Renishaw plc

New Mills, Wotton-under-Edge,
Gloucestershire GL12 8JR
United Kingdom

T +44 (0) 1453 524524
F +44 (0) 1453 524901
E uk@renishaw.com

www.renishaw.com

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Renishaw FHSS radio transmission technology compared with fixed frequency and DSSS

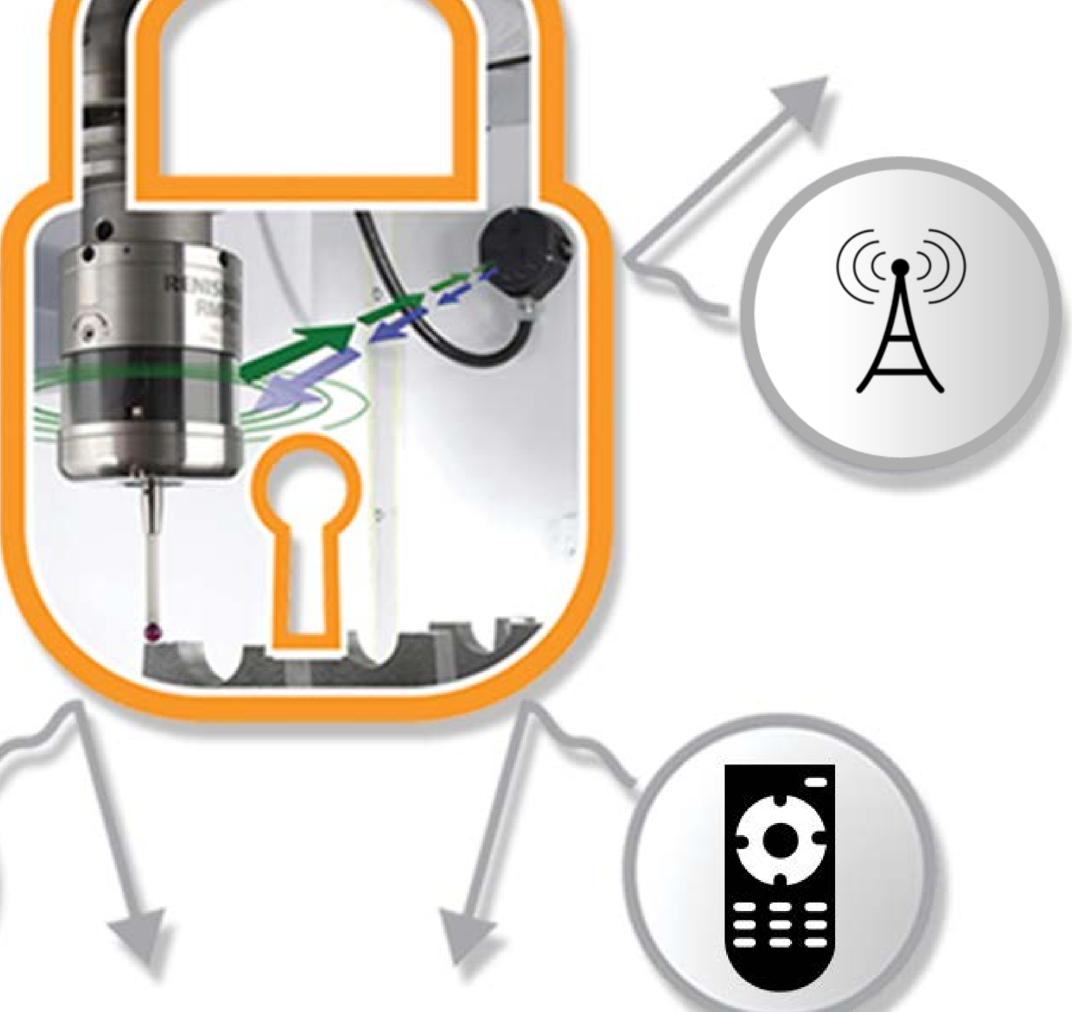
Inspection probes are vital to manufacturing process efficiency, enabling rapid part set-up, batch changeover, part verification and in-process control of critical component dimensions. All probes need a means of signal transmission, with radio being the most common on large machines and 5-axis machining centres.

Renishaw introduced the world's first radio transmission probe with frequency hopping technology in 2003 – the RMP60. Since then radio transmission probes have increased in popularity more than ten-fold.

The dramatic rise of WiFi in factory environments provides an ever more challenging environment for the safe and reliable operation of radio transmission probes.

Improvements to the unique real-time frequency hopping radio transmission technology in Renishaw's latest product range put safety and reliability beyond doubt, and, as a result...

... data transmission has never been so reliable!



Fixed frequency radio transmission technology explained

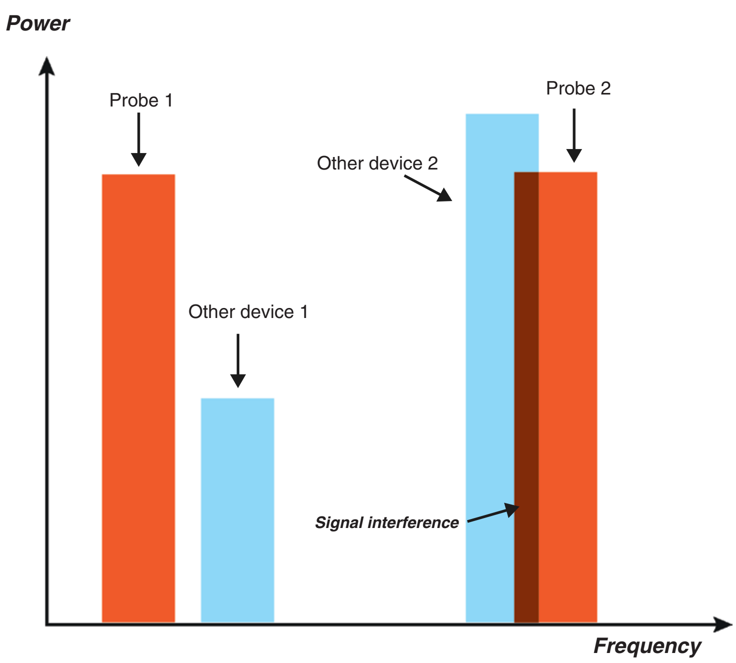
Definition:

Typically, a relatively high power signal is sent at a fixed frequency and remains fixed unless manually reselected.

Key Facts:

- Restricted by law to use different bandwidths of the radio spectrum and different transmission powers in various regions of the world. A single system of this type cannot be compliant worldwide.
- Different models must be stocked and supplied according to final destination. It is possible for a customer to receive probe systems that cannot legally be used.
- The probe and receiver need to be set to a specific, interference free channel during installation. This remains fixed until another channel is manually reselected. This method is time consuming.
- May operate flawlessly upon setup, but fail when transient interference enters the workplace, such as from walkie-talkies or remote controls. The result is compromised signal integrity and equipment failure.
- Can suffer from ‘dead spots’ (multi-path nulls) in the working environment, where signals transmitted directly between the transmitter and receiver interfere with signals that have taken indirect reflected paths.
- Outdated and unsuitable for critical applications in modern factory environments.

Example



1. Other device 2, with greater transmission power is blocking part of the probe 2 transmission channel.
2. This will corrupt the signals at the probe’s receiver.
3. The only solution is to change the probe channel until a clear part of the spectrum is found, or change the transmission band of the other device (if possible).

Direct sequence spread spectrum radio probe transmission (DSSS) explained

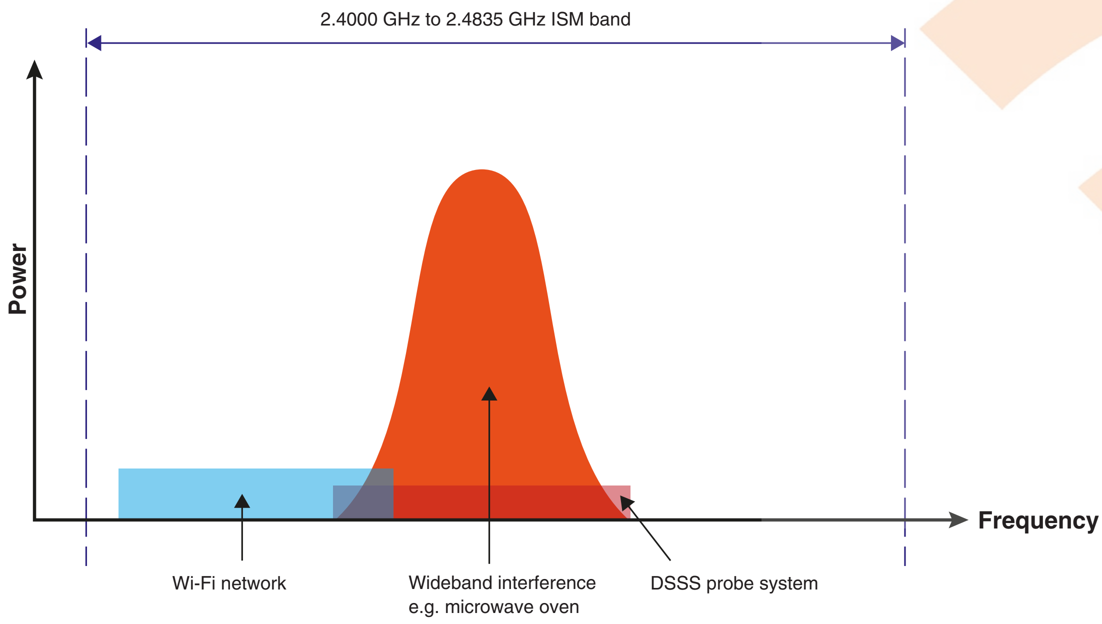
Definition:

Where a signal is sent over a broad range of frequencies simultaneously (e.g. Wi-Fi wireless networks)

Key Facts:

- Typically operates in the worldwide industrial, scientific and medical (ISM) band between 2.4000GHz and 2.4835GHz.
- Worldwide compliance – subject to receiving local regulatory approvals.
- A **fixed frequency** wideband technology. It cannot move around interference and is therefore not frequency agile.
- Transmit signals are spread over a wide bandwidth within the ISM radio spectrum.
- Due to the low transmit power, signal integrity can be compromised by other wideband devices operating in the same vicinity, such as Wi-Fi systems or stray emissions from, for example microwave ovens. Wi-Fi systems use almost a third of the total bandwidth available in the 2.4000GHz to 2.4835GHz ISM band
- The introduction of more DSSS probe systems, Wi-Fi systems, or any other wideband transmissions, quickly uses up the total available bandwidth and the transmissions will definitely overlap.
- The additional introduction of transient radio traffic, such as Bluetooth®, further exposes the fundamental weakness of a DSSS probe system.
- DSSS is not a reliable solution for real-time critical applications like probing in congested radio environments.

Example



DSSS probe transmissions compromised by a Wi-Fi network and a wideband interference source

Frequency hopping spread spectrum radio probe transmission (FHSS) explained

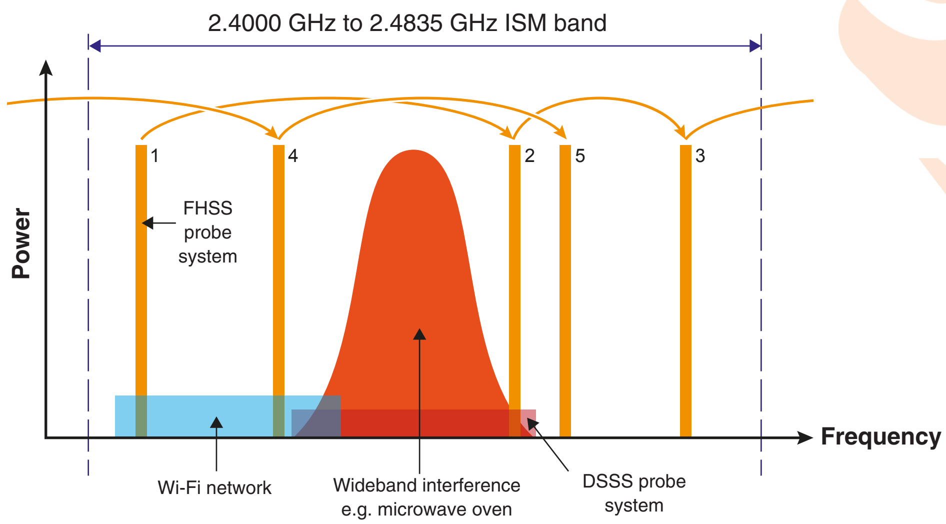
Definition:

Where a signal is transmitted at a relatively high power in a coded series of different frequencies, known to both transmitter and receiver e.g. Bluetooth® devices.

Key Facts:

- Renishaw radio products use a unique real-time frequency hopping spread spectrum (FHSS) transmission protocol, operating in the worldwide ISM band between 2.403GHz and 2.481GHz.
- Compliant worldwide, with the widest range of local regulatory approvals.
- Both ends of the system exchange data which is transmitted at a relatively high power on one of 79 defined channels, then simultaneously 'hop' to another channel in preparation for the next transmission.
- The order in which the channels are visited (the hopping sequence) is known to both ends of the system which means that each of the 79 channels is visited once before the hopping pattern is repeated.
- This frequency agility allows FHSS systems to jump through sources of interference. Each transmission on a single channel is of a high enough power to often be successful, even if it does coincide with a transmission from a Wi-Fi system.
- To avoid individual transmission failure e.g. collision with a transmission from another FHSS device or corruption via high power wideband interference, system integrity is maintained because the transmission is re-attempted on one of the other 78 channels in a subsequent 'hop'.
- Probe measurement performance is unaffected because the system design allows for multiple hops and transmission attempts for each packet of time-critical data.
- The frequency diversity achieved by hopping through different channels within the total bandwidth also means that the effects of multi-path nulls are eliminated.

Example



FHSS probe transmissions co-exist with other radio traffic, while DSSS probe transmissions are compromised

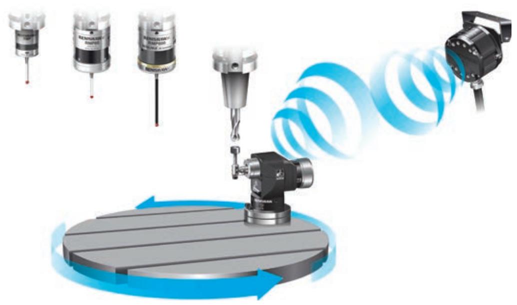
A world with more WiFi networks and radio probes is a major consideration

More Wi-Fi = more potential interference

- The numbers of wireless network systems in use within the industrial environment are much greater now than they were in 2003.
- Maintaining signal integrity in an environment with a high level of background radio transmission 'traffic' is a challenge for critical real-time applications.
- The higher power of the FHSS probe system is usually sufficient to overcome a static wideband device, such as a Wi-Fi system.
- In the unlikely event that transmission retries are required, it is beneficial to maximise the likelihood that the next transmissions will be successful.

More radio probes = more potential interference

- The success of FHSS transmission has led to a huge increase in the number of radio transmission probe systems now in use. Many manufacturing sites operate multiple tens, even hundreds of systems, often with several probes per machine.
- Maintaining signal integrity with multiple systems competing for the radio spectrum presents a challenge.
- Probe systems that attempt to transmit on a specific channel at the same time may fail in that particular transmission attempt, but will all retry the same transmission on a subsequent hop if necessary.
- For reliable operation of multiple FHSS radio probe systems operating in the same vicinity it is essential that the hopping pattern for each system is different.
- Until now, multiple tens of different hopping patterns have ensured that Renishaw radio probe systems operating within the same vicinity, can communicate error free.



In a development that "future proofs" use of its radio probes, Renishaw has introduced two new design enhancements, both present in the new RMI-Q interface and RTS tool setter, plus new versions of the RMP and RLP probes launched in 2013. As a result, Renishaw's FHSS transmission has never been so reliable.

Intelligent hopping sequence

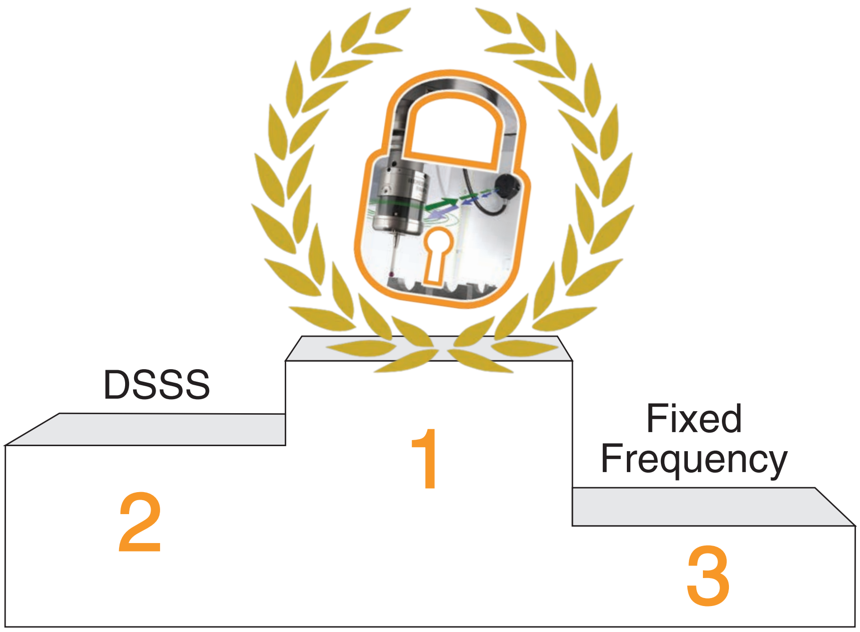
An intelligent way of generating a hopping sequence in which subsequent hops avoid collisions with wideband interference sources such as Wi-Fi systems.

More than 2,000,000 unique hopping patterns

Each probe system has a completely unique and different frequency hopping pattern. Renishaw now has 2^{21} (>2,000,000) unique hopping patterns.

5 reasons why Renishaw's FHSS radio transmission comes out on top

1. *Proven and robust technology (same modulation type as Bluetooth devices)*
2. *Worldwide regulatory compliance*
3. *Significantly greater tolerance to signal interference than other probing systems*
4. *Avoids transmission 'dead spots' in the working environment*
5. *Future-proof, due to the large increase in unique hopping patterns*



The Renishaw FHSS radio transmission family

Globally recognised 2.4 GHz waveband – compliant with radio regulations in all major markets

RMP40

Key features and benefits:

- Proven kinematic resistive design (1.00 µm 2σ repeatability)
- Smallest frequency hopping radio spindle probe in the world
- Ultra compact design
- Suitable for automated part-setting, in-process inspection and post process verification

RLP40

Key features and benefits:

- Proven kinematic resistive design (1.00 µm 2σ repeatability)
- Ultra compact design
- Increased environmental protection specifically for the harsh and demanding lathe environment
- Suitable for automated part-setting, in-process inspection and post process verification

RMP60

Key features and benefits:

- Proven kinematic resistive design (1.00 µm 2σ repeatability)
- Compact design
- Various activation options and adjustable trigger force
- Suitable for automated part-setting, in-process inspection and post process verification

The Renishaw FHSS radio transmission family

Globally recognised 2.4 GHz waveband – compliant with radio regulations in all major markets

RMP600

Key features and benefits:

- RENGAGE™ strain gauge technology – proven and patented (0.25 µm 2σ repeatability)
- Compact design
- Various activation options
- Suitable for automated health checks for multi-axis machine tools, part setting, complex 3D in-process inspection and post process verification

RTS

Key features and benefits:

- Proven kinematic resistive design (1.00 µm 2σ repeatability)
- Cable-free for unrestricted machine movement and ease of installation
- Use as a standalone or as part of a multi-probe system allowing use in a wide range of applications
- Suitable for broken tool detection and rapid measurement of tool length and diameter on a wide range of tools

RMI-Q

Key features and benefits:

- A combined transmitter, receiver and interface unit that enables individual radio turn on and operation of up to four separate Renishaw radio probes
- Negligible interference from other radio sources means consistent and reliable performance
- Robust, long range communications make RMI-Q ideal for larger machines

Which Renishaw FHSS radio transmission system is suitable for my machine?

Machine type & size / Probe System			RMP40 	RLP40 	RMP60 	RMP600 	RTS 
Vertical CNC machining Centres		S*	●				
		M*	●	●	●	●	●
		L*		●	●	●	●
Horizontal CNC machining centres		S*	●				
		M*	●		●	●	●
		L*			●	●	●
Gantry CNC machining centres		S*			●	●	●
		M*			●	●	●
		L*			●	●	●
CNC lathes		S*		●			
		M*		●			
		L*		●			
CNC multi-tasking Machines		S*	●	●		●	
		M*	●	●	●	●	
		L*	●		●	●	

*Notes

	CNC machining centres table size	CNC lathes – chuck size	CNC multi-tasking machines working range
S = SMALL	<700 mm x 600 mm	6 in to 8 in or smaller	<1500 mm
M = MEDIUM	<1200 mm x 600 mm	10 in to 15 in	<3500 mm
L = LARGE	<1200 mm x 600 mm	18 in to 24 in	>3500 mm

Frequently asked questions

Q. ***Why are there different transmission technologies for Renishaw products?***

A. It's about application of the right tool for the job. Hardwired probes and tool setters have the simplest form of transmission. Optical transmission systems use infrared technology to provide reliable and secure communications wirelessly. Renishaw's radio transmission using Frequency Hopping Spread Spectrum (FHSS) technology, provides secure communication over greater distances where line of sight between devices is not possible.

Q. ***How many Renishaw probes can be used on the same machine?***

A. Up to three probe/tool-setter combinations are possible with Renishaw's optical transmission systems, and up to four probe/tool setter combinations are possible with Renishaw's very latest RMI-Q transmission system.

Q. ***Do we need a licence to operate radio systems from Renishaw?***

A. No. Operating within the recognised 2.4 GHz frequency band, Renishaw radio systems are compliant with radio regulations in all major markets, which is why they are the preferred choice of many leading machine builders and experienced users.

Q. ***I have seen radio transmitters fitted on the outside of the machine. Why doesn't Renishaw do this?***

A. Because it is bad practice, requiring trial and error to make it work, and runs the risk of failure.

Q. ***Can we combine transmitters and probes from other manufacturers?***

A. No.

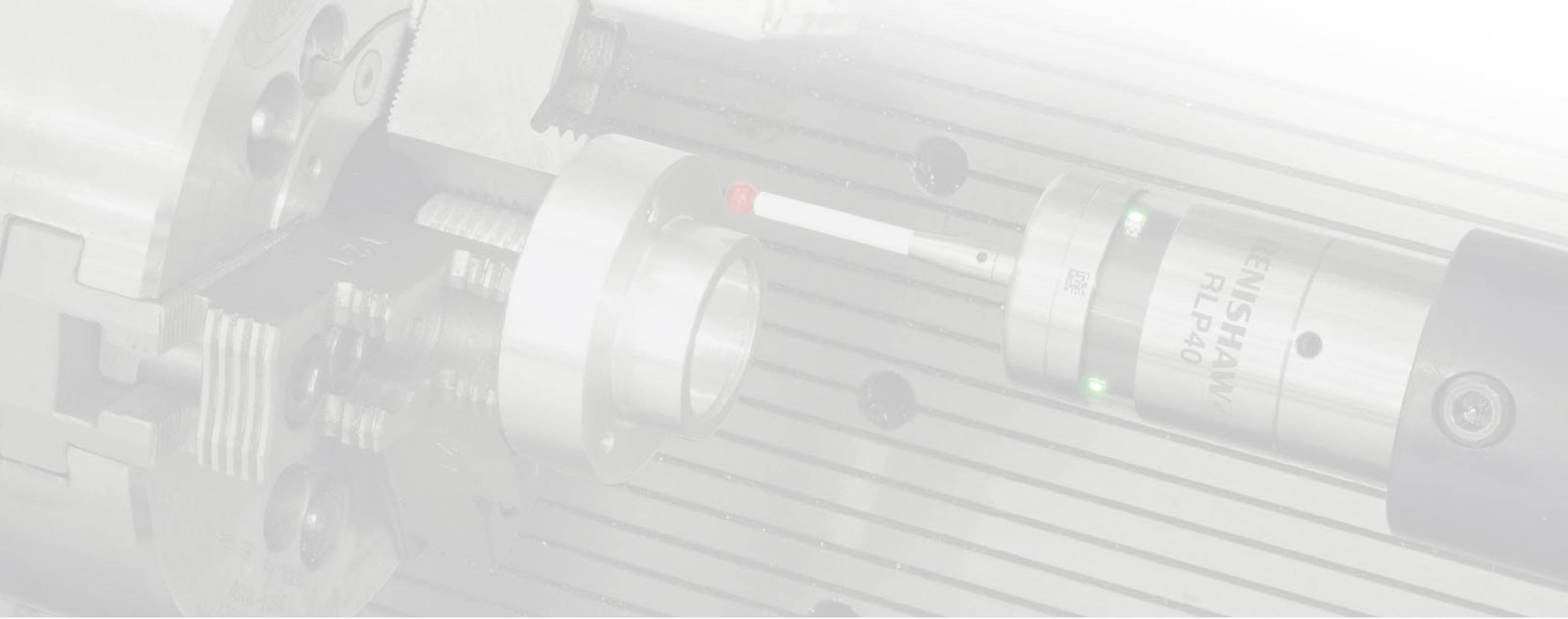
Q. ***What about battery life?***

A. Renishaw provides battery life data for standby and continuous use conditions. For its radio products, these figures can be up to 1,300 days and 1,700 hours respectively.

Overall battery life depends on the variable conditions during the probe's use from application to application and probe manufacturers do not qualify battery life data the same way.

Whilst some manufacturers quote longer battery life data, this is typically achieved as a trade off against the rate of transmissions and reduces crash protection capability.

Renishaw radio probes are optimised to provide unrivalled overall performance for metrology, durability, reliability and safety.



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About Renishaw

Renishaw is an established world leader in engineering technologies, with a strong history of innovation in product development and manufacturing. Since its formation in 1973, the company has supplied leading-edge products that increase process productivity, improve product quality and deliver cost-effective automation solutions.

A worldwide network of subsidiary companies and distributors provides exceptional service and support for its customers.

Products include:

- Additive manufacturing, vacuum casting, and injection moulding technologies for design, prototyping, and production applications
- Advanced material technologies with a variety of applications in multiple fields
- Dental CAD/CAM scanning and milling systems and supply of dental structures
- Encoder systems for high accuracy linear, angle and rotary position feedback
- Fixturing for CMMs (co-ordinate measuring machines) and gauging systems
- Gauging systems for comparative measurement of machined parts
- High speed laser measurement and surveying systems for use in extreme environments
- Laser and ballbar systems for performance measurement and calibration of machines
- Medical devices for neurosurgical applications
- Probe systems and software for job set-up, tool setting and inspection on CNC machine tools
- Raman spectroscopy systems for non-destructive material analysis
- Sensor systems and software for measurement on CMMs
- Styli for CMM and machine tool probe applications

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