength:
1312, 1550
Others available

Output Power
LP: 2mW
HP: 25mW

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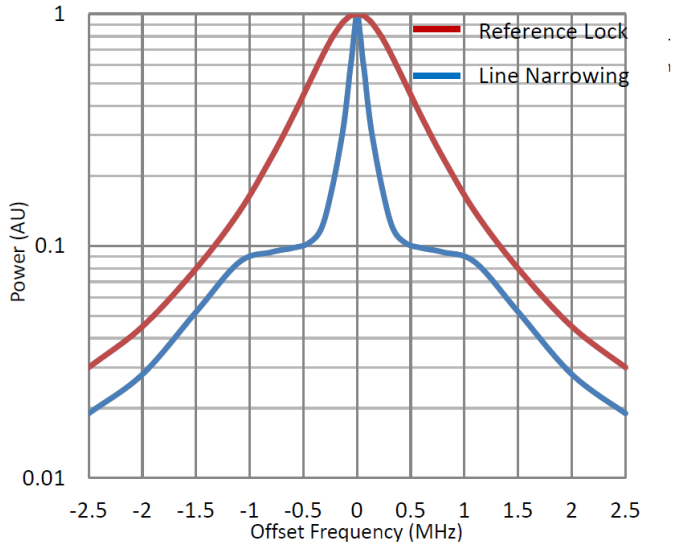
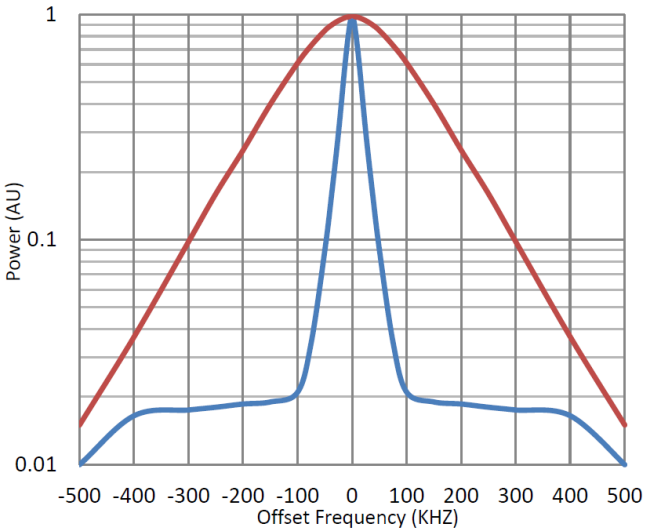
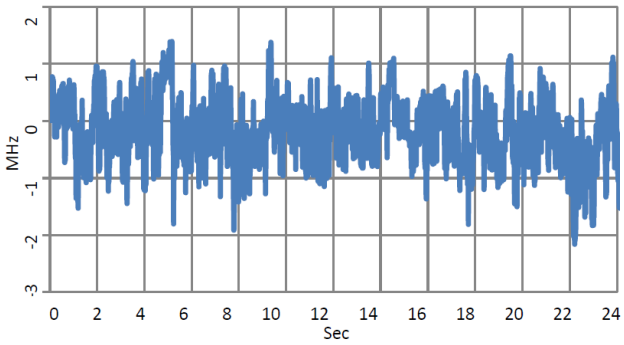


Lineshape of a Clarity NLL-1541-HP high power laser in the two operating modes: Reference Mode (locking to the center of the line) and Line Narrowed Mode (locking to the side of the line). The FWHM of this laser is 900 kHz in Reference mode and 150 kHz in Line Narrowed mode.



Lineshape of a Clarity NLL-1541-LP low power laser in the two operating modes: Reference Mode (locking to the center of the line) and Line Narrowed Mode (locking to the side of the line). FWHM of this laser is 200 kHz in Reference Mode and 25 kHz in Line Narrowed mode.



Short Term stability of the Clarity in Reference mode. The long term absolute accuracy is set by the unvarying gas absorption line. < 600kHz standard deviation.

Laser Phase Noise, Linewidth and Frequency Stability

The Clarity locked laser is referenced to a fundamental physical constant: the vibrational-rotational energy level of a specific molecular gas. These energy levels are highly insensitive to environmental effects such as temperature, time or electromagnetic field. The Consultive Committee for Length has specified C13 acetylene as a primary standard definition of the meter. NIST has developed a number of SRMs based on molecular lines as primary wavelength standards for telecommunication DWDM systems. The reproducibility of an acetylene-locked Clarity laser is < 1 MHz with absolute long-term accuracy specified at < ±0.1pm (±0.02pm typical).

The parameters of laser wavelength stability, phase noise and linewidth all refer to the frequency fluctuations of the laser but over different time scales. For white phase noise, the relationship between linewidth and phase noise is relatively simple resulting in a Lorentzian lineshape. Most vendors use only the Lorentzian component in their linewidth specifications which ignores the lower frequency 1/f component. The Clarity, being locked to an unvarying molecular line, suppresses the phase noise down to DC. This opens up a whole new range of applications where the absolute frequency stability must persist in all frequency regimes. With this, most low power communication DFB lasers have a linewidth of 3-5MHz while special high power version can exhibit linewidths of < 1 MHz. The Clarity PFR and NLL-HP use DFB lasers but the NLL-LP uses a laser with a different technology offering superior linewidth performance.

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