Copley Controls Corp.
Copley Motion Systems LLC

ServoTube 11
INSTALLATION GUIDE

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WARRANTY

Copley Motion Systems guarantees its equipment against faulty components for a period of twelve months from delivery. Replacement components will be free of charge. Copley Motion Systems shall not in any event be liable for consequential damage or loss.

Copley Motion Systems operates a customer care facility and all requests for repair and replacement should be directed to the Customer Care Department. The serial number of the equipment should be quoted in any communications. The right to change specification and price is reserved by Copley Motion Systems.

DISCLAIMER

Copley Motion Systems makes no guarantees of any kind with regard to this manual. Copley Motion Systems shall not be liable for errors contained herein or for consequential or incidental damages incurred as a result of acting on information contained in the manual.

CUSTOMER CARE

For enquiries relating to the operation and use of the ServoTube 11 described in this Manual please contact the Customer Care Helpdesk, Telephone : +44 (0)1268 287070.

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Contents

WARNINGS

Warning symbols and meanings

In this User Manual warning symbols are used. These are intended to alert you to the potential hazards to personnel which are associated with the equipment described, in all aspects of use, including handling, installation, operation and maintenance.

Heart pacemakers. Personnel fitted with pacemakers must not handle or work on this equipment.

Strong magnets. The thrust rod contains powerful magnets and will strongly attract ferrous objects. Damage can occur to computer disks and credit cards.

Electric shock. Potentially lethal voltages may be present during the commissioning and servicing of this equipment. Isolate and disconnect all sources of electrical supply before working on the equipment. Particular care needs to be taken when working on or around motor phase connections.

Hot surface. Surface temperatures of up to 80 °C can be present during the commissioning and servicing of this equipment. Allow the forcer and thrust rod to cool before working on the equipment.

Crush hazard. The forcer may move unexpectedly. Always isolate all sources of electrical supply before working on the equipment.

General hazard. Follow the advice given.

Electrical safety

This equipment must be earthed.

EMC precautions

This equipment is intended for use in a light industrial environment. It is recommended that the following precautions be observed during installation:

Keep all cable lengths to a minimum.

Provide as much physical separation as possible between power and signal cables. In particular, avoid long, parallel runs of cables.

Maintain screen continuity throughout the cable run.

Use 360 degree screen terminations where possible. “Pig-tail” terminations are not recommended.

It is the responsibility of the User to ensure compliance with any local electrical and EMC regulations in force at the time of installation.

READER'S NOTES

GENERAL

This manual describes the Installation, Maintenance and Spares of the ServoTube 11 linear motor.

ASSOCIATED PUBLICATIONS

The following publications are associated with the ServoTube 11 User Manual.

Title	Reference Number
STA Data sheet	DS01097
STB Data sheet	DS01098
Accelnet Micro Panel User Guide	-
Accelnet Micro Panel Data Sheet	-

Chapter 1
Product Overview

SERVOTUBE 11 ACTUATOR

The ServoTube Actuator is an optimal solution for industrial position control. Faster than a ballscrew with the clean reliability of a linear forcer, ServoTube is a cost-effective alternative to air cylinders in applications requiring greater flexibility and control.

The ServoTube Actuator incorporates an IP67 rated forcer and a sealed stainless steel thrust rod enclosing rare-earth magnets. Four models deliver a continuous force range of 9~27 N (2~6 lb) with peak forces up to 92 N (21 lb). 11 stroke lengths are available from 14~271 mm.

The patented magnetic design of ServoTube generates 12 micron (0.47 mil) repeatability and 350 micron (14 mil) accuracy from a non-contact, integral position sensor. No external encoder is required. Position output is industry standard 1V pk-pk sin/cos signals.

An internal dry bearing provides clean, quiet, maintenance-free performance. Life expectancy far exceeds typical ballscrew solutions.

The ServoTube Actuator is ideal for push/pull/lift material handling, packaging and automated assembly applications. ServoTube accepts a range of industry standard accesories for simple mechanical integration.

Flexible mid-stroke position control is simple with Accelnet - a matched, self-tuning indexer complete with plug-and-play cabling. Simply select your ServoTube model number and the system comes up tuned and ready to run. Clear diagnostics make system commissioning easy. Fill in the blanks to define position, velocity and acceleration.

Accelnet interfaces easily to PLCs and features CANopen network connectivity.

SERVOTUBE 11 COMPONENT

ServoTube delivers the speed of a belt-drive system with the clean reliability of a linear forcer at a price unprecedented in the industry. Familiar form factor, integral position feedback and large air gap make installation simple.

The ServoTube forcer components consist of an IP67 rated forcer and a sealed stainless steel thrust rod enclosing rare-earth magnets. Four models deliver a continuous force range of 9~27 N (2~6 lb) with peak forces up to 92 N (21 lb). A range of Thrust Rods are available for travel lengths up to 372mm.

The patented magnetic design of ServoTube generates 12 micron (0.47 mil) repeatability and 350 micron (14 mil) accuracy from a non-contact, integral position sensor. No external encoder is required. Position output is industry standard 1V pk-pk sin/cos signals.

ServoTube is an ideal OEM solution for easy integration into pick-and-place gantries and general purpose material handling machines. The load is mounted directly to the Forcer typically supported by a single bearing rail. The Thrust Rod is mounted at both ends, similar to a ballscrew. A large air gap reduces alignment constraints.

The tubular forcer has superior thermal efficiency, radiating heat uniformly. High duty cycles are possible without the need for forcer-air or water cooling.

ServoTube is complimented by a range of matched, self-tuning servo-amplifiers and indexers complete with plug-and-play cabling. Amplifiers interface easily to PLC's and feature CANopen network connectivity for distributed control applications.

Chapter 2

Installation


UNPACKING

- Check packaging for signs of damage.
- Metal surfaces may be hot or below 0°C following prolonged storage.
- Remove packaging. Do not discard. In the event of items requiring return, it is recommended that the original packaging be used.
- Ensure that the delivery note correctly reflects your order and the items delivered.
- Check equipment for signs of damage. Never use the equipment if it appears damaged in any way.
- Read the User Guide before installing and using this equipment.

INSTALLATION

Intended operating environment

This equipment is intended for use in an environment within the following conditions:

Operating temperature	0 to +40 °C
Storage temperature	-25 to +70 °C
Ingress Protection	IP67
Altitude (above mean sea level)	1000 m
Overvoltage category	II
Pollution degree	2
EMC	light industrial

Mechanical - STA

The outline drawing of the STA is shown in Figure 2.1. It comprises the forcer with integrated plastic bearings and the thrust rod. The integrated bearings act as a guide for the moving thrust rod. It is not intended to withstand side loading. If side loading is expected then it is advised that an external bearing is fitted.

The STA forcer can be mounted by two methods.

- Using the single M20 end fixing.
- Using the M3 clearance or M4 threaded fixings on the forcer body (4 off or 8 off depending on the forcer type).

IMPORTANT

When using the end flange fixing method, the fixings and mounting plate must be of a non- ferrous material such as aluminium, stainless steel, and plastic for example.

In addition, when two STAs are mounted side-by-side, they should be isolated by a minimum of 1 mm thick mild steel plate to prevent interaction. See Figure 2.1

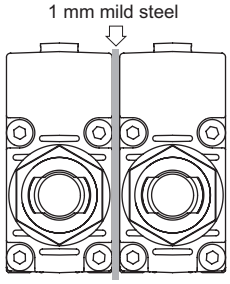

Figure 2.1 Side-by-side mounting of STAs must be separated by a 1 mm thick mild steel plate

Dimensional details for both are given in Figure 2.2.

The recommended tightening torque for the fixings are:

M20 end fixing 4 Nm M4 2 Nm (both non lubricated i.e. no thread lock)

The thrust rod has optional male and female threaded connections at each end. These are intended to interface to a number of standard accessories.

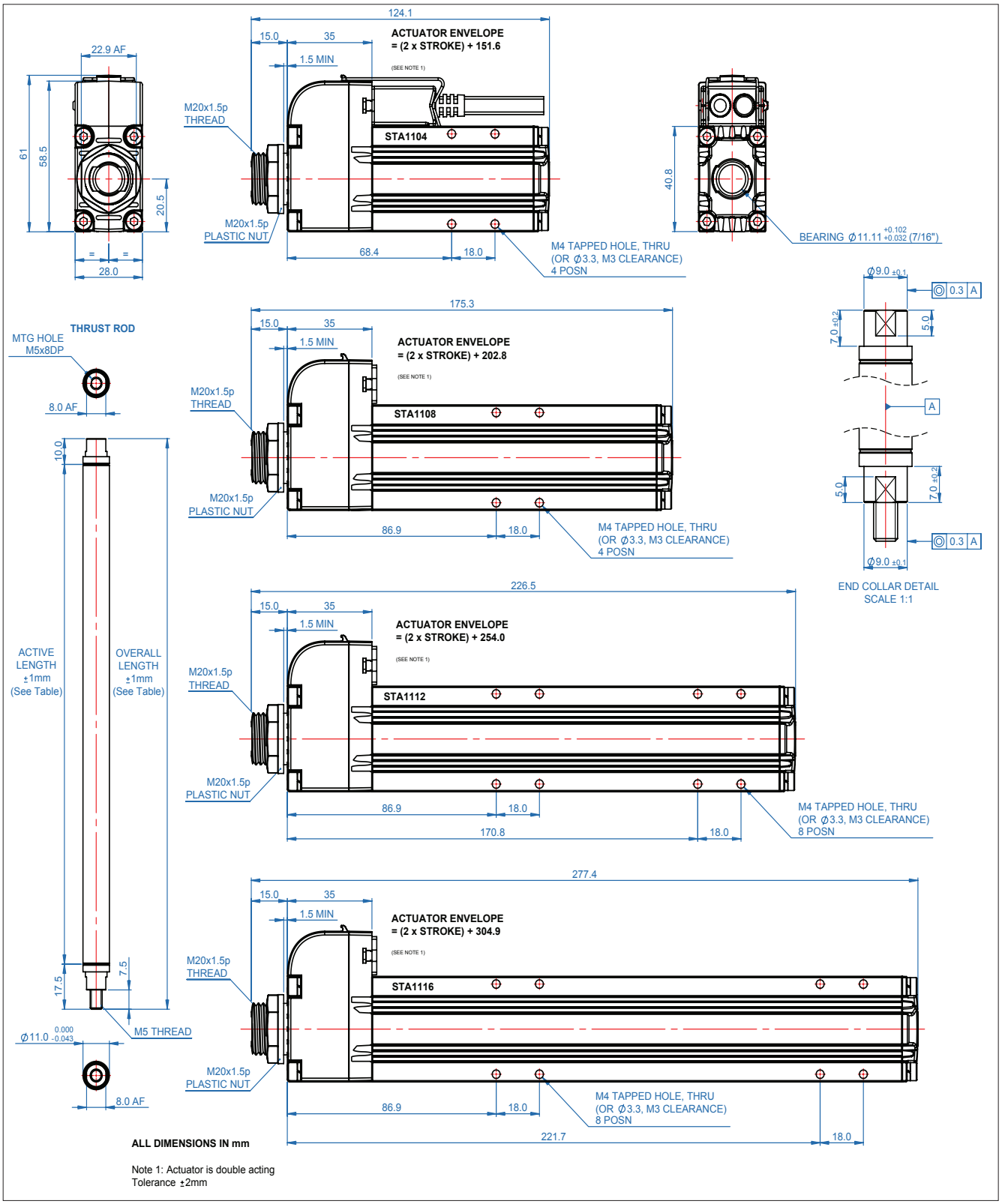

Figure 2.1 STA outline drawings and mounting details

Mechanical - STB

The outline drawing of the STB is shown in Figure 2.2. It comprises the forcer and the thrust rod. With the addition of thrust rod supports and a linear bearing, a moving forcer solution can be implemented.

Mounting holes are provided on the forcer body that are tapped M4 and clearance for M3. Dimensional details are shown in Figure 2.2. The recommended tightening torque for the fixings are:

M4 bearing to forcer 2 Nm

All torque figures are non-lubricated i.e. no thread lock.

As the STB has a moving forcer it is supplied with highly flexible cables suitable for continuous flexing operation In order to achieve the best reliability and life from these cables it is advised that some form of cable management system is used. Typically, this will be an energy chain mounted parallel to the direction of motion. Always follow the manufacturers recommendations when installing cables into energy chains. In particular:

- Observe cable minimum bend radius requirements (see Appendices).
- Never allow the cable to be under tension within the energy chain.
- Physically separate cables within the energy chain to prevent premature failure due to abrasion.
- Never cross cables within the energy chain.
- Be careful to prevent the cable from twisting or becoming kinked during installation into the energy chain.

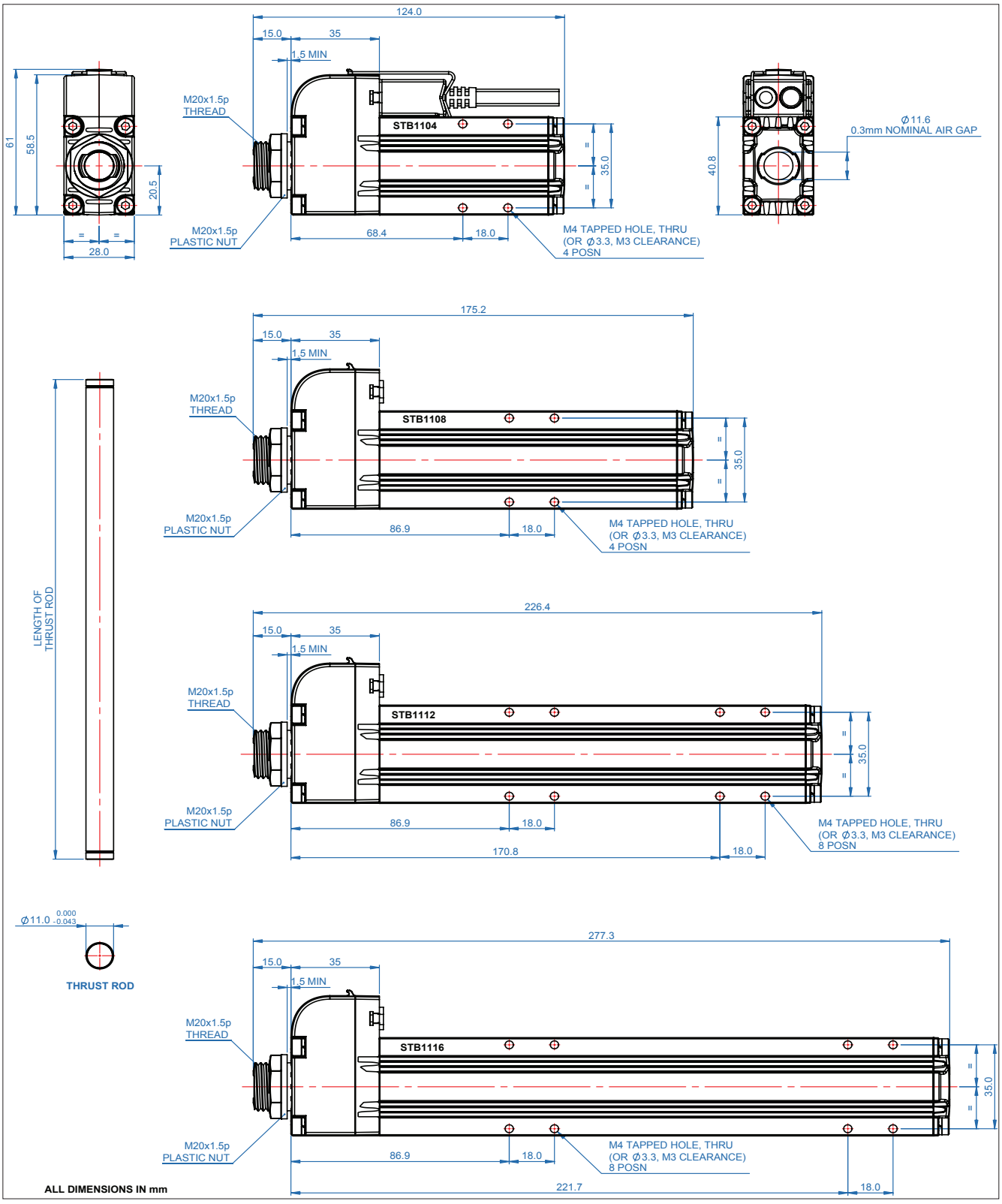

Figure 2.2 STB outline drawings and mounting details

Electrical

All electrical connections to the STA and STB are made via two cables, see Figure 2.3. One carries power to the forcer and the other carries signals from the position sensor. These cables are supplied either pre-terminated for a specific drive or with flying leads. Where they are pre-terminated, simply plug the cables into the relevant connectors on the drive.

FORCER POWER CONNECTOR REFERENCE	POSITION SENSOR CONNECTOR REFERENCE	AMPLIFIER
J2	J4	Copley Accelnet Micro Panel

WARNING

THE THRUST ROD ON BOTH STA AND STB MUST BE EARTHED. THIS CAN BE ACHIEVED BY EARTHING THE CONNECTED MECHANICAL PARTS ON THE USER'S MACHINE.

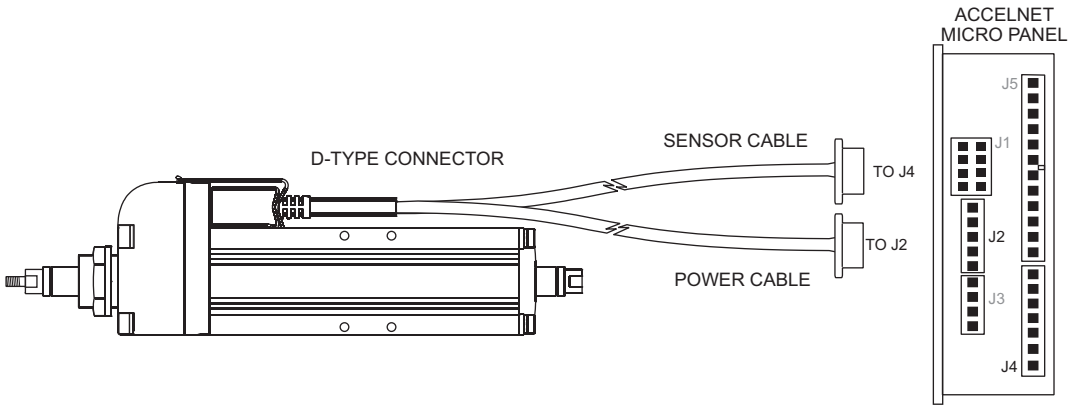

Figure 2.3 - Schematic showing connection of STA / STB to the Accelnet Micro Panel Amplifier

For cables other than those supplied, a connector lock insert kit is available that allows standard D-connector screws to be used. These replace the connector retaining clip and simply snap into either side of the forcer.

Chapter 3

Maintenance

WARNING

ISOLATE AND DISCONNECT ALL SOURCES OF ELECTRICAL SUPPLY BEFORE WORKING ON THE EQUIPMENT.

PREVENTATIVE

STA

The STA is low maintenance and as such requires only minimal periodic inspection.

The integral bearing is dry running, requiring no lubrication.

Periodically:

- Check that the thrust rod can move freely over the entire stroke.
- Clean any accumulated debris from the thrust rod surface (ferrous material, in particular, can be attracted to the thrust rod surface).
- Check all fixings are tight and secure.

STB

The STB is low maintenance and as such requires only minimal periodic inspection.

Where an external linear bearing is used, please consult the bearing manufacturer for recommendations on lubrication types and lubrication intervals.

Periodically:

- Check that the forcer can move freely over the entire stroke.
- Clean any accumulated debris from the thrust rod surface (ferrous material, in particular, can be attracted to the thrust rod surface).
- Check all fixings are tight and secure.
- Check all flexing cables for signs of wear or damage.

CORRECTIVE MAINTENANCE

CABLE REPLACEMENT

This procedure applies to both STA and STB versions.

If a cable needs to be replaced it will be necessary to change the complete cable assembly.

Removal

- Disconnect the cable assembly from the Accelnet Micro Panel Amplifier.
- Release the D-type connector retaining clip as shown in Figure 3.1.
- Unplug the connector and remove the cable assembly.

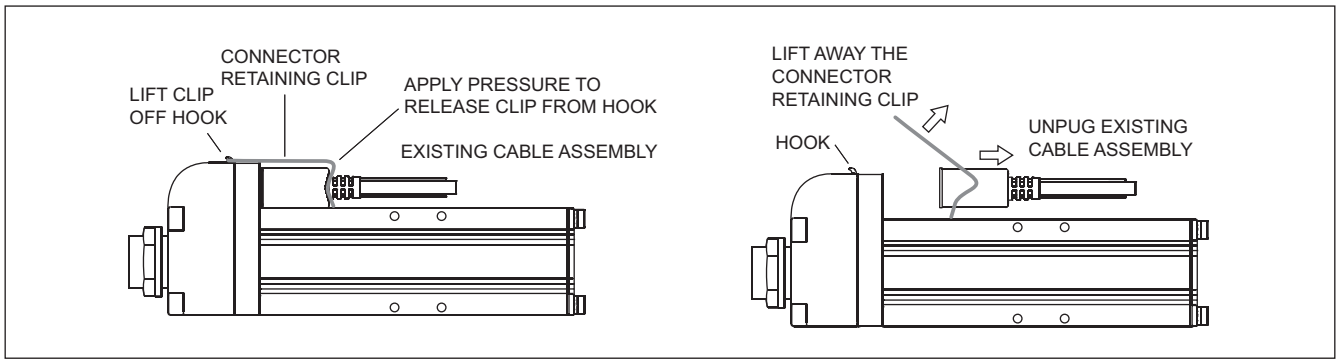

Figure 3.1 (left) Removing the retaining clip and (right) removing the cable assembly.

Replacement

- Plug the 15-pin D-type plug into the connector on the forcer and engage the connector retaining clip as shown in Figure 3.2.

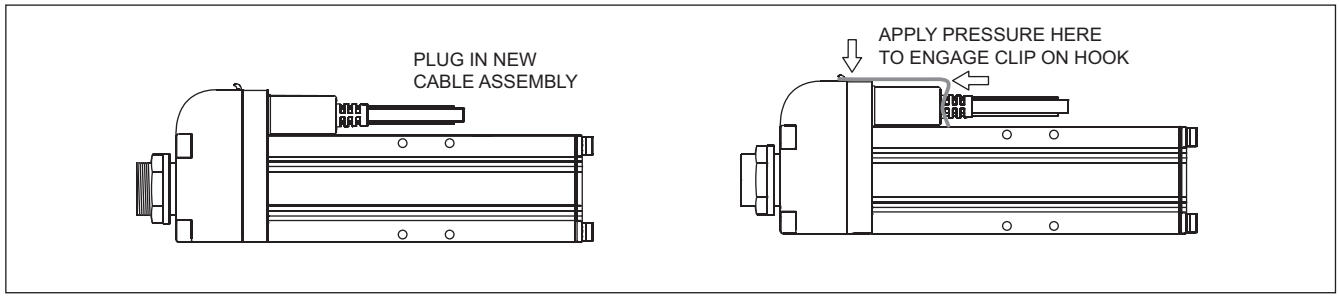

Figure 3.2 (left) Plugging in the new cable assembly and (right) fitting the retaining clip.

BEARING REPLACEMENT

This procedure applies only to the STA version.

There are two replaceable bearings, located one at each end of the housing.

Removal

- Withdraw the thrust rod away from the end containing the bearing to be replaced until the thrust rod disengages from the bearing, see Figure 3.3.

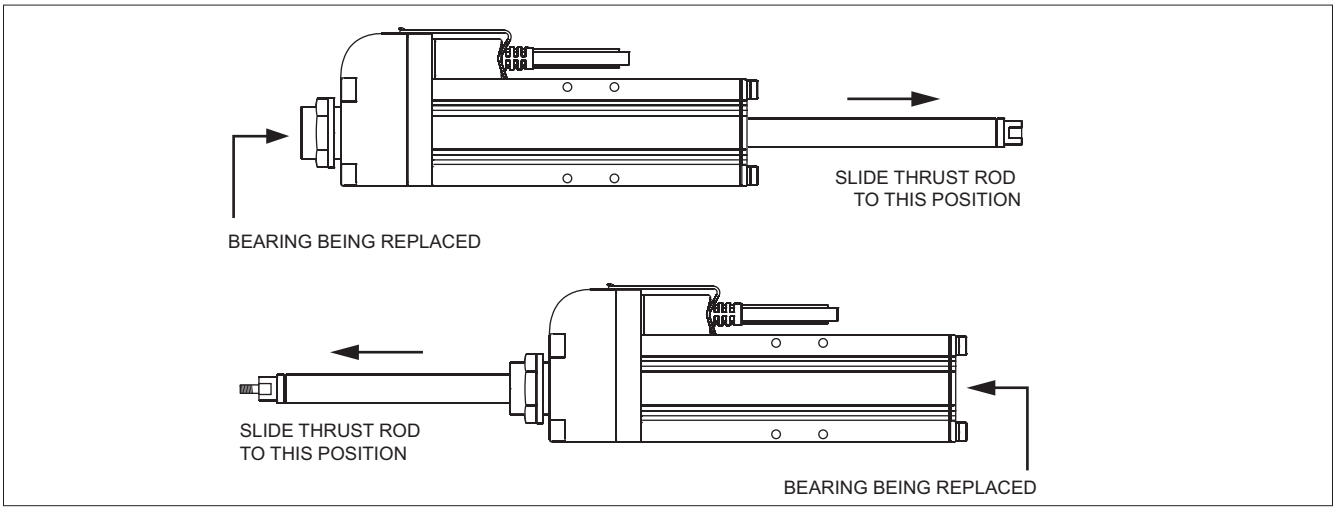

Figure 3.3 Positioning the thrust rod when removing a bearing.

- Use a small flat-blade screwdriver or similar, and rotate the spherical bearing through 90 degrees so that it aligns with the slot in the housing, see Figure 3.4.
- Push the thrust rod back into the housing until the rotated bearing is pushed out at the other end.

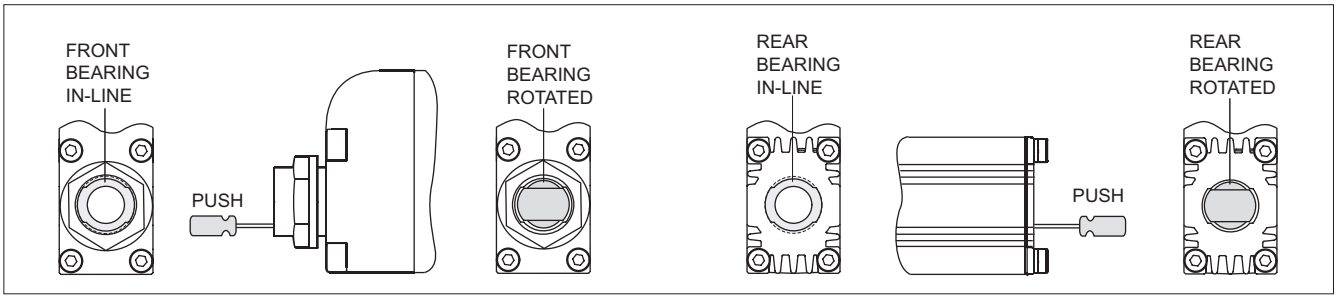

Figure 3.4 Setting the orientation of the front (left) and rear (right) spherical bearings.

Replacement

- Insert the bearing in the slot in the housing and push down gently. It will be in the rotated position shown in Figure 3.4.
- Use a small screwdriver to rotate the bearing through 90 degrees until it is in the in-line position as shown in Figure 3.4.
- Re-insert the thrust rod.

Chapter 4

Service

SERVICE

Should you need to return any items to Copley Motion Systems, before doing so, please call our Sales coordinator on +44 (0)1268 287070 or send a fax to +44 (0)1268 293344 in order to obtain an RMA (Returned Materials Authorisation) number. The RMA number should then be quoted on all items returned and quoted for all enquiries.

Please note that when returning items it is recommended that the original packaging be used.

SPARES

The available spares for the STA and STB are listed in Tables 4.1 and Table 4.2.

Table 4.1 Cables avaialable: terminated for Accelnet Micro Panel and with flying leads

Description	Accelnet Micro Panel	Flying leads
Non-flexing cables		
Cable length = 3m	180 475 123	450 480 143
Cable length = 5m	180 475 125	450 480 145
Flexing cables		
Cable length = 3m	180 475 133	450 480 153
Cable length = 5m	180 475 135	450 480 155

Table 4.2 Hardware

Description	Order Code
STA Polymer Bearing (kit of 2)	401 000 001
M20 plastic nut	150 583 056
Connector retaining clip	400 046 446
Connector lock inserts (kit of 2)	401 000 002

To place an order for spare parts please telephone or fax your order to the Sales co-ordinator:

Tel: +44 (0)1268 287070
Fax: +44 (0)1268 293344

Appendices

CONTENTS

Appendix A

Glossary of Terms & Abbreviations

GLOSSARY OF TERMS

TERM	DESCRIPTION OF TERM
Peak force	Peak force is the force produced when the peak current is applied to the motor. It is the product of Force constant (N/Apk) and Peak current (Apk). The motor is not moving, there is no forced cooling and no additional heat-sinking. The duration of the peak force is thermally limited and is therefore only allowable for a period of 1 second.
Continuous stall force	Continuous stall force is the force produced when the continuous current is applied to the motor. It is the product : Force constant (N/Apk) x Continuous stall current (Apk) or : Force constant (N/Arms) x Continuous stall current (Arms). The motor is not moving and there is no forced cooling. It is quoted with and without the addition of a 25 x 25 x 2.5 cm heatsink plate mounted with thermal grease to the mounting surface of the motor.
Peak current	Peak current is the current required to heat the motor phases to their maximum operating temperature when the ambient temperature is 25°C, the motor is not moving, there is no forced cooling and no additional heat-sinking. It is the maximum allowable current before demagnetisation of the magnets occurs when the magnet temperature is 100°C. The duration of the peak current is thermally limited and is therefore only allowable for a period of 1 second.
Continuous stall current	Continuous stall current is the current required to heat the motor phases to their maximum operating temperature when the ambient temperature is 25°C, the motor is not moving and there is no forced cooling. It is quoted with and without the addition of a 25 x 25 x 2.5 cm heatsink plate mounted with thermal grease to the mounting surface of the motor.
Force constant	Force constant is the peak force produced when 1 ampere (peak) flows into one phase and 0.5 ampere (peak) flows out of the remaining two phases (as in sinusoidal commutation) quoted in N/Apk. Alternatively, it is the peak force produced when 0.707 ampere (rms) flows into one phase and 0.353 ampere (rms) flows out of the remaining two phases (again as in sinusoidal commutation) quoted in N/Arms.
Back EMF	Back EMF constant is the peak phase to phase voltage generated when the motor is travelling at a velocity of 1m/s.
Fundamental motor constant	Fundamental motor constant is the continuous stall force divided by the square root of the power dissipated in the motor at that continuous stall force.
Eddy current loss	Eddy current loss is the amount of opposing force produced by the motor when it is travelling at a velocity of 1m/s.
Sleeve clogging force	Sleeve clogging force is the amount of force variation produced by having an iron sleeve. The variation is independant of motor current.
Resistance	Resistance is measured phase to phase at temperatures of 25°C and 100°C.
Inductance	Inductance is measured phase to phase at a frequency of 1 kHz. The actual value of inductance varies as the motor position varies so it is the minimum value that is quoted.

Electrical time constant	Electrical time constant is the time taken for a step current input to the motor to reach 63.2% of its value.
Continuous working voltage	Continuous working voltage is the maximum allowable continuous voltage between any two motor phases or between any motor phase and the motor safety earth.
Pole pitch	Pole pitch is the distance in millimetres for one complete electrical cycle (between like magnetic poles).
Power dissipation	Power dissipation is the maximum power that can be dissipated by the motor when the motor phases are at their maximum operating temperature, the ambient temperature is 25°C, the motor is not moving and there is no forced cooling. It is quoted with and without the addition of a 25 x 25 x 2.5cm heatsink plate mounted with thermal grease to the mounting surface of the motor.
Maximum phase temperature	Maximum phase temperature is the maximum operating temperature for the motor phases. It is limited to provide a safe operating temperature for the magnets.
Rthphase-houslng	Rthphase-houslng is the temperature rise from the motor housing to the motor phases for an input power of 1 watt to the motor. The motor is not moving, there is no forced cooling and no additional heatsinking.
Rthhousing-ambient	Rthhousing-ambient is the temperature rise from ambient temperature to the motor housing for an input power of 1 watt to the motor. The motor is not moving and there is no forced cooling. It is quoted with and without the addition of a 25 x 25 x 2.5cm heatsink plate mounted with thermal grease to the mounting surface of the motor.
Thermal time constant	Thermal time constant is the time taken for the motor phases to cool to 36.8% of the difference between motor phase and ambient temperatures when there is no current flowing, the motor is not moving there is no forced cooling and no additional heatsinking.

ABBREVIATIONS

The abbreviations used in this Guide are listed in the following table.

Apk	Ampere peak	PCB	Printed circuit board
Arms	Ampere root mean square	PUR	Polyurethane
AWG	American Wire Gauge	PVC	Poly Vinyl Chloride
COS	cosine	s	second
d.c.	direct current	SIN	sine
EMC	Electro-Magnetic Compatibility	TYP	Typical
EMF	Electro-Motive Force	UL	Underwriters Laboratory
kg	kilogramme	V	Volt
m	metre	Vpk	Volt peak
mA	milliampere	Vpk-pk	Volt peak to peak
mH	millihenry	Vrms	Volt root mean square
mm	millimetre	W	Watt
MTG	Mounting	°C degrees	Celsius
N	Newton	mm	micrometre (micron)
PTC	Positive Temperature Coefficient		

Appendix B

Troubleshooting

TROUBLESHOOTING CHART

Check to see if the problem you are experiencing is listed in the chart below. If the problem cannot be solved with reference to this chart, contact the customer services department.

Fault	Possible cause	Action
Forcer/thrust rod fails to move and produces no force.	1. Drive not powered.	1. Apply power to drive.
	2. Forcer phase connections not made.	2. Check forcer phase connections on drive.
	3. Forcer over-temperature sensor not connected.	3. Check forcer over-temperature sensor connections on drive.
	4. Forcer over-temperature.	4. Allow forcer to cool.
Forcer/thrust rod fails to move but does produce force.	1. One or more motor phase connections not made or made incorrectly.	1. Check forcer phase connections on drive.
	2. One or more position sensor connections not made or made incorrectly.	2. Check position sensor connections on drive.
	3. Forcer/thrust rod mechanically blocked.	3. Check forcer/thrust rod is free to move.
Forcer/thrust rod moves but is jerky in motion.	Incorrect pole pitch set up or phase offset between position sensor and forcer back emf.	Check drive or controller set up.
Forcer/thrust rod moves in wrong direction.	One or more position sensor and forcer phase connections made incorrectly.	Check position sensor and forcer phase connections on drive.

Appendix C

Technical Datasheet

ELECTRICAL SPECIFICATIONS

FORCER TYPE	1104	1108	1112	1116	Units
Peak force @ 25°C ambient for 1 sec	46.0	53.0	68.9	91.9	N
Peak current @ 25°C ambient for 1 sec	12	12	12	12	A_{pk}
With 25 x 25 x 2.5 cm heatsink plate					
Continuous stall force @ 25°C ambient (1)	9.27	15.78	21.44	26.75	N
Continuous stall current @ 25°C ambient	1.71	2.52	2.64	2.47	A_{rms}
	2.41	3.56	3.74	3.50	A_{pk}
Without heatsink plate					
Continuous stall force @ 25°C ambient (1)	6.02	10.83	15.18	19.28	N
Continuous stall current @ 25°C ambient	1.11	1.73	1.87	1.78	A_{rms}
	1.58	2.45	2.64	2.52	A_{pk}
Force constant (sine commutation)	5.42	6.26	8.12	10.83	N/A_{rms}
	3.83	4.42	5.74	7.66	N/Apk
Back EMF constant (phase to phase)	4.42	5.10	6.63	8.84	Vpk/m/s
Fundamental motor constant	1.75	2.49	3.05	3.52	$N/\sqrt{W}$
Eddy current loss	0.38	0.76	1.14	1.52	N/m/s
Resistance @ 25°C (phase to phase)	4.90	3.27	3.68	4.91	Ohm
Resistance @ 100°C (phase to phase)	6.32	4.29	4.74	6.31	Ohm
Inductance @ 1kHz (phase to phase)	1.15	0.99	0.87	1.15	mH
Electrical time constant	0.23	0.23	0.23	0.23	ms
Maximum working voltage	75	75	75	75	V d.c.
Pole pitch (one electrical cycle)	25.6	25.6	25.6	25.6	mm
Peak acceleration (2) (STA)	407	359	378	422	m/s^2
Maximum speed (3) (STA)	5.3	5.6	5.4	4.7	m/s
Peak acceleration (4) (STB)	155	119	109	120	m/s^2
Maximum speed (5) (STB)	5.2	5.2	3.9	3.1	m/s

Notes

(1) Reduce continuous stall force to 89% at 40°C ambient.
(2) Based on a moving thrust rod with 14 mm stroke and no payload.
(3) Based on a moving thrust rod with triangular move over maximum stroke and no payload.
(4) Based on a moving forcer with typical bearings and no payload.
(5) Based on a moving forcer with triangular move over maximum stroke and no payload.

THERMAL SPECIFICATIONS

MOTOR TYPE	1104	1108	1112	1116	Units
Maximum phase temperature	100	100	100	100	°C
Thermal resistance $R_{thphase-housing}$	1.48	0.72	0.47	0.35	°C/W
With 25 x 25 x 2.5 cm heatsink plate					
Power dissipation @ 25°C ambient	27.6	40.1	49.7	58.0	Watt
Thermal resistance $R_{thhousing-ambient}$	1.24	1.15	1.04	0.94	°C/W
Without heatsink plate					
Power dissipation @ 25°C ambient	11.8	18.9	24.8	30.0	Watt
Thermal resistance $R_{thhousing-ambient}$	4.88	3.24	2.55	2.15	°C/W
Thermal time constant	142	176	202	223	s

MECHANICAL SPECIFICATIONS

FORCER TYPE	1104	1108	1112	1116	Units
Maximum stroke (STA)	245	245	271	271	mm
Maximum stroke (STB)	240	390	520	650	mm
Forcer mass (excluding thrust rod and cable)	188	375	563	750	gram
Thrust rod mass/metre	0.68	0.68	0.68	0.68	kg/m
Integrated bearing type (STA only)	2 x plastic polymer, self-lubricating, self-aligning				-

POSITION SENSOR

The position sensor outputs analogue, differential sine and cosine signals for providing position feedback. Figure C.1 shows the relationships between forcer phase back EMF and position sensor outputs for one direction of motion (as shown by arrows in Figures C.1 and C.2).

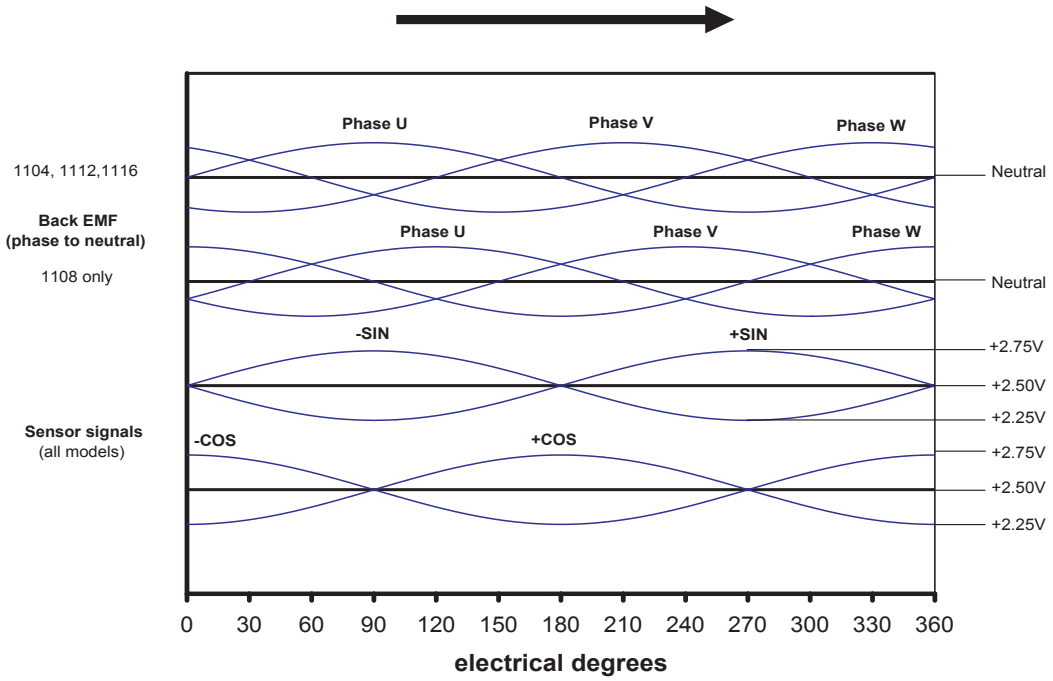

Figure C.1- The relationships between motor phase back EMF and position sensor outputs

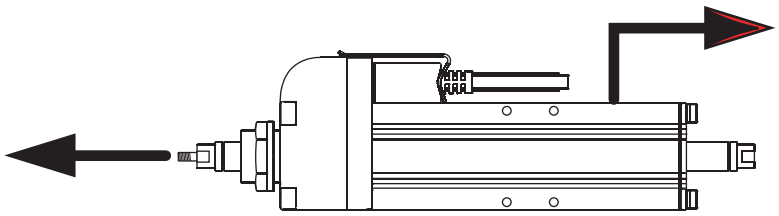

Figure C.2 - Arrows indicate direction of motion

SPECIFICATION	VALUE	UNITS
Output signal period	25.6	mm
Signal amplitude (between +/- signals)	1	Vpk-pk
Output current	±10	mA
Supply voltage	5 ± 0.25	V d.c.
Supply current (output current =0)	32 ± 5	mA
Resolution (1)	8	mm
Position Repeatability (2)	±12	mm
Absolute Accuracy (3)	±350	mm/m

Notes

(1) Dependent on amplifier.

(2) Dependent on amplifier. Under constant operating conditions. Self-heating of the forcer will cause expansion in the thrust rod by the motor will cause expansion in the thrust rod during the initial warm up period. In high duty applications (corresponding to an internal forcer temperature of 80°C) a 0.5 metre thrust rod will expand typically by 125 microns.

(3) Maximum error over 0.5 metre under constant operating conditions.

MOTOR OVER TEMPERATURE SENSOR

It is strongly recommended that the forcer over-temperature sensor is connected to the drive amplifier or servo controller **at all times** in order to reduce the risk of damage to the forcer due to excessive temperatures.

Protection is provided by three, positive temperature coefficient (PTC) thermistors embedded in the forcer phases. As the forcer phase temperature approaches 100°C, the PTC thermistors exhibit a sharp increase in electrical resistance. This change in resistance can be detected by circuitry within the drive amplifier or servo controller and used to reduce or disable the output of the drive amplifier in order to protect the forcer.

SPECIFICATION	VALUE	UNITS
Resistance at 25°C	235 to 705	Ohms
Resistance at 95°C	4,700	Ohms
Resistance at 100°C	10,000	Ohms
Maximum continuous voltage	32	Vd.c.

CABLE OPTIONS

The ServoTube 11 has a cable assembly that comprises power and sensor cables with a 15-way high density D-sub female connector for direct connection to the forcer. There are two cable types available. Both cable types are available in 3 metre or 5 metre lengths.

Option S cables are flexible but are not intended for continuous flex or energy chain applications.

OPTION 'S' SPECIFICATION	POWER	SENSOR
Overall diameter (nominal)	5.3 mm	6.5 mm
Outer jacket material	PVC	PVC
Number of conductors	4	4 x twisted pair
Size of conductors	0.34mm^2 (22 AWG)	0.14mm^2 (26AWG)
Screened / Unscreened	Screened	Screened
Minimum bending radius-fixed routing	27mm	33mm
Operating temperature-fixed routing	-30°C to +70°C	-30°C to +70°C

Option R cables are suitable for continuous flex or energy chain applications.cables are standard on the STB.

OPTION 'R' SPECIFICATION	POWER	SENSOR
Overall diameter (nominal)	4.7 mm	5.8 mm
Outer jacket material	PUR	PUR
Number of conductors	4	4 x twisted pair
Size of conductors	0.34mm^2 (22 AWG)	0.14mm^2 (26AWG)
Screened / Unscreened	Screened	Screened
Minimum bending radius - flexible routing	36mm	44mm
Operating temperature - flexible routing	-40°C to +90°C	-40°C to +90°C
Operating temperature - flxed routing	-50°C to +90°C	-50°C to +90°C

FORCER ELECTRICAL CONNECTIONS

All connections to the forcer are made using the cable assembly supplied. This is terminated with a high-density 15-pin D-type female which mates with the connector on rear of the forcer pod as shown in Figure C.3. The connector is held secure by the retaining clip arrangment.

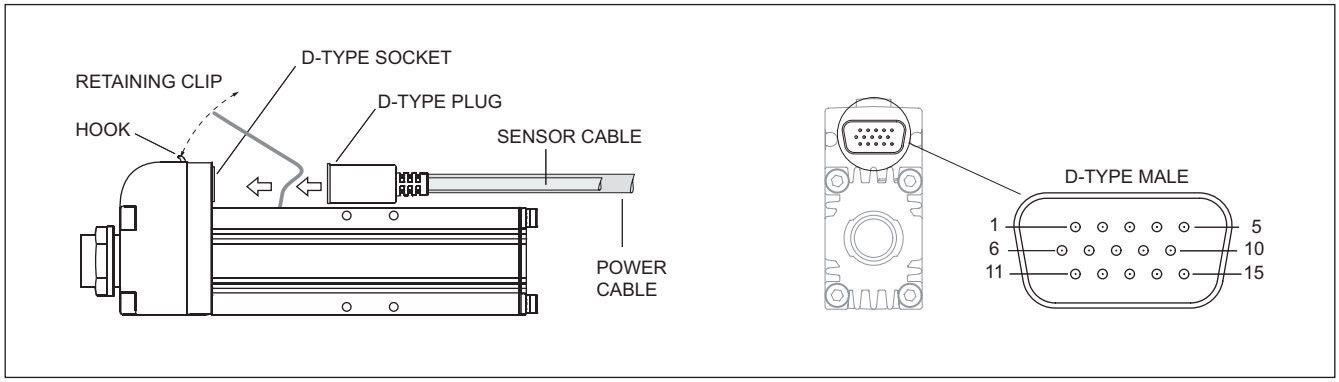

Figure C.3 Shows connecting the cable assembly to the forcer and connector details

The pinout details for this connector is shown below.

FUNCTION	15-PIN D-TYPE
+SIN	Pin 1
-SIN	Pin 2
+COS	Pin 3
-COS	Pin 4
+5Vd.c.	Pin 5
0V	Pin 6
+TH (Thermistor)	Pin 7
-TH (Thermistor)	Pin 8
Factory use only	Pin 9
Factory use only	Pin 10
No connection	Pin 11
Earth (forcer body)	Pin 12
Forcer phase U	Pin 13
Forcer phase V	Pin 14
Forcer phase W	Pin 15
SCREEN	Connector body

CABLE TERMINATIONS

The ServoTube 11 cable is available with two termination options.

- **Option F** has the wire ends stripped and solder tinned ready for termination.
- **Option C** is terminated with connectors that plug directly into a Copley Accelnet Micro Panel amplifier (ACJ-S).

The connections for both options are shown in the table below.

FUNCTION	F-FLYING LEADS	C-ACCELNET MICRO PANEL
Sensor		
Amplifier connection	NA	J4
Connector type	NC	Samtec IPD1-07-D
+SIN	Blue	J4, pin 8
-SIN	Red	J4, pin 1
+COS	White	J4, pin 9
-COS	Brown	J4, pin 2
+5Vd.c.	Yellow	J4, pin 4
0V	Green	J4, pin 11
+TH (Thermistor)	Pink	J4, pin 7
-TH (Thermistor)	Grey	J4, pin 6
SCREEN	SCREEN	J4, pin 14
Power		
Amplifier connection	NA	J2
Connector type	NC	Molex 39-01-4051
Forcer phase U	Yellow	J2, pin 4
Forcer phase V	White	J2, pin 3
Forcer phase W	Brown	J2, pin 2
Earth (forcer body)	Green	J2, pin 1
SCREEN	SCREEN	J2, pin 1

ENVIRONMENT

The ServoTube 11 is intended for use in an environment within the following conditions defined in the table below.

SPECIFICATION	VALUE
Operating temperature	0°C to +40°C
Storage temperature	-25°C to +70°C
Ingress protection	IP67
Altitude (above mean sea level)	1000m
Overvoltage category	II
Pollution degree	2
EMC	Light industrial

In addition In addition, the ServoTube 11 is available with two environmental coating options. **Option S** has the forcer body coated with a 25 micron layer of black anodise that is suitable for general use. **Option H** has the forcer body coated with a 90 micron layer of hard natural anodise that is suitable for harsher environments.

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