Installation and user guide

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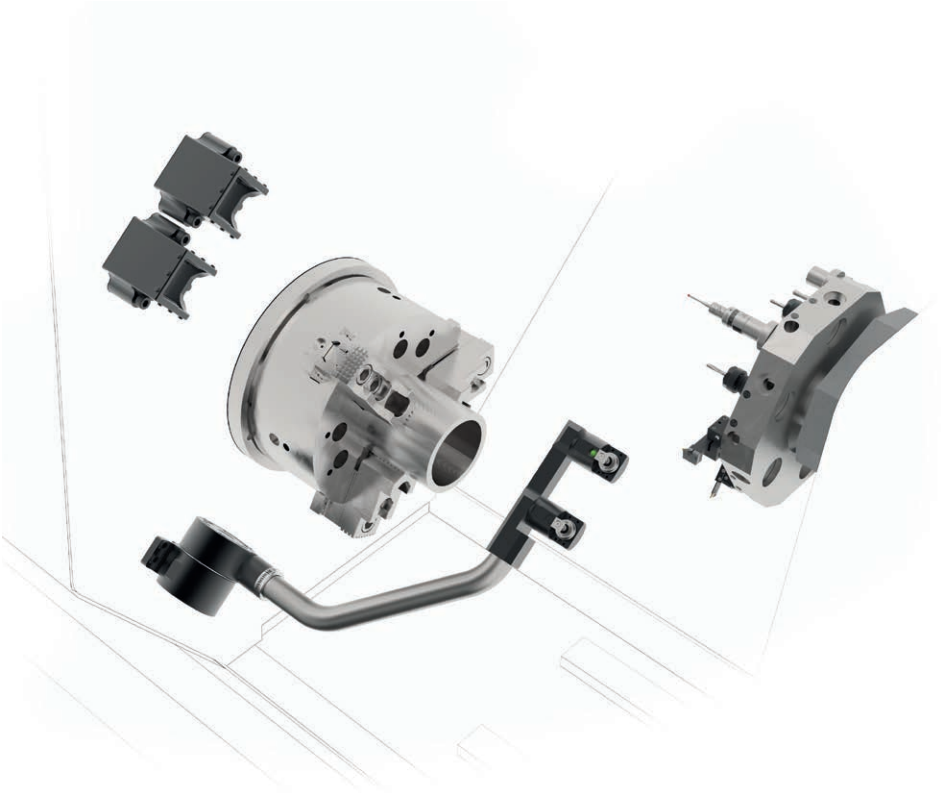
HPMA-X and TSI 3-X motorised arm and interface



Original instructions – translations of these original instructions are available on request.

www.renishaw.com/hpma-x

#renishaw

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Before you begin

Trade marks

Google Play and the Google Play logo are trademarks of Google LLC.

Apple and the Apple logo are trademarks of Apple Inc., registered in the U.S. and other countries. App Store is a service mark of Apple Inc., registered in the U.S. and other countries.

Warranty

Unless you and Renishaw have agreed and signed a separate written agreement, the equipment and/or software are sold subject to the Renishaw Standard Terms and Conditions supplied with such equipment and/or software, or available on request from your local Renishaw office.

Renishaw warrants its equipment and software for a limited period (as set out in the Standard Terms and Conditions), provided that they are installed and used exactly as defined in associated Renishaw documentation. You should consult these Standard Terms and Conditions to find out the full details of your warranty.

Equipment and/or software purchased by you from a third-party supplier is subject to separate terms and conditions supplied with such equipment and/or software. You should contact your third-party supplier for details.

CNC machines

CNC machine tools must always be operated by fully-trained personnel in accordance with the manufacturer's instructions.

Care of the system

Keep system components clean and treat the system as a precision tool.

Patents

Features of the Renishaw HPMA-X, and other related products, are subject of one or more of the following patents and/or patent applications:

EP 1537376
WO 2022/234248

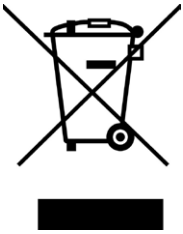
Compliance declaration

Renishaw plc hereby declares that the HPMA-X is in compliance with the essential requirements and other relevant provisions of:

- the applicable EU directives
- the relevant statutory instruments under UK law

Full declaration text is available at:
www.renishaw.com/mtpdoc

Disposal of waste electrical and electronic equipment (WEEE)



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.

Intended use

The HPMA-X system is a motorised tool setting solution predominantly intended for use on CNC machines for high-precision measurement and detection of cutting tools.

Safety

Information to the user

In all applications involving the use of machine tools, eye protection and safety footwear is recommended.

Remove power before performing any maintenance operations.

The expected method of providing an emergency stop for Renishaw products is to remove power.

Information to the machine supplier / installer

It is the machine supplier's responsibility to ensure that the user is made aware of any hazards involved in operation, including those mentioned in Renishaw product literature, and to ensure that adequate guards and safety interlocks are provided.

If the probe system fails, the probe signal may falsely indicate a probe seated condition. Do not rely on probe signals to halt the movement of the machine.

The high-precision motorised arm (HPMA-X) system must be installed by a competent person, observing relevant safety precautions. Before starting work, ensure that the machine tool is in a safe condition with the power switched OFF and the power supply to the TSI 3-X disconnected.

CAUTION: HPMA-X and TSI 3-X are intended for exclusive use as part of the HPMA-X system. Any attempts to integrate with other arms or interfaces could result in unexpected behaviour and/or product damage.

Information to the equipment installer

All Renishaw equipment is designed to comply with the relevant UK, EU and FCC regulatory requirements. It is the responsibility of the equipment installer to ensure that the following guidelines are adhered to, in order for the product to function in accordance with these regulations:

- Any interface MUST be installed in a position away from any potential sources of electrical noise (for example, power transformers, servo drives).
- All 0 V/ground connections should be connected to the machine “star point” (the “star point” is a single point return for all equipment ground and screen cables). This is very important and failure to adhere to this can cause a potential difference between grounds.
- All screens must be connected as outlined in the user instructions.
- Cables must not be routed alongside high current sources (for example, motor power supply cables), or be near high-speed data lines.
- Cable lengths should always be kept to a minimum.

Equipment operation

If this equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

WARNING: Under certain conditions, such as power loss during actuation, it is possible for the HPMA-X arm to move due to gravity/inertia until it reaches its end-stop. Potential finger traps exist between the rotating hub and base.

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安全须知

用户须知

在所有涉及使用机床的应用中，建议采取保护眼睛的措施，并应穿着安全靴。

在执行任何维护操作之前，请先断开电源。

雷尼绍产品的建议急停方法是断开电源。

机床供应商/安装商须知

机床制造商有责任确保用户了解操作过程中存在的任何危险，包括雷尼绍产品说明书中所述的危险，并应确保提供充分的防护装置和安全联动装置。

如果测头系统发生故障，则可能误发测头已复位的信号。切勿单凭测头信号即停止机床运动。

高精度机动对刀臂 (HPMA-X) 系统必须由具备资质的人员在遵守相关安全措施的前提下进行安装。在开始工作之前，须确保机床的电源已关闭，处于安全状态，并且TSI 3-X的电源已断开。

小心：HPMA-X和TSI 3-X仅可作为HPMA-X系统的一部分进行使用，如果试图将其与其他对刀臂或接口进行集成，将可能导致意外操作及/或产品损坏。

设备安装商须知

雷尼绍所有设备的设计均符合相关的UK、EU和FCC监管要求。为使产品按照这些法规正常运行，设备安装商有责任确保遵守以下指导原则：

- 任何接口的安装位置**必须**远离任何潜在的电噪声源（例如变压器、伺服系统驱动装置）。
- 所有0伏/接地连接都应当连接到机床接地终端上（“接地终端”是所有设备地线和屏蔽电缆的单点回路）。这一点非常重要，不遵守此规定会导致接地点之间存在电位差。
- 所有屏蔽装置都必须按照使用说明书中所述进行连接。
- 电缆线路不得与电机电源电缆等高电流源并行或靠近高速数据传输线。
- 电缆长度应始终保持最短。

设备操作

如果设备的使用方式与制造商要求的方式不符，则设备提供的保护功能可能会减弱。

警告：在某些条件下，例如在驱动HPMA-X对刀臂的过程中突然断电时，对刀臂可能会因重力/惯性的作用而继续运动，直至其到达止动位置。旋转的轮轴和基座之间存在可能夹手的部位。

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

China RoHS

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

FCC information to user (USA only)

Supplier's declaration of conformity

47 CFR Section 2.1077 Compliance information

Unique identifier: HPMA-X high-precision motorised arm
Responsible party – US contact information
Renishaw Inc.
1001 Wesemann Drive
West Dundee
Illinois
IL 60118
United States
Telephone number: +1 847 286 9953
Email: usa@renishaw.com

FCC compliance statement

47 CFR Section 15.19

This device complies with part 15 of the FCC Rules. Operation is subject to the following two 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.

47 CFR Section 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.

47 CFR Section 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 installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at their own expense.

ICES information to user (Canada only)

Class A Equipment Statement

This ISM device complies with Canadian ICES-001(A) / NMB-001(A).

Cet appareil ISM est conforme à la norme ICES-001(A) / NMB-001(A) du Canada.

TSI 3-X software notices

This TSI 3-X product includes embedded software (firmware) to which the following notices apply:

US government notice

NOTICE TO UNITED STATES GOVERNMENT CONTRACT AND PRIME CONTRACT CUSTOMERS

This software is commercial computer software that has been developed by Renishaw exclusively at private expense. Notwithstanding any other lease or licence agreement that may pertain to, or accompany the delivery of, this computer software, the rights of the United States Government and/or its prime contractors regarding its use, reproduction and disclosure are as set forth in the terms of the contract or subcontract between Renishaw and the United States Government, civilian federal agency or prime contractor respectively. Please consult the applicable contract or subcontract and the software licence incorporated therein, if applicable, to determine your exact rights regarding use, reproduction and/or disclosure.

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www.renishaw.com/legal/softwareterms

TSI 3-X software licensing agreement

This TSI 3-X product includes the following third-party software:

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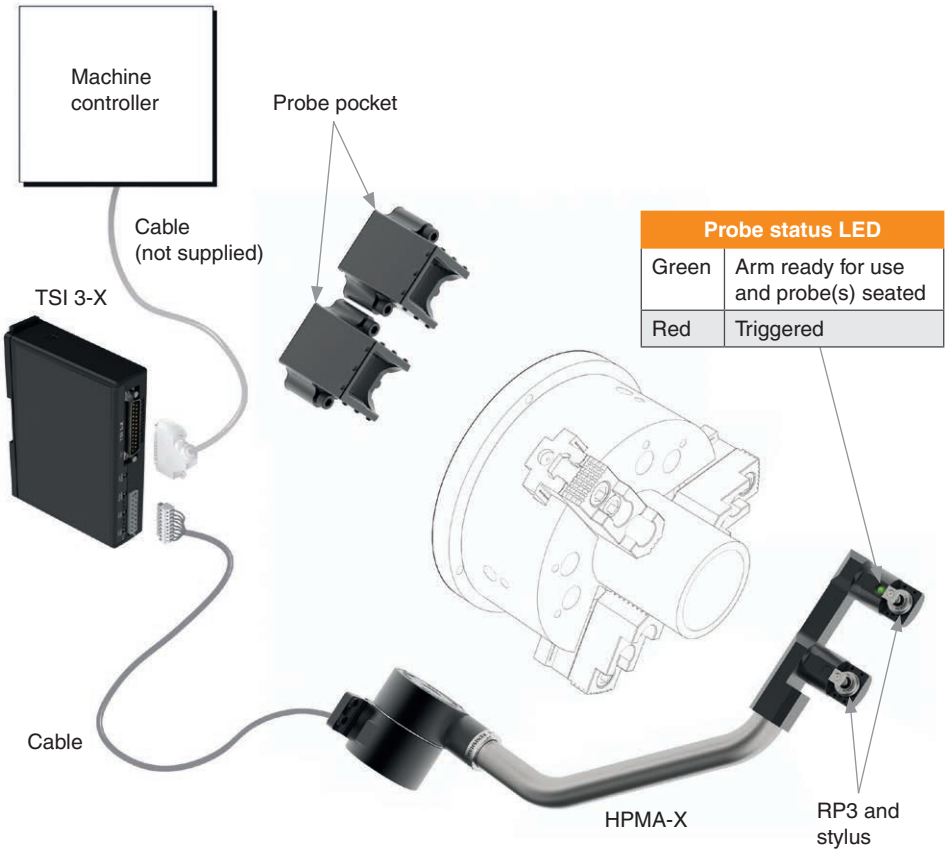
Glossary of terms

Abbreviation	Definition
HPMA	High-precision motorised arm
CNC	Computer numerical control
TSI	Tool setting interface
ARO	Arm ready output
MRO	Machine ready output
AWG	American wire gauge
INH	Inhibit input
SEL	Select input
ARC	Arm ready command
MRC	Machine ready command
NO	Normally open
NC	Normally closed
GND	Ground
SCR	Screen
OCT	Open collector transistor
SSR	Solid-state relay
COM	Common
PELV	Protective extra-low voltage
PPE	Personal protective equipment
LED	Light-emitting diode

System kit



NOTE: For part numbers, refer to the parts list on **page 59**.

The HPMA-X system is a mechanism for delivering a probe (or probes) into the working envelope of a machine tool, in order for tool setting and/or tool breakage detection to be carried out. Once complete, the system retracts the probe(s) to a safe location.

HPMA-X specification

Principal application		Tool measurement and broken tool detection, primarily for use on large CNC machines
Transmission type		Hard-wired transmission
Weight		≈ 3 kg (106 oz), without tube or probes (total weight dependent on arm configuration)
Probe(s)		RP3 (capacity for one or two probes) [1]
Cable (arm to interface)	Type	Ø6.9 mm (0.27 in), 12-core screened cable, 0.22 mm^2 per core
	Length	30 m (98.43 ft) maximum
Sense directions		±X, ±Y, +Z (probe axes; refer to **page 26**, "HPMA-X dimensions", for definition)
Typical positional repeatability (probe axes) [2] [3]		8 µm (315 µin) 2σ X/Y (tighter repeatability will be achieved on shorter tube lengths)
Stylus trigger force (probe axes) [4] [5] XY low force XY high force +Z direction		 1.5 N, 153 gf (5.4 ozf) 3.5 N, 357 gf (12.59 ozf) 12 N, 1224 gf (43.16 ozf)
Arm sweep motion		Motorised
Arm sweep time		Typically 3 seconds in each direction
Arm sweep angle		90° (if not using Renishaw probe pocket(s), maximum arm sweep angle is 91°)
Mounting		M8 bolts (× 3)
Probe pocket mounting		M6 bolts (× 2 per probe pocket)
Environment	IP rating	IPX6 and IPX8, BS EN 60529:1992+A2:2013 (IEC 60529:1989+A1:1999+A2:2013)
	Storage temperature	–25 °C to +70 °C (–13 °F to +158 °F)
	Operating temperature	+5 °C to +55 °C (+41 °F to +131 °F)

[1] Where the RP3 is to be used in the probe's Z axis (typically the CNC lathe Y axis), a five-faced stylus is available to order from the Renishaw Online store at **www.renishaw.com/shop**.

[2] Test conditions: Stylus length: 22 mm (0.87 in)
Stylus velocity: 36 mm/min (1.42 in/min)

[3] Repeatability performance is not specified in the arm rotational axis. Refer to **page 26**, "HPMA-X dimensions", to identify this axis.

[4] Trigger force, which is critical in some applications, is the force exerted on the stylus by the tool when the probe triggers. The maximum force applied will occur after the trigger point (overtravel). The force value depends on related variables including measuring speed and machine deceleration.

[5] These are the factory settings; manual adjustment is not possible.

TSI 3-X specification

Principal application		Input and output interfacing between the HPMA-X arm and the host CNC controller
Weight		≈ 0.2 kg (7 oz)
Mounting		DIN rail preferred; alternatively M4 screw (× 2)
Status reporting		Four LEDs to identify command status, arm position, probe status and arm status
I/O connector type		25-way D-sub
Inputs		Opto isolated drive commands and probe inhibit command, 15 Vdc to 30 Vdc
Outputs		Voltage-free SSRs for probe status, arm ready and arm stowed
Four-wire I/O probe option (for example, Fanuc automatic length measurement input XAE, ZAE)		Four internally pulled down active high inputs, four OCT active high outputs
Power supply requirement	Voltage	24 Vdc
	Current	3 A
Environment	IP rating	IP20, BS EN 60529:1992+A2:2013 (IEC 60529:1989+A1:1999+A2:2013)
	Storage temperature	–25 °C to +70 °C (–13 °F to +158 °F)
	Operating temperature	+5 °C to +55 °C (+41 °F to +131 °F)

HPMA-X installation

WARNINGS:

Safety footwear and eye protection should be worn while installing the HPMA-X.

Remove all power before commencing installation.

Although HPMA-X should not be manually actuated during normal operation, it is acceptable to move it by hand during installation, to aid set-up. Care should be taken to avoid any finger traps.

CAUTIONS:

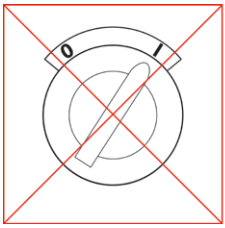
It is possible for the weight of the HPMA-X arm to cause the hub to rotate relative to the base. To avoid this, ensure the tube is supported during manual handling.

Lifting equipment may be attached around the tube, around the hub and base, and around the probe holder (taking care to avoid the probe or probes), if required.

Do not add any attachments to the arm. If any attachment is deemed essential, contact your local Renishaw representative.

For best performance of the HPMA-X, the following installation guidelines are recommended:

- The HPMA-X is ideally mounted on a solid fixed part of the machine tool, such as a casting. If mounting brackets or plates are used, these must be designed to maximise stiffness with minimal joints. If mounted onto a moving part of the machine tool, repeatability may be adversely affected.
- The HPMA-X is sealed to IPX6 and IPX8, designed for the harsh environments inside a machine tool. However, high-pressure jets and reflected jets can exceed this specification and must not spray directly onto the HPMA-X. If it is not possible to position the HPMA-X away from these jets, the hub and base should be protected with suitable guarding. Guarding is not supplied by Renishaw.
- Like all metrology systems, repeatability can be adversely affected by thermal effects on the machine tool. Renishaw recommends that thermal compensation routines are incorporated into the measurement software cycles to counteract these effects.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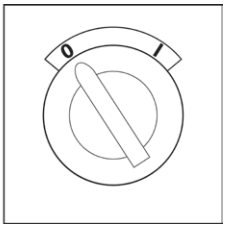
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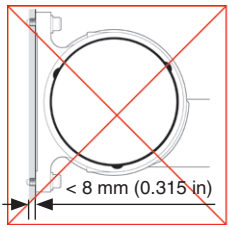
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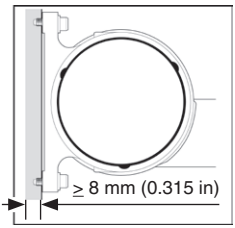
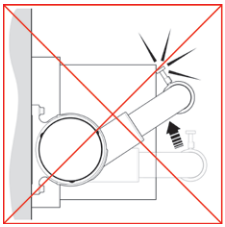
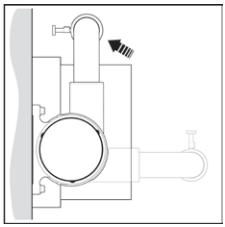
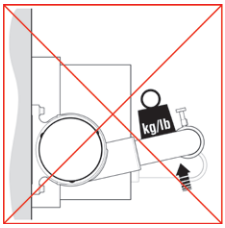
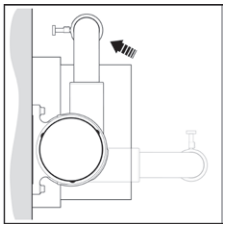

≥ 8 mm (0.315 in)

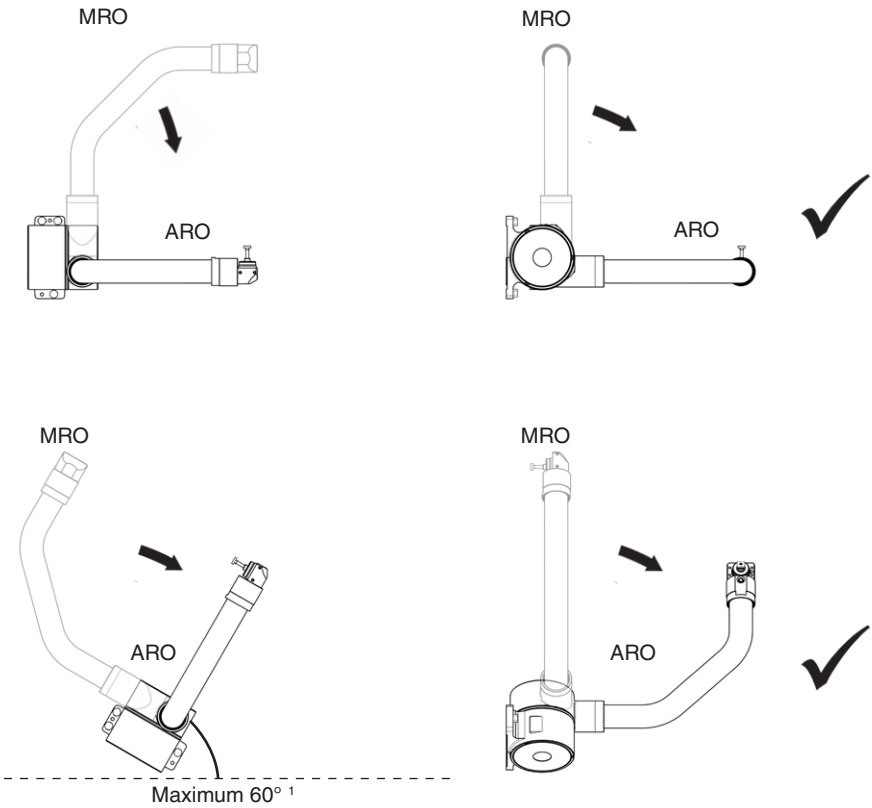





kg/lb



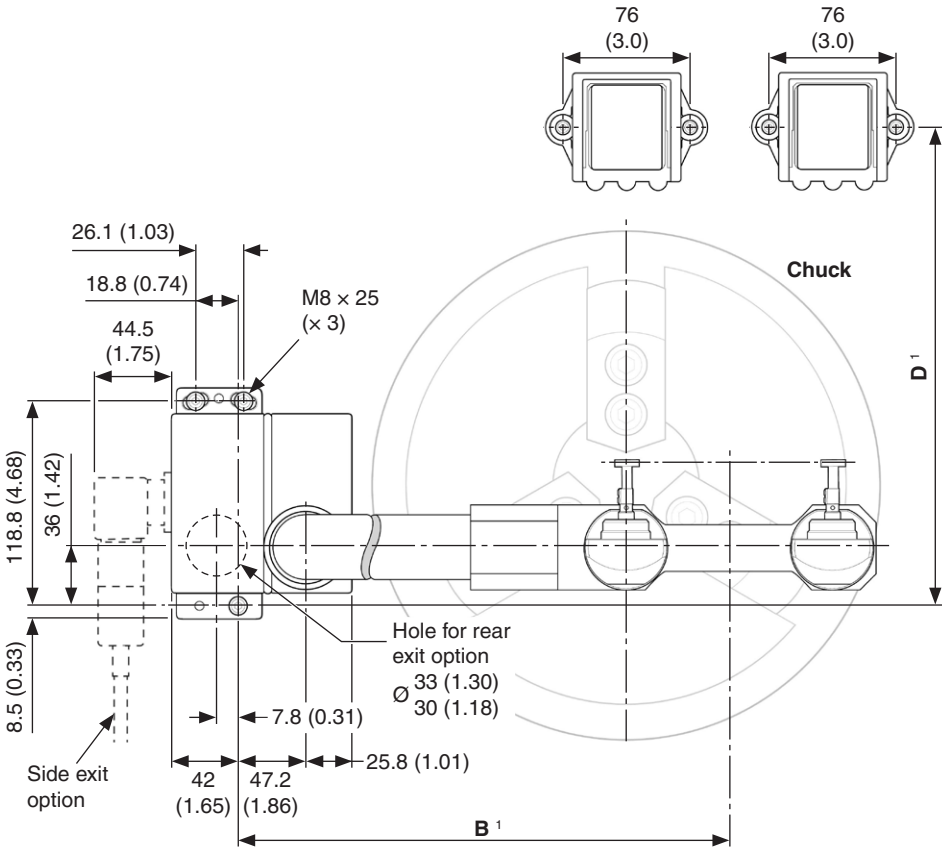
Acceptable orientation of hub and base



[1] For applications outside of this range, contact Renishaw.

HPMA-X mounting details

The arm and probe holder arrangement shown is for illustration purposes only.

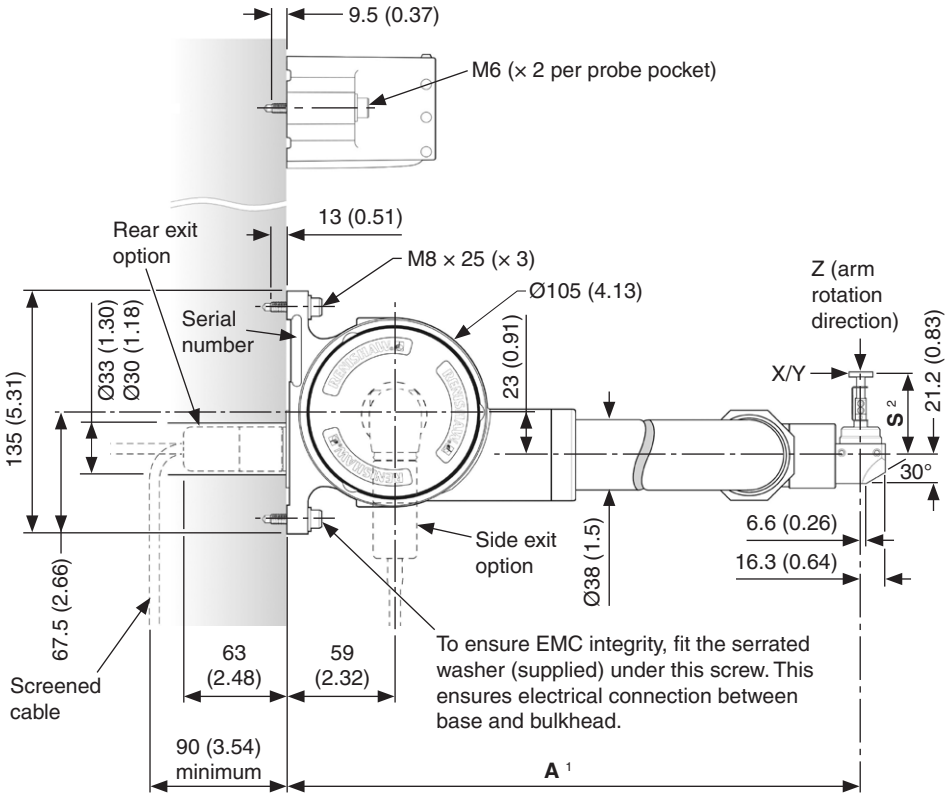


Dimensions given in mm (in)

[1] Dimension dependent on the configuration of the arm and probe(s).

HPMA-X dimensions

The arm and probe holder arrangement shown is for illustration purposes only.



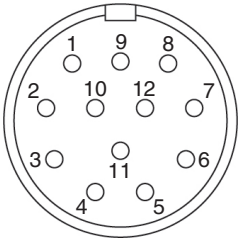
Dimensions given in mm (in)

1 Dimension A is dependent on the configuration of the arm and probe(s).

2 A wide range of custom and standard stylus options are available.

Rear and side exit wiring

12-way M23
arm connector

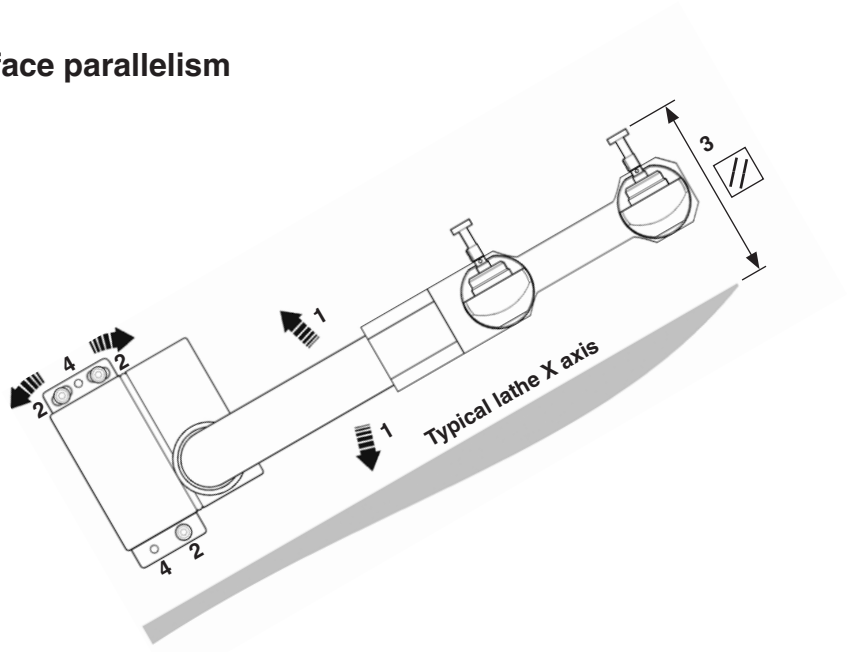


NOTE: For the rear exit variant, connect the cable before fitting the HPMA-X.

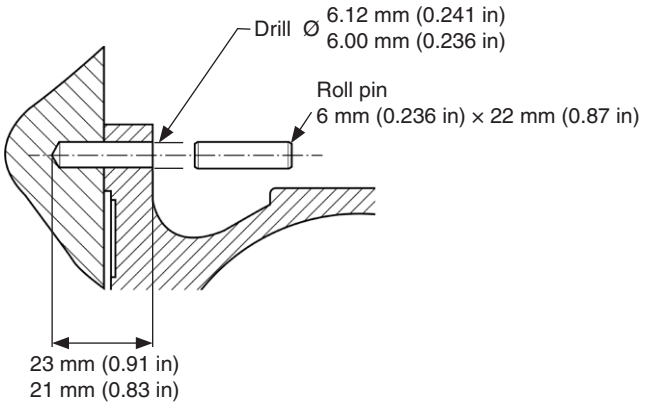
Pin	Function	Wire colour
1	Probe +	Orange
2	Probe –	Purple
3	0 Vdc	Black
4		Brown and white
5		Black and white
6	24 Vdc	Red
7		Brown
8		White
9	Motor control	Yellow
10		Blue
11		Green
12		Grey
Body	Screen	Not applicable

Side exit connector

Top face parallelism

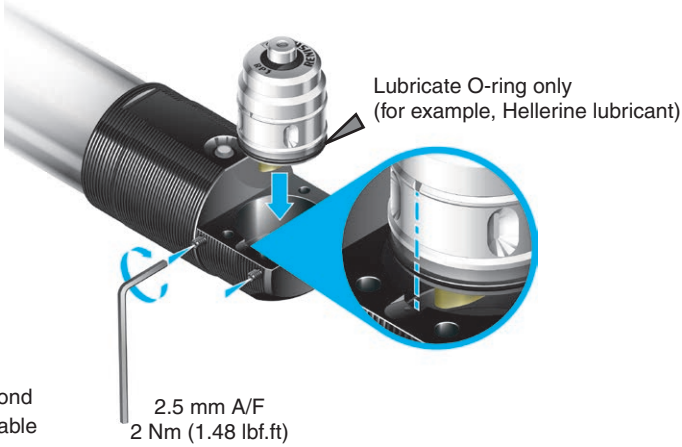


1. Rotate arm on bottom mounting screw to set stylus alignment.
2. Tighten all screws to 10 Nm (7.38 lbf.ft).
3. Check that stylus alignment has not moved after tightening.
4. Drill through base into mounting using pilot holes as a guide.
5. Fit roll pins supplied in base fixing kit. Apply corrosion inhibitor to pins after fitting.



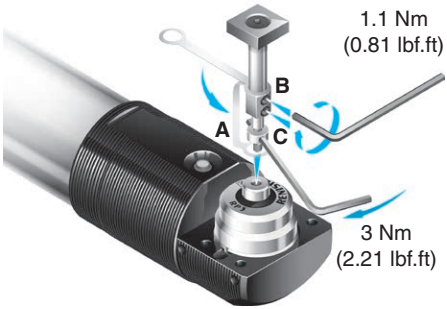
Fitting the probe(s) to the arm

1. Loosen grub screws (× 2)
2. Insert probe
3. Tighten grub screws (× 2)
4. Repeat for second probe, if applicable

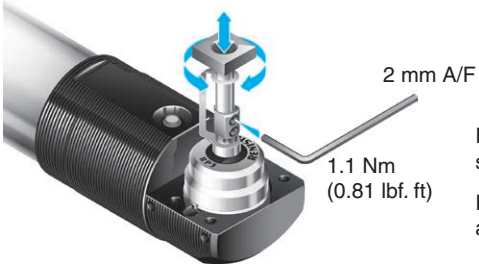


Stylus fitting

1. Fit the free end of the captive link over the threaded end of the break stem (**A**).
2. Fit the break stem inside the stylus and secure it by tightening the M3 grub screw(s) (**B**).
3. Using a 2 mm hexagonal key fitted through the hole in the break stem (**C**), fit the stylus to the probe.

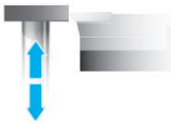


Stylus coarse adjustment



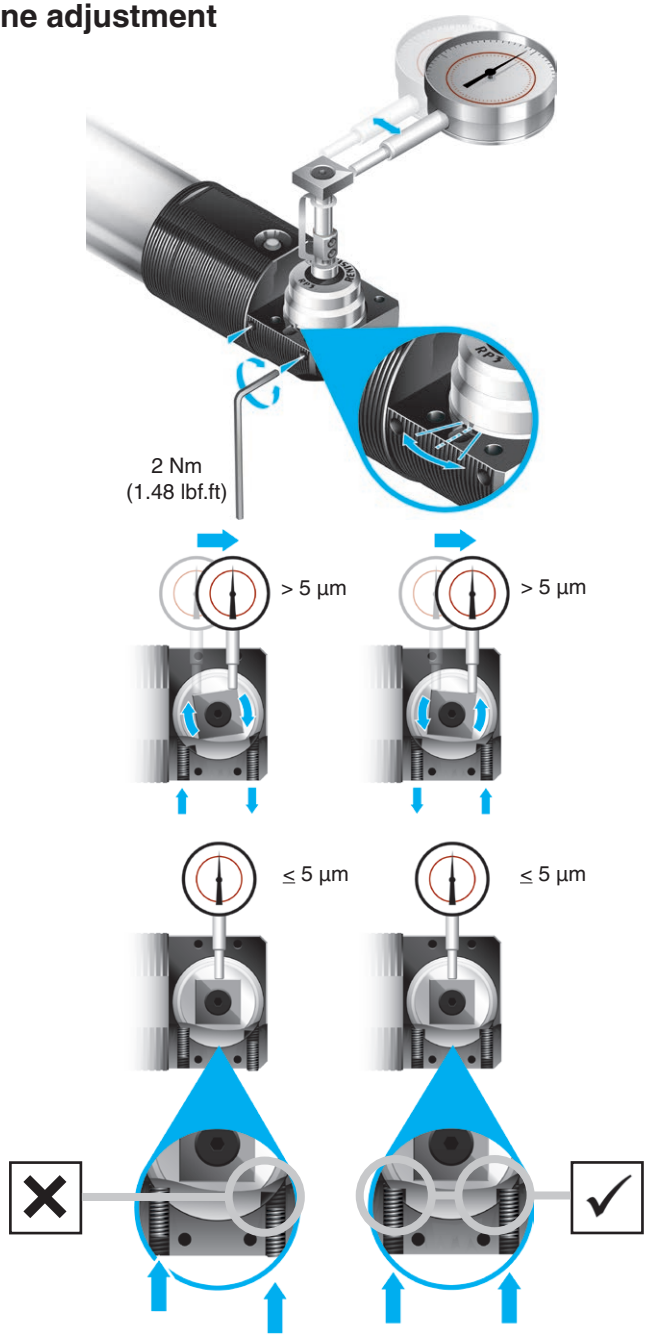
For 16 mm and 20 mm stylus ±0.8 mm

For 25 mm, 32 mm, 40 mm and 50 mm stylus ±1.3 mm



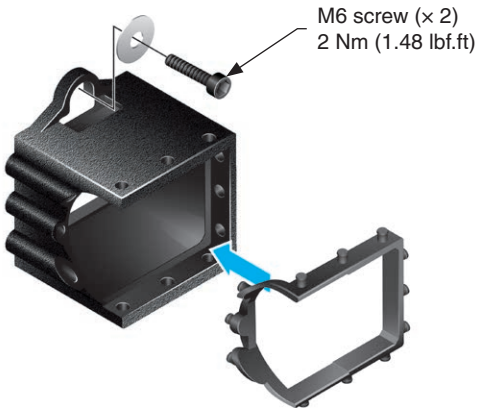
Set approximately parallel with machine tool axes.

Stylus fine adjustment



Installing the probe pocket(s)

Additional information can be found in “HPMA-X dimensions” on **page 26**.



1. Fit the probe pocket(s) using the probe pocket fixing kit supplied (M6 screws and washers). Ensure the screws are loose (finger-tight).
2. Cycle the arm to the machine ready position.

NOTE: During installation, this may be performed either by issuing MRC or by moving the arm manually, taking care to avoid any finger traps.

3. Ascertain the optimum position for the probe pocket(s) by repositioning the pocket(s) until aligned to the probe holder(s), then securely tighten the M6 screws. This step is necessary to ensure equal pressure is exerted on all sides of the probe pocket seal(s).
4. Check that the position of the probe pocket(s) is correct and does not inhibit the movement of the arm by cycling the arm to the arm ready position then back to the machine ready position.

TSI 3-X installation

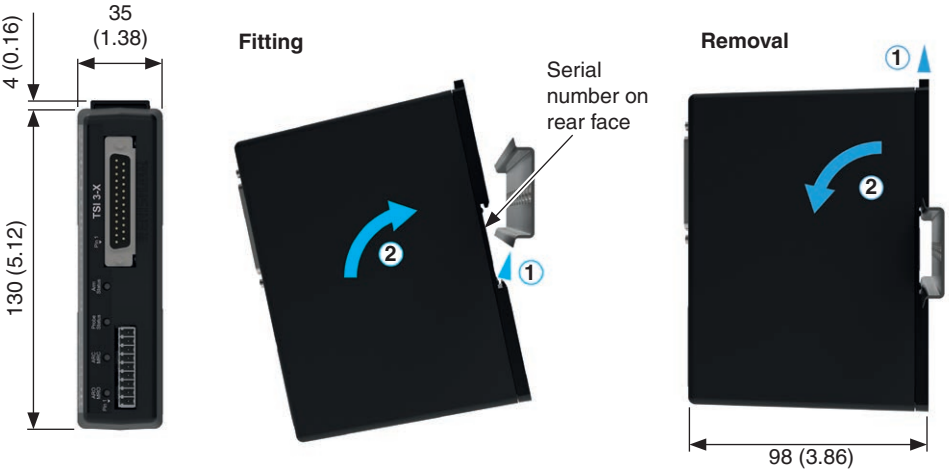
WARNINGS:

Safety footwear and eye protection should be worn while installing the TSI 3-X.

Remove all power before commencing installation.

Standard mounting and dimensions

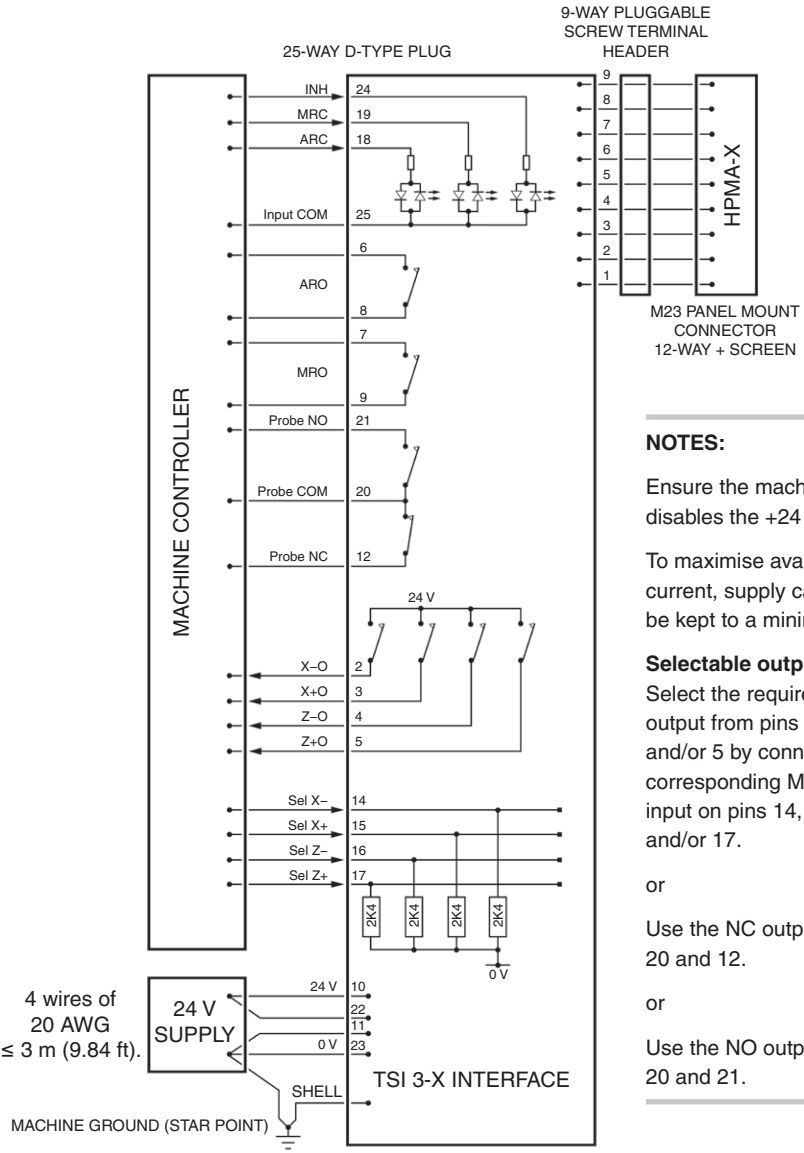
The TSI 3-X interface unit should be installed in the CNC controller cabinet. Where possible, site the unit away from potential sources of interference such as transformers and motor controllers.



Dimensions given in mm (in)

Alternative mounting

Wiring diagram



NOTES:

Ensure the machine interlock disables the +24 V supply.

To maximise available current, supply cable should be kept to a minimal length.

Selectable outputs:
Select the required 24 V output from pins 2, 3, 4 and/or 5 by connecting the corresponding M-code driven input on pins 14, 15, 16 and/or 17.

or

Use the NC output from pins 20 and 12.

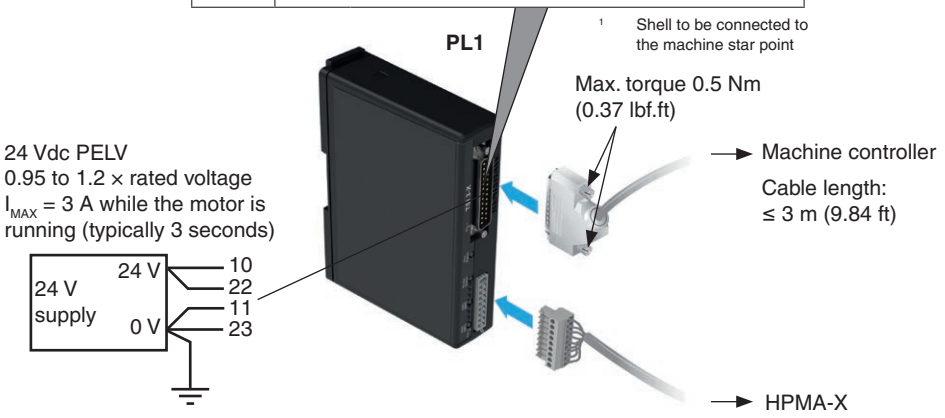
or

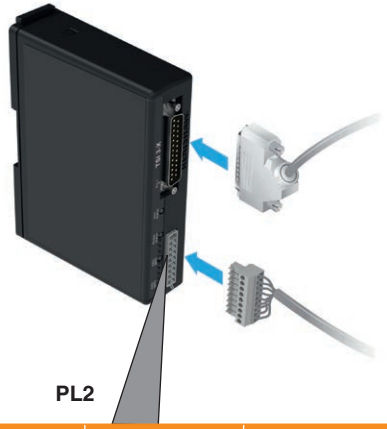
Use the NO output from pins 20 and 21.

24 V supply = 24 Vdc PELV 0.95 to 1.2 × rated voltage.
I_{MAX} = 3 A, while the motor is running (typically 3 seconds).
Circuit protection: power supply protected against overcurrent and reverse connection.

Interface connections

Pin	Function
1, 13	Not connected
10, 22	24 Vdc supply
11, 23	0 Vdc (0 V)
2	X– output (X–O)
3	X+ output (X+O)
4	Z– output (Z–O)
5	Z+ output (Z+O)
14	Select X– input (Sel X–)
15	Select X+ input (Sel X+)
16	Select Z– input (Sel Z–)
17	Select Z+ input (Sel Z+)
12	Probe status (NC)
20	Probe status COM
21	Probe status (NO)
6	ARO (NO)
8	
7	MRO (NO)
9	
18	ARC (15 Vdc to 30 Vdc)
25	Input COM
19	MRC (15 Vdc to 30 Vdc)
25	Input COM
24	Probe inhibit (INH) (15 Vdc to 30 Vdc)
25	Input COM
Shell [1]	SCR

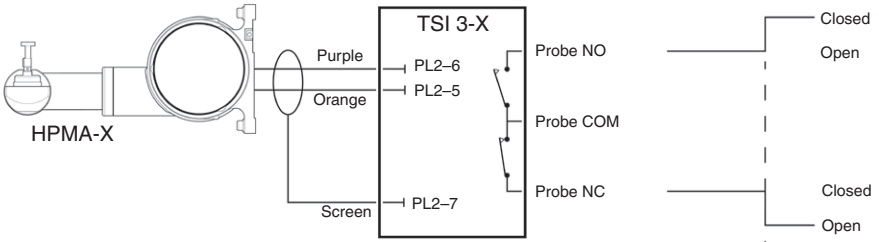




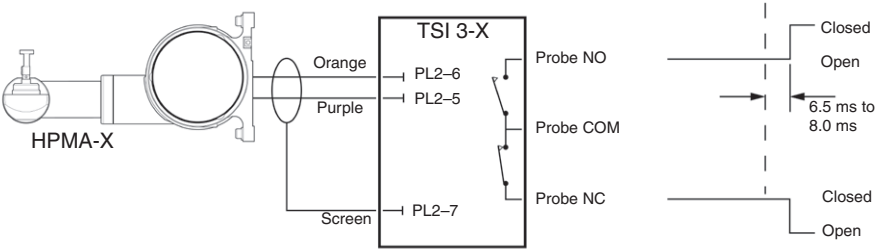
Pin	Function	Standard	Trigger delay
1	Motor control	Grey	
2		Green	
3		Blue	
4		Yellow	
5	Probe +	Orange	Purple
6	Probe –	Purple	Orange
7	SCR	Screen	
8	Motor 24 Vdc	Red	
		White	
		Brown	
9	Motor 0 Vdc	Black	
		Black and white	
		Brown and white	

Probe trigger delay

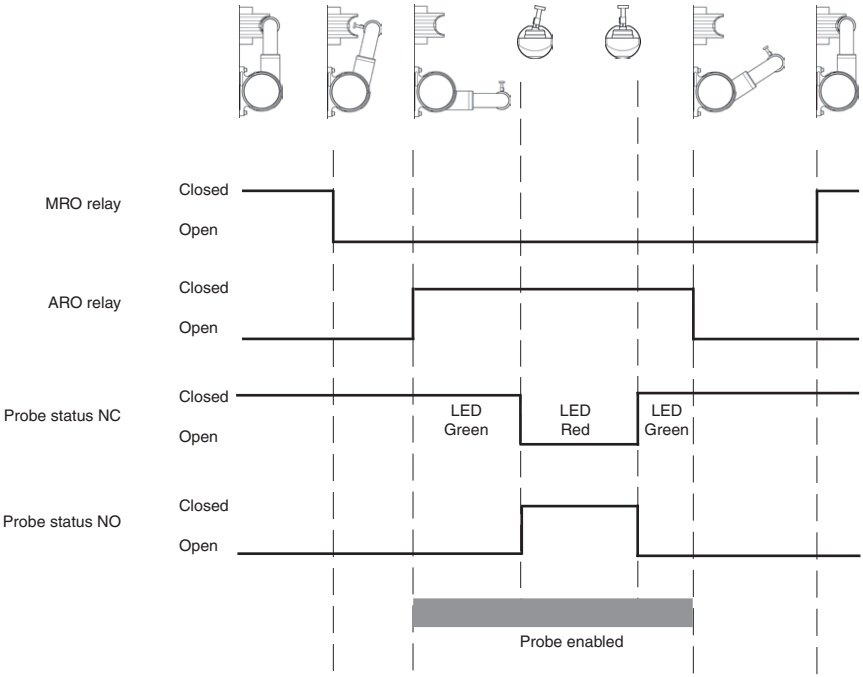
Configuration for DELAY OFF



Configuration for DELAY ON



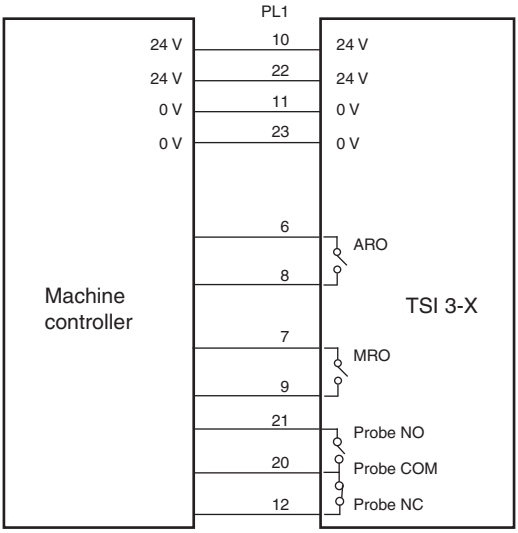
Standard wiring for probe output



NOTES:

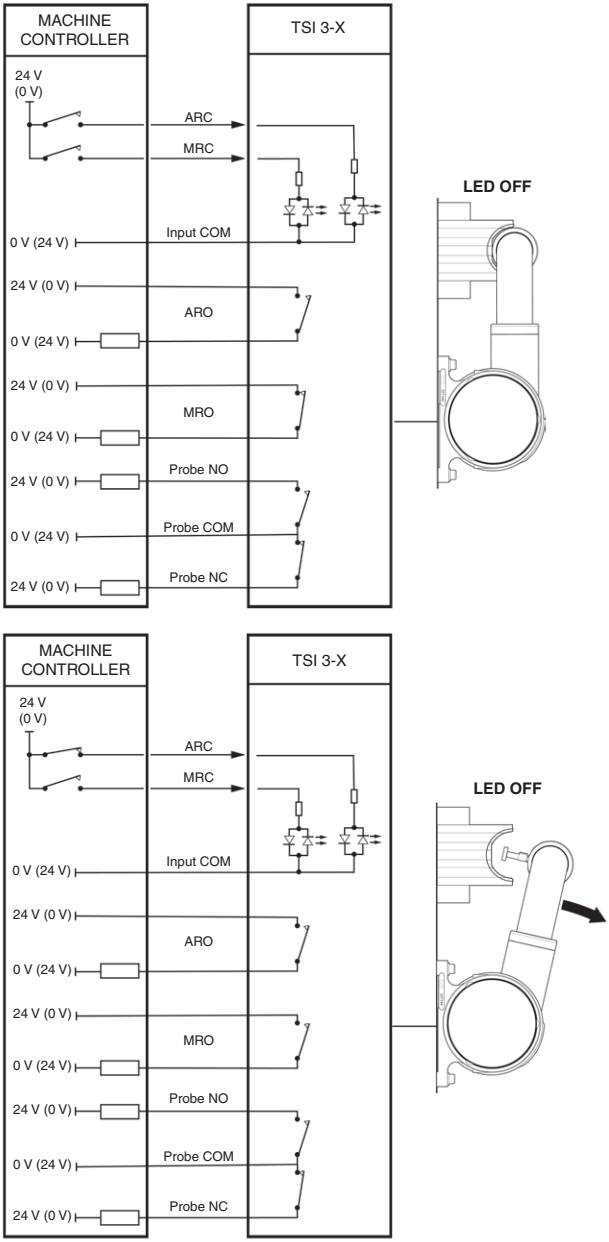
These wiring diagrams assume the probe status SSR outputs can be used.

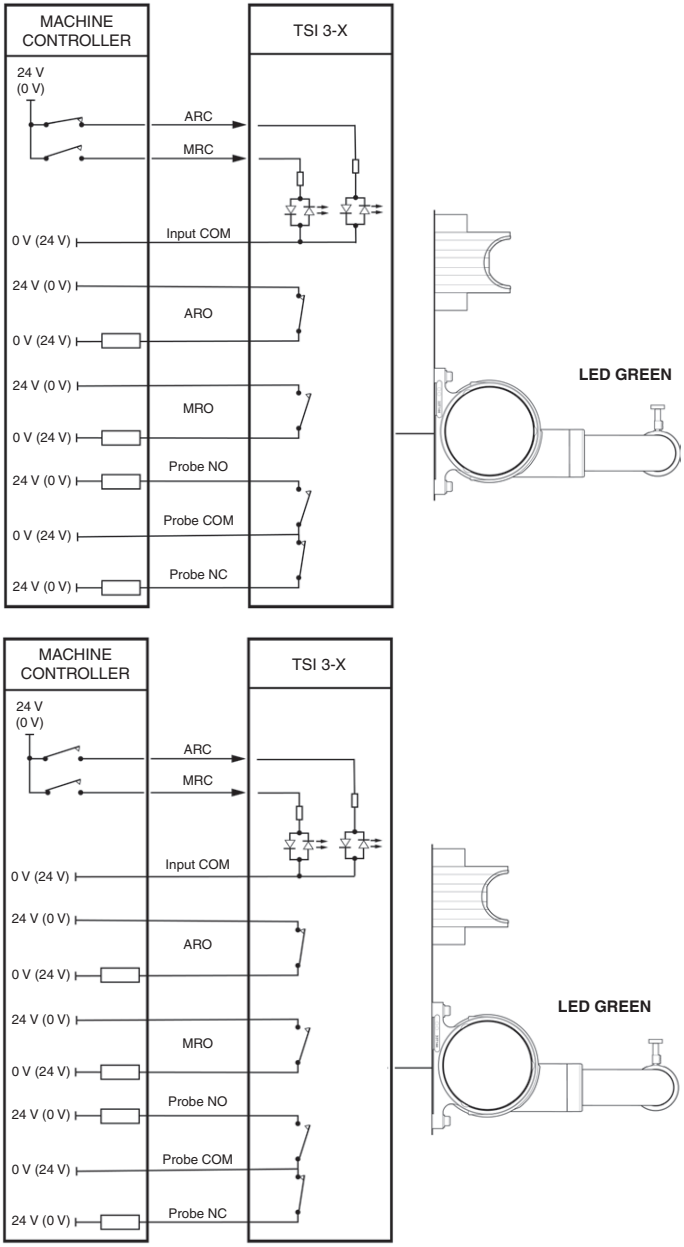
Where the four-wire option is required (for example, Fanuc automatic length management input XAE, ZAE), the user must provide **four** inputs from the controller to indicate which axis is moving in order to obtain a probe trigger (Sel X–, Sel X+, Sel Z–, Sel Z+). This signal will instruct the TSI 3-X to send the probe trigger output out through one of four possible channels (X–, X+, Z–, Z+).

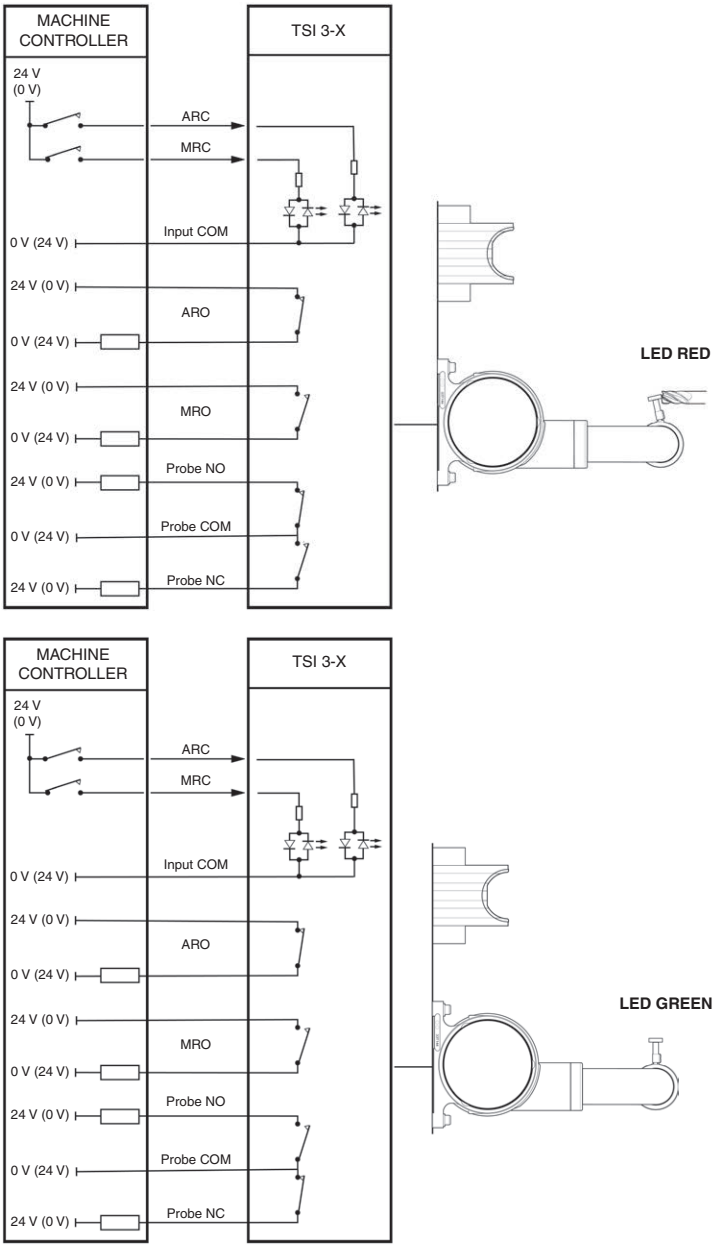


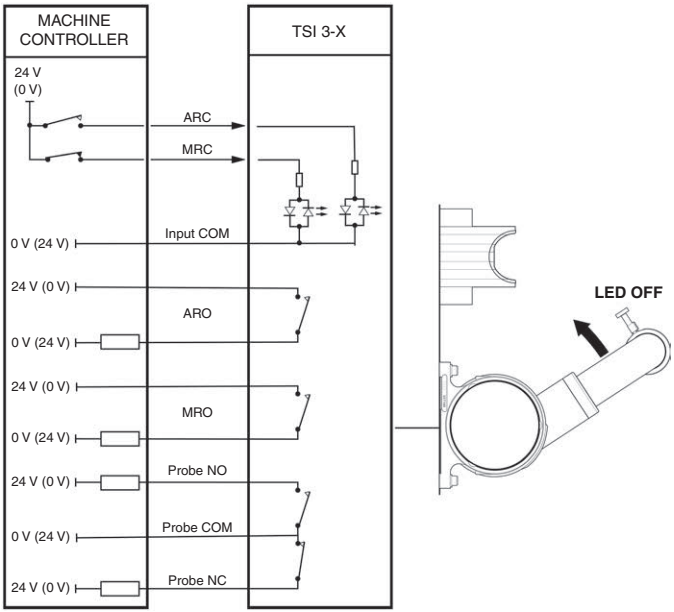
System operation

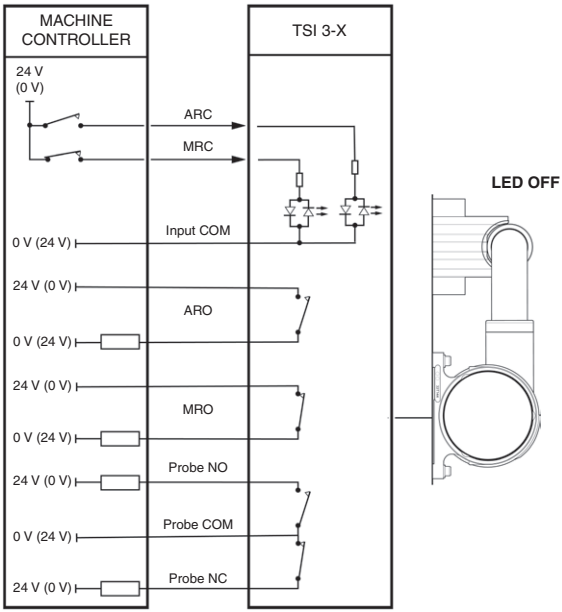
Shown as “active high” (with “active low” shown in brackets).

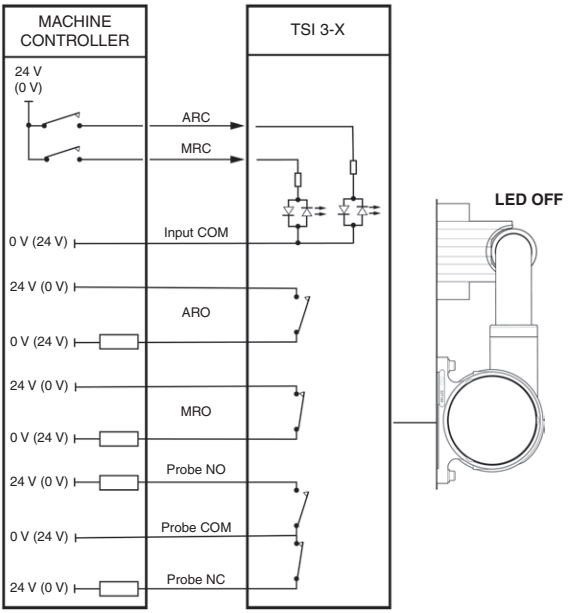



MACHINE CONTROLLER
TSI 3-X
24 V (0 V)
ARC
MRC
0 V (24 V)
Input COM
24 V (0 V)
ARO
0 V (24 V)
24 V (0 V)
MRO
0 V (24 V)
Probe NO
24 V (0 V)
Probe COM
0 V (24 V)
Probe NC
24 V (0 V)
LED GREEN
MACHINE CONTROLLER
TSI 3-X
24 V (0 V)
ARC
MRC
0 V (24 V)
Input COM
24 V (0 V)
ARO
0 V (24 V)
24 V (0 V)
MRO
0 V (24 V)
Probe NO
24 V (0 V)
Probe COM
0 V (24 V)
Probe NC
24 V (0 V)
LED GREEN


MACHINE CONTROLLER
TSI 3-X
24 V (0 V)
ARC
MRC
Input COM
0 V (24 V)
24 V (0 V)
ARO
0 V (24 V)
24 V (0 V)
MRO
0 V (24 V)
Probe NO
24 V (0 V)
Probe COM
0 V (24 V)
Probe NC
24 V (0 V)
LED RED
MACHINE CONTROLLER
TSI 3-X
24 V (0 V)
ARC
MRC
Input COM
0 V (24 V)
24 V (0 V)
ARO
0 V (24 V)
24 V (0 V)
MRO
0 V (24 V)
Probe NO
24 V (0 V)
Probe COM
0 V (24 V)
Probe NC
24 V (0 V)
LED GREEN


MACHINE CONTROLLER
TSI 3-X
24 V (0 V)
ARC
MRC
Input COM
0 V (24 V)
24 V (0 V)
ARO
0 V (24 V)
24 V (0 V)
MRO
0 V (24 V)
24 V (0 V)
Probe NO
0 V (24 V)
Probe COM
24 V (0 V)
Probe NC
LED OFF


MACHINE CONTROLLER
TSI 3-X
24 V (0 V)
ARC
MRC
Input COM
0 V (24 V)
24 V (0 V)
ARO
0 V (24 V)
24 V (0 V)
MRO
0 V (24 V)
24 V (0 V)
Probe NO
0 V (24 V)
Probe COM
24 V (0 V)
Probe NC
LED OFF

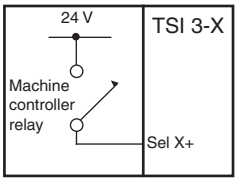


NOTES:

The diagrams on **pages 38** to **42** assume that the probe status SSR outputs can be used.

Where the four-wire option is required (for example, Fanuc automatic length measurement input XAE, ZAE), the user must provide **four** inputs from the controller to indicate which axis is moving in order to obtain a probe trigger (Sel X–, Sel X+, Sel Z–, Sel Z+). This signal will instruct the TSI 3-X to send the probe trigger output out through one of four possible channels (X–, X+, Z–, Z+).

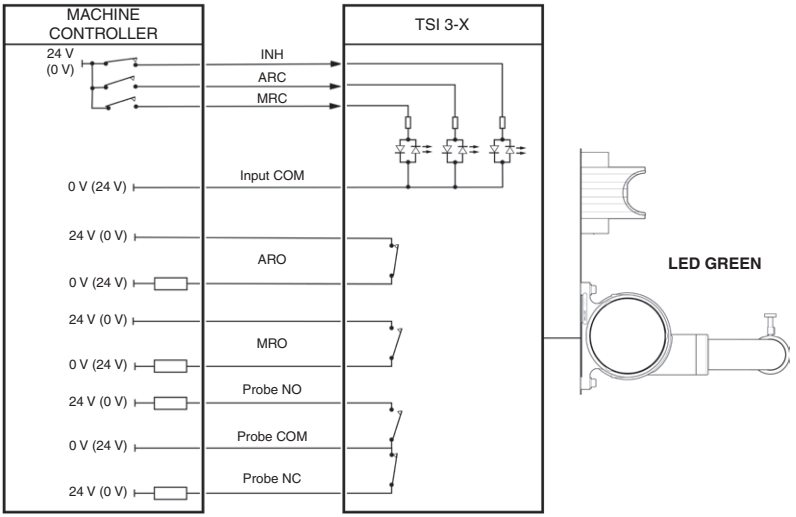
Probe select inputs

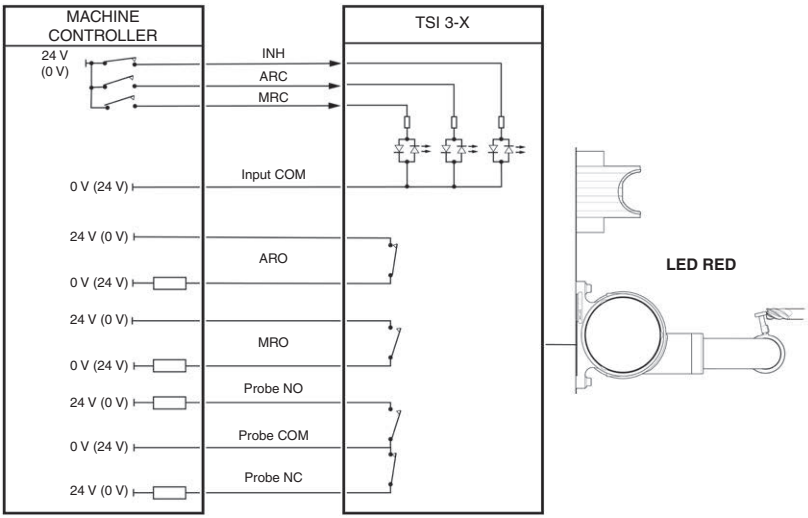


NOTE: The example above shows Sel X+; it also applies to Sel X–, Sel Z– and Sel Z+.

Probe inhibit

Shown as “active high” (with “active low” shown in brackets).

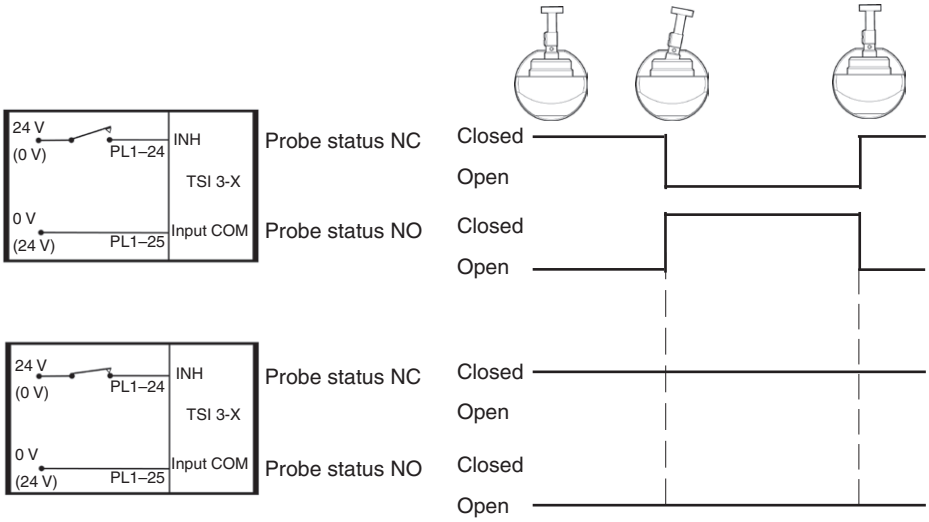




Inhibit input

Shown as “active high” (with “active low” shown in brackets).

The inhibit input also inhibits the probe trigger output on channels X–, X+, Z–, Z+.



NOTE: The probe status LED will still function when inhibit is active.

System inputs and outputs

Input specification

INH, ARC, MRC

Opto isolated.
12.5 mA max. @ 30 V max.
Activation voltage: 15 Vdc to 30Vdc.
With reference to Input COM.

Output specification

ARO and MRO are voltage-free SSR contacts.
ARO: NO, MRO: NO.
40 mA max., 30 V max., 10 V min.
Current limited.

Probe signal outputs

Probe status outputs are voltage-free SSR contacts.
Probe status: NO, Probe status: NC.
40 mA max., 30 V max., 10 V min.
Current limited.

For more information, see “Interface connections” on **page 34**.

Input specification (four-wire option)

Sel X–
Sel X+
Sel Z–
Sel Z+

Internally pulled down (2K4) ACTIVE HIGH inputs

Output specification (four-wire option)

X–O, X+O, Z–O, Z+O are protected by the supply fuse in the TSI 3-X.

(PL1-2) X–O
(PL1-3) X+O
(PL1-4) Z–O
(PL1-5) Z+O

OCT ACTIVE HIGH outputs

24 V supply – 3.8 V @ max. source 120 mA
24 V supply – 2.4 V @ 20 mA

Tool setting definitions

Probe datuming

Determines the relationship between the machine spindle and the stylus location, as well as the effective size of the tool setting stylus.

Your Renishaw tool setting probe can be datumed by measuring a ‘datum tool’ of known size and position.

Tool setting

Establishes the size and position of your cutting tools before you use them to machine a component. This enables you to produce parts that are ‘right first time’.

With a Renishaw tool setting probe, you can determine the size and position of your cutting tools quickly and easily.

Tool breakage detection

Checks the length of tools to see if the tool has chipped or broken since it was last set.

Why datum the probe?

A Renishaw touch-trigger probe allows you to use your machine tool to determine the size and position of your tools. When the stylus contacts the surface of your tool, the positions of the machine axes are recorded at that moment.

To determine the location of the surface of the tool, the software must know the size and position of the stylus.

Various probe datuming techniques allow you to determine the relationship between the stylus and the machine spindle.

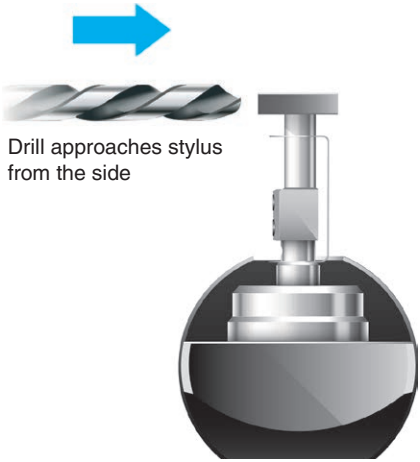
Whilst the spindle/stylus relationship will not change under normal conditions, there are certain circumstances under which you should redatum the tool setting probe:

- Before using the probe for the first time on a machine.
- Whenever a new stylus is fitted.
- If you have made any adjustment to the probe alignment.
- If you suspect that the stylus has become distorted.

Setting tools and tool breakage detection

Static tool length setting

Suitable for tools whose cutting edges are located on the spindle centre line, for example, drills. Static length setting involves moving the tip of a tool to contact the stylus.



Drill approaches stylus from the side

Rotating tool length setting (for driven tools)

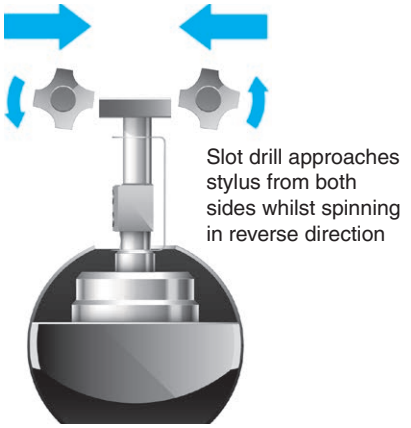
Suitable for tools whose cutting edges are located around the circumference, for example, slot drills. As with static length setting, rotating length setting involves moving the tip of a tool to contact the stylus but doing so while rotating, and doing so in the opposite direction to that which is used for cutting.

Rotating length setting ensures that the true high or low point of the tool is detected.

Rotating diameter setting (for driven tools)

Suitable for tools that are used to interpolate features, for example, slot drills, and which must be set for diameter. It involves moving the side of a tool to contact the stylus tip and, as with rotating length setting, the tool must be rotating in the opposite direction to that which is used for cutting (to protect the stylus).

NOTE: Do not use “Probe trigger delay” if setting the diameter of rotating tools.



Slot drill approaches stylus from both sides whilst spinning in reverse direction

Tool breakage detection

Tool breakage detection checks the lengths of your tools to identify tooling failures. By preventing damaged tools from being used for further machining, tool breakage detection forms a vital element of an automated machining process. Renishaw tool setting probes can be used to perform in-cycle checks on tooling. Measuring the length of the tool before and after use ensures that damaged tools will not be used on subsequent machining operations. This reduces the risk of scrap, machine damage and broken tooling in subsequent operations, for example, taps.

Tool breakage detection software records the most recent tool length for each tool and compares this with the length measured during the tool breakage detection operation. If a significant difference is detected, the operator can be called to change the damaged tool.

Maintenance and fault-finding

The following section describes the maintenance actions that can be carried out on the HPMA-X. A fault-finding section for assisting the user in diagnosing faults begins on **page 56**.

WARNING: It is recommended that eye protection and protective gloves be worn while inspecting and cleaning the HPMA-X.

HP Arms app

The HP Arms app makes configuring and supporting the range of Renishaw high-precision tool setting arms simple.

Intended for suitably-trained installation and maintenance engineers, the app provides a convenient, single point of reference for typical configuration, maintenance and troubleshooting tasks.

The app is easy to use with detailed animations, images, help text and step-by-step instructions and can be downloaded by searching for 'HP Arms' on the following stores:

HPMA-X calibration

The exact procedure adopted is specific to each machine, controller system and software package. However, certain rules are common.

Before setting tools, it is necessary to calibrate the stylus position to establish its trigger points in relation to a datum on the machine. This can be achieved by using a tool of known reference.

The HPMA-X must be recalibrated periodically (at least every 6 months), and in special circumstances, for example, if the arm has been subjected to a crash or if the stylus has been replaced.

The recommended frequency of normal recalibration is dependent on how frequently the arm is used. This may vary greatly depending on the application of the tool setting arm; for example, a typical jobbing shop may want to set tools twice per day and have eight tools to set. This would therefore result in two arm operations per day. A large volume manufacturer, however, may only wish to check for broken tools, but with a typical cycle time of 5 minutes and 24-hour working days, would operate the arm 288 times per day.

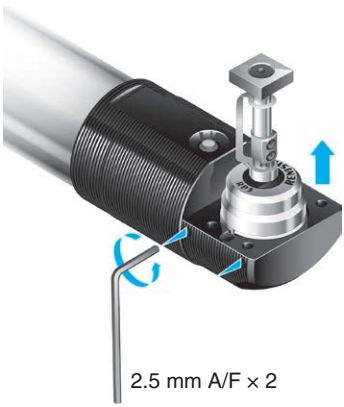
Use the table below to determine how frequently you should recalibrate your HPMA-X.

Recommended frequency of arm recalibration	
Arms operations per day	**Recalibrate every ...**
< 50	6 months
< 100	3 months
> 100	1 month

RP3 probe removal

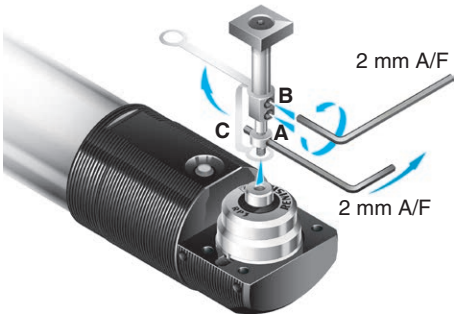
CAUTION: Ensure the area around the probe is dry and free of swarf and coolant before removing the probe.

1. Remove the M5 grub screws prior to cleaning to allow any coolant to escape.
2. Clean the probe and the area around the probe using clean dry air (Dust Remover clean air spray).
3. Remove the probe.



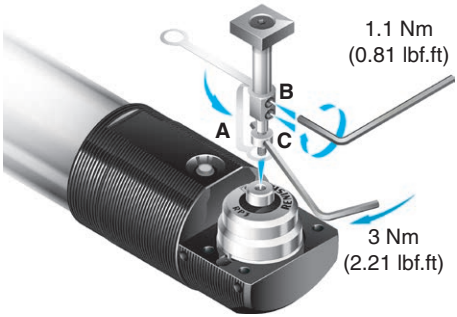
Stylus and break stem removal

1. Using a 2 mm hexagonal key fitted through the hole in the break stem (**A**), unscrew the stylus from the probe.
2. Using a 2 mm hexagonal key, unscrew the M3 grub screw(s) (**B**) that hold the break stem to the stylus.
3. Free the end of the captive link from the threaded end of the break stem (**C**) and remove the break stem.



Break stem and stylus fitting

1. Fit the free end of the captive link over the threaded end of the break stem (**A**).
2. Fit the break stem inside the stylus and secure it by tightening the M3 grub screw(s) (**B**).
3. Using a 2 mm hexagonal key fitted through the hole in the break stem (**C**), fit the stylus to the probe.



RP3 probe care

The probe mechanism is protected from coolant and debris by a diaphragm. This provides adequate protection under normal working conditions.

Periodically clean the probe(s) and check the diaphragm for signs of damage.

CAUTION: Do not remove the diaphragm. If the diaphragm is damaged, return the probe to your supplier for repair.

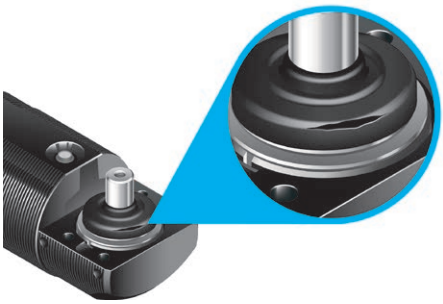
Cleaning and diaphragm inspection

1. Leaving the probe(s) in the arm, use a screwdriver to release and remove the front cover.
2. Clean the probe mechanism with low-pressure clean coolant.

   CAUTION: Do not use high-pressure water jets to clean the probe mechanism.

3. Inspect the diaphragm for damage. If it is damaged, return the probe to your supplier.

   CAUTION: Do not remove the diaphragm, as this will invalidate your warranty.



Fitting the cover

4. Fit the front cover by pressing it back into place with your hand, while supporting the probe holder.

HPMA-X inspection

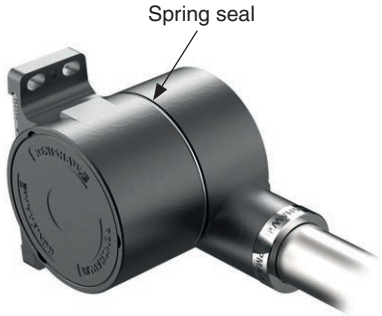
Periodically inspect the arm for signs of damage. It is acceptable to move the arm by hand to carry out this inspection, taking care to avoid any finger traps.

CAUTION: Contact your supplier if damaged. Do not attempt to fix it yourself.

Spring seal and probe pocket inspection

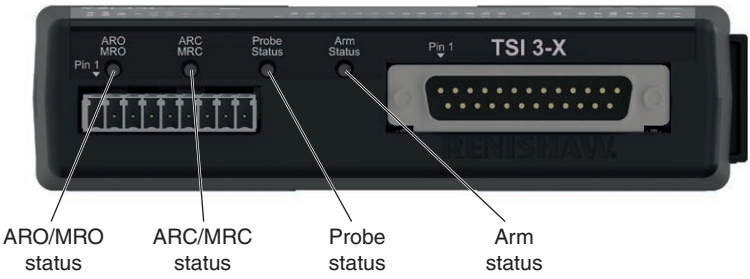
Regularly clean the spring seal, probe pocket(s) and surrounding areas with a brush to prevent swarf build-up, taking care not to push debris into the seals or between the HPMA-X and its mounting surface.

CAUTION: Do not use high-pressure water jets to clean the spring seal.



TSI 3-X LED diagnostics

Four indicator LEDs are provided on the TSI 3-X to give system status information.



LED colour	ARO/MRO status	Graphic hint
Constant green	ARO	
Constant red	MRO	
Off	No output	

LED colour	ARC/MRC status	Graphic hint
Constant green	ARC	
Constant red	MRC	
Constant yellow	Error (ARC and MRC are both active)	
Off	No command	

LED colour	Probe status	Graphic hint
Constant green	Seated	
Constant red	Triggered	
Constant yellow	Inhibit	
Off	Inactive	

LED colour	Arm status	Graphic hint
Constant green	System OK	
Constant yellow	Arm motion error (for example, command lost during sweep)	
Constant violet	Power-up in unknown arm position	
Constant blue	Underspeed issue (for example, arm stalled during sweep)	
Flashing blue	Overspeed issue (for example, arm manually accelerated)	
Flashing yellow	Error confirming position	
Flashing red	Motor error	
Off	No power	

Fault-finding

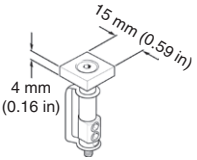
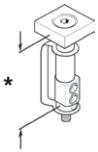
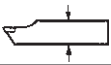
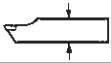
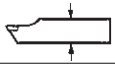
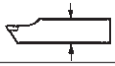
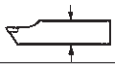
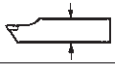
Symptom	Cause	Action
Poor system repeatability.	Mounting screws not fully tightened.	Tighten screws to specified torque.
	Loose probe.	Verify tightness of probe in arm assembly.
	Loose stylus.	Ensure tip of stylus is tight. Ensure M4 grub screw in stylus stem is tight. Ensure break stem is fully tightened into RP3 probe.
	Swarf on tool tip.	Remove swarf.
	Calibration and updating of offsets is not occurring.	Review software.
	Calibration and probing speeds are not the same.	Review software.
	Probing is being performed within the machine's acceleration/deceleration zones.	Review software.
	Arm not mounted as recommended (for example, on sheet metal guards).	Mount on solid base.
	Probing feedrate is too high for the machine controller.	Perform repeatability trials at various feedrates.
	Temperature variation is causing excessive movement of the machine and the HPMA-X.	Minimise machine and HPMA-X temperature changes. Increase the frequency of calibration.
	Machine has poor repeatability due to loose encoders, backlash, tight slideways and/or accidental damage.	Perform health check on machine.

Symptom	Cause	Action
Poor system repeatability (continued).	Excess machine vibration.	Eliminate vibration. Change wiring to enable probe trigger delay circuit.
	Minor collision.	Move arm to stow position and back to active position to reset arm to kinematic seating.
No probe output (probe status LED not lit).	Damaged or dirty probe contacts.	Check condition of probe contacts. If contacts are dirty, clean using compressed air and a clean lint-free cloth.
	Probe not connected.	Check wiring to machine. Check that the probe is properly located in the holder.
	Probe has failed.	Remove probe and check probe for continuity across probe contacts (resistance should be less than 1 KΩ).
Arm system not responding to commands.	Power supply not connected.	Check electrical connections (ensure motor and I/O supplies are connected). Check power supply (supplies) for voltage and polarity.
	Command not received.	Check machine controller electrical outputs. Check electrical connections.
	TSI 3-X not responding.	Remove power from TSI 3-X (power machine down or alternatively disconnect 25-way D-type connector for 5 seconds minimum and reconnect).

Symptom	Cause	Action
Arm system responds to commands but does not acknowledge completion of move (ARO and MRO).	ARO or MRO not received by machine controller.	Check machine controller inputs. Check electrical connections.
No ARO signal received.	Arm has not completed move.	Check for swarf in the probe pocket.
No probe output.	Probe not connected.	Check probe holder LED is green when probe is seated. Ensure probe is fully inserted in the probe holder (see “Fitting the probe(s) to the arm” on **page 29**).
	Probe status or four-wire output not received by machine controller.	Check machine controller inputs/outputs. Check electrical connections.

NOTE: In the unlikely event that an unresponsive system issue is not resolved by the above actions, it is acceptable to manually move the HPMA-X to the MRO position, if required.

Parts list

Recommended for:	 Stylus assembly	 * Stylus length	 Break stem
 16 mm	A-2197-0157	14.2 mm (0.56 in)	M-2197-0156
 20 mm	A-2197-0158	19.5 mm (0.77 in)	M-2197-0156
 25 mm	A-2197-0159	29.5 mm (1.16 in)	M-2197-0150
 32 mm	A-2197-0160	34.5 mm (1.36 in)	M-2197-0150
 40 mm	A-2197-0161	39.5 mm (1.55 in)	M-2197-0150
 50 mm	A-2197-0162	49.5 mm (1.95 in)	M-2197-0150

Item	Part number	Description
Tool kits	A-2176-0636	Standard HP arm tool kit.
	A-2176-0639	Micro HP arm tool kit.
Base fixing	A-2275-0113	HPMA-X base fixing kit.
Front cover	A-2197-0006	RP3 probe front cover kit.
Spring seal	M-2275-0549	Spring seal for HPMA-X base.
Probe pocket	A-2275-0098	HPMA-X arm probe pocket.
TSI 3-X	A-6671-0200	TSI 3-X interface unit with DIN rail mounting.
RP3 probe	A-2197-0004	RP3 probe assembly.
Cables	A-6671-0410	2 m SCR HPMA-X cable, 12 W M23 socket.
	A-6671-0415	5 m SCR HPMA-X cable, 12 W M23 socket.
	A-6671-0417	7 m SCR HPMA-X cable, 12 W M23 socket.
	A-6671-0420	10 m SCR HPMA-X cable, 12 W M23 socket.

Item	Part number	Description
Publications. These can be downloaded from our website at **www.renishaw.com**.		
RP3	H-2000-5187	User guide: RP3 probe.
HPMA-X and TSI 3-X data sheet	H-6671-8200	Data sheet: HPMA-X and TSI 3-X motorised arm and interface.
Styli	H-1000-3200	Technical specifications guide: Styli and accessories – or visit our Online store at **www.renishaw.com/shop**.
Probe software	H-2000-2298	Data sheet: Probe software for machine tools – programs and features.

Notes

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