



QC20 ballbar

Why you need a QC20 ballbar

The QC20 ballbar provides the quickest, most effective health check and diagnosis of machine tool performance. Ballbar tests are widely recognised in international standards and are essential for quality assurance in manufacturing.

	Build	
<input checked="" type="checkbox"/>	Verify	<input checked="" type="checkbox"/>
	Compensate	
<input checked="" type="checkbox"/>	Diagnose	

Process foundation

Component quality is dependent on machine performance. Without understanding the errors in a machine it is impossible to have confidence that your components will meet specification.

Accurate measurement and setup of machines is the foundation of process control, providing the best performance and stable environment for the process to be performed. Quantifying process capability reduces costs and improves efficiency.



Highly regarded within the industry for machine tool verification

Even with the best machinery and operators, machine derived defects can occur and producing bad parts costs you time, money and even customers. Nobody sets out to produce defective parts. Bad tooling, worn spindles or workpiece clamping may cause component dimensional and finish defects, but the major causes of defects can usually be attributed to machine tool positioning errors. The sources of these are geometric, dynamic and play errors within the machine.

QC20 ballbar offers a simple method to perform a system performance snapshot which provides the process capability knowledge to reduce scrap levels and

resolve the issues discovered. With performance insight and quantified results, many errors can often be fixed in minutes. It doesn't matter if your machine is new or old; all can have errors.

The secret of reject-free production is to know just how good your machines really are; helping to plan production and make adjustments when required.

In the past this may have been achieved by time consuming machining tests or "master" part inspection – great if your component is dimensionally similar to the master, less so in many situations.



QC20 ballbar test on a lathe

Less machine downtime

A machine that is 'fit for purpose' will deliver consistently good parts and will suffer fewer unplanned stoppages. This means more time available for metal cutting and also allows your maintenance staff to stop fire-fighting and become more proactive.

Regular checks of the condition of your machines with powerful diagnosis of the source of any errors, means that you can minimise reactive maintenance effort and focus on valuable preventative work.



System overview



QC20 ballbar

The QC20 ballbar is a highly accurate, telescopic linear sensor with precision balls at both ends. When in use, the balls are kinematically located between precision magnetic cups; one attached to the machine table and the other to the machine spindle, or spindle housing. This enables the ballbar to measure minute variations in the radius, as it rotates around a fixed point. For larger machines, 50, 150 and 300 mm long extension bars can be combined to perform tests up to 1,350 mm radius. For smaller machines, accessories are available to support tests with radial requirements of less than 100 mm.

The ballbar has an LED status indicator which shows battery, communications and fault status. Signal processing is carried out within the ballbar, with the data being transmitted to a PC using Bluetooth® Low Energy technology. A robust wireless connection ensures no wire handling issues, closed door operation and reduced possibility for system damage.

Key features and benefits

✓ Repeatabile

Kinematic ball mounts provide secure and repeatable position location of the ballbar.

✓ Flexible

Centre pivot and tool cup extension provide versatile mounting in the machine tool environment.

✓ Accurate

Calibrated precision linear sensor.

✓ Portable

The QC20 ballbar is supplied in a case, providing robust protection while maximising portability.

Measurement capability

The QC20 ballbar is capable of measuring a broad range of different types of machine errors which can be broken into two categories.

Some examples of these errors are shown below.

Positional

These errors remain the same magnitude regardless of feedrate.

✓ Positional tolerance

✓ Scaling error

✓ Squareness

Dynamic

These errors will vary according to feedrate.

✓ Backlash

✓ Reversal spikes

✓ Servo gain

Ballbar testing explained

Three simple stages of QC20 ballbar testing

1 Set-up

The QC20 ballbar is mounted on the machine between two repeatable magnetic joints. A simple software created part programme comprising a series of G02 and G03 programme moves is required to run the test.

2 Data capture

During the test the Ballbar 20 software displays a real-time plot of the machine's ability to track a circle.

3 Data analysis and diagnosis

Ballbar 20 software measures and diagnoses specific machine error characteristics. The data is analysed in accordance with ISO 230-4, ANSI/ASME B5.54 machine performance standards.



Standard test

The standard test calls for the machine tool to perform two consecutive circles; one in a clockwise direction, the other counter-clockwise. In practice there is an extra arc added before and after the test circle to allow for the machine speeding up and slowing down.



Partial arc test

The QC20 ballbar can perform a 220° arc test in planes through the centre pivot axis. This means that you can perform ballbar tests in three orthogonal planes without the need to reposition the centre pivot, so speeding up testing. The results are displayed in the volumetric analysis report function with the assurance that all data has been gathered around the same reference point. Partial arc testing simplifies Z axis testing, with no custom fixturing required, and reduces axis travel requirement, e.g. 100 mm less Z axis travel on a 150 mm radius test.

Accessories



360° lathe accessory kit

The lathe accessory kit helps to perform 360°, 100 mm radius ballbar tests to diagnose specific errors on a lathe.

The kit comprises an arm assembly for the lathe turret and a spindle bar assembly for the lathe spindle. Both parts include magnetic cups to locate the QC20 ballbar.

Machine requirements

X-axis clearance	≥ 220 mm from centre line
Y-axis clearance	≥ 330 mm from centre line
Spindle diameter	ø25 mm (others will require additional magnetic base)
Tool header	accepts 20 mm or 25 mm tool shanks
CNC control	circular interpolation in ZX plane

On lathes with restricted axis travel it may be possible to perform a 50 mm radius test using the QC20 small circle accessory kit. It is crucial to ensure that there is clearance for the ballbar to perform the test in this configuration.

Ballbar calibrator

Manufactured from a material with a temperature expansion coefficient of near zero, the ballbar calibrator is used to calibrate the length of the ballbar. When used with the calibrator, the QC20 ballbar calibrates absolute (rather than relative) errors for axis scaling and radial deviation values. 100, 150 and 300 mm lengths can be calibrated.



Small circle accessory kit

The small circle accessory kit allows the QC20 ballbar to perform 50 mm radius tests (the standard minimum is 100 mm). This is ideal for testing machines with short-axis travel or to provide enhanced analysis of servo control systems on most types of machines (small circles require higher machine accelerations and decelerations). To support the smallest machines, a 30 mm radius accessory is available on request.



VTL adaptor

The VTL adaptor enables diagnosis of 2-axis CNC applications, for example, vertical turning lathes, laser cutting machines, and pick and place machines. This replaces the tool cup in the standard set-up and gives restricted movement of the centre cup in a single axis.

With tests performed in the ZX plane, the VTL adaptor allows the magnetic centre cup to retract after centring, without losing the centre location. This enables the machine to be moved to the test start position without introducing offset errors in the other axes.

Ballbar spindle centring device

To perform tests to ISO 10791-6 standard using a QC20 ballbar, the tool cup must be centralised in the spindle before testing. Although ISO 10791-6 does not specify a centricity value, to eliminate test set-up error the tool cup must be aligned to the spindle centreline.

The ballbar spindle centring device helps to centralise the tool cup tip with the spindle centreline.





Ballbar 20 software

Check and diagnose servo performance errors and path deviations

Ballbar 20 software is a powerful and easy-to-use tool for commissioning and testing throughout the life of your machine tool. The software captures and automatically analyses QC20 ballbar data to the latest standards (ISO 230-4 and ANSI B5.54).

Ballbar 20 provides flexibility for comprehensive tests to be run as a 'one-off' or using customer-defined test templates. The captured data is displayed as a graphical trace and each diagnosed error is ranked according to its impact on the overall machine accuracy, with a value for positional tolerance.



Part program generator

The part program generator enables ballbar test CNC part programs to be automatically generated quickly. Define the ballbar test and select a machine controller type (several defaults are available but additional controllers can be added and customised). The part program is generated by a single click which can be edited and downloaded for easy transfer to the CNC machine. Generated programmes can be stored for future use.

Volumetric analysis

The volumetric analysis feature allows three test files, selected from orthogonal planes (subject to matching criteria), to be displayed on a single page. The analysis feature finds overall maximum and minimum circularity values to give 'sphericity' and shows individual test circularity results.

Ballbar simulator

The ballbar simulator is a powerful tool to aid decisions on corrective action or maintenance prediction. It allows users to see their test results on screen and change various machine geometry, play and dynamic parameters to see "what if" results on the ballbar plot, circularity, and positional tolerance values.

Analysis reports

Results can be displayed as analysis reports in a variety of international standards (including ISO 230-4, ANSI B5.54), as well as a comprehensive Renishaw analysis format. Ballbar 20 software ranks each diagnosed error according to its impact on overall machine accuracy, allowing easy and targeted improvements to be made.

Machine history

Test history for any specific machine can be easily reviewed to monitor variations in the machine's performance over time, enabling the user to:

- Predict maintenance requirements in advance to reduce unscheduled downtime.
- Compare performance before and after a crash to pinpoint corrective maintenance requirements.
- Review the effects of maintenance and service adjustments in real-time.
- Assess machine history to identify recurring problems and the effectiveness of previous fixes.

The results are displayed graphically, selecting from the standard report parameter values, for example; circularity and squareness. For in-depth explorations, individual plot points can be selected for the original test report and polar graph.

Ballbar Trace software

Flexible software for time-based data capture

Ballbar Trace software can be used with the QC20 ballbar to capture time-based data and test the kinematic accuracy of 4-axis and 5-axis machines that have three linear and one or two rotary axes.

Real-time data is captured by Ballbar Trace, satisfying the ISO 10791-6 reporting standard with maximum to minimum deviation.



QC20 ballbar for ISO 10791-6 standard testing

Everyone benefits

The QC20 ballbar provides quick machine performance verification, benefiting many job functions.

✓ Production

Know the machine's full potential. Choose the right machine for each job to achieve manufacturing tolerances and reduce scrap, rework and time-consuming set up and inspection processes.

✓ Purchasing

Demonstrate machine performance upon commissioning with confidence.

✓ Quality

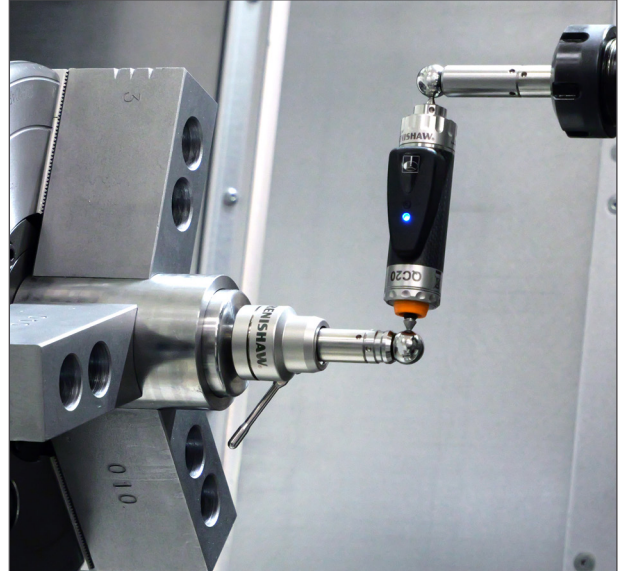
Test reports provide proof of performance to international standards, satisfying audit requirements. They are also a powerful tool when bidding for contracts.

✓ Maintenance

Implement predictive maintenance programs by regularly tracking a machine's performance, evaluate repair strategies and test results.

✓ Service

Powerful diagnosis capabilities gives an overall assessment of machine performance. This allows more accurate estimation of an engineer's time to evaluate and restore the machine's accuracy. The test reports provide tangible proof of service, increasing customer confidence.



QC20 with small circle adaptor

“ The QC20 ballbar can detect multiple kinematic errors in a machine tool within 10 minutes. This helps us to quickly identify the reasons for substandard machining quality, making it easier to trace and resolve associated problems.

Guangdong Jinke Machine Tool Co. Ltd
(China) ”



“ QC20 ballbar identifies problems quickly with no need to strip down the machine just to see if something is wrong.

BOST Machine Tools (Spain) ”



QC20 ballbar specification

QC20 ballbar	
Sensor resolution	0.1 μm
Measurement accuracy* (radial variation)	$\pm (0.7 + 0.3\% L) \mu\text{m}$
Measurement range	$\pm 1.0 \text{ mm}$
Sensor stroke	-1.25 mm to +1.75 mm
Maximum sample rate	1000 hz
Test radii supported**	30 mm to 1,350 mm
Battery type	CR2 (3v) photo lithium prime
Battery life	>200 typical 3 minute tests (12 hour continuous live display and data capture)
Operating temperature	0 °C to 40 °C

* Valid 15 °C to 25 °C

L = length over which error is measured

Specification if measuring 10 μm error on machine $\pm 0.73 \mu\text{m}$; specification if measuring 100 μm error on machine $\pm 1.00 \mu\text{m}$.

** Small circle accessory kit required for 50 mm test. Maximum calibrated radius 300 mm; maximum radius with standard kit 600 mm, up to 1,350 mm with additional extensions.

Radio communication	
Class	Class 2 Bluetooth Low Energy 5.0 device
Bluetooth transmission range	10 m typical
Output power	0 dBm nominal 4 dBm maximum
Frequency band	2.402 GHz to 2.480 GHz

Certificate and recalibration

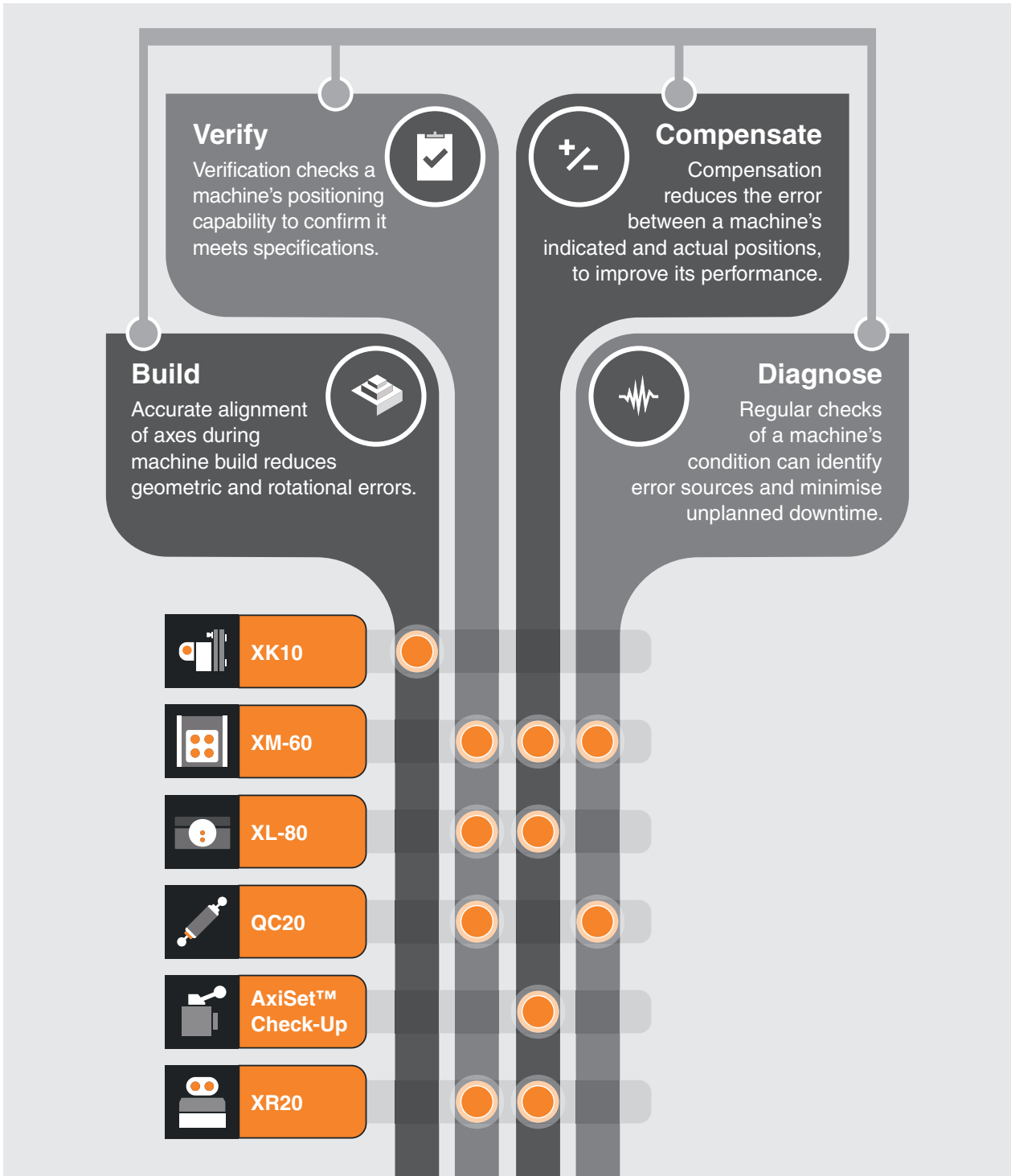
Renishaw's QC20 ballbars are supplied with a detailed calibration certificate; your guarantee of accuracy.

Machine shops are harsh environments and accidents can affect the ballbar's performance. Renishaw recommend the QC20 ballbar is recalibrated every 12 months to be confident that it is measuring within specification.

Our calibration service includes inspection and testing of the ballbar, replacement of tool cups and balls, comparison against a laser reference standard, computation of a new scale factor, and issue of a certificate of accuracy and traceability.

Renishaw's machine measurement solutions

Renishaw offers a range of calibration solutions for improved machine performance, increased machine up-time and preventative maintenance schedules.



Renishaw's innovation has transformed industrial metrology

Renishaw offers a range of calibration solutions for machine tools, CMMs and other applications:



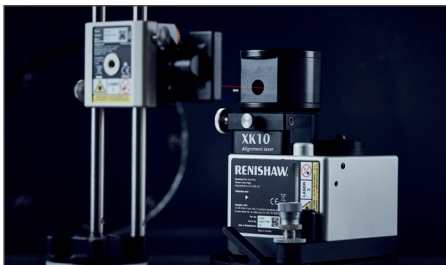
XL-80 laser measurement system

- The ultimate in traceable, versatile motion system analysis
- ± 0.5 ppm certified linear measurement accuracy



XR20 rotary axis calibrator

- Measurement accuracy of up to ± 1 arc second
- Totally wireless operation for quick and easy set up



XK10 alignment laser system

- Versatile laser alignment and set-up tool for machines and peripherals
- Intuitive software provides a step-by-step approach for each measurement type



XM-60 multi-axis calibrator system

- Measure six degrees of freedom in any orientation from a single set-up
- Unique technology, optical roll measurement and fibre optic launch



AxiSet™ Check-Up for machine tools

- Rapid on-machine measurement of rotary axis performance
- Accurate detection and reporting of errors in rotary axis pivot points

Service and quality

Our ongoing commitment to service and quality provides our customers with the complete solution



Training

Renishaw offers an established range of comprehensive operator training courses either on-site or at a Renishaw training centre. Our experience in metrology allows us to teach not just about our products, but also underlying scientific principles and methods of best practice.

This enables our customers to get the most out of their manufacturing processes.

Support

Our products enhance quality and productivity, and we strive for total customer satisfaction through superior customer service and expert knowledge of potential product applications. When you purchase a laser or ballbar system from Renishaw, you are buying into a worldwide support network that understands machine metrology and the service of production equipment.

Renishaw calibrations in the UK are traceable to the National Physical Laboratory, a signatory of the CIPM MRA. Calibration facilities worldwide can provide local laser calibration traceability.

Design and build

Not only does Renishaw have comprehensive in-house design capability, our extensive manufacturing capacity allows us to produce nearly all components and assemblies in-house. This gives us the ability to fully understand and control our design and build process.

The performance of Renishaw lasers has been independently verified by the National Physical Laboratory (UK) and the Physikalisch-Technische Bundesanstalt (Germany).

Certification

Renishaw plc is certified and audited regularly to the latest ISO 9001 quality assurance standard. This ensures all aspects of design, manufacture, sales, after sales support, and recalibration remain at the highest standards.

The certificate is issued by BSI Management Systems, an internationally recognised certification body, accredited by UKAS.



www.renishaw.com/calibration



#renishaw

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