Frequently Asked Questions About TMS LaserTach

How is this product different than standard tachometers, and why does it exist?

The LaserTach is a unique offering that combines a common measurement (rotational speed) with a standardized measurement interface (ICP®[1] sensors). Dynamic signal analyzers have long leveraged the fact that they could measure dynamic phenomena such as force, pressure, acceleration, and strain with a 2-wire constant current excitation. This standardization allows simplified cabling and a lower cost measurement channel. The traditional tachometer measurement contrasts this situation by requiring a (non-standardized) array of power supply requirements and multi-wire cabling.

Does the LaserTach work with standard 2 mA constant current excitation?

No, due to the power requirements of the laser diode, LaserTach requires a minimum of 3 mA constant current.

Some older ICP sensor signal conditioners offer adjustable 2mA constant current supply as a means of reducing power consumption and extending battery life.

Fortunately, 4 mA of constant current power is standard on most modern multi-channel dynamic signal analyzers.

Is the laser eye-safe? What is the safety rating of the laser?

The LaserTach is a Class IIIA device. While considered safe, users should avoid looking into the device. The strength of the beam is similar to that of a handheld laser pointer.

How does the accuracy of the LaserTach compare to that of continuously sampled tachometers?

The Lasertach digitally samples the photodetector at 1.8 kHz, resulting in an approximate 1.8 kHz (550 μs) phase jitter. The uncertainty associated with this sampling is uniformly distributed from the mean, or true value, so that when processed with FFT averaging, the uncertainty will converge to 225 μs.

This digital sampling also determines the minimum reflective tape length for a given application.

What are the advantages of having a sampled channel of tachometer data?

Acquiring rotational speed data on a sampled FFT data channel offers several advantages:

- ICP tachometer signals allow the unwrapping of phase during post processing. Phase matching in post processing must be performed on speed data that has been acquired with the same anti-aliasing filters as other measurement channels
- ICP tachometer signals enable multi tachometer applications that are not feasible using dedicated counter-timer channels

[1] ICP is a registered trademark of PCB Group

- Speed referencing to ICP tachometer signals is supported in many popular application software packages
- The time history of the pulse train can be viewed at a later date

The Modal Shop recognizes the need of our customers to reference the spectral content of dynamic measurements to shaft speed. By offering the LaserTach, TMS has opened the concept of simplified cabling to those ICP sensor users that need a tachometer signal.

Does the LaserTach have TTL output?

No. The output voltage of the LaserTach drops 1 V_{pp} upon detection of 650 nm light that surpasses the detection threshold. The level returns to approximately 0 V otherwise. The amplitude of this voltage drop will vary on the constant current supply to the LaserTach.

What is the voltage level of the output pulse?

The output voltage level of the LaserTach drops more with increased constant current supply. Figure 1 shows the typical output levels with a 5' length of coaxial cable.

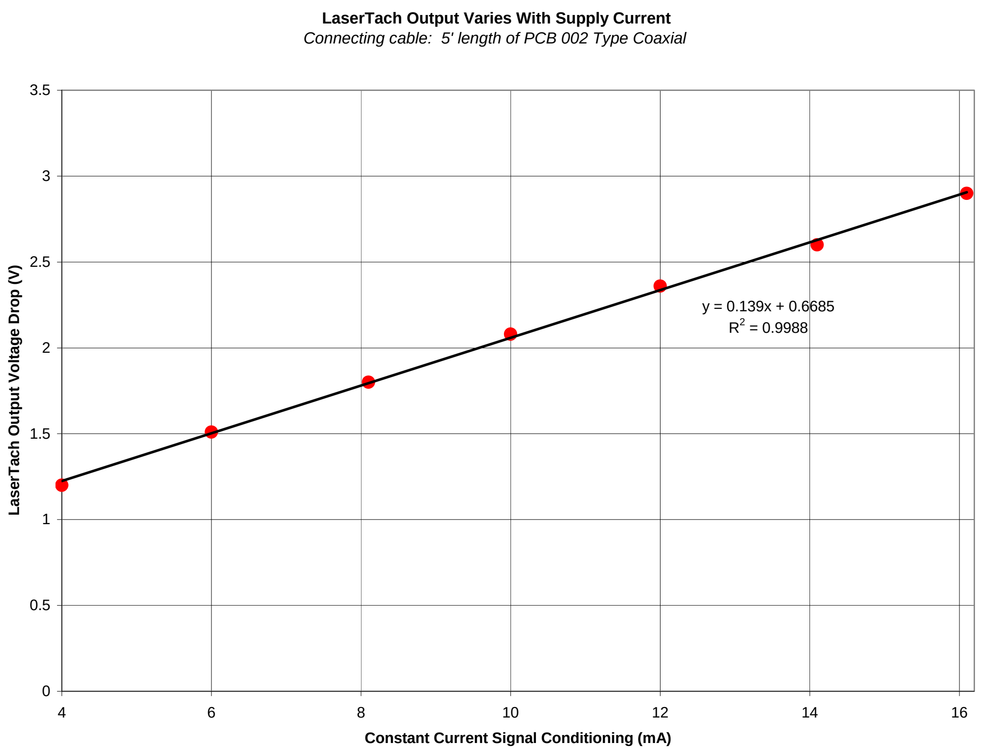

Figure 1 - LaserTach Output Voltage Drops More With Increased Current

What is the output pulse shape?

The output voltage of the LaserTach drops approximately 1 V_{pp} upon detection of 650 nm that surpasses the detection threshold. The level returns to approximately 0 V otherwise. The amplitude of this voltage drop will vary on the constant current supply to the LaserTach.

Figure 2 shows a time history of LaserTach output voltage. In this case, the reflective surface was a small (<10%) portion of the overall shaft circumference. The pulse train looks like a series of short blips.

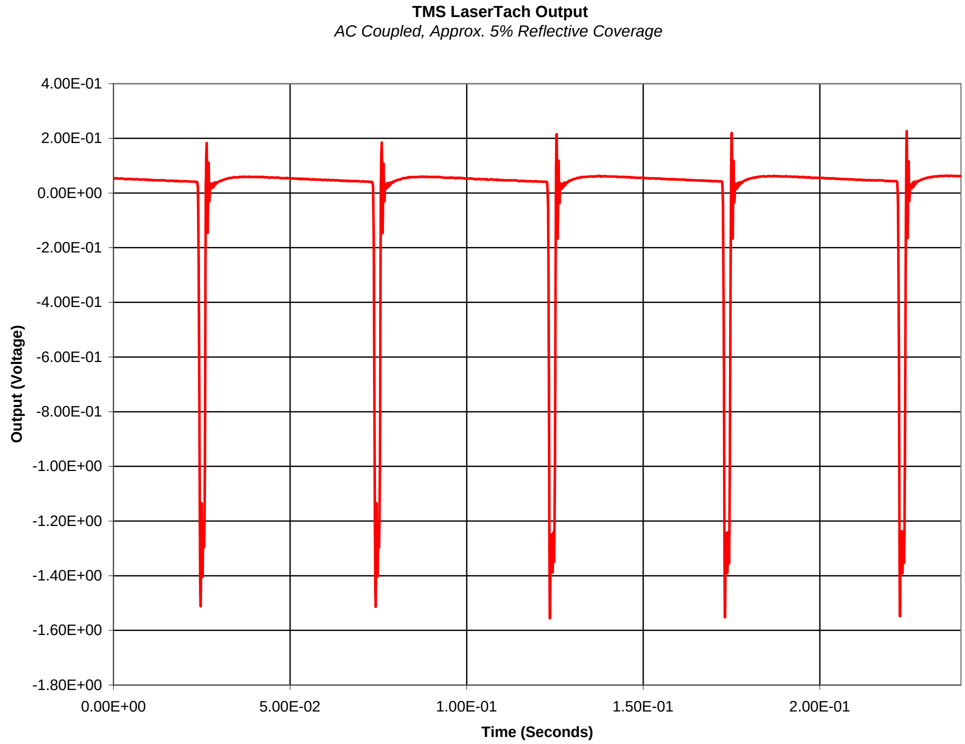

Figure 2 – LaserTach Pulse Train With Small Reflective Surface Coverage

Figure 3 shows a LaserTach pulse train when targeted at a shaft with over 30% reflective surface coverage. This waveform begins to approximate a square wave. Both Figure 2 and Figure 3 show rippling of the output at the voltage change points, which is typical ‘ringing’ of anti-alias filters when the data is acquired on a sampled FFT analyzer channel.

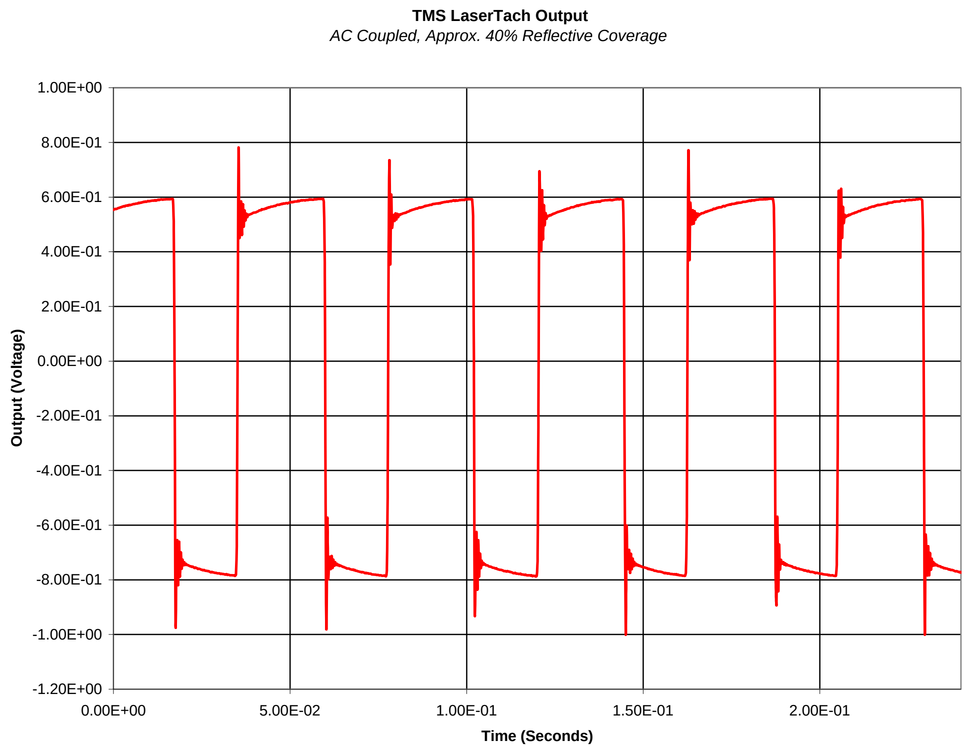

Figure 3 - LaserTach Pulse Train With High Reflective Surface Coverage

Is this device affected by ambient light or sunlight?

The LaserTach detects the change in reflected light of 650nm wavelength. So, ambient light will act as a measurable noise source if it is at this wavelength and synchronously strobing with the passing of the target.

How do infrared heat sources affect the LaserTach?

IR sources can interfere much like sources of ambient light. Possible sources of synchronized infrared energy are stroboscopes and DC motors.

Can I use the LaserTach by inserting the optics into a pressurized (100 psi) environment?

The LaserTach is not designed for use in environments above atmospheric pressure. Subjecting the LaserTach to significant differential pressures by threading it into the wall of a pressurized vessel will result in catastrophic failure of the device and possibly explosive disassembly.

Does the LaserTach operate through glass?

Yes, although any opacity in the glass will reduce the operating range.

Can it be used in rain, oil, or an oil mist?

Rain usually doesn't affect the performance of the LaserTach unless the relative humidity causes moisture to condense in the optics. The LaserTach is an optical sensor, so visibility through the sensing medium directly affects the performance.

Will the LaserTach operate through water?

The LaserTach is an optical sensor that detects changes in the intensity of reflected light of 650 nm wavelength. The transparency of any liquid through which the LaserTach is detecting this reflected light will affect the performance. Pure water will work better than water with contaminants. Any wave field that exists in the water will certainly distort the light detected on the optic sensor, and could reduce performance, or make measurements impossible. Any refraction of the reflected light will also reduce the capabilities of the LaserTach (This will be most noticeable when holding the LaserTach at an angle away from the normal to the water's surface).

NOTE: *The LaserTach is not designed to be submersed in any liquid. Pointing the LaserTach through a glass or clear plastic porthole or sightglass is a good way to measure through liquid media.*

Will it detect the contrast between black and white strips of paper, or a paint pen?

The LaserTach operates using the limited power budget offered to ICP circuits. For this reason, the LaserTach requires retroreflective tape for best results. The use of contrasting colored surfaces dramatically reduces the operating range of the LaserTach. In a test case, the LaserTach detected a target created on a laser printer from a maximum of 3-1/2" (8.9 cm). The target was printed on color copy paper with a brilliance rating of 96.

What's the difference between reflective surfaces and retroreflective surfaces?

Reflective surfaces are designed to reflect light away from the surface at an angle equal to the angle at which it hits the surface. Reaching back to our freshman physics book reveals that classic relationship 'the angle of incidence equals the angle of reflection', which is plotted in Figure 4. A reflective surface will reflect light directly back to the source only when the source is 90°, or normal, to the surface.

Figure 5 illustrates the behavior of a retro reflective surface, reflecting light directly back to the source, regardless of the angle of incidence.

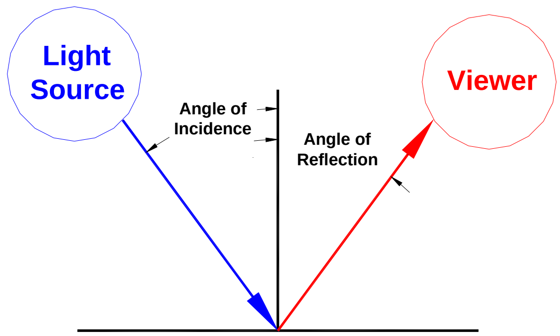

Figure 4 - Reflection

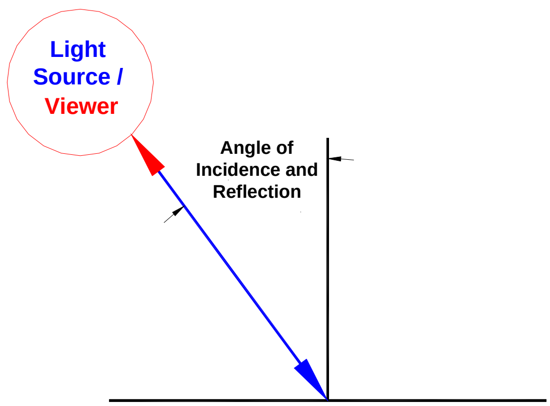

Figure 5 - Retro reflection

The performance of the LaserTach is greatly enhanced when using retro reflective tape.

Where can I get retroreflective tape?

3M Corporation markets retroreflective materials under its Scotchlite™ brand. The Modal Shop also offers Model LT-Tape, which is retroreflective.

What are the temperature limits of the LaserTach?

The LaserTach has operating temperature range of 14°F to 122°F (-10°C to 50°C). The temperature range for storage is -40°F to 185°F (-40°C to 185°C).

Why does the LaserTach have an upper frequency limit?

This is a limitation that can be traced back to the limited power budget of ICP sensor circuits. To accommodate the limited power, the LaserTach circuitry cycles the power to the laser, intermittently turning the laser on and off. This duty cycle is far above the visibly observable frequencies of humans. This cycling results in a sampling effect as the LaserTach observes the rotating shaft.

What is the minimum frequency of the LaserTach?

The LaserTach is capable of detecting 0 Hz, steady state changes in reflected light. However, since it is by definition attached to an ICP sensor signal conditioner, the signal will most likely be AC coupled by the signal conditioner circuitry. This makes the low frequency limit of the LaserTach equal to the low frequency cutoff of the signal conditioner AC coupling circuitry.

What is the minimum distance from the LaserTach to the target for successful operation?

Position the LaserTach no closer than 1" (2.54 cm) from the target to detect the reflected laser light.

What is the maximum distance from the LaserTach to the target for successful operation?

The maximum distance is 20" (51cm). This is with the LaserTach positioned on the normal to the mounting surface of a retro reflective target. Introducing an angle to the mounting surface reduces the operating range. Typical data is shown in Figure 6.

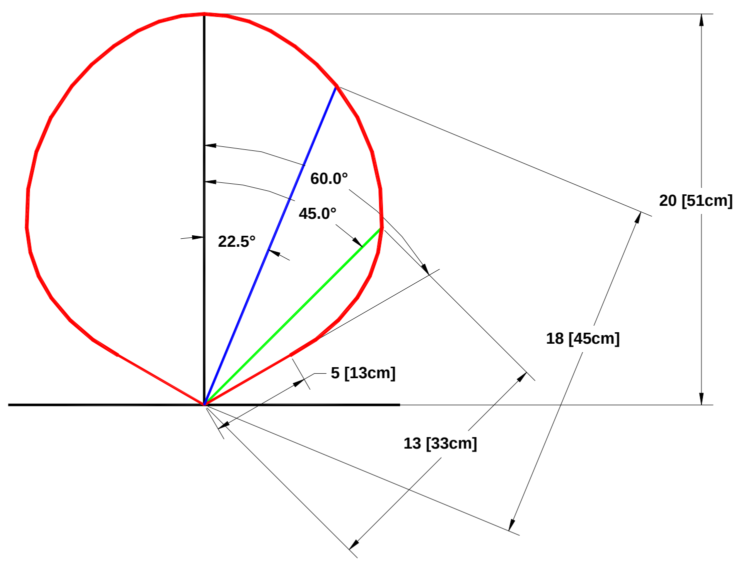

Figure 6 – Typical Operating Envelope For LaserTach

Why doesn't the LaserTach work at distances greater than 20 inches?

This is a limitation of the energy supplied to the Class IIIA laser from the ICP sensor signal conditioner.

Can I adjust the focus on the LaserTach to improve performance?

No. Do not adjust the slotted cap of the laser. The units are focused during acceptance test at the manufacturer. Adjusting this piece may reduce performance of the LaserTach or damage the laser itself, and voids warranty.

What is the maximum angle of incidence for successful operation of the LaserTach?

We have successfully tested operated the LaserTach at angles of incidence of up to 60° when using retro reflective tape.

Can the LaserTach be used to measure torsional vibration?

Torsional vibration analysis is not a target application for the LaserTach. The digitally sampled nature of the device makes it adept at measuring wide, instantaneous rotational speed swings.

Can I use multiple tape stripes on my shaft for multiple pulses per revolution?

Yes, although you should be aware that that the frequency content of the signal will depend upon the accurate spacing of the stripes.

What is the minimum / maximum circumference of the shaft that must be reflecting the laser?

The required surface of the shaft that must be covered in reflective material is related to that maximum speed to be observed and the size of the shaft. Use the following equation to calculate the minimum circumference of the shaft that must be covered in reflective tape:

$$MinTapeLength = 1.164 \times 10^{-4} \times ShaftRadius \times RPM$$

Where *MinTapeLength* and *ShaftRadius* have the same units, and *RPM* is the maximum observed speed in revolutions per minute.

This equation gives the minimum circumference that must be covered. Since the LaserTach detects *changes* in reflected light, this equation also determines the minimum distance that must be *non-reflective*.

800-860-4867