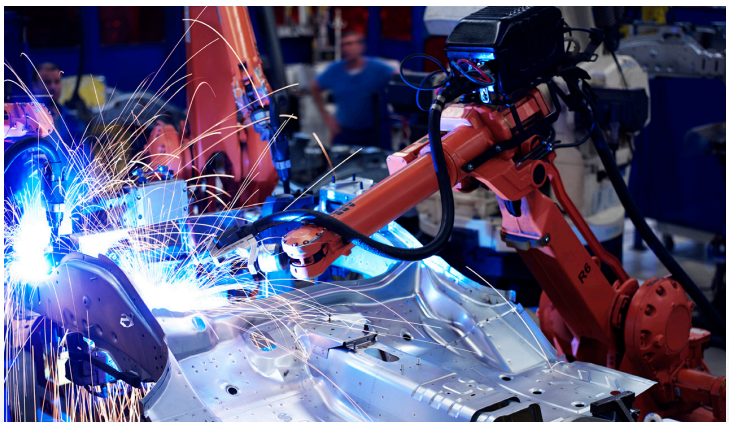
APPLICATION NOTE

LASER APPLICATIONS IN THE AUTOMOTIVE INDUSTRY DEMAND PEAK PERFORMANCE OF LASER MEASUREMENT INSTRUMENTS

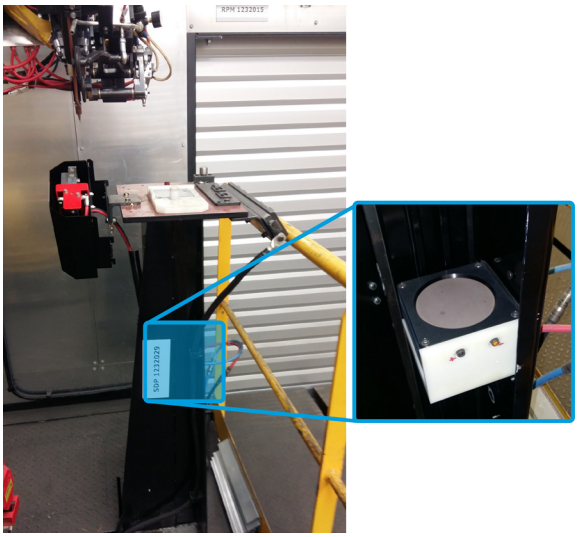


Besides their widespread use in research, medical and manufacturing applications, laser power measurement instruments are also making their way into automobile manufacturing. The automotive industry is a demanding sector in which craftsmanship, precision and quality are indispensable. Carmakers will only use the best equipment on the market to meet their demanding measurement and process quality needs as well as the ever-growing expectations of their customer base. One wrong step can lead to catastrophic failures in a production line, where everything already works in harmony to obtain optimal results.

Following the dramatic increase in the number of automated laser welding systems used in assembly lines, the number of integrated laser power meters has largely grown as well. Since laser power meters are used to measure the output optical power directly at the working point, they have the inherent advantage of being a global solution and are surpassing the existing monitoring systems' ability to measure laser stability and thus, work quality. Indeed, it has become obvious in laser industrial applications that measuring the output power of a laser beam before the working point cannot be considered a global solution to monitor beam power stability. Critical failures can occur anywhere along the path the light follows before it reaches the material being processed. Considering this, it is mandatory to use a non-intrusive method to periodically monitor the output power after the final delivery optics. A laser power detector is the ideal device to do so. For example, facility operators can use a laser power detector to set up an alarm in a feedback control loop to stop the assembly line if a laser welding head delivers power outside the expected range. With regular verifications, the assembly line can be paused before many expensive parts are scrapped. In this regard, power detectors have become system quality control tools that car manufacturers cannot afford not to have.

PSA GROUP'S MODE OF OPERATION

The French company PSA Group understands the benefits of adding power detectors to their automated lines and took this step without hesitation. Over the past few years, they have integrated at least one laser power measurement device on each of their 100 welding systems. In its facilities, PSA uses the power detectors for two different types of welding applications: with and without metal deposit. To prevent dust from reaching and contaminating the absorbing surfaces, the detectors are placed in clean enclosures built with a 10 mm aperture. Each laser head is programmed to periodically stop its work to move, aim at the detector, and expose it for approximately 30 seconds. This happens twice during every 7-hour work shift. A measurement that is within ± 100 W (2.5 %) of the expected value (4 kW) is considered acceptable. However, if the difference exceeds 100 W, a warning is sent to the controller and the



The PSA group measures laser power at the working point

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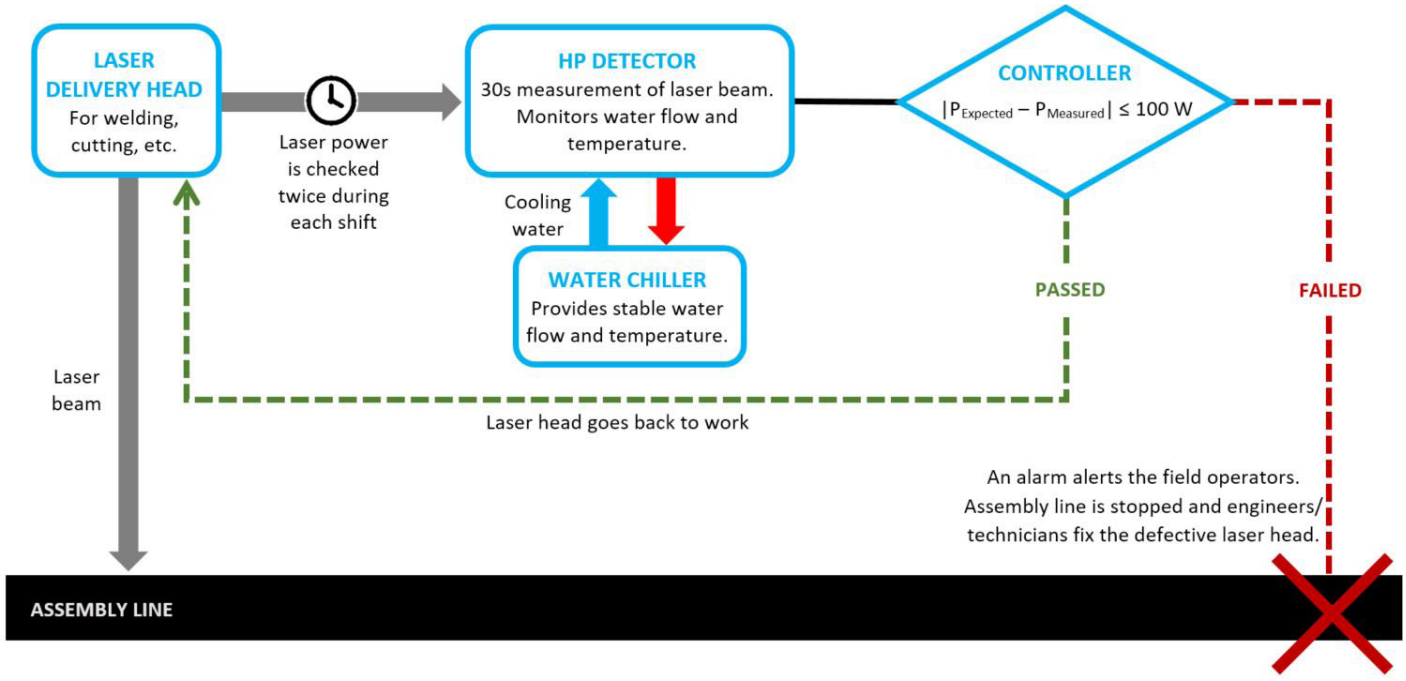
assembly line is stopped. This difference indicates that there is probably a failure or degradation of the optics in the laser delivery head. Mr. Thierry Tual, laser specialist at PSA Group, mentions that "the idea is to control laser power after the delivery head by firing a long pulse that is comparable in length to the welding time during production. Thanks to this **laser power monitoring process**, we can **quickly diagnose** a root cause in the optical path following a potential drift of the welding process. **It is important to stop the line before defective parts are produced.**"

FEEDBACK CONTROL LOOP TO MONITOR LASER STABILITY ON WELDING STATIONS



Laser power feedback control loop at PSA Group

HIGH POWER DETECTORS FROM GENTEC ELECTRO-OPTICS

The high power detectors, which can be customized to measure average power up to more than 100 kW, are manufactured by Gentec Electro-Optics, a Canadian company with 45 years of experience in the laser measurement field. Gentec-EO is committed to providing the market with the most reliable and accurate high quality laser beam measurement devices. For PSA, who wants to monitor the power stability of its lasers, the outstanding repeatability (better than 2 %) that these detectors feature is a critical parameter. According to Mr. Tual, these Gentec-EO power detectors bring nothing less than robustness and advanced quality control to the whole process. "The HP detectors are a plus to existing in-process and post-process quality monitoring systems. With them, our process is robust, and quality is guaranteed during production with the automatic monitoring of laser power." Considering the undeniable reliability of the detectors and the method, it is not surprising that other car manufacturers, like PSA Group, take advantage of in-line laser power measurements to control quality and get stable and repeatable processes.

Gentec-EO's HP100A-12KW-HD is used by the PSA Group for process quality

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How does the HP100A-12KW-HD high power detector work? Instead of analyzing the electrical output of a thermopile disk like most thermal detectors do, high power detectors from Gentec-EO's HP series measure both the flowrate and temperature of water going through a cooling circuit in a thermal mass. After the laser optical power hits the absorber of the detector, the heat absorbed by the mass is transferred to the cooling water in the cooling circuit. As heat is evacuated by water at a measured flowrate, a temperature difference rises between the entrance and the exit ports of the cooling circuit. Both the measured flowrate and water temperature difference are then used to determine the optical input laser power. Water temperature, flowrate and a calibration coefficient (which includes water density, water heat capacity and optical absorption) are optically calibrated as a whole system thanks to a traceable detector from the National Institute of Standards and Technology (NIST). Being a calorimetric technology, it has the inherent strong advantage of being outstandingly linear with power, all the way from a few hundreds of watts up to more than 100 kW! It is also worth mentioning that the built-in thermometer and flowmeter provide the HP detectors with "intelligence": they can sense inappropriate cooling-water parameters. Alarms can be set in order to warn the operators if a water chiller is not working properly.

IMPROVEMENT IS A QUEST

Prior to using calorimetric technology, PSA used smaller and fast thermopile-based detectors. Instead of measuring power during several tens of seconds, these thermal detectors were used in single-shot energy mode to measure the energy contained in pulses of about 20 ms to 50 ms. The average power of the laser was then calculated using the calibrated output voltage of the detectors. Despite its low cost and its speed, this method had limitations. "With the experience feedback, we found out that laser monitoring of short pulses could be improved. Since it was far from the length of the real welding time during production, it could not trap every potential drift in the welding system." said Mr. Tual. The ramp up effect of the laser is the main cause. Since the power is not perfectly constant and rises up during the first milliseconds of the pulse, the average power calculations underestimate the real value. Additionally, energy per pulse changes from one shot to the next. Measuring the energy of single pulse is therefore not a good representation of the true average power of the laser during the whole welding process. Thankfully, the root cause of the problem was identified and PSA was able to work in cooperation with Gentec-EO to get the new HP calorimetric solutions on their assembly lines. It suits their application better because it measures the laser for the same period of time as a laser welding system takes to do the work. With this, they get more accurate and more relevant measurements. "The search for an industrial solution with Gentec-EO allowed me to find solutions to my specific needs. A relation with Gentec-EO is a true partnership," added Mr. Tual.

There is no doubt that **process control is critical in the industry**. Gentec Electro-Optics has proudly achieved the **highest level of confidence** in the automotive industry as the **best manufacturer of laser measurement equipment** for this sector, which is mandatory in today's high-tech car assembly lines. With powerful laser welding systems and cutting-edge customized laser beam measurement solutions, car manufacturers are now more than ever **ready to improve the reliability of their automated processes**.

Alexandre Charbonneau
Application Physicist
Gentec Electro-Optics Inc.

THANK YOU

I would like to express my special thanks to PSA Group and Thierry Tual, laser specialist, for their faith in our know-how, attention to detail and adaptability, and to Laser Components SAS, our business partner in France, who helped us develop this great partnership with PSA.

We hope this technical information will prove useful!
Should you have more questions, please contact your local Gentec-EO representative at info@gentec-eo.com.