

# 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 primary frequency standard. The Clarity can lock to several transitions and materials, check for availability.

The locking mechanism also has the ability to narrow the linewidth of the laser which when coupled with our low noise electronics can achieve a linewidth of <30KHz making the product ideal for a wide range of interferometric applications. Unlike other lasers marketed at this application the low phase noise persists over even low frequency where often 1/f components are significant and can be troublesome.

We can offer custom module or board only designs for OEM applications that have very attractive price, form factor, and power dissipation.

Specification	Performance	Notes
Wavelengths Available	1300nm and 1500nm regions	Consult factory for availability of wavelengths
Lock Wavelength Modes	Line Narrowing Reference Lock	Locks to side of absorption line Locks to the center of the absorption line
Absolute Accuracy	<±0.1ppm <±0.02ppm typical	Acetylene locked laser at 25°C ± 5°C after 20 minute warm up and self scan in reference lock
Wavelength Short Term Stability	<600KHz RMS	Reference lock at 25°C after 20 minute warm-up, 0.001 sec to 1000 sec
Allan Deviation	<1x10 <sup>-10</sup> <5x10 <sup>-11</sup>	Typical 100 seconds all modes Typical 1000 seconds reference lock
Wavelength Modulation Artifacts	none	Locking process does not introduce intentional wavelength modulation
Laser Linewidth (Line Narrowing mode)	<30KHz <150KHz <1MHz <5MHz	NLL High Power NLL option High Power PFR option Standard PFR
Laser Linewidth (Reference Lock)	<200KHz <1 MHz <1MHz <5MHz	NLL High Power NLL option High Power PFR option Standard PFR
Side Mode Suppression	>35 dB	Typical
Output Power	5mW >30mW	Typical High Power option
Fiber Type	SMF28e PM Panda	Typical High Power option
Fiber Interface	SCAPC	
External Interface	RS232	
Operating Temperature	0°C to +50°C	
Power Requirements	90-250VAC, 50/60Hz 0.5 amp	Module requirements +5V @ 2 amp

## Features

- The ultimate in stability and accuracy, primary frequency standard
- Narrow linewidth, <30KHz
- Low cost
- Low acoustic sensitivity
- High power

## Applications

- Calibration of optical instrumentation
- Sensing
- Interferometry

## Options

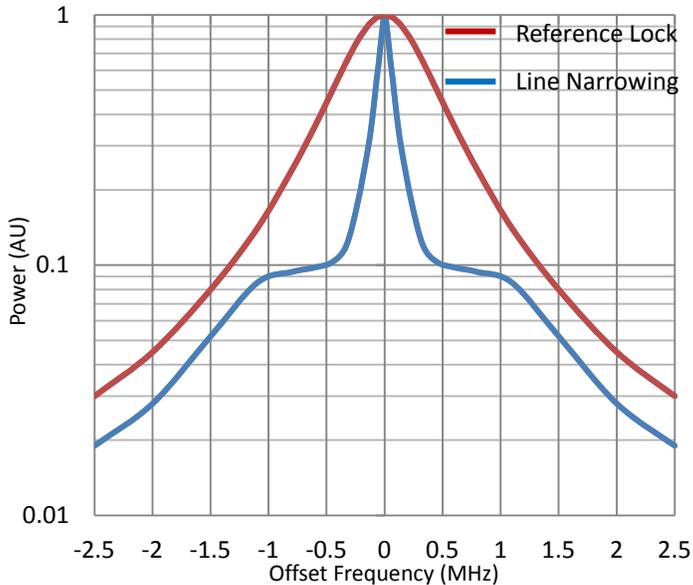
- PFR primary frequency reference
- NLL narrow line
- OEM module
- Standard wavelengths in 1530-1560 nm region and 1310nm region and wherever a suitable gas line and laser are available

**Wavelength  $\lambda$  References Inc**

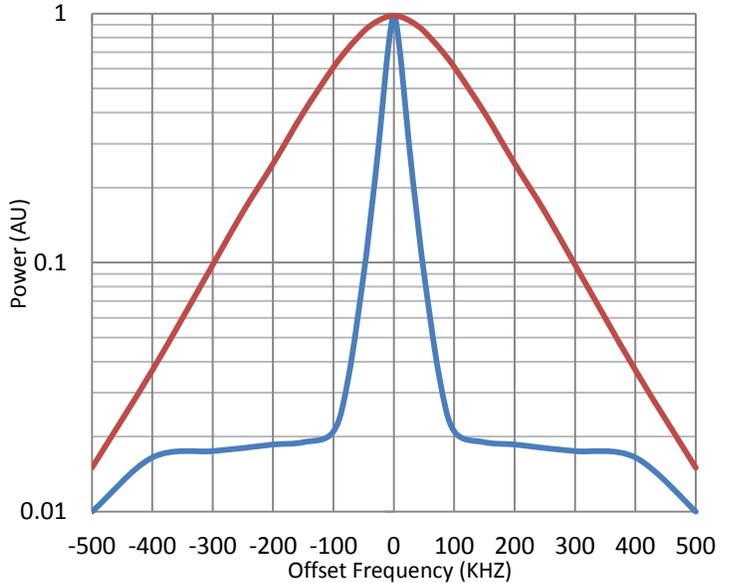


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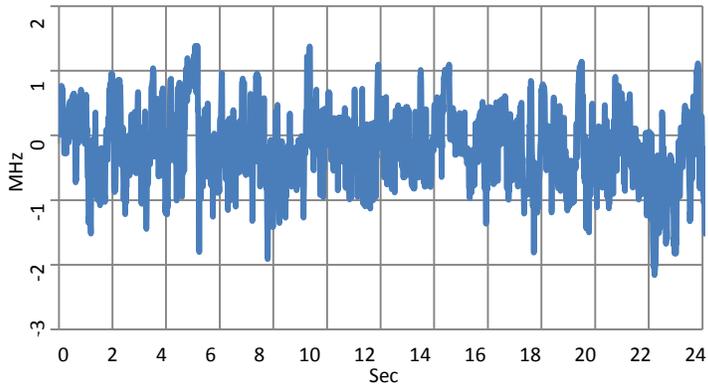
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Lineshape of Clarity-NLL-1541-HP high power laser in the two operating modes, the reference mode which references the average laser frequency to the center of the absorption line and the line narrowing mode which uses the gas cell line to narrow the linewidth of the laser. The FWHM of the laser is 900 KHz in reference mode and 150KHz in line narrowing mode.



Lineshape of Clarity-NLL-1541 laser in the two operating modes, the reference mode which references the average laser frequency to the center of the absorption line and the line narrowing mode which uses the gas cell line to narrow the linewidth of the laser. The FWHM of the laser is 200 KHz in reference mode and 25KHz in line narrowing mode.



Short term stability of the Clarity in reference lock. The standard deviation of the frequency fluctuations is <600KHz. The long term absolute accuracy is set by the unvarying gas absorption line.

### Ordering Information:

#### Examples:

##### Clarity-PFR-1530

This is the low cost primary frequency reference stabilized to the P9 line of C12 acetylene. The laser may be ordered at 1530nm or 1312nm stabilized to hydrogen flouride. Other wavelengths may be available, please consult factory.

##### Clarity-NLL-1541

The ultra narrow linewidth laser stabilized to the P16 line of C13 acetylene.

##### Clarity-NLL-1541-HP

The high power option of the narrow line laser. This laser combines >30mW output with PM fiber and a linewidth of <150KHz.

#### Standard wavelengths:

- 1530-1560nm region
- 1300nm region
- 1653nm (methane)
- 2000nm (CO2)

## Laser Phase Noise, Linewidth, and Frequency Stability

The Clarity-PFR laser wavelength is referenced to a fundamental physical constant, the vibrational rotational energy level of a specific molecular gas. These molecular energy levels show remarkable insensitivity to environment such as temperature, time, or electromagnetic fields. They are for example much more stable than spectroscopic discharge lamps or gas lasers such as even a stabilized HeNe laser. The Consultive Committee for Length has specified C13 acetylene lines as a primary international standard definition of the meter. NIST has developed a number of SRMs based on molecular lines as primary wavelength standards for telecommunications DWDM systems. The reproducibility of the acetylene locked Clarity laser's average wavelength is <1 MHz with the absolute long term accuracy specified at better than  $\pm 0.1\text{pm}$  ( $\pm 0.02\text{pm}$  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 which can be troublesome. The Clarity, being locked to an unvarying molecular line, suppresses the phase noise all the way 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 line width of 3-5MHz while special high power versions can exhibit line widths of <1MHz. The Clarity PFR and NLL-HP use DFB lasers but the ultra narrow NLL utilizes a laser with a different technology offering superior line width performance.