Installation guide
M-9693-9717-04-C

RENISHAW
apply innovation™

ATOM™ rotary encoder system

www.renishaw.com/atomdownloads

#renishaw

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Contents

Legal notices

Patents

Features of Renishaw's encoder systems and similar products are the subjects of the following patents and patent applications:

CN101300463B	EP1946048	JP5017275	US7624513B2
CN101310165B	EP1957943	US7839296	WO2014096764

Terms and conditions and 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.

Declaration of Conformity

Renishaw plc hereby declares that the encoder system is in compliance with the essential requirements and other relevant provisions of:

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

The full text of the declaration of conformity is available at: www.renishaw.com/productcompliance.

Compliance

Federal Code Of Regulation (CFR) FCC Part 15 – RADIO FREQUENCY DEVICES

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 his own expense.

47 CFR Section 15.27

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

Supplier's Declaration of Conformity

47 CFR § 2.1077 Compliance Information

Unique Identifier: ATOM

Responsible Party - U.S. Contact Information
Renishaw Inc.
1001 Wesemann Drive
West Dundee
Illinois
IL 60118
United States
Telephone number: +1 847 286 9953
Email: usa@renishaw.com

ICES-003 – Information Technology Equipment (including Digital Apparatus)

This ISM device complies with Canadian ICES-003(A).

Cet appareil ISM est conforme à la norme ICES-003(A).

ATOM FPC readhead and ACi

The ATOM FPC readhead and ACi have been designed as system components and to be compliant with EMC regulations for products of their type. Care must be taken with shielding and grounding arrangements to ensure EMC performance once installed. It is the system integrator's responsibility to implement, test and prove EMC compliance for the whole machine.

Intended use

The ATOM rotary encoder system is designed to measure position and provide that information to a drive or controller in applications requiring motion control. It must be installed, operated, and maintained as specified in Renishaw documentation and in accordance with the Standard Terms and Conditions or the Warranty and all other relevant legal requirements.

Further information

Further information relating to the ATOM encoder range can be found in the *ATOM™ miniature encoder system* data sheet (L-9517-9563). This can be downloaded from our website at **www.renishaw.com/atomdownloads** and is also available from your local Renishaw representative.

Packaging

The packaging of our products contains the following materials and can be recycled.

Packaging Component	Material	ISO 11469	Recycling Guidance
Outer box	Cardboard	Not applicable	Recyclable
	Polypropylene	PP	Recyclable
Inserts	Low density polyethylene foam	LDPE	Recyclable
	Cardboard	Not applicable	Recyclable
Bags	High density polyethylene bag	HDPE	Recyclable
	Metalised polyethylene	PE	Recyclable

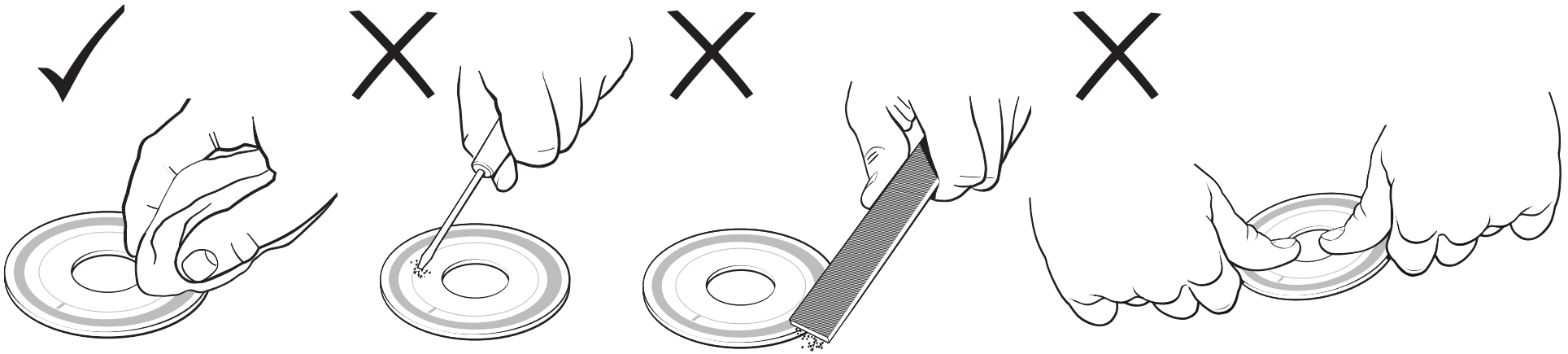
REACH regulation

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**

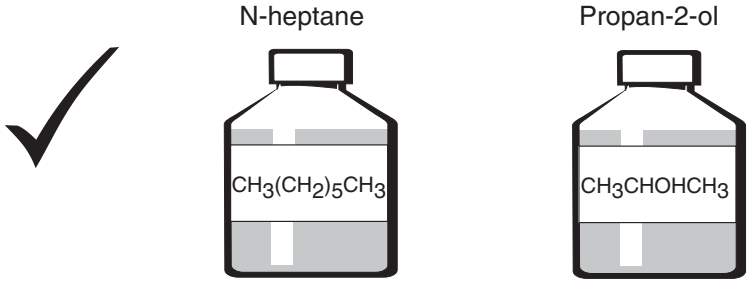
Disposal of waste electrical and electronic equipment

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

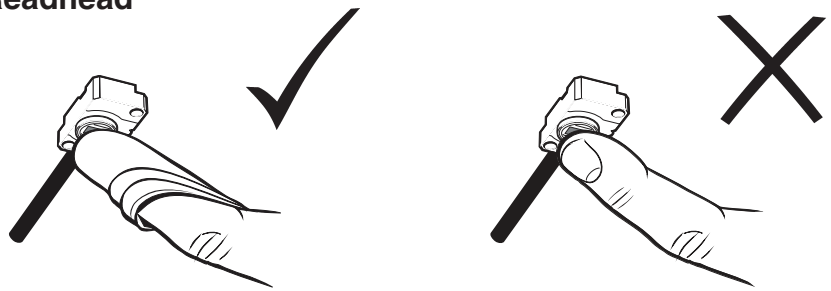
Storage and handling



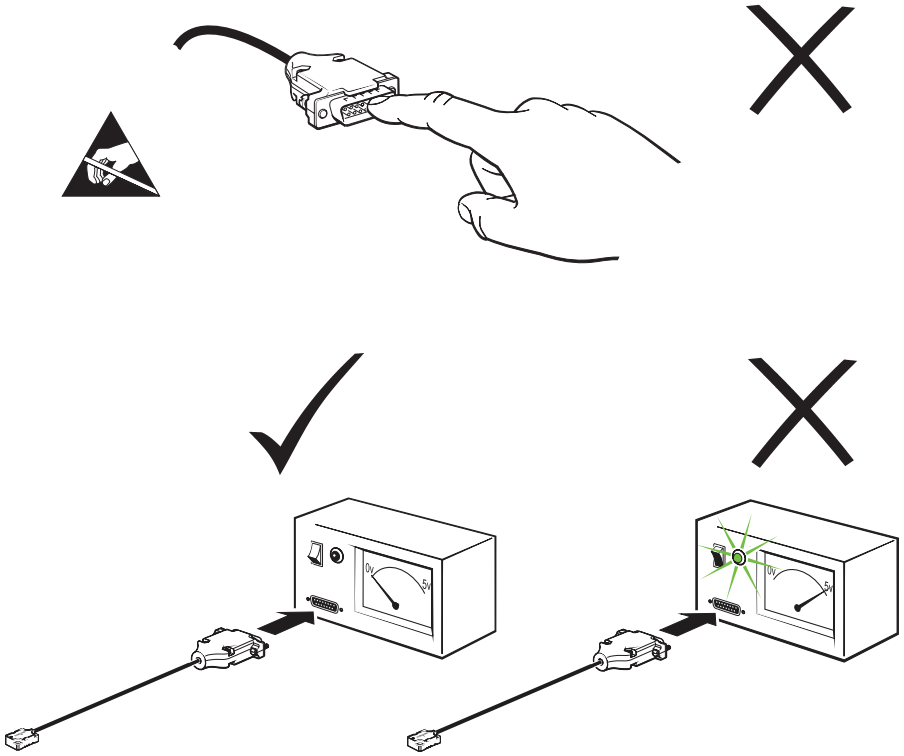
Scale and readhead



Readhead



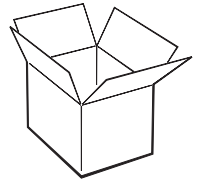
Readhead and interface

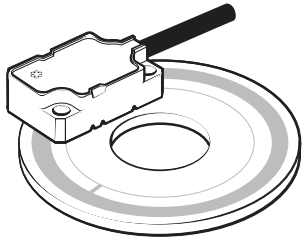


Temperature

Storage	
System	–20 °C to +70 °C

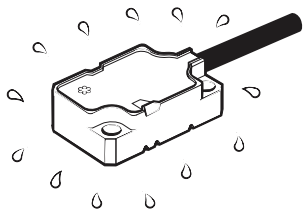
Operating	
System	0 °C to +70 °C

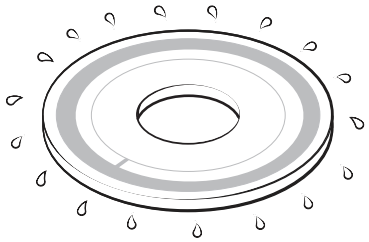




Humidity

95% relative humidity (non-condensing) to IEC 60068-2-78

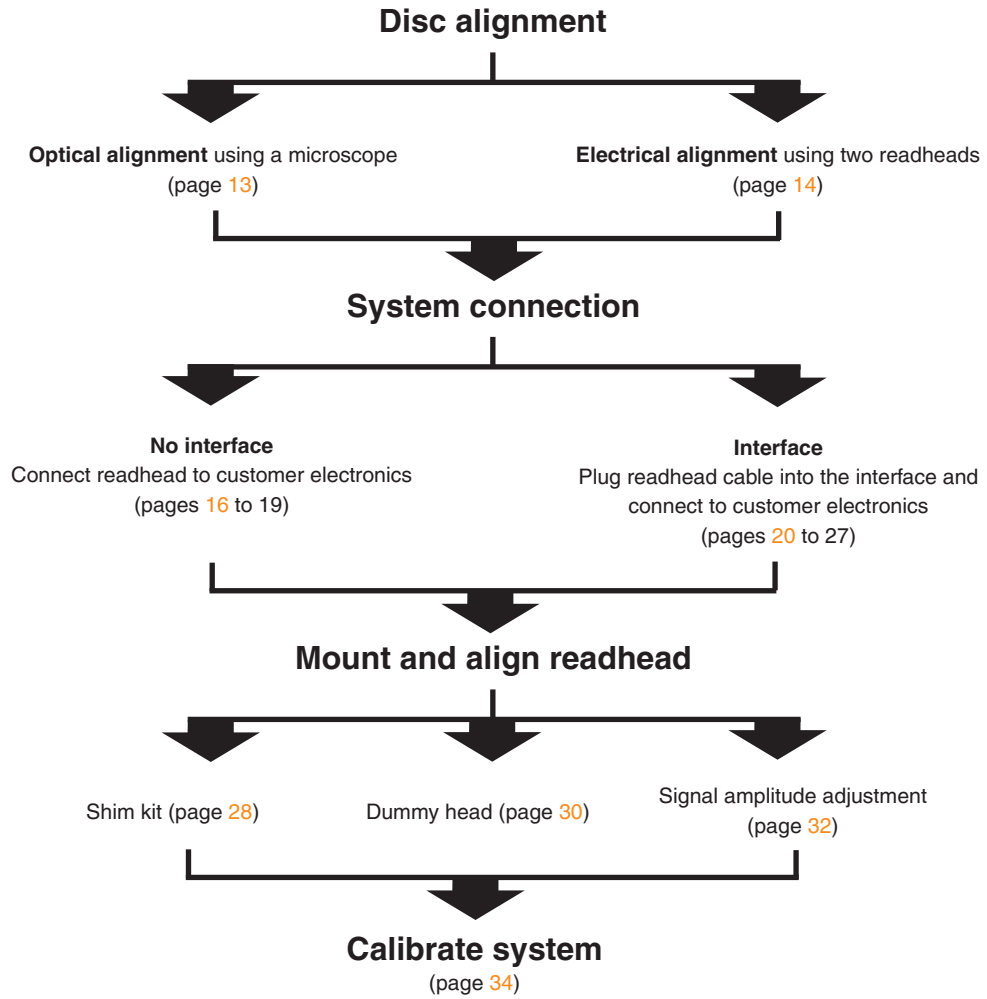




ATOM system installation overview

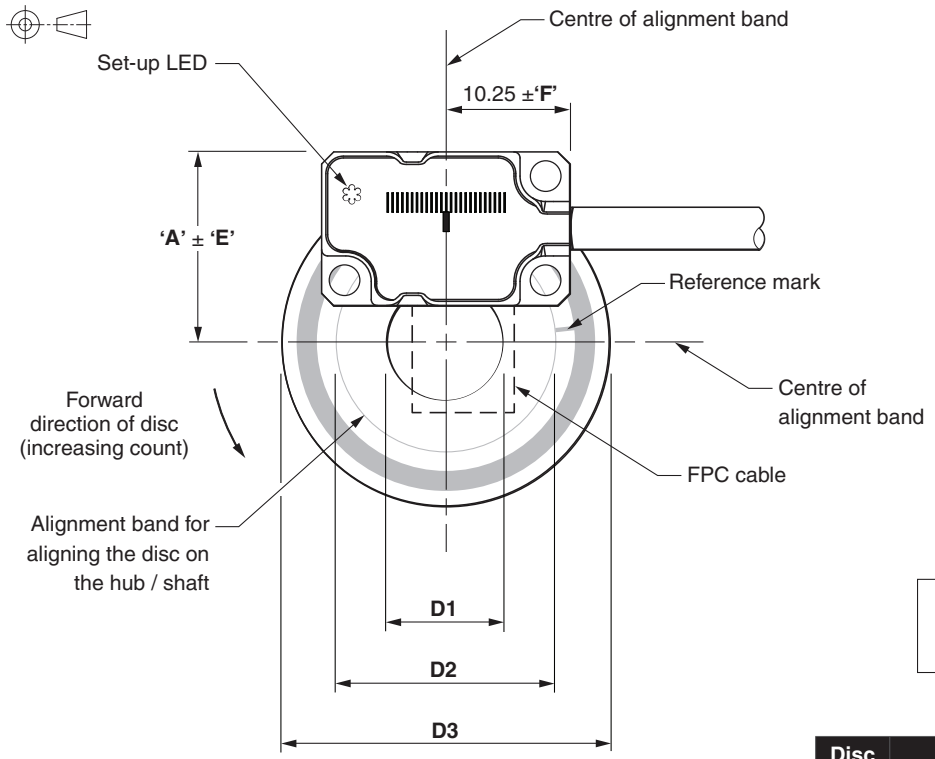
This section gives an overview of the steps involved in installing, setting-up and calibrating an ATOM system. More detailed information is contained within the rest of the document. For information on designing the readhead and disc into the system refer to the detailed installation drawings and 3D models at **www.renishaw.com/atomdownloads** or contact your local Renishaw representative. For information on the ATOM product range refer to the *ATOM™ miniature encoder system* data sheet (Renishaw part no. L-9517-9563).

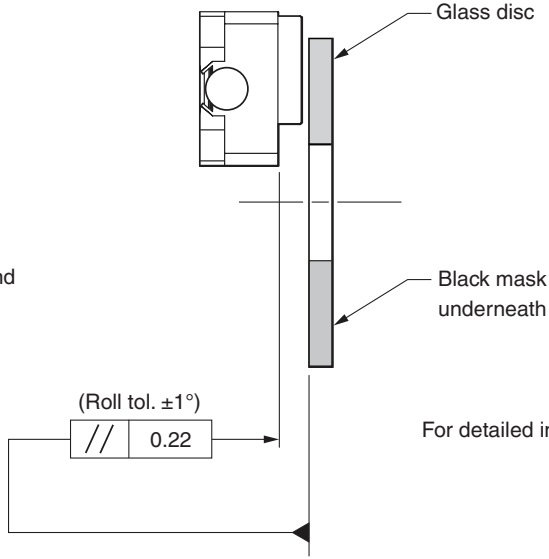
IMPORTANT: Prior to installing the readhead and disc, installation drawings should be reviewed to ensure the correct orientation of the readhead relative to the disc.



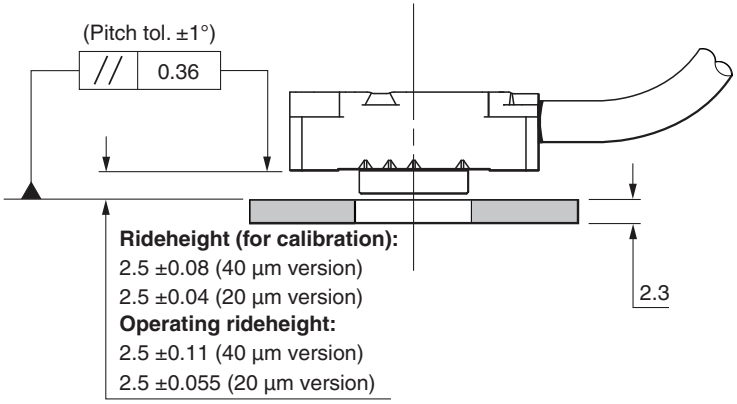
RCDM rotary disc installation drawing

Dimensions and tolerances in mm





For detailed installation drawings, including tolerances, refer to
www.renishaw.com/atomdownloads



Disc size (mm)	Line count		D1	D2	D3	Optical diameter (mm)	A (mm)	Radial tolerance E (mm)		Longitudinal tolerance F (mm)	
	20 µm version	40 µm version						20 µm version	40 µm version	20 µm version	40 µm version
17	-	1 024	3.275	8.10	16.9	13.04	10.63	-	0.1	-	0.1
20	-	1 250	3.275	11.00	19.9	15.92	12.07	-	0.1	-	0.1
25	-	1 650	6.46	16.10	24.9	21.01	14.62	-	0.125	-	0.075
27	-	1 800	9.625	18.00	26.9	22.92	15.57	-	0.125	-	0.075
30	4 096	2 048	12.8	21.15	29.9	26.08	17.15	0.1	0.125	0.075	0.125
36	5 000	2 500	12.8	26.90	35.9	31.83	20.03	0.125	0.175	0.075	0.2
50	7 200	3 600	25.5	40.90	49.9	45.84	27.03	0.125	0.2	0.075	0.2
56	8 192	4 096	25.5	47.25	55.9	52.15	30.19	0.125	0.2	0.1	0.225
68	10 000	5 000	25.5	58.55	67.9	63.66	35.94	0.15	0.2	0.125	0.3
108	16 384	8 192	50.9	99.20	107.9	104.30	56.26	0.2	0.2	0.225	0.3

Mounting the disc

Mounting surface design

The recommended mounting surface (hub/shaft) profile must allow for the following features:

- Overspill areas either side of the adhesive mounting surface for excess adhesive to run-off.
- Sufficient clearance between the disc ID and hub/shaft to allow correct alignment.
- A small height clearance between the disc contact surface and the adhesive mounting surface to allow application of a controlled thin film of adhesive.
- A maximum outer diameter of the disc contact surface to ensure it is not touching the black mask on the reverse of the disc. See the table below for dimensions.

Disc size (mm)	17 [1]	20	25	27	30	36	50	56	68	108
Maximum OD of disc contact surface (mm)	-	9.52	14.2	16.12	19.28	25.04	39.04	45.36	56.66	97.3

Contact your local Renishaw representative for more information on designing the mounting surface, suggested materials and adjustment methods.

[1] 17 mm disc can be mounted on black mask due to space constraints. All other size discs the black mask must not impede the disc contact surface.

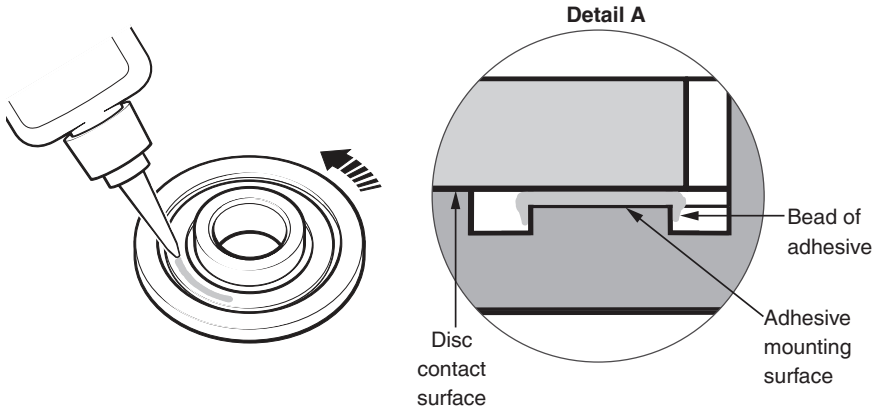
Gluing the disc

There are 2 recommended types of adhesives for bonding the disc to the hub/shaft:

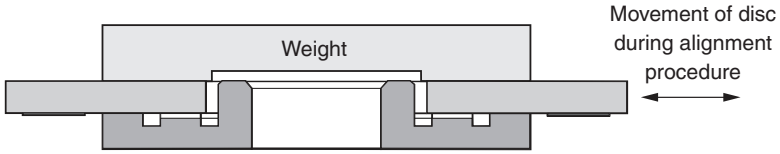
- UV cure adhesive (such as Dymax OP4, gel version)
- Room cure 2-part epoxy (such as Araldite 2014)

1. Apply a thin bead of adhesive to the adhesive mounting surface.

   It should be of sufficient quantity only to fill the gap between the hub and disc. Small amounts may run off into adhesive overspill areas, however these areas should not be filled with adhesive.

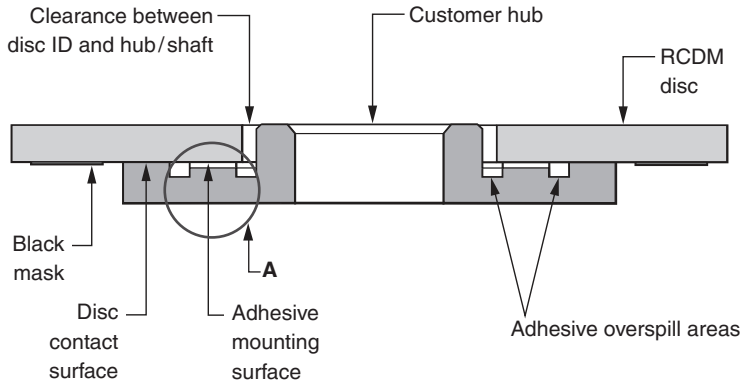


2. Using a weight (or similar) ensure the disc touches the hub/shaft over the entire disc contact surface.



3. Align the disc so it is concentric with the hub/shaft.
4. Cure the adhesive.

Cross section of typical hub and disc assembly



Aligning the disc

There are two possible ways to accurately align the disc to minimise eccentricity:

- Optical alignment using a microscope
- Electrical alignment using two readheads

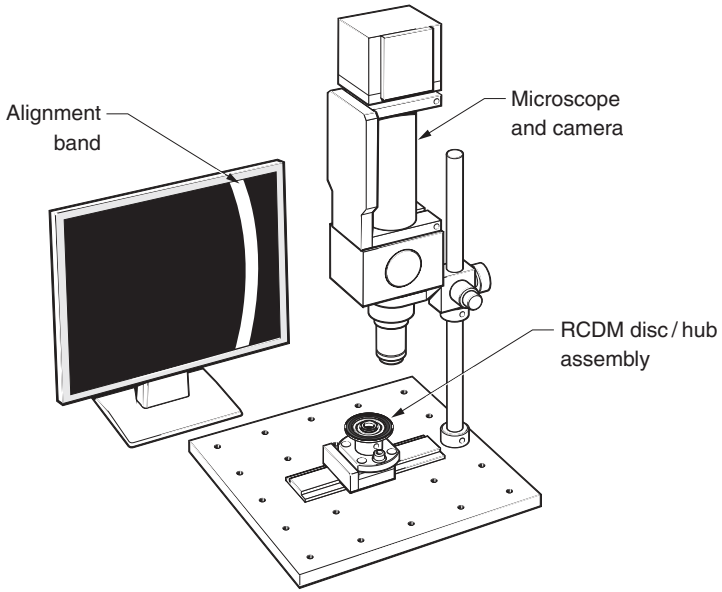
The method chosen to align the disc on the system depends upon the application and available space, etc. It should be noted that the graduations and alignment band are accurately concentric with each other but not with the glass disc. The following sections outline how to align the disc using these methods.

NOTE: The disc should not be mounted on the black mask on the reverse of the disc (apart from 17 mm disc).

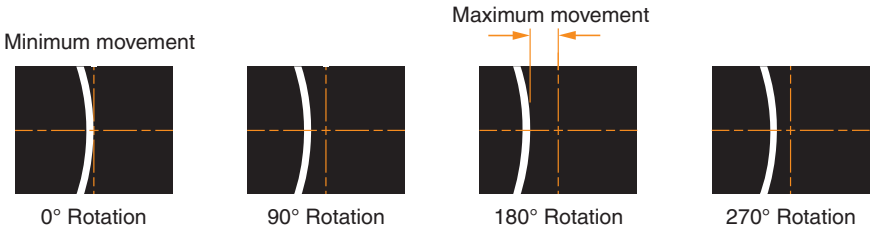
Optical alignment

This method uses a microscope, which could be connected to a camera, to monitor the movement of the alignment band as the disc is rotated.

1. Position the microscope/camera over the alignment band on the disc so that any displacement of the alignment band due to rotation of the disc/hub assembly can be observed.



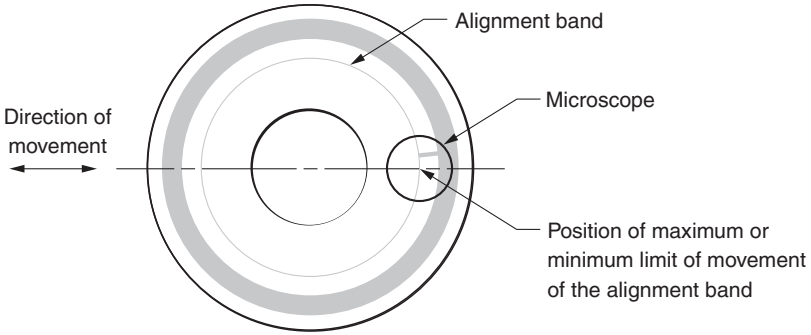
2. Rotate the disc/hub assembly and observe the maximum and minimum limits of movement of the alignment band as shown below.



3. Note the axis position at the limits of movement.
4. Rotate the disc so either of these limits of movement is located under the microscope.
5. Gently move the disc relative to the hub in a radial direction so the alignment band moves half way between the limits of movement.

NOTE: The alignment band is 30 µm wide.

Position of disc at limit of movement of alignment band.



6. Rotate the assembly and repeat steps 3-5 until the total alignment band movement is within the design specifications.
7. Cure the adhesive.
8. Re-check the run-out.

Contact your local Renishaw representative for more information on aligning the disc.

Electrical alignment

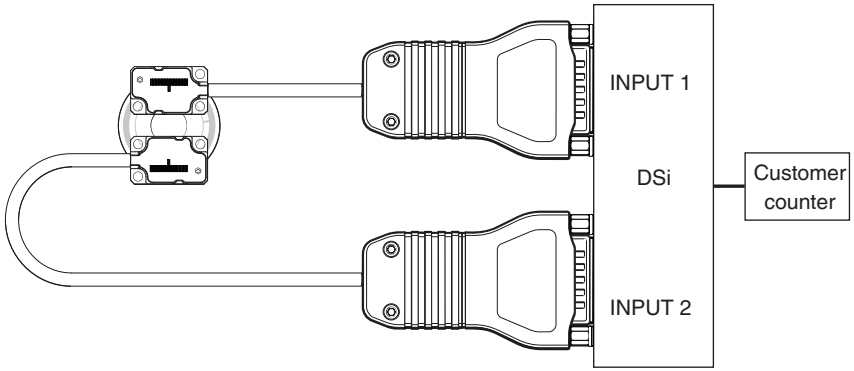
This method involves monitoring the output signals of two readheads mounted 180 degrees apart and adjusting the disc to minimise the difference in count between the two heads.

NOTE: Due to spacing it is not possible to use this method on discs smaller than 22 mm diameter.

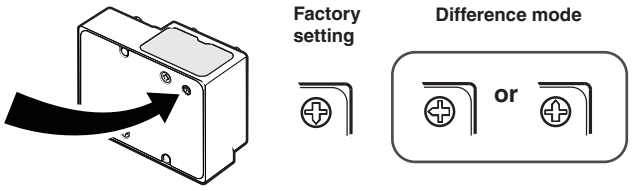
This requires:

- A DSi interface
- 2 × Ri or Ti interfaces
- A digital counter

The clock frequency of the DSi, interfaces and digital counter must be matched to ensure there is no miscounting. For more information on choosing appropriate DSi and interfaces for your system contact your local Renishaw representative. For more information on the DSi refer to the *TONiC DSi dual readhead rotary encoder system* data sheet (L-9517-9466).



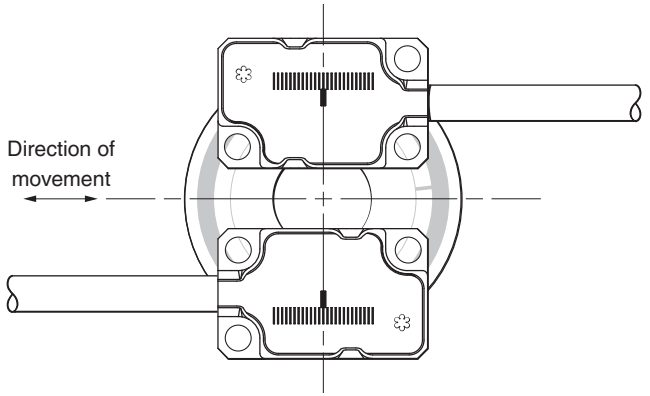
1. Connect system as shown on previous page.
2. Set the orientation switch on the reverse of the DSi to 'difference' mode.



3. Power the system.
4. Restore factory defaults on both ATOM systems by pressing and holding the CAL button on both interfaces whilst switching the system on. This can be done individually or whilst the interfaces are plugged into the DSi. See 'Restoring factory defaults' on page 36 for more information.
5. Using a custom designed bracket adjust both readheads to maximise the signal strength for a complete rotation of the axis (readhead set-up LED should be Green on both readheads)
6. Rotate the axis until the count displayed on the customer counter is at its minimum.

NOTE: If the count continues to increase then the orientation switch on the DSi is not in the correct position.

7. Rotate the axis to the minimum count position and reset the counter to zero.
8. Rotate the axis until a maximum count is displayed. This should be ~180° from the position when the count is minimum.
9. Gently move the disc relative to the hub in a radial direction at 90° to the readheads, as shown below, until the count displayed on the customer counter is reduced by approximately half.



10. Repeat steps 6 to 9 until the difference in (maximum count) – (minimum count) is within the design specifications.
11. Cure the adhesive.
12. Recheck the run-out.

Contact your local Renishaw representative for more information on aligning the disc.

System connection

Readhead only (no interface)

The ATOM readhead is available in several variants:

- Cable variant with a 15 way D-type connector
- Cable variant with interboard connector
- FPC variant

None of these readhead variants has an integral calibration (CAL) button. Provision should be made in the customers' electronics for momentarily connecting the CAL line to 0 V to initiate the calibration routine, switch AGC on/off or restore factory defaults. See page 42 for pin-out information.

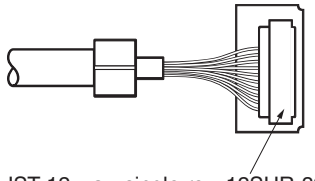
Calibration is an essential part of system set-up that optimises the incremental signals and phases the reference mark. See page 34 for information on the calibration routine.

For cable variant with interboard connector

- Ensure that the interboard connector is inserted into the connector on the customers' electronics

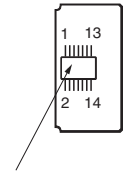
NOTE: Care should be taken to ensure correct orientation

- Use a metal clamp around the cable ferrule to ground the readhead cable and ensure continuity of the shields
- Provide appropriate strain relief
- Ensure suitable clamping to retain interboard connector to the mating connector



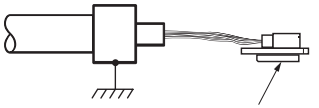
JST 12-way, single row 12SUR-32S.

JST mating connector: P-CN10-0051 (SM12B-SURS-TF).



Hirose
Interboard connector
14-way, dual row
DF23C-14DP-0.5 V

Hirose mating connector:
P-CN03-0024
(DF23-14DS-0.5 V)



Interboard connector

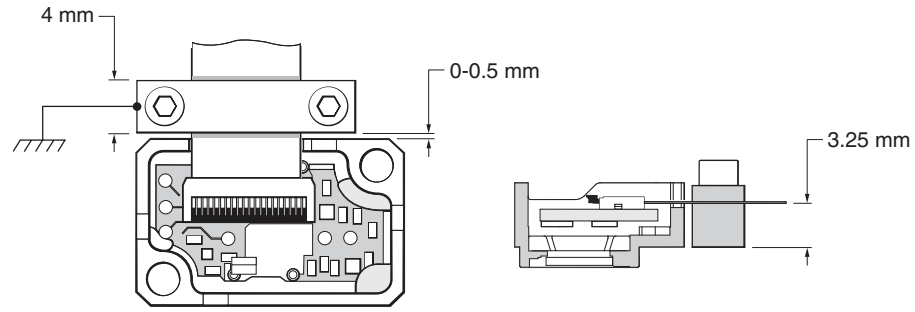
For FPC variants

Ensure that the FPC cable being used has the following specifications:

- 16 core
- Conductor pitch 0.5 mm
- Minimum exposed conductor strip length 1.5 mm
- Maximum exposed conductor strip length 2.5 mm (to ensure isolation from the body)

Contact your local Renishaw representative for more information regarding FPC design requirements.

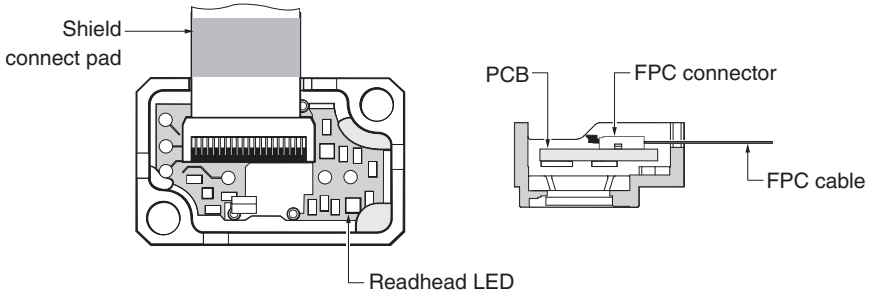
Example of strain relief



Shielding

For optimum performance:

- Ensure 100% shielding
- Ground the mounting brackets
- Ensure continuity of all shields
- Maximise the distance between the encoder and motor cables
- Provide appropriate strain relief at the readhead

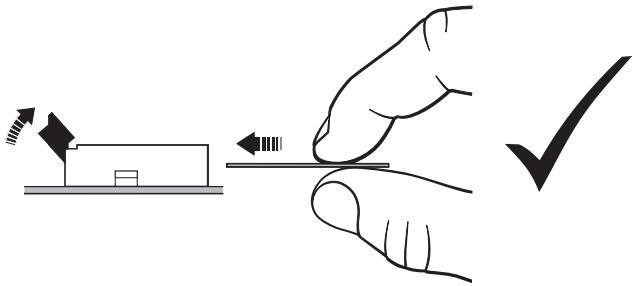


Approved ESD precautions must be followed at all times during readhead electrical connection.

NOTE: The FPC cable must be connected before fitting the readhead lid. The lid is secured by the readhead mounting screws.

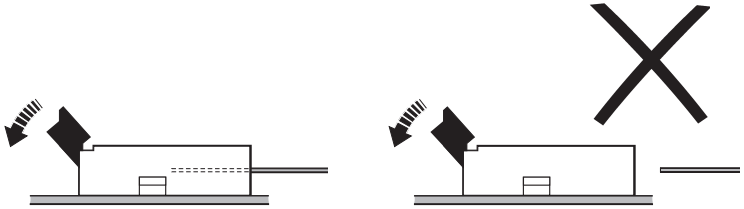
Inserting the FPC cable

1. Ensure the locking lever is up (open) before fully inserting the FPC cable into the connector.



CAUTION: Check the correct orientation of the cable before inserting into the connector. The readhead will be shipped with the connector in the open position.

2. Applying pressure to the whole locking lever, push it down to lock the FPC cable in place.



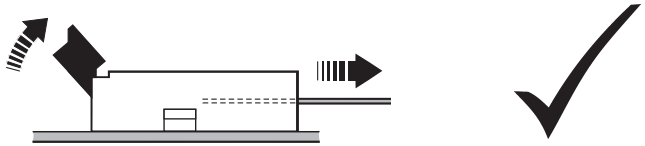
CAUTION: Do not push the locking lever down if no FPC cable is inserted as this will damage the locking mechanism.

3. When the system has been connected, proceed with 'Readhead mounting and alignment' on page 28 and 'System calibration' on page 34.

Approved ESD precautions must be followed at all times during readhead electrical connection.

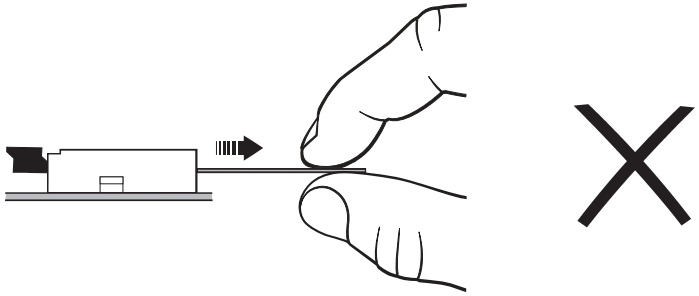
Removing the FPC cable

1. Placing your finger on the whole of the locking lever, slowly lift it up and away to disengage the locking mechanism.

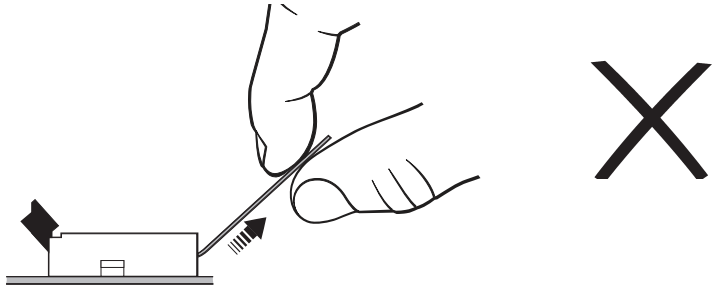


CAUTION: Do not use tools such as screwdrivers or tweezers to open the locking lever as this may cause damage to the connector or PCB.

2. Ensure locking lever is fully open before removing the FPC cable.



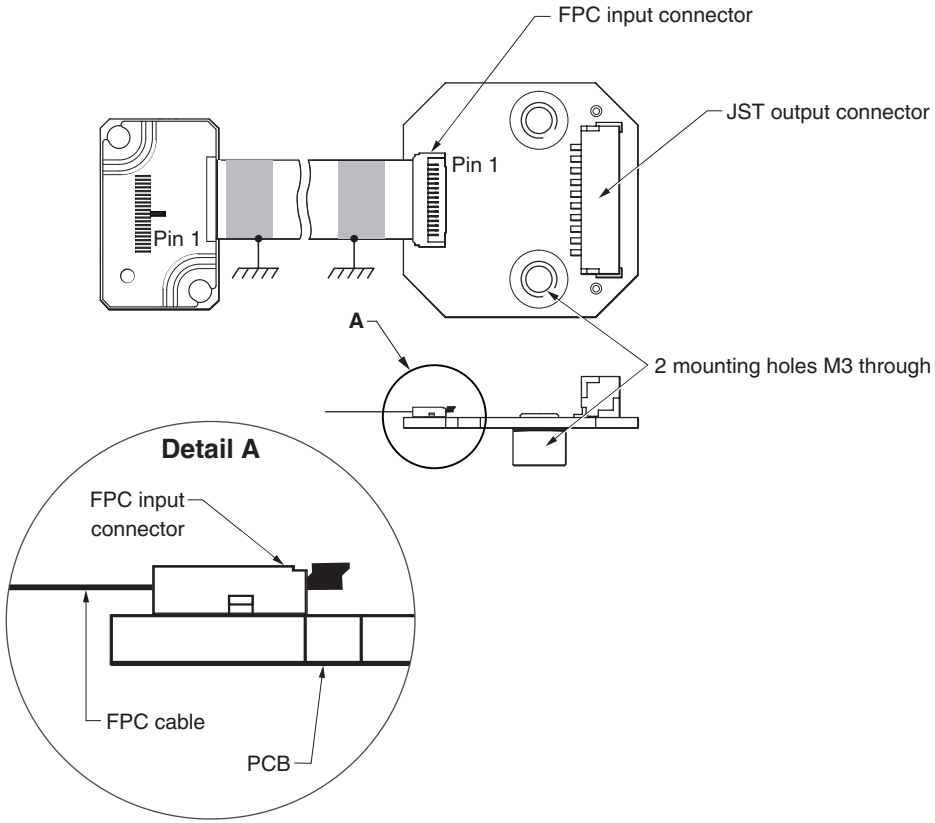
3. Pull the FPC cable straight back to remove it.



CAUTION: Do not pull upwards or sideways as this may damage the readhead.

ACi interface

FPC variant



Ensure that the FPC cable being used has the following specifications:

- 16 core
- Conductor pitch 0.5 mm
- Minimum exposed conductor strip length 1.5 mm
- Maximum exposed conductor strip length 2.5 mm (to ensure isolation from the body).

Contact your local Renishaw representative for more information regarding FPC design requirements.

Shielding

For optimum performance:

- Ensure 100% shielding
- Ground the mounting brackets, readhead and FPC cable clamp
- Ensure continuity of all shields
- Maximise the distance between the encoder and motor cables
- Provide appropriate strain relief at the readhead and interface
- The ACi should be contained within a shielded enclosure

Mounting

The ACi can be mounted to customers' system using two M3 screws or two M2.5 screws for through mounting.

Output

The output connector is a 10-way JST, GH crimp connector with 1.25 mm pitch. It is suitable for cable size 26 to 30 AWG. See page 44 for pin-out information.

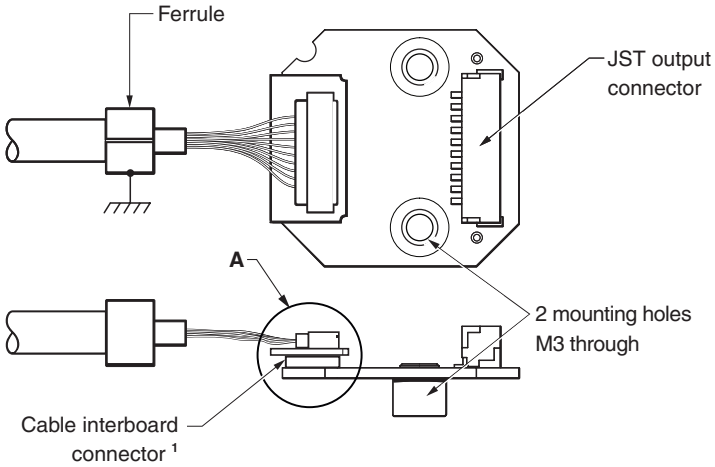
Connection

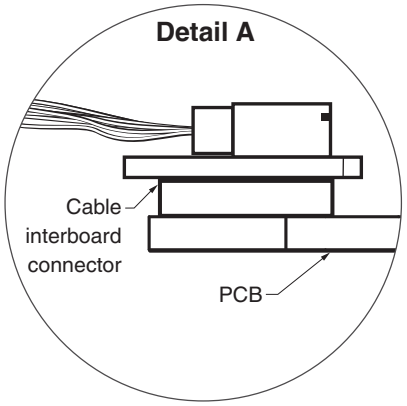
For information on inserting and removing the FPC cable to the ACi and readhead, see pages 18 and 19.

Approved ESD precautions must be followed at all times during readhead and interface electrical connection.

NOTE: The FPC cable must be connected to the readhead before fitting the lid. The lid is secured by the readhead mounting screws.

Cable variant





Shielding

For optimum performance:

- Ensure 100% shielding
- Ground the mounting brackets
- Use a metal clamp around the cable ferrule to ground the readhead cable
- Ensure continuity of all shields
- Maximise the distance between the encoder and motor cables
- Provide appropriate strain relief at the readhead and interface
- The ACi should be contained within a shielded enclosure
- Ensure suitable clamping to retain interboard connector to the mating connector

Mounting

The ACi can be mounted to customers' system using two M3 screws or two M2.5 screws for through mounting.

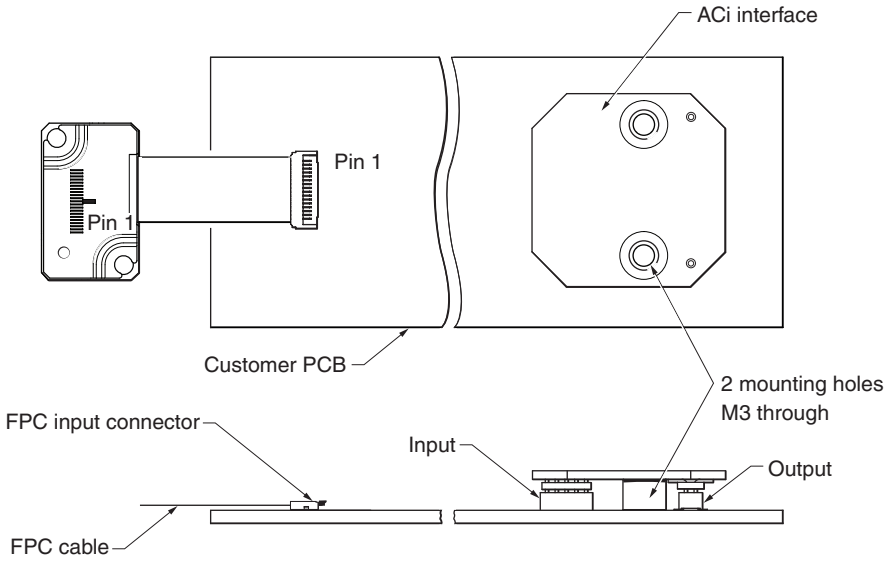
Output

The output connector is a 10-way JST, GH crimp connector with 1.25 mm pitch. It is suitable for cable size 26 to 30 AWG. See page 46 for pin-out information.

Approved ESD precautions must be followed at all times during readhead and interface electrical connection.

[1] Ensure suitable clamping to retain interboard connector on ACi.

PCB mounting: connecting an FPC variant ATOM readhead



Ensure that the FPC cable being used has the following specifications:

- 16 core
- Conductor pitch 0.5 mm
- Minimum exposed conductor strip length 1.5 mm
- Maximum exposed conductor strip length 2.5 mm (to ensure isolation from the body)

Contact your local Renishaw representative for more information regarding FPC design requirements.

Shielding

For optimum performance:

- Ensure 100% shielding
- Ground the mounting brackets, readhead and FPC cable clamp
- Ensure continuity of all shields
- Maximise the distance between the encoder and motor cables
- Provide appropriate strain relief at the readhead and interface
- The ACi should be contained within a shielded enclosure

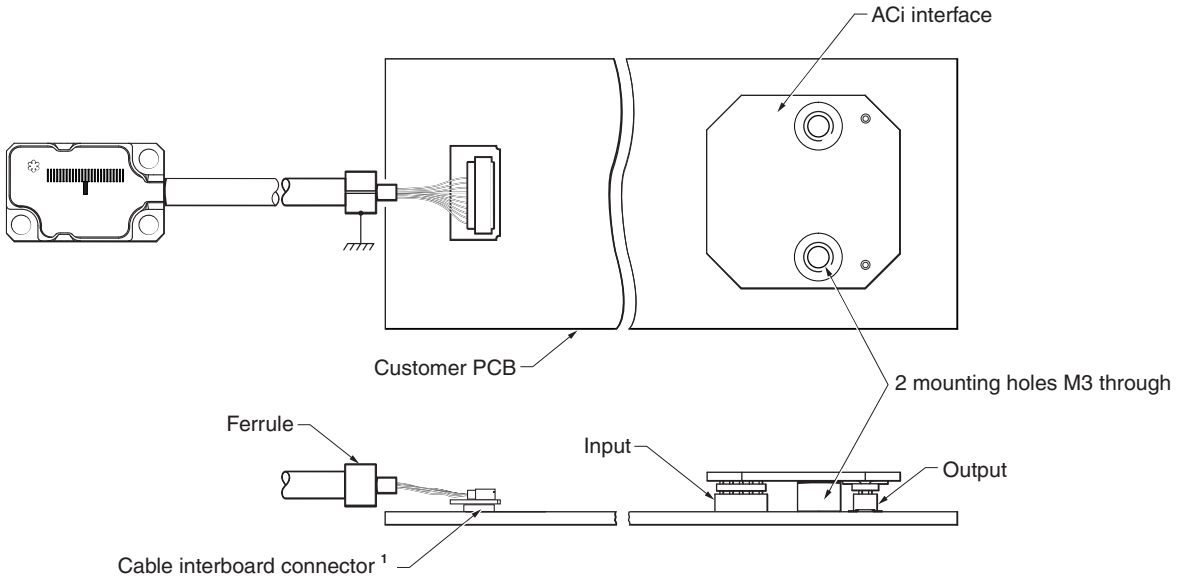
Connection

For information on inserting and removing the FPC cable to the mating socket, see pages 18 and 19.

Approved ESD precautions must be followed at all times during readhead and interface electrical connection.

NOTE: The FPC cable must be connected to the readhead before fitting the lid. The lid is secured by the readhead mounting screws.

PCB mounting: connecting a cable variant ATOM readhead



Shielding

For optimum performance:

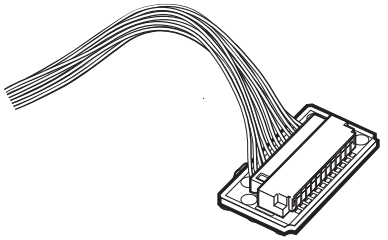
- Ensure 100% shielding
- Ground the mounting brackets
- Use a metal clamp around the cable ferrule to ground the readhead cable
- Ensure continuity of all shields
- Maximise the distance between the encoder and motor cables
- Provide appropriate strain relief at the readhead and interface
- The ACi should be contained within a shielded enclosure
- Ensure suitable clamping to retain interboard connector to the mating connector

Approved ESD precautions must be followed at all times during readhead and interface electrical connection.

[1] Ensure suitable clamping to retain interboard connector on PCB.

Ri interface

Approved ESD precautions must be followed at all times during readhead and interface electrical connections.



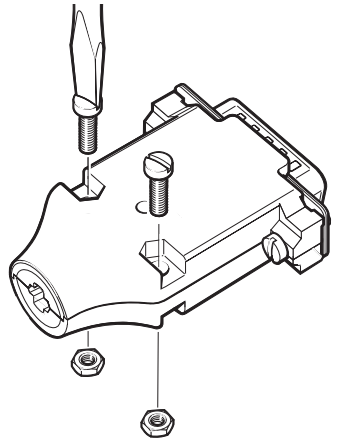
The readhead is connected to the Ri interface via a small, rugged connector to allow for easy feed-through during installation.

NOTE: An optional Ri cable guide (A-9693-2577) is available to simplify assembly.

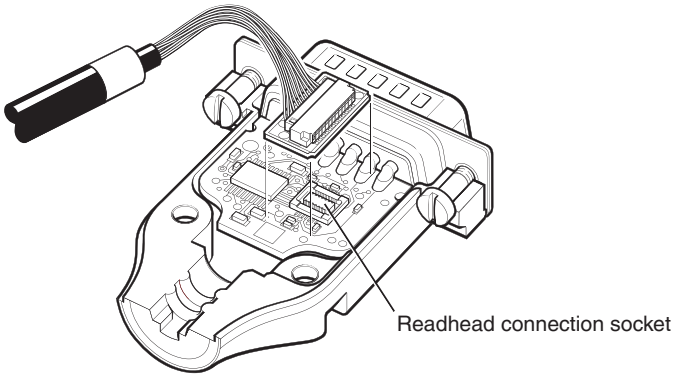
For instructions on how to install the Ri cable guide, download the *Ri interface cable guide* (Renishaw part no. M-9770-9478) from the website at **www.renishaw.com/atomdownloads**

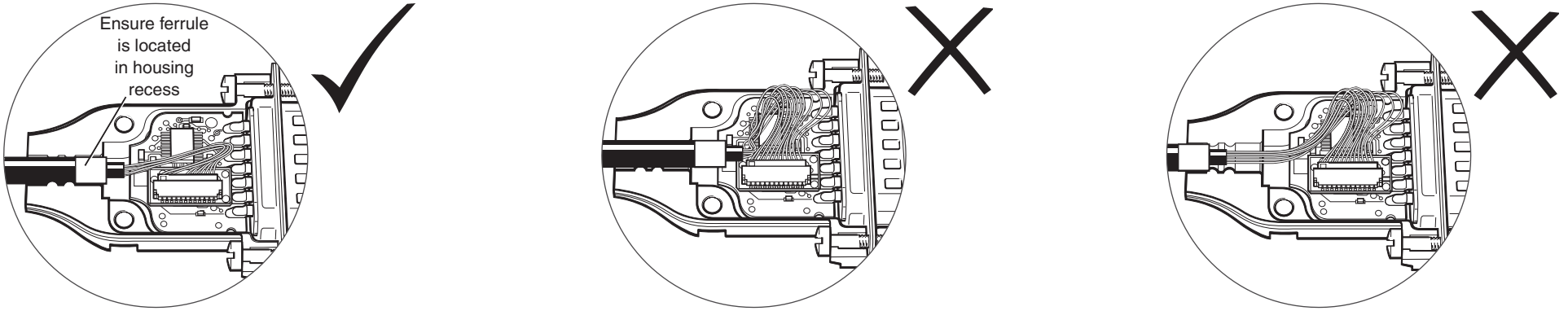
Connecting the readhead

1. Open the interface housing by removing the two screws shown (4-40 UNC screws and nuts).
2. With the plain side facing up, remove the top half of the housing, so that the interface PCB is exposed and the readhead connection socket is visible.
3. Taking care not to touch the pins, plug the connector into the socket in the interface, ensuring correct orientation as shown.



NOTE: Care is required to hold the assembly together as the PCB is fixed only to the 15-way connector and the jack screws are loose.





4. Re-assemble the housing ensuring the cable ferrule is located in the recess on the inside and no wires are trapped.
5. Refit the screws.
6. When the system has been connected, proceed with 'Readhead mounting and alignment' on page 28 and 'System calibration' on page 34.

Disconnecting the readhead

1. Disconnect power.
2. Open the interface housing as detailed earlier in this section.
3. Gently lever the connector PCB (on the end of the cable) out of the socket.
4. Place the connector in an anti-static bag.
5. Re-assemble the interface.

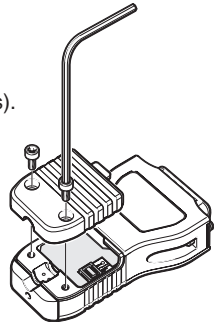
Ti interface

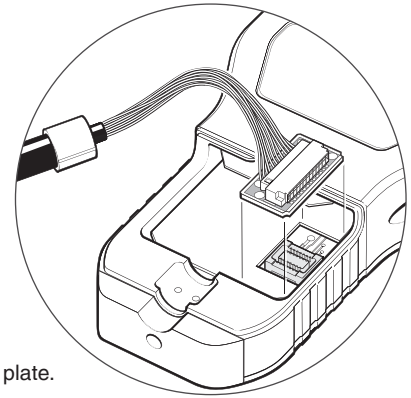
Approved ESD precautions must be followed at all times during readhead and interface electrical connection.

The readhead is connected to the Ti interface via a small, rugged interboard connector to allow for easy feed-through during installation.

Connecting the readhead

1. Remove the cover plate as shown (two M2.5 hex head screws).

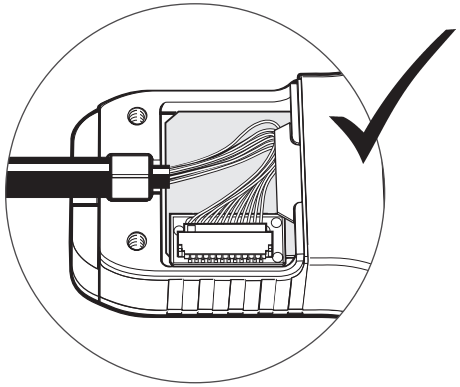


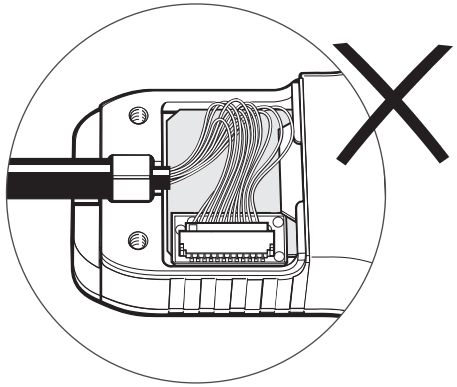


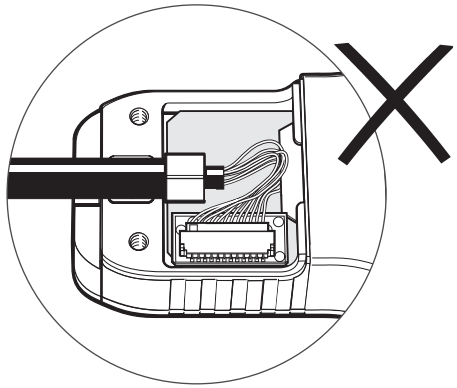
2. Taking care not to touch the pins, plug the connector into the socket in the interface, ensuring correct orientation as shown.

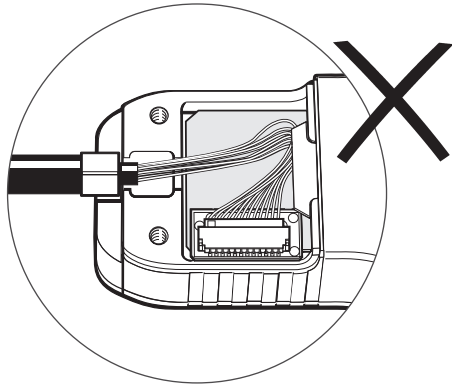
3. Refit the cover plate, ensuring the cable ferrule is located in the recess on the inside, and no wires are trapped under the cover plate.

NOTE: The tightening torque should be between 0.25 Nm and 0.4 Nm.









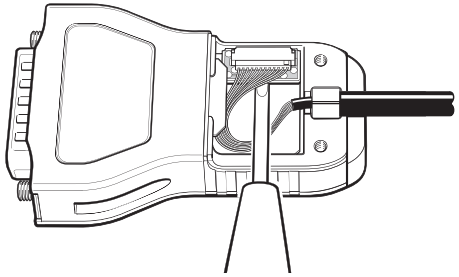
4. Proceed with 'Readhead mounting and alignment' on page 28 and 'System calibration' on page 34.

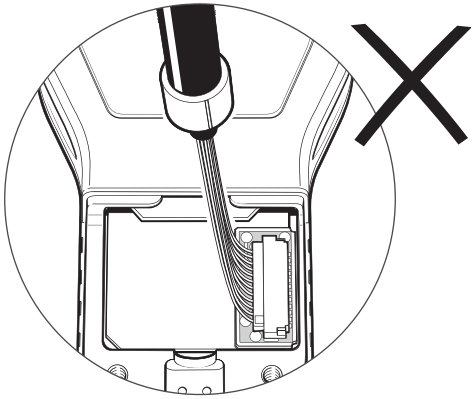
Disconnecting the readhead

1. Disconnect power.
2. Remove the cover plate on the interface (two M2.5 hex head screws).
3. Gently lever the connector PCB (on the end of the cable) out of the socket.

CAUTION: Do not pull the cable to remove the connector.

4. Place the connector in an anti-static bag.
5. Refit the cover plate.





Readhead mounting and alignment

Methods

There is a range of tools available to assist with readhead installation depending upon the system design; these are detailed below. For more details on designing the mounting bracket and selecting the appropriate mounting tools, contact your local Renishaw representative.

Ensure that the disc, readhead optical window and mounting face are clean and free from obstruction.

CAUTION: Do not saturate the readhead window with cleaning solvent as this may cause contamination on the inside of the readhead window which cannot be cleaned.

AGC should be switched off before installing the readhead and, when reinstalling, factory defaults should be restored.

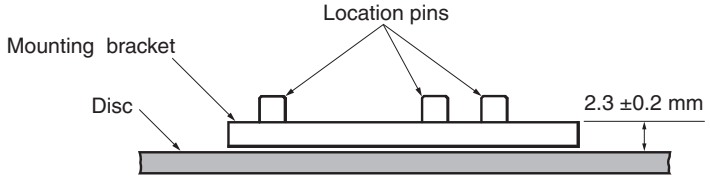
NOTE: For FPC readheads, the FPC cable must be fitted prior to mounting the readhead. See page 18 for more details.

IMPORTANT: Whichever method is used to mount the readhead, care should be taken to ensure the scale surface is not damaged during this operation, particularly when metal-to-metal contact is necessary.

Shim kit

Suitable for:

- Applications where the rideheight of the readhead cannot be adjusted. The system should be designed to achieve a nominal distance of 2.3 mm (±0.2 mm) from the readhead mounting surface to the disc surface.

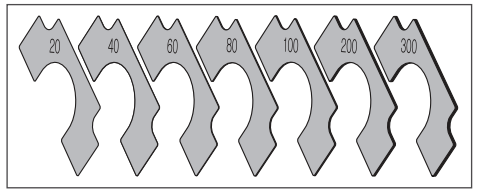


Shims of a known thickness are inserted between the mounting face of the readhead and the bracket to give the correct rideheight.

Required parts:

- Digital dial gauge (DTi) or similar
- 2 × M2 × 6 screws
- ATOM readhead Shim kit (A-9401-0050) constisting of:

Part number	Thickness (µm)	Quantity in pack
A-9401-0041	20	10
A-9401-0042	40	10
A-9401-0043	60	10
A-9401-0044	80	10
A-9401-0045	100	20
A-9401-0046	200	20
A-9401-0047	300	10



Optional parts:

- DTi adaptor (A-9401-0105)

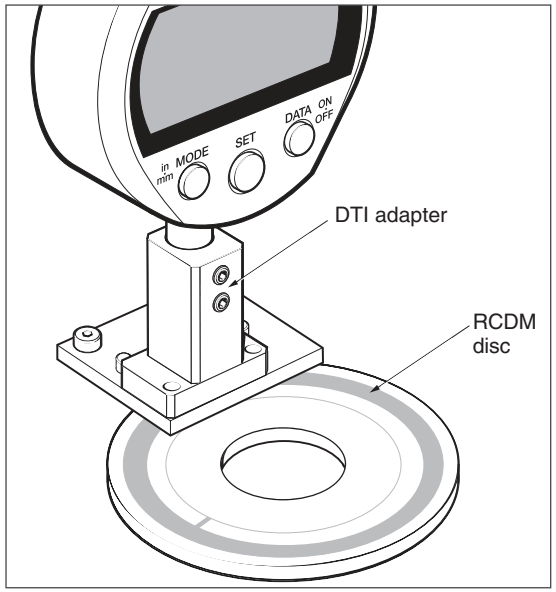
1. Using a digital dial gauge or similar, measure the distance from the readhead mounting surface to the disc surface.

   Care must be taken to ensure the disc surface is not scratched. Renishaw offer a DTI adapter (A-9401-0105) that can be used to assist with this process.

   - Insert the gauge into the adapter and zero the gauge on a flat surface.
   - Position or fix the gauge/adapter in place of the readhead and measure the distance to the disc surface.

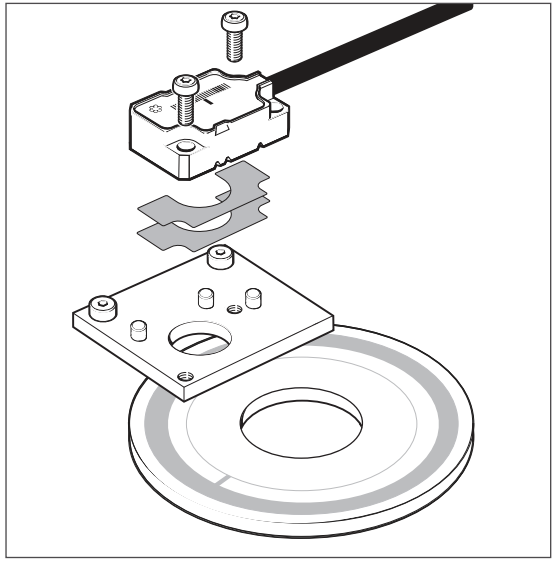
   Contact your local Renishaw representative for details of the DTi adapter and digital dial gauge.

2. Subtract the distance measured from the nominal rideheight of 2.5 mm to calculate the required shim thickness. For example if the distance measured is 2.37 mm the required shim thickness is 130 µm.
3. Select a combination of two shims that gets within 10 µm of the difference. For distances less than 100 µm a single shim should be used; for distances greater than 100 µm select one thick (≥ 100 µm) and one thin (< 100 µm) shim. In the above example this could either be 1 × 100 µm shim and 1 × 40 µm shim or 1 × 100 µm shim and 1 × 20 µm shim.
4. Place the chosen shim(s) between the readhead and the bracket.
5. Fix the readhead to the bracket using two off M2 × 6 screws in diagonally opposite fixing holes, ensuring readhead is tightened down evenly and parallel to the bracket face.



Using location pins/shoulder:

6. Ensure the readhead is pushed back against the location pins or shoulder.
7. Tighten the fixing screws.
8. Check the readhead set-up LED is green around the full axis of rotation
9. Proceed with 'System calibration' on page 34.



Not using location pins:

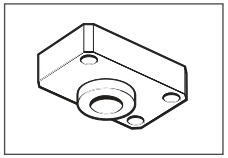
10. Adjust longitudinal and radial offset of the readhead to obtain a green readhead set-up LED around the full axis of rotation. An oscilloscope or Renishaw USB set-up tool kit and software can be used to help maximise the signal size. For more information on the Renishaw USB set-up tool kit contact your local Renishaw representative.
11. Tighten the readhead fixing screws.
12. Proceed with 'System calibration' section.

Dummy kit

Suitable for:

- Applications where the readhead mounting bracket allows adjustment of rideheight

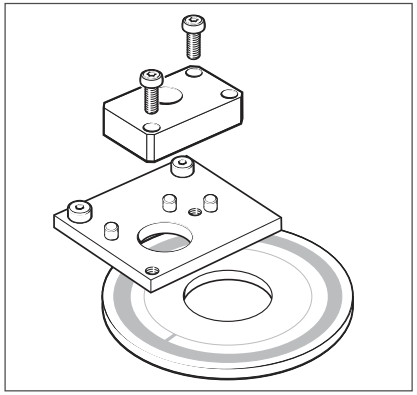
  The reusable dummy head is mounted directly onto the bracket in place of the readhead. It has the same dimensions as the ATOM readhead with a longer 'nose' that is machined to the optimum rideheight (2.5 mm ±0.02 mm). The bracket should have location pins or a shoulder to control readhead yaw. Contact your local Renishaw representative for more information on bracket design.



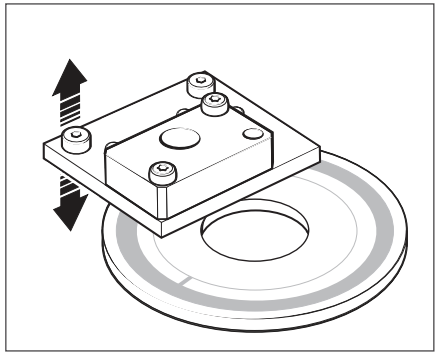
Required parts:

- Dummy head (A-9401-0072)
- 2 × M2 × 6 screws
- Customer designed bracket
- 2 × bracket mounting screws
- ATOM readhead

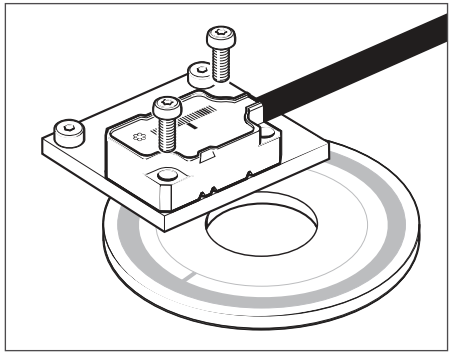
1. Mount the dummy head onto the bracket using two screws.
2. Loosely mount the readhead bracket onto the axis.



3. Adjust the height of the bracket or disc assembly until the 'nose' of the dummy head touches the disc.



4. Tighten the bracket fixing screws whilst ensuring good contact between the 'nose' of the dummy head and the surface of the disc.
5. Remove the dummy head.
6. Install the ATOM readhead in place of the dummy head using screws in diagonally opposite fixing holes.



Using location pins/shoulder:

7. Ensure the readhead is pushed back against the location pins or shoulder.
8. Tighten the fixing screws.
9. Check the readhead set-up LED is Green around the full axis of rotation.
10. Proceed with 'System calibration' section.

Not using location pins:

11. Adjust longitudinal and radial offset of the readhead to obtain a Green readhead set-up LED around the full axis of rotation. An oscilloscope or Renishaw USB set-up tool kit and software can be used to help maximise the signal size. For more information on the Renishaw USB set-up tool kit contact your local Renishaw representative.
12. Tighten the readhead fixing screws.
13. Proceed with the 'System calibration' section on page 34.

Signal amplitude adjustment

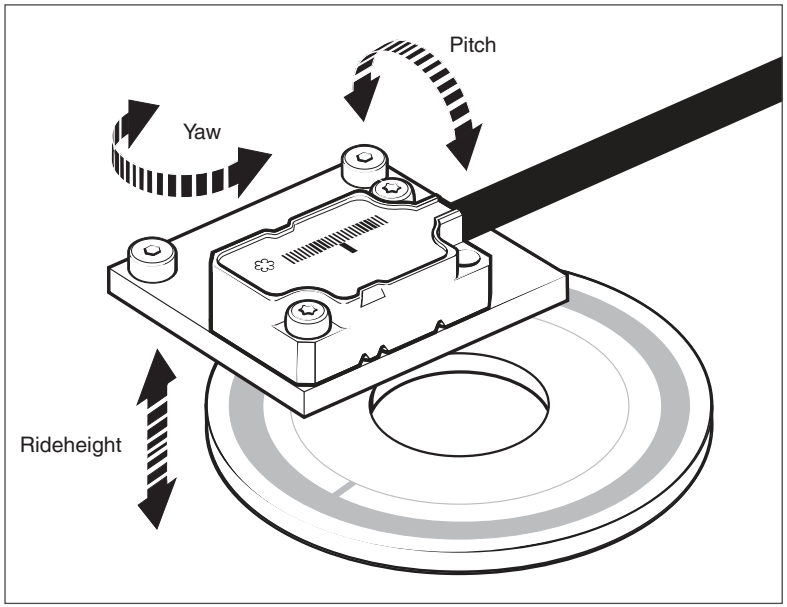
Suitable for:

- Applications where the readhead mounting bracket allows full adjustment of the readhead and the Renishaw USB set-up tool kit and software or an oscilloscope can be used to monitor the output signals.

Required parts:

- Customer designed bracket [1]
- 2 × bracket mounting screws
- 2 × M2 × 6 screws
- ATOM readhead
- Oscilloscope or Renishaw USB set-up tool kit [1] and software

For more information on system tolerances refer to the installation drawings at **www.renishaw.com/atomdownloads**

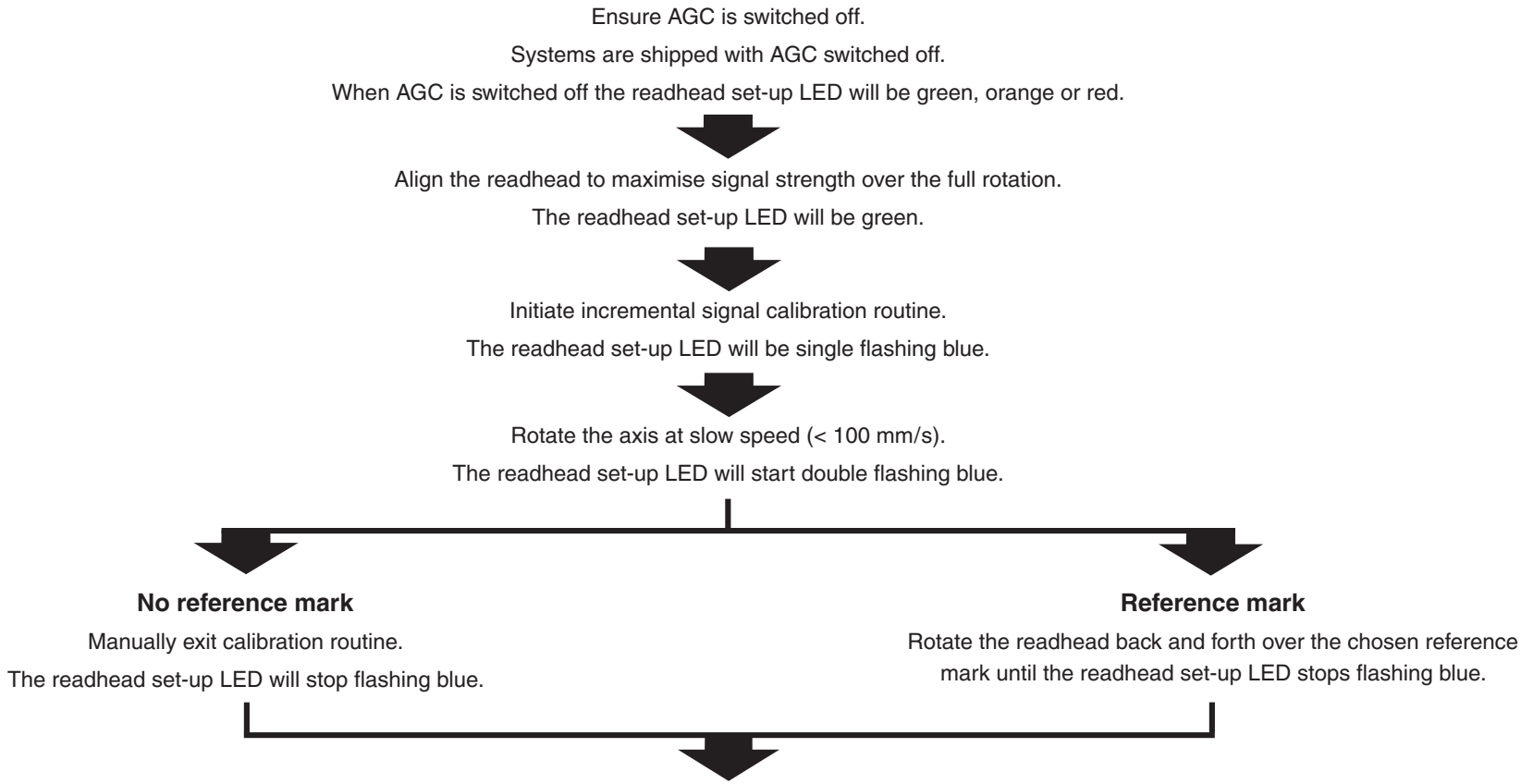


1. Mount the readhead onto the bracket.
2. Loosely mount the readhead bracket onto the axis.
3. Using the Renishaw USB set-up tool kit or an oscilloscope adjust the yaw, pitch and rideheight of the readhead to maximise the signal strength.
4. Tighten the bracket and readhead fixing screws.
5. Check the readhead set-up LED is green around the full axis of rotation.
6. Proceed with the 'System calibration' section on page 34.

[1] For more information on bracket design and the Renishaw USB set-up tool kit, contact your local Renishaw representative.

Calibration overview

Calibration is an essential operation that completes readhead set-up, with the optimum incremental and reference mark signal settings stored in the readhead's non-volatile memory. This section is an overview of the calibration procedure for an ATOM system. For more detailed information on calibrating the system see 'System calibration' on page 34.



NOTE: If calibration fails (readhead set-up LED continues flashing blue), restore factory defaults (see page 36), and repeat the installation and calibration routine.

System calibration

Calibration (CAL) is an essential operation that completes readhead set-up, with the optimum incremental and reference mark signal settings stored in the readhead's non-volatile memory.

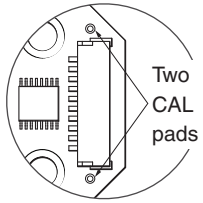
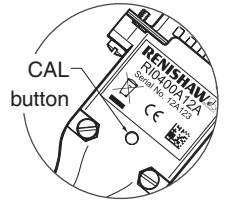
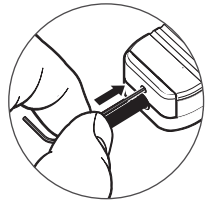
Before system calibration:

- Clean the disc and readhead optical window
- If reinstalling, restore factory defaults (see 'Restoring factory defaults' on page 36)
- Ensure AGC is switched off (readhead set-up LED is green, red or orange)
- Maximise the signal strength for complete rotation around the disc (readhead set-up LED is green)

NOTE: Maximum calibration speed 100 mm/s or less than the readhead maximum speed, whichever is slowest.

Step 1 – Incremental signal calibration

- Initiate calibration routine.

No interface	ACi interface	Ri interface	Ti interface
Ground the CAL pin for < 2 seconds.	Connect the CAL pads together or ground the remote CAL line (pin 8) for < 2 seconds. 	Press the CAL button on the side of the interface for < 2 seconds using a 2 mm Allen key or similar tool.  **WARNING:** Activating the CAL switch only requires 2.5 N force. Applying excess force may permanently damage the switch.	Press the CAL button on the end of the interface for < 2 seconds using a 2 mm Allen key or similar tool. 

- The readhead set-up LED will now periodically single-flash blue to indicate that it is in the incremental signal calibration routine. The set-up signal (V_x) will be a nominal 0 V.
- Slowly rotate the readhead around the disc, ensuring you do not pass a reference mark, until the readhead set-up LED starts double-flashing blue. This indicates the incremental signal is now calibrated and the new settings are stored in the readhead memory. The set-up signal (V_x) will be a nominal 1.65 V.
- The system is now ready for reference mark phasing.
- For systems without a reference mark, go to 'Calibration routine – manual exit' on page 35.
- If the system does not automatically enter the reference mark phasing stage (no double-flashing blue of the readhead set-up LED) the calibration of the incremental signals has failed. After ensuring failure is not due to overspeed (> 100 mm/s), exit the calibration routine, restore factory defaults and check the readhead installation and system cleanliness before repeating the calibration routine.

Step 2 – Reference mark phasing

- Slowly rotate the readhead back and forth over the reference mark until the readhead set-up LED stops flashing and remains green. The reference mark is now phased. The set-up signal (V_X) will be a nominal 3.3 V depending upon system set-up (see 'Output specifications' on page 58).
- The system automatically exits the CAL routine and is ready for operation.
- If the readhead set-up LED continues double-flashing blue after passing the reference mark many times, it is not detecting the reference mark. Ensure that the readhead orientation and lateral offset are correct.

Calibration routine – manual exit

- The calibration routine can be exited at any stage. Depending upon the interface used follow the relevant section in the table below to exit CAL mode.

No interface	ACi interface	Ri interface	Ti interface
Ground the CAL pin for < 2 seconds.	Connect the CAL pads together or ground the remote CAL line (pin 8) for < 2 seconds.	Press and hold the CAL button on the side of the interface for < 2 seconds.	Press the CAL button on the end of the interface for < 2 seconds.

- On successful exit, the readhead set-up LED will stop flashing blue and remain green.

Restoring factory defaults

When realigning the readhead, reinstalling the system, or in the case of continued calibration failure, factory defaults should be restored.

To restore factory defaults:

- Switch the system off, then switch on again using the following methods depending on the interface used.

No interface	ACi interface	Ri interface	Ti interface
Ground and hold the CAL pin whilst switching the system on.	Connect the CAL pads together or ground the remote CAL line (pin 8) whilst switching the system on.	Press and hold the CAL button on the side of the interface whilst switching the system on.	Press and hold the CAL button on the end of the interface whilst switching the system on.

- The readhead set-up LED will flash blue four times on switch on.
- Release CAL button, CAL pads link or CAL pin ground.
- Check the readhead mounting/installation and recalibrate the system.

NOTE: The system must be recalibrated after restoring factory defaults.

Switching Automatic Gain Control (AGC) on or off

AGC can be switched on or off via the interface or the CAL line.

No interface	ACi interface	Ri interface	Ti interface
Ground the CAL pin for > 3 seconds then remove ground link.	Connect the CAL pads together or ground the remote CAL line (pin 8) for > 3 seconds then disconnect.	Press and hold the CAL button on the side of the interface for > 3 seconds then release.	Press and hold the CAL button on the end of the interface for > 3 seconds then release.

- The readhead set-up LED will be green with the addition of blue when AGC is enabled.

NOTE: The system must be calibrated before switching AGC on.

LED diagnostics

Readhead

The readhead set-up LED consists of a tri-coloured LED which can display any combination of red, blue or green.

Signal	Indication	Status
Incremental (AGC off) [1]	Green	Normal set-up; signal level > 70%, AGC off
	Orange [2]	Acceptable set-up; signal level 50% to 70%, AGC off
	Red	Poor set-up; signal may be too low for reliable operation; signal level < 50%, AGC off
CAL	Single-blue flashing	Calibrating incremental signals
	Double-blue flashing	Calibrating reference mark
Reference mark	Green (flash) [3]	Normal phasing
	Blank (flash)	Acceptable phasing
	Red (flash)	Poor phasing; clean scale and recalibrate if required
Restore factory defaults	Four blue flashes on switch on	Factory defaults restored

Ti interface

Signal	Indication	Status	Alarm output [4]
Incremental	Purple	Normal set-up; signal level 110% to 135%	No
	Blue	Optimum set-up; signal level 90% to 110%	No
	Green	Normal set-up: signal level 70% to 90%	No
	Orange	Acceptable set-up; signal level 50% to 70%	No
	Red	Poor set-up; signal may be too low for reliable operation; signal level < 50%	No
	Red / blank - flashing	Poor set-up; signal level < 20%; system in error	Yes
	Blue / blank - flashing	Overspeed; system in error	Yes
	Purple / blank - flashing	Over signal; system in error	Yes
Reference mark	Blank flash	Reference mark detected (speed < 100 mm/s only)	No

NOTE: See 'Troubleshooting' on page 38 for more information on diagnosing faults.

1 When AGC is enabled the LED indication will be as shown but with the addition of a blue indication.

2 When stationary will be green or red.

3 Flash will effectively be invisible when incremental signal level is > 70% when passing reference mark.

4 Alarm output will take the form of 3-state or line driven E– signal depending on interface configuration. Also, some configurations do not output overspeed alarm. See the *ATOM™ miniature encoder system* data sheet (Renishaw part no. L-9517-9563) for more details.

- Momentary status only, while fault condition remains.
- Alarm may result in axis position error, re-datum to continue.

Troubleshooting

Fault	Cause	Possible solutions
LED on the readhead is blank	There is no power to the readhead	• Ensure 5 V are supplied at the readhead. • For cable variants check correct wiring of connector. **NOTE:** Analogue and digital systems have different pin-outs • When using Ti, Ri or cabled ACi interfaces check the interboard connector that plugs in the interface is properly seated and the correct orientation. • For FPC variants check correct insertion and orientation of the FPC cable.

LED on the readhead is red and I cannot get a green LED	The signal strength is < 50%	• Check the readhead optical window and disc are clean and free from contamination.
		• Restore factory defaults (page 36) and check alignment of the readhead. In particular;
		  • Rideheight
		  • Yaw
		  • Offset
		• Check the disc and readhead orientation.
		• Check that the readhead variant is the correct type for the chosen scale (see the *ATOM™ miniature encoder system* data sheet (Renishaw part no. L-9517-9563) for details of readhead configuration).

Unable to get a green LED around a complete rotation	System run-out is not within specification	• Check that the readhead variant is the correct type for the chosen disc (see the *ATOM™ miniature encoder system* data sheet (Renishaw part no. L-9517-9563) for details of readhead configuration). • Use a DTi gauge and check the run-out is within specifications. • Restore factory defaults. • Realign readhead to obtain a green LED at the mid-point of the run-out. • Recalibrate the system (page 34). • For 20 µm systems a green or orange readhead set-up LED is acceptable around the full axis of rotation. However the system must be calibrated over an area of scale with a green LED.
Cannot initiate the calibration routine	Cabled D-type readhead does not have CAL button	• If not using an interface with a CAL button, check that the correct pin is being shorted to 0 V for < 2 seconds. • Check that the LED is green before initiating calibration (signal size > 70%).
LED on the readhead remains single flashing blue even after moving it around the full rotation	The system has failed to calibrate the incremental signals due to the signal strength being < 70% before the calibration routine was initiated	• Exit CAL mode and restore factory defaults (page 36). • Check system set-up and realign the readhead to obtain a green LED along the full axis of rotation before recalibrating.
LED on the readhead appears purple	This is blue and red combined. AGC is switched on and signal level is < 50%	• Check the readhead optical window and disc are clean and free from contamination. • Restore factory defaults (page 36) then check the LED is green around the full axis of rotation and recalibrate the system (page 34). If it is not green, check the alignment of the readhead.

Fault	Cause	Possible solutions
LED on the readhead appears white with flashes of other colours as the readhead is moved along the axis	AGC is switched on and the signal level is < 70%	• Check the readhead optical window and disc are clean and free from contamination. • Restore factory defaults (page 36) then check the LED is green around the full axis of rotation and recalibrate the system (page 34). If it is not green check the alignment of the readhead.
LED on the readhead is double flashing blue even after moving it past the reference mark several times	The readhead is not seeing a reference mark	• Check the readhead orientation. • Check the readhead alignment. • Check the readhead optical window and disc are clean and free from contamination. • Check that the readhead variant is the correct type for the chosen disc (see the *ATOM™ miniature encoder system* data sheet (Renishaw part no. L-9517-9563) for details of readhead configuration).

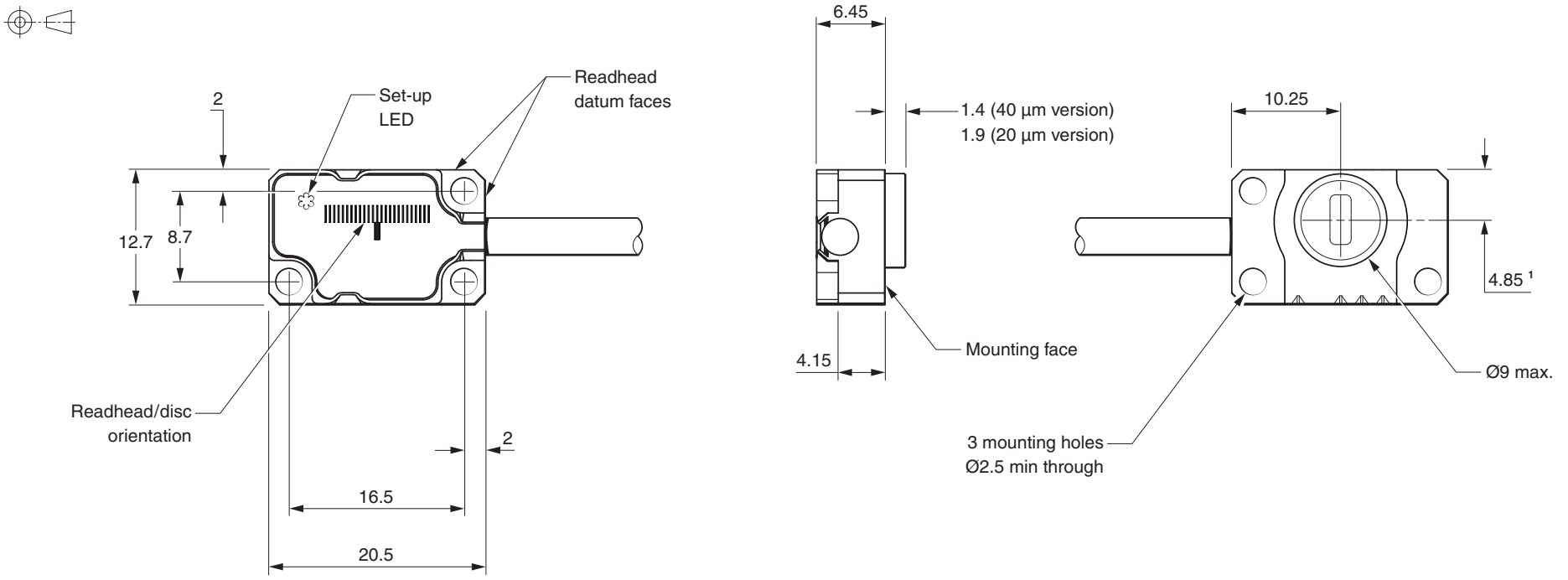
No reference mark output		• Ensure you are not moving the readhead too fast during calibration mode (maximum speed < 100 mm/sec).
		• Calibrate the system (page 34)
		  • If the system completes calibration mode, then it has successfully seen and calibrated the reference mark. If you still cannot see a reference mark then check the system wiring.
		  • If the system does not calibrate the reference mark (LED on the readhead double flashes blue), see above for possible solutions.

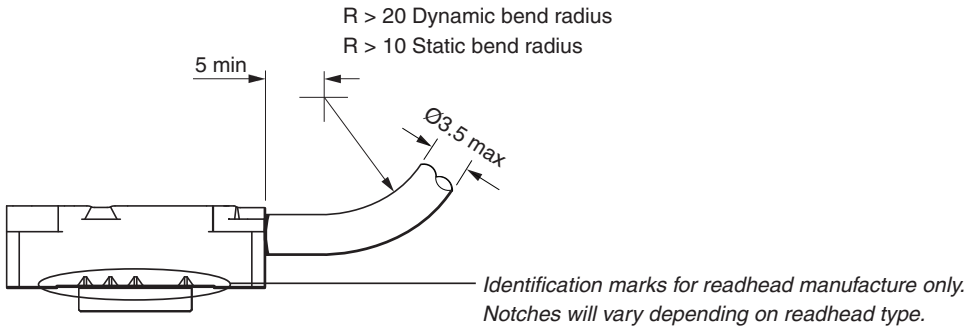
Reference mark is not repeatable		• Ensure the reference mark is calibrated (see page 35). • The readhead bracket must be stable and not allow any mechanical movement of the readhead. • Clean the disc and readhead optical window and check for damage then recalibrate the system (see page 34).
LED on the readhead is flashing red or blank over the reference mark	The reference mark is not phased	• Ensure the reference mark is calibrated (see page 35). • Clean the disc and readhead optical window and check for scratches then recalibrate the system (see page 34).
Multiple reference marks output	FPC is damaged	• Replace damaged FPC (if applicable).

ATOM readhead

Cabled readhead dimensions

Dimensions and tolerances in mm



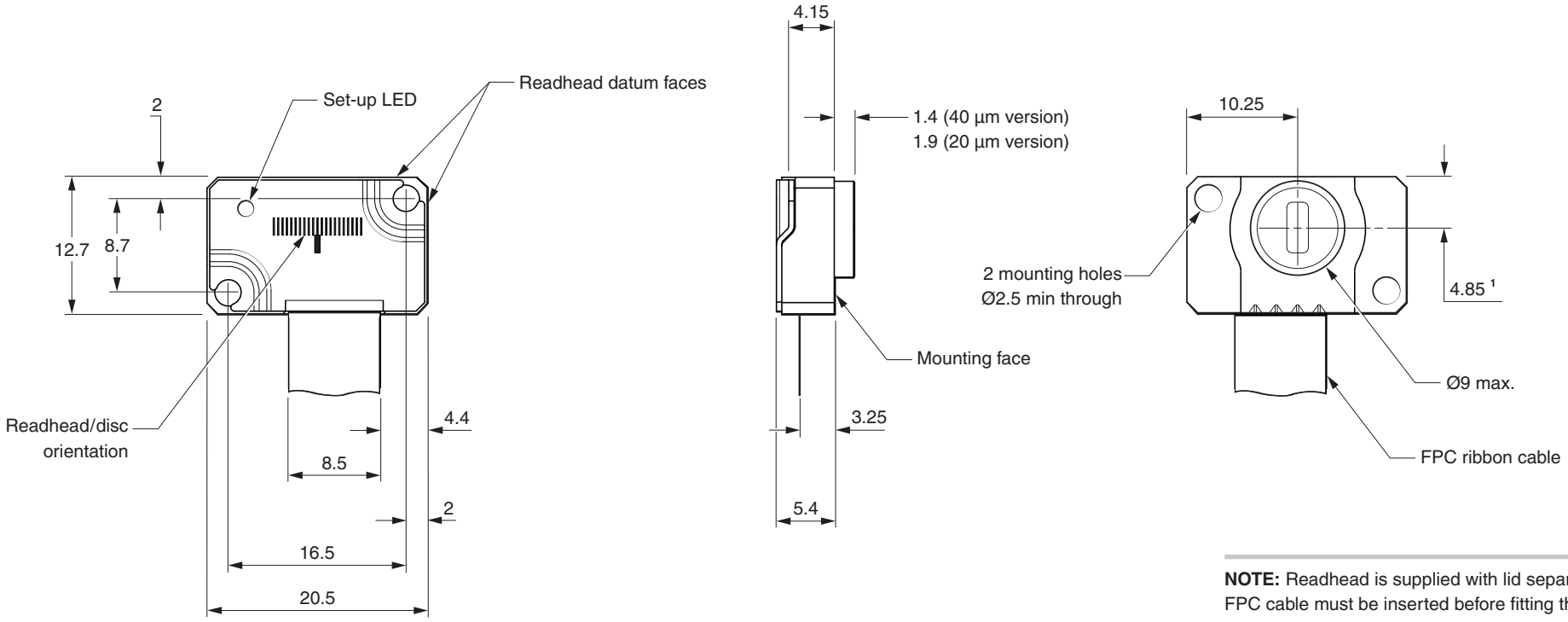


For detailed installation drawings, refer to
www.renishaw.com/atomdownloads

[1] Not optical centreline

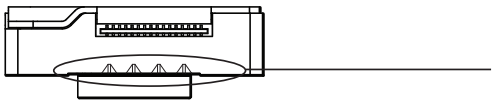
FPC readhead dimensions

Dimensions and tolerances in mm



NOTE: Readhead is supplied with lid separate. FPC cable must be inserted before fitting the lid.

For detailed installation drawings, refer to
www.renishaw.com/atomdownloads

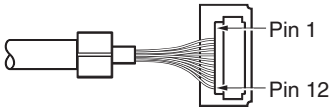


Identification marks for readhead manufacture only. Notches will vary depending on readhead type.

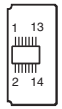
[1] Not optical centreline

Output signals

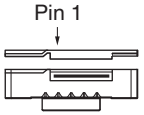
					JST [2] (on interboard)	Interboard connector (T)	FPC (F)	15-way D-type (D)
Function		**Signal**		**Colour**	**Pin**	**Pin**	**Pin**	**Pin**
Power [1]		5 V		Brown	11	4	9, 10	4, 5
		0 V		White	5	13	3, 6, 11, 14	12, 13
Incremental	**Cosine**	V_1	+	Red	4	9	5	9
			–	Blue	3	5	4	1
	Sine	V_2	+	Yellow	7	12	2	10
			–	Green	6	14	1	2
Reference mark		V_0	+	Violet	10	2	13	3
			–	Grey	9	8	12	11
Set-up		V_X		Clear	12	6	16	6
Remote CAL		CAL		Orange	8	10	15	14
Shield		-		Screen	Cable ferrule	Cable ferrule	Readhead body	Case
Do not connect		-		-	1, 2	1, 3, 7, 11	7, 8	7, 8, 15



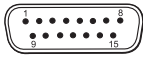
JST connector



Interboard connector for connection to Ri, Ti and cabled ACi interfaces



FPC connection



15-way D-type plug

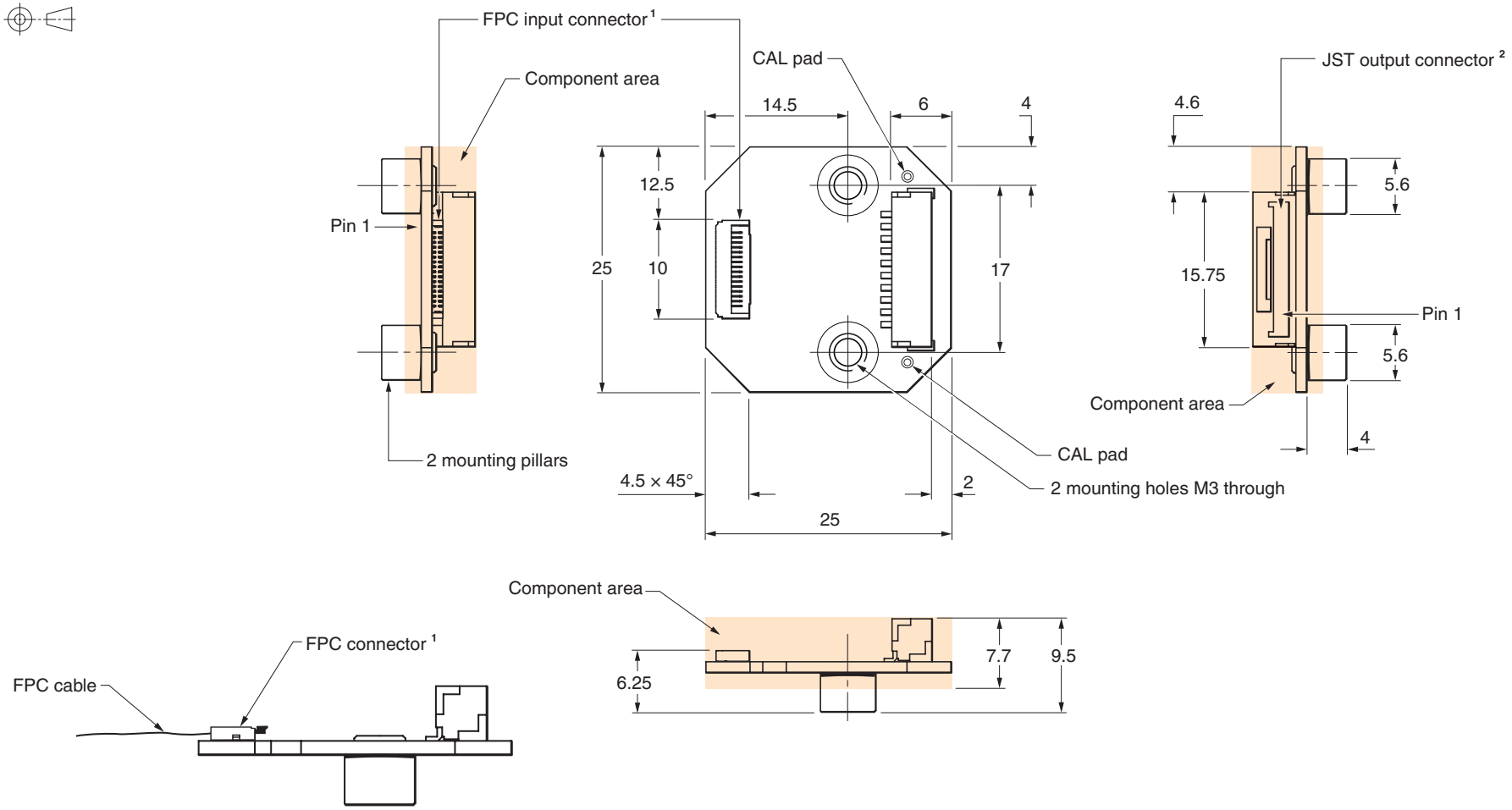
[1] All power connections should be used either to minimise voltage drop down the cable or incorporate voltage sensing.

[2] Only available on interboard connector.

ACi interface

FPC variant installation drawing

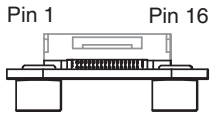
Dimensions and tolerances in mm



1 Care must be taken not to damage the FPC connector when fitting / removing the cable.

2 10-way JST, GH crimp connector. 1.25 mm pitch. Suitable for cable size 26 to 30 AWG. 3 m JST to 15-way D-type cable A-9412-1001.

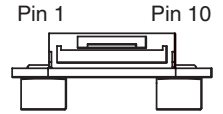
Input signals



ACi FPC input connector

Function	Signal		Pin
Power [1]	5 V		7, 8
	0 V		3, 6, 11, 14
Incremental	V_1	+	12
		–	13
	V_2	+	15
		–	16
Reference mark	V_0	+	4
		–	5
Set-up	V_X		1
Remote CAL	CAL		2
Do not connect	-		9, 10

Output signals



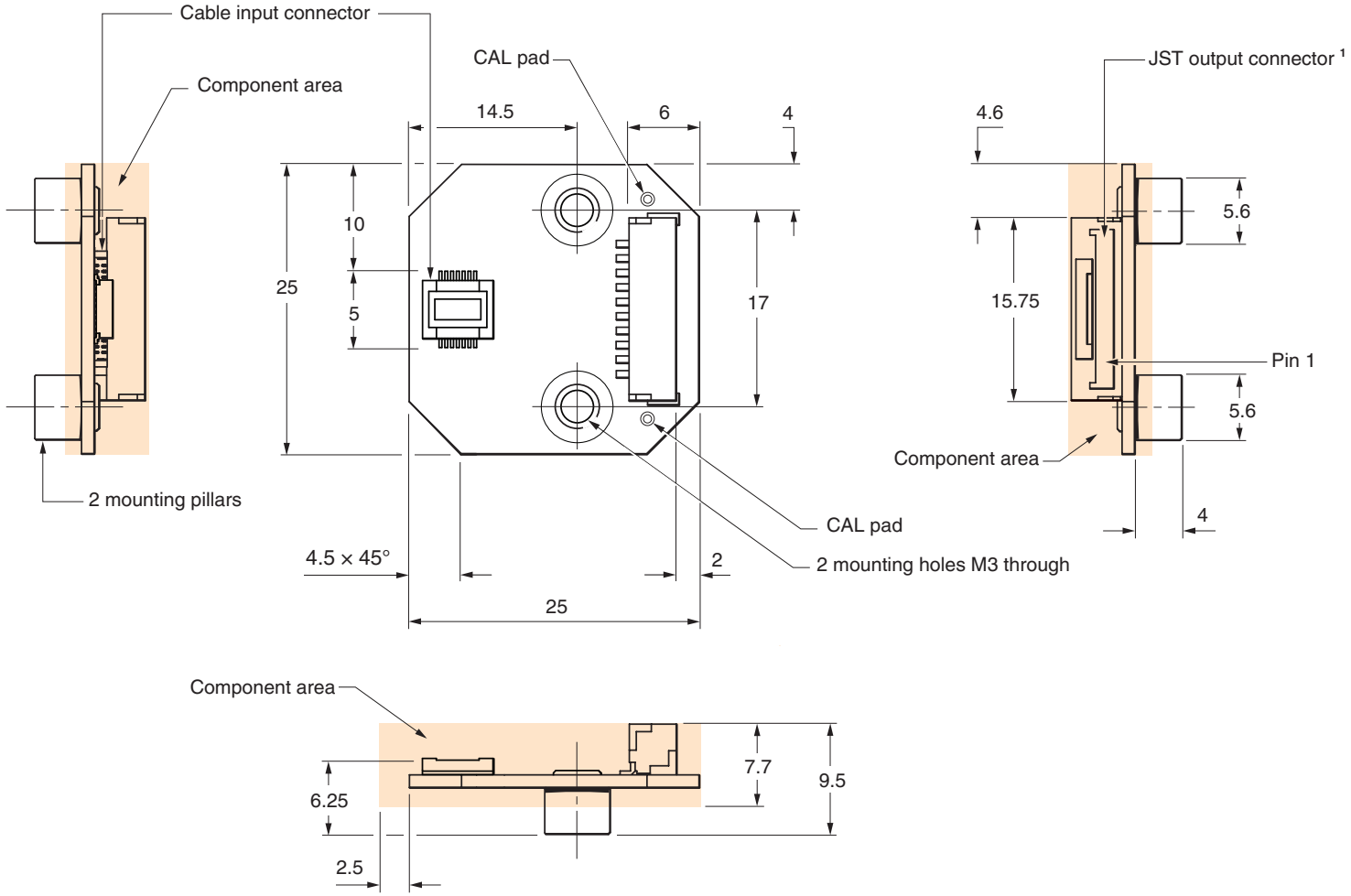
ACi JST output connector

Function	Signal		Pin	
			JST connector	A-9412-1001 cable (15-way D-type)
Power	5 V		9	7, 8
	0 V		10	2, 9
Incremental	A	+	1	14
		–	2	6
	B	+	3	13
		–	4	5
Reference mark	Z	+	5	12
		–	6	4
Set-up	X		7	1
Remote CAL	CAL		8	11

[1] All power connections should be used either to minimise voltage drop down the cable or incorporate voltage sensing.

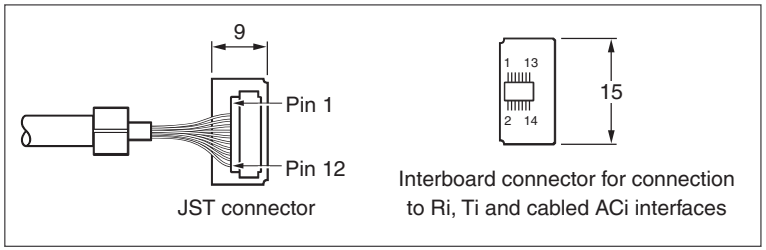
Cable variant installation drawing

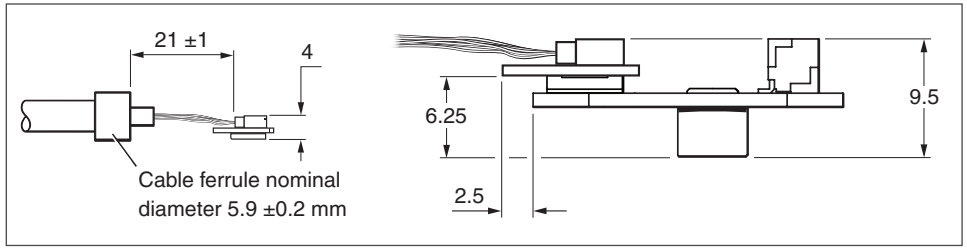
Dimensions and tolerances in mm



1 10-way JST, GH crimp connector. 1.25 mm pitch. Suitable for cable size 26 to 30 AWG. 3 m JST to 15-way D-type cable A-9412-1001.

Readhead cable input connector





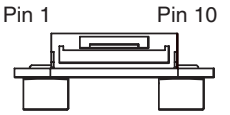
Input signals

					JST [2] (on interboard)	Interboard connector (T)
Function		**Signal**		**Colour**	**Pin**	**Pin**
Power [1]		5 V		Brown	11	4
		0 V		White	5	13
Incremental	**Cosine**	V_1	+	Red	4	9
			–	Blue	3	5
	Sine	V_2	+	Yellow	7	12
			–	Green	6	14
Reference mark		V_0	+	Violet	10	2
			–	Grey	9	8
Set-up		V_X		Clear	12	6
Remote CAL		CAL		Orange	8	10
Shield		-		Screen	Cable ferrule	Cable ferrule
Do not connect		-		-	1, 2	1, 3, 7, 11

[1] All power connections should be used either to minimise voltage drop down the cable or incorporate voltage sensing.

[2] Only available on interboard connector.

Output signals

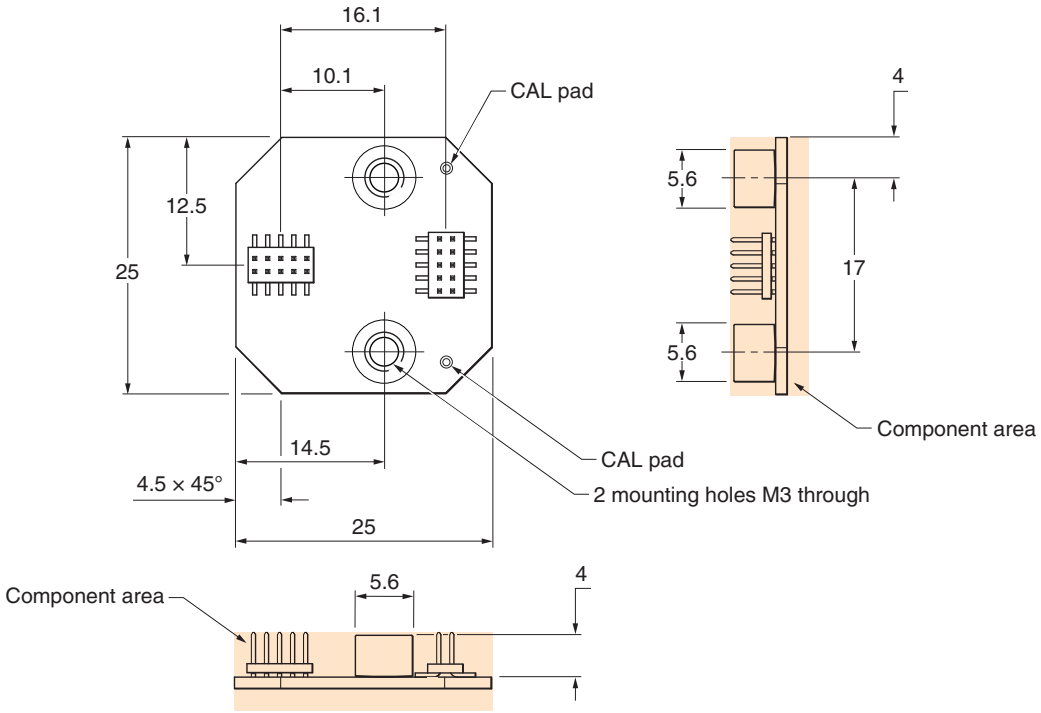


ACi JST output connector

			Pin	
Function	**Signal**		**JST connector**	**A-9412-1001 cable (15-way D-type)**
Power	5 V		9	7, 8
	0 V		10	2, 9
Incremental	A	+	1	14
		–	2	6
	B	+	3	13
		–	4	5
Reference mark	Z	+	5	12
		–	6	4
Set-up	X		7	1
Remote CAL	CAL		8	11

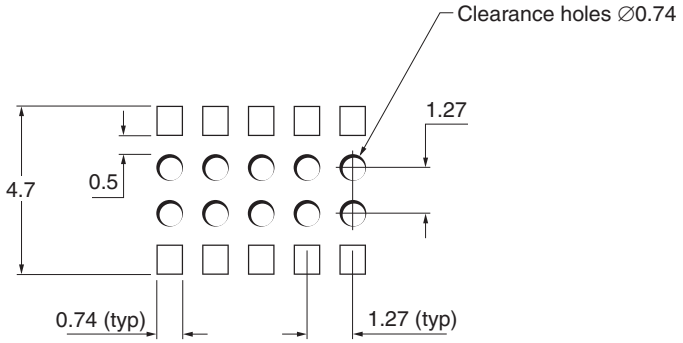
PCB mounting variant installation drawing

Dimensions and tolerances in mm



Recommended mating connector
Samtec CLP-105-02-F-D-P-TR

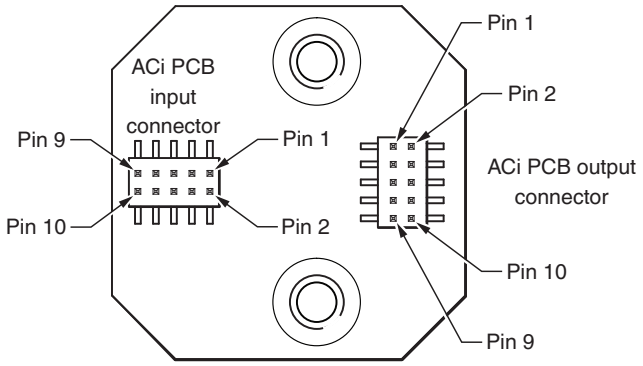
PCB footprint



ACi PCB mounting variant interface (digital output only)

	Input			Output		
Function	**Signal**		**Pin**	**Signal**		**Pin**
Power	5 V		9	5 V		6
	0 V		2	0 V		5
Incremental	V_1	+	4	A	+	8
		–	6		–	10
	V_2	+	3	B	+	7
		–	1		–	9
Reference mark	V_0	+	8	Z	+	3
		–	10		–	1
Set-up	V_X		7	X		4
Remote CAL	CAL		5	CAL		2

Samtec FTS-105-01-L-DV-P-TR



Speed

20 µm system

Maximum speed (m/s)								Lowest recommended counter input frequency (MHz)
0020 (1 µm)	0040 (0.5 µm)	0080 (0.25 µm)	0100 (0.2 µm)	0200 (0.1 µm)	0400 (50 nm)	1000 (20 nm)	2000 (10 nm)	
6.5	6.5	6.5	5.8	3	-	-	-	**40**
6.5	6.5	4	3.2	1.6	-	-	-	**20**
-	-	-	-	-	0.35	0.13	0.065	**12**
6.5	4	2	1.6	0.8	-	-	-	**10**
-	-	-	-	-	0.18	0.06	0.03	**6**
4	2	1	0.8	0.4	-	-	-	**5**
-	-	-	-	-	0.12	0.04	0.02	**4**

40 µm system

Maximum speed (m/s)								Lowest recommended counter input frequency (MHz)
0020 (2 µm)	0040 (1 µm)	0080 (0.5 µm)	0100 (0.4 µm)	0200 (0.2 µm)	0400 (0.1 µm)	1000 (40 nm)	2000 (20 nm)	
13	13	13	11.6	6	-	-	-	**40**
13	13	8	6.4	3.2	-	-	-	**20**
-	-	-	-	-	0.7	0.26	0.13	**12**
13	8	4	3.2	1.6	-	-	-	**10**
-	-	-	-	-	0.36	0.12	0.06	**6**
8	4	2	1.6	0.8	-	-	-	**5**
-	-	-	-	-	0.24	0.08	0.04	**4**

Angular speed

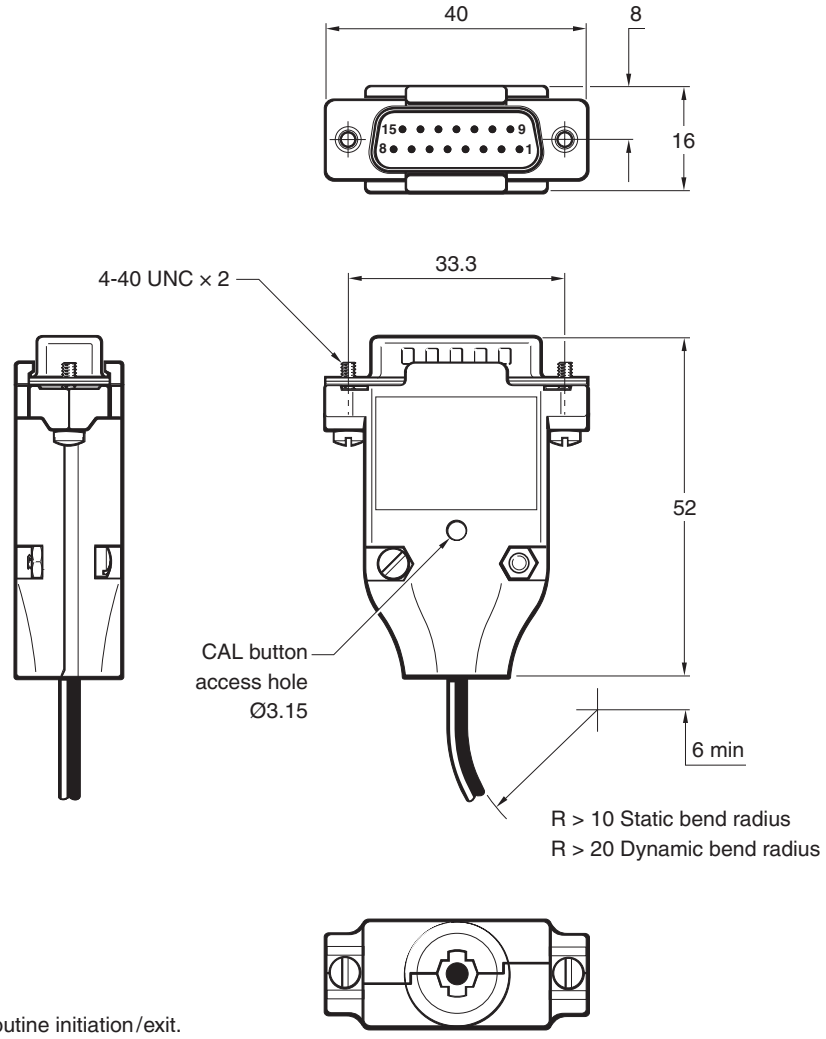
Angular speed depends on disc optical diameter. Use the following equation to convert to rev/min.

$$\text{Angular speed (rev/min)} = \frac{V \times 1000 \times 60}{\pi D}$$

Where V = maximum linear speed (m/s) and D = Optical diameter (mm).

Ri interface drawing

Dimensions and tolerances in mm



CAL button operation

Push and release (< 2 seconds) – Calibration (CAL) routine initiation/exit.
Push and release (> 3 seconds) – Automatic Gain Control (AGC) initiation/exit.
Push and hold during power 'Off/On' cycle – Restore factory defaults.

Output signals

Digital

Function	Signal		Pin
Power [1]	5 V		7, 8
	0 V		2, 9
Incremental	A	+	14
		–	6
	B	+	13
		–	5
Reference mark	Z	+	12
		–	4
Alarm [2]	E	+	11
		–	3
Set-up	X		1
Shield	-		Case
Do not connect	-		10, 15

Analogue

Function		Signal		Pin
Power [1]		5 V		4, 5
		0 V		12, 13
Incremental	**Cosine**	V_1	+	9
			–	1
	Sine	V_2	+	10
			–	2
Reference mark		V_0	+	3
			–	11
Set-up		V_X		6
Remote CAL		CAL		14
Shield		-		Case
Do not connect		-		7, 8, 15

[1] All power connections should be used either to minimise voltage drop down the cable or incorporate voltage sensing.

[2] The alarm signal can be output as a line driven signal or 3-state. Select the preferred option at time of ordering.

Speed

Clocked outputs

Ri0100, Ri0200 and Ri0400 interfaces have clocked outputs.

Customers must ensure they comply with the lowest recommended counter input frequency.

Maximum speed (m/s)						Lowest recommended counter input frequency (MHz)
20 µm system			40 µm system			
0100 (0.2 µm)	0200 (0.1 µm)	0400 (50 nm)	0100 (0.4 µm)	0200 (0.2 µm)	0400 (0.1 µm)	
-	0.8	0.4	-	1.6	0.8	**12**
-	0.5	0.25	-	1.0	0.5	**10**
0.8	0.4	0.2	1.6	0.8	0.4	**6**
0.5	0.25	0.12	1.0	0.5	0.24	**4**

Non-clocked outputs

Ri0004, Ri0008, Ri0020 and Ri0040 interfaces have non-clocked outputs.

20 µm system		40 µm system		Lowest recommended counter input frequency (MHz)
Interface type	Maximum speed (m/s)	Interface type	Maximum speed (m/s)	
0004 (5 µm)	10	**0004** (10 µm)	20	$\left(\frac{\text{Encoder velocity (m/s)}}{\text{Resolution (µm)}}\right) \times 4$ safety factor
0008 (2.5 µm)	10	**0008** (5 µm)	20	
0020 (1 µm)	10	**0020** (2 µm)	20	
0040 (0.5 µm)	10	**0040** (1 µm)	20	

Analogue speed

40 µm system - 20 m/s (–3dB)
20 µm system - 10 m/s (–3dB)

Angular speed

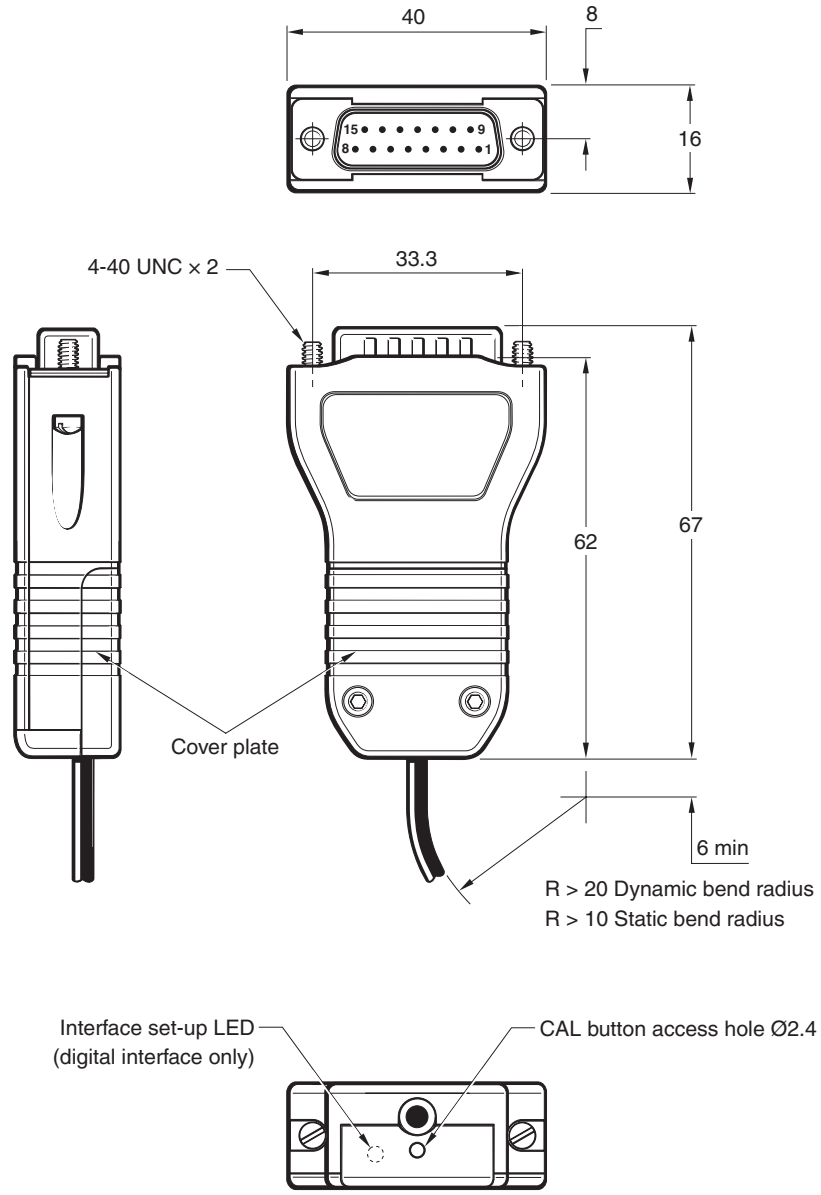
Angular speed depends on disc optical diameter. Use the following equation to convert to rev/min.

$$\text{Angular speed (rev/min)} = \frac{V \times 1000 \times 60}{\pi D}$$

Where V = maximum linear speed (m/s) and D = Optical diameter (mm).

Ti interface drawing

Dimensions and tolerances in mm



CAL button operation

Push and release (< 2 seconds) - Calibration (CAL) routine initiation/exit.
Push and release (> 3 seconds) - Automatic Gain Control (AGC) initiation/exit.
Push and hold during power 'Off/On' cycle - Restore factory defaults.
Refer to 'Readhead LED diagnostics' and 'Ti LED diagnostics' for LED indications.

Output signals

Digital

Function	Signal		Pin
Power[1]	5 V		7, 8
	0 V		2, 9
Incremental	A	+	14
		–	6
	B	+	13
		–	5
Reference mark	Z	+	12
		–	4
Alarm[2]	E	+	11
		–	3
Set-up	X		1
Shield	-		Case
Do not connect	-		10, 15

Analogue

Function		Signal		Pin
Power[1]		5 V		4, 5
		0 V		12, 13
Incremental	**Cosine**	V_1	+	9
			–	1
	Sine	V_2	+	10
			–	2
Reference mark		V_0	+	3
			–	11
Set-up		V_X		6
Remote CAL		CAL		14
Shield		-		Case
Do not connect		-		7, 8, 15

[1] All power connections should be used either to minimise voltage drop down the cable or incorporate voltage sensing.

[2] The alarm signal can be output as a line driven E signal or 3-state depending on the interface configuration. Select the preferred option at time of ordering.

Speed

Digital speed

20 µm system

Maximum speed (m/s)											Lowest recommended counter input frequency (MHz)
0004 (5 µm)	0020 (1 µm)	0040 (0.5 µm)	0100 (0.2 µm)	0200 (0.1 µm)	0400 (50 nm)	1000 (20 nm)	2000 (10 nm)	4000 (5 nm)	10KD (2 nm)	20KD (1 nm)	
10	10	10	6.48	3.24	1.62	0.648	0.324	0.162	0.0654	0.032	**50**
10	10	10	5.4	2.7	1.35	0.54	0.27	0.135	0.054	0.027	**40**
10	10	8.1	3.24	1.62	0.81	0.324	0.162	0.081	0.032	0.016	**25**
10	10	6.75	2.7	1.35	0.675	0.27	0.135	0.068	0.027	0.013	**20**
10	9	4.5	1.8	0.9	0.45	0.18	0.09	0.045	0.018	0.009	**12**
10	8.1	4.05	1.62	0.81	0.405	0.162	0.081	0.041	0.016	0.0081	**10**
10	6.48	3.24	1.29	0.648	0.324	0.13	0.065	0.032	0.013	0.0065	**8**
10	4.5	2.25	0.9	0.45	0.225	0.09	0.045	0.023	0.009	0.0045	**6**
10	3.37	1.68	0.67	0.338	0.169	0.068	0.034	0.017	0.0068	0.0034	**4**
4.2	0.84	0.42	0.16	0.084	0.042	0.017	0.008	0.004	0.0017	0.0008	**1**

40 µm system

Maximum speed (m/s)											Lowest recommended counter input frequency (MHz)
0004 (10 µm)	0020 (2 µm)	0040 (1 µm)	0100 (0.4 µm)	0200 (0.2 µm)	0400 (0.1 µm)	1000 (40 nm)	2000 (20 nm)	4000 (10 nm)	10KD (4 nm)	20KD (2 nm)	
20	20	20	12.96	6.48	3.25	1.296	0.648	0.324	0.013	0.064	**50**
20	20	20	10.8	5.4	2.7	1.08	0.54	0.27	0.108	0.054	**40**
20	20	16.2	6.48	3.24	1.62	0.648	0.324	0.162	0.064	0.032	**25**
20	20	13.5	5.4	2.7	1.34	0.54	0.27	0.136	0.054	0.026	**20**
20	18	9	3.6	1.8	0.9	0.36	0.18	0.09	0.036	0.018	**12**
20	16.2	8	3.24	1.62	0.8	0.324	0.162	0.082	0.032	0.0162	**10**
20	12.96	6.48	2.58	1.296	0.648	0.26	0.13	0.064	0.026	0.013	**8**
20	9	4.5	1.8	0.9	0.45	0.18	0.09	0.046	0.018	0.009	**6**
20	6.74	3.36	1.34	0.676	0.338	0.136	0.068	0.034	0.0136	0.0068	**4**
8.4	1.68	0.84	0.32	0.168	0.084	0.034	0.016	0.008	0.0034	0.0016	**1**

Analogue speed

20 µm system - 10 m/s (–3dB)
40 µm system - 20 m/s (–3dB)

Angular speed

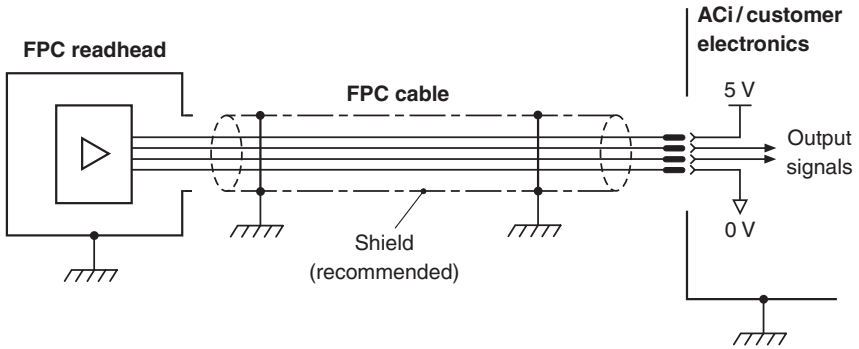
Angular speed depends on disc optical diameter. Use the following equation to convert to rev/min.

$$\text{Angular speed (rev/min)} = \frac{V \times 1000 \times 60}{\pi D}$$

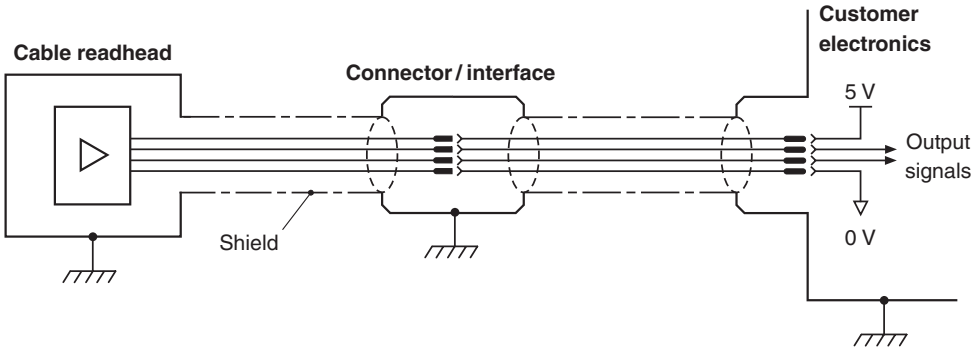
Where V = maximum linear speed (m/s) and D = Optical diameter (mm).

Electrical connections

Grounding and shielding



For more information on FPC contact your local Renishaw representative.

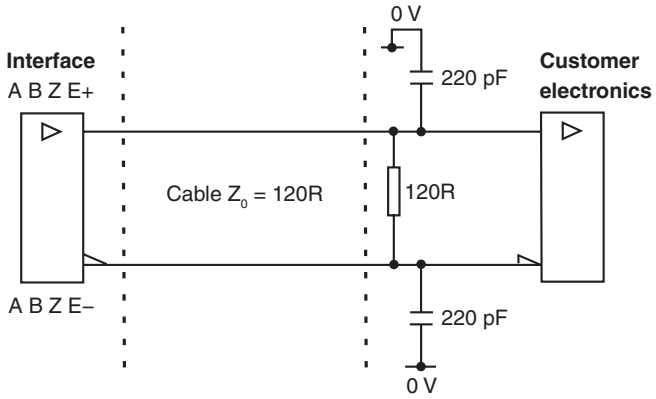


IMPORTANT: The shield should be connected to the machine earth (Field Ground).

NOTE: Maximum cable length between interface and customer electronics is 25 m for ACi and Ri and 50 m for Ti (Maximum length for Ti with 40 or 50 MHz clocked output is 25 m).

Recommended signal termination

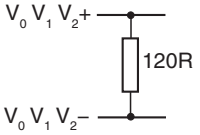
Digital outputs



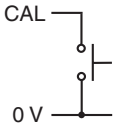
Standard RS422A line receiver circuitry.

Capacitors recommended for improved noise immunity.

Analogue outputs



Remote CAL operation



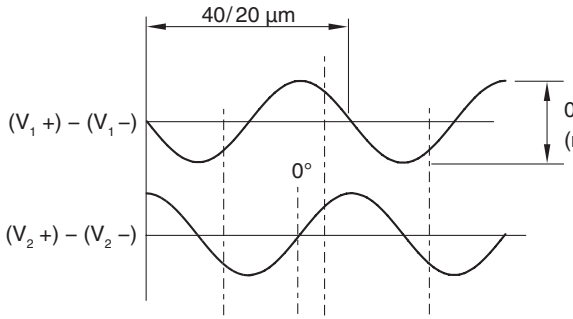
Remote CAL operation is possible via the CAL pin. For applications where no interface is used, remote CAL operation is essential.

Output specifications

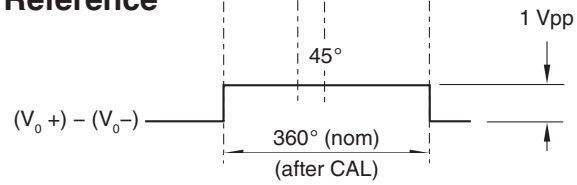
Analogue output signals

All ATOM readheads and Ri and Ti analogue interfaces.

Incremental 2 channels V_1 and V_2 differential sinusoids in quadrature, centred ~ 1.65 V (90° phase shifted)



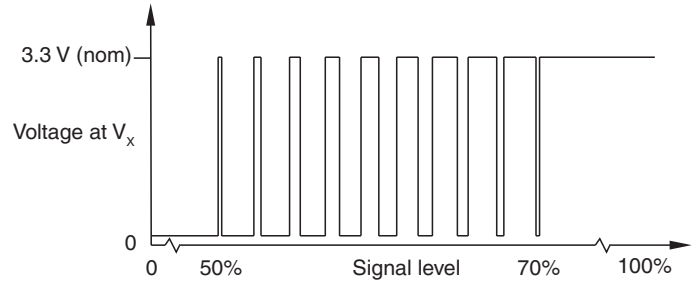
Reference



Differential signals V_0+ and V_0– centred on ~ 1.65 V.

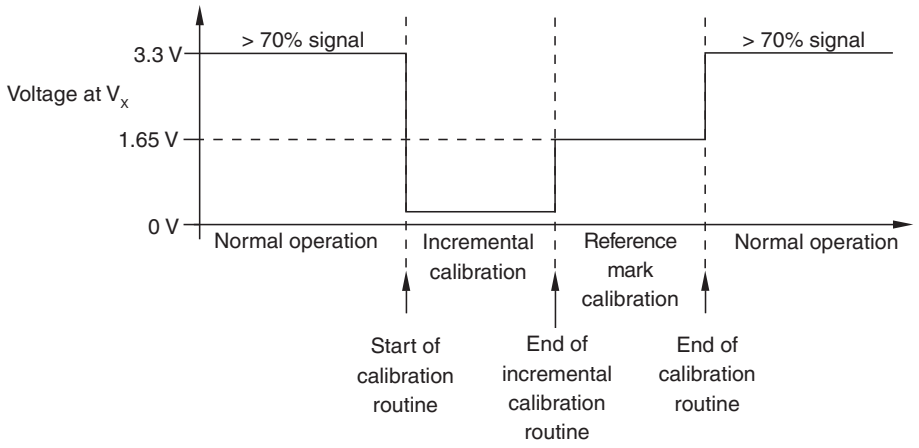
Set-up (Readhead, ACi, Ri and Ti analogue)

During normal operation



Between 50% and 70% signal level, V_x is a duty cycle.
Time spent at 3.3 V increases with incremental signal level.
At > 70% signal level V_x is nominal 3.3 V.

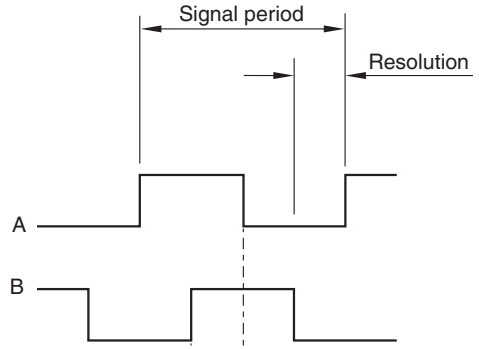
During CAL routine (Readhead, Ri analogue and Ti analogue only)



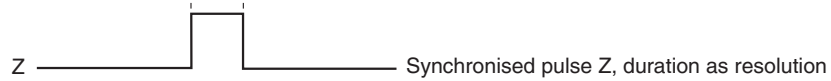
Digital output signals

Form – Square wave differential line driver to EIA RS422A.
All ACi interfaces, Ri and Ti digital interfaces.

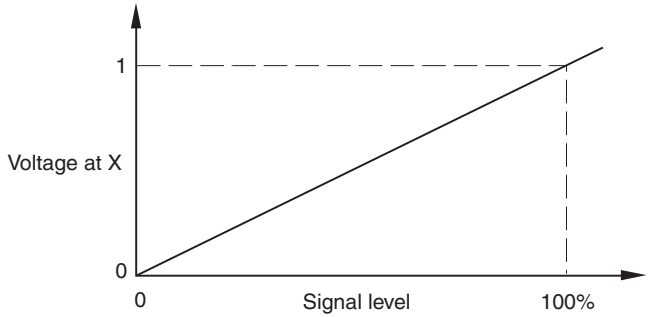
Incremental [1] 2 channels A and B in quadrature (90° phase shifted)



Reference [1]

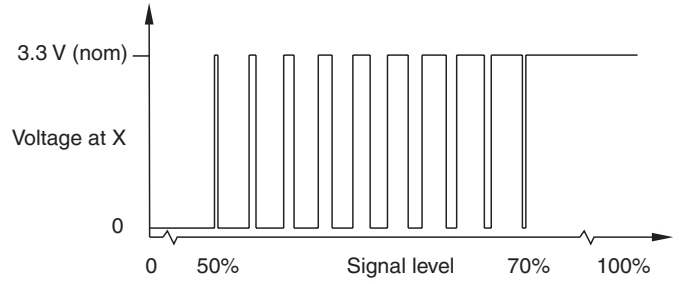


Set-up [2] (Ti digital interfaces)



Set-up signal voltage proportional to incremental signal amplitude

During normal operation (ACi interfaces and Ri digital interfaces)



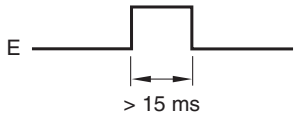
Between 50% and 70% signal level, X is a duty cycle.
Time spent at 3.3 V increases with incremental signal level.
At > 70% signal level X is nominal 3.3 V.

[1] Inverse signals not shown for clarity.

[2] Set-up signals as shown are not present during calibration routine.

Alarm [1]

Differential line driven output (Ri and Ti digital interfaces)



Interface model	Alarm asserted when
Ri0004	• < 40% signal • Overspeed
Ri0008	
Ri0020	
Ri0040	
Ri0100	• < 20% signal • > 130% signal
Ri0200	
Ri0400	

Interface model	Alarm asserted when
Ti	• < 20% signal • > 135% signal • Overspeed

3-state alarm (ACi, Ri and Ti digital interfaces)

Differentially transmitted signals forced open circuit for > 15 ms when alarm conditions valid.

(Ri and Ti alarm conditions same as differential line driven output. ACi alarm conditions: < 40% signal or overspeed).

[1] Inverse signals not shown for clarity.

General specifications

Power supply	5 V ±10%	ATOM readhead typically < 50 mA ATOM with ACi typically < 100 mA ATOM with Ri typically < 100 mA ATOM with Ti typically < 200 mA For analogue outputs a further 10 mA in total will be drawn when terminated with 120R. For digital outputs a further 25 mA per channel pair (e.g. A+, A–) will be drawn when terminated with 120R. Power from a 5 Vdc supply complying with the requirements for SELV or standard IEC 60950-1.
	Ripple	200 mVpp maximum @ frequency up to 500 kHz
Temperature	Storage	–20 °C to +70 °C
	Operating	0 °C to +70 °C
Humidity		95% relative humidity (non-condensing) to IEC 60068-2-78
Sealing		Cable variant IP40 Ri interface IP20 FPC variant IP20 (with lid fitted) Ti interface IP20
Acceleration (scale and readhead)	Operating	400 m/s², 3 axes
Shock (scale and readhead)	Operating	1000 m/s², 6 ms, ½ sine, 3 axes
Vibration	Operating	100 m/s² max @ 55 Hz to 2000 Hz, 3 axes
Mass		FPC readhead 2.3 g Cable readhead 4 g Cable 18 g/m ACi 4 g Ri 70 g Ti 100 g
Readhead cable		10 core, high flex, EMI screened cable Outside diameter 3.5 mm maximum Flex life > 20 × 10⁶ cycles at 20 mm bend radius Maximum length 5 m (Extension cable up to 25 m when using Renishaw approved extension cable) UL recognised component
FPC cable		16 core, 0.5 mm pitch Minimum exposed conductor length 1.5 mm Maximum exposed conductor length 2.5 mm Maximum length 1 m
Connector options	Cable variants	Interboard connector compatible with the Ri, Ti and ACi (cable variant) series interfaces 15-way, D-type connector
	FPC	16 core, 0.5 mm pitch, compatible with ACi (FPC variant)
Typical sub-divisional error (SDE) (analogue)		40 µm version < ±120 nm 20 µm version < ±75 nm

NOTE: Current consumption figures refer to unterminated systems.

CAUTION: Renishaw encoder systems have been designed to the relevant EMC standards, but must be correctly integrated to achieve EMC compliance. In particular, attention to shielding arrangements is essential.

Disc specifications

Material		Soda lime glass (2.3 mm thick)
Reference mark		Single reference mark
Graduation accuracy	Discs < 100 mm	±0.5 µm
	Discs > 100 mm	±0.7 µm

Disc size (mm)	**17**	**20**	**25**	**27**	**30**	**36**	**50**	**56**	**68**	**108**
Graduation accuracy (arc seconds)	15.81	12.95	9.82	9.0	7.91	6.49	4.5	3.95	3.24	2.78

Coefficient of thermal expansion		~8 µm/m/°C
Nominal outer diameter (mm)	40 µm	17, 20, 25, 27, 30, 36, 50, 56, 68 and 108
	20 µm	30, 36, 50, 56, 68 and 108

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