TE512

RENISHAW
apply innovation™

Unique 'tool recognition system' detects broken tools with ease

Abstract

The swift and reliable detection of broken tools on many machining centres is essential. A broken tool can lead to scrap and rework and can have costly implications on subsequent processes if left undetected. Conventional 'contact' broken tool detection systems have a number of weaknesses and are often unsuitable for smaller tools.

The emergence of laser systems in recent years has enabled non-contact broken tool detection, and the ability to measure increasingly small tools safely. However, using a 'beam block' system for broken tool detection also has its weaknesses, as it cannot distinguish between a tool and contaminants such as coolant and swarf and can be an expensive solution. Renishaw has addressed these limitations with the latest version of its innovative laser system, offering extremely fast and reliable broken tool detection.

Existing tool detection systems

Currently, 'contact' systems are the most common method of broken tool detection. Generally these can be divided into two types - a 'button' system and a 'rotating wire' system. The button system involves bringing a tool into contact with the 'button', thus triggering the device and so confirming that the tool is present and not broken.

The rotating wire system consists of an actuator, which rotates a wand until it comes into contact with a tool. Failure to contact the tool therefore leads to the conclusion that it is broken.

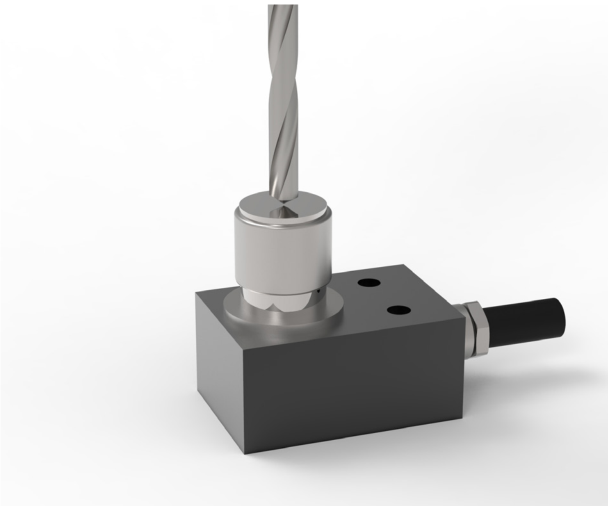
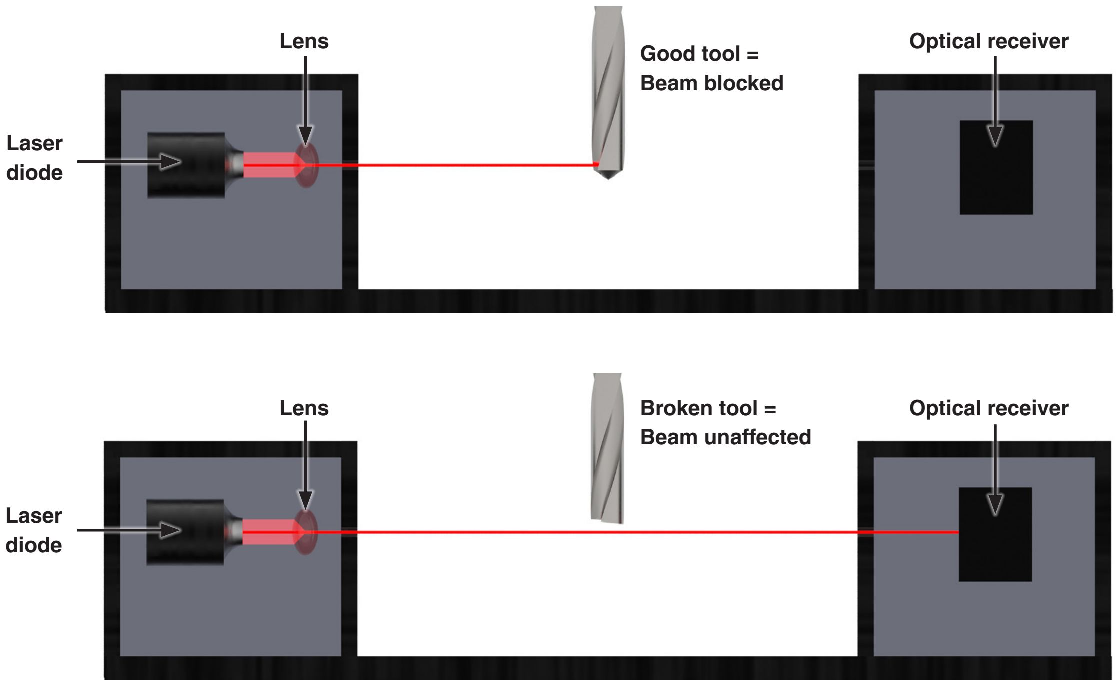


Figure 1 Example of button system

Figure 2 Example of wire system

Conventional non-contact tool setting systems use a beam of laser light passing between a transmitter and a receiver, located either on the table of the machine, or on each side of it so that the beam passes through the working volume.

The presence of a tool in the beam causes a reduction in light seen at the receiver, and a trigger signal is generated. If there is no reduction in the light received, it is assumed that the tool has failed to obstruct the beam as anticipated and is therefore broken.



RENISHAW
apply innovation™

Limitations of conventional systems

Although both contact and non-contact conventional systems have many advantages, and are a good option for many applications, they do have some drawbacks to be overcome.

A common problem with contact tool systems is the possibility of damaging the tool through physical contact. Smaller tools can be broken and delicate surface finishes damaged. Consequently, tools have to be over a certain diameter to be safely tested. Furthermore, using a contact method for broken tool detection can be a slow process, so as to avoid damaging the tool, increasing production cycle time. These systems are usually mounted within the working environment, taking up valuable table space.

Although not always a problem, in circumstances where space is required, another solution must be sought. Many non-contact systems are also situated on the table, and for both systems, there can be an increase in cycle time as the tool travels to the edge of the table, the usual location for broken tool detection systems, to be checked.

Non-contact systems overcome the danger of breaking delicate tools, as there is no physical contact, but have a few issues of their own. Since the systems detect broken tools by the breaking of a laser beam, it is possible for coolant and swarf to break the beam and trigger the system. In this way coolant streams, that have not switched off before tool checking, or drops on the tool could fool the system into believing a broken tool is actually whole.

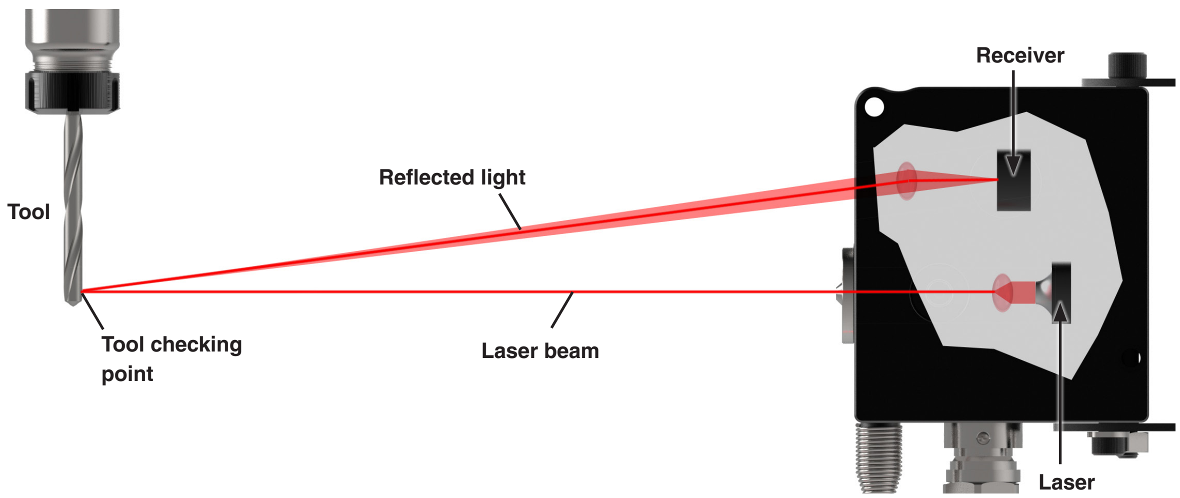
The reliability can be improved through the tool spending more time in the beam, allowing time for the coolant to disperse or using air blast systems to clean the tool prior to checking.

Many contact and non-contact systems can be used for both broken tool detection and tool setting, but for broken tool detection alone, they can be an expensive option.

What is clear from this, is that there is a space in the market for a relatively inexpensive, fast and reliable method of checking tools.

The Renishaw response: the TRS2

The TRS2 is the next generation of Renishaw's innovative single sided tool detection device. The TRS2 uses a laser beam, but dispenses with the beam block method of tool detection. Instead, the TRS2 relies on the beam being reflected back to the receiver, which is contained in the same housing as the transmitter. The unique tool recognition system (TRS) electronics then establish whether a tool is present - and hence is good, or is not present.



RENISHAW apply innovation™

How it works

The tool recognition system electronics, ToolWise™ used in the TRS2 represent a major step forward in reliable broken tool detection. The system is capable of quickly and definitively establishing whether or not a tool is present.

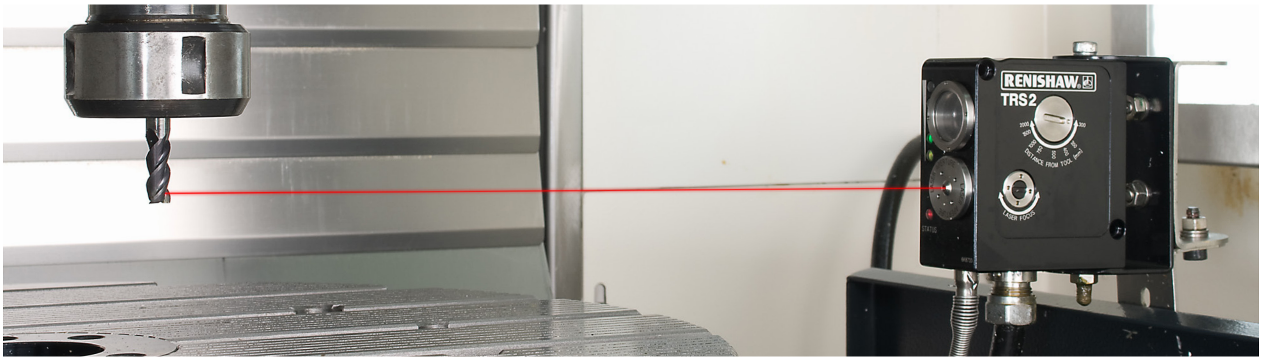
The TRS2 works by directing a class 2 laser beam towards a point where the tool detection is to be conducted. The tool is then positioned so that the laser beam shines onto the tip of the tool - typically 3 mm from the end of the tool.

The tool is rotated at 200 rpm, 1000 rpm or 5000 rpm, and the laser is reflected off the tool and back to the TRS2 receiver. Due to the tool's rotation, the reflected light level varies resulting in a repeating pattern. This repeating pattern is recognised by the micro controller within the TRS2 and the output relay is triggered, rapidly signifying a good tool and allowing the machining cycle to continue. If no tool is identified at the end of a given period, the application software issues a 'broken tool' alarm.

This range of rotational speeds allows a variety of tools to be detected, gun drills can be detected at 200 rpm while others can be spun at 5000 rpm decreasing cycle time.

There are considerations in the design to ensure safe and reliable operation. The TRS2 relies on reflected light to identify the tool - the amount of light reflected depending on a number of factors, such as tool size, surface finish, tool shape, operating range and coolant. If the tool cannot be rapidly recognised, the user can vary the amount of time allowed before an alarm is generated. Typically, the TRS2 requires around 1 second to identify a good tool, but in cases where the reflected light level is low, or the repeating pattern is obscured, the detection cycle may last longer than this. This time is only then required for certain specific circumstances, not for every tool detection cycle.

As TRS2 has been designed to be able to detect small dark tools, it also incorporates an automatic power system. If the reflected signal is of low power, the system increases transmission power to compensate for the low reflectivity of these types of tools.



In a theoretical extreme case, if the tool is not recognised during the time limit set by the user, a broken tool alarm will result - a failsafe condition.

Longer cycle times are therefore rare and limited to particular conditions where steps can be made to reduce the effect. Optimisation of the application of the TRS2 is advised to gain the maximum benefit in production. The TRS2 is easy and flexible to mount, and range-adjustable by the user, allowing the best parameters to be quickly determined to ensure tools can be recognised. Using the TRS2 at the shortest possible range will increase the reflected light level. Furthermore, by adjusting the position on the tool at which checking is done, detection reliability can be improved further. For example, on some tools, coolant tends to gather near the tip, so checking higher up the tool is likely to be beneficial. Spinning the tool at high speed or removing coolant with an air blast before checking, are also considerations. Recently the TRS2 has also been upgraded, with electronic and firmware changes improving detection by up to 69% in typical conditions.

The software also incorporates retry logic for the user to implement, where, if the tool has not been detected after a defined, short, period of the time, the check position or spindle speed can be altered. Repositioning the tool in successive steps, allows the system to find a check position clear of swarf or coolant, or that's slightly more reflective. When a clear defined signal is found, TRS2 can trigger, this significantly decreases detection time over continuously checking a less responsive position until triggering.

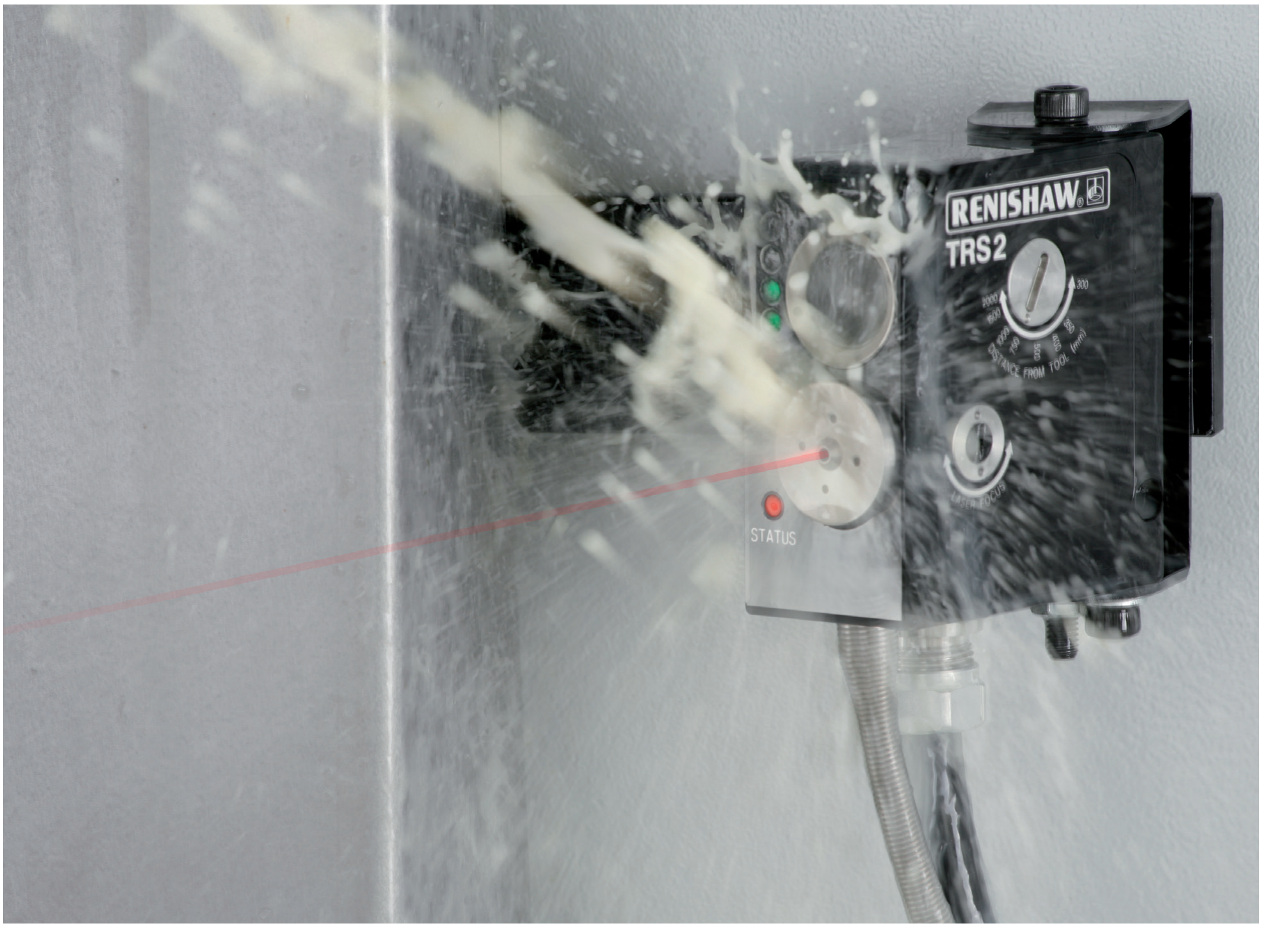
RENISHAW
apply innovation™

The advantages of the TRS2

The innovative technology of the TRS2 brings with it numerous advantages over existing tool detection systems. The compact single unit is straightforward to install, requiring no M-Codes or calibration routines. It can be fitted outside the working envelope of the machine, eliminating any possibility of a collision and saving machine table space. Similarly, installation time and space is saved in the machine's control cabinet, as there is no interface.

In terms of performance, the TRS2 can operate over a range of up to 2 m. The TRS2 does not contact the tool, therefore it can safely detect tools as small as 0.2 mm diameter, without damaging or breaking the tool. High feed rates can be used, resulting in short cycle times.

The simple design of the TRS2, with no moving parts, makes the device extremely robust, reliable and capable of enduring even the harshest of machining conditions. The crucial laser optics are well protected by an air stream, sealed to IPX8, originating from the same hole as the laser itself and preventing any contaminants entering into the device. The simplicity of the TRS2 makes the product a cost-effective solution to broken tool detection.



www.renishaw.com/machinetool

#renishaw

+44 (0) 1453 524 524 uk@renishaw.com

Part no.: H-5650-2025-02-A