

# Operating and Maintenance Handbook

## TR SERIES PRECISION Z TRANSLATOR



REVISION	DATE	COMMENTS	INITIALS
1	Feb 1996	Original release	MJD
2	Oct 1997		ECN# 2768
3	Aug 2015	VACGEN rebrand	AJL

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## **WARRANTY**

1. Subject to fair wear and tear and the due, observance of any installation user, storage, operating or maintenance instructions the Seller undertakes to replace or, at its option repair free of charge to the purchaser, any goods which the purchaser can establish are defective by reason of defective workmanship or materials which are returned to the Seller, carriage paid, within 12 months of the date of dispatch by the Seller. In the event, however, that the Seller supplies spare parts either direct, or that are fitted or installed or replaced by the Sellers' service center such spare parts will be subject to a warranty period of six months only.
2. The Purchaser cannot return any product for warranty repair without the prior approval of VACGEN and the issue of a Goods Return Number (GRN). This shall be obtained by contacting the service center at VACGEN. All returned products must be accompanied by a completed Declaration of Contamination form. Customers must, in the first instance, contact the local selling agent.
3. We reserve the right to decline to service equipment, we consider is in any way hazardous until a clearance or safety certificate, in a form satisfactory to VACGEN, has been completed and returned by the customer.

## **REPAIR**

The following additional terms and conditions apply in the event that the customer elects to use the services of VACGEN workshop on a chargeable basis.

1. At its own cost the customer shall dispatch the equipment to the workshop, carriage paid, suitably packaged, protected and insured, bearing, a Goods Return Number (GRN) and a completed Declaration of Contamination certificate obtained from VACGEN in advance of shipment.
2. During the period that the equipment is on VACGEN premises, VACGEN will insure the equipment against all risks.
3. Vacuum Generator will provide an acknowledgement of the receipt together with an estimate of the repair charges. Such estimates are carried out on a visual basis and are therefore intended as a guide only. Formal fixed price repair quotations are available and involve the disassembly of the equipment to determine the full extent of the work necessary to restore the equipment to an acceptable standard. In the event that the customer chooses not to proceed with the repair VACGEN will make a charge to cover this examination effort.

### **Note:**

The above are extracts from VACGEN Conditions of sale. Complete copies can be obtained from: VACGEN, Maunsell Road, Castleham Industrial Estate St. Leonards on Sea, East Sussex, TN38 9NN, United Kingdom.

## 1. INTRODUCTION

### 1.1 HEALTH AND SAFETY INFORMATION

This equipment is a component for use with vacuum systems. Whilst every effort has been made to eliminate hazards, its safe use is also dependant on the system to which it will be connected. The owner of the equipment must ensure that all users are aware of the Health and Safety information contained in this handbook. If the equipment is sold or passed to another owner, this handbook must be included with the equipment. If in doubt contact VACGEN.

**Warning:** This equipment must be installed by qualified personnel.

**Warning:** It is the responsibility of the user to consider the safety requirements of hazardous materials used with this equipment and the consequence of any leakage, however caused. Consider possible reactions with materials of construction. Any equipment returned to VACGEN must have the correct Declaration of Contamination securely fastened to the outside of the packaging.

**Warning:** Harmful gases may be evolved if this equipment is heated to temperatures above the maximum specified bakeout temperature.

**Warning:** Lubricants used in this assembly may cause irritation to sensitive skin. Wear protective clothing.

**Warning:** Where cryogenic liquids are used with the equipment, it is the responsibility of the user to ensure that the correct safety precautions are taken when handling and storing these materials.

**Warning:** Safe disposal of the equipment is the responsibility of the user.

**Warning:** It is the responsibility of the user to fit emergency stops to automated equipment.

**Warning:** Keep clear of moving pans.

**Warning:** Do not use this equipment with positive internal pressure above the specified maximum.

**Warning:** Some equipment may develop extreme hot or cold surfaces. Wear protective clothing.

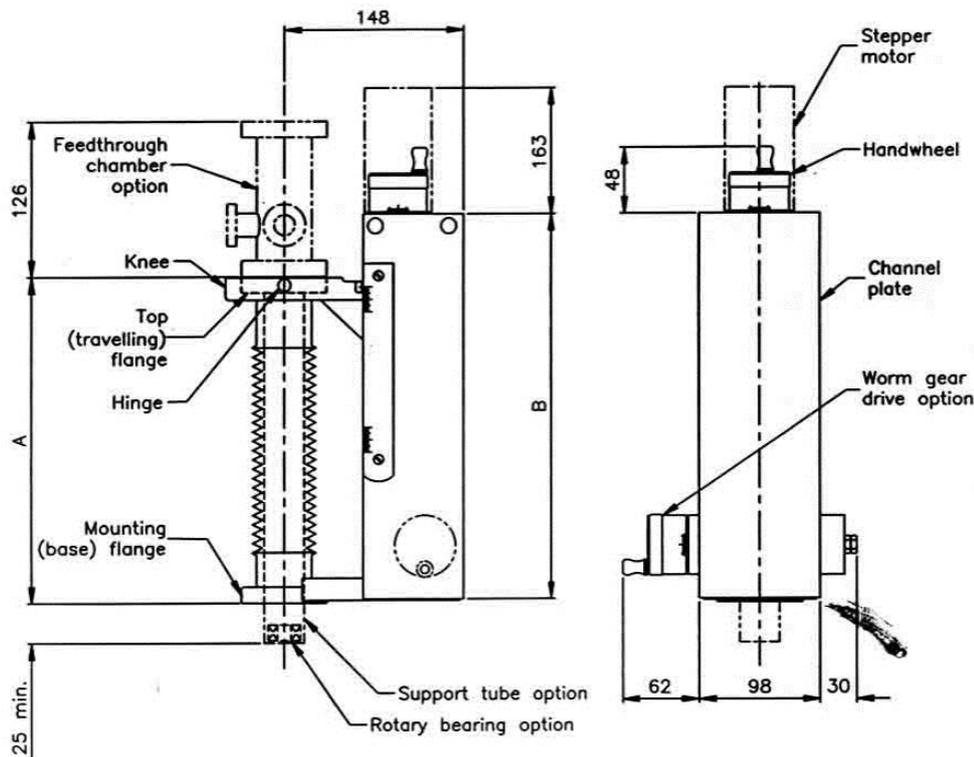
**Warning:** Equipment must be fully earthed to prevent dangerous electrostatic charge build-up.

## 1.2 OVERVIEW

The TR is a series of precision ultra-high vacuum (UKY) specimen translators of modular construction, suitable for a range of Z motions. The modular construction means that the specification can be upgraded or modified by the addition or replacement of well defined modules.

The TR series has been designed for ease of use and most functions should be straightforward. This handbook outlines the general considerations for installation, use and maintenance.

Most manipulator configurations utilising the TR translator may also use drives and instrumentation that are not included in this handbook. This handbook should therefore be read in conjunction with documentation supplied for the other equipment.



Z travel, mm	Dimension A, mm (retracted to extended)	Dimension B, mm
150	129 to 279	314
300	166 to 466	499
450	202 to 652	685
600	215 to 815	849

Figure 1 - TR translator basic dimensions

## 1.3 SUMMARY OF ACCESSORIES

### 1.3.1 Support Stand (Part Code: ZTRS)

The support stand is required for 300Z to 600Z manipulators that are mounted horizontally. It is not suitable for applications where the "Z" translator is attached to an XY stage.

### 1.3.2 Support Tube Accessories (Part Code: ZTRST)

The support tube can be used to increase the stability of the sample. It also prevents the bellows sagging when the manipulator is mounted other than vertically. It is connected to the top flange and guided by a linear bearing in the bottom flange. The end of the support tube is machined to accept the rotary bearing option.

**Important Note:** With the support tube option fitted to the translator, many rotary drives must have the accessory chamber (ZTRFC) to allow attachment to the translator.

### **1.3.3 Rotary Bearing Accessory (Part Code. ZTRRB)**

The rotary bearing is suitable for 9.525mm (3/8") diameter shafts, such as the RD 1, 2, 6 and 7. (See note above). It fits to the support tube and provides good support to rotary drive shafts at all Z travel positions. It has two apertures in the outer edge for the passage of wires etc.

### **1.3.4 Feedthrough Chamber (Part Code: ZTRFC)**

The chamber has 70 mm diameter top and bottom flanges (FC38), with three 34 mm diameter ports spaced at 90° apart for instrumentation and services.

### **1.3.5 Stepper Motor Kit (Part Code ZTRSMK)**

The stepper motor provides excellent control of the Z travel, enabling 5 micron resolution, and linear motion speeds of up to 15 mm/sec. The kit consists of a pair of limit switches and mounting brackets, motor mounting brackets, motor coupling and stepper motor.

### **1.3.6 Worm Gear Drive Accessory (Part Code: ZTRWD)**

The worm drive accessory can allow the operator to view the sample end of the manipulator, whilst controlling the motion of the translator. It reduces oscillating sample movements then manually operating the Z movement. It is recommended for long travel and vertically mounted manipulators. This accessory is not available for the shorter ZTI5.

## 1.4 SPECIFICATION

Z Motion Range:	150, 300, 450 and 600mm
Resolution:	0.01 mm (manual) 0.005mm 1 half step (with stepper motor option)
Linear Motion/Turn:	2mm (0.5mm with worm drive option, 4:1 gear ratio)
Z Scale:	1mm divisions, numbered every 10 divisions
Motion Thimble:	0.01mm divisions, numbered at 0.2mm intervals
Bellows Clear Bore.	33 mm diameter (without support tube)
Support Tube:	31.75mm OD, 28.7mm bore
Base Flange:	NW35CF (2.75" OD)
Traveling Flange:	NW35CF (2.75" OD)
Bakeout Temperature:	230°C (motor and switches removed)
Mounting Orientation:	Any
Maximum Stage Load:	20kg (manual operation)
Maximum Stage Load Motorised (inclusive of support tube load):	
Series connected 3.5 Amps:	20kg @ 2400 ½ steps/sec
Parallel connected 4.5 Amps:	16kg @ 1600 ½ steps/sec
Motor Type:	Stepper 23HS 409E 400 half steps / revolution

Support Tube End Loading:

<b>Z travel:</b>	<b>150mm</b>	<b>300mm</b>	<b>450mm</b>	<b>600mm</b>
Horizontal:	3.3kg	2.6kg	2.3kg	2.0kg
Vertical:	10kg	10kg	10kg	10kg

## 1.5 CONSTRUCTION

The vacuum envelope is constructed from stainless steel with welded joints.  
The superstructure is stainless steel and aluminium alloy.

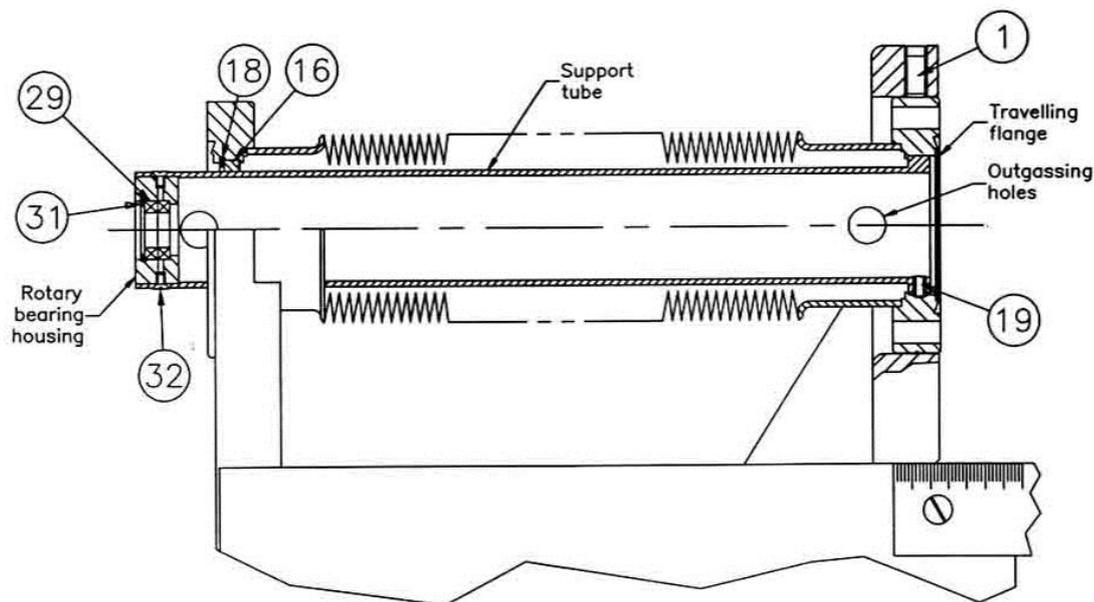
The "Z" motion drive screw is supported by a pair of ball races housed in the aluminium top plate, and a ball race in the mounting flange end plate (except for the ZTR1570). The knee is guided by stainless

steel guide rods with adjustable PTFE lined bearing bushes. The knee also houses the bronze "Z" motion nut.

The "Z" slide is provided with a linear scale that can be mounted to either side of the manipulator. All moving parts (excluding the linear bush bearings) are lubricated with high temperature lubricants. All parts of the translator and its accessories are interchangeable, thus enabling parts to be upgraded or replaced as and when required.

The support tube (see figure 2), is made of polished stainless steel. It is fitted to the top flange which can pivot about two hinge points in the knee, whilst being guided by a mica filled, PTFE linear bearing (16) located in the base flange. The hinge can be locked for applications that do not require a support tube.

The rotary bearing option (ZTRRB) consists of two stainless ball races (29) held within the support tube end piece by a circlip (31). It is retained by two countersink head screws (32). Two M3 tapped holes on 21 mm centers are provided on the end face for attachment purposes.



**Figure 2 - Sectioned view showing Support Tube and Rotary Bearing**

## 2. INSTALLATION

### 2.1 IMPORTANT - READ BEFORE UNPACKING

**Warning:** Take care when lifting the unit that the weight and position do not exceed comfortable limits, When installing the device make sure that it is adequately supported at all times.

- a. With two or more persons, lift out the translator. DO NOT use bellows, drives or instrumentation as lifting points. Take care not to hit or damage any protruding parts of the translator. Lie the translator on its back.
- b. Carefully inspect the translator for visual signs of damage. The packaging is designed to with stand shock and vibration but some of the fixing screws may become loose, more especially with air freight shipment. All parts should be secure and there should be no 'play' in any of the movements. All screws should be securely fastened but not excessively tight.
- c. Any damage in transit should be, reported to the carrier and to VACGEN at Hastings, or your local agent, within three days. Retain the packaging.
- d. Remove all transit items before operating any of the controls.

## 2.2 INSTALLATION GUIDELINES

**Warning:** This equipment must be installed by qualified personnel.

**Warning:** It is the responsibility of the user to consider the safety requirements of hazardous materials used with this equipment and the consequence of any leakage, however caused. Consider possible reactions with materials of construction. Any equipment returned to VACGEN must have the correct Declaration of Contamination securely Fastened to the outside of the packaging.

**Warning:** Lubricants used in this assembly may cause irritation to sensitive skin. Wear protective clothing.

**Warning:** It is the responsibility of the user to fit emergency stops to automated equipment.

**Warning:** Equipment must be fully earthed to prevent dangerous electrostatic charge buildup.

*Consideration must be given to ensuring that the level of stress exerted onto the chamber and within the translator itself is as low as possible. For horizontally mounted units, special mounting arrangements are required. See section 2.3*

b. Bolt the translator to the system flange using the correct size bolts and gaskets as indicated in the table below. For tapped flanges use a thread lubricant, such as VACGEN ZTL on the bolt threads. Use washers under bolt heads or nuts.

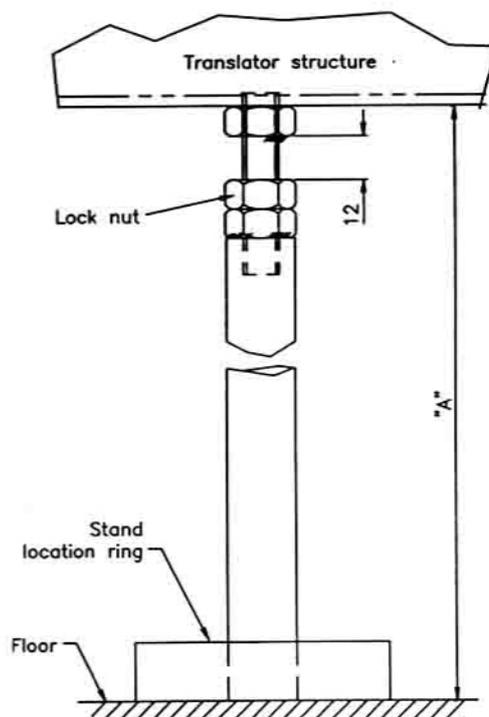
<b>Flange Size:</b>	<b>NW35CF (2.75" OD)</b>
Gasket size (VG ref):	ZCU38
Tapped holes:	M6
Clearance holes(mm)	Ø 6.8

- c. Install equipment to the top flange, using the same guidelines as the base flange.
- d. if the stepper motor option has been requested, the motor is normally removed for shipment. Refit to the translator: see section 2.5.
- c. The hinged flange may be 'locked' in position by tightening the M4 grub screw at the front of the knee: item (1) in figure 2.
- For applications which use the support tube, the upper flange must be unlocked by loosening the grub screw before pumping down.
  - For applications without the support tube, the top flange must be held solidly in place by tightening the M4 set screw (1).

### 2.3 HORIZONTAL MOUNTING

- Offer up the manipulator to its installed position (assistance is required)
- Measure the vertical distance from the 10mm diameter hole in the rear of the structural member to the floor, dimension 'A',
- Set the nuts to 12mm apart as shown.
- Cut the support stand assembly to the measured length "A" (cut plain end only).
- Fix stand location ring in the appropriate position on the floor.
- Locate the cut end of the stand within the floor mounted ring. Locate the adjustment end stud with the central hole of the channel plate.
- Adjust the position of the stud so that the vacuum flange joint faces are parallel. Tighten stud locking nut down on to the tube to secure setting (see caution note).

**Caution:** The adjustment range is +/-12mm from the 12 mm set position stated in instruction (c). above. Do not attempt to exceed this as it is possible for the stud to unscrew completely. flange, tighten vacuum joint barrier around the support guard it and personnel from injury.

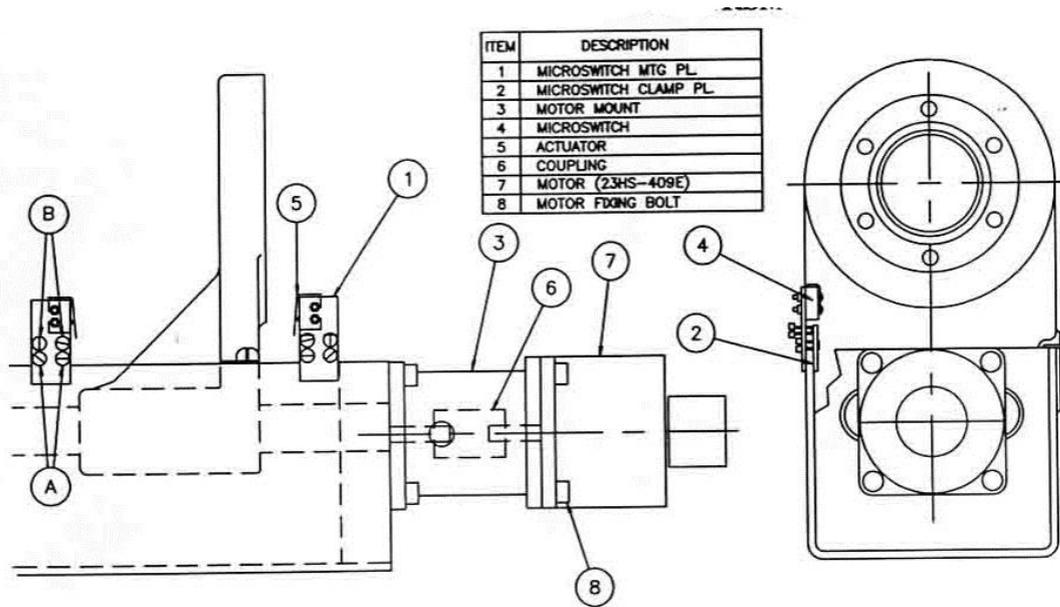


**Figure 3 - TRESS support stand**

#### **2.4 SUPPORT TUBE INSTALLATION (ZTRST)**

- a. Refer to figure 2. Remove the translator from the vacuum system and place horizontally on its back on a flat surface.
- b. Insert the linear bearing (16) into the bottom flange recess and insert the bearing retainer ring (18) into the flange groove.
- c. Gently insert the support tube through the top flange and guide the bellows over it as it is pushed towards the bottom flange. Take care not to damage the bellows.
- d. When support tube reaches the bottom flange, guide it through the linear bearing (16).
- e. Once through the linear bearing locate the support tube and ring within the top flange register. Insert the retaining ring screws (19) and tighten to hold it in-situ. Assembly is now complete.
- f. If applicable insert the rotary bearing accessory into the bottom end of the support tube and fix in place with the two screws (32).

#### **2.5 STEPPER MOTOR KIT INSTALLATION (ZTRSMK)**



**Figure 4 - Stepper motor and microswitches**

**Warning:** It is the responsibility of the user to fit emergency stops to automated equipment.

- Remove the "Z" motion hand wheel from the drive screw shaft.
- Attach the motor coupling (6) to the motor; ensure that the depth of shaft engagement within the coupling is 6-7 mm.
- Screw the motor mounting block (3) to the aluminium end plate.
- Locate the motor coupling (6) with the drive screw shaft, and attach the motor (9) to the mounting block. Tighten the motor coupling screws.
- Mount the microswitch units as detailed below.
- It is recommended that the motor is connected with the windings "series connected" as Appendix A

## 2.6 Z MOTOR LIMIT SWITCHES

Refer to figure 4.

**Caution:** It is important that both microswitches are correctly adjusted so that there is no risk of driving the knee into the end stops as this may damage the drive mechanism or lead screw.

**Caution:** Microswitches are intended for emergency use only. Do not use microswitches as position indicators or datum markers. Stepper motors may overrun by several steps when a microswitch is activated, particularly if traveling at speed. Always check the datum position and reset as necessary after activation.

- Mount the microswitch units to the edge NOT occupied by the rule.
- The screws that hold the microswitch (4) to the mounting plate (1) must be arranged so that the nuts are to the outside as drawn.
- Orientate the microswitch units as shown.
- Tighten screws 'A' before screws 'B', ensuring that the two plates (items 1 and 2) are parallel.
- All cables must be clear of moving parts.
- Check the microswitch settings by slowly driving the Z-slide to either end of travel until the switch operates, preventing further movement in that direction.

## 2.7 ACCESSORY CILKMBER (ZTRFC)

When rotary drives (RD1 or RD2 etc.) are fitted to the feedthrough collar (ZTRFC) ensure that the three 34 mm OD ports are closer to the vacuum system, as shown in figure 1, otherwise the rotary drive will obstruct the access to the three 34 mm OD ports.

## 2.8 WORM DRIVE ACCESSORY INSTALLATION (ZTRWD)

The worm drive reduction ratio is 4.1, thus one turn of the hand wheel will cause 0.5mm of linear motion to the stage etc.. Refer to figure 5. The bronze worm wheel is driven by a steel worm gear supported on three bearings (26). This is the temperature controller screen that you will normally see.

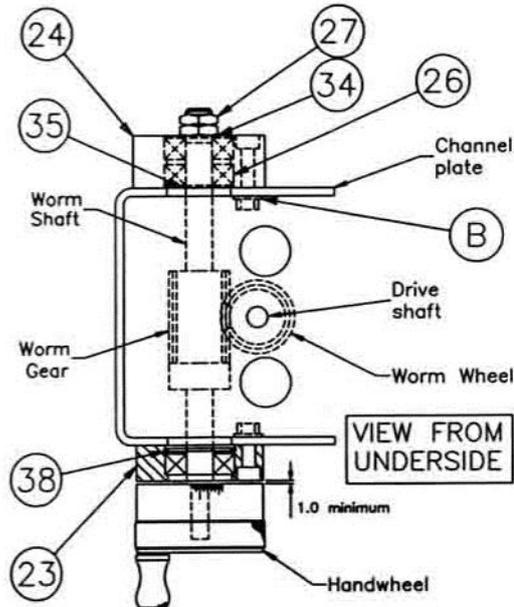


Figure 5 - Worm Drive Accessory

The worm drive is intended to be orientated as shown; otherwise the hand wheel readings will be incorrect.

- a. Remove the translator from the vacuum system.
- b. Remove equipment mounted to the top flange.
- e. Lay the translator on a flat surface with bellows horizontal set to mid travel position.
- d. Remove the two top flange hinge screws and the M4 locking set screw (1) in figure 1.
- c. Move the top flange away from the knee casting towards the base flange. Protect and park the bellows flange unit.
- f. Remove the "stop nut and bolt" located in the side of the top end of the channel plate. Remove the four M6 hex head bolts and the two M4 set screws that secure the aluminium top plate to the bearing rods and channel plate.
- g. Withdraw together the top plate, drive screw and knee. Slide along the guide rods until they are clear of the bellows area.
- h. Remove the circlips and bearing from the bottom end of the drive screw.
- i. Locate the square key into the slot of the main drive screw shaft. Assemble the worm wheel to the drive screw shaft with the worm wheel boss facing the base flange. Do not tighten set screw.
- j. Assemble the two ball races (26) with the housing (24) as shown in figure 5.
- k. Slide the worm gear onto the shaft such that the retaining screw locates with the spot hole of the shaft, and the worm is orientated as shown. Tighten the worm gear retaining screw.
- l. Locate the circlip (35) in the groove in the worm shaft. Assemble the shaft into the bearing assembly (24). Note the orientation of counter bored holes.
- m. Pre-load the bearings by tightening nut (34) to finger tight only locking it in place with nut (27),

- n. Assemble bearing with housing (23) and retaining clip (38). Note, to simplify this, stretch the retaining clip axially such that when released it remains stretched by 3mm. Insert into the groove. Note, for removal, prise out with a sharp pointed object,
- o. Superglue M5 nuts to washers.
- p. Re-assemble by reversal of procedures d to h.
- q. Insert the worm shaft through the hole in the side of the structural member, noting correct orientation. Loosely attach in place using M5 nut washer bonded assembly.
- r. Fit bearing housing assembly (23) over remaining free end of worm shaft and loosely attach to the channel plate using the MS nut/washer bonded assemblies.
- s. Slide the worm wheel along the drive screw shaft and to align with the worm gear. Tighten the worm wheel retaining set screw.
- t. Adjust the meshing of the worm to the worm wheel and tighten screws and nuts (B). Do not force the worm into mesh with the worm wheel.
- u. Attach the hand wheel and move the stage to the zero position. Slacken the worm drive hand wheel and set to zero also. The assembly is now complete.

## 2.9 ROTARY BEARING ACCESSORY (ZTRRB)

The rotary bearing option (see figure 2) consists of two stainless ball races (29) held within the support tube end piece (30) by circlip or wire ring (31). The end piece has cut away sides to accommodate the passage of wires etc. The end piece locates within the end of the support tube and is retained by two M2.5 screws (32). The end face of the bearing accessory contains two M3 x 6 mm deep tapped holes for attachment purposes.

## 3. OPERATION

### 3.1 NORMAL USE

#### 3.1.1 Important information

**Warning:** Do not use this equipment with positive internal pressure above the specified maximum.

**Warning:** Keep clear of moving parts.

**Caution:** The translator uses precision guidance mechanisms: avoid undue strain due to clashes with fixed objects, overloading, leaning on the equipment, etc.

**Caution:** Where the motor is fitted, the motor connector must not be disconnected unless the power to the drive has first been switched off. Allow a few seconds for the circuits to discharge.

**Caution:** Microswitches are intended for emergency use only. Do not use microswitches as position indicators or datum markers. Stepper motors may overrun by several steps when a microswitch is activated, particularly if traveling at speed. Always check the datum position and reset as necessary.

#### 3.1.2 Operation

- The unit must be correctly installed, and the information above followed carefully.
- Manual operation is straightforward and needs no special consideration.
- Operation with the stepper motor is dependent on the motor controller used, and the user should refer to the controller instructions.
- Routine maintenance is required. See section 4.1

### 3.2 BAKEOUT

### 3.2.1 Bakeout guidelines

**Warning:** Harmful gases may be evolved if this product is heated above the maximum specified bakeout temperature.

- With the motor and microswitches removed the translator may be baked to 230°C. The maximum motor bakeout temperature is 120°C, and the maximum microswitch bakeout temperature is 180°C.
- Heater tape should be avoided as this can cause local hot spots.
- The temperature sensing element controlling the heaters must be suspended in air near the translator and at a level approximately 50 -100 mm below the highest part of the translator.
- In no event should the temperature sensing element be in contact with or attached to any part of the translator or the vacuum system, i.e. it must always sense the air temperature.
- Position the Z slide at mid travel on horizontally mounted translators.
- If the motor is fitted, release the motor coupling screws from the "Z" drive shaft and remove the four motor mounting screws. Withdraw the motor and coupling. Remove the microswitches if bakeout is greater than 180°C.

## 4. MAINTENANCE

### 4.1 ROUTINE MAINTENANCE

#### 4.1.1 Inspection schedule

The following inspections and procedures should be performed after 150 to 200 hours of accumulated bakeout or when the Z-slide has traveled 150m.

#### 4.1.2 Screw fixings

Check that all screws are secure: not slack nor excessively tight. It will be noted during any dismantling that Belville washers (disc springs) have been fitted under certain screw heads. It is important that these washers are refitted in the correct locations.

#### 4.1.3 Monitoring the Two-Part Nut on the Z slide

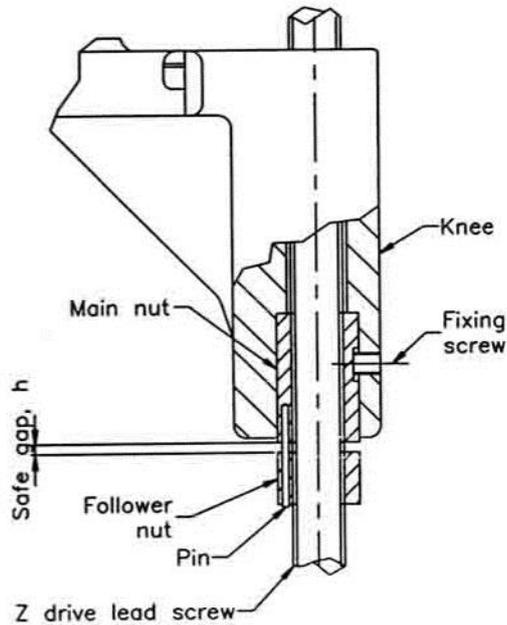
The two-part nut helps prevent collapse of the Z-slide into the chamber in cases of extreme thread wear. The diagram below shows the arrangement.

**Warning:** is essential for safety reasons that regular checks are made.

- The rate of wear depends on many factors such as lubrication, usage, applied load and orientation.
- When failure of the main nut occurs, the gap between the two nuts (shown as 'h' in the figure) will become zero as the full load is taken on the follower nut.

**Warning:** The slide must not be used in this condition. If usage continues, a dangerous collapse is possible.

- The condition of the nut must be monitored to ensure that wear of the main nut is never such that the follower nut is needed to support the load.
- The state of wear of the main nut can be checked by monitoring the following three conditions:
  - a. The gap distance, h: If the gap reduces by 0.5 mm from that measured when first installed, the nut should be replaced.
  - b. The torque required to turn the worm gear shaft. If the torque required reaches a level of 40
  - c. The free play of the follower nut on the pin connecting it to the main nut: If the follower nut has no free play on the pin, the nut should be replaced.



#### 4.2 LUBRICATION

The 'Z' drive worm and wheel gears and the 'Z' drive screw require lubrication with Carbaflo grease after 100m of Z travel in either direction and after every fifth bakeout, **IMPORTANT**: The Z slide guide rods must not be lubricated: the slide bearings are lined bushes which must run dry.

Other parts require less frequent renewal of lubricant - typically after 150 - 200 hours of accumulated bakeout, or whenever any of the motions appear to require more effort to operate than previously.

Ball bearings (eg. drive screw and worm shaft bearings): Use a small quantity of Carbaflo fluid to lubricate the ball bearing. Apply using a dropper or by dipping a clean wire into the container and allowing it to drip onto each bearing.

#### 4.3 FACTORY SERVICING

A factory servicing scheme exists for all translators. The translator should be returned to the VACGEN factory with a covering order. The servicing scheme includes the following-

- Complete strip down and clean
- Re-lubrication
- Re-assembly

When shipping the units use the original packing and pack with care to avoid expensive transit damage. Consider that the crate is liable to be dropped on any face or corner. A completed Health and Safety Declaration (See back pages) must accompany any equipment returned for servicing.

### 5. SPARES AND ACCESSORIES

#### 5.1 GENERAL

Gaskets: The large selection of gasket types shown below is normally available from stock for standard CF flange sizes. Please contact VACGEN for more information.

- \* Super quality copper (CU series)
- \* Commercial user copper (CUC series)
- \* Blank copper gaskets (CUB series)
- \* Annealed high quality copper (CUA series)
- \* Silver plated copper (CUSP series)
- \* Viton (VIT series)
- \* Aluminium (AL series)

**Nut, Bolt and Washer sets.** Metric sets are available for most flange combinations. Please contact VACGEN for more information.

Tool Kit: ZTOOLK  
 Lubrication Kit: ZLUBEK

Most component parts including bellows assemblies can be supplied as spares. Please contact VACGEN with your model type and serial number, stating requirements clearly.

## APPENDIX A. STEPPER MOTOR CONNECTIONS

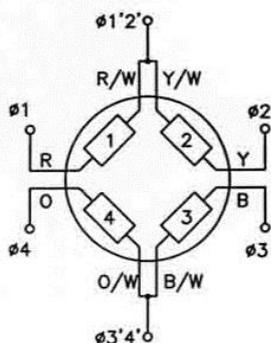
### AI. OVERVIEW

Motors and encoders used in VACGEN equipment achieve their intended performance with VACGEN controllers (SDU, SMC or SMC-E) and no responsibility can be accepted should performance be inadequate when other controllers are used.

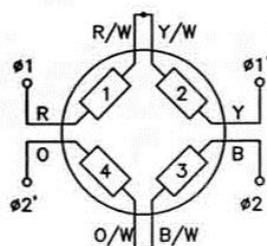
For attachment to VACGEN controllers, the motors (and encoders if applicable) can be supplied wired with suitable connectors. Otherwise, motors are supplied without connectors to allow connection to alternative drive and controller systems.

All motor variants are 4 phase, 8-lead hybrid stepper motors that can be wired up in most normal configurations as shown below. Some motor kits may include microswitches.

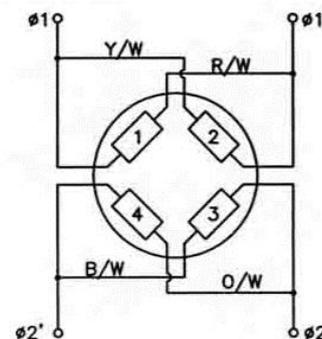
For motors fitted with incremental encoders, the VACGEN SMC-E range of controllers is required to provide passive feedback. If the motor has no encoder fitted, the controller cannot be used in the "Loop Active" mode. Note that encoders cannot be retrofitted to motors.



**UNI-POLAR:**  
 Use only where low torque  
 at low speed is sufficient.



**BI-POLAR IN SERIES**  
 Provides high torque  
 at low speed.



**BI-POLAR IN PARALLEL**  
 Provides moderate torque  
 at low and high speeds.

Key to Colour Coding:

Wire colours as follows.

R - Red, W - White, Y - Yellow. B - Black, O - Orange, G - Green

Alternative motors may be used, with alternative colours. Refer to the following sections.

## A2. MOTOR SPECIFICATION

Motor Type	Step angle	Step angle tolerance	Rotor inertia	Resistance per phase	Current per phase	Inductance per phase
23HS-108E	1.8 <sup>o(1)</sup>	5%	0.12 kg cm <sup>2</sup>	0.33	3.9A <sup>(2)</sup>	0.38mH
23HS-309E	1.8 <sup>o(1)</sup>	5%	0.23 kg cm <sup>2</sup>	0.40	4.7A <sup>(2)</sup>	0.84mH
23HS-409E	1.8 <sup>o(1)</sup>	5%	0.33 kg cm <sup>2</sup>	0.48	4.6A <sup>(2)</sup>	1.00mH
34HS-109E	1.8 <sup>o(1)</sup>	5%	0.67 kg.cm <sup>2</sup>	0.45	4.7A <sup>(2)</sup>	1.30mH
34HS-209E	1.8 <sup>o(1)</sup>	5%	11.30 kg cm <sup>2</sup>	0.55	4.6A <sup>(2)</sup>	2.50mH

Notes:

(1) Step angle quoted for full step drive. VACGEN controllers use half step drives with step angle being 0.9<sup>o</sup>.

(2) Limit the maximum current to the following values, determined by the drive used.

(Note that running at maximum current can cause motor to run hot and can give rise to resonance.)

\* Maximum current/phase for unipolar drive = rated current.

\* Maximum current/phase for bi-polar in series = 0.70 x rated current.

\* Maximum current/phase for bi-polar in parallel = 1.4 x rated current.

## A3. COLOUR CODING OF MOTOR WIRES

Key to Colour Coding:

R - Red, W - White, Y - Yellow, B - Black, O - Orange, G - Green

Alternative motors may be used. Wire colours as follows.

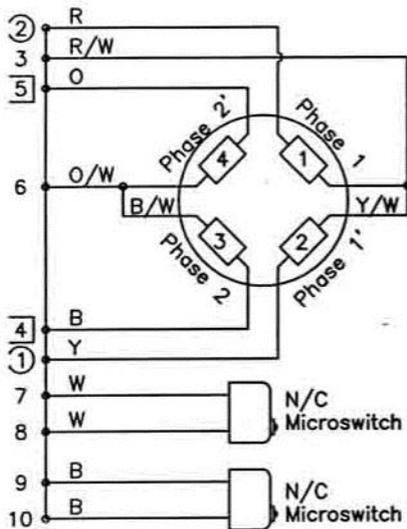
	As drawn	Alternative 1	Alternative 2
Phase 1	R	R	R
Phase 1'	R/W	B	Purple
Phase 2	Y	R/W	Y
Phase 2'	Y/W	W	Blue
Phase 3	B	G/W	Pink
Phase 3'	B/W	B/W	Grey
Phase 4	O	G	B
Phase 4'	O/W	O	W

## A4. MOTOR WIRING DIAGRAMS

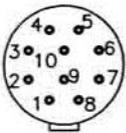
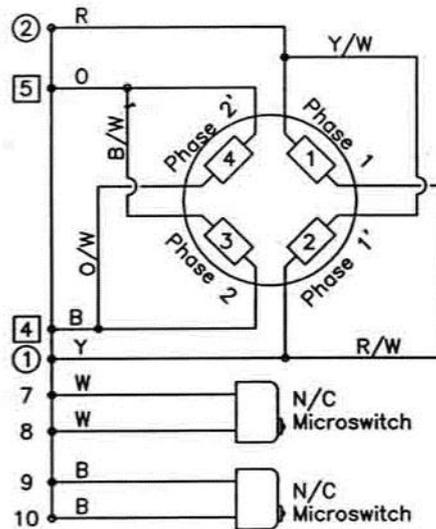
**Caution:** When wiring motors, care must be taken to make all connections secure. Failure to do so may result in disconnection during use and this can permanently damage the motor drive. For the same reason, never disconnect a motor from its drive unless the power has first been switched off.

Refer to previous section for colour coding of wires.

Series Motor Wiring



Parallel Motor Wiring



These diagrams show connections for compatibility with Vacuum Generators motor controllers.

Socket used is ref. XSOC24 (Series and parallel connection).

Series connection is preferred for high torque at low speed. Parallel connection is used for higher speed applications.

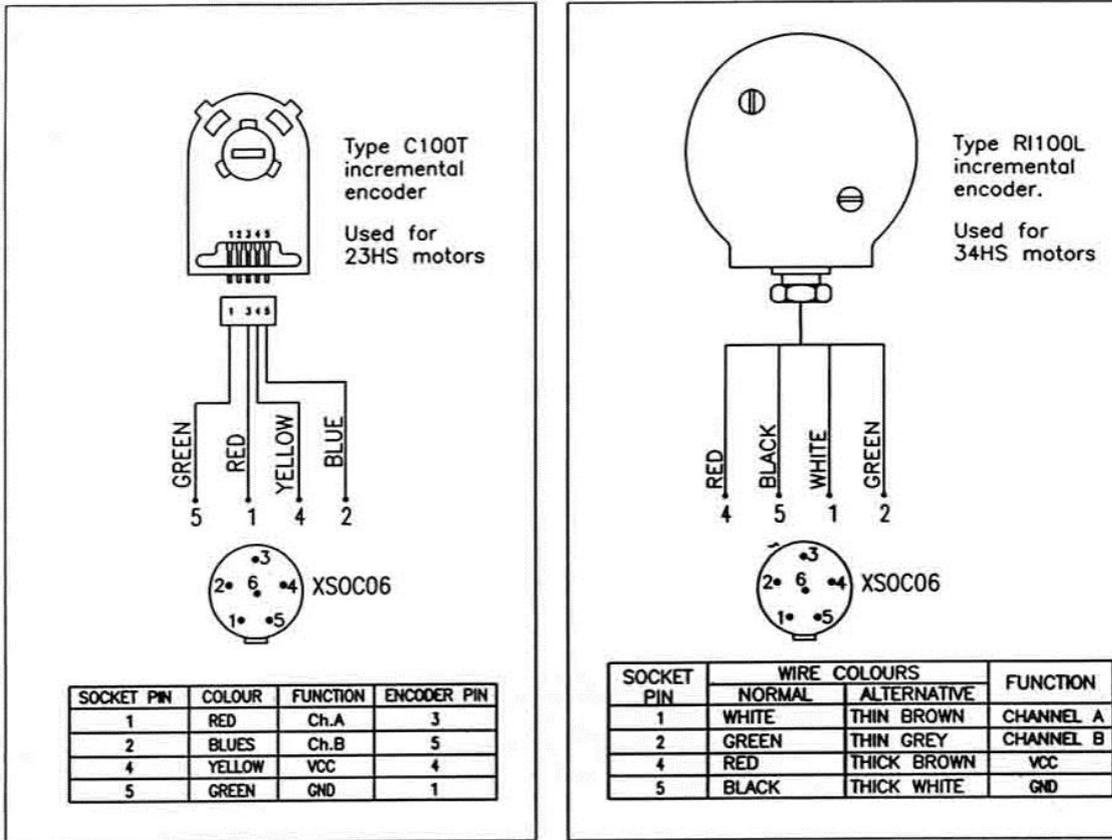
Where microswitches are not used, links must be made between pins 7 and 8, and between pins 9 and 10.

If the rotation direction is opposite to that required, reverse the connections on pins 1 and 2.

Twist together phase pairs to reduce electro-magnetic emission, i.e.: ① and ②, and ④ and ⑤.

Wiring diagrams for motors suitable for VACGEN Controllers

## A5. ENCODER WIRING DIAGRAMS



Wiring diagrams for incremental motor encoders

## A6. MOTOR SPARES

Order Code	Description
ZSMPC3LH	Cable: Motor to SMC, SME-E or SDU controller.
DB08073	Cable: Encoder to SMC-E controller.
XSOC24	Connector socket. Fitted to motor lad or connection to VACGEN controllers.
XPLU11	Connector plug. Fitted to controllers for connection to XSOC24 motor socket.

## APPENDIX B. HEATER AND VACGENCOUPLES

### B1. DESCRIPTION

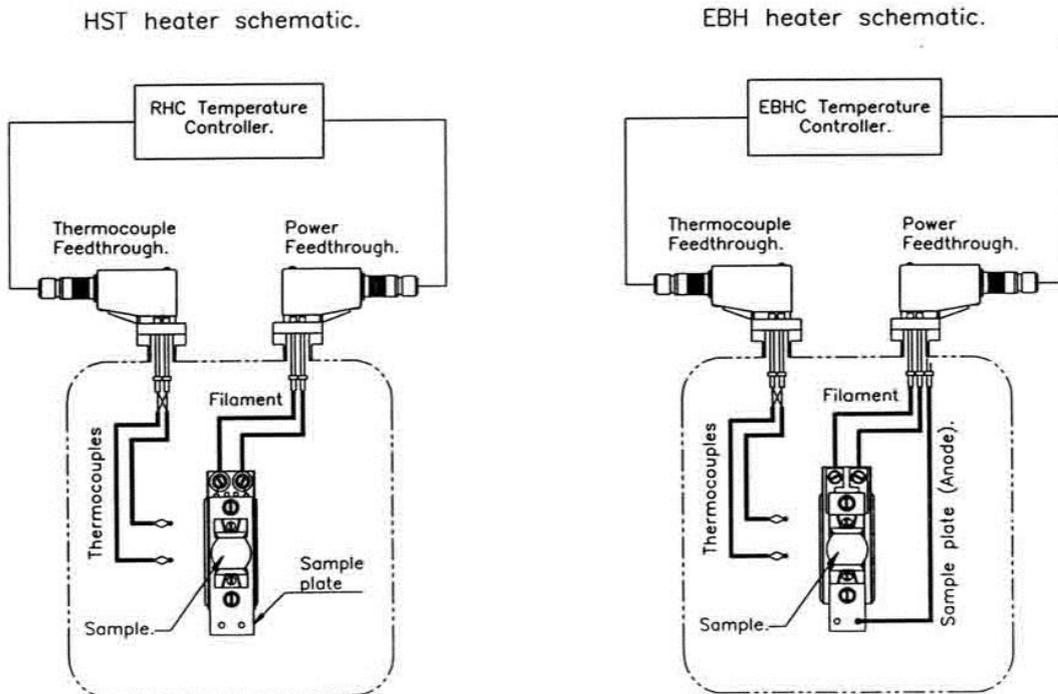
Sample heating is normally by either:  
 \* Resistance heating (HST option), or  
 \* Electron bombardment heating (FBH option).

These heaters are intended for mounting onto the standard range of VACGEN sample holders (e.g. SH1, SH1E50, SH2, SH2E50, SH2R64, SH2F, SH2RT, SM2T and SM2VT.)

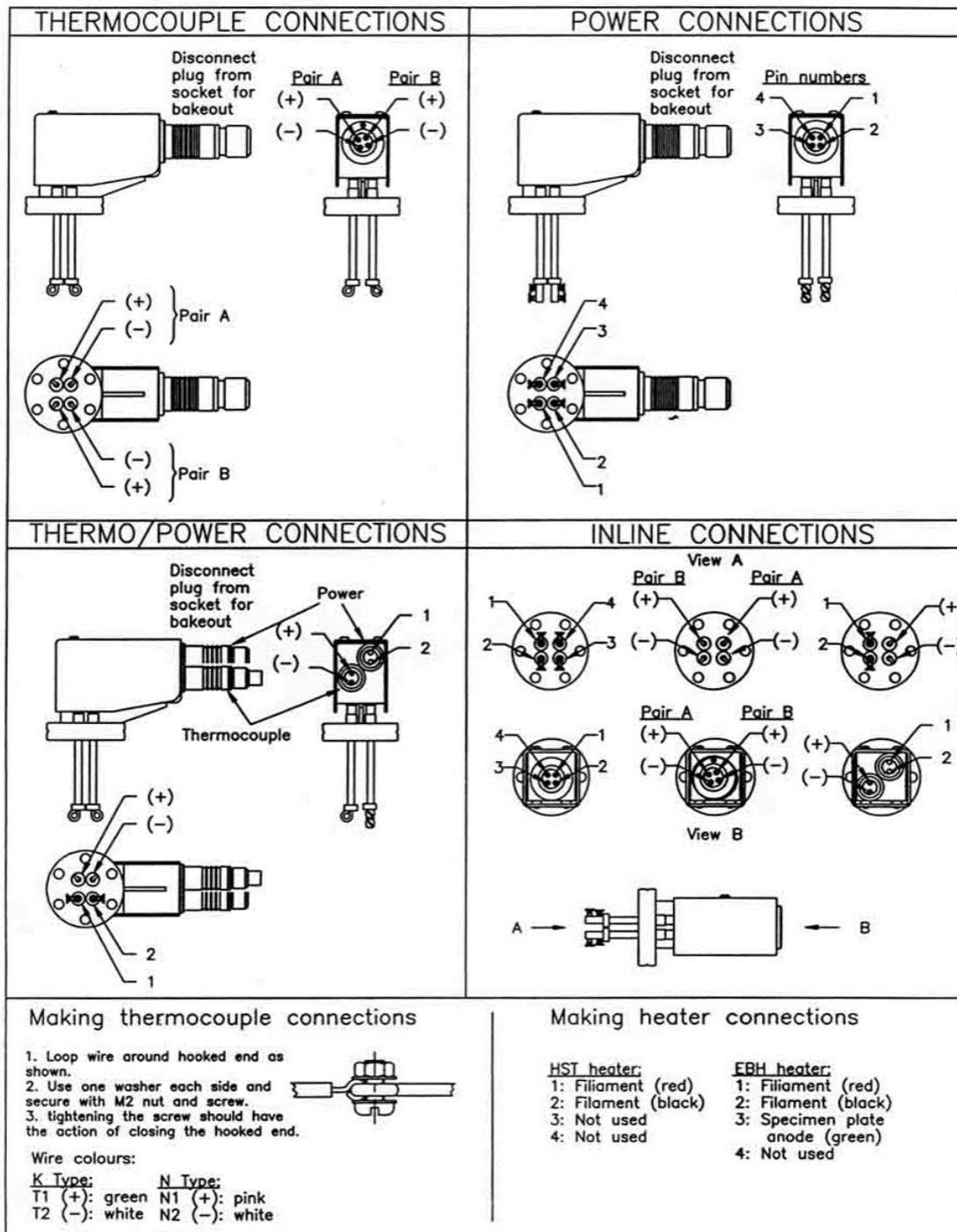
Two VACGENcouples are provided with either heater module. These are available as either Type K (Chromel-Alumel) or Type N (Nicrosil-Nisil). Type N is recommended where low magnetic permeability is important. Temperature control is recommended, using:

- \* the RHC controller for the HST and
- \* the EBHC controller for the EBH

## B2. WIRING DIAGRAMS



**WARNING:** It is very dangerous to leave feedthrough contacts isolated, especially during bakeout and when high voltages are present near to the sample. It is the responsibility of the user to be aware of electrostatic charge buildup and to provide suitable earthing.



## APPENDIX C. LIQUID NITROGEN COOLING

**WARNING:** VACGEN cannot advise on the safe use and handling of liquid gases which is entirely the responsibility of the user. The use of liquid nitrogen in confined spaces can be extremely dangerous

as nitrogen gas levels can build up rapidly. Ensure that the area is well ventilated. Always wear insulated gloves and safety goggles when handling liquid gases and surfaces that may be cold.

### C1. REQUIREMENTS

A supply of high purity nitrogen gas from a regulated supply.

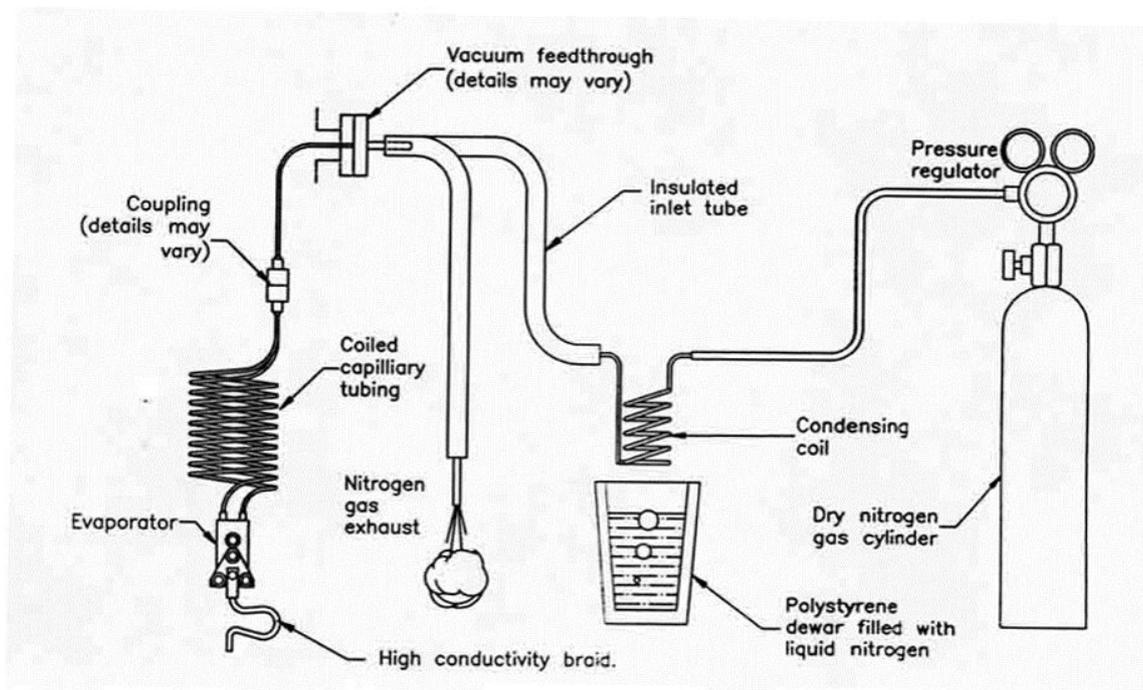
A supply of liquid nitrogen.

A condenser coil, insulated open polystyrene dewar and connecting polythene tubes with insulation (These items are available from VACGEN as an accessory, order code ZLNHX).

### C2. DESCRIPTION

Liquid nitrogen condensed from dry gas, enters and leaves the translator through liquid feedthrough connections. In-vacuum capillary tubing extends to the evaporator which should be mounted close to the sample position. The capillary tube is normally coiled to allow movement.

Conductive braid, electrically isolated from the evaporator, is supplied for mounting as near as possible to the sample.



LIQUID NITROGEN COOLING SCHEMATIC

### **C3. SETTING UP**

Position the copper condenser coil and polystyrene dewar as near as possible to the nitrogen entry feedthroughs. Using 6.35mm bore tubing, connect the regulator on the cylinder to the coiled end of the copper coil and secure with hose clips.

Connect the vertical end of the coil using 3mm bore tube to (either) feedthrough port. External insulating tube should cover the tube as completely as possible.

The outlet connection should be made to the other manipulator port. Ensure that the exhaust gas/liquid is well away from equipment that could be affected by moisture.

For horizontally mounted units a simple foil sheet should be fitted under the inlet 1 outlet connections to help to prevent condensation dripping onto the drive screw and bearing shafts.

### **C4. OPERATION**

a. Open the regulator to 0.5 bar to start a flow of gas through the system. Check that flow is coming from the system outlet pipe. Allow the gas flow to continue through the system for at least 2 minutes. This will purge the system of air to avoid formation of ice during cooling.

b. Place the coil in the dewar and fill the dewar with liquid nitrogen. Always maintain at least 25 mm of liquid above the top coil.

c. Increase the pressure to a maximum of 2 bar to start the cool-down cycle.

d. Liquid nitrogen will start to emerge in droplets from the outlet pipe within 10 minutes.

e. Reduce the gas pressure so that occasional droplets of nitrogen emerge. Excessive liquid mixed with the exhaust gas will reduce the cooling efficiency.

f. Once the desired temperature has been reached the gas flow can be reduced further.

g. On the completion of the cooling run, remove the copper coil from the dewar and allow the system to return to ambient temperature with a very gentle flow of nitrogen gas to prevent condensation.

### **C5. PERFORMANCE**

The cooling performance will vary depending on many factors, including the nature of the sample, the sample mounting arrangements, radiated heat from the chamber, vacuum pressure and experimental conditions. The temperature will drop sharply once liquid has reached the evaporator, (when liquid droplets begin to emerge from the exhaust.) The temperature will continue to fall and stabilise after approximately 1 hour.

### **C6. BAKEOUT**

Disconnect all plastic tubes from the liquid nitrogen feedthrough connections before commencing bakeout.

VACGEN  
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E.C. Declaration of Incorporation  
ref Dol-147 (VGF 4.06d Iss2)

We hereby declare that the following product range:

Part Codes:

**ZTR1570, ZTR3070, ZTR4570, ZTR6070. ZTRST, ZTRFC, ZTRRB,  
ZTRS, ZTRWD, ZTRSMK**

are, suitable for incorporation or assembly into a vacuum system or other machinery. These products may only be put into service if it has been verified that the system or machinery into which it is incorporated conforms to the provisions of the appropriate EU directives and with the limitations of the equipment specifications.

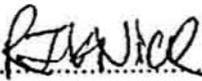
Applicable regulations:

89/392/EEC Version.93/68/EEC

Appropriate harmonised or national standards.

EN292-1

EN292-2

(Signed).....

Dr R J K Nicholson  
Director of Development

## 1.1

### Service and Repair Form

## 1.2

Declaration of Contamination of Equipment and Components

Servicing and repairs will only be carried out if the conditions for Servicing and Repair are complied with in full, according to the VACGEN Ltd. Conditions of Sale. A summary of these requirements are included on the inside front cover of the Operating Instructions. The manufacturer will refuse to accept any equipment without a signed declaration attached to the OUTSIDE of the packaging. This declaration can only be completed and signed by authorized and qualified staff.

**1 Description of Equipment and Components**

Equipment Type..... Model Number.....  
 Serial Number..... Your Reference Number.....

**2** **Reasons** **for**  
**return**.....  
 .....  
 .....  
 .....

**3 Condition of Equipment**

YES ( ) NO ( ) Toxic? YES ( ) NO ( ) Corrosive?  
 YES ( ) NO ( ) Explosive? YES ( ) NO ( ) Biological Hazard?  
 YES ( ) NO ( ) Radioactive? YES ( ) NO ( ) Other Harmful Substances?

Equipment and Components that have been contaminated, WILL NOT be accepted without written evidence of decontamination.

**5 Contamination Materials**

List all the substances, gases and by-products that may have come in contact with the equipment, giving trade name, manufacture, chemicals names or symbols.  
 Please note that any of these listed, must be completely removed, so it is safe to handle and weld, without giving off health threatening gases. Please enter details below and/or attach data sheets  
 .....  
 .....  
 .....

**6 Legally Binding Declaration**

I hereby declare that the information supplied on this form is complete and accurate.  
 There by stating that the goods offer no risk to health or safety  
 Organisation..... Name.....  
 Country..... Job Title.....  
 Post/ZIP code..... Telephone.....  
 Email.....  
 Signature..... Date.....

Return goods to: Address at top  
 Phone: (0) 1424 851291 Fax (0) 1424 851489 (Form VGF33)