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XM-60 and XM-600 multi-axis calibrator

www.renishaw.com/xm60

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Legal information

Warranty

Equipment requiring attention under warranty must be returned to your equipment supplier.

Unless otherwise specifically agreed in writing between you and Renishaw, if you purchased the equipment from a Renishaw company, the warranty provisions contained in Renishaw's CONDITIONS OF SALE apply. You should consult these conditions in order to find out the details of your warranty but, in summary, the main exclusions from the warranty are if the equipment has been:

- neglected, mishandled or inappropriately used; or
- modified or altered in any way except with the prior written agreement of Renishaw.

If you purchased the equipment from any other supplier, you should contact them to find out what repairs are covered by their warranty.

Patents

Features of the XM multi-axis calibrator, and other similar Renishaw products, are subject of one or more of the following patents and/or patent applications:

CN	101715540	US	2016/0169710
CN	105637326	US	5975744
EP	3028011	US	6473250
GB	2337339	US	6597505
IN	WO2015/015213	US	7304815
JP	2015/015213	US	8368887
JP	4499924		

Legal information

International regulations and conformance

EC and UKCA compliance

Renishaw plc declares that the XM system complies with the applicable directives, standard and regulations. A copy of the full EC Declaration of Conformity is available upon request.

In compliance with BS EN 61010-1:2010 the product is safe to use in the following minimum environmental conditions:

- Indoor use only
- Altitude up to 2000 m
- Maximum relative humidity (non-condensing) of 80 % for temperatures up to 31 °C decreasing linearly to 50 % relative humidity at 40 °C
- Pollution Degree 2

USA and Canadian regulations

FCC

Information to the user (47CFR:2001 part 15.19)

This device complies with part 15 of the FCC rules. Operation is subject to the following conditions:

1. This device may not cause harmful interference, and
2. This device must accept any interference received, including interference that may cause undesired operation.

Information to the user (47CFR:2001 part 15.105)

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses and can radiate radio frequency energy and, if not used in accordance with this user guide, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case you will be required to correct the interference at your own expense.

Legal information

Information to the user (47CFR:2001 part 15.21)

The user is cautioned that any changes or modifications not expressly approved by Renishaw plc or authorised representative could void the user's authority to operate the equipment.

Special accessories (47CFR:2001 part 15.27)

This unit was tested with shielded cables on peripheral devices. Shielded cables must be used with the unit to ensure compliance.

Canada – Industry Canada (IC)

This device complies with RSS 210 of Industry Canada. Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of this device.

L'utilisation de ce dispositif est autorisée seulement aux conditions suivantes: (1) il ne doit pas produire d'interference et (2) l'utilisateur du dispositif doit étre prêt à accepter toute interference radioélectrique reçu, même si celle-ci est susceptible de compromettre le fonctionnement du dispositif.

REACH regulation

Information required by Article 33(1) of Regulation (EC) No. 1907/2006 ("REACH") relating to products containing substances of very high concern (SVHCs) is available at: **www.renishaw.com/REACH**

RoHS compliance Compliant with EC directive 2011/65/EU (RoHS)

China RoHS

For more information on China RoHS, visit:
www.renishaw.com/calcompliance

Legal information

Packaging

Packaging component	Material	94/62/EC code	94/62/EC number
Outer box	Cardboard - 70 % recycled content	PAP	20
Inserts	Cardboard - 70 % recycled content	PAP	20
Bags	Low density polyethylene	LDPE	4

Disposal of waste electrical and electronic equipment

The use of this symbol on Renishaw products and/or accompanying documentation indicates that the product should not be mixed with general household waste upon disposal. It is the responsibility of the end user to dispose of this product at a designated collection point for waste electrical and electronic equipment (WEEE) to enable reuse or recycling. Correct disposal of this product will help to save valuable resources and prevent potential negative effects on the environment. For more information, contact your local waste disposal service or Renishaw distributor.

Disposal of batteries

Please see the relevant battery manufacturers' website for further information: (Varta) **https://www.varta-storage.com/produkte/power/cellpac-lite/**

The use of this symbol on the batteries, packaging or accompanying documents indicates that used batteries should not be mixed with general household waste. Dispose of the used batteries at a designated collection point. This will prevent potential negative effects on the environment and human health which could otherwise arise from inappropriate waste handling. Contact your local authority or waste disposal service concerning the separate collection and disposal of batteries. All lithium and rechargeable batteries must be fully discharged or protected from short circuiting prior to disposal.

Legal information

Radio communication

The wireless communication module used within the XM system is pre-approved in a number of regions including EU, EFTA countries, USA and Canada.

Module manufacturer:	Laird plc
Part number:	TRBLU23-00200
FCC ID:	FCC ID PI401B
Module ID No:	1931 B-BISMII

For details of national radio approvals for this device, see the Compliance with radio device regulations document on the **Calibration product quality and conformance** web pages.

Further radio approval country specific statements can be found below:

Singapore

Reg. No. N1116-17

Complies with
IDA Standards
DA104642

Mexico

La operación de este equipo está sujeta a las siguientes dos condiciones:

1. es posible que este equipo o dispositivo no cause interferencia perjudicial y
2. este equipo o dispositivo debe aceptar cualquier interferencia, incluyendo la que pueda causar su operación no deseada.

Taiwan

低功率電波輻性電機管理辦法

第十二條經型式認證合格之低功率射頻電機，非經許可，公司、商號或使用者均不得擅自變更頻率、加大功率或變更原設計之特性及功能。

第十四條低功率射頻電機之使用不得影響飛航安全及干擾合法通信；經發現有干擾現象時，應立即停用，並改善至無干擾時方得繼續使用。前項合法通信，指依電信規定作業之無線電信。低功率射頻電機須忍受合法通信或工業、科學及醫療用電波輻射性電機設備之干擾。

Safety information

WARNING: Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.

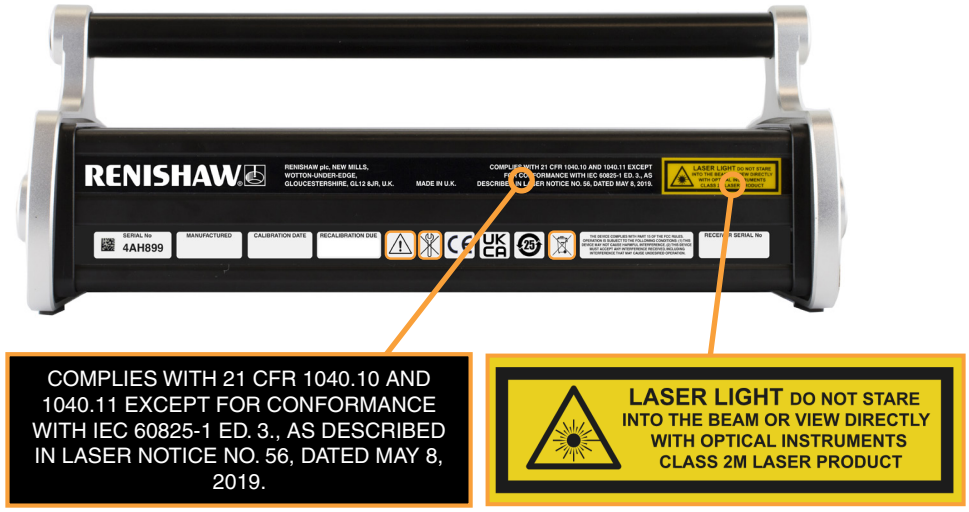
Ensure that you read and understand the XM system user guide before using any XM system.

The XM system can be used in a variety of environments and applications. To ensure the safety of the user and other personnel in the vicinity it is therefore paramount that a comprehensive risk assessment is carried out for the machine under test before using the XM system. It is the responsibility of the user to esnure the system is safe to use.

This should be carried out by qualified users (requiring machine competency, applicable technical knowledge and a trained risk assessor) with consideration for the safety of all personnel. The risks identified must be mitigated prior to using the product. The risk assessment should pay particular attention to machine, manual handling, mechanical, laser, electrical, power and fibre optic safety.

Based on current research, the wireless devices used in this product would not seem to pose a significant health problem for the vast majority of pacemaker wearers. However, people with pacemakers may want to ensure a minimum distance of 3 cm between the XM system and the pacemaker.

Safety labelling



WARNING: There are no user-serviceable parts inside the XM system. Do not remove any part of the housing; to do so could expose the user to high voltages and/or Class 3R laser radiation.

CAUTION: Ensure that you read and understand the XM system user guide before using any XM system.

Mechanical safety

- When setting up and mounting Renishaw XM and XC-80 systems beware of pinch and/or crush hazards that may be created, for example, due to magnetic mounting bases.
- Beware of trip hazards that may be created when using the XM and XC-80 systems, for example, due to trailing cables.
- Exercise caution if components are to be mounted to moving or rotating machinery. Beware of cables becoming entangled.
- Exercise extreme caution if XM and XC-80 system components are to be mounted to machinery that may accelerate rapidly or move at high speed, which could lead to items colliding or being ejected.
- If it is necessary to operate the machine with the guards or any safety feature removed or disabled, it is the responsibility of the operator to ensure that alternative safety measures are taken in line with the machine manufacturer's operating instructions or relevant codes of practice.
- If you are using a part program or error correction parameters generated by the Renishaw software, it is your responsibility to validate these at low feedrate and be prepared to operate the emergency stop button if necessary.
- The XM system weighs approximately 24 kg in the case (31 kg with the machine tool fixturing kit attached). Users should exercise caution and follow local manual handling guidelines.



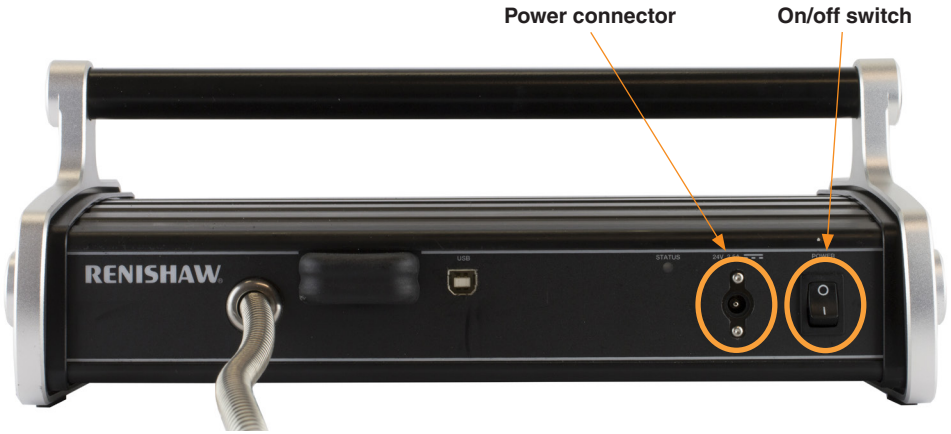
Laser optical safety

- In accordance with (IEC) EN60825-1, XM systems are Class 2M lasers and safety goggles are not required (under normal circumstances the eye will blink and look away before damage can occur).
- Do not stare directly into the laser beams or view them with optical equipment such as telescopes, convergent mirrors or binoculars as permanent retinal damage could occur. Do not direct the beam at other people or into areas where people unconnected with laser work might be present. It is safe to view a diffuse-reflected beam during system alignment.
- Complies with 21 CFR 1040.10 and 1040.11 except for conformance with IEC 60825-1 Ed. 3., as described in Laser Notice No. 56, dated May 8, 2019.

Rotating the shutter to the closed position (the right-hand position on the picture) ensures no beam is emitted.

Electrical and power safety

- The power supply unit must not come into contact with fluids, for example, coolant on the floor.
- The power supply unit must not be positioned inside the machine volume.
- The XM system has been qualified for use with the power supply unit supplied with the system. A specification for this power supply unit can be found **on page 53**.
- In the event of damage to the single-phase mains cabling section of the power supply (power lead), all power must be isolated from the equipment before any other action is taken.
- In the event of a fault with the XM system, switch it off immediately using the 'ON/OFF' switch, or by disconnecting the 'Power connector', or by disconnecting the mains power supply.
- Ensure the XM system is positioned in such a way that the power can be easily disconnected by the operator.
- Never connect the system to devices not intended to be used with the XM system.



Battery safety

The XM multi-axis calibrator is supplied with rechargeable batteries.

- Once depleted, recharge the battery in the charger provided: do not attempt to charge the battery by other means.
- For specific battery operating, safety and disposal guidelines, please refer to the battery manufacturers' literature.
- Replace the batteries only with the specified type.
- Ensure that all batteries are inserted with the correct polarity.
- Do not store batteries in direct sunlight.
- Do not heat or dispose of batteries in a fire.
- Do not short-circuit or force discharge the batteries.
- Do not disassemble, pierce, deform or apply excessive pressure to the batteries.
- Do not swallow the batteries.
- Keep the batteries out of the reach of children.
- Do not get batteries wet.
- If a battery is damaged, exercise caution when handling it.

Battery safety

Transportation

Ensure that you comply with international and national battery transport regulations when transporting batteries or XM system kits.

The XM system uses a Lithium-ion battery. Lithium batteries are classified as dangerous goods and strict controls apply on their shipment by air. To reduce the risk of shipment delays, should you need to return the XM system to Renishaw for any reason, do not return any batteries.

The operation of wireless appliances on aircraft is forbidden by many airlines to prevent interference with communications systems. Remove the battery from the receiver unit when boarding an aircraft to ensure it cannot be switched on inadvertently.

Fibre optic safety

The XM system contains fibre optics. In the unlikely event that the flexible steel conduit is cut or severed, fibre optic splinters may be produced.

Fibre optic splinters can be very small and extremely sharp. Should any fibre optic splinter become embedded in the skin, medical attention should be sought immediately.

Should the fibre optic become damaged, the following procedure should be followed (be aware that the affected area might contain splinters of unattached fibre optic which can present a hazard):

- Immediately power down the XM system.
- Wear eye protection and protective gloves when handling damaged or exposed fibre optics.
- Carefully remove the XM system from the machine and package in a suitable thick-walled cardboard box, clearly marked ‘Caution: exposed fibre optics, handle with care’ on the outside of the box.
- Return the unit to the nearest Renishaw office.

No attempt should be made to repair or dismantle the fibres from the laser unit.

NOTE: Fibre optic splinters do not show up on X-rays.

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Principles of measurement

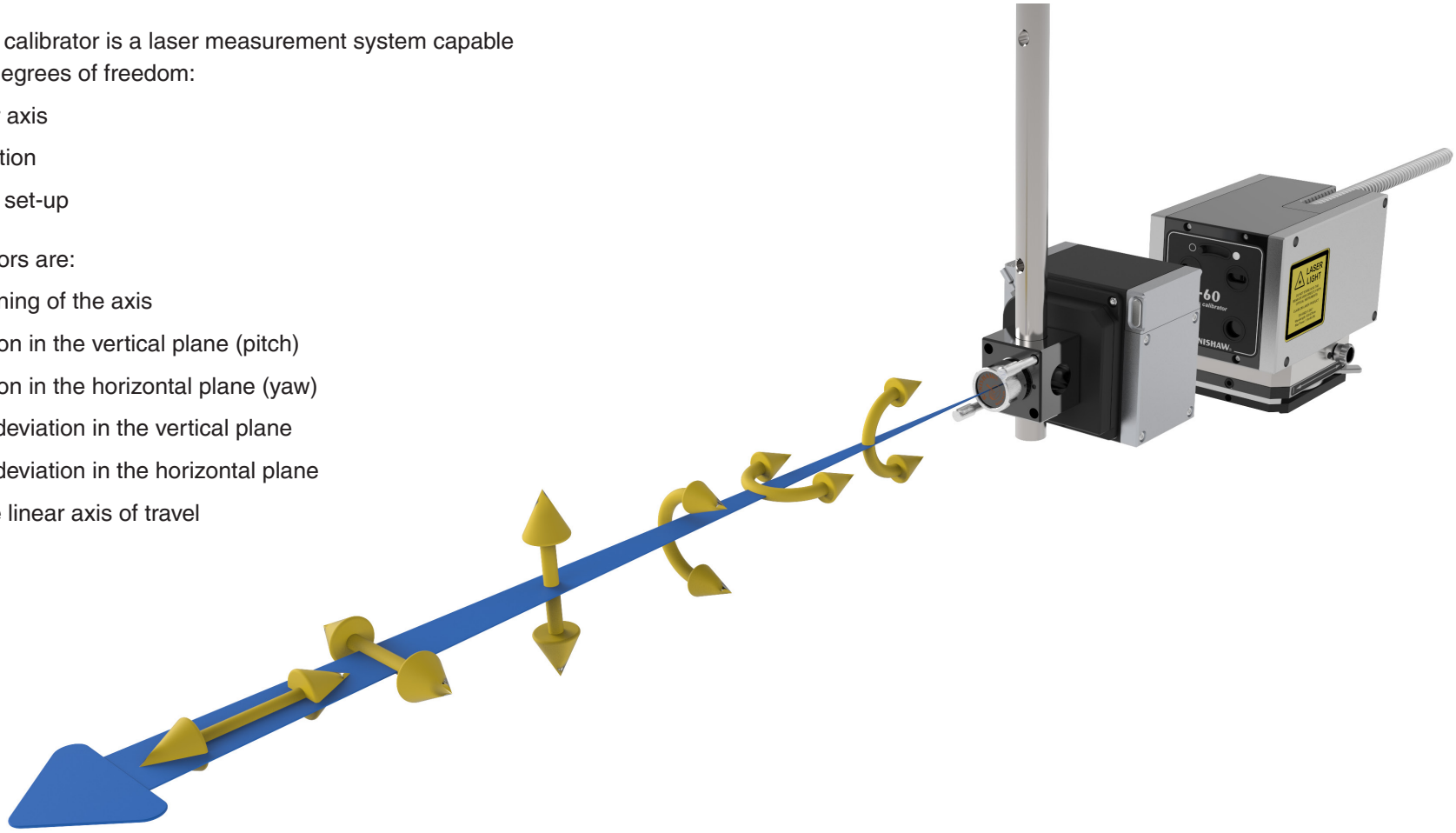
XM multi-axis calibrator

The XM multi-axis calibrator is a laser measurement system capable of measuring six degrees of freedom:

- Along a linear axis
- In any orientation
- From a single set-up

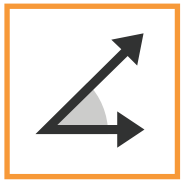
The measured errors are:

- Linear positioning of the axis
- Angular rotation in the vertical plane (pitch)
- Angular rotation in the horizontal plane (yaw)
- Straightness deviation in the vertical plane
- Straightness deviation in the horizontal plane
- Roll about the linear axis of travel



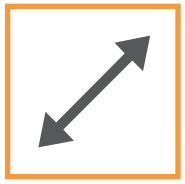
The XM system uses three laser beams (1, 2 and 3) to measure the linear, pitch and yaw errors using interferometry. The light emitting diode (LED) beam (4) is used for straightness and roll measurements.

The basic measurement concept is:



Angular

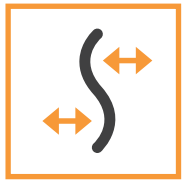
The three interferometric beams provide a linear measurement of the separation between launch and receiver. Because the distance between these beams is known, angular errors of pitch and yaw can be determined by the system.



Linear

Using the pitch and yaw measurements, the linear error is determined based on the combination of beams 1, 2 and 3 to calculate the linear error at the position of beam 4.

The fourth (diode source) beam is used to measure straightness and roll.

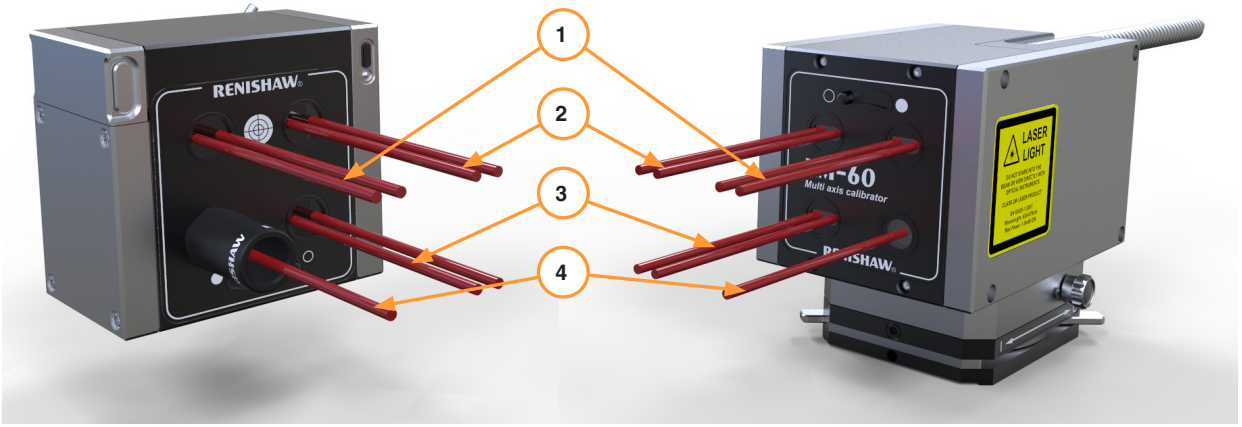


Straightness

The vertical and horizontal straightness error is measured using a position sensor within the receiver and transmitted back to the laser via wireless communication.

Roll

Roll measurement is performed optically using a roll detector inside the receiver. Roll measurements are absolute between the launch and the receiver.



System components

XM-60 system kit

1	Laser unit
2	Launch unit
3	Receiver
4	Magnetic base
5	M8 pillars × 4

6	Vertical mount
7	Battery Li-Polymer 3.7 V × 3
8	Dock
9	Clamp blocks × 2
10	Beam shroud

11	Spirit level
12	Cable clamps × 3
13	Beam blocker (for rotary applications, see the *XR20 rotary axis calibrator* user guide)

NOTE: The kit will also contain required cables and product quality documentation.

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System components

XM-600 system kit

1	Laser unit
2	Launch unit
3	Receiver
4	Magnetic base
5	M8 pillars × 4

6	Vertical mount
7	PICS cable
8	Battery Li-Polymer 3.7 V × 3
9	Dock
10	Clamp blocks × 2

11	Beam shroud
12	Spirit level
13	Cable clamps × 3
14	Beam blocker (for rotary applications, see the *XR20 rotary axis calibrator* user guide)

NOTE: The kit will also contain required cables and product quality documentation.

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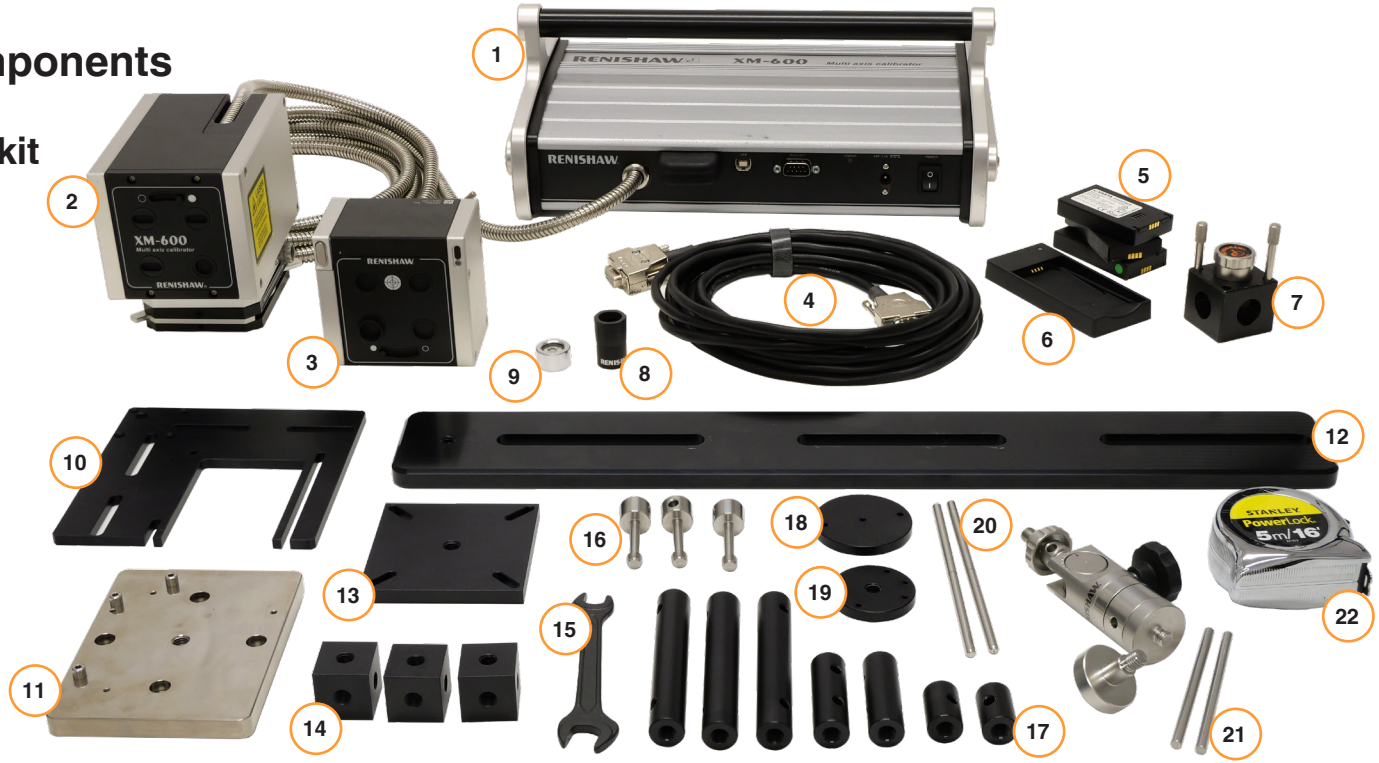
System components

XM-600 CMM kit



1	Laser unit
2	Launch unit
3	Receiver
4	PICS cable
5	Battery Li-Polymer 3.7 V × 3
6	Dock
7	Clamp block
8	Beam shroud

9	Spirit level
10	Optics mounting plate
11	Steel mounting plate
12	CMM table plate adaptor
13	Head mouting plate
14	25 mm cubes
15	Spanner 13 – 10 mm
16	Captive screws

17	25 mm, 50 mm, 100 mm spacers
18	Reflector optics mounting plate
19	Shank adaptor
20	5 mm x 130 mm LG Tommy bars
21	Pan / Tilt adaptor
22	Tape measure

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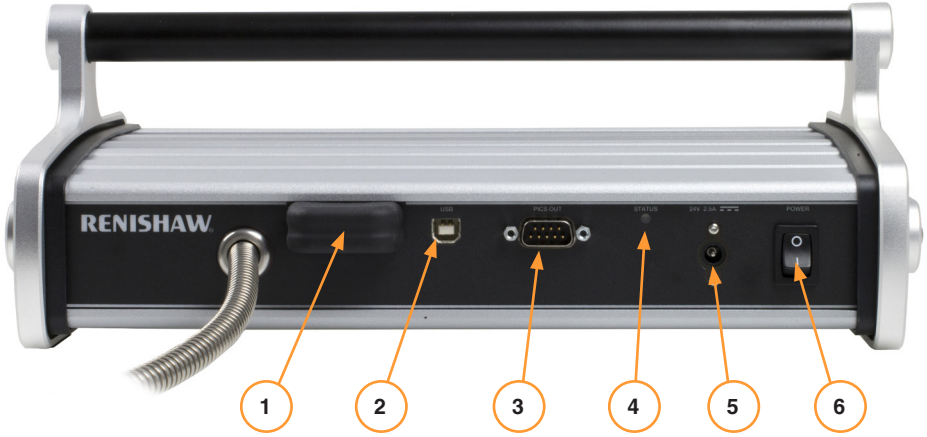
Laser / Launch

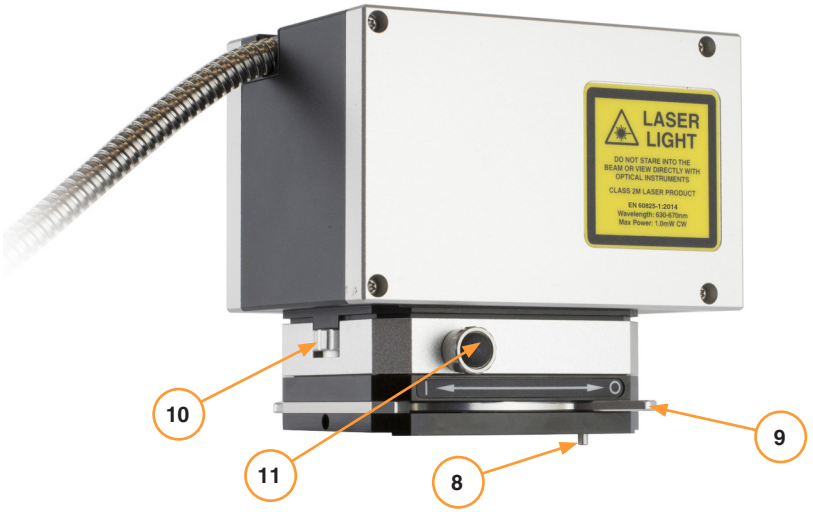
The laser contains a Helium-Neon (HeNe) laser tube providing laser beams to the launch via fibre optics. In addition, the laser contains signal processing electronics.

The laser beam is split into three in the launch for linear and angular measurements. It also houses a diode beam source for roll and straightness measurements.



1	Wireless communication module
2	USB connection port
3	PICS connector (XM-600 only)
4	System status LED
5	Power connector
6	Power on/off switch

7	Laser safety shutter
8	Magnetic mount safety pin (prevents accidental magnet operation)
9	Magnetic clamp on/off lever
10	Pitch adjuster
11	Yaw adjuster



Receiver

The receiver contains three retro-reflectors for the interferometric laser beams. It also contains a straightness and roll sensor for the diode beam. Data from this sensor is transmitted to the laser via wireless communication.

1	Beam shroud
2	Roll adjuster
3	Shutter
4	Battery release buttons
5	Power button
6	Receiver/battery status LED

The beam shroud is attached by a ‘push-fit’ on to the receiver roll aperture.

CARTO software suite

The XM system is used with the CARTO software suite. This is made up of three applications; Capture to collect laser interferometry data, Explore to provide powerful analysis and Compensate to provide semi-automatic error correction.

www.renishaw.com/carto

NOTE: The XM-600 supports additional functionality when used on a CMM which is equipped with Renishaw's UCC system. This functionality is accessed using UCC Assist, which is part of UCC Suite – a software package for the CMM controller. The XM-600 is supported from UCC Suite V5.4.

UCC Assist enables additional features which are unique to the XM-600, and contains support information on how to use the XM-600 to calibrate a UCC-equipped CMM.

XC-80 environmental compensator

The XM specified accuracy for interferometric measurements is only valid when used with a calibrated XC-80 environmental compensator.

Changes in air temperature, pressure and relative humidity affect the wavelength of the laser light and, therefore, the measurement readings taken.

The XC-80 environmental compensator and its sensors very accurately measure the environmental conditions and compensate the wavelength of the laser beam for variations in air temperature, air pressure and relative humidity.

NOTE: For full details on XC-80 operation and specification, please refer to the *XC-80 environmental compensator* user guide (Renishaw part no. F-9908-0294).

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Fixturing kit

An optional fixturing kit is available. It provides the user with more flexible mounting options, particularly when a magnetic surface is available. Typical applications of the fixturing kit include:

- Overhanging the XM launch unit to enable the full travel of an axis to be measured
- Securing the launch unit in the chuck of a lathe or mill-turn machine tool (see **Appendix D**)

1	450 mm extrusion 350 mm extrusion 250 mm extrusion 200 mm extrusion 150 mm extrusion
2	Extrusion connectors × 8
3	Magnets × 5
4	Extrusion alignment aids × 2
5	Lathe adaptor
6	Steel mounting plate
7	Hex drivers × 3

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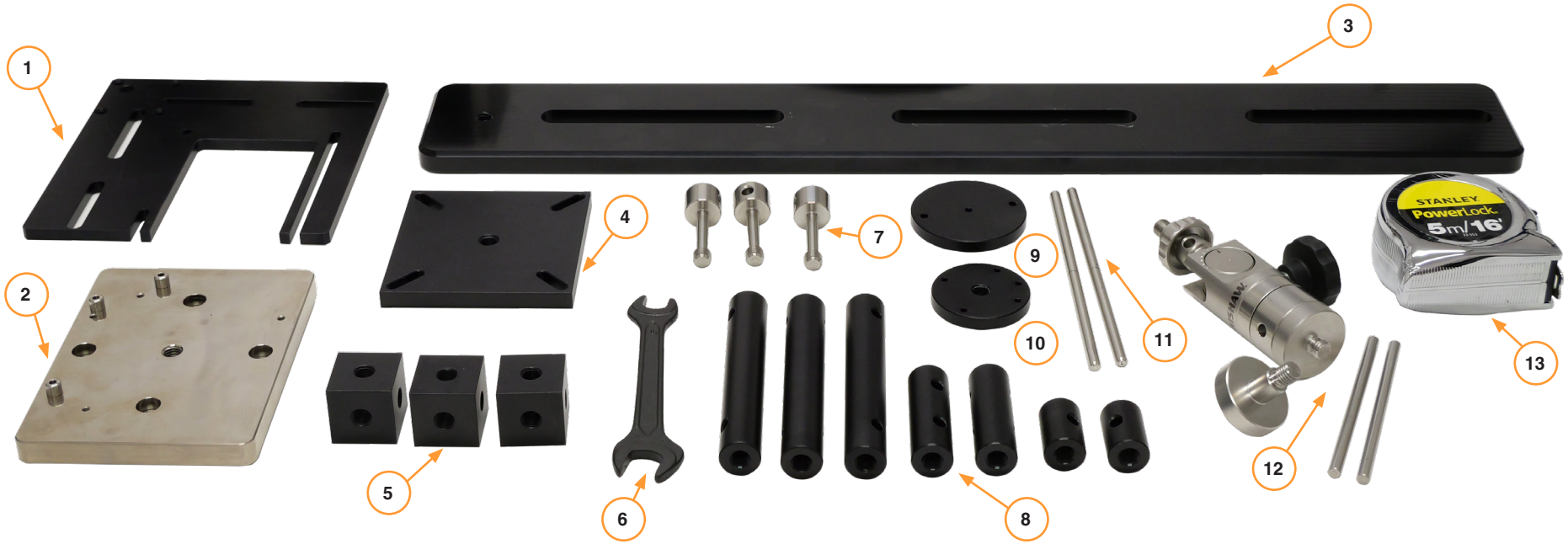
System components

XM-600 CMM accessories kit

Additional accessories are available to allow flexible use of the XM system (see **Appendix E**).



1	Optics mounting plate
2	Steel mounting plate
3	CMM table plate adaptor
4	Head mouting plate
5	25 mm cubes

6	Spanner 13 – 10 mm
7	Captive screws
8	25 mm, 50 mm, 100 mm spacers
9	Reflector optics mounting plate
10	Shank adaptor

11	5 mm x 130 mm LG Tommy bars
12	Pan / Tilt adaptor
13	Tape measure

Setting up a test

Testing precautions

Light interference

External light can cause errors in roll measurement performance.

To minimise the effect of light interference the user should:

- Always use the beam shroud
- Switch off the machine lighting
- Minimise external lighting

Sources of lighting that can affect the performance are:

- Sunlight
- Flashing beacons
- Welding
- LED and fluorescent room lighting

Performance can be affected by abnormal changes in any of the above. It is important to consider light effect and reflections over the full range of the axis under test.

CARTO software allows the user to perform an ambient light check. See the *CARTO Capture* user guide (Renishaw part no. F-9930-1007) for details.

Testing precautions

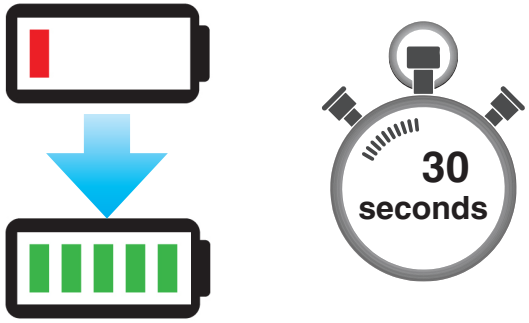
Thermal stabilisation

To meet the quoted specifications the XM system must be thermally stable.

Thermal stability is achieved 45 minutes after the laser/launch and receiver are powered on. Therefore it is recommended to turn the laser/launch and receiver on at the earliest opportunity.

The receiver and the launch must be removed from the case during the thermal stabilisation period and should be placed at least 200 mm away from each other.

To avoid the need for further thermal stabilisation, once discharged the receiver battery should be changed within 30 seconds.

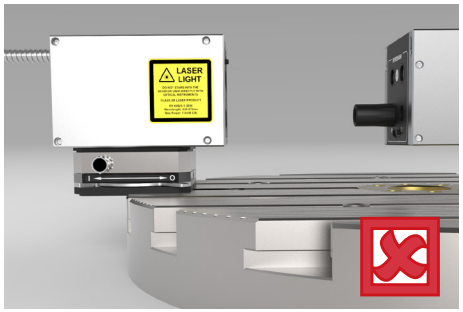


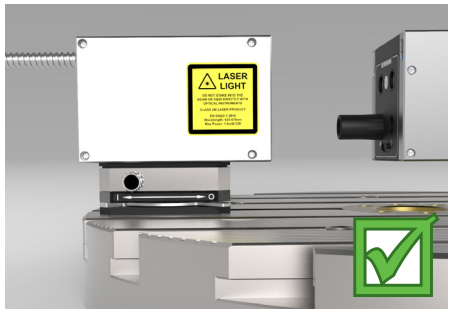
NOTE: An uninterruptible power supply can be used when moving the XM system from one machine to the next.

Mechanical set-up

- In order to take relative measurements between the tool and the workpiece, the launch must always be attached to the structure that holds the workpiece, for example, the machine bed or the chuck on a lathe. See **Appendix F** for XM set-up best practice.
- When the XM system is used on a machine where the workpiece moves, the conduit should be fixed to the machine bed to stop it dragging, misaligning, or causing the launch to move during machine motion. Magnetic cable clamps are included in the kit for this purpose.

- There may be situations when sufficient magnetic force is not available to securely mount the launch unit. This could occur when there is a requirement for overhanging the launch unit, or the machine bed is not magnetic. In this case, additional fixturing components (such as the machine tool fixturing kit or other mounting accessories) may be required.
- In general, metrology performance is improved when the system is used with fewer accessories. Use only the minimum amount of fixturing components required to align the system to the axis under test.





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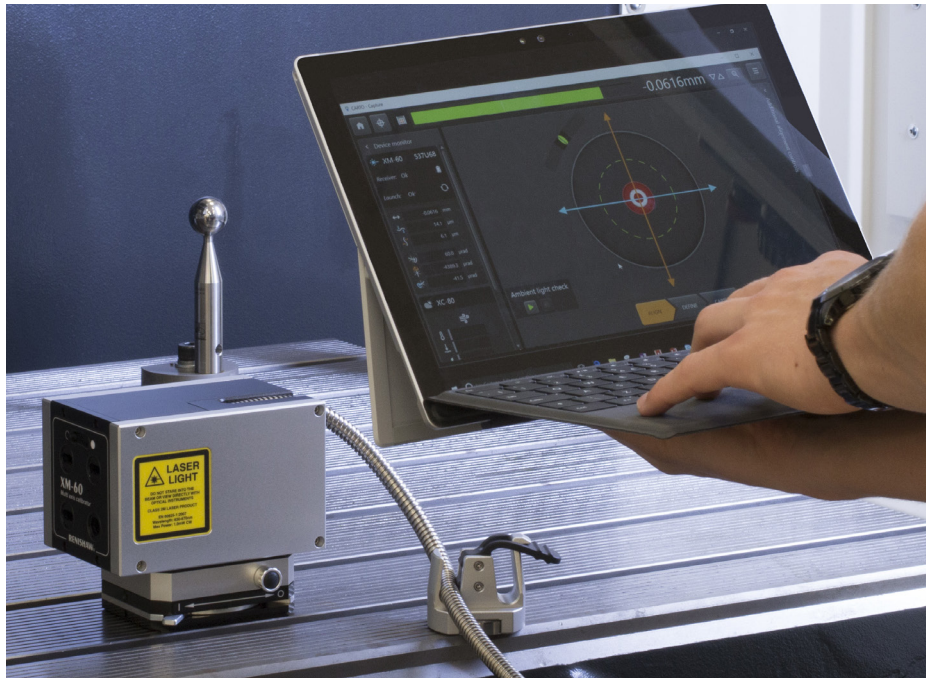
System set-up using CARTO software

Together with Renishaw's CARTO software suite, the XM system can be used to calibrate most CNC machines.

When using the XM-600 system, additional features are available on some machines (such as a CMM with a UCC controller), and other software may offer greater functionality.

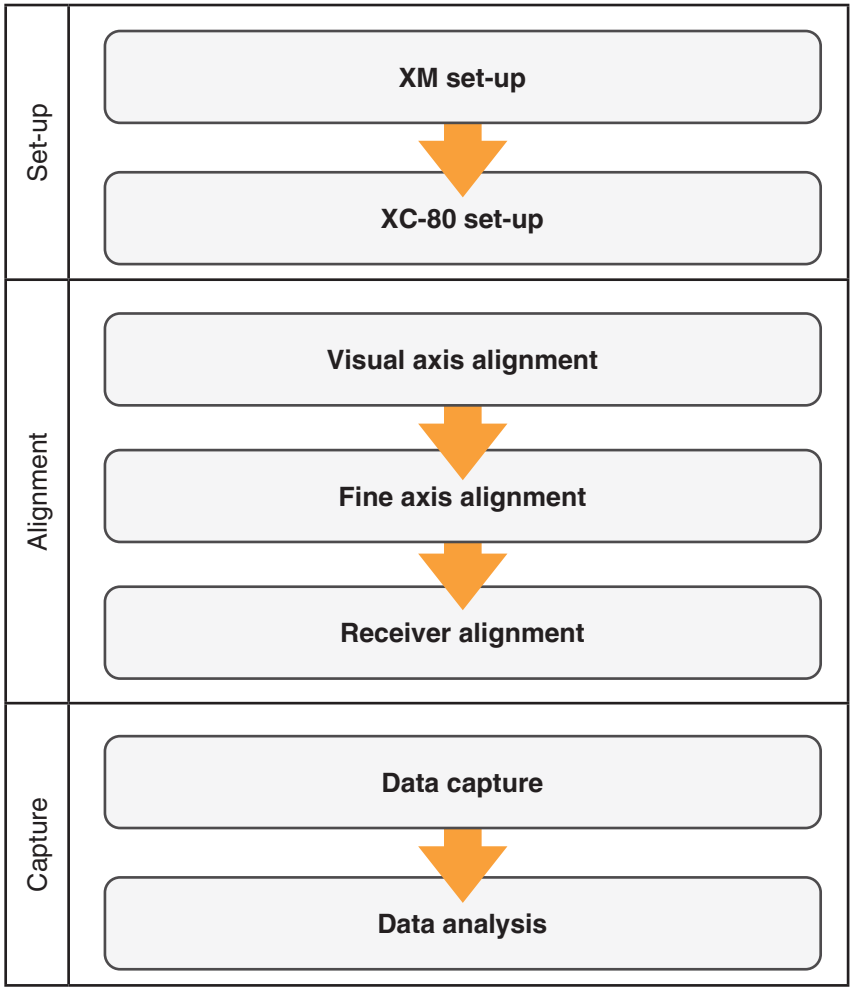
Application	XM-60	XM-600
CNC machine tool / lathe	CARTO software	CARTO software
UCC-equipped CMM	CARTO software	UCC Assist software
Non-UCC-equipped CMM	CARTO software	Contact your local Renishaw office



Test overview

The steps to perform a test using the XM system are as follows:

(Click on links to jump to relevant section)



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XM system set-up

The recommended set-up sequence for the XM system is as follows:

Take the removable tray out of the case before removing launch

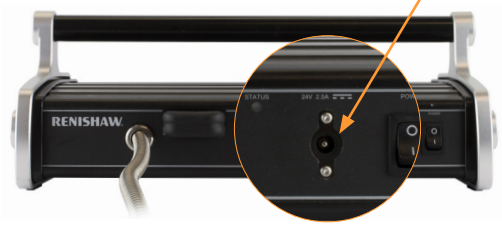
Ensure the launch shutter is closed

Connect the power supply to the laser

Switch the laser on

Fit the battery in the receiver

Attach the beam shroud to the receiver roll aperture



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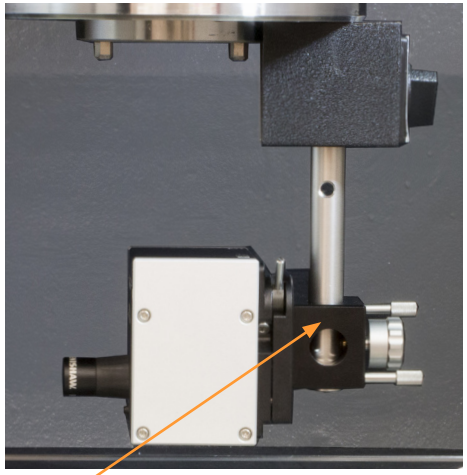
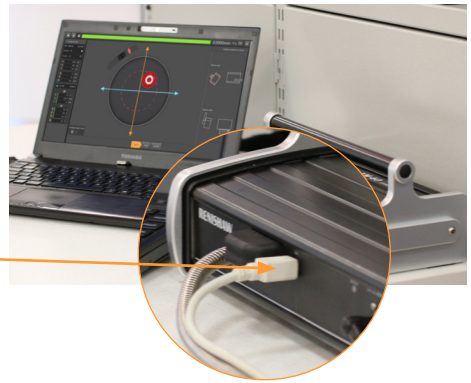
XM system set-up

1. Turn the receiver on
2. Attach the launch to the bed of the machine, parallel to the axis under test
3. Where appropriate, level the launch using the spirit level
4. Mount the receiver to the part of the machine where the tool would be attached
5. Connect the XM laser to the PC





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XC-80 system set-up

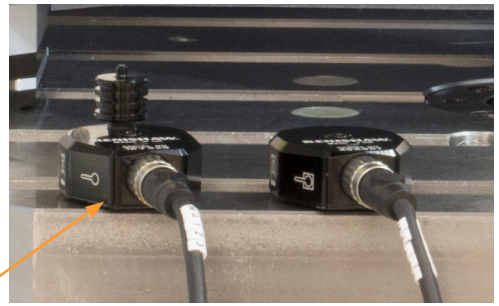
The recommended set-up sequence for the XC-80 environmental compensator is as follows:

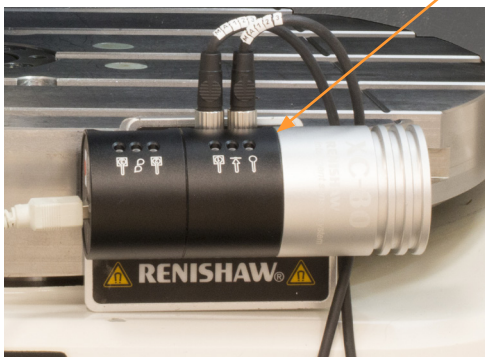
Connect the air and material sensors to the XC-80

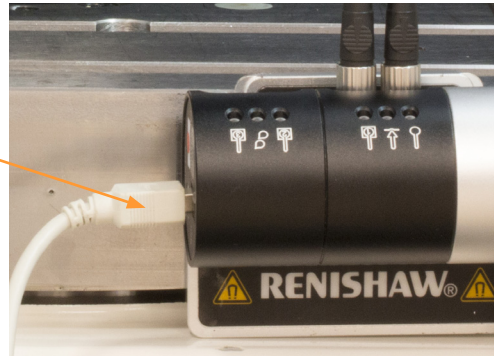
Attach the XC-80 to the machine

Position the air temperature sensor on the machine

Connect the XC-80 to the PC







NOTE: For more information on sensor positioning, refer to the *XC-80 environmental compensator* user guide (Renishaw part no. F-9908-0294).

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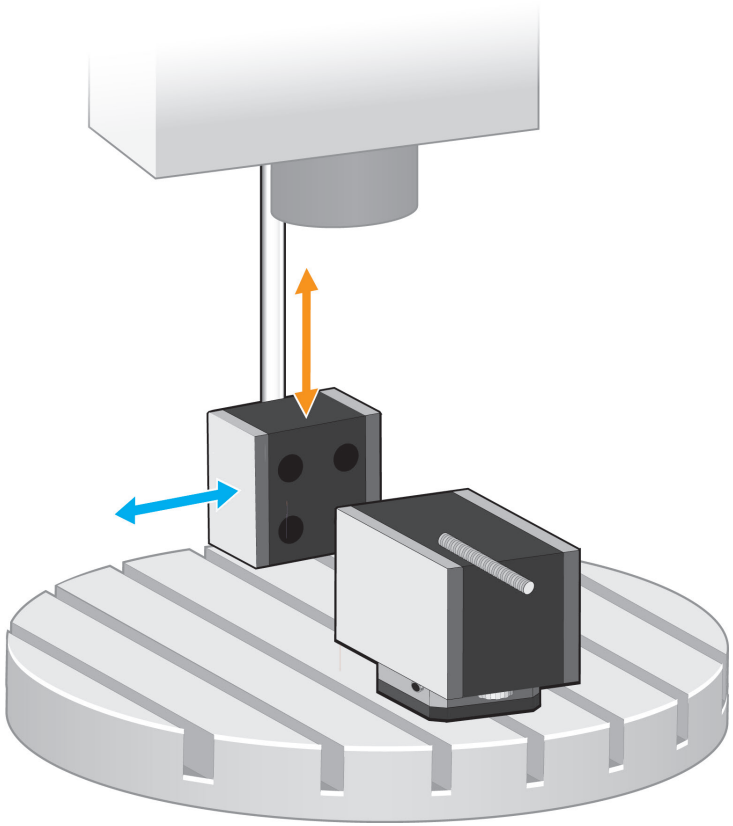
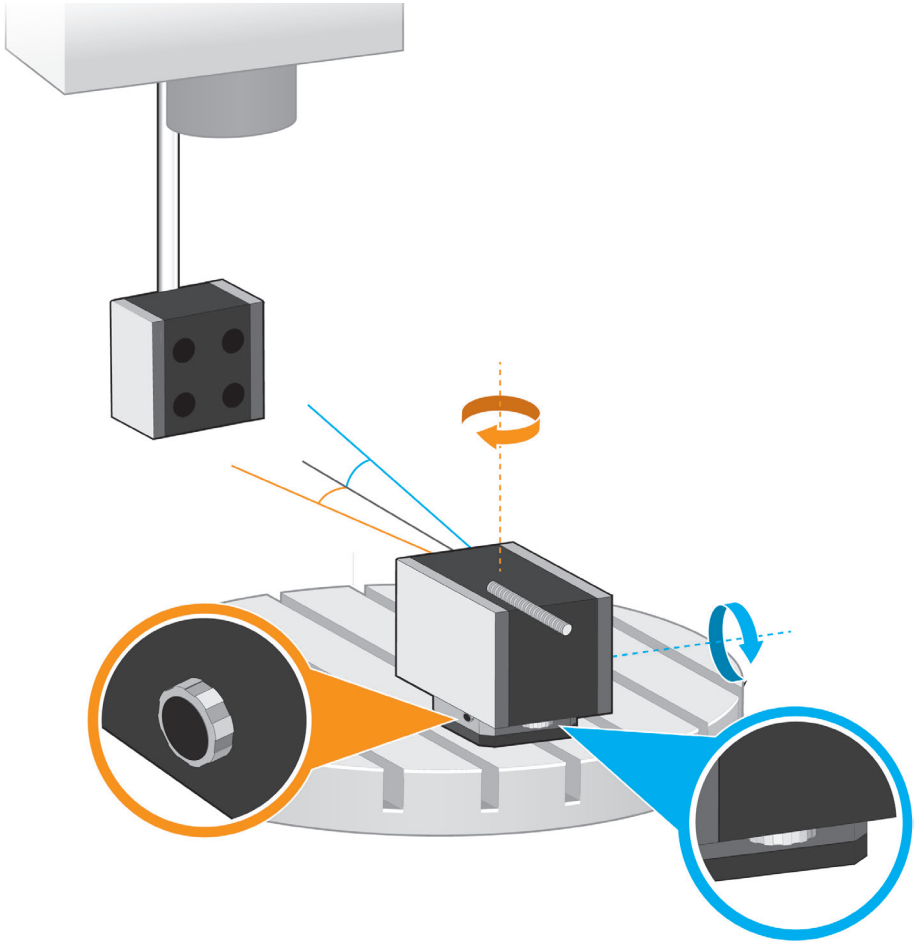
Basic rules of alignment

1. Launch and receiver are close to each other = **translation adjustment**
2. Launch and receiver are far from each other = **rotation adjustment**

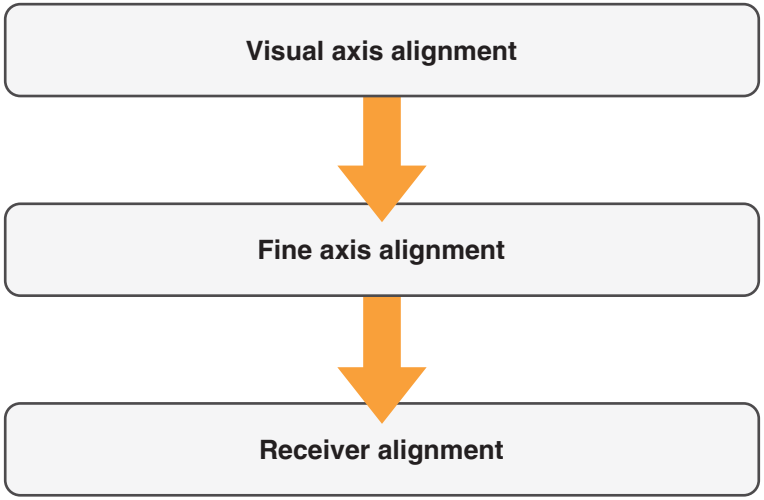




Alignment overview

The recommended alignment sequence is as follows:

(Click on links to jump to relevant section)



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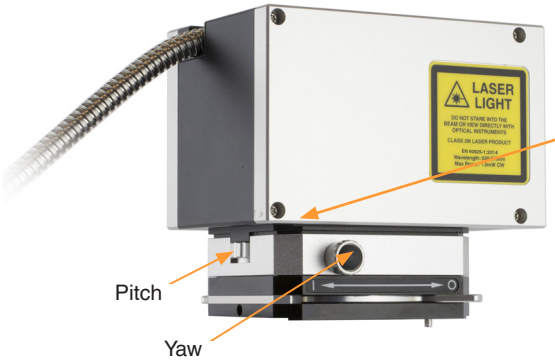
Visual axis alignment

Visual axis alignment is performed using the target on the front of the receiver.



Set the pitch and yaw adjusters to the middle of their travel

Move the launch and the receiver as close to each other as possible

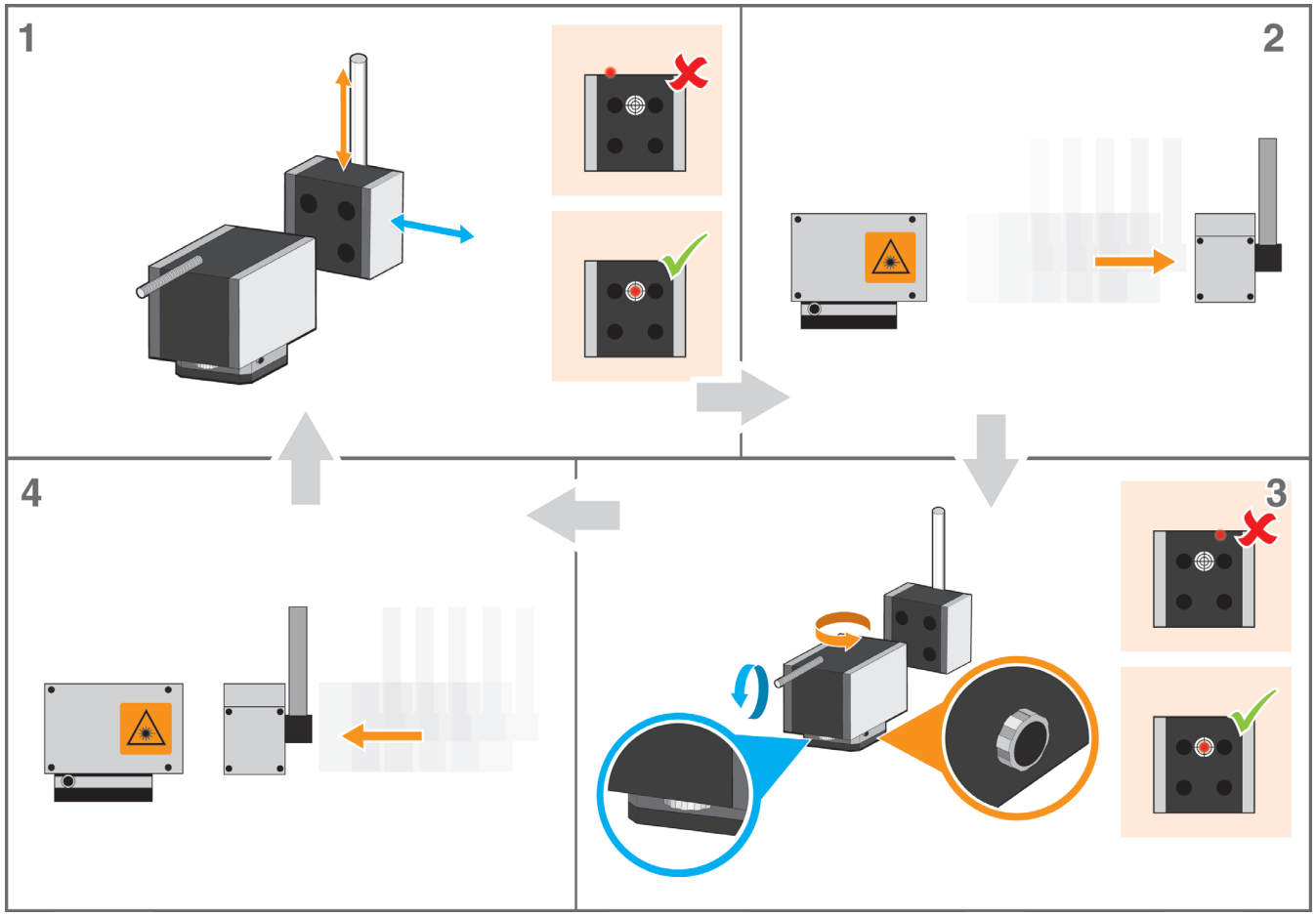
Visually check the launch and the receiver are parallel to each other

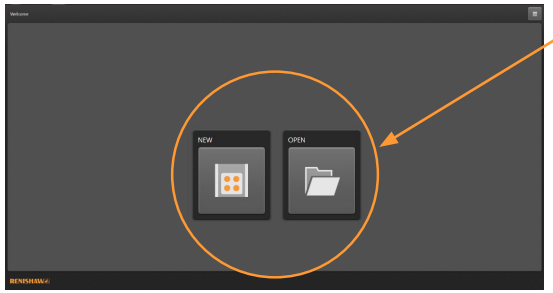
Open the shutter on the launch and the receiver

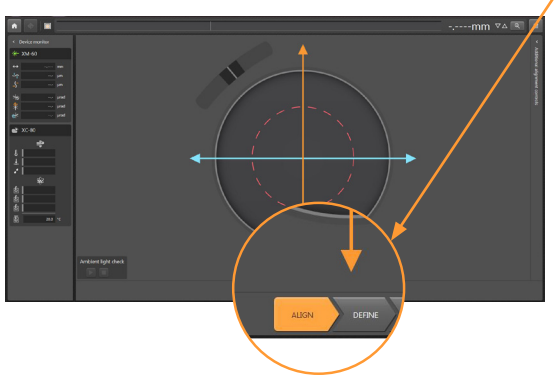
Translate the machine so that one of the beams is on the receiver target

Visual axis alignment

Continue the process below until the beam stays on the target during the full machine movement. Use the machine to perform translations and pitch/yaw adjusters for rotational alignment.







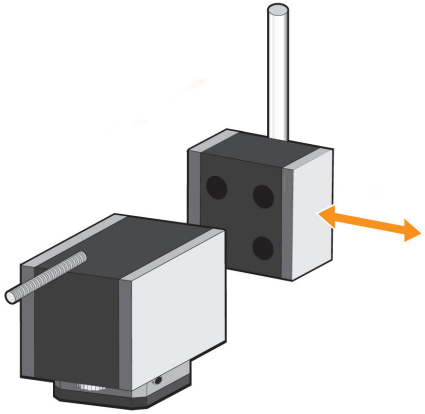
Run the CARTO Capture software

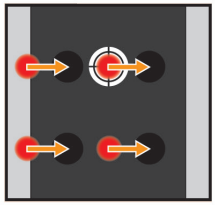
Select ‘New’ or ‘Open’

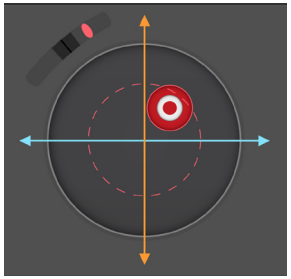
Select ‘Align’

Translate

Move the machine to align the laser beams into the receiver apertures. Adjust the position until the straightness beam appears in Capture







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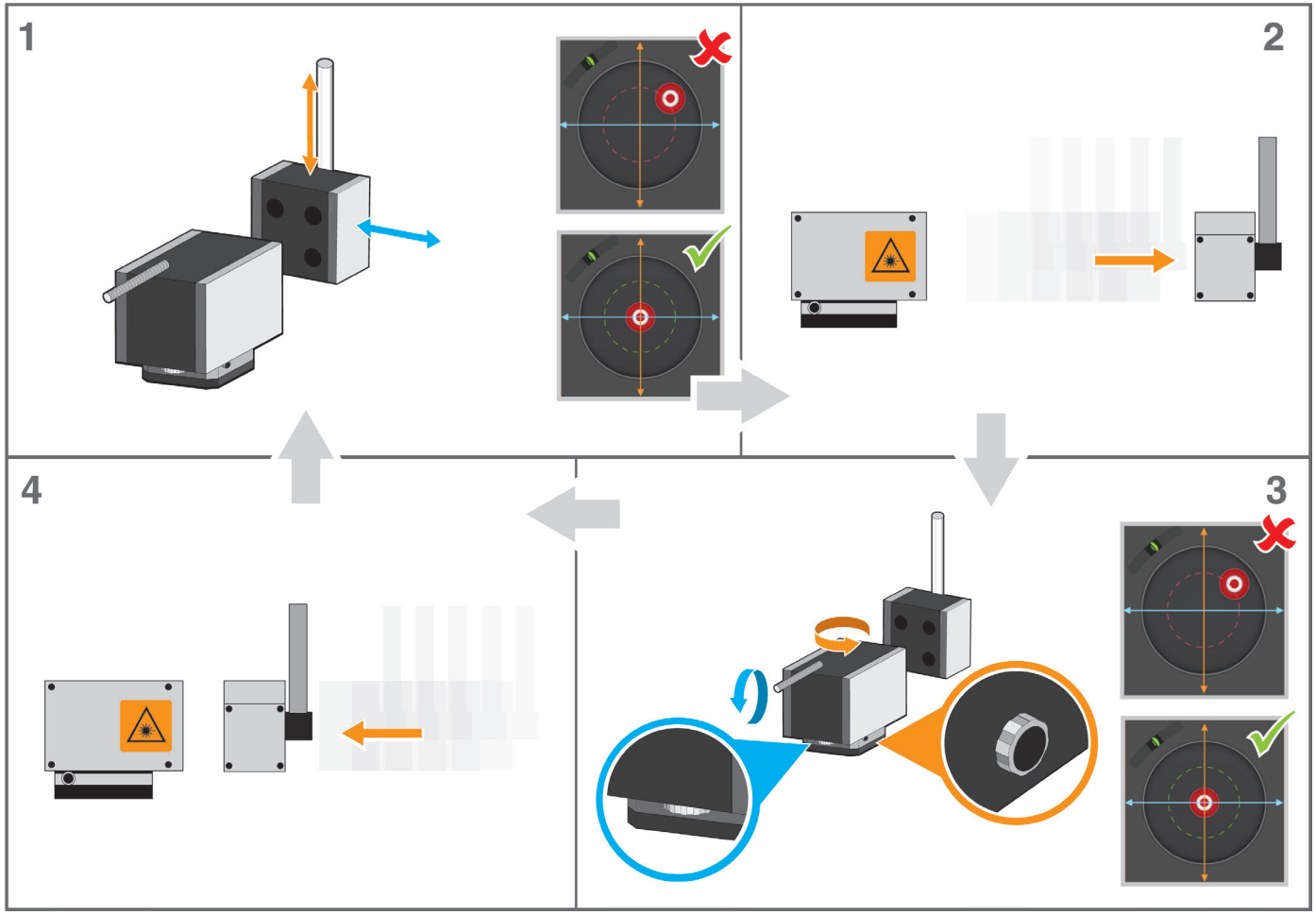
Fine axis alignment

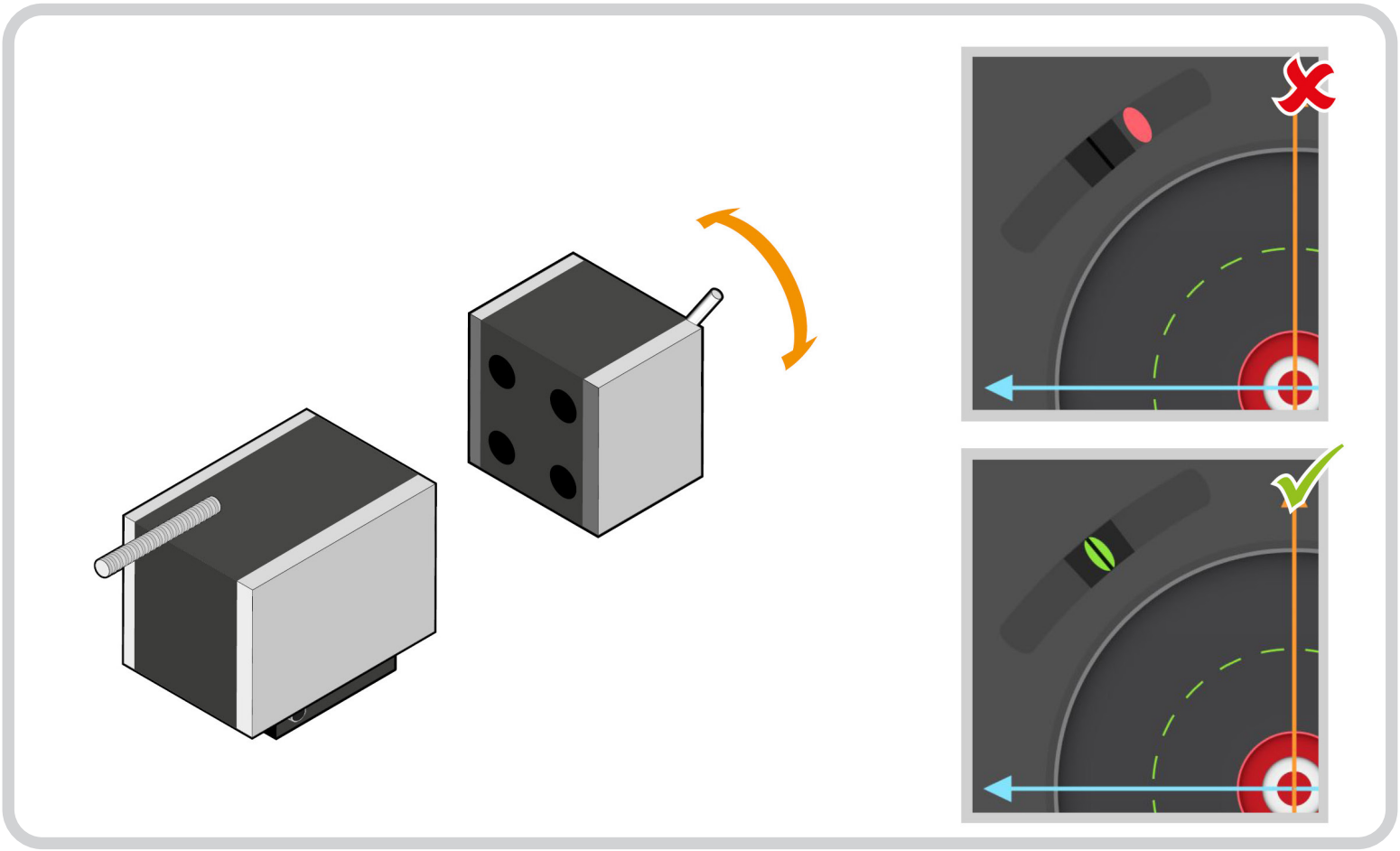
Continue the process below until the beam stays on the target in CARTO software during the machine movement.



Fine axis alignment

Roll alignment

Adjust the roll lever to the centre of the roll display.

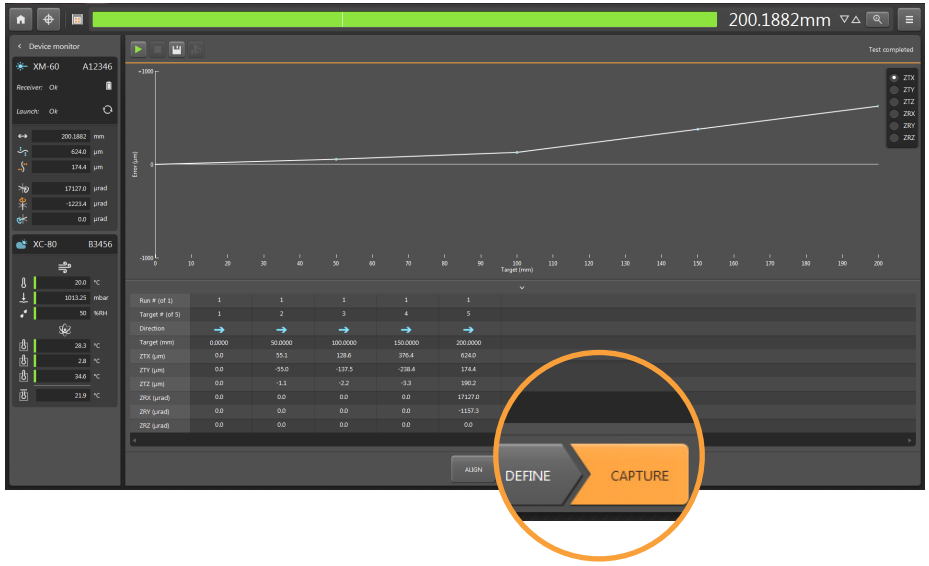


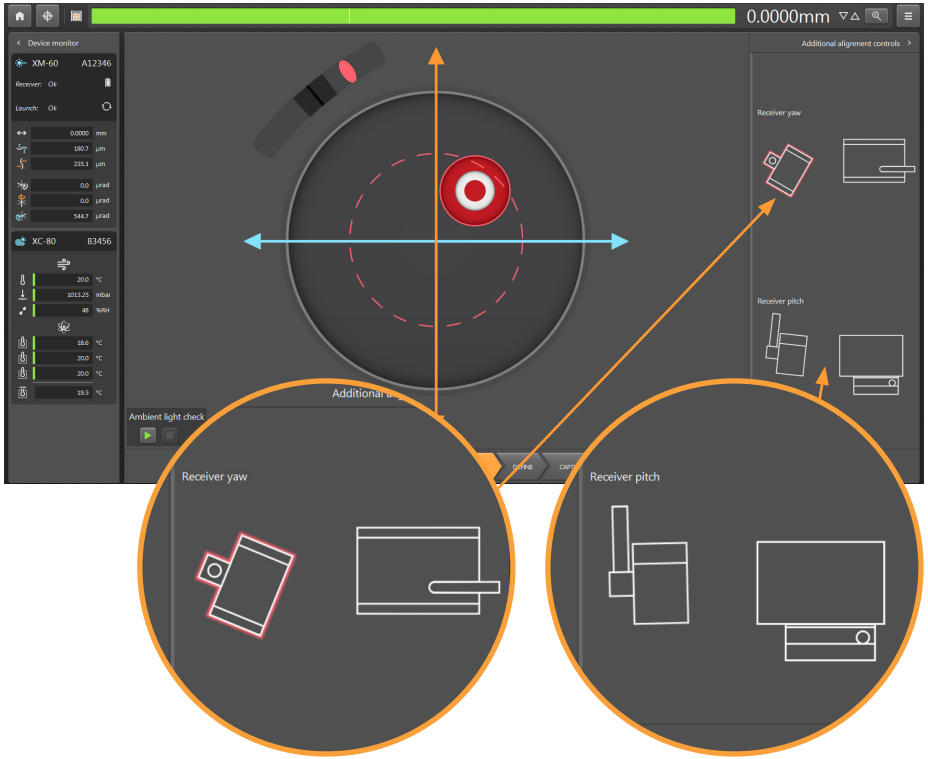
Receiver alignment

- To maintain the system accuracy the launch and the receiver must be parallel to each other.
- The software will check the parallelism on the completion of the fine axis alignment.
- If the parallelism tolerance is not met when selecting Capture, the software will prompt the user to physically adjust the mounting of the receiver. Rotate the receiver until the red border disappears. Do not adjust the pitch and yaw adjustment of the launch unit.

NOTE: It may be necessary to perform minor translation of the machine after this step is complete.

NOTE: Once set-up is complete and before capturing data, it is recommended to perform an ambient light check. See the *CARTO Capture* user guide (Renishaw part no. F-9930-1007) for details.





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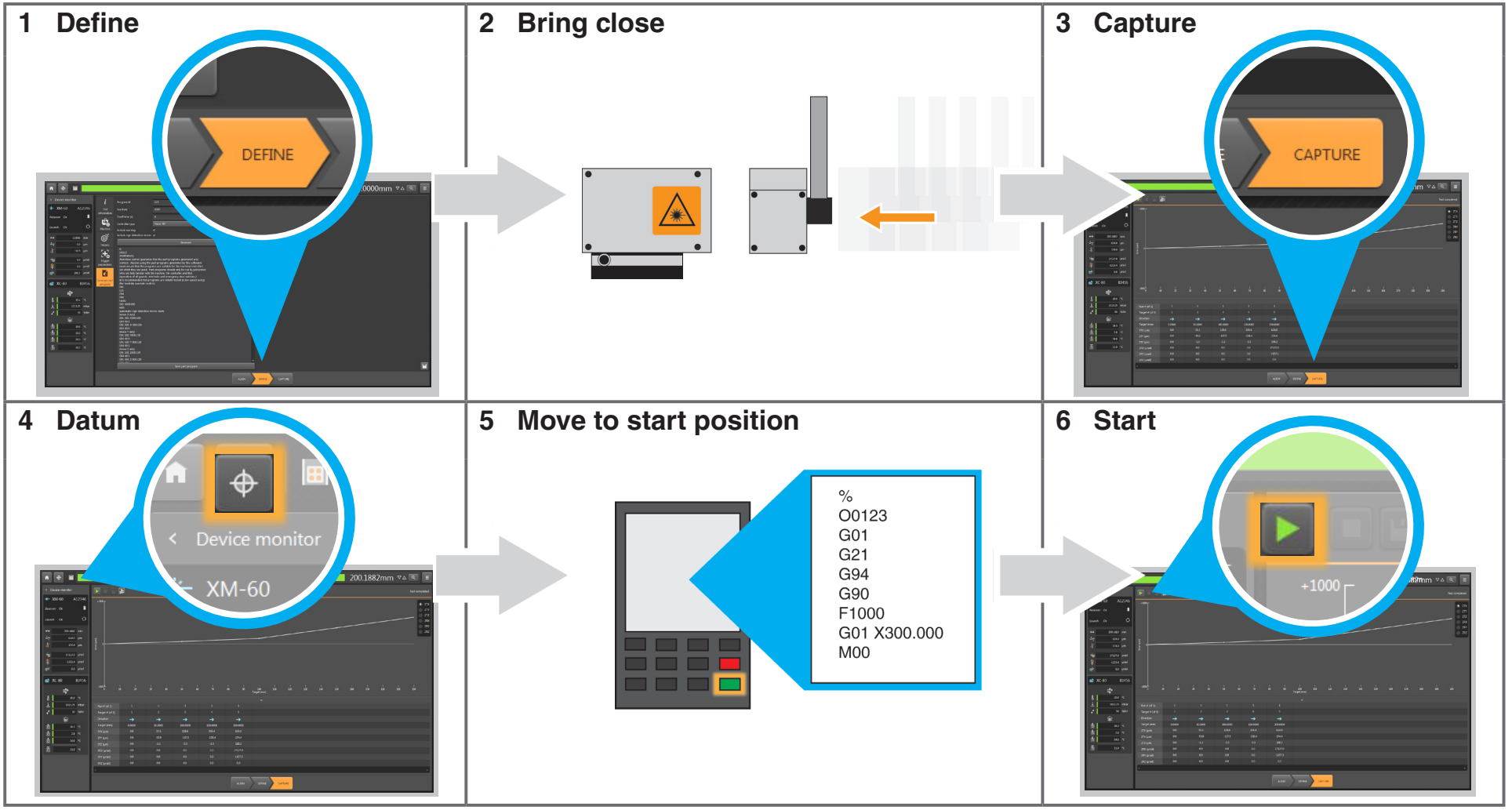
Data capture

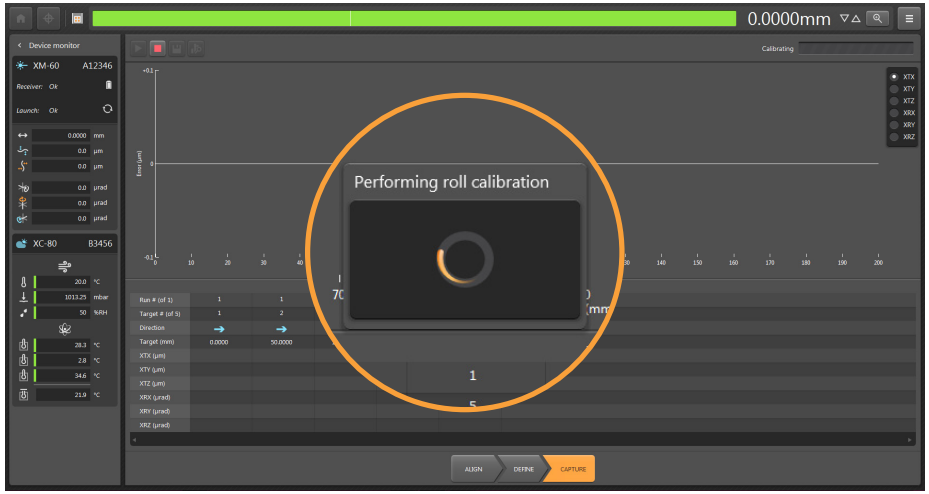


NOTE: For full details on Capture please, refer to the *CARTO Capture* user guide (Renishaw part no. F-9930-1007).

Data capture

Roll tuning

When ‘Start’ is selected the system will perform a calibration cycle on the roll detection scheme to compensate for the set-up conditions.



Sign detection

To ensure the errors of the machine are measured with the correct sign (+/–) it is important that the co-ordinate system of the XM (X,Y,Z and their directions) is labelled according to that of the machine. Further details on sign detection can be found in **Appendix C**.

There are two methods of sign detection:

- Automatic

  Part programs produced with CARTO will perform machine moves to detect the sign.

- Manual

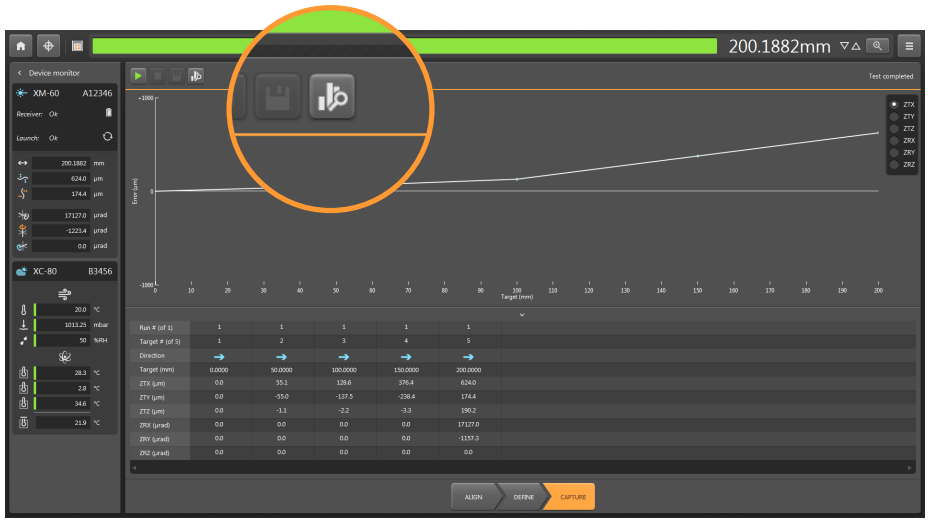
  The user can manually jog the machine ±150 µm in each axis when prompted by the software to perform sign detection.

NOTE: Users can skip an axis if there are not three perpendicular axes. Further details can be found in the *CARTO Capture* user guide (Renishaw part no. F-9930-1007) for details.

On completion of these steps the system will start capturing data.

Data analysis

On completion of the test select ‘Analyse’ to launch Explore.



NOTE: For further details on Explore please, refer to the *CARTO Explore* user guide (Renishaw part no. F-9930-1008) for details.

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Diagnostics and troubleshooting

Laser LED

This LED demonstrates the laser status and the wireless communication with the receiver.

LED status		Description	Actions
Flashing amber		Pre-heat cycle	No action required
Solid green		Laser is stabilised Receiver is not switched on or the wireless communication is not yet established	Check the receiver is powered on
Solid blue		Wireless communication is established Software is not running (not synced)	Open Capture in XM mode
Flashing blue		System operational The software is running and the data is being transmitted from the receiver	No action required
Solid amber		Laser unstable	• Check launch/receiver alignment • If the issue persists, power cycle the laser • If the issue persists, contact local Renishaw office
Flashing or solid red		Error encountered	• Check all four beams are present • Power cycle the laser • If the issue persists, contact your local Renishaw office

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Receiver LED

After the receiver power button has been pressed, the receiver LED will go through a start-up sequence and after a few seconds will settle on one of the following options:

LED status		Description	Actions
Flashing amber		No roll beam detected	• Open launch/receiver shutters • Check launch/receiver alignment • If the issue persists, contact your local Renishaw office
Flashing purple		Launch/receiver not synchronised and/or no roll beam detected	Run Capture while making sure launch/receiver shutters are open
Flashing blue		System is operational	No action required
Periodic one second amber followed by usual operational sequence		Low battery	Replace the battery (see **Appendix A**)
None		Battery charge too low Battery contacts dirty/damaged Battery inserted incorrectly Receiver not operational	• Insert a fully charged battery • If the issue persists, contact your local Renishaw office
Flashing green		Wireless communication device is not operational	• Power cycle the receiver • If the issue persists, contact your local Renishaw office
Flashing or solid red		Receiver not operational	• Power cycle the receiver • If the issue persists, contact your local Renishaw office

Battery charging LED status

To recharge the battery, remove it from the unit and place it into the slot in the dock. Ensure the battery is inserted into the dock in the correction orientation.

The colour status for the LED on the current dock and previous battery charger are shown below:

Dock (BTA-001)		Description
Flashing green and amber		The inserted battery is currently being charged.
Solid green		The battery is charged and can be removed for use.
Solid amber		Failure or no battery connected.
Solid red		Battery detected but no external power supplied.

Battery Charger (RRC-SCC-EZP)		Description
Solid amber		The inserted battery is currently being charged.
Solid green		The battery is charged and can be removed for use.
Flashing red		Battery detection phase.
Solid red		Failure.

Dock (BTA-001)

Battery Charger (RRC-SCC-EZP)

NOTE: To maintain optimum battery performance, batteries should be recharged every 6 months irrespective of use.

Battery life

Battery life in use will depend on many variables including the age and condition of battery, initial charge and test cycle and duration. The published specification is for a new battery and with the XM system used in a typical configuration.

For optimum battery performance only fit fully charged batteries.

A battery should be continued to be used until battery low is indicated by the receiver status LEDs. Once battery low is indicated, replace the battery with a fully charged one as soon as possible.

NOTE: Batteries should be removed during transportation.

System troubleshooting

Problem	Action
Software is not installed in my language	• Check PC system locale is set correctly
XM system is not recognised by CARTO	• Ensure Capture is running in the XM system mode • Check the XM is connected to the PC USB port • Try a different USB port on the PC (the port could be damaged) • Disconnect USBs, power cycle the XM/PC, and reconnect the USBs • If the issue persists, contact your local Renishaw office
Cannot align the XM system	• Ensure shutters on launch/receiver are open • Check four beams are present from launch using a card as a target. If not present, power cycle the XM system. • **Restart XM alignment** • If the issue persists, contact your local Renishaw office
CARTO diagnostic messages	• Refer to the *CARTO Capture* user guide (Renishaw part no. F-9930-1007).

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Measurement troubleshooting

Problem	Possible causes	Action
Beam strength fluctuating	• Environment is outside operating temperature range	• Ensure XM environment is between 10 °C and 40 °C
Beam strength fluctuating during machine movement	• Normal behaviour at increased speed between targets • Receiver clamp block is not tight	• No action required (this has no effect on metrology) • Tighten the receiver clamp block
All data looks noisy	• XM system fixed loosely	• Improve the rigidity of the system mounting
All data **(except for roll)** looks noisy	• The unit is positioned in turbulent air environment	• Reposition the unit to avoid the turbulent air or stir the air with a fan
Noisy straightness measurement	• None or short-term averaging is used	• Select long-term averaging in Capture
Drift (most significant for linear measurements)	• The system and/or the set-up is not thermally stabilised	• Perform a number of runs before capturing data for the machine axis to thermally stabilise • Ensure the laser/receiver are warmed up as per recommendations before testing (see **Specifications - warm up time**) • If the receiver battery has been replaced, follow the **thermal stabilisation** recommendations. • Avoid excessive handling of the launch/receiver to avoid body heat exchange • If using custom mounting parts, ensure they are suitable to avoid thermal growth

Care and handling

System

- It is recommended to store the XM calibrator in the system case when not in use.
- Do not attempt to clean the system with water or other fluids.
- Avoid exposure to oil and coolant.
- Do not direct the air lines at the XM system.
- Do not expose the system to impact.

Conduit

- Ensure the conduit is not pinched, crushed or stretched. If damaged, consult the **Fibre optic safety** section.
- When storing in the case, twist the launch whilst vertical to allow the conduit to coil.
- If the laser is left in the case during measurement, do not close the lid of the case to avoid damage to the conduit.
- Fix the conduit using the magnetic cable clamps to ensure the conduit does not drag, misaligning the launch.
    - Manually check the movement of the axis over the full range of the test, before running a test.
- Never hold the laser or launch by the conduit.

Optics

Cleaning of the optics should be a last resort

To maintain system performance, the XM optics must be kept clean by following good handling practice:

- Close the receiver and launch shutters when not in use.
- Do not touch the optical surfaces.
- Minimise use in contaminated atmospheres.

Cleaning recommendations

- Only use approved solvents for cleaning the optics: Methylated spirit and optical grade IPA only (methylated spirit is preferred to IPA).
- Wipe only with non-abrasive lens tissue or lint-free cloth wrapped around a cotton bud (do not use a cotton bud directly on the optic as this may increase debris).
- Clean the optics using a gentle action. Never use a scrubbing action as this might damage the coatings.

Failure to follow these recommendations may lead to damage to the coatings and glass elements of the optics.

System specifications

XM system	
Beam source	HeNe laser and light emitting diode (LED) (Class 2M)
Beam power (maximum output)	< 1 mW (sum of four beams)
Mode of operation	Continuous-wave (HeNe) Pulsed (LED)
Nominal laser beam diameter	3 mm
Vacuum wavelengths	633 nm and 655 nm nominal
Recommended recalibration period	2 years under typical use
Warm up time (measured from receiver and laser power on)	45 minutes 15 minutes laser tube pre-heat 30 minutes thermal drift reduction
Input power connector	Inner core = 24 V Outer core = 0 V 
Maximum velocity	1 m/s

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Performance specifications

Linear	
Axial range	0 m to 8 m
Mesurement range	0 m to 8 m
Accuracy	±0.5 ppm (with environmental compensation)
Resolution	1 nm

Angular (pitch/yaw)	
Axial range	0 m to 8 m
Measurement range	±500 µrad
Accuracy	±0.004A ±(0.5 + 0.11M) µrad
Resolution	0.03 µrad

A = displayed error reading
M = measured distance in metres

* The data stitch functionality in CARTO supports accurate readings for all six degrees of freedom beyond 6 metres.

NOTE: Accuracy values are reported to a statistical confidence of 95 % (k=2), they do not include the errors associated with the normalisation of the readings to a material temperature of 20 °C.

Straightness *	
Axial range	0 m to 6 m
Measurement range	±50 µm ±250 µm
Accuracy	±0.01A ±1 µm ±0.01A ±1.5 µm
Resolution	0.25 µm

Roll *	
Axial range	0 m to 4 m 4 m to 6 m
Measurement range	±500 µrad
Accuracy	0 m to 4 m: ±0.01A ±6.3 µrad 4 m to 6 m: ±0.01A ±10.0 µrad
Resolution	0.12 µrad

All specifications assume the use of the XC-80 environmental compensator and an environment with less than 1 °C change and a rate of change that does not exceed 1 °C over a 20 minute period (0.05 °C/min).

Specifications do not include the effect of air turbulence (for example, measurements at 4 m are obtained by averaging multiple sets of data).

The roll and straightness specification assume 1 second of averaging of the signal.

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Operating and storage environment

Operating environment		
Pressure	600 mbar to 1150 mbar	Normal atmospheric
Relative humidity	0 % to 95 % RH	Non-condensing
Temperature	10 °C to 40 °C	

Storage environment		
Pressure	550 mbar to 1200 mbar	Normal atmospheric
Relative humidity	0 % to 95 % RH	Non-condensing
Temperature	–20 °C to 70 °C	

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Radio communication

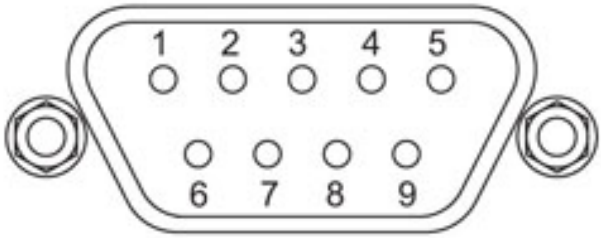
Class 1 wireless communication device	
Output power	0 dBm nominal; +6 dBm maximum
Frequency band	2.402 GHz to 2.480 GHz
Communication distance	12 m typical operation

PICS connector (XM-600 only)

The XM-600 includes a synchronisation output which is designed to be compatible with the PICS interface of Renishaw's UCC range of CMM controllers. The PICS signal from the XM-600 is a protected, isolated, open – collector output. The connector on the launch unit is a male 9-way D-Subminiature plug.

The connections on this plug are as follows:

PIN number	Function
5	Collector
9	Emitter
All others	No Connection



9-way male D-Subminiature plug, viewed from connector side

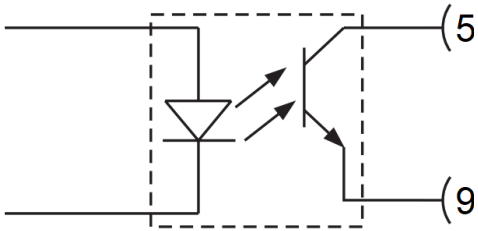


Illustration of internal connection of PICS output

Battery, dock, power supply and cables

NOTE: To ensure correct operation, only use the USB power supply supplied and USB cables with the correct power rating (see specifications).

Replacement USB power supply and USB cables (A-B and micro USB) are available from Renishaw.

1	Dock
2	Power cable
3	Power supply
4	Battery

Rechargeable battery

Technical data		
Battery type	Varta EasyPack XL Part no. 56456 702 099 (rechargeable Li-Polymer), 3.7 V 2400 mAh 8.9 Wh	MSDS ref LPP 503562 S
Nominal voltage	3.7 VDC	
Battery life	3 hours typical operation (for new batteries)	

Dock

Micro USB cable (Power cable)	
Shielded USB2	High speed
Gauge (AWG)	30 AWG (for data) 20 AWG (for power)

USB Plug and Go (Power supply)	
Standard output connector	USB A
Minimum current	2 A
Output voltage	5 V
Rate output power	10 W
Rated input voltage	100 - 240 VAC

Dock

Technical data			
Input voltage	5 V nom.	Output voltage	4.2 VDC Tolerance: ±1 % max
Input current	2 A nom.	Output current	1 A max. Tolerance: ±10 % max. @1.00 A
Input power	10.00 W	Output protection	Short circuit, Battery over/ under temperature, Charger over temperature, Charger timer
Charge Time	3 hours nominal		
Safety and EMC (*In combination with included external AC/DC power supply and USB cable)*	Europe International Europe Canada USA	EN 62368-1 (CE) IEC 62368-1 (CB) EN 61326-1:2021 (radiated emissions, ESD, radiated RF field immunity) ICES-003 2017 Section 5 (Information technology equipment (Including Digital Apparatus) Limits and methods of measurement) 47 CFR Part 15 B (Electrical equipment for measurement, control and laboratory use – EMC requirements – Part 1: General requirements)	

Environmental product specifications	
Cooling	Convection cooled
Temperature	Operating: 0 °C to 40 °C Storage: -20 °C to 80 °C
Pressure and Altitude	Operating: 1060 hPa to 795 hPa (-382 m to 2000 m) Storage: 1060 hPa to 572 hPA (-382 m to 4570 m)
Humidity	10 % to 90 % r.H., non-condensing

General product specifications	
Indicator	Multi-color LED (green, red, orange) (see **Battery charging LED status** details)
Battery types	Standard battery Varta EasyPack EZPack XL
Green procurement	RoHS 2011/65/EU, 2015/863/EU WEEE 2012/19/EU Chinese RoHS
Humidity	10 % to 90 % r.H., non-condensing

External AC/DC power supply

NOTE: Only use the power supply and mains cables supplied with the XM kit. Do not use any other power supplies or mains cables without the express prior permission of Renishaw.

Technical data			
Input voltage	100 V to 240 V	Output voltage	24 V
Input frequency	47 - 63 Hz	Output power	72 W
Input current	~1.5 A	Output current	3 A
Stand by power	No load < 0.10 W	Output protection	Over current, short circuit
Safety and EMC	Europe	CE	
	International	CB	
	USA & Canada	cULus / cETlus	
	Mexico	NOM	
	Australia & New Zealand	RCM / SAA	
	Korea	KC	
	China	CCC	
	Japan	PSE	
	United Kingdom	UKCA EN (IEC) 62368-1:2014+A11:2017	

Environmental product specifications		
Temperature	Operating: 0 °C to 40 °C	Storage: -20 °C to 80 °C
Humidity	Operating: 10 % to 90 % r.H., non condensing Storage: 5 % to 95 % r.H., non condensing	
Altitude	Operating: <2000 m	Storage: <2000 m

General product specifications	
Efficiency	California's energy efficiency level VI
Line / load regulation	±1 % / ±5 %
Ripple & Noise	200.00 mV (p-p)

Data cable (XM-60)

USB (A-B) cable	
Shielded USB2	Full or high speed
For cable length less than 3 m	28 AWG/2C (for data) 24 AWG/2C (for power)
For cable length greater than 3 m	28 AWG/2C (for data) 20 AWG/2C (for power)

PC minimum requirements

For details on PC minimum requirements, visit:
www.renishaw.com/lasercalsoftware

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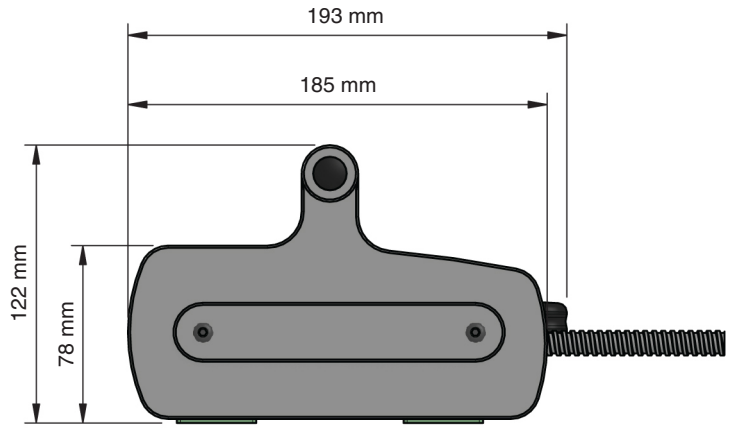
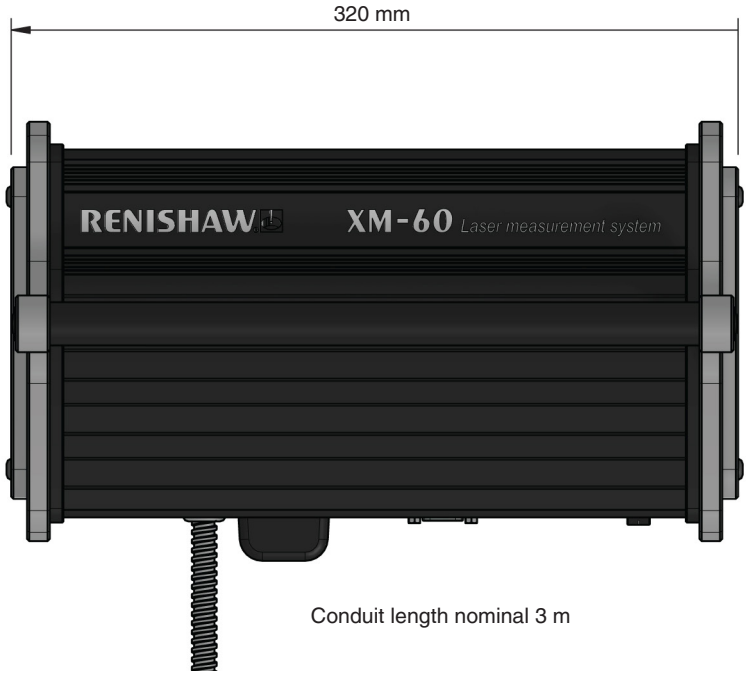
Weights and dimensions

Weights (approximately)	
XM system	6.2 kg (complete system in the case excluding optional XC-80 compensator: 23 kg)
Laser	3.7 kg
Launch	1.9 kg
Receiver	0.6 kg
Battery dock	21 g (excluding power supply)

Dimensions (dock)	
Housing dimensions (LxWxH)	102.3 x 42.3 x 12.5 mm

Laser unit





Conduit length nominal 3 m

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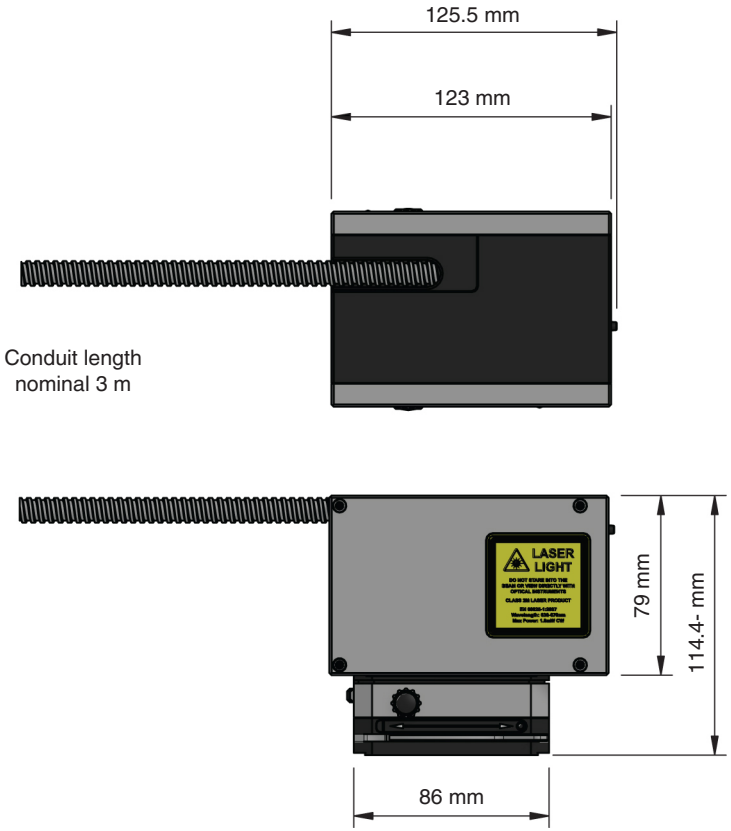
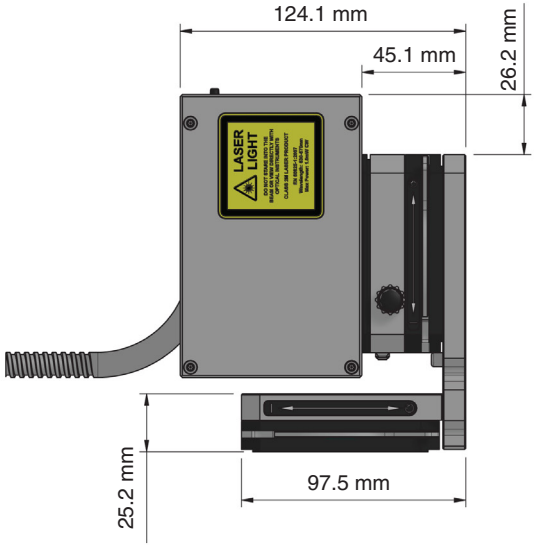
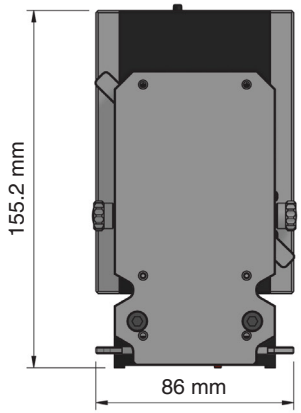
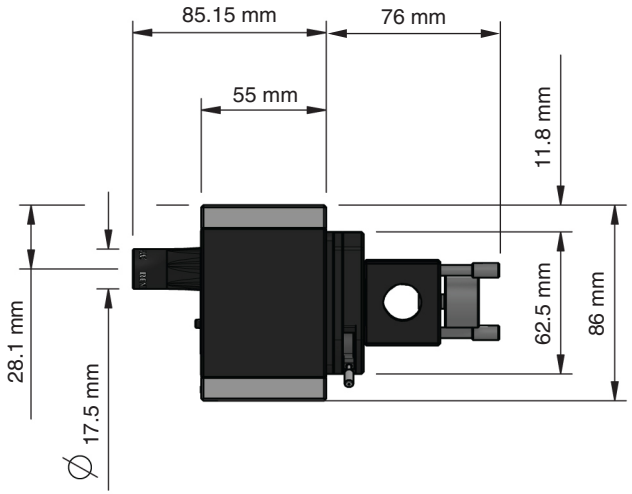
Launch unit

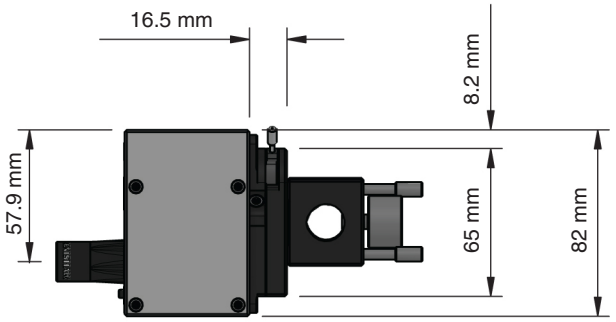






Receiver unit





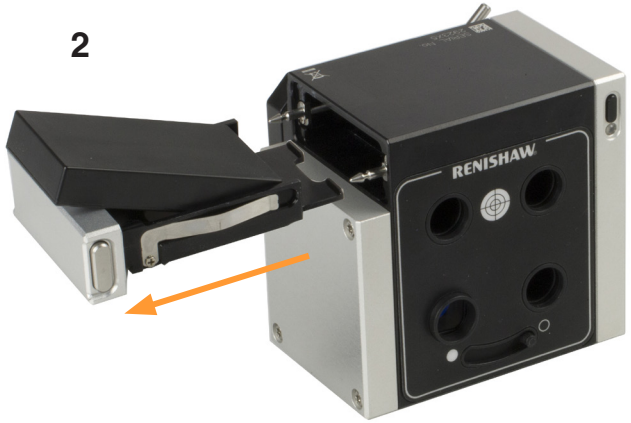
Appendix A

Replacing the receiver battery

To replace the battery, follow the procedure below:

1

2



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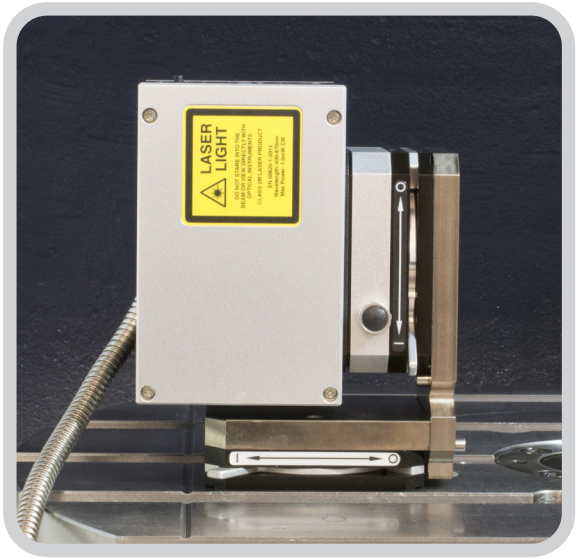
Appendix B

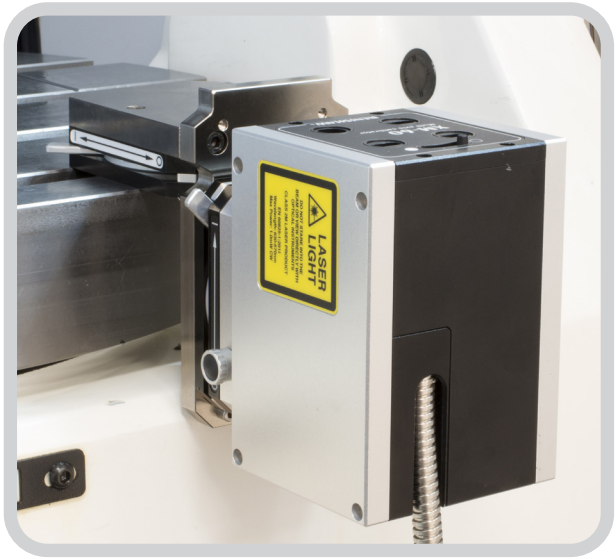
Using the vertical mount

The vertical mount can be used in two orientations (standard and reverse). Reverse orientation allows the launch to be mounted from the side of the machine tool bed to maximise the length of the axis that can be measured.

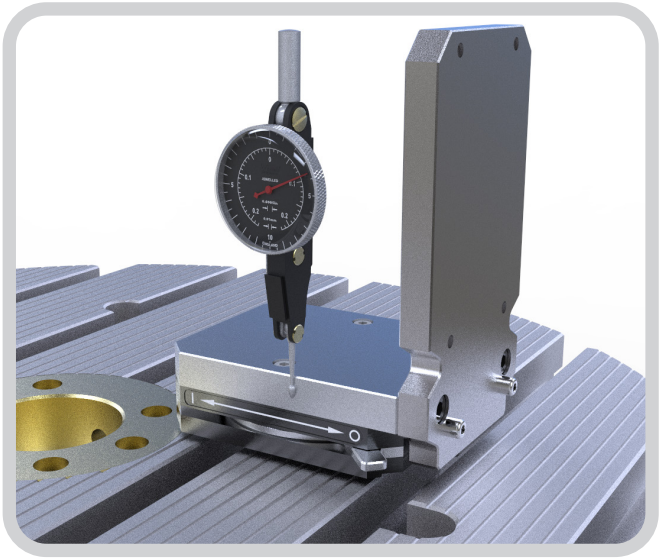
When using the vertical mount the user must clock the side face of the vertical mount to ensure it is parallel to the axis of travel (for example, if measuring Z on a vertical machining centre, clock one of the faces of the vertical mount to the X or Y axis of the machine).



Standard orientation



Reverse orientation



Clocking the side face of the vertical mount

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Appendix C

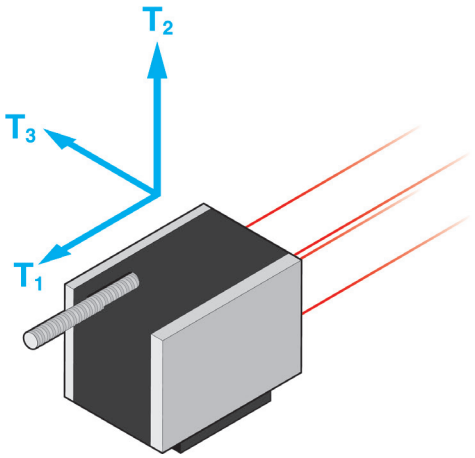
Sign detection

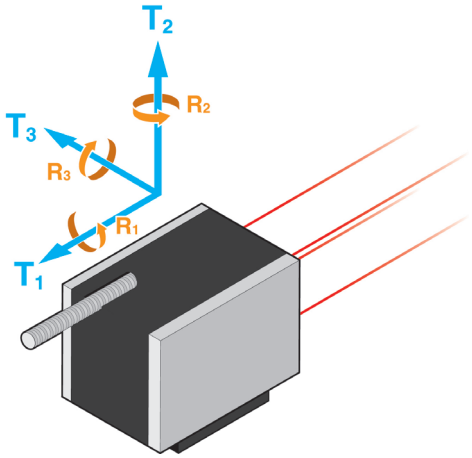
The XM system has six measurement channels:

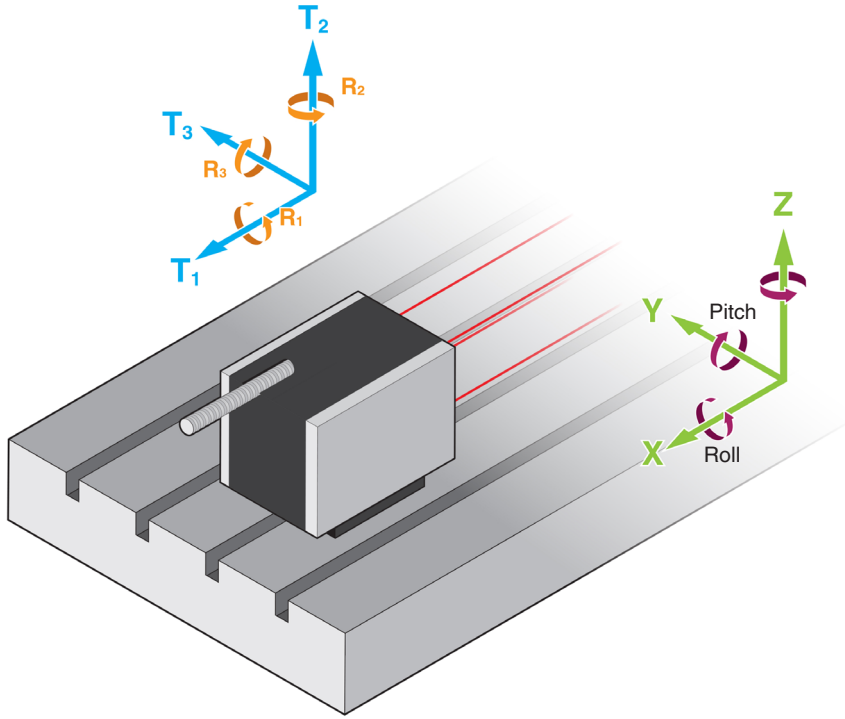
- 3 channels (T1, T2 and T3) correspond to translations (linear and straightness)
- 3 channels (R1, R2 and R3) correspond to rotations around T1, T2 and T3

Sign detection process performs the following:

- Links the T1, T2 and T3 axes of the XM to the machine linear axes
- Sets the sign (+/–) of the T1, T2 and T3 measurements
- Sets the sign (+/–) of the R1, R2 and R3 measurements







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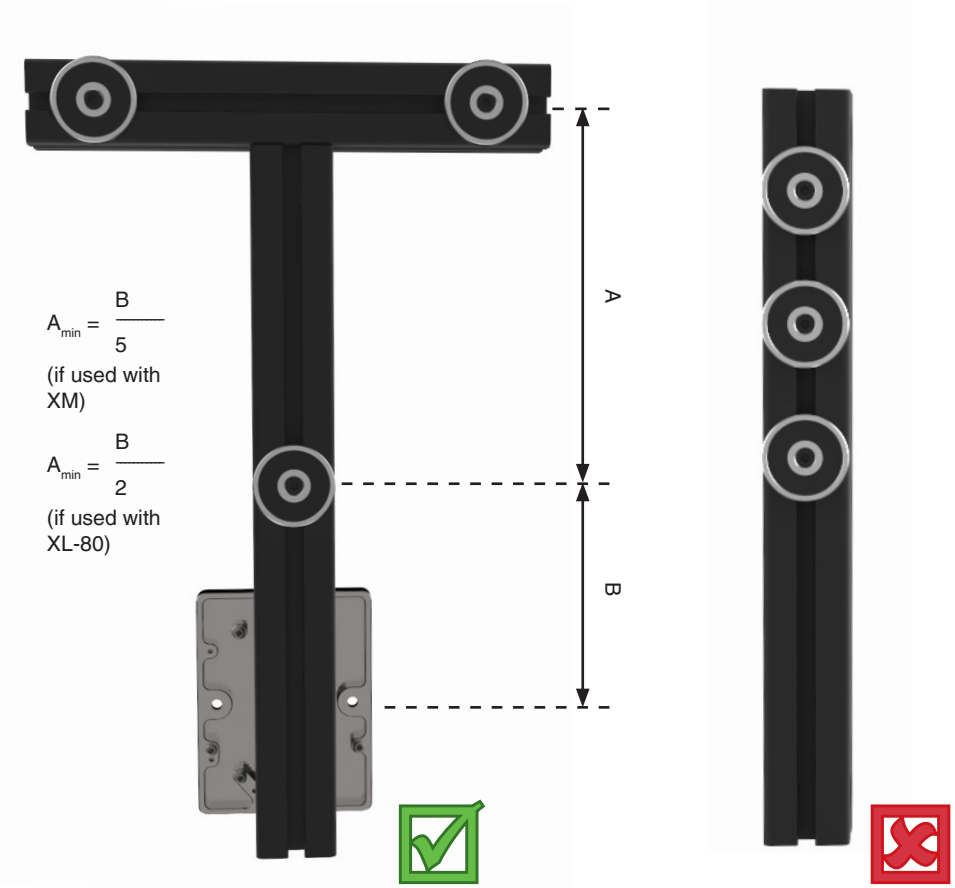
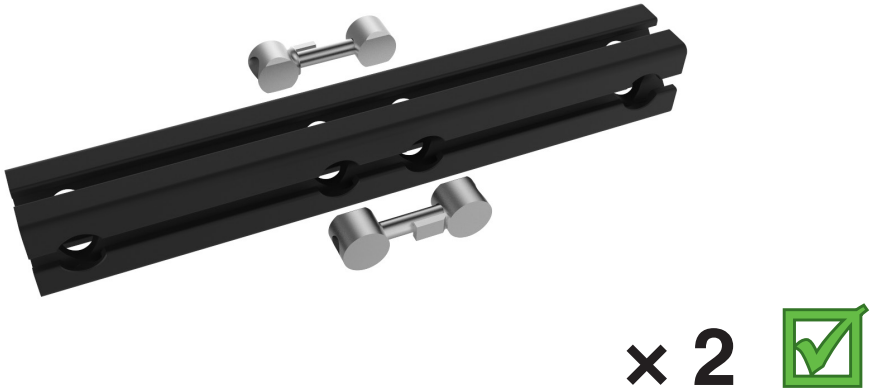
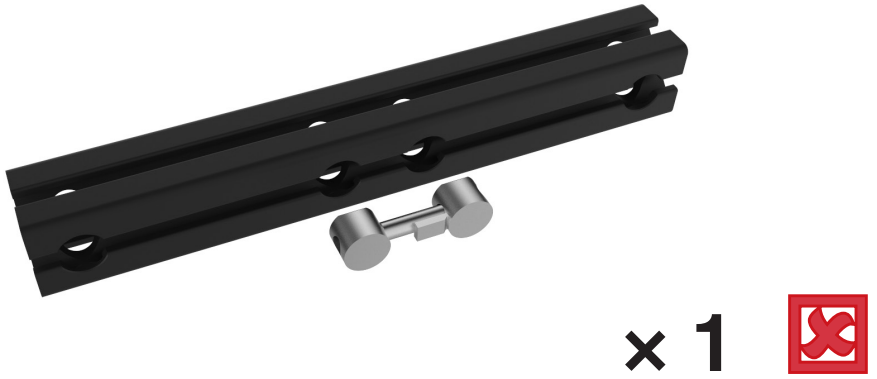
Appendix D

Machine tool fixturing kit good practice guide







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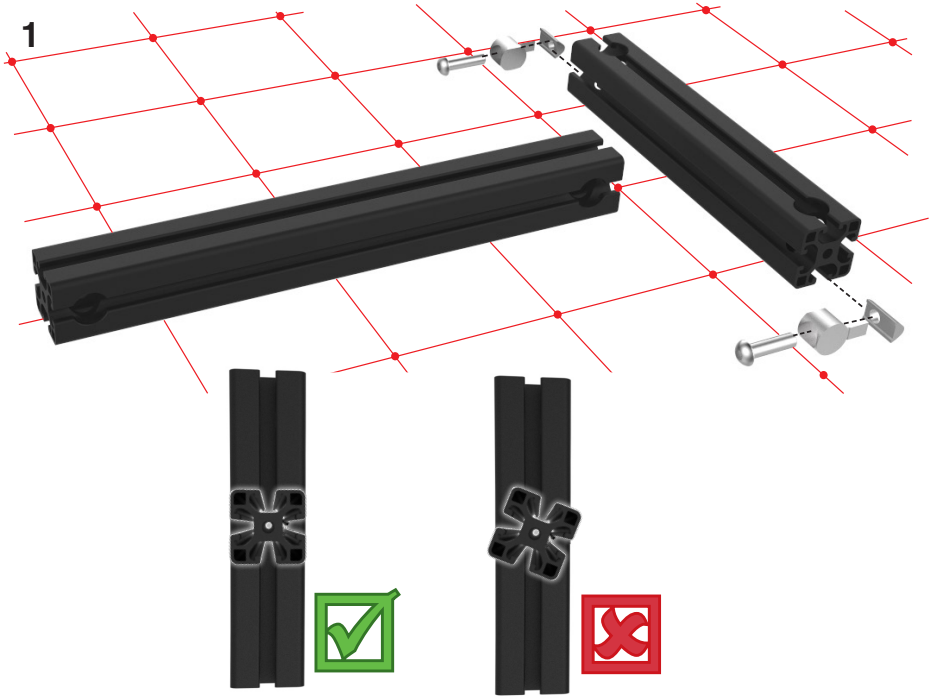

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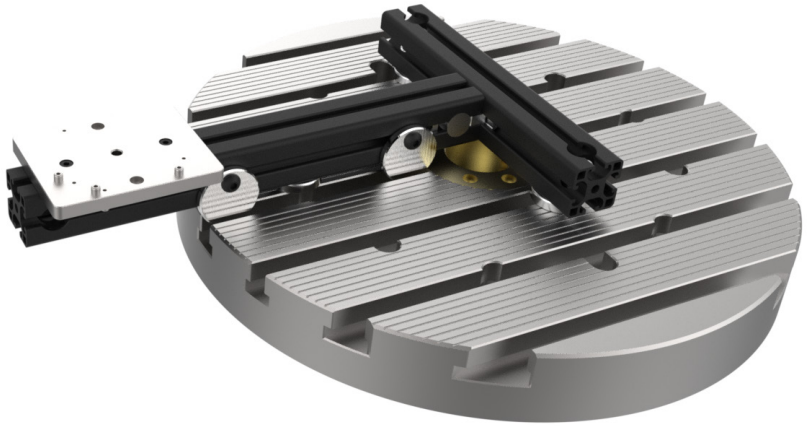

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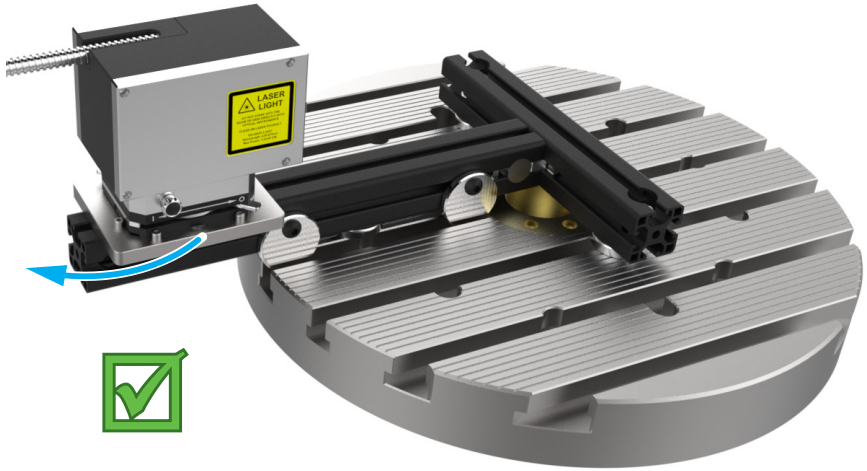

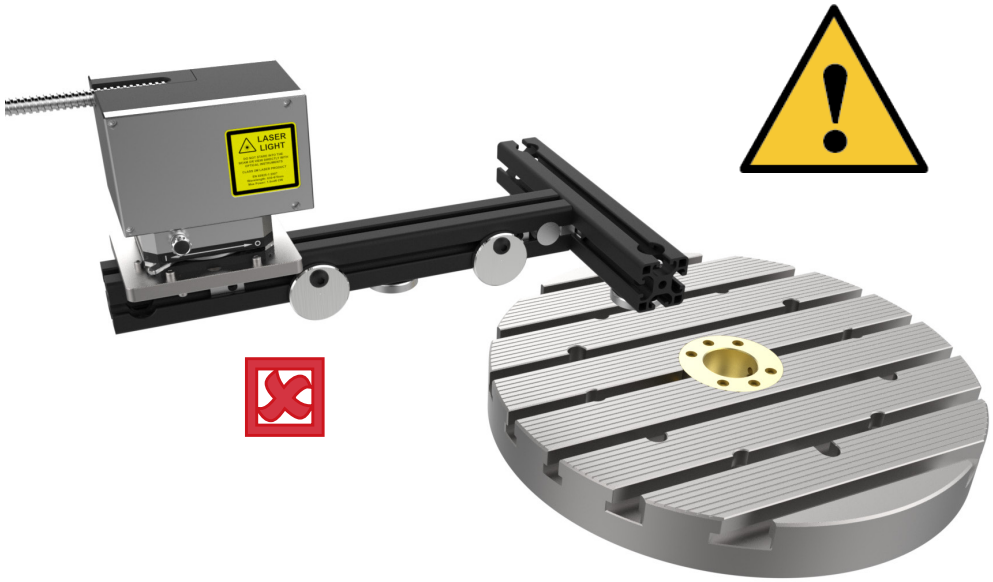

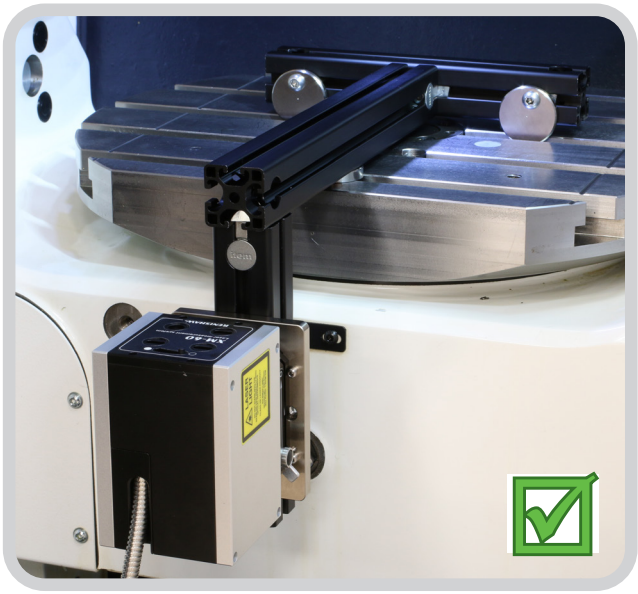

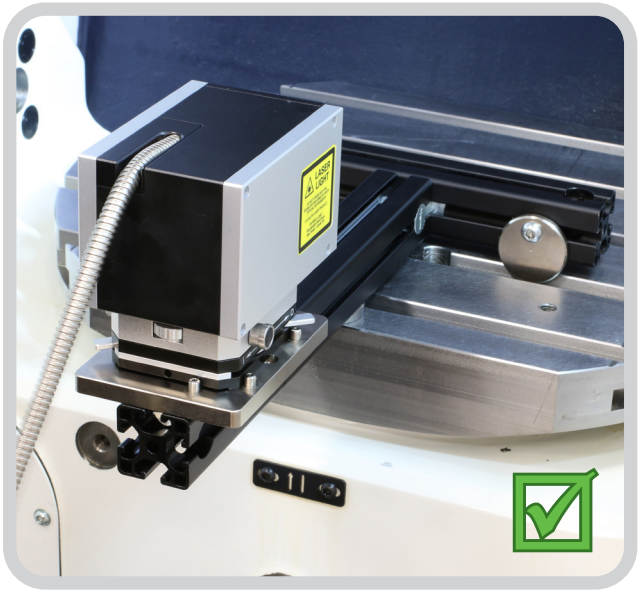


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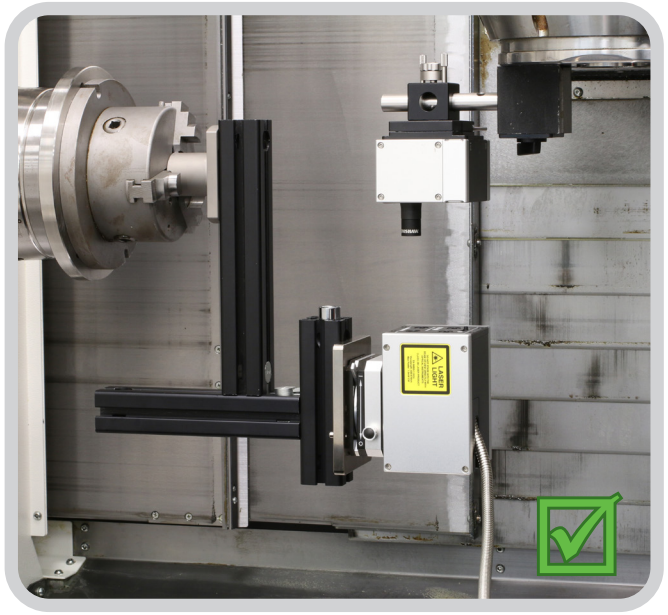
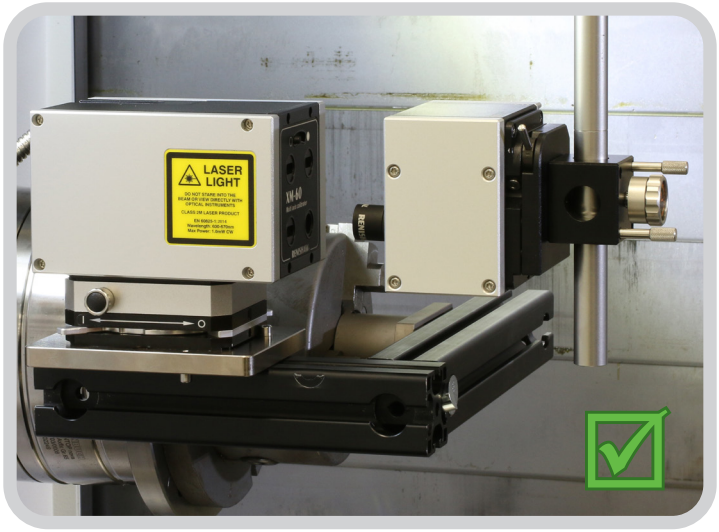
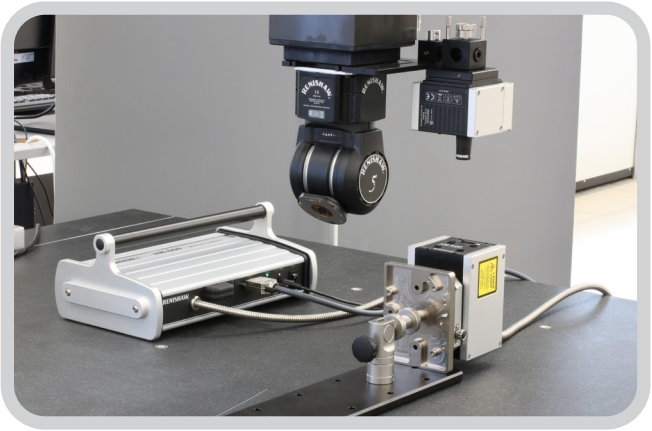
LASER LIGHT

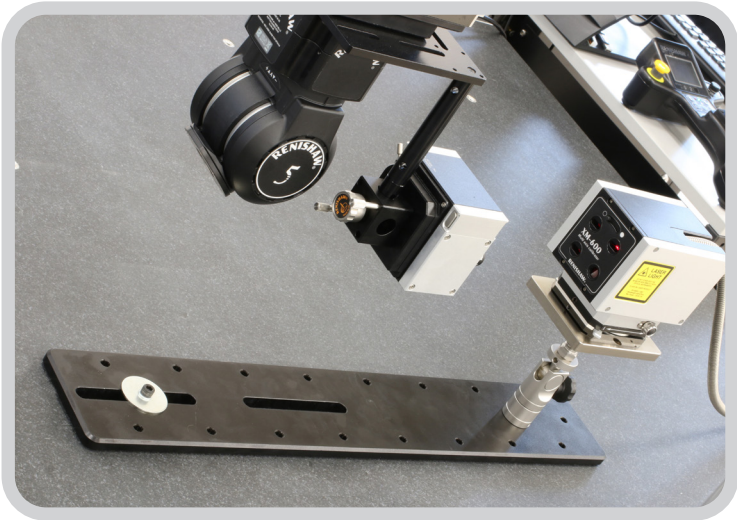


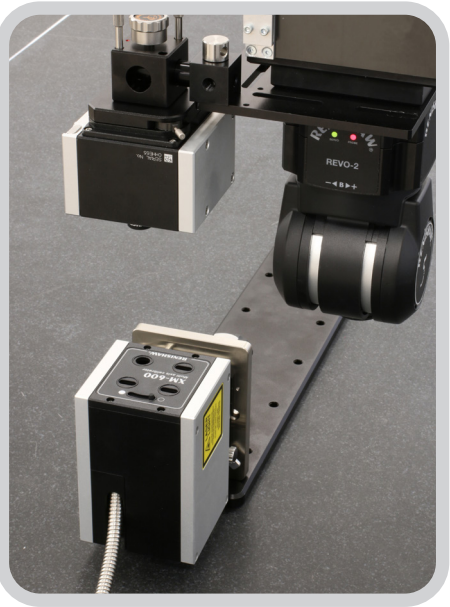

LASER LIGHT

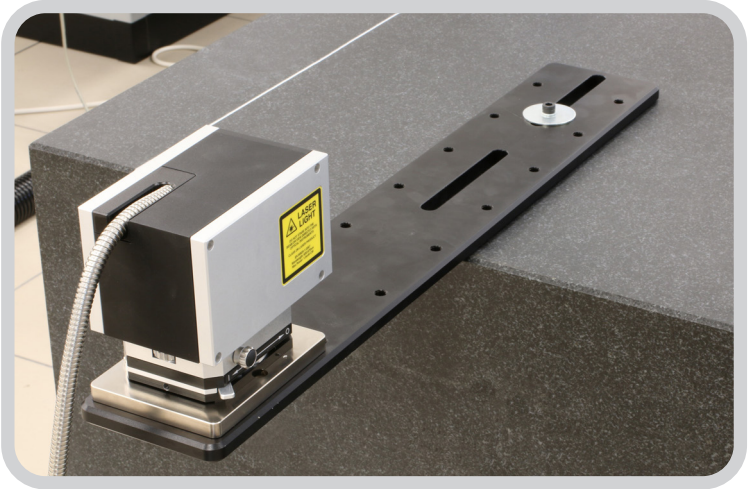
Appendix E

Example XM system set-ups on CMM



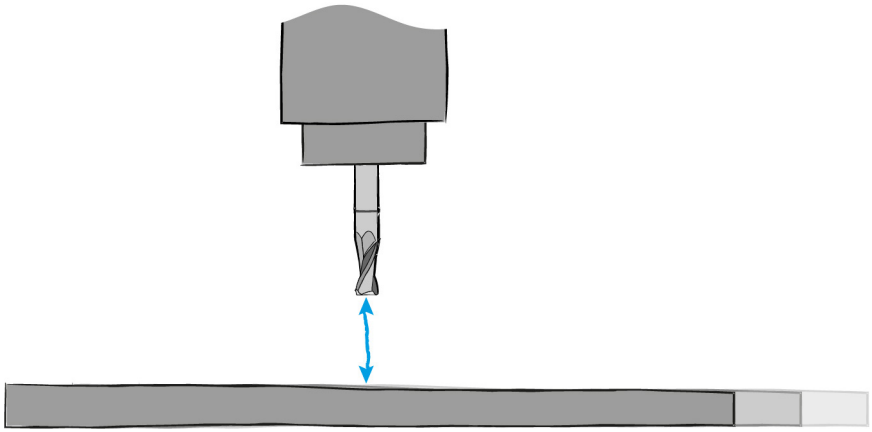




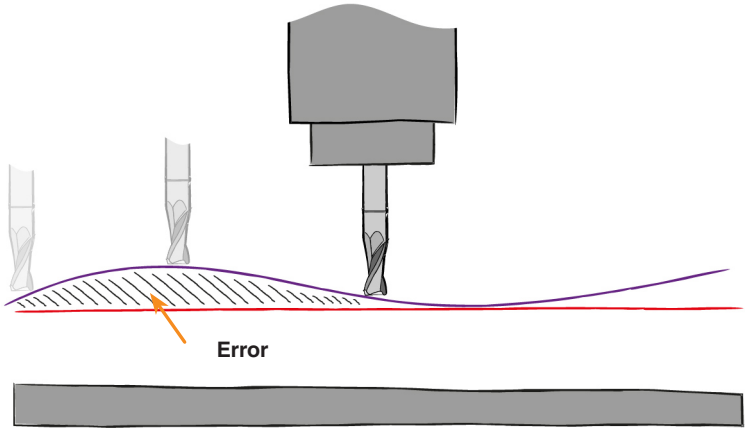


Appendix F

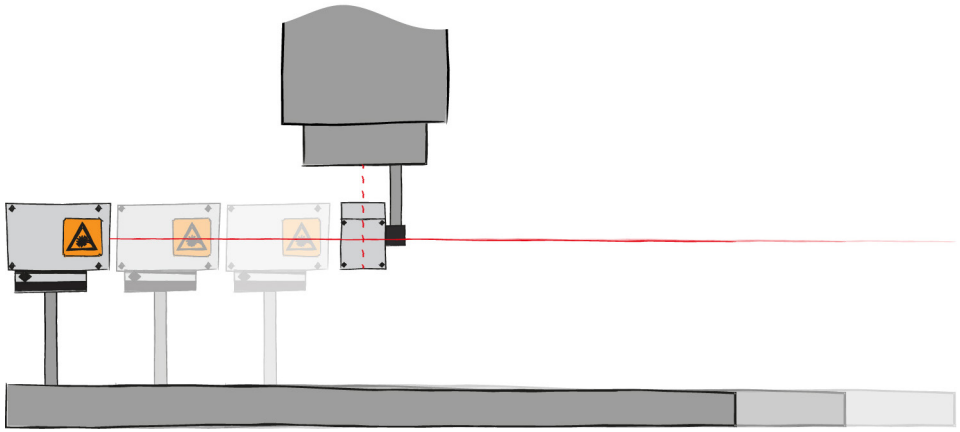
Straightness measurement



Consider a tool machining a component on a machine bed. As the bed moves from right-left, errors in the machine cause the height of the tool to vary above the bed.



To measure this effect we measure the height between the tool and the bed at ‘intervals’ along the movement of the axis. The error is the variation from a straight line.



Placing the launch unit on the bed of a machine means that the laser beam becomes the reference. Variations in height are detected by the receiver as the machine moves left-right.

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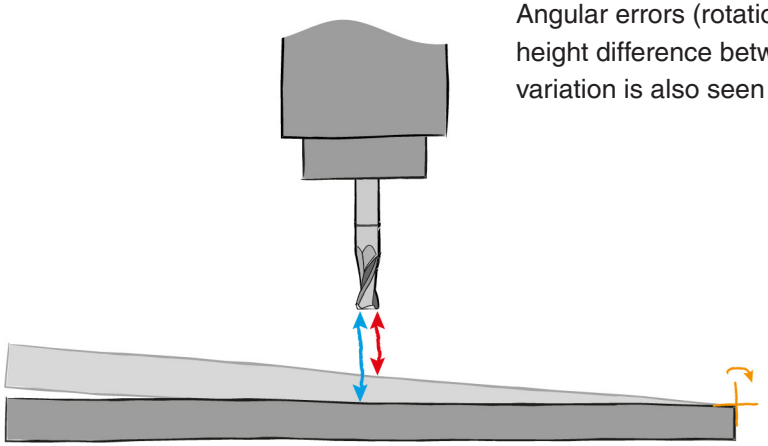
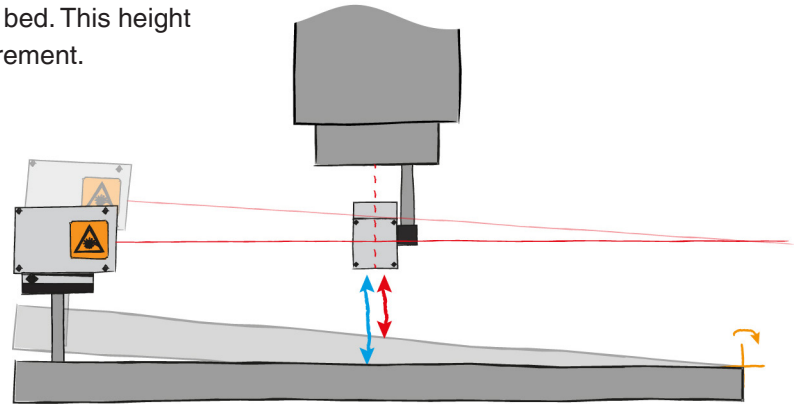
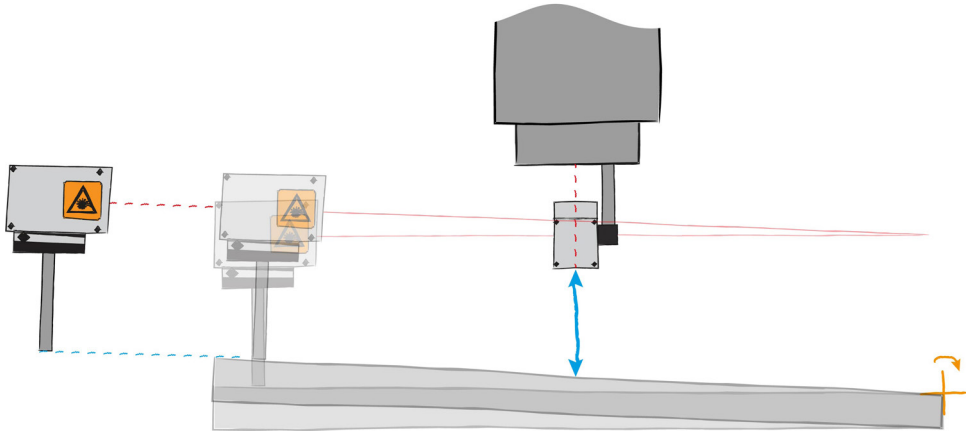
Angular errors



Angular errors (rotations while moving) will cause a variation in the height difference between the tool and machine bed. This height variation is also seen on the XM system measurement.

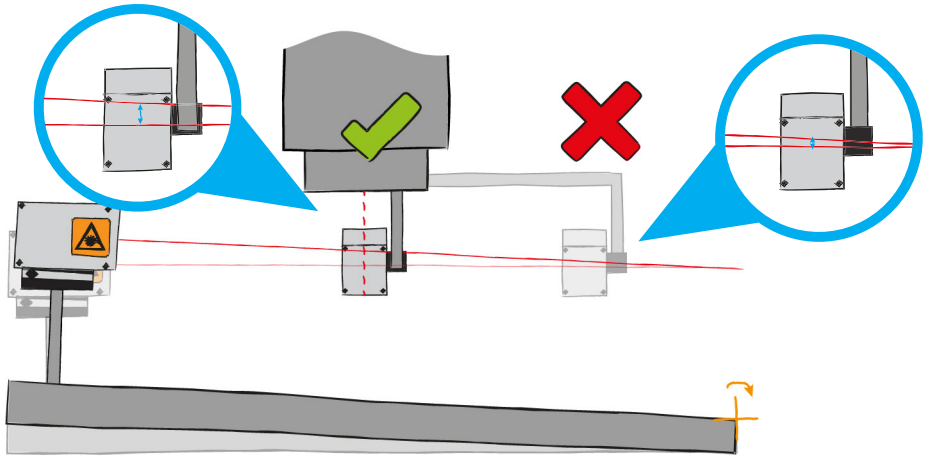


The measurement is not influenced by the exact position of the launch unit ...



… but it is affected by the position of the receiver.

The receiver should be positioned as close as possible to the centre line of the spindle.



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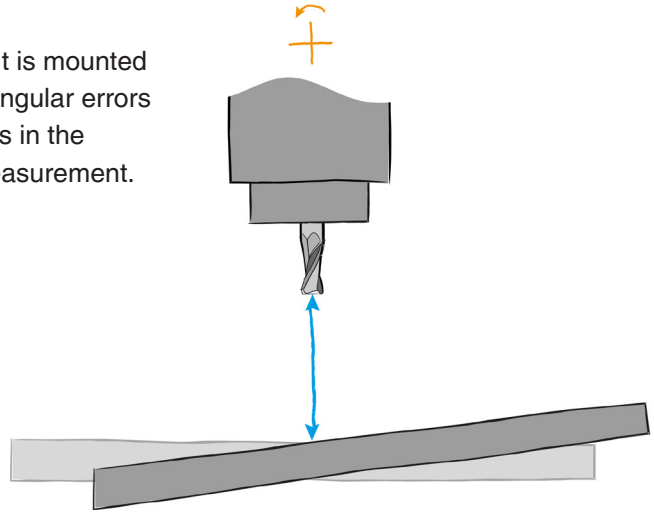
XM set-up best practice

For relative measurements between the tool and the bed/component, the launch unit must always be mounted on the bed of the machine.

The receiver must always be mounted on centreline of the spindle. At the point measured below there is zero height variation between tool and bed, but the XM system would show a deviation because of the rotation of the bed.

If the launch unit is mounted in the spindle, angular errors can cause errors in the straightness measurement.



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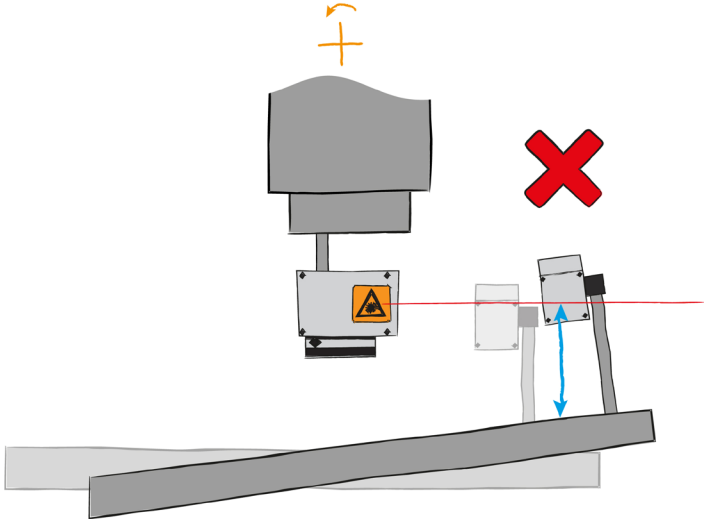
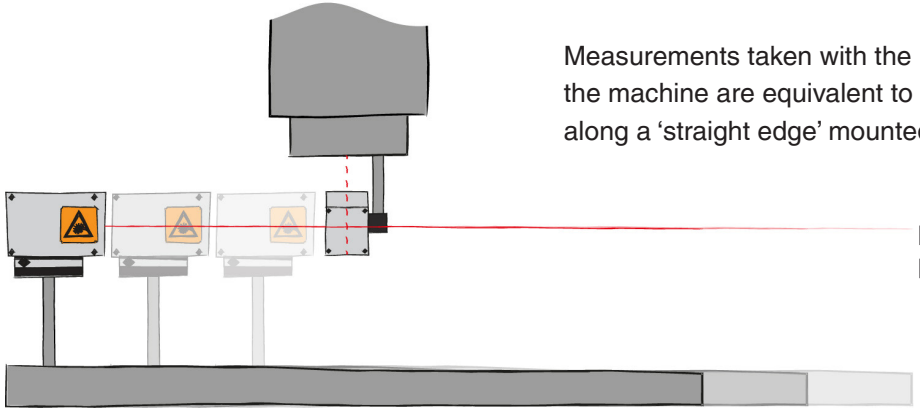
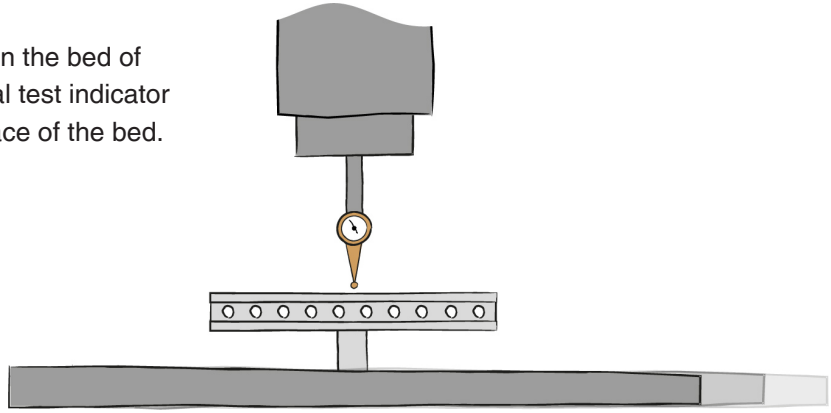


Measurement comparisons



Measurements taken with the launch unit on the bed of the machine are equivalent to running a dial test indicator along a ‘straight edge’ mounted to the surface of the bed.

=



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