High Speed Fiber Optic Infrared Transmitter
is "Spot-On" for Temperature Measurement

Omega Engineering, Stamford, CT, has introduced a high speed industrial fiber optic infrared transmitter and probe system, the OS4000, which offers many new and important measurement capabilities (See Figure 1). These include an optical field of view or spot size as small as 0.025", which is less than half the size typically available, and a response time as fast as 1 msec, an order of magnitude faster than similar devices. The unit is CE compliant and is manufactured in the USA. Before we review this product, let's review this product category and take a look at some typical applications.

Figure 1 - OS4000 High Speed Industrial Fiber Optic Transmitter

Infrared Probe Devices

One of the most effective methods of making non-contact high temperature measurements in industrial applications is with a fiber optic infrared probe. These devices typically consist of a lens probe assembly which is aimed at the object to be measured, and a fiber optic interconnecting cable, which is connected to an electronics package, the transmitter, to make the temperature measurement and convert it into a useable output signal. Let's examine each of these components.

The probe assembly consists of a housing suitable for the conditions to which it will be exposed, a lens or an optical rod to collect the infrared radiation from the target, and an optical fiber interface for connection to the fiber optic cable. The probe is usually placed within a few inches of the object being measured. Because of this, the construction of the probe assembly can vary dramatically. For measurements in an open air environment, it can be a simple metal cylinder; however, it is not uncommon for these devices to be used in very harsh environments. This may be in a high temperature chamber, under a vacuum, in a corrosive atmosphere, and even immersed in molten plastic. As a result, specialized probes may have threaded housings, be constructed of special materials such as ceramics, and even have non-glass lenses or glass or quartz optical rod (tips).

The fiber optic interconnecting cable acts as a waveguide to bring the radiation to the infrared detector assembly in the electronics package. The quality of the fiber optic interfaces at each end is critical to overall system accuracy and repeatability. Because the signal is transmitted optically, it is immune to the often substantial electrical and magnetic interference found in industrial settings.

The electronic package does the work of converting the infrared radiation delivered by the fiber optic cable into a temperature reading or a signal proportional to the temperature. It may include many enhancements such as high and low temperature alarms, various output options, and even a computer interface connection.

FEATURES

- Temperature ranges from 100 to 1600°C (212 to 2912°F)
- Very fast response time of 1 msec
- Three standard optical field of Views
- Four standard fiber optic cable lengths 0.3, 0.9, 1.8, and 3 m (1', 3', 6', and 10')
- Emissivity adjustable from 0.05 to 0.99
- Four standard analog outputs
- High & low alarm outputs. Optional built-in relays with contact closure outputs
- RS232 PC Interface with Windows based data logging software
- Peak-hold and sample-hold functions
- Built-In through the lens laser sighting
- Mounting bracket and mounting nuts are included
- Optional water cool jacket and vacuum bushing accessories

Applications for Non-Contact Temperature Measurement

Although thermocouples are the most common temperature measurement devices in process control, they have their limitations. They must be in contact with the measured object, they have a slow response time, and they are subject to electrical and magnetic interference. Fiber optic infrared transmitters overcome these issues but are generally limited to reading temperatures above 100°C. This limitation is imposed by the fiber optic cable which cannot transmit infrared energy below a certain wavelength. This is dependent on the cross-section of the fiber optic strands and their optical properties. Following are some typical applications.

Annealing Processes

The critical surface temperature of the metal can be monitored directly while it is inside an oven, rather than indirectly by measuring the ambient oven temperature.

Induction Heating of Metal

The strong RF field used can heat up conventional heating devices and interfere with their electronics, while fiber optics is immune to RF fields.

Plastic Extrusion and Injection Molding

Precise control of the melt temperature is essential for proper polymer formation. An infrared reading eliminates errors that are common for thermocouple-based devices immersed in the plastic flow.

Drill Bit Temperature Monitoring

For high speed PC board drilling, wear can be determined by optically monitoring the drill bit temperature.

Semiconductor Doping, Deposition or Sputtering

Since these processes are usually carried out in a vacuum or controlled gas atmosphere using induction heating, conventional temperature measurement devices cannot be used.

Any high-temperature application where a direct measurement of the part temperature is critical to success.

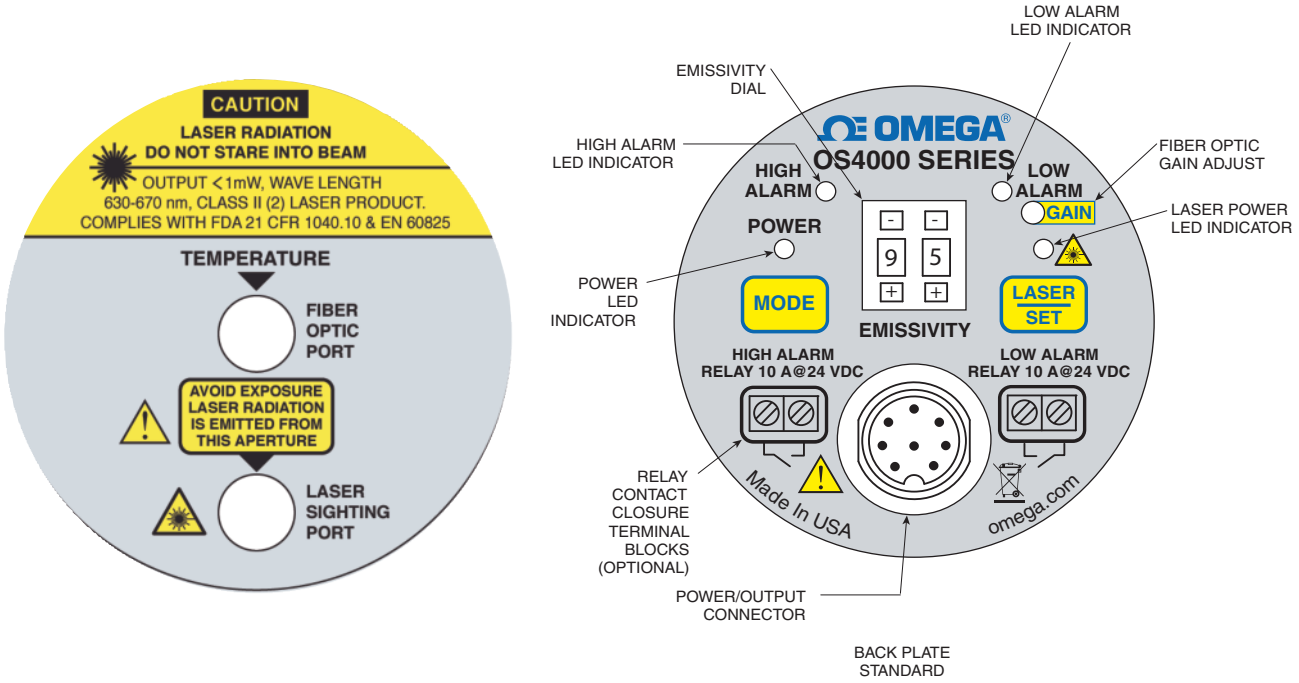

Figure 2 - OS4000 Transmitter Front and Rear Views

About the OS4000

The OS4000 High Speed Industrial Fiber Optic Infrared Transmitter is quite a versatile product with many options and configuration choices. It covers a temperature range of 100 to 1600 °C with sampling rates ranging from an extraordinary 1 msec up to 3.2 seconds. This unit also offers Peak & Hold function with an adjustable holding time. The optical field of view ranges from 0.22" to a very small 0.025". This is the smallest spot size available on a standard product, and a customized version can go as low as 0.010" spot size. Combined with the high sampling rate, the small spot size can catch transient temperature variations that would otherwise go undetected or closely track the temperature of very small objects such as wire strands or small diameter drill bits. The fiber optic cable has a high strand count and can tolerate certain amount of abuse without impacting the unit's performance.

Because measurement conditions vary widely, several probe options are available; a fiber optic lens probe in which the lens determines the field of view, a fiber optic tip probe for general purpose applications, and a polymer bolt probe for immersion in polymer plastic flow, which is threaded so it can be inserted through a pipe or chamber wall. In addition to the common metal housing, there is a ceramic housing for high temperature conditions with a choice of glass or quartz tip assemblies. A built-in laser sighting aids in aligning the field of view to the exact measurement location.

The transmitter contains the electronic package and converts the infrared signal into a useful format. It has a connector for the fiber optic probe at one end and one for power and output signals at the other end (See Figure 2). The OS4000 offers a choice of analog outputs for connection to a display device, a data logger, or a process control system. Configurations for every common industrial system are available: 1mV/deg, 0 to 5 Vdc, 0 to 10 Vdc, and 4 to 20 mA, so interfacing is no problem. Additionally, high and low alarm relay contact closures are available for signaling or control system use. An Emissivity adjustment covers the range from 0.05 to 0.99. Although the unit is standalone, it also includes an RS232 PC interface, which adds data logging capability and some other useful features. As an option, a wireless transceiver like Omega's WRS232-USB can be used to eliminate cabling between the OS4000 and a possibly distant PC, and make the data communication wireless.

The OS4000 Software Package

Hats off to the software designer, because you will know how to use this feature by simply looking at it. The layout is intuitive and straight forward, with only two screens (see Figures 3 and 4) requiring your attention.

The main screen displays the temperature reading in analog and digital format and charts the readings over time. An image of the OS4000 back panel shows the status of the LED indicators and can be used to turn the laser alignment feature on and off. The settings screen is used to set the high and low alarms, temperature units, and sampling rate. The time base and scaling of the charting function are also controlled here. Additionally, for analysis and archiving purposes, data points can be saved to a data file which can then be imported into a spreadsheet.

PC Interface Software

The OS4000 series comes with a Windows® based PC interface software. The software runs on Windows 2000, XP and Vista. The software allows the user to do the following:

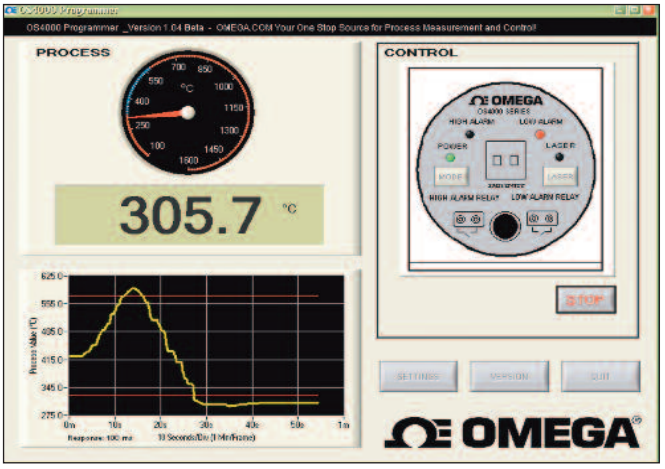

Figure 3 – OS4000 Software Main Screen

- **Establish communication with the OS4001 and display temperature in real real time both digitally and graphically**
- **Select sound, COM port, and temperature engineering unit**
- **Select the response time, and high and low alarm set points, and peak hold functions**

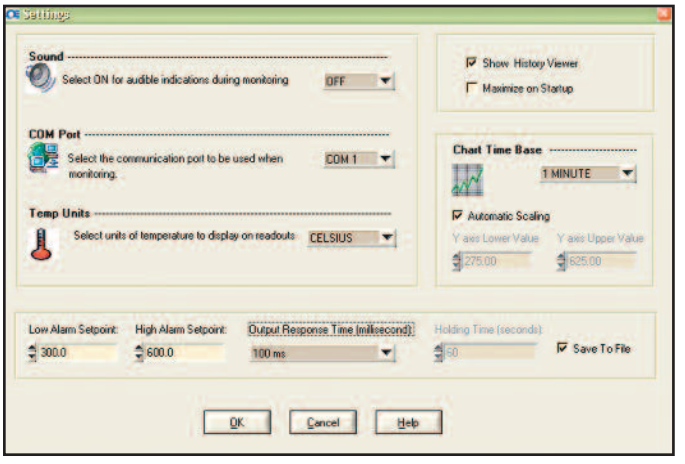

Figure 4 – OS4000 Software Settings Screen

- **Select chart scale either manual or automatic and chart time base**
- **Display the temperature vs. time along with high and low alarm lines**
- **Save the temperature data to a file**

Conclusion

The OS4000 is a state of the art infrared measurement tool. The wide choice of analog output options, wide temperature range, probe assembly models, excellent software interface, and custom capability makes this product an excellent choice for infrared temperature measurement applications. When a spot size of 0.025" is needed or the sampling rate requirement is in the 1 msec range, then it is a no-brainer; choosing the OS4000 in these situations will be "spot-on."

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