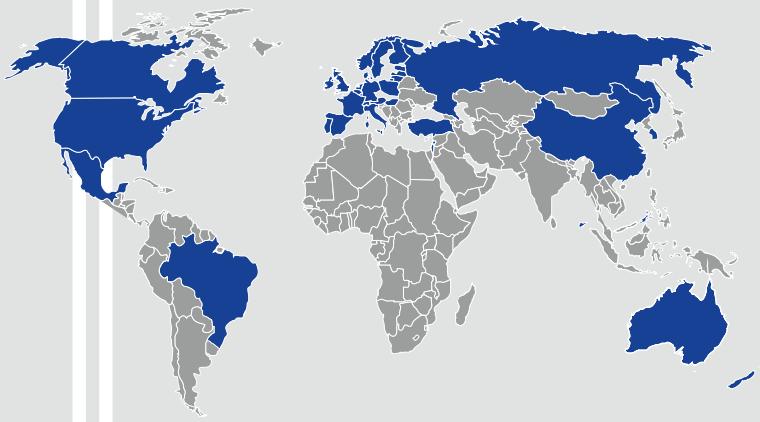


ServoTube 11 Module
User guide

Operating Manual ServoTube 11 Module
Publication Ref: UM03017/B

Betriebanaleitung ServoTube 11 Module
Publikation Ref: UM03017/B

Dunkermotoren GmbH | Allmendstraße 11 | D-79848 Bonndorf/ Schwarzwald
Phone +49 (0) 7703 930-0 | Fax +49 (0) 7703 930-210/ 212 | info@dunkermotoren.com

Version 08/2017

ADVANCED MOTION SOLUTIONS

WARRANTY

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

Dunkermotoren 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 Dunkermotoren.

DISCLAIMER

Dunkermotoren makes no guarantees of any kind with regard to this User Guide. Dunkermotoren 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 Module described in this User Guide, please contact the Sales department, Telephone : +49 (0)7703 930-0.

ServoTube 11 Module
USER GUIDE

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 forcer phase connections.

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

Heavy object. May need two people to lift.

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 sensor 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.
- Ensure compliance with any local electrical and EMC regulations in force at the time of installation. This is the responsibility of the User.

READER'S NOTES

GENERAL

This manual describes the Installation, Maintenance and Spares of the ServoTube module.

ASSOCIATED PUBLICATIONS

The following publications are associated with the ServoTube 11 Module User Guide.

Title	Reference Number
ServoTube 11 Module Data sheet	DS01101/A
C-Accelnet Micro Panel User Guide	-
C-Accelnet Micro Panel Data sheet	-

Chapter 1

Product Overview

The ServoTube Module with fully integrated bearing rail and position encoder offers unprecedented value in high performance applications. The ServoTube Module is a cost effective alternative to ballscrew and belt drive systems where high speed and flexibility are required.

Four models deliver a continuous force of 9~27N (2~6lb) with peak forces of up to 92N (21lb). Standard stroke lengths of 28~825 mm are available.

The magnetic design of ServoTube generates 12 micron repeatability and 350 micron absolute accuracy, from a non-contact, integral position sensor. The standard ServoTube position encoder output is an industry standard 1V pk-pk sin/cos signal. For applications requiring higher levels of accuracy, the ServoTube Module is available with a fully integrated optical position encoder giving a resolution of up to 1 micron.

The non-contact nature of the direct linear drive results in life expectancy far above that for typical belt drive and ballscrew systems, with the added advantage of no deterioration in accuracy or repeatability over the entire life of the product.

The ServoTube Module is an ideal OEM solution for easy integration into pick-and-place gantry and general purpose material handling machines. The load is mounted directly to the forcer giving a very stable base. Servotube Modules can be easily integrated with each other or with other ServoTube products to create multi axis systems with minimal design effort.

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

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

Chapter 2

Installation

UNPACKING

- Check packaging for signs of damage.
- Remove packaging. Do not discard. In the event of items requiring return, it is recommended that the original packaging be used.
- Metal surfaces may be hot or below 0°C following prolonged storage.
- 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 °C to +70 °C
Altitude (above mean sea level)	1000 m
Overvoltage category	II
Pollution degree	2
EMC	light industrial

Mechanical

Mounting module to user's surface

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

For all modules, ensure that the mounting surface is as flat as possible. The module can be mounted by two methods:

- Using the system clamp top fixings. Both sides should be clamped with a distance between clamp centres of no more than 100 mm. Each M4 bolt should be tightened to a torque of 4 Nm.
- Using the M4 T-nut slots on the underside of the module. This requires access from underneath the mounting surface. Both sides should be fixed with a distance between fixing centres of no more than 100 mm. Each M4 bolt should be tightened to a torque of 4 Nm.

Mounting user's payload to module moving forcer

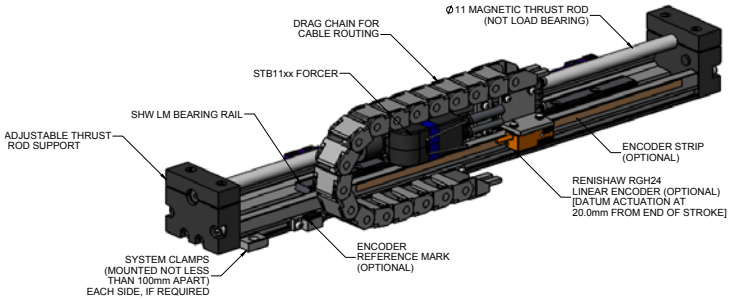
The payload is mounted to the moving forcer top surface using the M3 clearance holes.

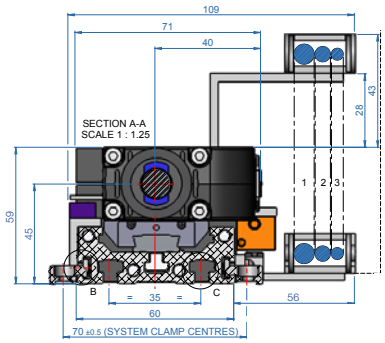
OUTLINE DRAWINGS

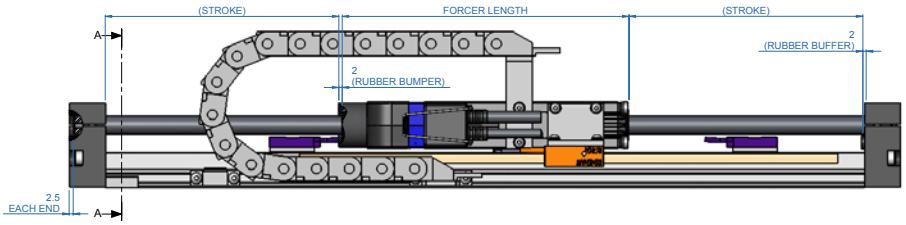
FORCER	LENGTH (mm)	WITH BUFFERS	APPROXIMATE MODULE MASS (kg)
1104	123.7	127.7	0.661 + (0.003251 x System Length In mm)
1108	174.9	178.9	0.758 + (0.003251 x System Length In mm)
1112	226.1	230.1	0.958 + (0.003251 x System Length In mm)
1116	277.0	281.0	1.086 + (0.003251 x System Length In mm)

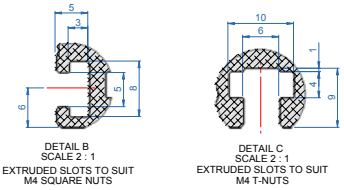
CABLES:

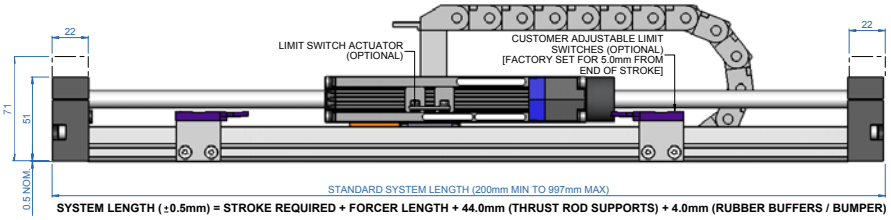
1. Ø7.6 POWER CABLE
2. Ø5.8 SENSOR CABLE
3. Ø4.5 ENCODER CABLE (OPTIONAL)











SYSTEM LENGTH (±0.5mm) = STROKE REQUIRED + FORCER LENGTH + 44.0mm (THRUST ROD SUPPORTS) + 4.0mm (RUBBER BUFFERS / BUMPER)

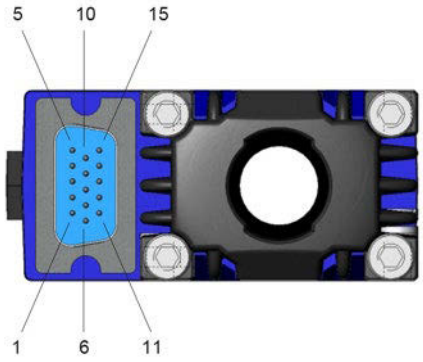
STROKE TABLES

Length	Stroke			
	1104	1108	1112	1116
200	28	-	-	-
226	54	-	-	-
251	79	28	-	-
277	105	54	-	-
303	131	80	28	-
329	157	106	54	-
354	182	131	79	29
380	208	157	105	55
406	234	183	131	81
431	259	208	156	106
457	285	234	182	132
483	311	260	208	158
508	366	285	233	183
534	362	311	259	209
560	388	337	285	235
586	414	363	311	261

Length	Stroke			
	1104	1108	1112	1116
611	439	388	336	286
637	465	414	362	312
663	491	440	388	338
688	516	465	413	363
714	542	491	439	389
740	568	517	465	415
765	593	542	490	440
791	619	568	516	466
817	645	594	542	492
843	671	620	568	518
868	696	645	593	543
894	722	671	619	569
920	748	697	645	595
945	773	722	670	620
971	799	748	696	646
997	825	774	722	672

Electrical

Connections to the forcer are made via a 15-way high density D-sub male connector which is fitted to the forcer. The pin-outs are shown in the diagram below and the pin functions shown in the table.



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

Cable assembly

The ServoTube Module 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 male connector on the forcer. The cables are available in 3 metre and 5 metre lengths.

The cables are suitable for continuous flex or drag chain applications.

OPTION R SPECIFICATION	POWER	SENSOR
Overall diameter (nominal)	4.7mm	5.8mm
Outer jacket material	PUR	PUR
Number of conductors	4	4 x twisted pair
Size of conductors	0.34mm^2 (22 AWG)	0.14mm^2 (26 AWG)
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

Cable terminations

The ServoTube Module 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.

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

LIMIT SWITCHES

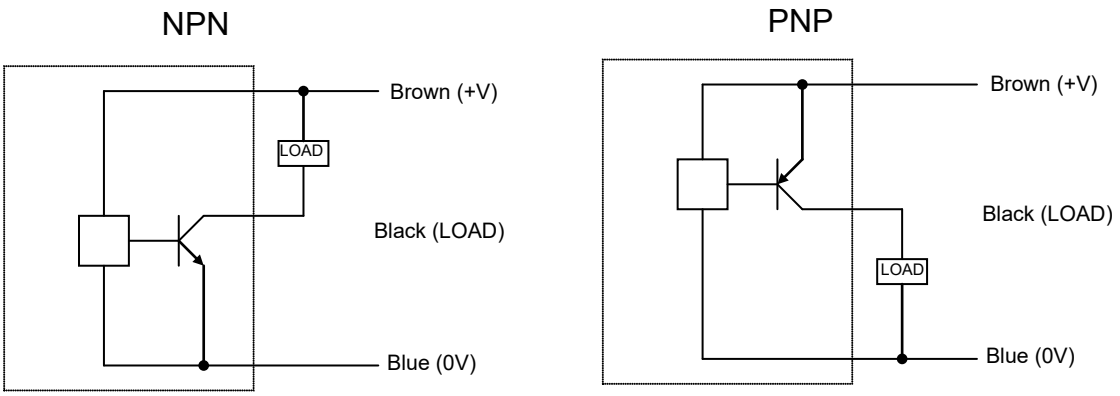
WARNING. These limit switches are not intended as safety devices or as part of a system intended to ensure personal safety. When two switches are mounted in close proximity (as in the case of a left and right limit switch), a minimum of 30mm spacing between sense areas must be maintained.

If ordered, the ServoTube Module can be supplied with two limit switches fitted. There are two types available, NPN output and PNP output. Each output type is available with 5 metres of cable suitable for continuous flexing. Each limit switch position is adjustable and switching is achieved by an actuator vane mounted on the forcer. Electrical connections are made via wire ends stripped and solder tinned ready for termination.

SPECIFICATION	VALUE			
	minimum	typical	maximum	units
Supply voltage	10	24	30	Vd.c.
Supply current	-	15	-	mA
Sink current	-	-	100	mA
“Closed” voltage	-	-	1	Vd.c.
Frequency response	-	-	600	Hz

The output for all types can be normally closed (NC) or normally open (NO) open collector transistor. The NC ouptuts switch open when a limit is detected and current stops flowing in the LOAD. The NO outputs switch closed when a limit is detected and current starts flowing in the LOAD.

A red indicator shows the output status.



OVER-TEMPERATURE SENSOR

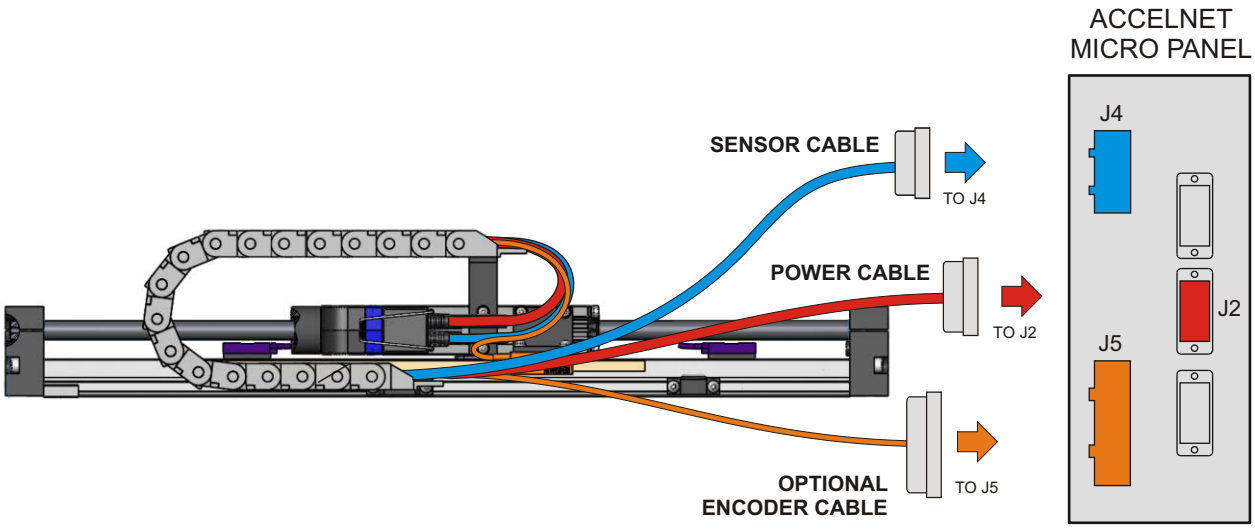
CAUTION. It is strongly recommended that the forcer over-temperature sensor is connected to the drive amplifier or servo controller <u>at all times</u> in order to reduce the risk of damage to the forcer due to excessive temperatures.

OPTIONAL ENCODER

If an additional encoder (Renishaw) has been supplied, there will be a third cable to connect to the amplifier. The Renishaw encoder cable is terminated in 9-pin D-type plug. An adaptor cable is supplied to allow the sensor to connect to the amplifier at connector J5.

CONNECTING TO AN AMPLIFIER

Connection details to the Accelnet Micro Panel Amplifier are shown in the diagram below.



Chapter 3

Maintenance

WARNING

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

PREVENTATIVE MAINTENANCE

BEARING SYSTEM

The ServoTube 11 modules are supplied as complete, ready to use mechanical systems. Each system incorporates a profile rail re-circulating ball bearing system for support and guidance. The bearing carriages, to which the moving forcer is attached, are fully charged with grease before delivery. This grease will last for the life of the bearing system and there are no means to regrease the bearing carriages.

THRUST ROD

The thrust rod must be kept clean and central to the forcer bore to avoid damage to the windings inside the forcer. Check that the thrust rod is centrally aligned by moving the forcer along the entire length of the thrust rod and observing the gap between the thrust rod and forcer bore.

If the thrust rod is becoming polished in places, this is usually an indication that the forcer is coming into contact with the thrust rod. Check the surface of the thrust rod for any raised areas that may damage the inside lining of the forcer. A soft cloth can be used to clean the thrust rod and self adhesive tape can be used to lift off any ferrous debris that may be attracted to it.

FORCER

Forcers have a fluoropolymer inner lining that does not require maintenance. However, when carrying out checks, a visual inspection should be made to ensure there is nothing trapped in the ends of the forcer.

CABLES

Check that all connecting cables are secured and not under strain. Inspect cables for signs of wear.

ENCODER (WHERE FITTED)

The encoder scale should be cleaned with a soft, lint free cloth to remove any oil, grease or dirt. Under no circumstances must solvents be used on optical encoder scales as the protective lacquer coating may become damaged.

CORRECTIVE MAINTENANCE

The corrective maintenance by the user is limited to the following items:

- Power and Sensor cable assembly
- Thrust rod
- Forcer
- Encoder readhead (integral cable)

CABLES

If a power or sensor cable needs to be replaced, it will be necessary to change the complete cable assembly.

Note. *It is not possible to replace an encoder cable. If an encoder cable needs replacing, the complete encoder assembly will have to be replaced. See ENCODER READHEAD on page 22 in this chapter.*

CAUTION. If the optional Renishaw encoder is fitted, it has an integral cable that also runs through the drag chain. Take care not to damage this item when releasing the other cables.

Removal

- Disconnect the cable assembly from the Accelnet Micro Panel Amplifier, if connected.
- Unclip the covers of all links in the drag chain. These are shown coloured green in Figure 3.1.

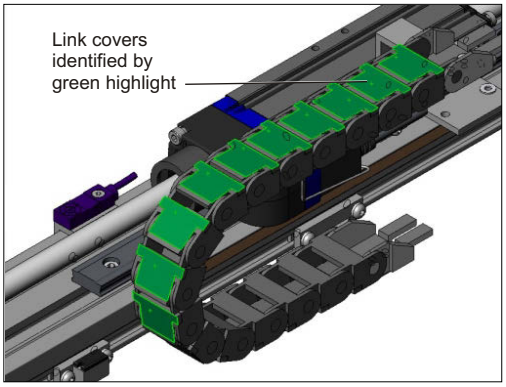


Figure 3.1

- They can be removed as a single item by progressively pulling up the tongue of the first cover until all are unclipped, see Figure 3.2.

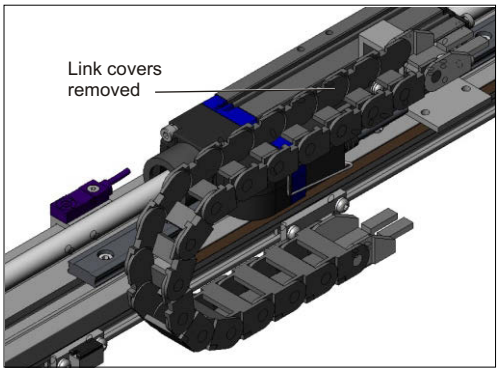


Figure 3.2

- Remove any cable ties that have been used to hold the cables in position.
- Release the D-type connector retaining clip as shown in Figure 3.3 and Figure 3.4

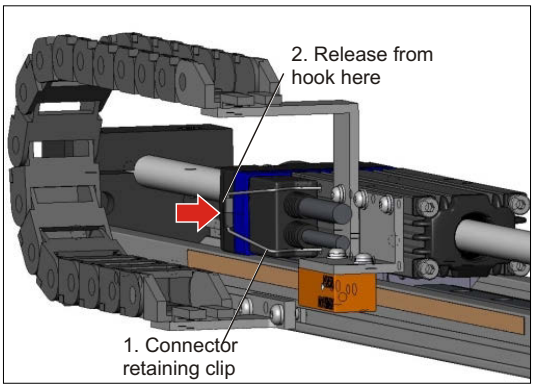


Figure 3.3

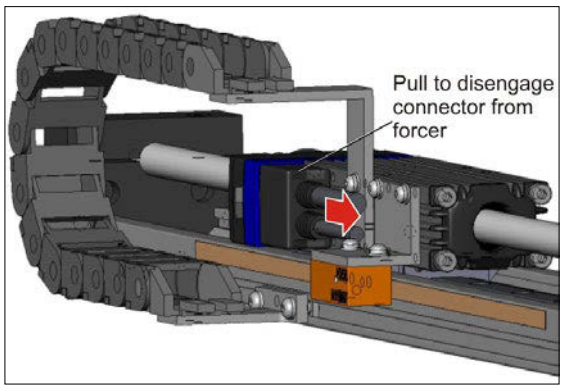


Figure 3.4

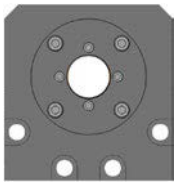
- Unplug the connector and remove the cable assembly from the module.
- Remove the cable assembly from the drag chain.

Replacement

Re-fitting the cable assembly is the reverse of the removal procedure.

- Plug in the replacement cable15-way D-type plug into the connector on the forcer and engage the connector retaining clip as shown in Figure 3.3.
- Place the cable assembly inside the drag chain.
- Fit new cable ties to secure the cables as originally fitted.
- Re-clip the drag-chain covers that were previously unclipped.
- Reconnect the cable assembly to the Accelnet Micro Panel Amplifier.

THRUST ROD



One of two types of thrust rod end supports are fitted to the module. If the thrust rod end supports fitted are as shown right, it is not recommended that thrust rod replacement is attempted. In this case the complete module must be returned to the supplier for replacement to be carried out. For the type of thrust rod support shown in Figure 3.5, carry out the following procedure.

Removal

- Move the forcer to the centre of the module, Figure 3.5.

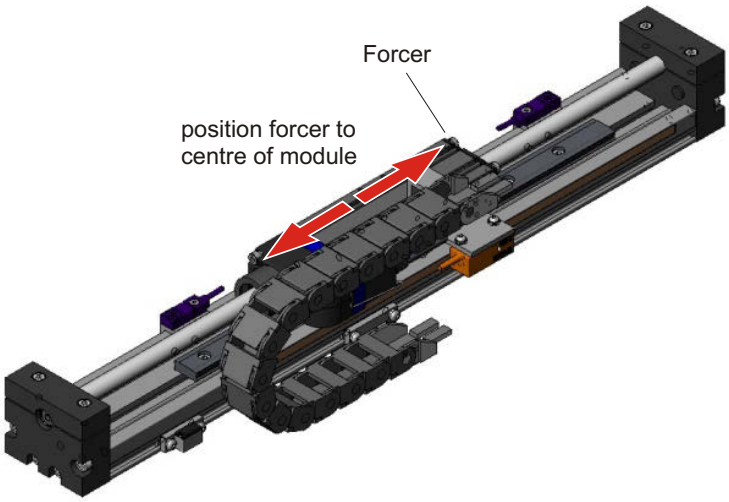


Figure 3.5

- Place spacers around or under the thrust rod to prevent it coming into contact with the bearing rail or other ferrous material. Foam pipe insulation or wooden blocks are ideal for this.
- Loosen the two M4 bolts on each of the thrust rod end supports, see Figure 3.6.

WARNING. If people with Pacemaker work with this equipment, the Pacemaker could interfere or fail.

» People with Pacemakers or metal implants must not handle or work with the thrust rod

CAUTION. Thrust Rod contains powerful magnetic components and must be handled with care. If you do not follow the instructions below, it may cause personal injury, such as bruises, up to amputation of limbs (e.g. fingers).

» Only handle one rod at a time

» Never remove safety sleeving if not absolutely necessary, and handle/transport the thrust rods in the original packaging

» Never use thrust rod, if it appears damaged

CAUTION. The linear modules can be particularly heavy and can not be lifted alone.

» Lift linear modules always together with another person

NOTICE. The magnetic field from the thrust rod can damage magnetic media and credit cards when in close proximity.

» Keep away any magnetic media and credit cards from the thrust rod

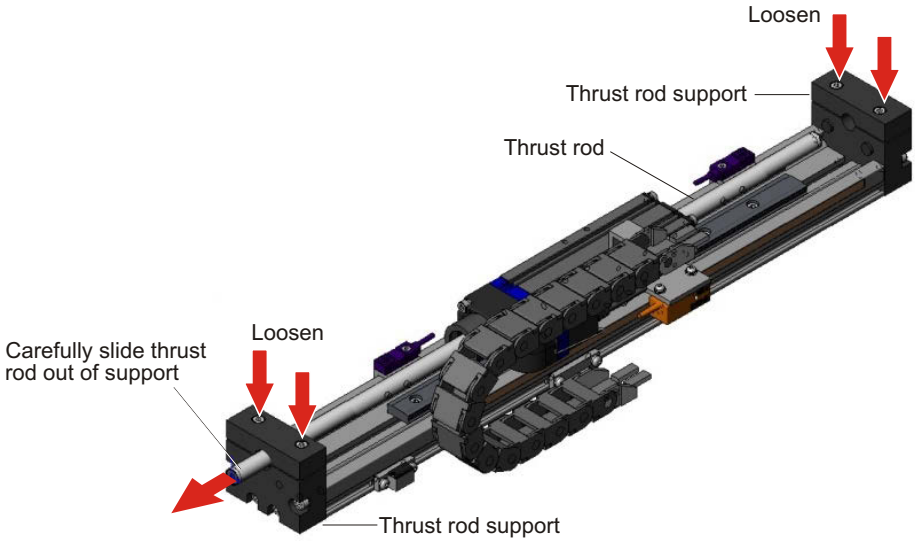


Figure 3.6

- Carefully slide the thrust rod out through the thrust rod supports and forcer (Figure 3.13) until it is clear of the module assembly, see Figure 3.7.
- Store the thrust rod in a safe place away from ferrous material.

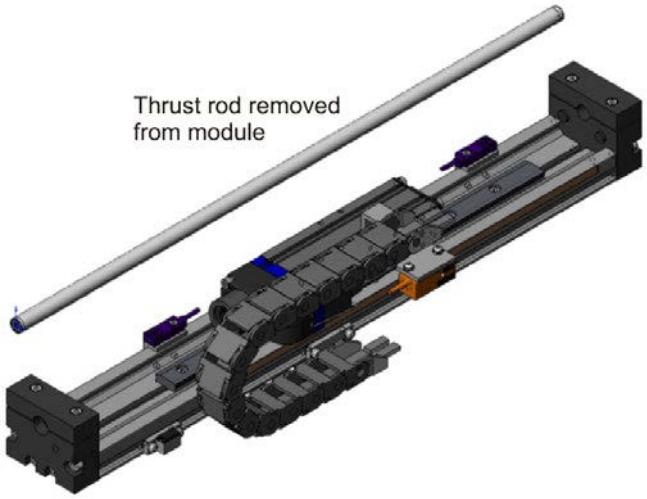


Figure 3.7

Replacement

- Carefully slide the replacement thrust rod in through the first thrust rod support. Place spacers around or under the thrust rod as soon as it passes through the thrust rod support.
- Continue to slide the thrust rod to pass through the forcer and into the other thrust rod support.
- When it is correctly positioned, tighten the M4 fixings in each of the thrust rod supports to a torque of 2 Nm.

FORCER

When the forcer is removed from the module, it will have the following items attached that will need to be transferred to the replacement forcer.

- Bearing carriage(s). There will be 1 or 2 bearing carriages depending on the particular version.
- The encoder readhead bracket fitted with the encoder readhead.
- The limit switch actuator if fitted.
- The drag chain upper mounting bracket.

Removal

- Remove the thrust rod as described on page 18.
- If the Renishaw encoder is fitted, follow the procedure for cable removal described on page 16 and free the cables in the drag chain and carefully withdraw the encoder cable from drag chain.
- Remove the drag chain link that secures the drag chain to the drag chain upper mounting bracket which is fitted to the forcer.
- Unplug the power /sensor cable assembly from the forcer as described on page 17.

The removal of the forcer requires a thrust rod support to be removed.

- Undo and remove the four M5 fixings securing one of the thrust rod supports to the backing bar and slide the thrust rod support out of the backing bar, see Figure 3.8.
- Remove the forcer by sliding it off the bearing rail, Figure 3.9. Take care to keep the forcer square to the bearing rail so that balls are not lost from the re-circulating bearing carriage. If balls do fall out they can be re-inserted into the carriage. Push the ball bearings using a small screwdriver into the end of the re-circulating path at the plastic end plates on the carriage.

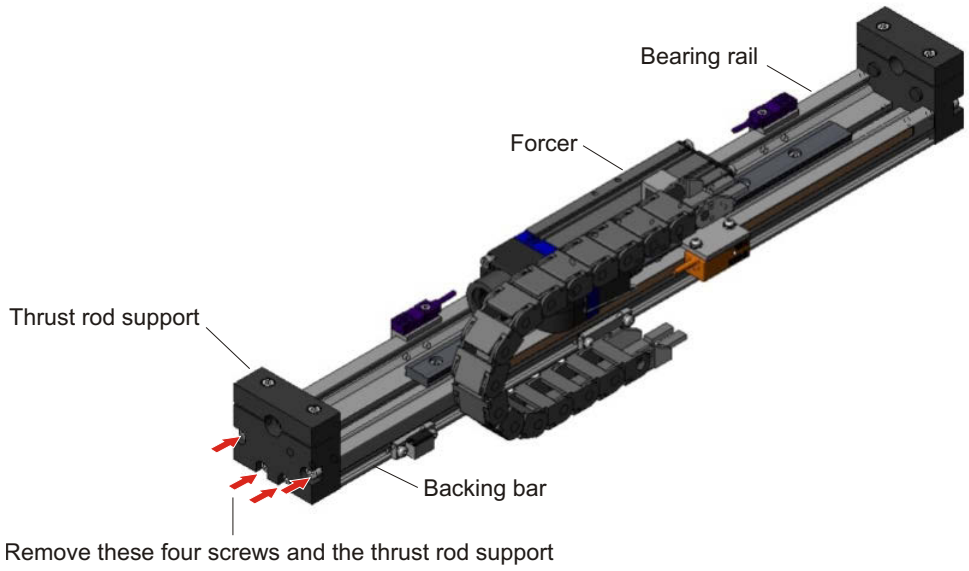


Figure 3.8

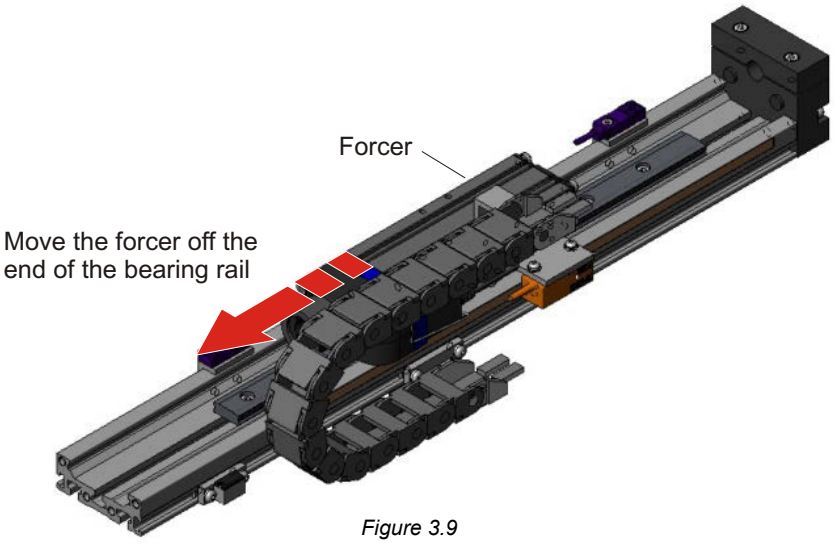


Figure 3.9

Preparation of replacement forcer

Refer to Figure 3.10. Transfer the following items from the removed forcer to the replacement forcer:

- The bearing carriage. Align the bearing carriage to be 0.5 mm below and parallel to the edge of the forcer.
- The encoder readhead bracket fitted with the encoder readhead (optional items).
- The limit switch flag (optional).
- The drag chain upper mounting bracket.

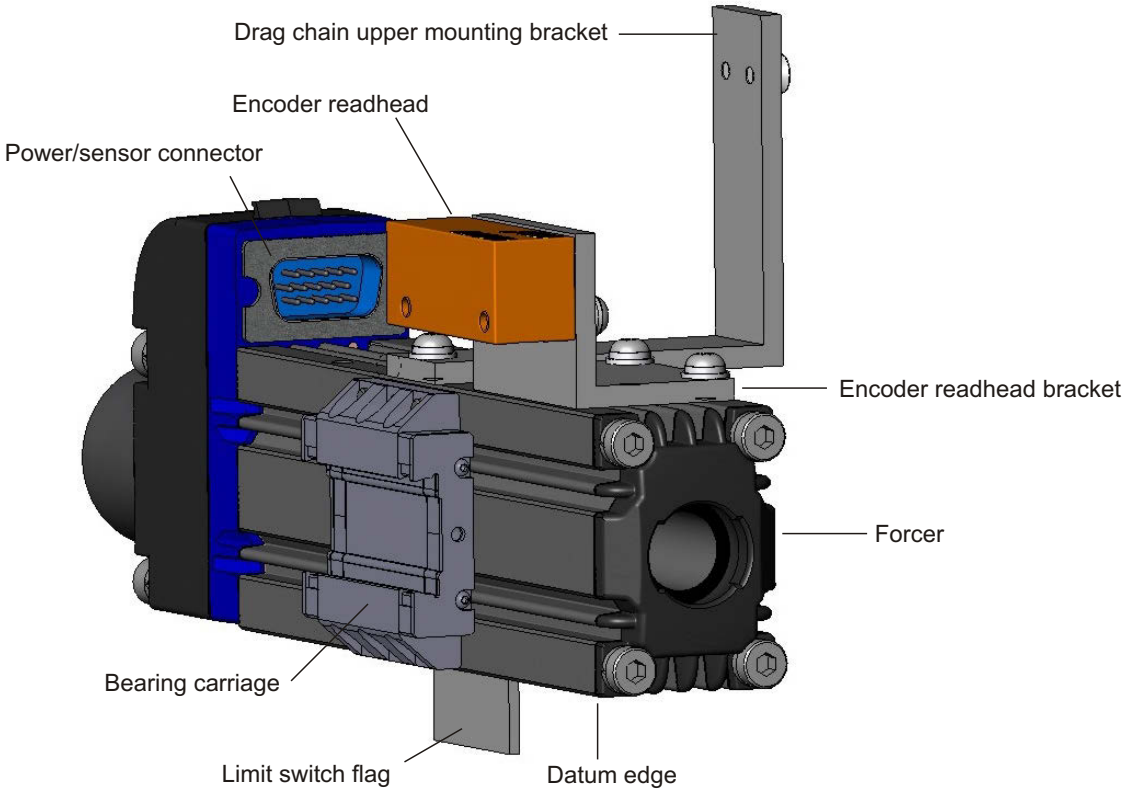


Figure 3.10

Replacement

- Slide the newly assembled forcer on to the bearing rail taking care to keep the forcer square to the bearing rail so that balls are not lost from the re-circulating bearing carriage(s). If balls do fall out they can be re-inserted into the carriages. Push the ball bearings using a small screwdriver into the end of the re-circulating path at the plastic end plates on the carriage.
- Refit the thrust rod support to the end of the backing bar and secure using the four M5 fixings tightened to a torque of 5 Nm.
- Replace the thrust rod as described on page 19.
- Place the encoder cable (if fitted) in the drag chain.
- Reconnect the power/sensor connector to the forcer connector and clip to secure.
- Reconnect the drag chain link previously removed from the drag chain upper mounting bracket.
- Refit the drag chain covers.

ENCODER READHEAD (Optional item)

Before commencing any work, it is important to note that the encoder may require alignment to achieve optimum performance after replacement.

Removal

- Undo the two M3 x 14 fixings to remove the encoder readhead with integral cable.

Replacement

- Refit the replacement encoder readhead to the encoder bracket using the two M3 x 14 fixings and tighten to a torque of 0.7 Nm.

Alignment

The encoder may need aligning. To check:

- Connect the encoder to the control system and apply power to the encoder only.
- Move the forcer along the entire length of the module and check that the LED indicator on the back of the readhead lights up green. It will light up red as it passes over the reference mark. If this does not happen, alignment is necessary.
- Loosen the two M3 x 14 fixings securing encoder to the encoder bracket.
  Note. The fixings should be loosened just enough to allow movement of the encoder.
- Using a thin piece of rigid plastic (100mm x 20mm x 1mm), adjust the encoder readhead by sliding the plastic between the backing bar and forcer. Push the readhead until the LED on the back of the readhead lights up green.
- Move the forcer along the entire length of the module and check that the LED indicator on the back of the readhead lights up green. It will light up red as it passes over the reference mark.
- Tighten the two M3 x 14 fixings that secure the encoder to the encoder bracket and tighten each to a torque of 0.7 Nm.

BEARING REPLACEMENT

Should excessive play be detected in the bearing system the bearing will need replacing. It is recommended that the bearing carriage and the bearing rail are replaced at the same time.

Due to the complex nature of the process and specialist equipment required, please contact your supplier regarding replacement.

Chapter 4

Service

SERVICE

Should you need to return any items to Dunkermotoren, before doing so, please call our Sales coordinator 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.

ACCESSORIES AND SPARES

The Accessories and Spares for the modules are listed in Tables 4.1 and Table 4.2.

Table 4.1 Accessories

Description	Order Code
Mounting Hardware	
M4 T Nut (10 off pack)	91500.00088

Table 4.2 Spares

Description	Length
Renishaw readhead replacements	
1 µm readhead	3 metre cable
1 µm readhead	5 metre cable
Limit Switches	
NPN Robotic Switch, NC	5 metre robotic cable
PNP Robotic Switch, NC	5 metre robotic cable

... continued on next page

Table 4.2 Spares *(continued)*

Description	Length
NPN Robotic Switch, NO	5 metre robotic cable
PNP Robotic Switch, NO	5 metre robotic cable
Drag Chain	
I2 (Igus 07.2) drag chain	
I3 (Igus 07.3) drag chain	

Should you have any questions or problems, please contact:

» Your local Dunkermotoren sales outlet
» Your local Dunkermotoren key account manager
» Our hardware support department
» Our software support department

You can also visit our online support portal at www.dunkermotoren.de/support.

You can download this operating manual in PDF format and obtain more information by visiting us on the Internet at www.dunkermotoren.de/downloads.

Dunkermotoren GmbH
Allmendstrasse 11
D-79848 Bonndorf
Telephone: +49 7703/930-0
Fax: +49 7703/930-210
E-Mail: info@dunkermotoren.de

Appendices

CONTENTS

Appendix A

GLOSSARY OF TERMS

TERM	DESCRIPTION OF TERM
Peak force	Peak force is the force produced when the peak current is applied to the forcer. It is the product of force constant (N/Apk) and Peak current (Apk). The forcer 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 forcer. It is the product : Force constant (N/Apk) x Continuous stall current (Apk) or : Force constant (N/Arms) x Continuous stall current (Arms). The forcer 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 forcer.
Peak current	Peak current is the current required to heat the forcer phases to their maximum operating temperature when the ambient temperature is 25°C, the forcer 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 forcer phases to their maximum operating temperature when the ambient temperature is 25°C, the forcer 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 forcer.
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 forcer is travelling at a velocity of 1m/s.
Fundamental forcer constant	Fundamental forcer constant is the continuous stall force divided by the square root of the power dissipated in the forcer at that continuous stall force.
Eddy current loss	Eddy current loss is the amount of opposing force produced by the forcer when it is travelling at a velocity of 1m/s.
Sleeve cogging force	Sleeve cogging force is the amount of force variation produced by having an iron sleeve. The variation is independent of forcer 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 forcer 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 forcer to reach 63.2% of its value.
Continuous working voltage	Continuous working voltage is the maximum allowable continuous voltage between any two forcer phases or between any forcer phase and the forcer safety earth.
Pole pitch	Pole pitch is the distance in millimetres for one complete electrical cycle (between like magnetic poles).

TERM	DESCRIPTION OF TERM
Power dissipation	Power dissipation is the maximum power that can be dissipated by the forcer when the forcer phases are at their maximum operating temperature, the ambient temperature is 25°C, the forcer 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 forcer.
Maximum phase temperature	Maximum phase temperature is the maximum operating temperature for the forcer phases. It is limited to provide a safe operating temperature for the magnets.
R_{th}phase-housing	R_{th}phase-housing is the temperature rise from the forcer housing to the forcer phases for an input power of 1 watt to the forcer. The forcer is not moving, there is no forced cooling and no additional heatsinking.
R_{th}housing-ambient	R_{th}housing-ambient is the temperature rise from ambient temperature to the forcer housing for an input power of 1 watt to the forcer. The forcer 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 forcer.
Thermal time constant	Thermal time constant is the time taken for the forcer phases to cool to 36.8% of the difference between forcer phase and ambient temperatures when there is no current flowing, the forcer 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	µm	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 fails to move and produces no force.	1. Drive not powered. 2. Forcer phase connections not made. 3. Forcer over-temperature sensor not connected. 4. Forcer over-temperature.	1. Apply power to drive. 2. Check forcer phase connections on drive. 3. Check forcer over-temperature sensor connections on drive. 4. Allow forcer to cool.
Forcer fails to move but does produce force.	1. One or more forcer phase connections not made or made incorrectly. 2. One or more position sensor connections not made or made incorrectly. 3. Forcer/thrust rod mechanically blocked.	1. Check forcer phase connections on drive. 2. Check position sensor connections on drive. 3. Check forcer/thrust rod is free to move.
Forcer 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 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 Specifications

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	Apk
With 25 x 25 x2.5cm 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	Arms
	2.41	3.56	3.74	3.50	Apk
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	Arms
	1.58	2.45	2.64	2.52	Apk
Force constant (sine commutation)	5.42	6.26	8.12	10.83	N/Arms
	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 forcer constant	1.75	2.49	3.05	3.52	N/√W
Eddy current loss	0.14	0.25	0.36	0.47	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)	156	119	110	121	m/s^2
Maximum speed (3)	10.8	9.5	7.9	8.2	m/s

Notes

(1) Reduce continuous stall force to 89% at 40°C ambient

(2) Based on a moving forcer with to payload

(3) Based on a moving forcer with triangular move over maximum stroke and no payload

THERMAL SPECIFICATIONS

FORCER TYPE	1104	1108	1112	1116	units
Maximum phase temperature	100	100	100	100	°C
Thermal resistance $Rth_{phase-housing}$	1.48	0.72	0.47	0.35	°C/Watt
With 25 x 25 x2.5cm heatsink plate					
Power dissipation @ 25°C ambient	27.6	40.1	49.7	58.0	Watt
Thermal resistance $Rth_{housing-ambient}$	1.24	1.15	1.04	0.94	°C/Watt
Without heatsink plate					
Power dissipation @ 25°C ambient	11.8	18.9	24.8	30.0	Watt
Thermal resistance $Rth_{housing-ambient}$	4.88	3.24	2.55	2.15	°C/Watt
Thermal time constant	142	176	202	223	s

MECHANICAL SPECIFICATIONS

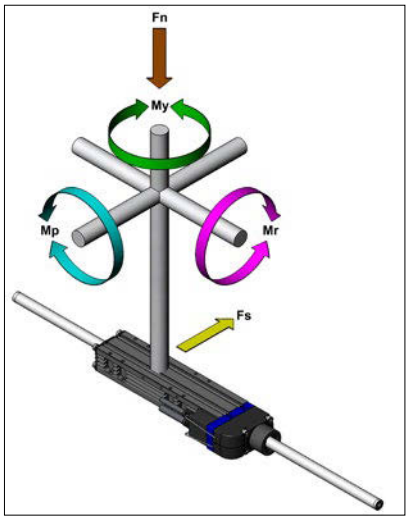
FORCER TYPE	1104	1108	1112	1116	units
Maximum stroke	825	774	722	672	mm
Moving mass	0.293	0.443	0.626	0.756	kg
Maximum normal force, Fn [1] [3]	0.737		1.474		kN
Maximum side force, Fs [1]					
Maximum roll moment, Mr [1]	5.2		10.4		Nm
Maximum pitch moment, Mp [1]	2.9		123.6		Nm
Maximum yaw moment, My [1]					
Maximum normal force, Fn [2] [3]	0.342		0.684		kN
Maximum side force, Fs [2]					
Maximum roll moment, Mr [2]	2.4		4.8		Nm
Maximum pitch moment, Mp [2]	1.3		57.3		Nm
Maximum yaw moment, My [2]					
Constrained vertical straightness (flatness)	60				µm/m
Constrained horizontal straightness	80				µm/m
Unconstrained vertical straightness (flatness)	100				µm/m
Unconstrained horizontal straightness	80				µm/m

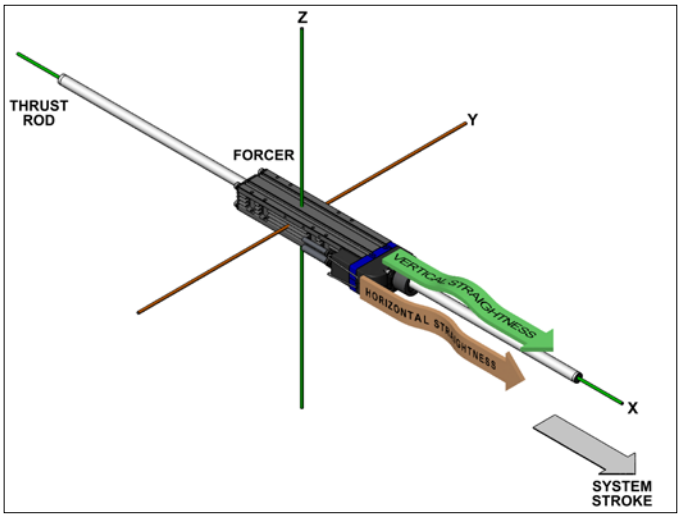
Notes

[1] For a bearing life expectancy of 10000 km with no other forces or moments

[2] For a bearing life expectancy of 100000 km with no other forces or moments

[3] Load in kg = force/9.81

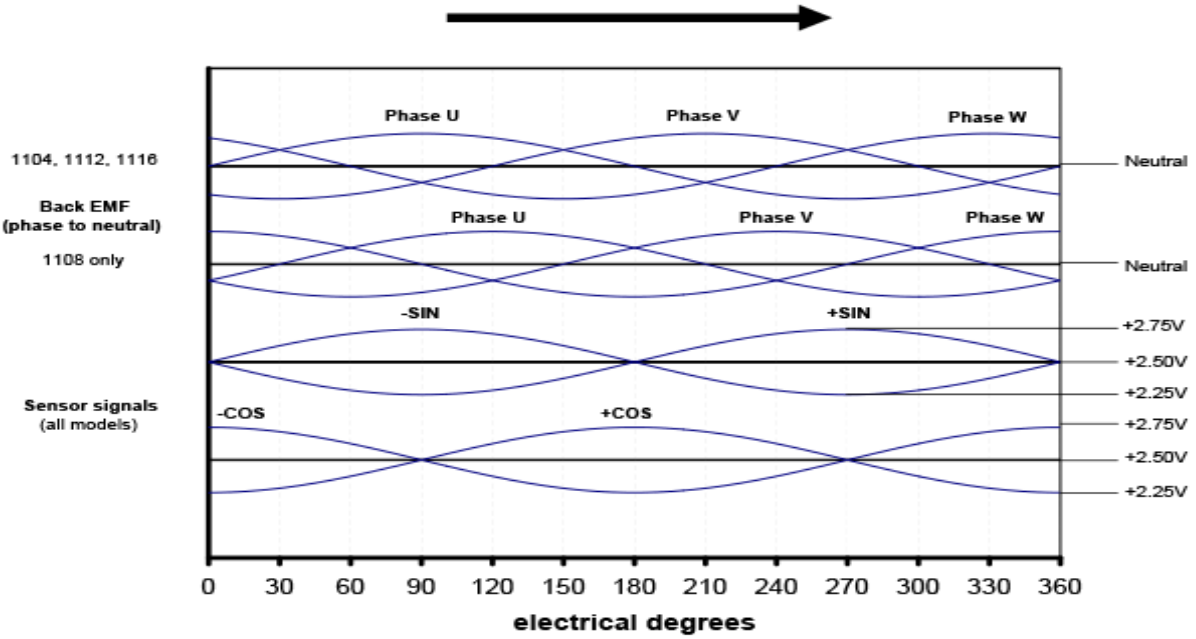




FEEDBACK

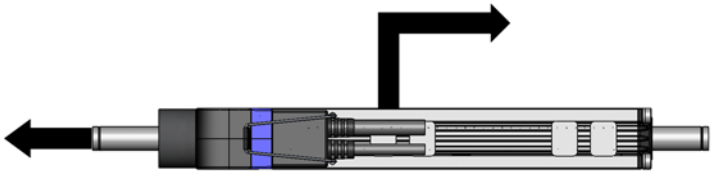
The ServoTube Module is available with three feedback options with option S supplied as standard.

Option S feedback outputs analogue, differential sine and cosine signals for providing position feedback. Shown below are the relationships between forcer phase back EMF and position sensor outputs for one direction of motion (as shown by arrows). It should be noted that +SIN or -SIN is always in phase with forcer phase U. For the motion shown, -SIN is in phase with forcer phase U. For motion in the opposing direction +SIN is in phase with forcer phase U.



Notice:
If the used servo controller can only handle digital 5V TTL signals, you can join up in circuit an additional interface converter (SI10).
For more information, see Documentation SI10.

Hinweis:
Sollte der eingesetzte Servoregler nur einen Encodereingang mit 5V TTL Pegel verarbeiten können, so kann ein zusätzlichen Schnittstellenwandler (SI10) dazwischengeschalten werden.
Nähere Infos siehe Doku SI10.



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	Vd.c.
Supply current (output current=0)	32 ± 5	mA
Resolution(1)	8	micron
Position repeatability(2)	± 12	micron
Absolute accuracy(3)	± 350	micron

Notes:

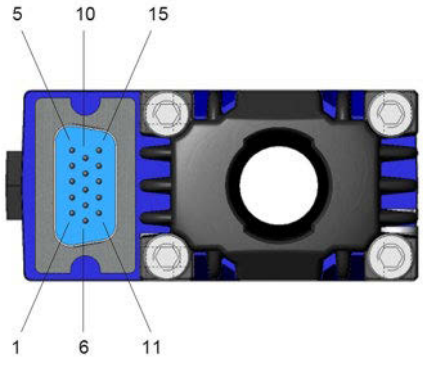
(1) Dependent on amplifier

(2) Dependent on amplifier. Under constant operating conditions. Self-heating of the forcer will cause expansion in the thrust rod during the initial warm up period. In high duty applications (corresponding to an internal forcer temperature of 80°C) a 1 metre thrust rod will expand typically by 250 µm.

(3) Maximum error over 1 metre under constant operating conditions.

FORCER ELECTRICAL CONNECTIONS

Connections to the forcer are made via a 15-way high density D-sub male connector which is fitted to the forcer. The pin-outs are shown in the diagram below and the table shown right.



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

CABLES

The ServoTube Module 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. The cables are available in 3 metre or 5 metre lengths.

The cables are suitable for continuous flex or drag chain applications

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	0.34 mm^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	-40 °C to +80 °C	-50 °C to +90 °C

The ServoTube Module cables are 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.

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

LIMIT SWITCHES

WARNING. These limit switches are not intended as safety devices or as part of a system intended to ensure personal safety. When two switches are mounted in close proximity (as in the case of a left and right limit switch), a minimum of 30mm spacing between sense areas must be maintained.

If required, the ServoTube Module can be supplied with limit switches.

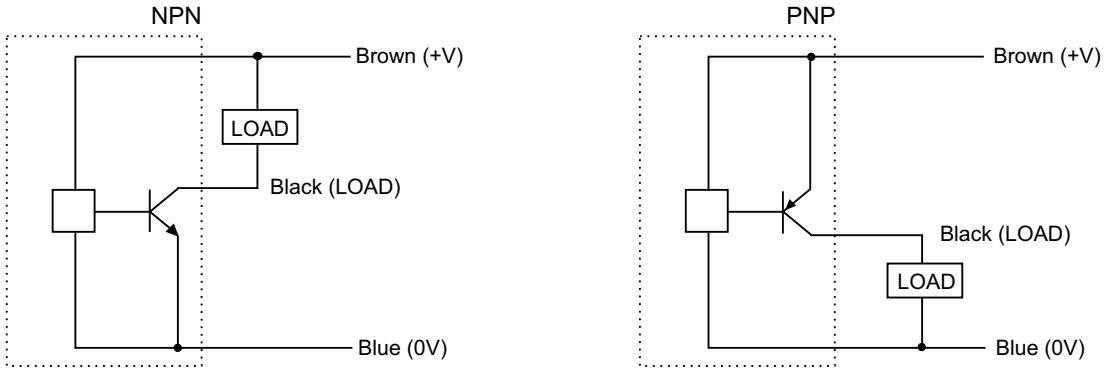
There are two types available, NPN output and PNP output. Each output type is available with 5 metres of cable suitable for continuous flexing.

Each limit switch position is adjustable and switching is achieved by an actuator vane mounted on the forcer. Electrical connections are made via wire ends stripped and solder tinned ready for termination.

SPECIFICATION	VALUE			
	minimum	typical	maximum	units
Supply voltage	10	24	30	Vd.c.
Supply current	-	15	-	mA
Sink current	-	-	100	mA
“closed” voltage	-	-	1	V d.c.
Frequency response	-	-	600	Hz

The output for all types can be normally closed (NC) or normally open (NO) open collector transistor. The NC outputs switch open when a limit is detected and current stops flowing in the LOAD. The NO outputs switch closed when a limit is detected and current starts flowing in the LOAD.

A red indicator shows the output status.



ENCODERS

If improved positional accuracy is required, external encoder option is available.

The Renishaw RGH24X is an optical encoder. The encoder head provides two channels, A and B, in phase quadrature (90° phase separated). A reference channel, Z, is also available that produces a single output at a position set by a reference mark.

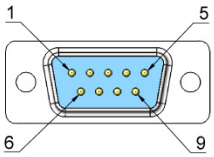
SPECIFICATION	OPTION C	UNITS
Signal output	EIA RS422A	-
Supply voltage	5 ± 0.25	Vd.c.
Supply current (output current=0)	120	mA
Supply current (outputs terminated with 120R)	195	mA
Resolution	1	µm
Position repeatability(1)	± 1	µm
Absolute accuracy(2)	± 10	µm

Notes

(1) Dependent on amplifier. Under constant operating conditions.

(2) Typical maximum error over 1 metre under constant operating conditions.

The encoder is fitted with a cable terminated with a 9-way D-sub male connector. The pin-out of this connector is shown below.



FUNCTION	+5Vd.c.	0V	A+	A-	B+	B-	Z+	Z-	Screen
PIN NUMBER	5	1	2	6	4	8	3	7	Case

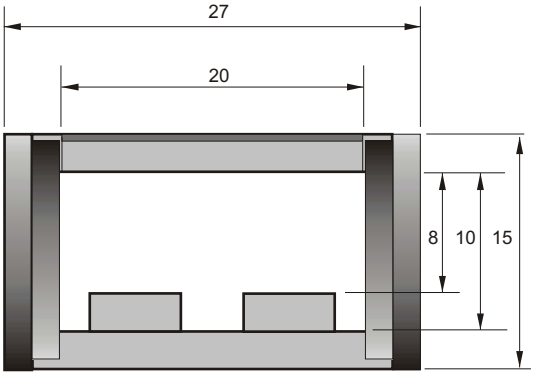
FORCER OVER-TEMPERATURE SENSOR

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

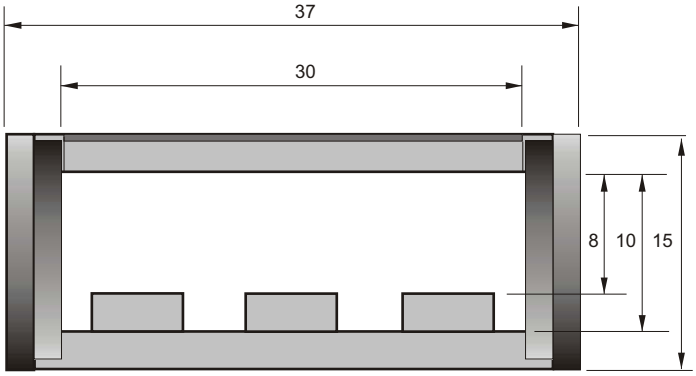
SPECIFICATION	VALUE	UNITS
Resistance at 25°C	235 to 705	ohms
Resistance at 95°C	4700	ohms
Resistance at 100°C	10000	ohms
Maximum continuous voltage	32	Vd.c.

DRAG CHAIN

The ServoTube module is available with two sizes of drag chain. **Option 3** is standard and provides Igus size 07.3 drag chain while **Option 2** provides Igus size 07.2



Option 2



Option 3

ENVIRONMENT

The ServoTube Module is intended for use in an environment within the following conditions:

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