
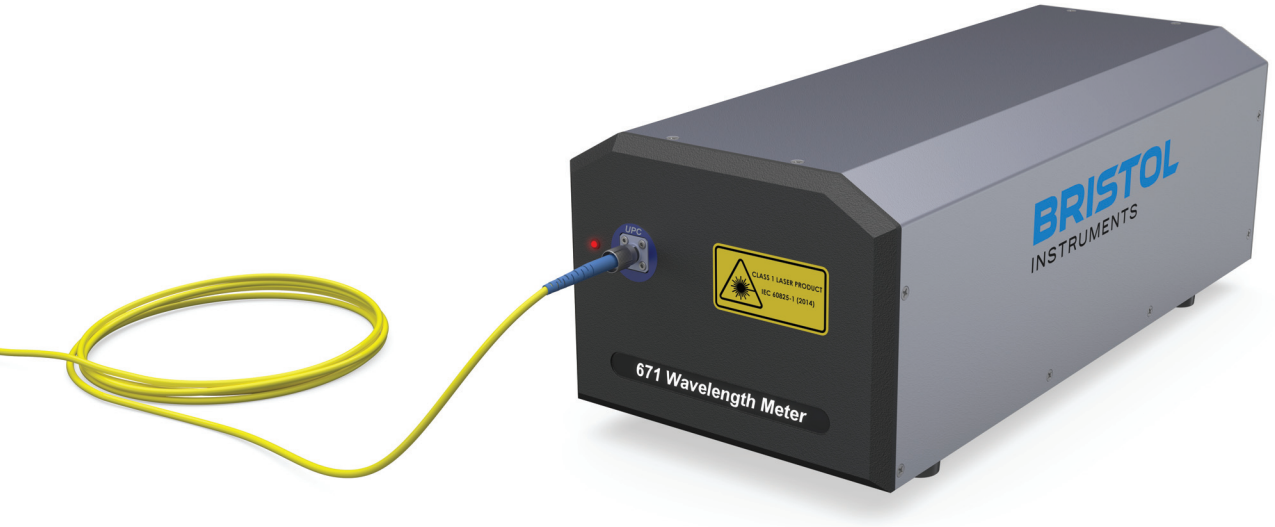


## **671** Series

# LASER WAVELENGTH METER

Using proven **Michelson interferometer-based design** gives you **reliable accuracy** as high as ± 0.2 parts per million for **greater confidence** in your experimental results.

BRISTOL INSTRUMENTS

**p:** (585) 924-2620
**w:** www.bristol-inst.com
**e:** info@bristol-inst.com

**The 671 Series Laser Wavelength Meter is ideal for scientists and engineers who need to know the exact wavelength of their CW laser. The 671 system employs a proven Michelson interferometer-based design to measure laser wavelength to an accuracy as high as ± 0.0001 nm. What's more, this is accomplished with an unprecedented level of reliability, versatility, and convenience.**

## LASER WAVELENGTH MEASUREMENT

Two versions of the 671 Laser Wavelength Meter are available. The model 671A is offered for the most demanding experiments, measuring laser wavelength to the highest accuracy of ± 0.2 parts per million. For experiments that are less exacting, the model 671B is a lower-priced alternative with a wavelength accuracy of ± 0.75 parts per million. The MIR version of the model 671B has a wavelength accuracy of ± 1 part per million.

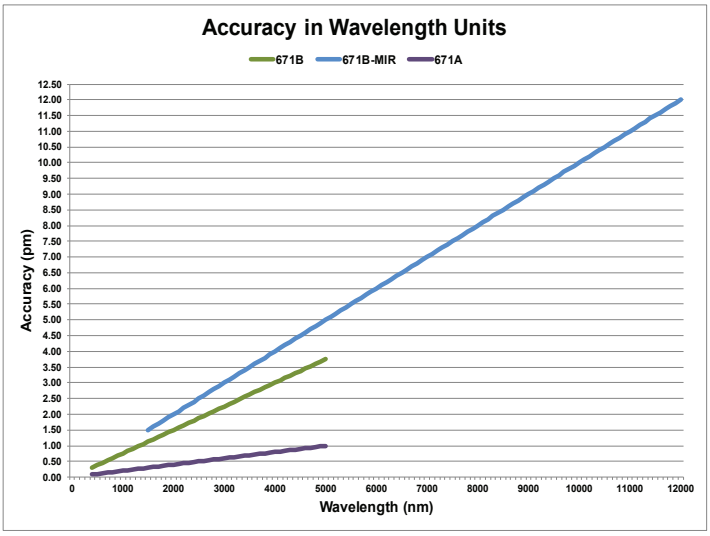


***Figure 1.** ± Accuracy in picometers vs. Wavelength for the 671 product family*

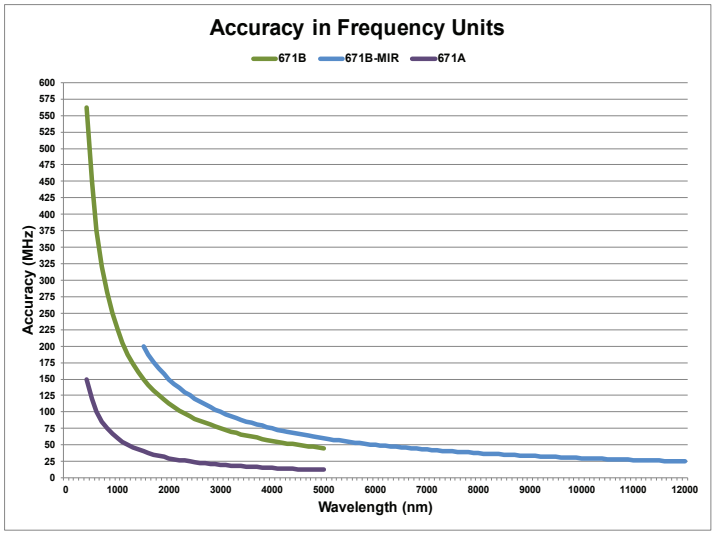


***Figure 2.** ± Accuracy in MHz vs. Frequency for the 671 product family*

### Guaranteed Accuracy

The most important aspect of a laser wavelength meter is its accuracy. Bristol Instruments guarantees this specification by taking into account all factors that can affect wavelength measurement.

Wavelength accuracy is quantified by Bristol Instruments using the NIST definition for expanded uncertainty. Components of error arising from both systematic and random effects are included. Systematic errors result in an offset between the measured value and the true value. Random errors result in measurements that have a statistical distribution associated with short-term measurement repeatability.

The 671 Laser Wavelength Meter is designed to address both types of uncertainty. Continuous instrument calibration with a built-in wavelength standard corrects for potential sources of systematic error. Random errors are minimized with a robust Michelson interferometer design.

## Continuous Calibration

To ensure the most meaningful experimental results, the wavelength accuracy specifications are guaranteed by continuous calibration with a built-in HeNe laser. This is an ideal reference source because its wavelength is well-known and fixed by fundamental atomic structure. To achieve the highest accuracy of ± 0.2 parts per million, the 671A system uses a single-frequency HeNe laser that is stabilized using a precise balanced longitudinal mode technique. A standard HeNe laser is used as the wavelength reference in the model 671B to achieve an accuracy specification of ± 0.75 parts per million.

## Exceptional Repeatability

The design of the 671 Laser Wavelength Meter is based on Bristol's unique expertise in Michelson interferometer technology and how it is applied to laser wavelength measurement. This results in exceptional measurement repeatability which ensures that all wavelength measurements are well within the specified accuracy limits.

The repeatability specification for the model 671A is defined as the standard deviation of all measurements over a 10-minute period. This is 0.03 parts per million (0.06 parts per million with the IR version). Because of the longitudinal mode drift of the standard HeNe reference laser used in the model 671B, long-term measurement variations can be as high as 0.4 parts per million. However, the standard deviation over a period of one minute is 0.1 part per million.

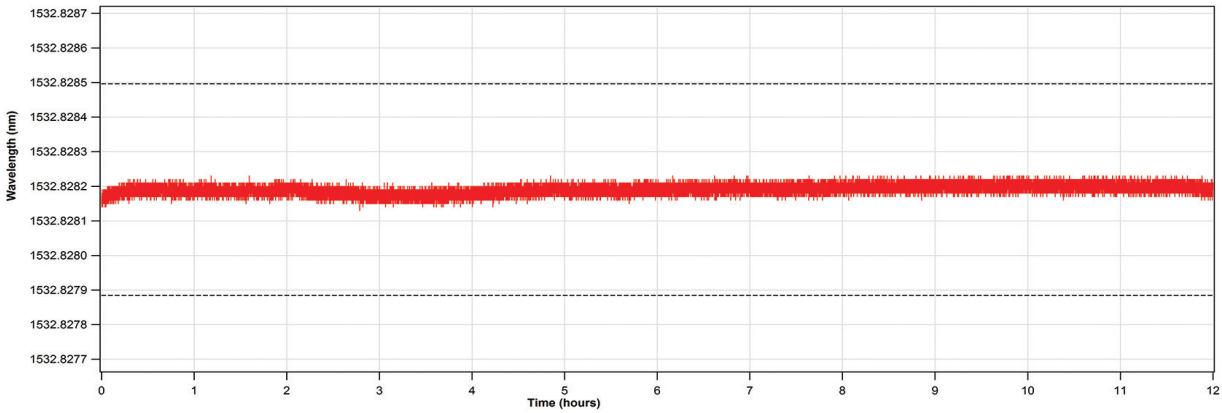


***Figure 3.** Long-term wavelength measurement data of a DFB laser locked to an absorption line of acetylene. The specified accuracy is given by the dashed lines.*

The measurement repeatability specification of the 671 Laser Wavelength Meter also defines its ability to detect small changes in laser wavelength. This wavelength resolution is approximately two times the specified repeatability. Therefore, the model 671A can detect wavelength changes as small as 0.06 parts per million (0.06 pm at 1000 nm). The 671B system can determine a wavelength deviation as small as 0.2 parts per million (0.2 pm at 1000 nm).

# OPERATION

The 671 Laser Wavelength Meter measures laser wavelength with an unsurpassed level of reliability, versatility, and convenience. Five broad wavelength configurations are available, laser input is straightforward, and the system has a very high sensitivity. Wavelength is calculated using an on-board digital signal processor and then displayed on a PC. On-board processing provides the end-user with maximum flexibility in their choice of connection computer. It is also easy to integrate the 671 Laser Wavelength Meter into an experiment for automatic wavelength reporting via the included SCPI command library.

## Broad Wavelength Coverage

The 671 Laser Wavelength Meter is available in five broad wavelength configurations to satisfy virtually any experimental requirement.

- **VIS (375 – 1100 nm)**
- **NIR (520 – 1700 nm)**
- **NIR2 (1 – 2.6 µm)**
- **IR (1 – 5 µm)**
- **MIR (1.5 – 12 µm)**

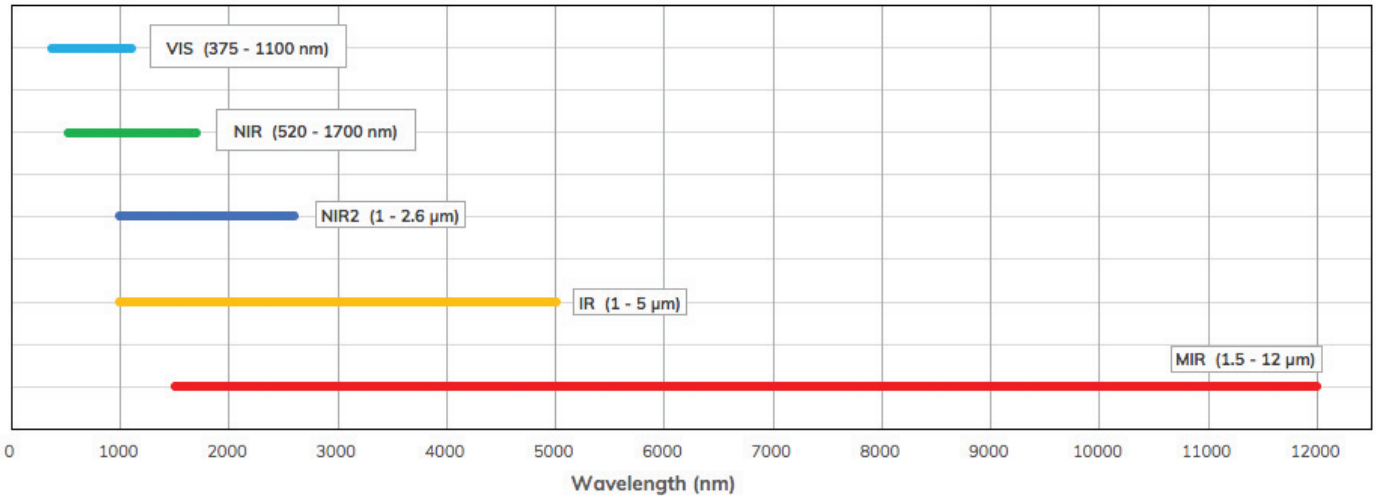


***Figure 4. Available wavlength configurations of the 671 Series Laser Wavelength Meter***

## Convenient Laser Input

A laser under test (LUT) enters the VIS, NIR, and NIR2 versions of the model 671 through a pre-aligned FC/UPC or FC/APC fiber-optic input connector. This ensures optimum alignment of the laser beam to the instrument's interferometer resulting in uncompromised accuracy. With fiber-optic input, the 671 system can be placed in an out of the way location, thereby conserving valuable optical bench space.

Since optical fiber is not readily available for infrared wavelengths, the laser under test enters the IR and MIR versions of the model 671 as a collimated, free-space beam through a 2-3 mm input aperture. To facilitate alignment to the instrument, the internal HeNe reference laser is emitted from the input aperture as a visible tracer beam. The laser under test is simply superimposed on the tracer beam to optimize alignment. This is accomplished by using the three adjustable-height legs (± 0.25") of the 671 system.


***Figure 5.** Front panel layout for fiber coupled models.*


***Figure 6.** Front panel layout for free-space models.*
***(Note: aperture and height adjustable legs)***

## High Sensitivity

The minimum input signal required by the 671 Laser Wavelength Meter is as low as 5 µW. Therefore, only a small portion of your laser needs to be diverted from an experiment to the wavelength meter. In addition, the electronic gain of the 671 system is adjusted automatically to accommodate changes in the input signal which is particularly useful, for example: when scanning a tunable laser over its operational wavelength range.

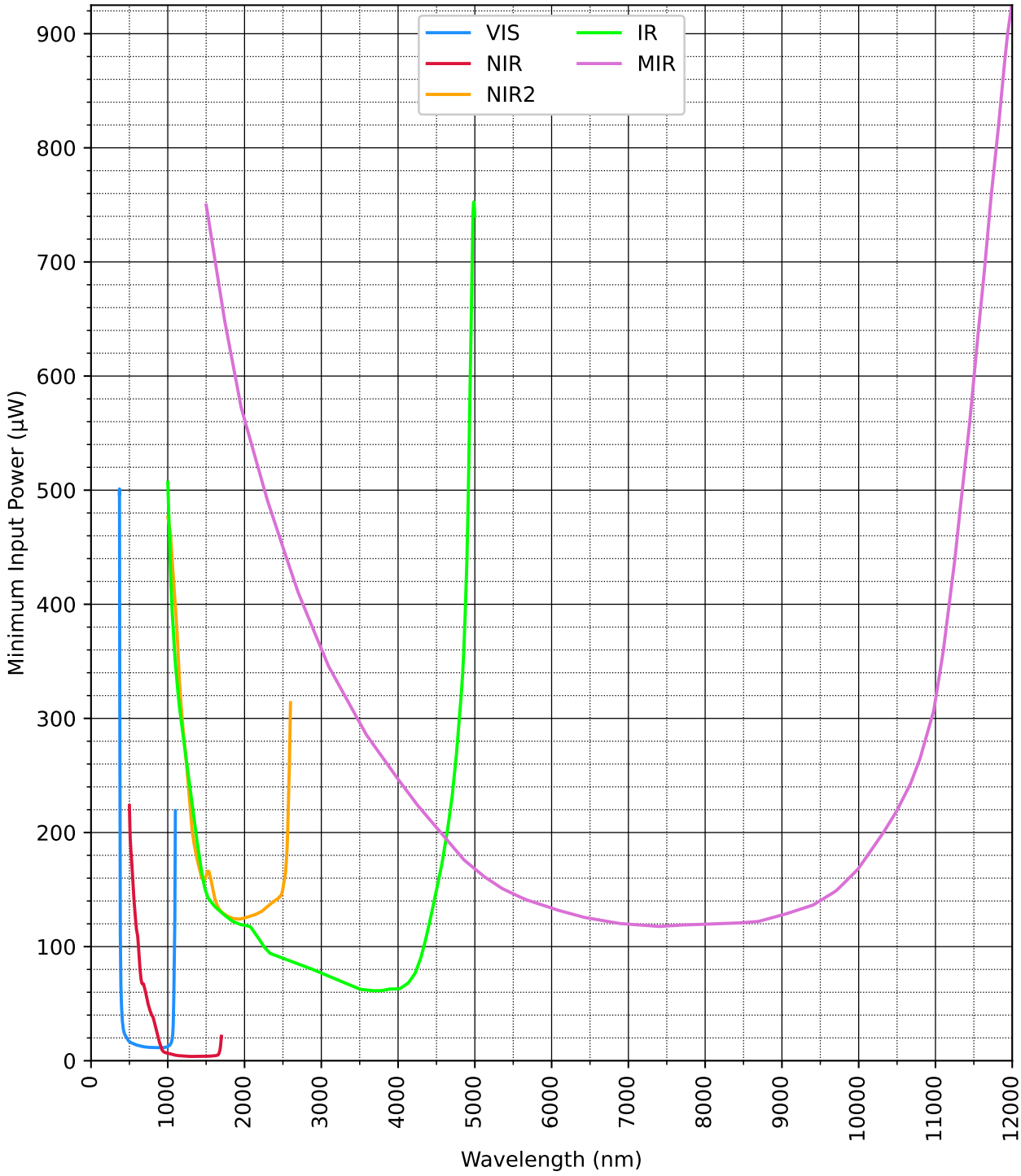


***Figure 7. Minimum Input Power vs. Wavelength for the 671 instrument models***

## Simultaneous Optical Power Measurement

In order to provide a more complete analysis of laser performance, the VIS and NIR versions of the 671 Laser Wavelength Meter measure the total optical power of the input signal. The accuracy of the power measurement is ± 15%.

The NIR2, IR, and MIR versions do not measure power, but they do display a graphical representation of the relative input intensity to aid instrument setup and alignment.

## Versatile Instrument Interface

The 671 Laser Wavelength Meter determines wavelength in real-time using an on-board digital signal processor. Therefore, the measured wavelength information can be accessed in a variety of ways.

- Data can be transferred and displayed on a Windows-based PC using USB and NuView™ software provided with the instrument. The 671 system can also connect directly to a PC via USB, or a local area network using Ethernet.
- The 671 system, when connected to a capable local area network, can report wavelength measurements to any PC or mobile device via a web browser.
- The 671 Laser Wavelength Meter can be easily integrated into an experiment for automatic wavelength reporting and control. Our on-board signal processing eliminates the need for a dedicated PC so calculated wavelength information can be sent directly from the instrument to any computer for use with LabVIEW or other custom programming. What's more, the system's library of SCPI (Standard Commands for Programmable Instruments) commands can be used with any PC and any operating system.


***Figure 8. 671 system rear panel connection layout***

## Wavelength Measurement Display

The *NuView*™ software provided with the 671 Laser Wavelength Meter reports measurement data with an easy-to-read display. It offers many user customizable features to tailor measurements to your specific application. Measurement units can be expressed in wavelength (nm or µm), wavenumber ($cm^{-1}$), or frequency (GHz or THz). Power is reported in a linear (mW) or logarithmic (dBm) format. Every measurement can be displayed, or a rolling average of as many as 100 measurements can be calculated automatically.

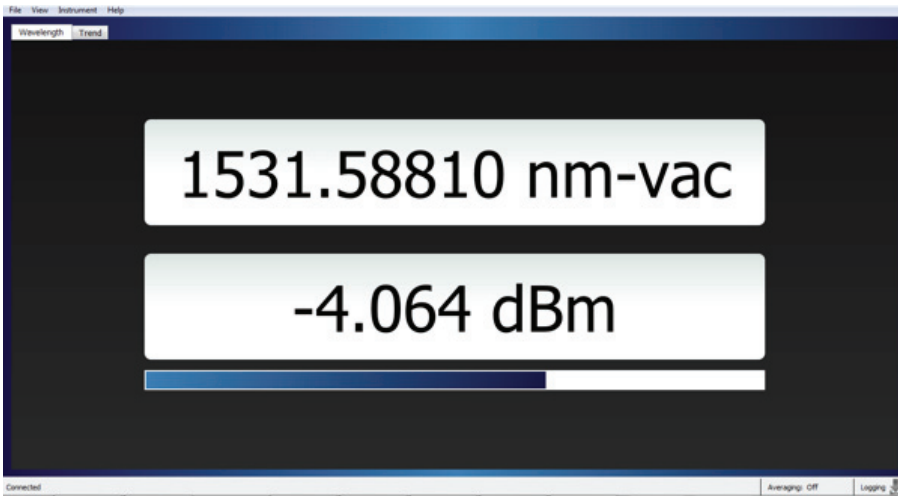


***Figure 9.** Wavelength and power measurment results for the 671 VIS and NIR models*

The NIR2, IR, and MIR versions of the model 671 do not measure optical power, and therefore only display wavelength measurements and a graphical respresentation of relative intensity to aid with instrument alignment.

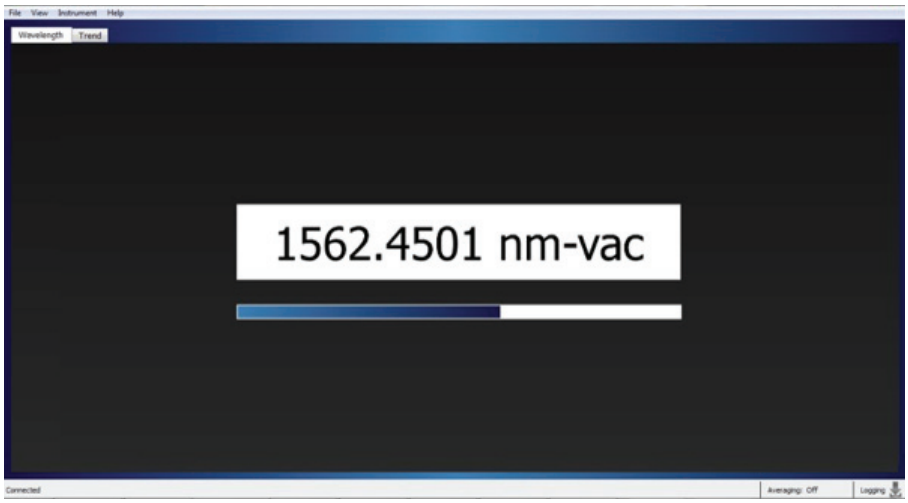


***Figure 10.** Wavelength measurement results with relative intensity bar below for the 671 NIR2, IR and MIR models*

Wavelength data can also be logged to a file using a *.csv format for analysis with other graphing programs. Data can be logged by number of measurements, amount of time, or continuously until the logging is stopped manually.

## Wavelength Measurement Trends

The 671 Laser Wavelength Meter display software offers an integrated wavelength trending feature that automatically charts a laser's wavelength over time. A rolling graphical trace of up to 100,000 wavelength measurements can be displayed and recorded. A variety of statistics over the measurement period are also computed. These include the maximum and minimum wavelength measurements, laser drift (current wavelength - start wavelength), standard deviation, and mean. These values are reported in a table below the trend graph.

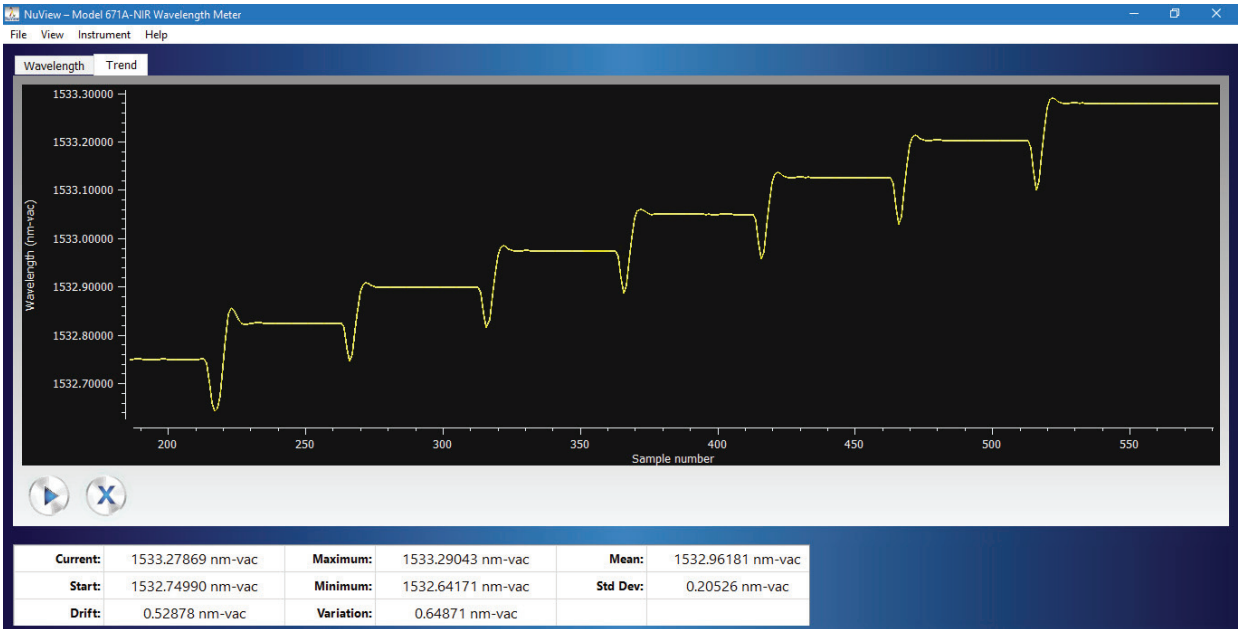


***Figure 11.** NuView™ wavelength trend display of a tunable laser, showing the settling behavior as the laser wavelength is tuned at 5 minute intervals.*

# SPECIFICATIONS — 671 Series

| | | |
|---|---|---|
| **MODEL** | 671A | 671B |
| **LASER TYPE** | CW and quasi-CW (repetition rate > 10 MHz) | |
| **WAVELENGTH** | | |
| Range | VIS: 375 - 1100 nm<br>NIR: 520 - 1700 nm<br>NIR2: 1 - 2.6 µm<br>IR: 1 - 5 µm<br>MIR: 1.5 - 12 µm | |
| Accuracy [1, 2] | ± 0.2 ppm (± 1 ppm for MIR λ > 5 µm)<br><br>± 0.0002 nm @ 1000 nm<br>± 0.002 $cm^{-1}$ @ 10,000 $cm^{-1}$<br>± 60 MHz @ 300,000 GHz | ± 0.75 ppm (± 1 ppm for MIR λ > 5 µm)<br><br>± 0.0008 nm @ 1000 nm<br>± 0.008 $cm^{-1}$ @ 10,000 $cm^{-1}$<br>± 225 MHz @ 300,000 GHz |
| Repeatability [3, 4, 5] | VIS/NIR/NIR2: 0.03 ppm (0.03 pm @ 1000 nm)<br>IR: 0.06 ppm (0.2 pm @ 3 µm)<br>MIR: 0.1 ppm (1 pm @ 10 µm) | 0.1 ppm (0.1 pm @ 1000 nm) |
| Calibration | Continuous - built-in stabilized single-frequency HeNe laser | Continuous - built-in standard HeNe laser |
| Display Resolution | 9 digits | 8 digits |
| Units [6] | nm, µm, $cm^{-1}$, GHz, THz | |
| **POWER (VIS / NIR) [7]** | | |
| Calibration Accuracy | ± 15% | |
| Resolution | 2% | |
| Units | mW, µW, dBm | |
| **OPTICAL INPUT SIGNAL** | | |
| Maximum Bandwidth [8] | 1 GHz | 10 GHz |
| Minimum Input [9, 10] | VIS: 10 - 500 µW<br>NIR: 5 - 225 µW<br>NIR2: 125 - 500 µW<br>IR: 65 - 750 µW<br>MIR: 120 - 925 µW | |
| Maximum Input | 10 mW | |
| **MEASUREMENT RATE** | 4 Hz (VIS / NIR / NIR2) 2.5 Hz (IR / MIR) | 10 Hz (VIS / NIR/ NIR2) 2.5 Hz (IR / MIR) |
| **INPUTS/OUTPUTS** | | |
| Optical Input [11] | VIS/NIR: Pre-aligned FC/UPC or FC/APC connector (9 µm core diameter) - optional free beam-to-fiber couplers<br>NIR2: Pre-aligned FC/UPC or FC/APC connector (7 µm core diameter) - optional free beam-to-fiber couplers<br>IR/MIR: Collimated beam, 2-3 mm diameter aperture, visible tracer beam to facilitate alignment | |
| Instrument Interface | USB and Ethernet interface with Windows-based display program<br>Library of commands (SCPI) for custom and LabVIEW programming using any PC operating system | |
| **COMPUTER REQUIREMENTS [12]** | PC running Windows 10/11, 1 GB available RAM, USB 2.0 (or later) port, monitor, pointing device | |
| **ENVIRONMENTAL[10]** | | |
| Warm-Up Time | < 15 minutes | None |
| Temperature \| Pressure \| Humidity | +15°C to +30°C (-10°C to +70°C storage) \| 500 – 900 mm Hg \| ≤ 90% R.H. at + 40°C (no condensation) | |
| **DIMENSIONS AND WEIGHT** | | |
| Dimensions (H x W x D)[13] | VIS / NIR / NIR2: 5.6" x 6.5" x 15.0" (142 mm x 165 mm x 381 mm) | IR / MIR: 7.5" x 6.5" x 15.0" (191 mm x 165 mm x 381 mm) |
| Weight | 14 lbs (6.3 kg) | |
| **POWER REQUIREMENTS** | 90 - 264 VAC, 47 - 63 Hz, 50 VA max | |
| **WARRANTY** | 5 Years (parts and labor) | |

(1) Defined as measurement uncertainty, or maximum wavelength error, with a confidence level of ≥ 99.7%.
(2) Traceable to accepted physical standards.
(3) For 671A, standard deviation for a 10 minute measurement period after the instrument has reached thermal equilibrium.
(4) For 671B, standard deviation for a 1 minute measurement period after the instrument has reached thermal equilibrium. Long-term measurement variations due to longitudinal mode drift of the HeNe reference laser are < 0.4 ppm.
(5) Wavelength resolution is approximately two times repeatability.
(6) Data in units of nm, µm, and $cm^{-1}$ are given as vacuum values.
(7) The NIR2, IR, and MIR versions do not measure absolute power. An intensity meter displays relative power.
(8) Bandwidth is FWHM. When bandwidth is greater, wavelength accuracy is reduced.
(9) Sensitivity at specific wavelengths can be determined from a graph provided in the 671 Series Product Details brochure.
(10) Characteristic performance, but non-warranted.
(11) IR and MIR required beam height is 5.4 ± 0.25".
(12) For use with Windows-based display program. Interface with SCPI can be done using any PC operating system.
(13) IR and MIR instrument height is adjustable (7.25 ± 0.25") for alignment purposes.


CE

Bristol Instruments reserves the right to change the specifications as may be required to permit improvements in the design of its products.

REV 06-25