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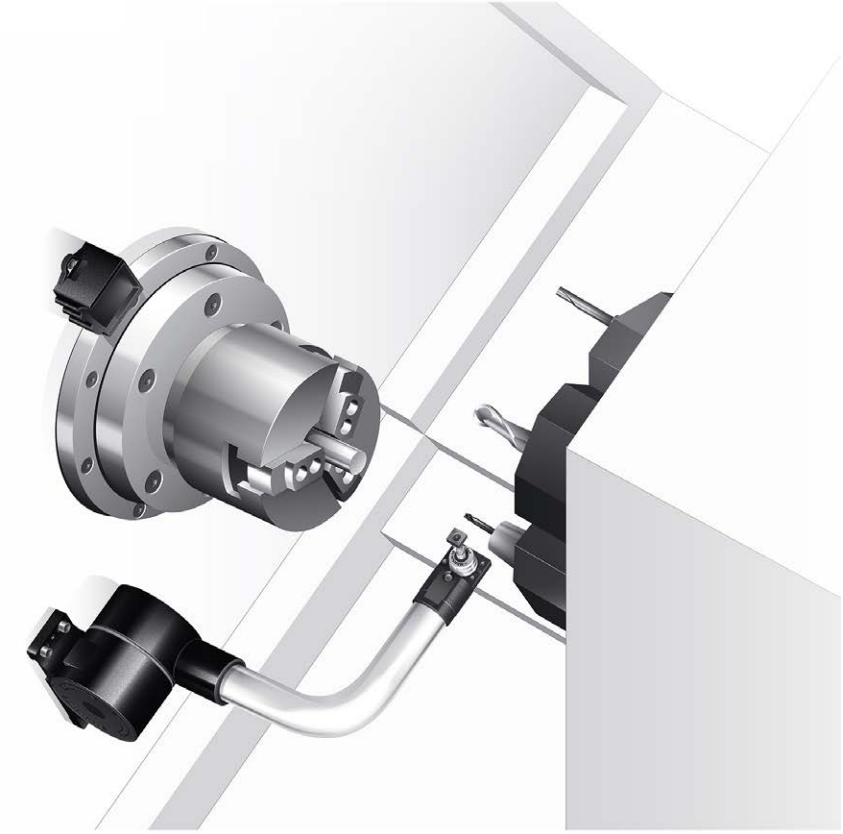
HPMA and TSI 3 / TSI 3-C motorised arm and interface



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

EN		Publications for this product are available by scanning the barcode or visiting **www.renishaw.com/hpma**.
DE	Für dieses Produkt stehen weitere Informationen zur Verfügung. Scannen Sie dazu den Barcode oder besuchen Sie **www.renishaw.de/hpma**.	
ES		Para acceder a las publicaciones sobre este producto escanee el código de barras o visite **www.renishaw.es/hpma**.
FR	Les documentations pour ce produit sont disponibles en scannant le code barres ou en visitant **www.renishaw.fr/hpma.**	
IT		Le pubblicazioni relative a questo prodotto sono disponibili scansionando il codice a lato oppure visitando il sito: **www.renishaw.it/hpma**.
日本語	本製品に関する資料については、バーコードをスキャンするか **www.renishaw.jp/hpma** をご覧ください。	

NL		Publicaties voor dit product zijn te verkrijgen door de barcode te scannen of te gaan naar **www.renishaw.nl/hpma**.
PT	As publicações sobre este produto estão disponíveis pelo código de barras ou visitando **www.renishaw.com.br/hpma**.	
中文 (繁體)		可透過下列方式獲得此產品的出版物 透過掃描條碼，或造訪 **www.renishaw.com.tw/hpma**。
中文 (简体)	可通过以下方式获得此产品的相关文档： 扫描二维码，或访问 **www.renishaw.com.cn/hpma**。	
한국어		본 제품에 대한 간행물은바코드를 스캔하거나 다음을 방문하여 확인하실 수있습니다 **www.renishaw.co.kr/hpma**.

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Contents

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, and other related products, are subject of one or more of the following patents and/or patent applications:

EP 1537376

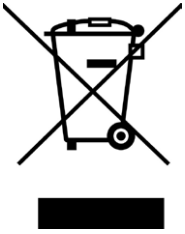
Compliance declaration

Renishaw plc hereby declares that the HPMA 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 system is a motorised tool setting solution predominantly intended for use on CNC turning 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) 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 or TSI 3-C disconnected.

CAUTION: HPMA and TSI 3 / TSI 3-C are intended for exclusive use as part of the HPMA 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.

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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) 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或TSI 3-C的电源已断开。

小心：HPMA和TSI 3 / TSI 3-C仅可作为HPMA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。

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 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 / TSI 3-C software notices

This TSI 3 / TSI 3-C 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.

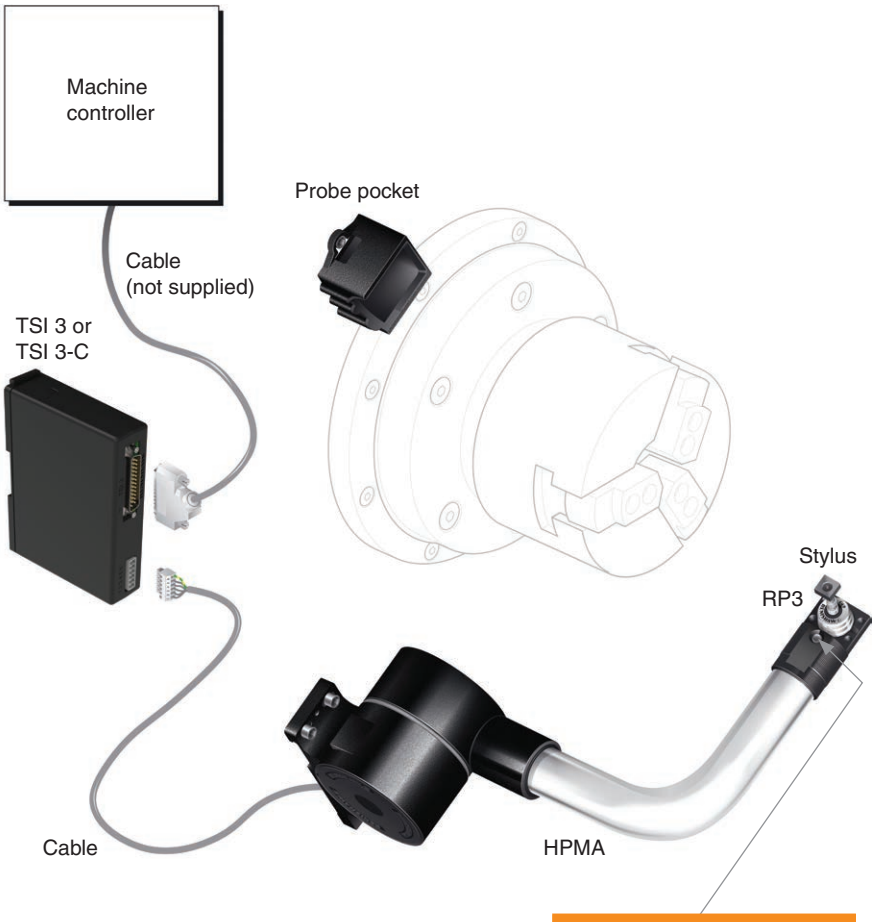
Renishaw software EULA

Renishaw software is licensed in accordance with the Renishaw licence at:
www.renishaw.com/legal/softwareterms

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



Probe status LED	
Green	Arm ready for use and probe seated
Red	Triggered

NOTE: For part numbers, refer to the parts list on **page 71**.

The HPMA system is a mechanism for delivering a probe 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 to a safe location.

HPMA specification

Variant		Standard rear exit	Standard side exit
Principal application		Tool measuring and broken tool detection on 2-axis and 3-axis CNC lathes.	
Transmission type		Hard-wired transmission	
Weight		≈ 5 kg (176 oz)	
Probe		RP3 [1]	
Compatible interfaces		TSI 3 or TSI 3-C	
Cable (arm to interface)	Type	Ø7.3 mm (0.29 in), 5-core screened cable, each core is 0.75 mm^2	Ø4.35 mm (0.17 in), 4-core screened cable, each core is 0.22 mm^2
	Length	2 m (6.5 ft), 5 m (16.4 ft), 10 m (32.8 ft)	7 m (22.9 ft)
Sense directions		±X, ±Y, +Z (probe axes; refer to **page 25**, "HPMA dimensions", for definition)	
Typical positional repeatability (probe axes) [2 3]		5 µm (197 µin) 2σ X/Y (arms for machines with 6 in to 15 in chucks) 8 µm (315 µin) 2σ X/Y (arms for machines with 18 in to 24 in chucks)	
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, maximum arm sweep angle is 91°)	
Mounting		M8 bolts (× 3)	
Probe pocket mounting		M6 bolts (× 2)	
Environment	IP rating	IPX6 and IPX8, BS EN 60529:1992+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 25**, "HPMA 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 / TSI 3-C specification

Variant		TSI 3	TSI 3-C
Principal application		Input and output interfacing between the HPMA arm and the host CNC controller	
Weight		≈ 0.2 kg (7 oz)	
Mounting		DIN rail preferred; alternatively M4 screw (× 2)	
I/O connector type		25-way D-sub	
Inputs		Opto isolated drive commands and probe inhibit command, 15 Vdc to 30 Vdc	
Outputs		OCT active high for ARO, MRO and X+, X–, Z+, Z–	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	N/A
Power supply requirement	Voltage	24 Vdc	
	Current	3 A	
Environment	IP rating	IP20, BS EN 60529:1992+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 installation

WARNINGS:

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

Remove all power before commencing installation.

Care should be taken to avoid any finger traps.

CAUTIONS:

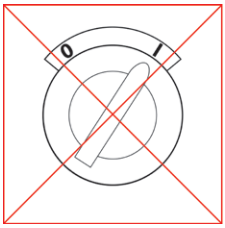
The HPMA must not be manually actuated, as this may cause irreparable damage.

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

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

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

- The HPMA 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 can be orientated at any angle between 0° and 60° from the horizontal, with the arm lowering into “arm ready position”. Performance can be compromised if the HPMA is orientated with the arm rising vertically into “arm ready position” and this should be avoided unless the installation is approved by Renishaw.
- The HPMA 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. If it is not possible to position the HPMA 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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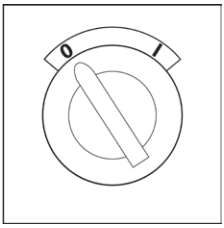
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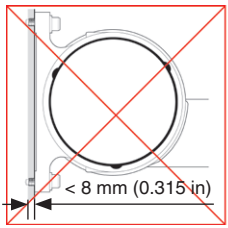
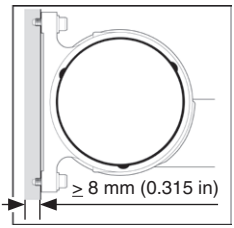
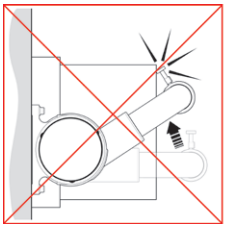
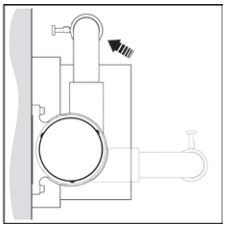
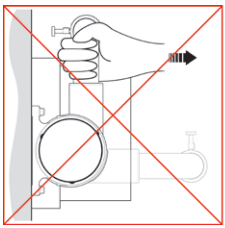
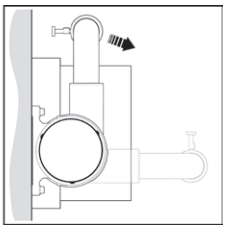

< 8 mm (0.315 in)

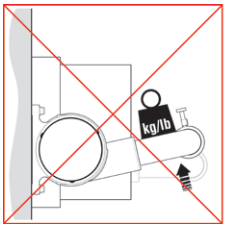

≥ 8 mm (0.315 in)

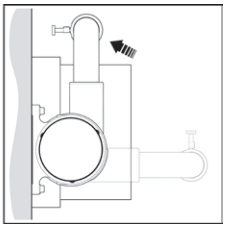




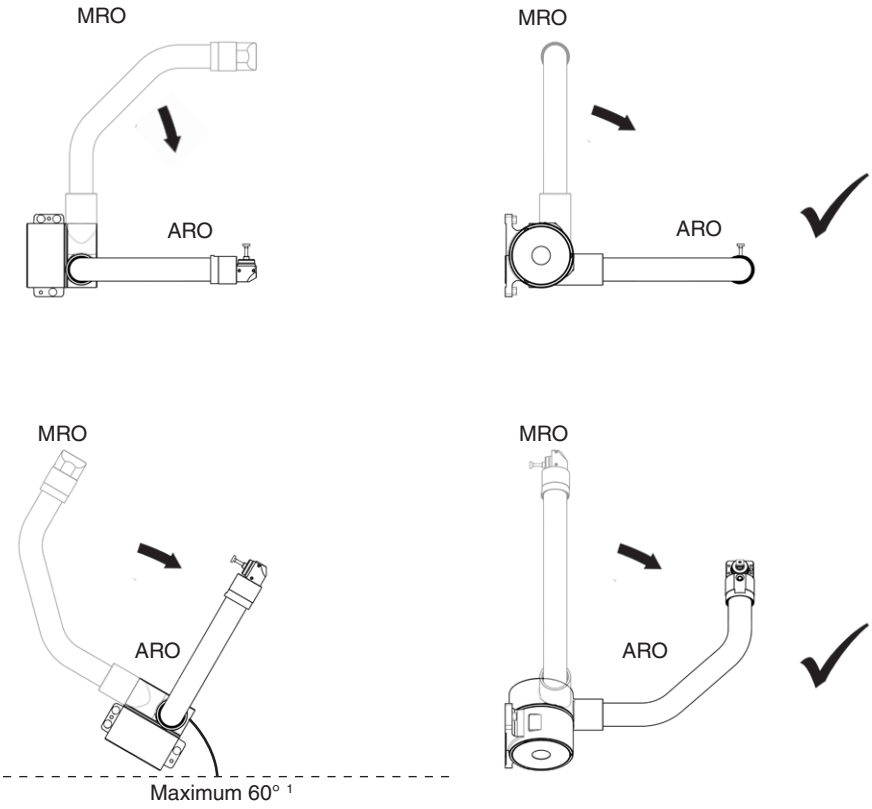





kg/lb



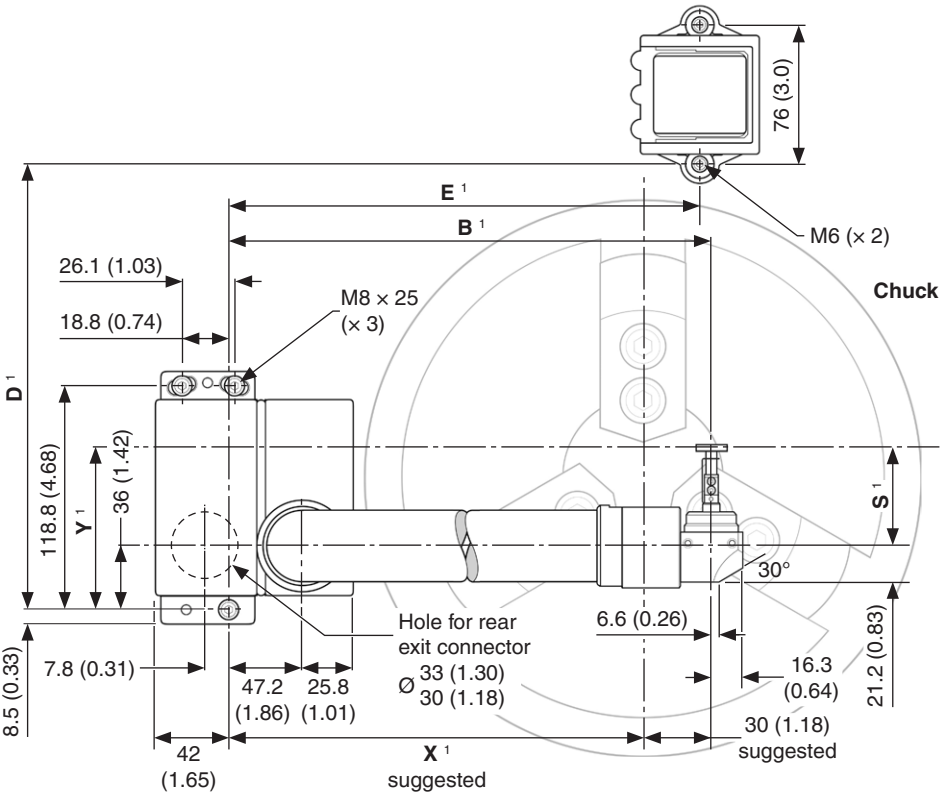
Acceptable orientation of hub and base



1 For applications outside of this range, contact Renishaw.

HPMA mounting details

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

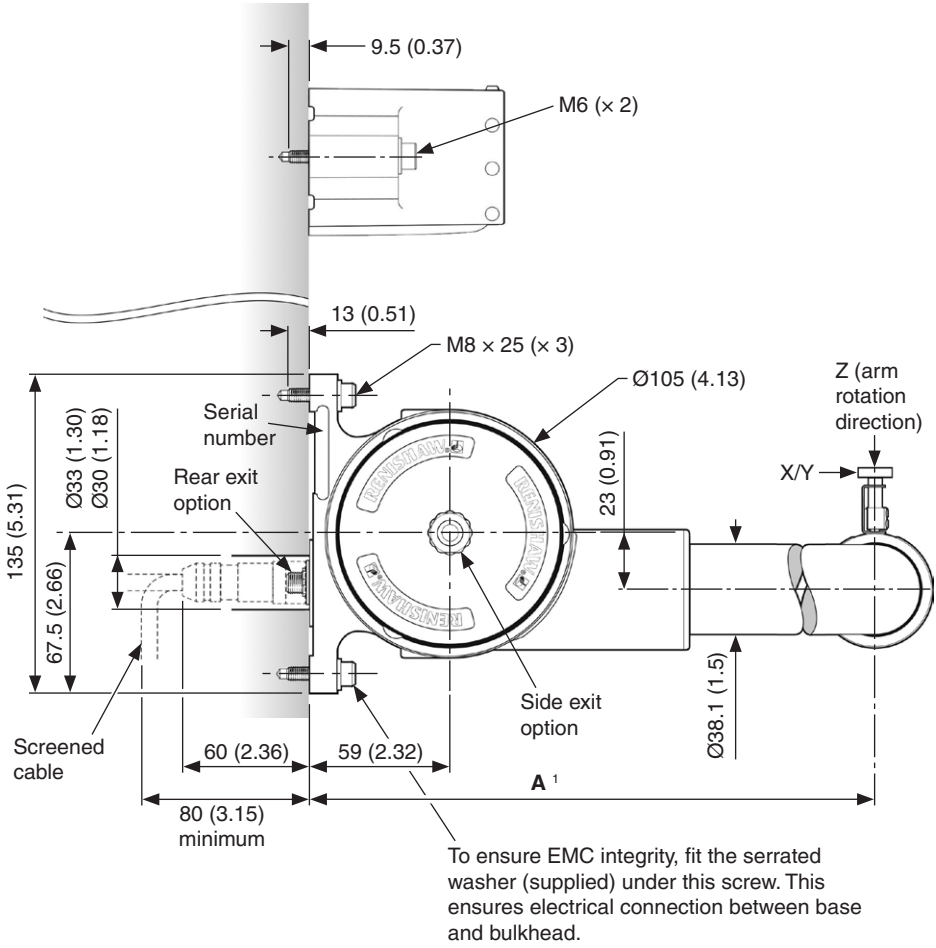


Dimensions given in mm (in)

[1] A range of standard sizes are available, with either a rear or side exit connection. See the table on **page 27** for further information.

HPMA dimensions

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

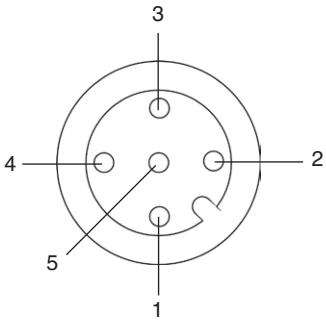


Dimensions given in mm (in)

[1] A range of standard sizes are available, with either a rear or side exit connection. See the table on **page 27** for further information.

Rear exit wiring

5-way M12 panel mount connector



NOTE: Connect the cable before fitting the HPMA. Ensure the connector is fitted finger-tight using the M12 knurled fitting.

Pin	Function
1	Probe +
2	Probe –
3	Not connected
4	Motor +
5	Motor –
Shell	Screen

Side exit wiring

Cable to TSI 3 or TSI 3-C 7 m (23 ft)

19 mm A/F conduit adaptor suitable for ¼ in flexible metal conduit.

Colour	Function
Blue	Probe +
Grey/black	Screen
Green	Probe –
Red	Motor +
Yellow	Motor –

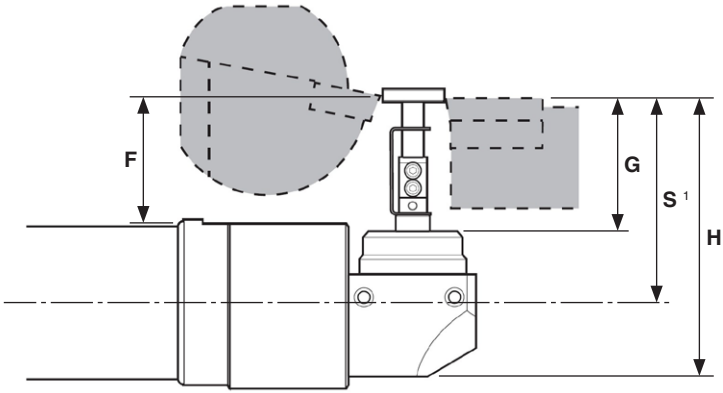
Standard arms dimension table

Chuck size	Tooling size	Arm size		D	E	S [1]	X	Y
		A	B					
6 in	16 mm 20 mm 25 mm 32 mm	250 (9.84)	219.2 (8.63)	212 (8.35)	212 (8.35)	35.7 (1.40) 41 (1.61) 51 (2.01) 56 (2.20)	189.2 (7.45)	71.7 (2.82) 77 (3.03) 87 (3.42) 92 (3.62)
8 in	16 mm 20 mm 25 mm 32 mm	286 (11.26)	249.2 (9.81)	248 (9.76)	242 (9.53)	35.7 (1.40) 41 (1.61) 51 (2.01) 56 (2.20)	219.2 (8.63)	71.7 (2.82) 77 (3.03) 87 (3.42) 92 (3.62)
10 in	16 mm 20 mm 25 mm 32 mm 40 mm	335 (13.19)	298.2 (11.74)	297 (11.69)	291 (11.46)	35.7 (1.40) 41 (1.61) 51 (2.01) 56 (2.20) 61 (2.40)	268.2 (10.56)	71.7 (2.82) 77 (3.03) 87 (3.42) 92 (3.62) 97 (3.82)
12 in	16 mm 20 mm 25 mm 32 mm 40 mm 50 mm	368 (14.49)	298.2 (11.74)	330 (12.99)	291 (11.46)	35.7 (1.40) 41 (1.61) 51 (2.01) 56 (2.20) 61 (2.40) 71 (2.80)	268.2 (10.56)	71.7 (2.82) 77 (3.03) 87 (3.42) 92 (3.62) 97 (3.82) 107 (4.21)
15 in	20 mm 25 mm 32 mm 40 mm 50 mm	400 (15.75)	343.2 (13.51)	362 (14.25)	336 (13.23)	41 (1.61) 51 (2.01) 56 (2.20) 61 (2.40) 71 (2.80)	313.2 (12.33)	77 (3.03) 87 (3.42) 92 (3.62) 97 (3.82) 107 (4.21)
18 in	25 mm 32 mm 40 mm 50 mm	469 (18.46)	383.2 (15.09)	431 (16.97)	376 (14.80)	51 (2.01) 56 (2.20) 61 (2.40) 71 (2.80)	353.2 (13.91)	87 (3.42) 92 (3.62) 97 (3.82) 107 (4.21)
24 in	25 mm 32 mm 40 mm 50 mm	555 (21.85)	458.2 (18.04)	517 (20.35)	451 (17.76)	51 (2.01) 56 (2.20) 61 (2.40) 71 (2.80)	428.2 (16.86)	87 (3.42) 92 (3.62) 97 (3.82) 107 (4.21)

Dimensions given in mm (in)

[1] Stylus height, S, is adjustable. See "Stylus coarse adjustment" on **page 30**.

Stylus dimensions by tool size

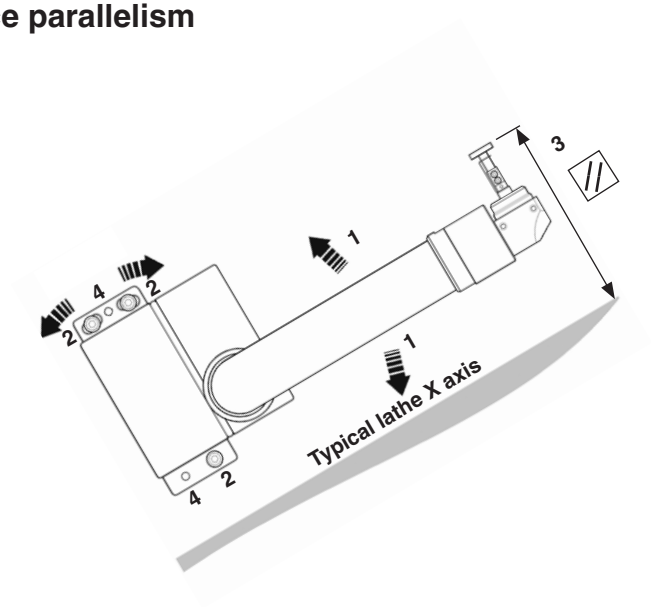


1 Stylus height, S, is adjustable. See “Stylus coarse adjustment” on **page 30**.

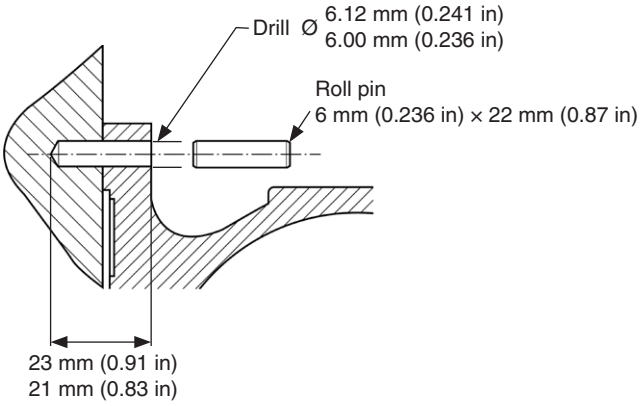
Tooling size	Stylus length (see “Parts list” on page 71)	F	G	H	S
16 mm	14.2 (0.56)	14.2 (0.56)	19.1 (0.75)	56.9 (2.24)	35.7 (1.40)
20 mm	19.5 (0.77)	19.5 (0.77)	24.4 (0.96)	62.2 (2.45)	41 (1.61)
25 mm	29.5 (1.16)	29.5 (1.16)	34.4 (1.35)	72.2 (2.84)	51 (2.01)
32 mm	34.5 (1.36)	34.5 (1.36)	39.4 (1.55)	77.2 (3.04)	56 (2.20)
40 mm	39.5 (1.56)	39.5 (1.56)	44.4 (1.75)	82.2 (3.24)	61 (2.40)
50 mm	49.5 (1.95)	49.5 (1.95)	54.4 (2.14)	92.2 (3.63)	71 (2.80)

Dimensions given in mm (in)

Top face parallelism

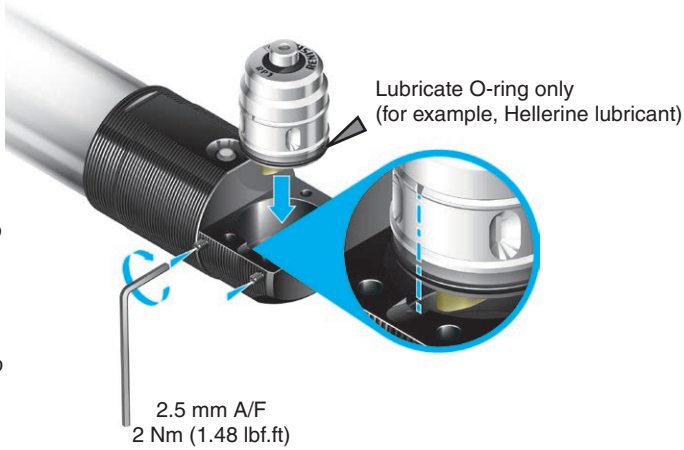


1. Rotate arm on bottom mounting screw to set stylus alignment.
2. Tighten all screws to 10 Nm (7.38 lbf.ft).
3. Check that stylus alignment has not moved after tightening.
4. Drill through base into mounting using pilot holes as a guide.
5. Fit roll pins supplied in base fixing kit. Apply corrosion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



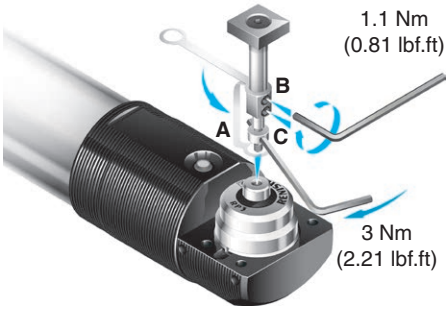
Fitting the probe to the arm

1. Loosen grub screws (× 2)
2. Insert probe
3. Tighten grub screws (× 2)

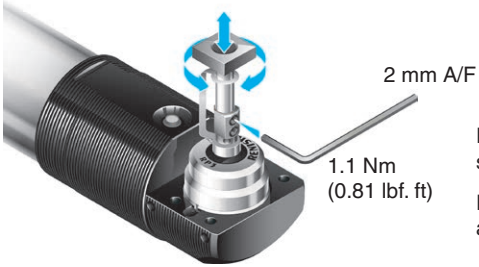


Stylus fitting

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

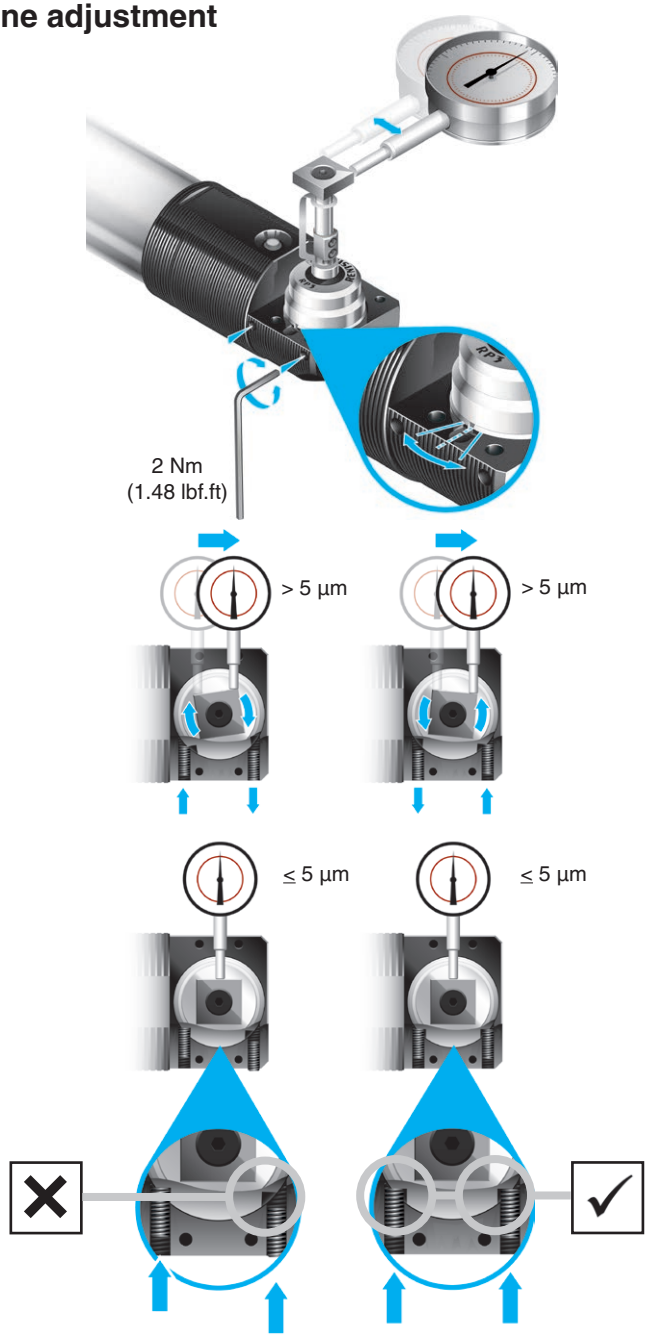


For 16 mm and 20 mm stylus ±0.8 mm

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

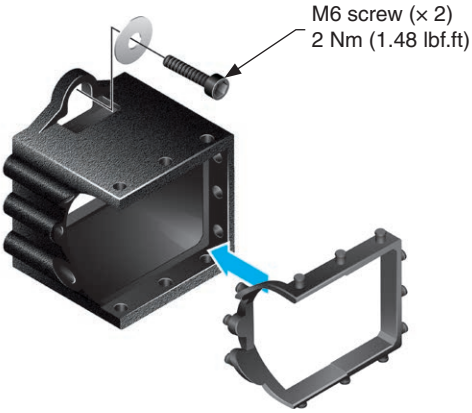
Set approximately parallel with machine tool axes.

Stylus fine adjustment



Installing the probe pocket

Additional information can also be found in “HPMA mounting details” on **page 24**.



1. Fit the probe pocket 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.
3. Ascertain the optimum position for the probe pocket by repositioning the pocket until it is aligned to the probe holder, then securely tighten the M6 screws. This step is necessary to ensure equal pressure is exerted on all sides of the probe pocket seal.
4. Check that the position of the probe pocket 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 / TSI 3-C installation

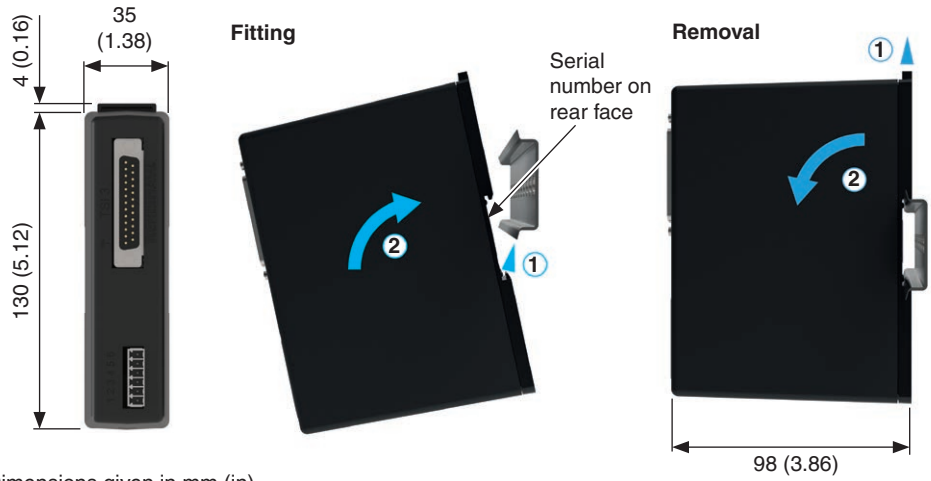
WARNINGS:

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

Remove all power before commencing installation.

Standard mounting and dimensions

The TSI 3 or TSI 3-C 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.

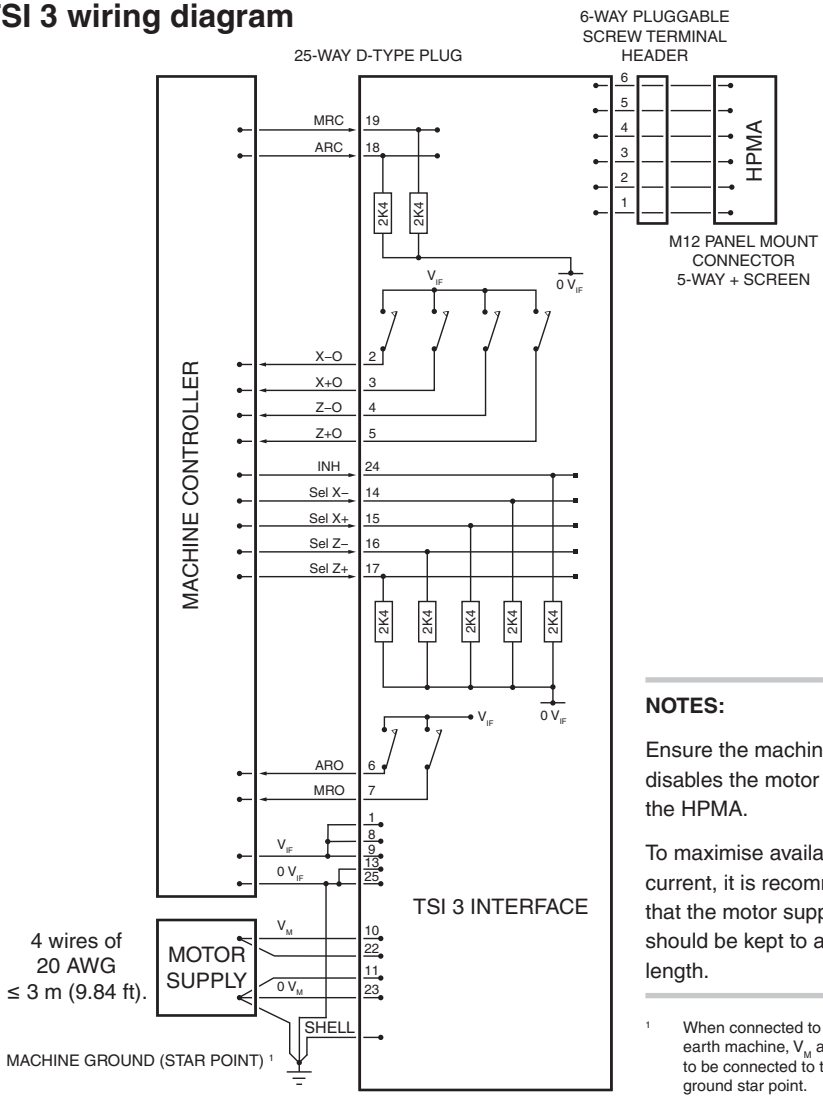


Dimensions given in mm (in)

Alternative mounting

TSI 3 installation and operation

TSI 3 wiring diagram



NOTES:

Ensure the machine interlock disables the motor supply to the HPMA.

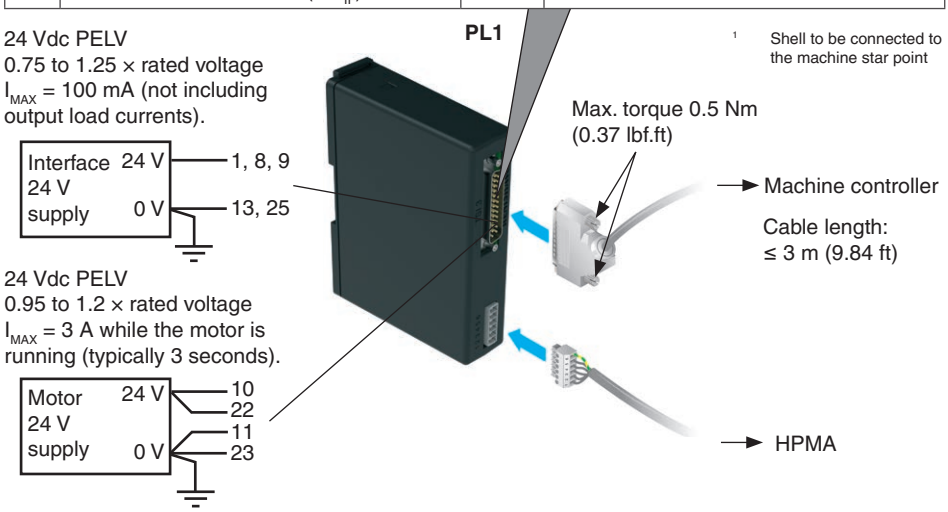
To maximise available motor current, it is recommended that the motor supply cable should be kept to a minimal length.

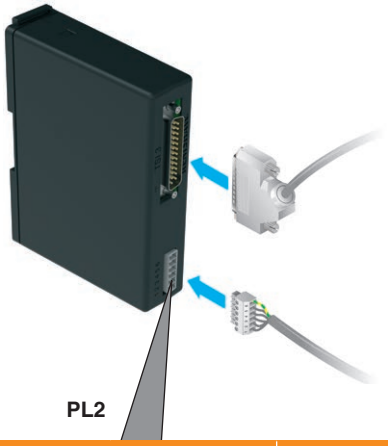
[1] When connected to a positive earth machine, V_M and V_{IF} need to be connected to the machine ground star point.

V_{IF} = 24 Vdc PELV 0.75 to 1.25 × rated voltage. This supplies the interface.
I_{IF} = 100 mA maximum (not including output load currents).
V_M = 24 Vdc PELV 0.95 to 1.2 × rated voltage. This supplies the motor drive.
I_M = 3 A maximum, while the motor is running (typically 3 seconds).
Circuit protection: power supply protected against overcurrent and reverse connection.

TSI 3 interface connections

Pin	Function	Pin	Function
1	Interface 24 Vdc supply (V_{IF})	14	Select X– input (Sel X–)
2	X– output (X–O)	15	Select X+ input (Sel X+)
3	X+ output (X+O)	16	Select Z– input (Sel Z–)
4	Z– output (Z–O)	17	Select Z+ input (Sel Z+)
5	Z+ output (Z+O)	18	ARC
6	ARO	19	MRC
7	MRO	20	No connection
8	Interface 24 Vdc supply (V_{IF})	21	No connection
9	Interface 24 Vdc supply (V_{IF})	22	Motor 24 Vdc supply (V_M)
10	Motor 24 Vdc supply (V_M)	23	Motor 0 Vdc (0 V_M)
11	Motor 0 Vdc (0 V_M)	24	Probe inhibit (INH)
12	No connection	25	Interface 0 Vdc (0 V_{IF})
13	Interface 0 Vdc (0 V_{IF})	Shell [1]	SCR

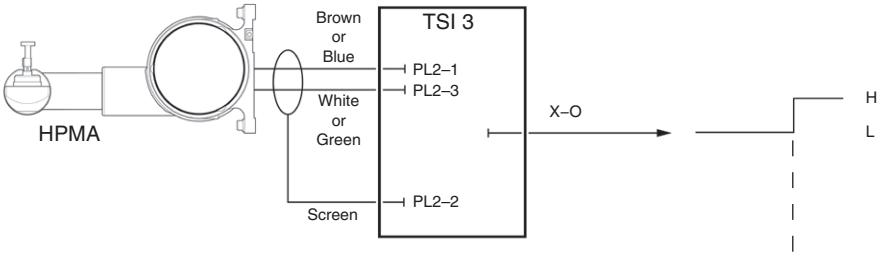




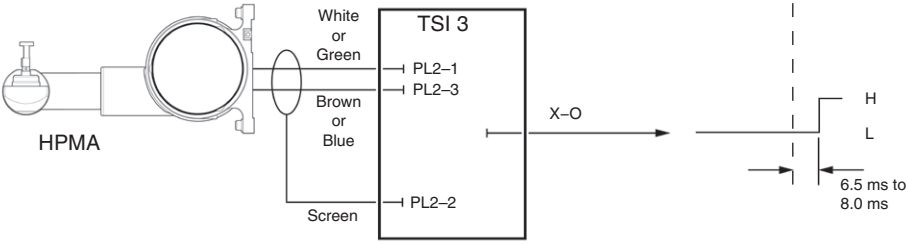
		Rear exit version		Side exit version	
Pin	Function	Standard	Trigger delay	Standard	Trigger delay
1	Probe +	Brown	White	Blue	Green
2	SCR	Screen	Screen	Grey/Black	Grey/Black
3	Probe –	White	Brown	Green	Blue
4	Not connected	Blue	Blue	Not connected	Not connected
5	Motor +	Black	Black	Red	Red
6	Motor –	Grey	Grey	Yellow	Yellow

TSI 3 probe trigger delay

Configuration for DELAY OFF
Brown/White (rear exit) or Blue/Green (side exit)



Configuration for DELAY ON
Brown/White (rear exit) or Blue/Green (side exit)

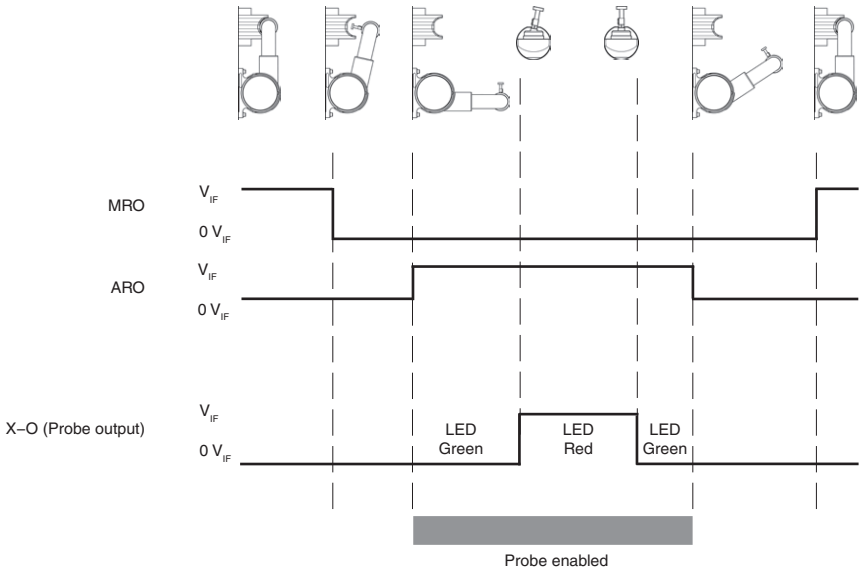


NOTES:

Probe trigger delay is only compatible with on-centre length measurement; it should not be used for setting the ROTATING DIAMETER.

See “TSI 3 interface connections” on **page 35** for more information on motor wiring instructions.

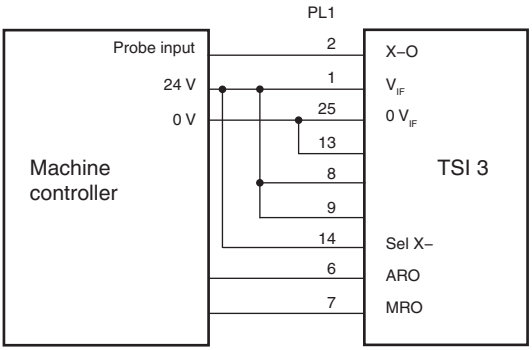
TSI 3 standard wiring for probe output



NOTES:

These wiring diagrams assume the standard one-wire Renishaw probe output can be used.

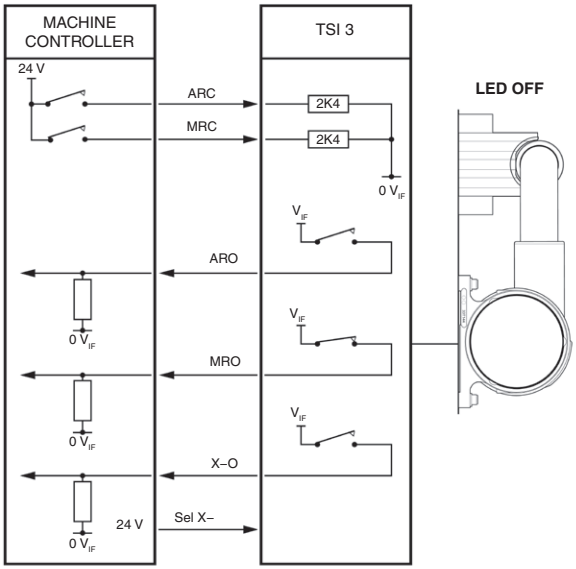
Where the four-wire option is required (for example, Fanuc automatic length management input XAE, ZAE), the user must provide **four** inputs from the controller to indicate which axis is moving in order to obtain a probe trigger (Sel X–, Sel X+, Sel Z–, Sel Z+). This signal will instruct the TSI 3 to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



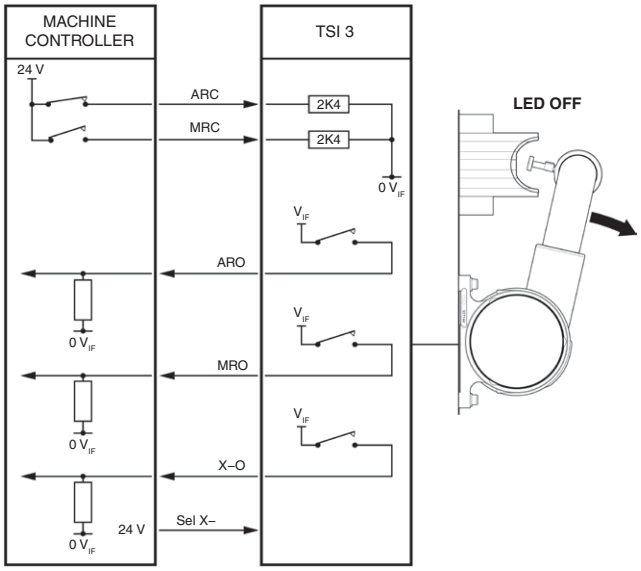
TSI 3 system operation

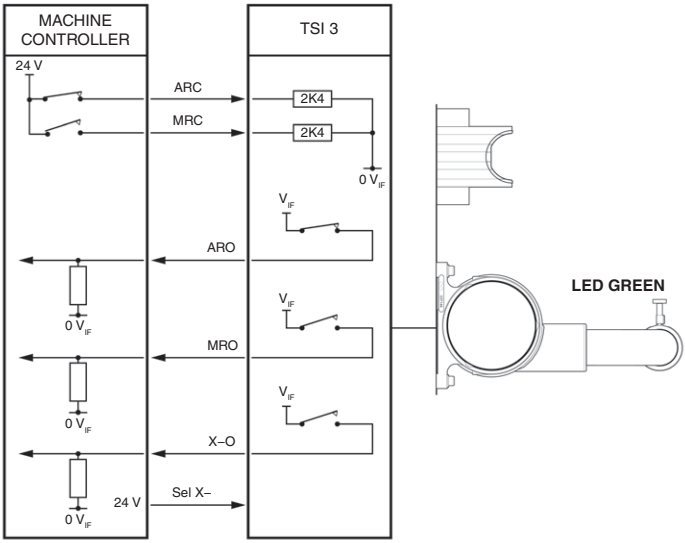
Shown as “active high”.

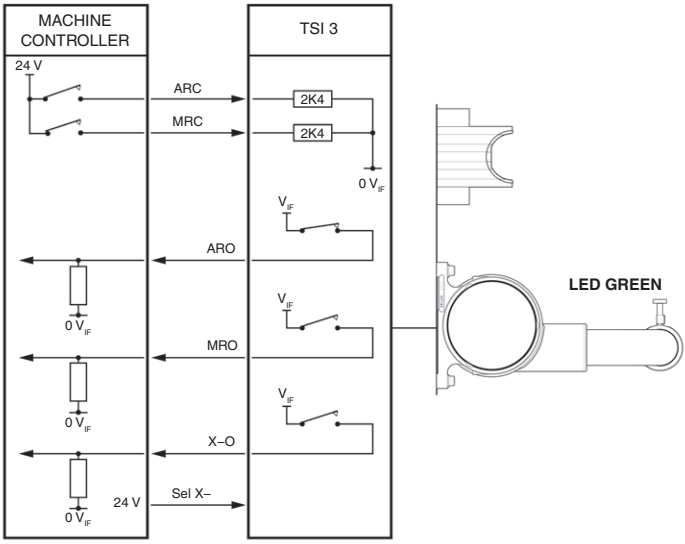
Two separate machine tool controller outputs are required to command the arm to move to MRC and ARC. The user must ensure that both outputs are never active at the same time. There must be a minimum time delay of 0.1 seconds (100 ms) between one command being deactivated and the other being activated. If both outputs are active at the same time then the arm is unable to determine what to do and will stop. This condition can only be overcome by deactivating both outputs.

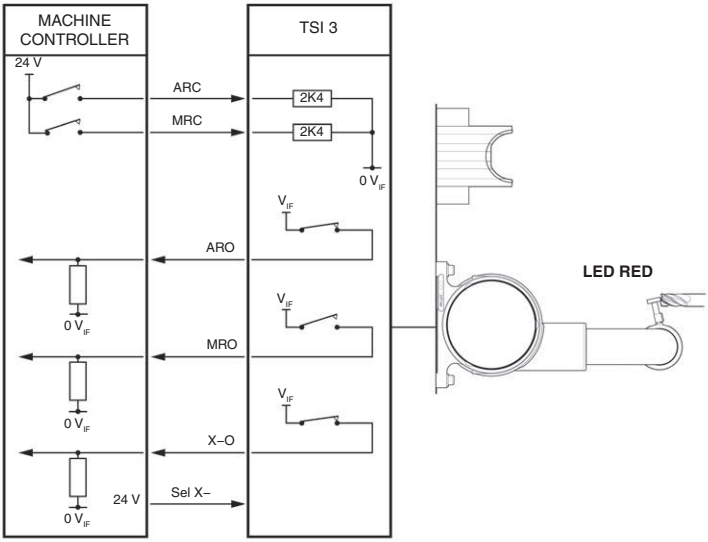


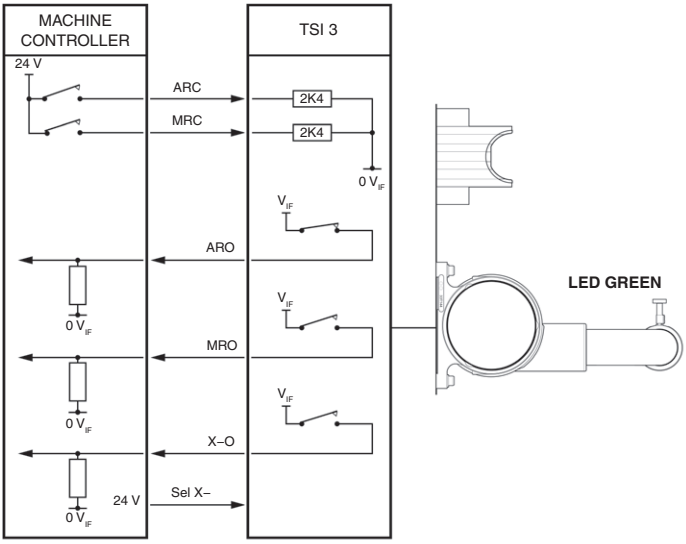
Two machine tool controller inputs are required to receive arm position confirmation signals for MRO and ARO.

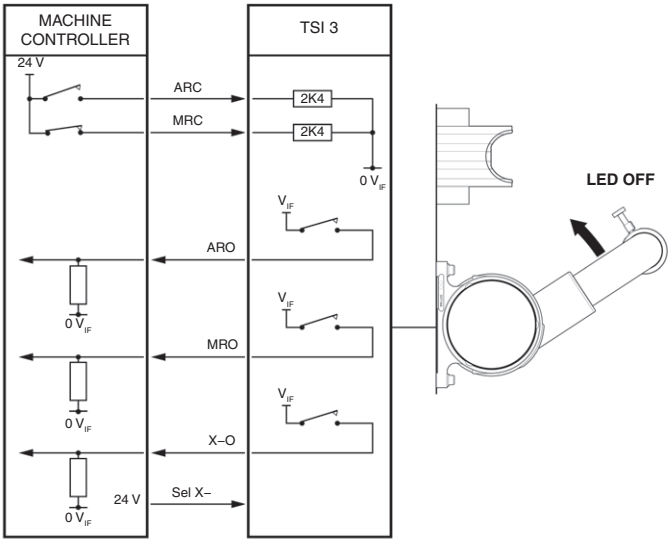


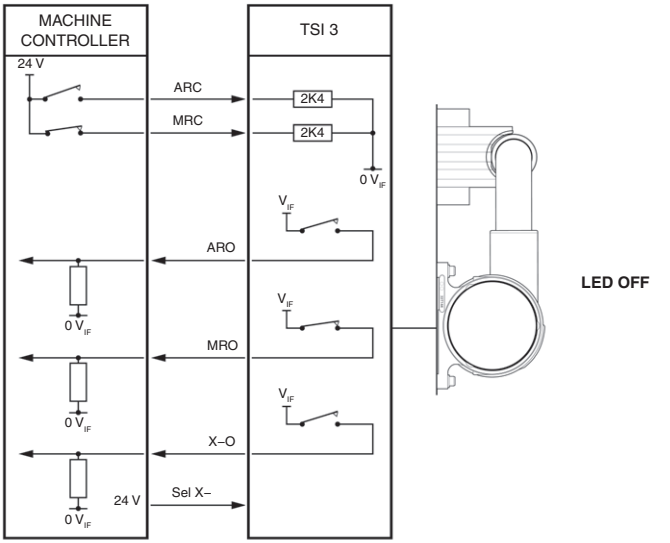

MACHINE CONTROLLER
TSI 3
24 V
ARC
MRC
2K4
2K4
0 V IF
V IF
ARO
0 V IF
V IF
MRO
0 V IF
V IF
X–O
0 V IF
24 V
Sel X–
LED GREEN

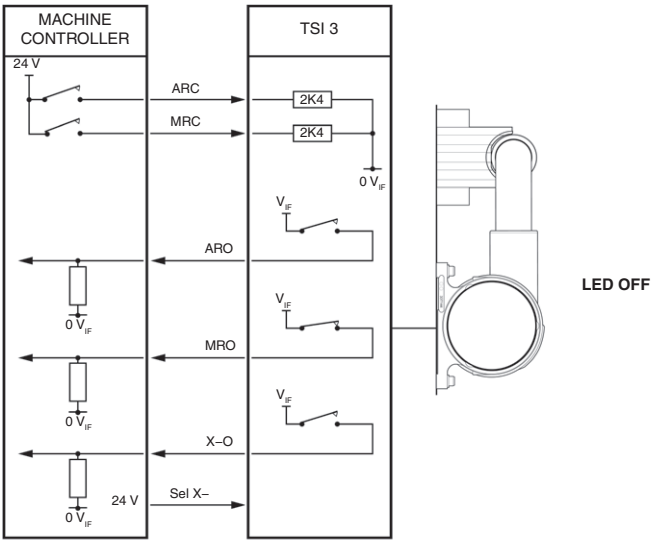

MACHINE CONTROLLER
TSI 3
24 V
ARC
MRC
2K4
2K4
0 V IF
V IF
ARO
0 V IF
V IF
MRO
0 V IF
V IF
X–O
0 V IF
24 V
Sel X–
LED GREEN


MACHINE CONTROLLER
TSI 3
24 V
ARC
MRC
2K4
2K4
0 V IF
V IF
ARO
0 V IF
V IF
MRO
0 V IF
V IF
X–O
0 V IF
24 V
Sel X–
LED RED


MACHINE CONTROLLER
TSI 3
24 V
ARC
MRC
2K4
2K4
0 V IF
V IF
ARO
0 V IF
V IF
MRO
0 V IF
V IF
X–O
0 V IF
24 V
Sel X–
LED GREEN


MACHINE CONTROLLER
TSI 3
24 V
ARC
MRC
2K4
2K4
0 V IF
V IF
ARO
0 V IF
V IF
MRO
0 V IF
V IF
X–O
0 V IF
24 V
Sel X–
LED OFF


MACHINE CONTROLLER
TSI 3
24 V
ARC
MRC
2K4
2K4
0 V IF
V IF
ARO
0 V IF
V IF
MRO
0 V IF
V IF
X–O
0 V IF
24 V
Sel X–
LED OFF

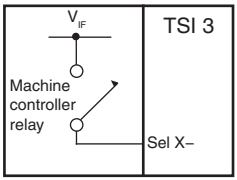


NOTES:

The wiring diagrams on **pages 39** to **43** assume that the standard one-wire Renishaw probe output 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 to send the probe trigger output out through one of four possible channels (X–, X+, Z–, Z+).

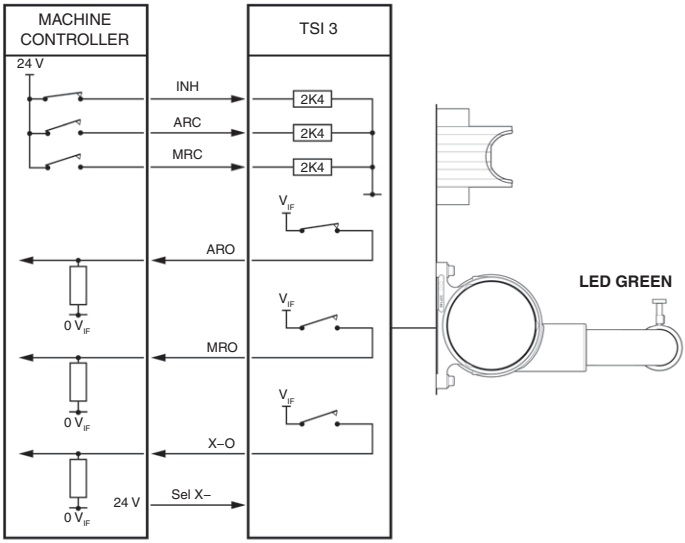
TSI 3 probe select inputs

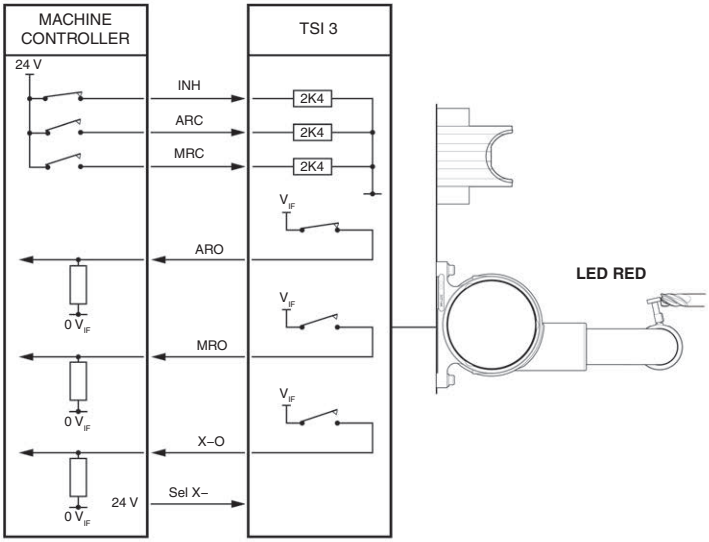


NOTE: The example above shows Sel X–; it also applies to Sel X+, Sel Z– and Sel Z+.

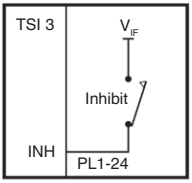
TSI 3 probe inhibit

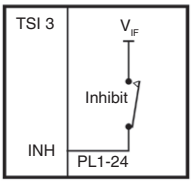
Shown as “active high”.

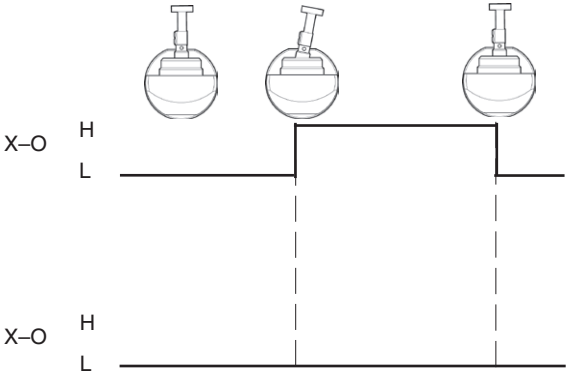




TSI 3 inhibit inputs







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

TSI 3 system inputs and outputs

Input specification

INH
Sel X–
Sel X+
Sel Z–
Sel Z+
ARC
MRC

} Internally pulled down (2K4) ACTIVE HIGH inputs

Output specification

ARO and MRO are current limited.

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

Probe signal outputs

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

} OCT ACTIVE HIGH outputs (one probe signal output only) V_{IF} – 3.8 V @ max. source 120 mA
V_{IF} – 2.4 V @ 20 mA

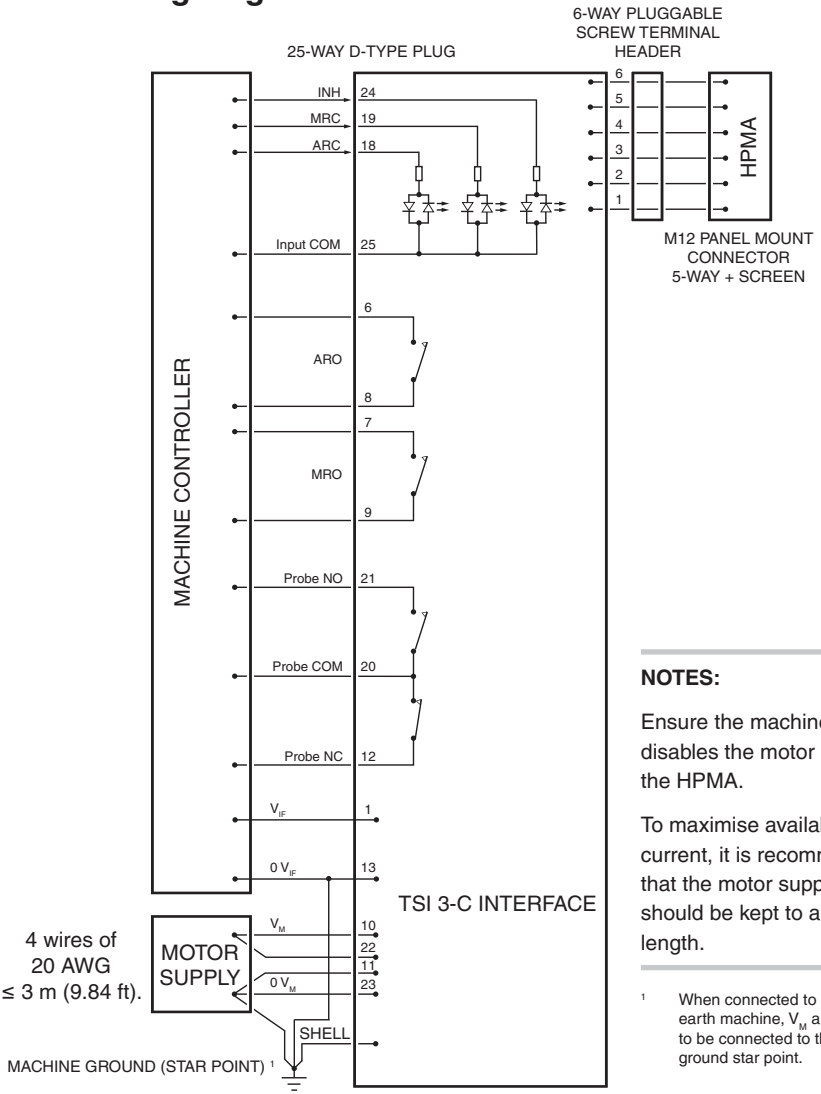
Arm ready (ARO) / Machine ready (MRO) outputs

ARO (PL1-6) MRO (PL1-7)

OCT ACTIVE HIGH outputs V_{IF} – 2.4 V @ 20 mA

TSI 3-C installation and operation

TSI 3-C wiring diagram



NOTES:

Ensure the machine interlock disables the motor supply to the HPMA.

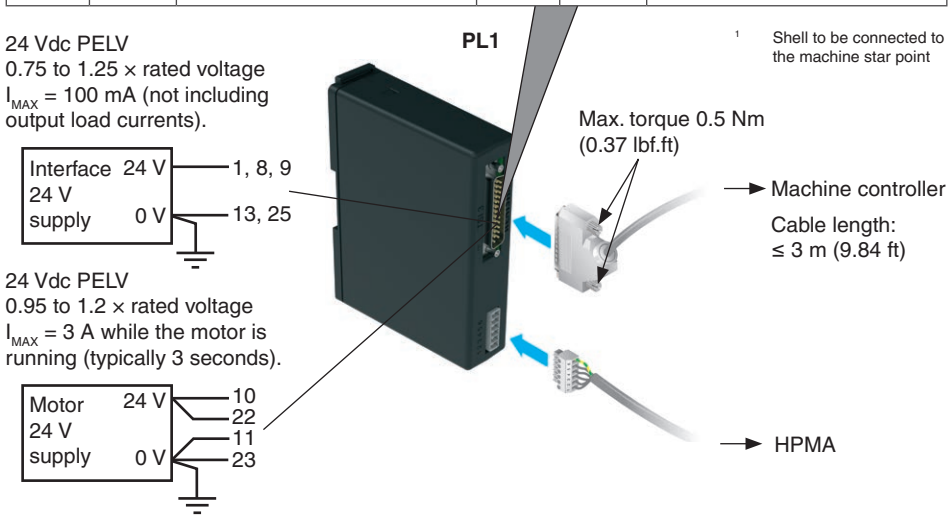
To maximise available motor current, it is recommended that the motor supply cable should be kept to a minimal length.

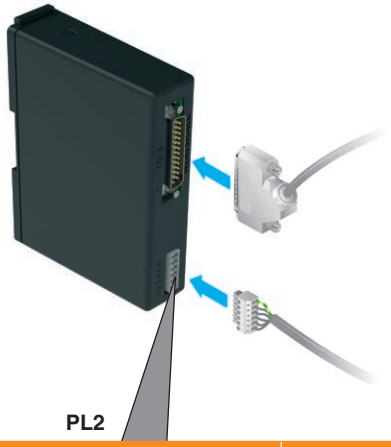
[1] When connected to a positive earth machine, V_M and V_{IF} need to be connected to the machine ground star point.

V_{IF} = 24 Vdc PELV 0.75 to 1.25 × rated voltage. This supplies the interface.
I_{IF} = 100 mA maximum (not including output load currents).
V_M = 24 Vdc PELV 0.95 to 1.2 × rated voltage. This supplies the motor drive.
I_M = 3 A maximum, while the motor is running (typically 3 seconds).
Circuit protection: power supply protected against overcurrent and reverse connection.

TSI 3-C interface connections

Pin	Function		Pin	Function	
Shell [1]		SCR	18		ARC (15 Vdc to 30 Vdc)
1		Interface 24 Vdc supply (V_{IF})	25		Input COM
6		ARO (NO)	19		MRC (15 Vdc to 30 Vdc)
8			25		Input COM
7		MRO (NO)	12		Probe status (NC)
9			20		Probe COM
10, 22		Motor 24 Vdc supply (V_M)	21		Probe status (NO)
11, 23		Motor 0 Vdc (0 V_M)	24		Probe inhibit (INH) (15 Vdc to 30 Vdc)
13		Interface 0 Vdc (0 V_{IF})	25		Input COM

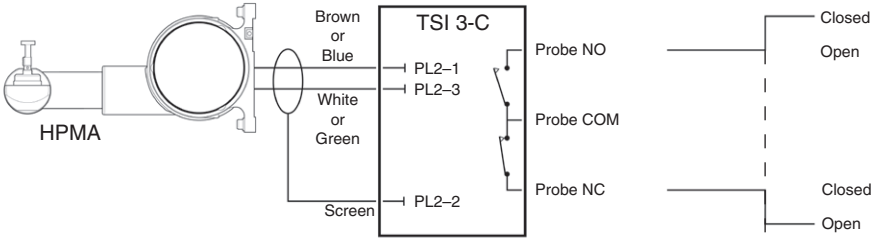




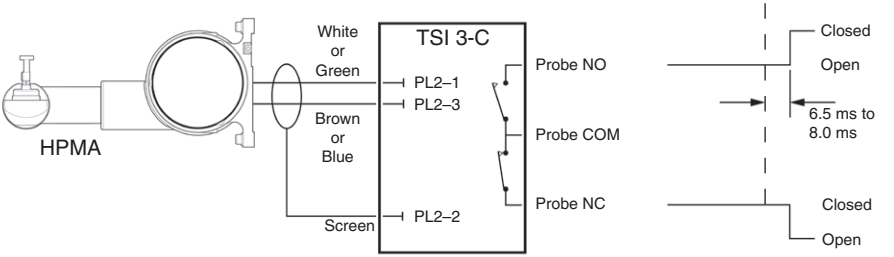
		Rear exit version		Side exit version	
Pin	Function	Standard	Trigger delay	Standard	Trigger delay
1	Probe +	Brown	White	Blue	Green
2	SCR	Screen	Screen	Grey/Black	Grey/Black
3	Probe –	White	Brown	Green	Blue
4	Not connected	Blue	Blue	Not connected	Not connected
5	Motor +	Black	Black	Red	Red
6	Motor –	Grey	Grey	Yellow	Yellow

TSI 3-C probe trigger delay

Configuration for DELAY OFF
Brown/White (rear exit) or Blue/Green (side exit)

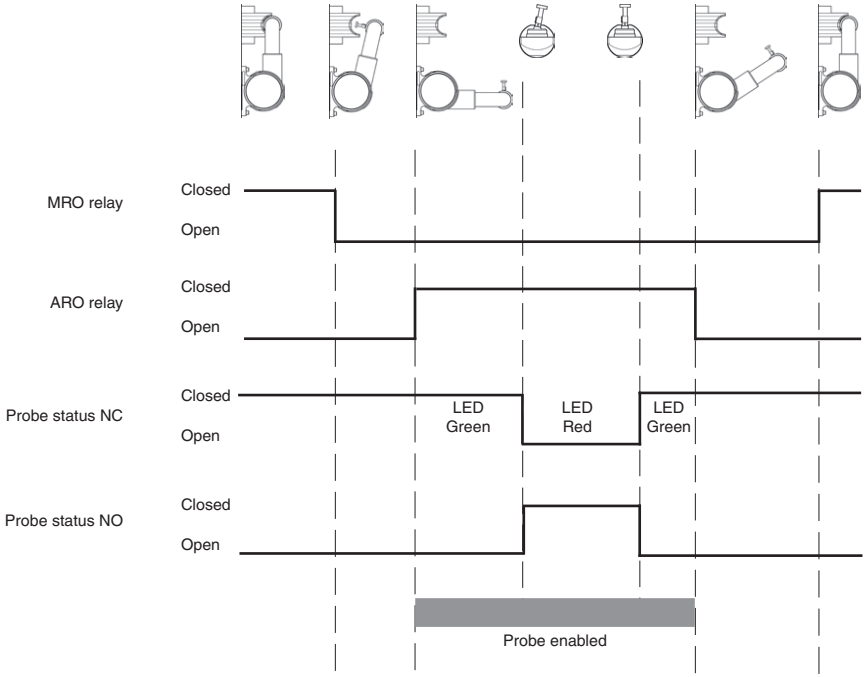


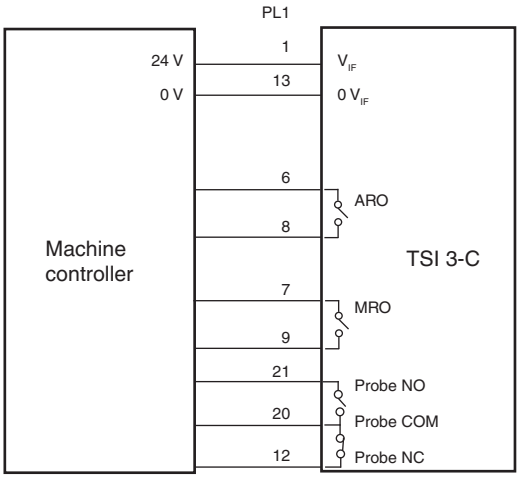
Configuration for DELAY ON
Brown/White (rear exit) or Blue/Green (side exit)



NOTE: See “TSI 3-C interface connections” on **page 48** for more information on motor wiring instructions.

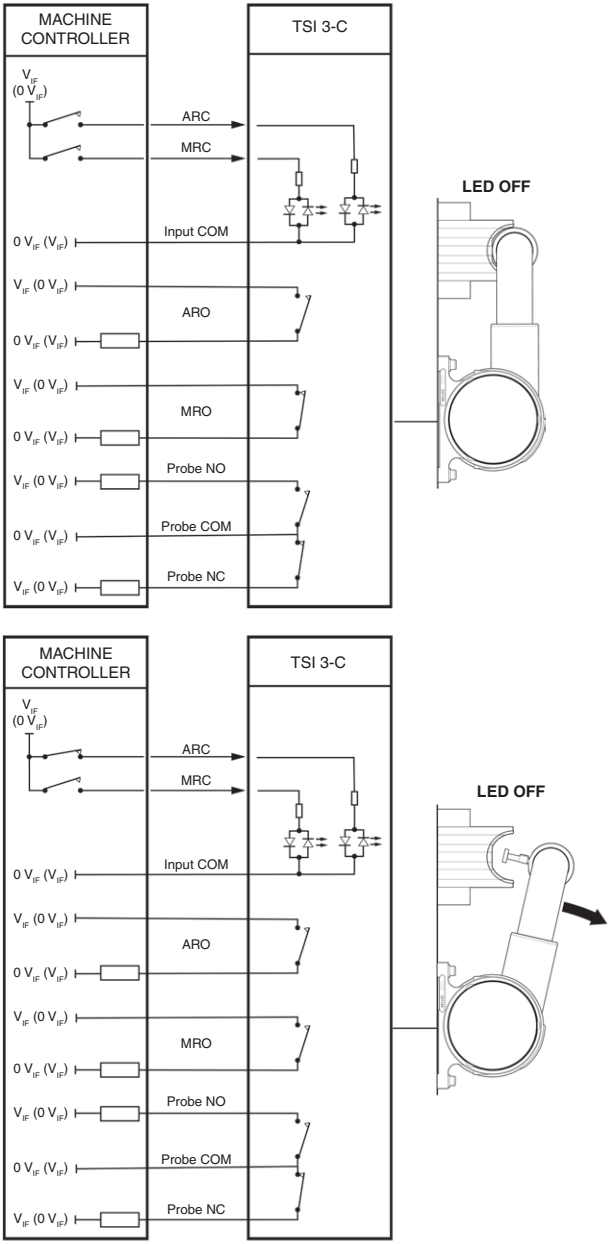
TSI 3-C standard wiring for probe output

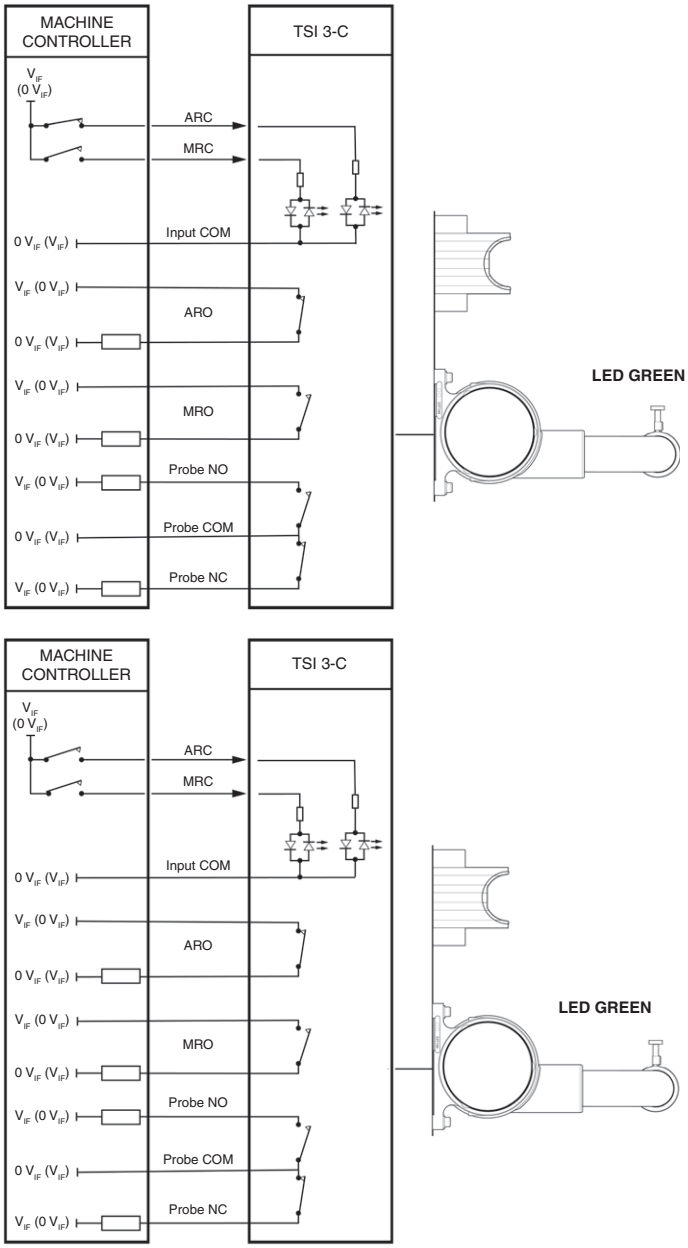


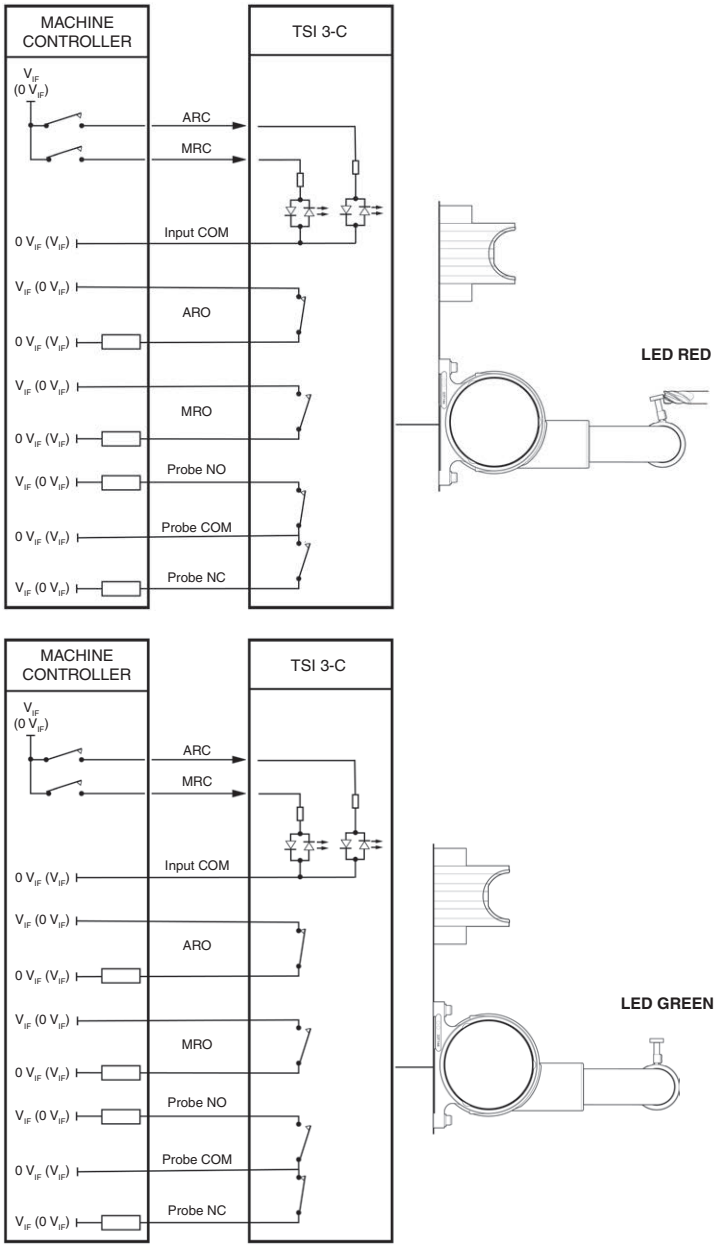


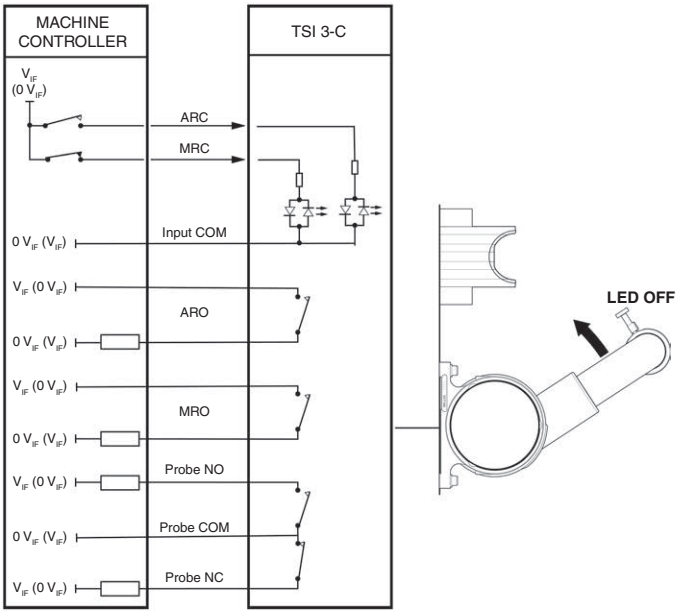
TSI 3-C system operation

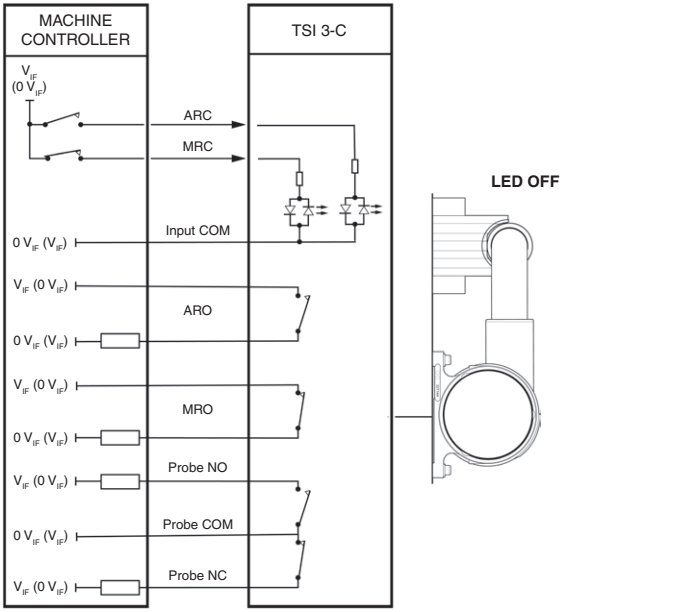
Shown as “active high” (with “active low” shown in brackets).

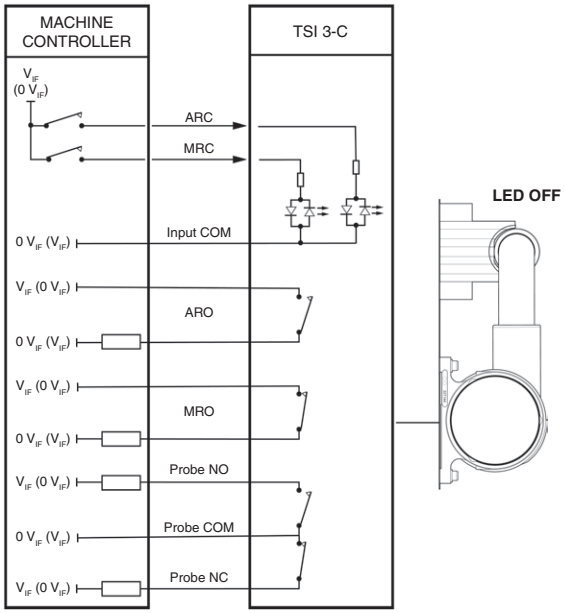



MACHINE CONTROLLER
TSI 3-C
V_{IF} (0 V_{IF})
ARC
MRC
Input COM
ARO
MRO
Probe NO
Probe COM
Probe NC
0 V_{IF} (V_{IF})
V_{IF} (0 V_{IF})
LED GREEN
MACHINE CONTROLLER
TSI 3-C
V_{IF} (0 V_{IF})
ARC
MRC
Input COM
ARO
MRO
Probe NO
Probe COM
Probe NC
0 V_{IF} (V_{IF})
V_{IF} (0 V_{IF})
LED GREEN


MACHINE CONTROLLER
TSI 3-C
V_{IF} (0 V_{IF})
ARC
MRC
Input COM
0 V_{IF} (V_{IF})
V_{IF} (0 V_{IF})
ARO
MRO
Probe NO
Probe COM
Probe NC
LED RED
MACHINE CONTROLLER
TSI 3-C
V_{IF} (0 V_{IF})
ARC
MRC
Input COM
0 V_{IF} (V_{IF})
V_{IF} (0 V_{IF})
ARO
MRO
Probe NO
Probe COM
Probe NC
LED GREEN

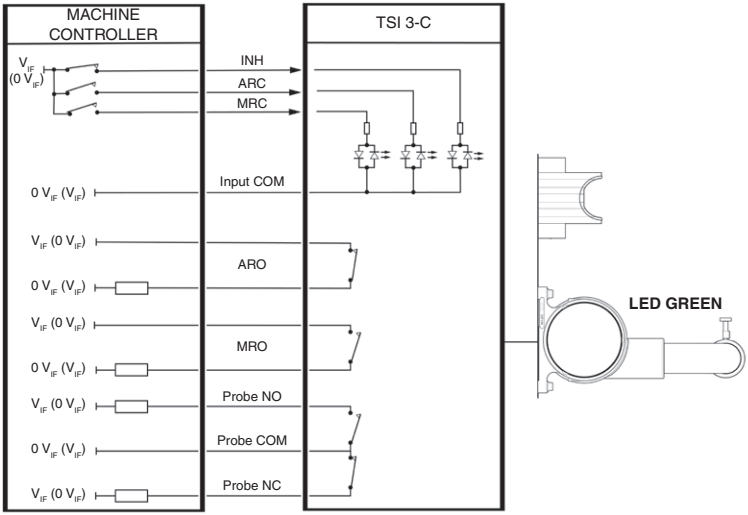

MACHINE CONTROLLER
TSI 3-C
V_{IF} (0 V_{IF})
ARC
MRC
0 V_{IF} (V_{IF})
Input COM
V_{IF} (0 V_{IF})
ARO
0 V_{IF} (V_{IF})
V_{IF} (0 V_{IF})
MRO
0 V_{IF} (V_{IF})
V_{IF} (0 V_{IF})
Probe NO
0 V_{IF} (V_{IF})
Probe COM
V_{IF} (0 V_{IF})
Probe NC
LED OFF

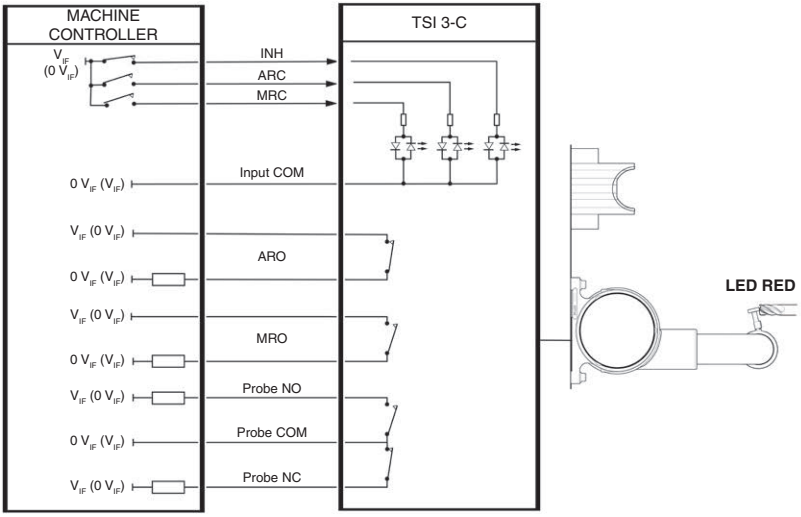

MACHINE CONTROLLER
TSI 3-C
V_{IF} (0 V_{IF})
ARC
MRC
0 V_{IF} (V_{IF})
Input COM
V_{IF} (0 V_{IF})
ARO
0 V_{IF} (V_{IF})
V_{IF} (0 V_{IF})
MRO
0 V_{IF} (V_{IF})
V_{IF} (0 V_{IF})
Probe NO
0 V_{IF} (V_{IF})
Probe COM
V_{IF} (0 V_{IF})
Probe NC
LED OFF


MACHINE CONTROLLER
TSI 3-C
V_{IF} (0 V_{IF})
ARC
MRC
LED OFF
Input COM
0 V_{IF} (V_{IF})
V_{IF} (0 V_{IF})
ARO
0 V_{IF} (V_{IF})
V_{IF} (0 V_{IF})
MRO
0 V_{IF} (V_{IF})
Probe NO
V_{IF} (0 V_{IF})
Probe COM
0 V_{IF} (V_{IF})
Probe NC
V_{IF} (0 V_{IF})

TSI 3-C probe inhibit

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



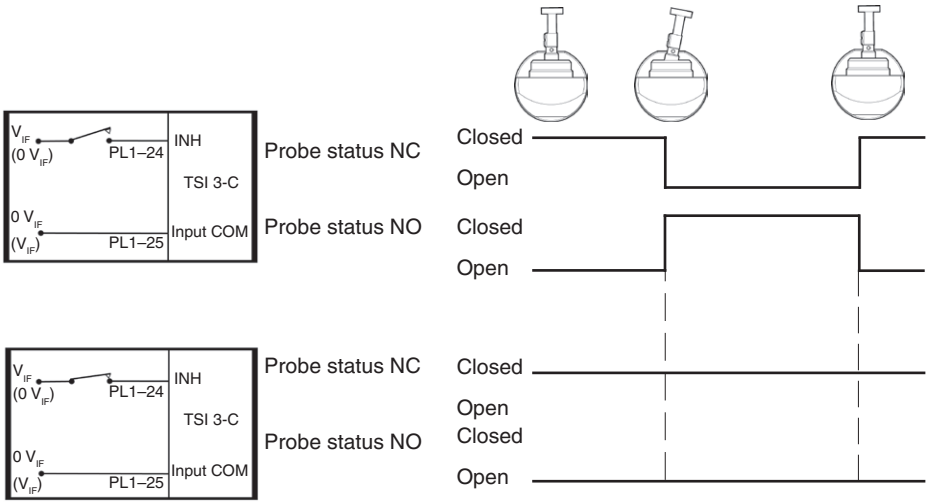


TSI 3-C inhibit inputs

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

NOTE: The inhibit input is not polarity sensitive.

Apply a voltage of 18 Vdc to 30 Vdc across PL1-24 and PL1-25 to activate. The inhibit input presents a load of 12.5 mA max. Probe inhibit disables the probe outputs.



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

TSI 3-C system inputs and outputs

Input specification

INH	}	Opto isolated.
ARC		12.5 mA max. @ 30 V.
MRC		30 V max.
Input COM		Activation voltage: 15 Vdc to 30Vdc.

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 “TSI 3-C interface connections” on **page 48**.

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.

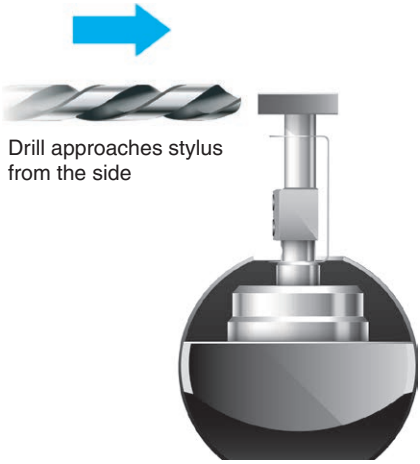
Whilst the spindle/stylus relationship will not change under normal conditions, there are certain circumstances under which you should redatum the tool setting probe:

- 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.



Rotating tool length setting (for driven tools)

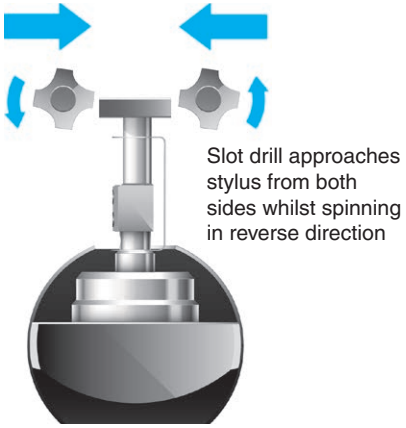
Suitable for tools whose cutting edges are located around their circumference, for example, slot drills. As with static length setting, rotating length setting involves moving the tip of a tool to contact the stylus but doing so while rotating, and doing so in the opposite direction to that which is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



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.
A fault-finding section for assisting the user in diagnosing faults begins on **page 68**.

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

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:

Download on the App Store

GET IT ON Google Play

HPMA 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 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.

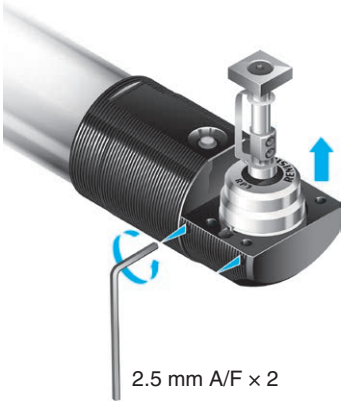
Use the table below to determine how frequently you should recalibrate your HPMA.

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

RP3 probe removal

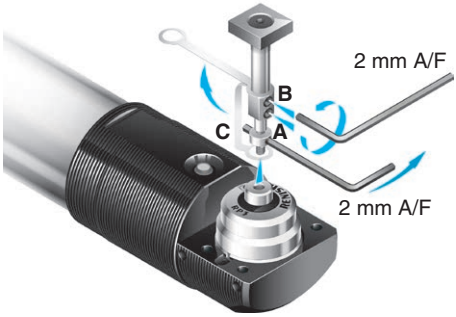
CAUTION: Ensure the area around the probe is dry and free of swarf and coolant before removing the probe.

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.



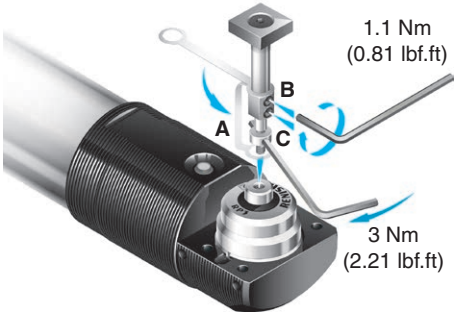
Stylus and break stem removal

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 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.

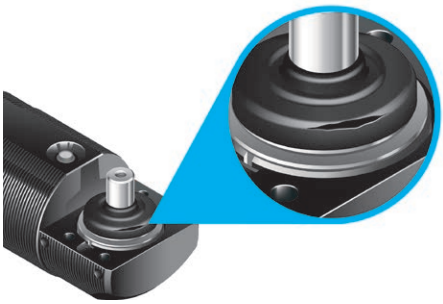
Cleaning and diaphragm inspection

1. Leaving the probe 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.



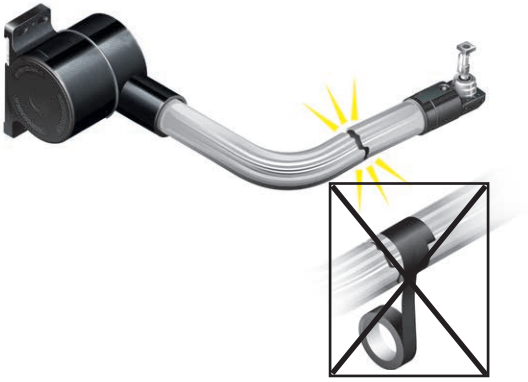
Fitting the cover

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

HPMA inspection

Periodically inspect the arm for signs of damage.

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 and surrounding areas with a brush to prevent swarf build-up, taking care not to push debris into the seals or between the HPMA and its mounting surface.

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

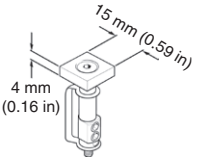
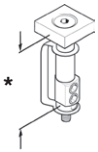
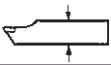
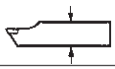
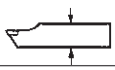
Fault-finding

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.	Minimise machine and HPMA 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 or TSI 3-C not responding.	Remove power from TSI 3 or TSI 3-C (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 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 to the arm” on **page 30**).
	Probe status or four-wire output not received by machine controller.	Check machine controller inputs/outputs. Check electrical connections.

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 base fixing kit.
Front cover	A-2197-0006	RP3 probe front cover kit.
Spring seal	M-2275-0549	Spring seal for HPMA base.
Probe pockets	A-2275-0098	HPMA arm probe pocket long.
	A-2275-0099	HPMA arm probe pocket short.
TSI 3-C	A-2181-2239	TSI 3-C interface unit with DIN rail mounting.
TSI 3	A-2181-0465	TSI 3 interface unit with DIN rail mounting.
RP3 probe	A-2197-0004	RP3 probe assembly.
Cables	A-2181-1080	2 m SCR HPMA cable, 5 W M12 socket.
	A-2181-1085	5 m SCR HPMA cable, 5 W M12 socket.
	A-2181-1090	10 m SCR HPMA cable, 5 W M12 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 and TSI 3 / TSI 3-C	H-2000-2037	Data sheet: HPMA and TSI 3 / TSI 3-C motorised arm and interface.
HPMA-X and TSI 3-X	H-6671-8200	Data sheet: HPMA-X and TSI 3-X motorised arm and interface.
HPMA-X and TSI 3-X	H-6671-8500	Installation and user guide: 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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