

## Operating and Maintenance Handbook

# ROTARY DRIVES RD1, RD2, RD224, RD5, RD6, RD7



REVISION	DATE	COMMENTS	INITIALS
1	Jan 1993	Original release	MJD
2	April 1998		ECN 2791
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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:** 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.

### 1.2 PRODUCT OVERVIEW

**RD1, RD2 and RD224:** (Figures 1a and 1b) These high precision drives have minimal backlash and are typically used for specimen manipulation. Vernier scales and rotation stops are fitted to the primary (rotary) axis. The RD2 and RD224 drives include an independent secondary (linear) axis, along the centre of the primary axis, with the RD224 having increased linear movement. These drives can be motorised.

**RD5:** (Figure 1c) This drive is designed for high speed continuous rotation applications such as beam choppers, planetary drives and tribology studies. The drive is supplied with plain input and output shafts; a graduated handwheel and position lock is available as an optional accessory.

**RD6 and RD7:** (Figure 1d and 1a) These robust, medium precision drives for general purpose applications can be quickly and easily dismantled, enabling them to be baked to 400°C. Both manual drives are fitted with a position lock. The RD7 handwheel is graduated and can be fitted with position stops. Motorisation is available with either an in-line motor (MI option) or an integral motor/gearbox (MGI option).

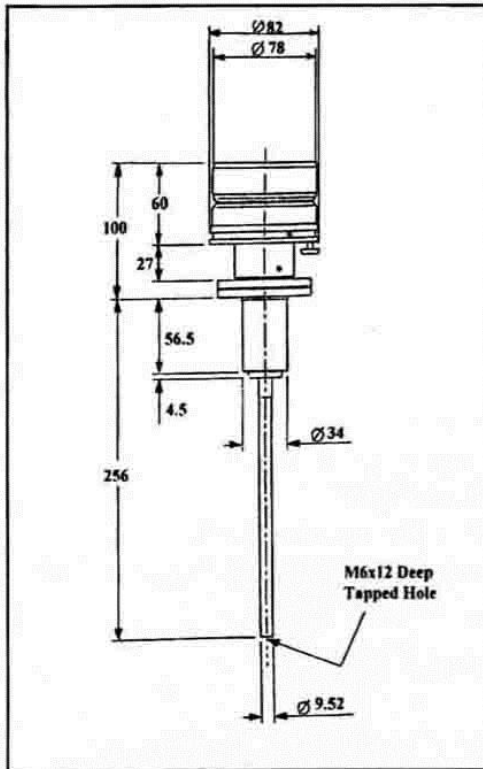
### 1.3 CONSTRUCTION

The vacuum envelope of all drives is stainless steel. All vacuum joints are welded. Parts within the vacuum enclosure are mainly stainless steel, with aluminum bronze supporting the linear drive shaft where applicable. All moving parts are guided by ball bearings. Internal bearings may be dry film lubricated, whilst parts external to vacuum are lubricated with high temperature lubricant.

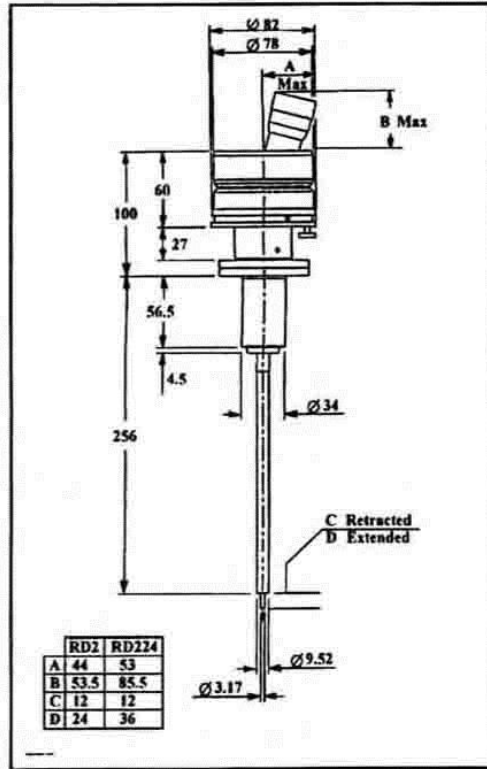
### 1.4 SPECIFICATIONS

	<b>RD1</b>	<b>RD2</b>	<b>RD224</b>	<b>RD5</b>	<b>RD6</b>	<b>RD7</b>
Rotation (continuous)	360°	360°	360°	360°	360°	360°
Maximum speed	500 rpm	500 rpm	500 rpm	1,000 rpm	300 rpm	300 rpm
Torque hand operated	5 Nm	5 Nm	5 Nm	1 Nm	5 Nm	5 Nm
Torque at max. speed	0.5 Nm	0.5 Nm	0.5 Nm	0.125 Nm	0.8 Nm	0.8 Nm
Primary shaft thrust	40 N	40 N	40 N	20 N	40 N	40 N
Secondary shaft thrust		20 N	20 N			
Primary axis resolution Manual Motorised	0.1 ° 0.01°	0.1 ° 0.01°	0.1 ° 0.01°	5°* -	- 0.9° (MI) 0.1° (MGI)	1.0° 0.9° (MI) 0.1° (MGI)
Angular repeatability	0.1°	0.1°	0.1°		0.5°	0.5°
Linear axis resolution Manual Motorised	-	0.02° 0.0556 µm	0.02° -	-	-	-
Shaft concentricity (TIR)	0.1 mm	0.1 mm	0.1 mm	0.05 mm	0.1 mm	0.1 mm

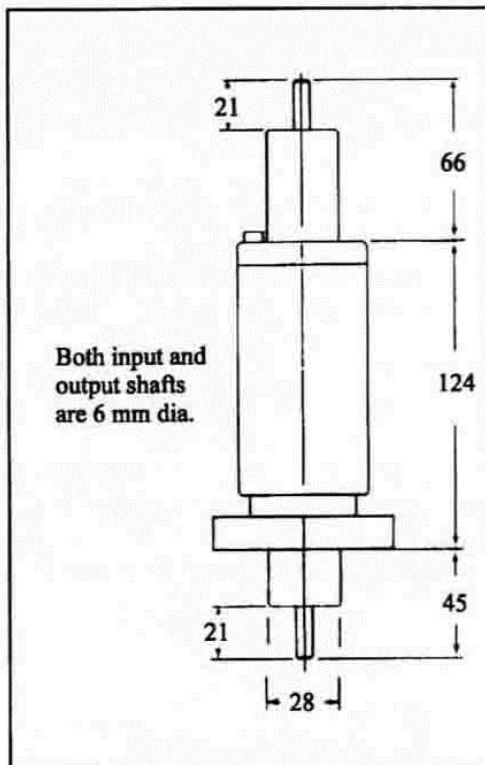
\* with optional handwheel



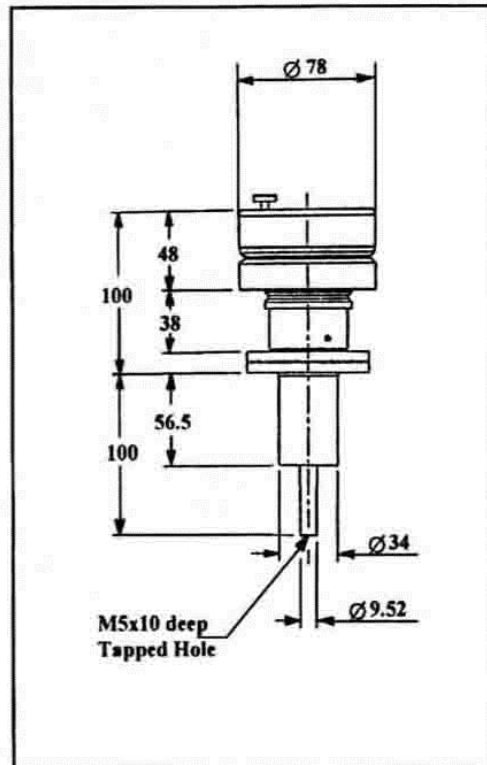
**Figure 1a. RD1 and RD7 drives**



**Figure 1b. RD2 and RD224 drives**



**Figure 1c. RD5 drive**



**Figure 1d. RD6 drive**

**General Data**

Construction:

Welded Stainless Steel, Aluminium, Bronze

Pressure Range:

Atmospheric pressure to less than  $10^{-11}$  mbar

Bakeout Temperature:

230°C - no dismantling

RD5 - 350°C with some dismantling

Operating Temperature:	RD6 and RD7 - 400°C with some dismantling -20°C to +150°(manual) -20°C to +40°(motor kits)
Mounting flange:	DN35CF (70 mm (2 3/4") OD)
Orientation:	Any

### Other Facilities

Rotational Lock:	Standard on all models except RD5
Rotational Stops:	Standard on RD 1, RD2 and RD224, and as an option on RD7
Zero and stop positions:	Fully adjustable over 360°C
Extended bearing housing:	Available for RD1, RD2, RD224 and RD7

## 2. INSTALLATION

### 2.1 MOUNTING THE DRIVE TO THE SYSTEM

These drives are fitted with standard ConFlat flanges and require a similar mating flange on the system. When bolting up, use an appropriate gasket, depending on the application (refer to Section 5: Spares and accessories for the available gasket options). It is advisable to use a thread lubricant on the bolts and to tighten the bolts gradually and evenly in an diagonal pattern to minimise the risk of leaks.

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

**Warning:** 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.

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

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



## 2.2 ROTARY DRIVE MOTOR KITS

### 2.2.1 RDI, RD2 and RD224 primary axis motor kit (RDPMK)

#### Description:

The Primary axis Motorisation Kit, RDPMK, can be retrofitted to the RD1, RD2 and RD224 drives. Limit switches are included.

The motor is an 8 lead, 4 phase hybrid stepper motor, VACGEN ref. 23HS1 08E. A full description of the motor and connections is given in Appendix A. The motor can be driven by any of the VACGEN stepper motor control units type SDU or SMC. Other controller types can be used, but the performance will be affected. VACGEN cannot advise on alternative controller selection or be held responsible for loss of performance.

For bakeout, the motor unit can be removed.

For high precision repeatability, always approach measured positions from the same direction of rotation.

- Torque available at the rotary drive tip is 1.7 Nm maximum at low speed, reducing to 0.5 Nm at maximum speed.
- The worm gear provides a 90:1 reduction drive (so 1 motor revolution gives 4° shaft rotation).
- Operating temperature range is -20°C + 40°C

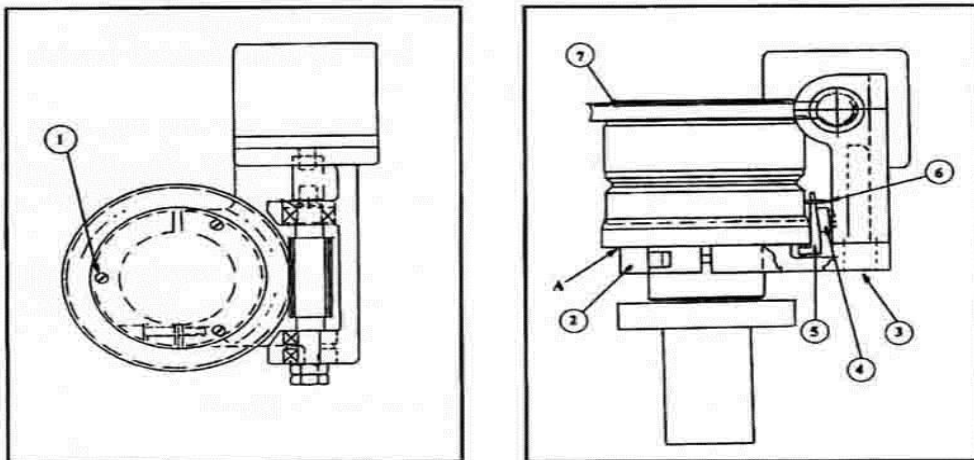


Figure 2 - Top and side views of the RD1 drive with RDPMK motor kit attached

**Warning:** To comply with EU directives, emergency stops must be fitted in location(s) that safeguard the user at all times.

### 2.2.1 Fitting the RDPMK unit to the RD1 drive

Numbers in ( ) refer to the items indicated in figure 2.

- a. Remove the three screws and cover plate from the top of the drive.
- b. Locate the spigot of the worm wheel gear (7) in the rotary drive. Align so that the large hole coincides with the bearing below. Fit the cover plate and attach both the gear and the cover plate with the long screws provided (1).
- c. Locate the motor mounting assembly to the rotary drive so that the clamp bracket face is against the shoulder (A); ensure that the worm gear and worm wheel are meshed. Clamp in position with split clamp (2). Do not over tighten the clamp screws.
- d. Slacken the three MS screws (3) that secure the worm bearing assembly to the mounting plate. Adjust the gear meshing so that minimum backlash is achieved. Note: Do not force worm into tight mesh with the wheel, this could cause motor to stall. Re-tighten the screws (3).
- e. Rotate the motor by hand to check that the rotary drive rotates smoothly through one revolution.
- f. Attach the limit microswitches (4) to the rotary drive stop arms (5) with the screws provided. Position the switches such that the striker pin (6) engages with the switch actuator. To reposition the stop arm, slacken the stop arm M3 clamp screw, slide that arm to new position and re-tighten.

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

#### Fitting the RDPMK unit to the RD2 or RD224 drive:

- a. Loosen the two set screw securing the linear motion thimble (item 1 in figure 3) and remove the thimble.
- b. Remove the three screws and cover plate from the top of the drive.
- c. If the secondary motion motor kit (RDSMK) is already fitted to the rotary drive, this must be partly removed so that only the mounting barrel (item 1, figure 4) remains.
- d. Pass the worm wheel gear over the linear motion unit and proceed as for the RD1 above. Check the correct functioning of the linear and rotary motions.

### 2.2.1 RD2 secondary (linear) axis motor kit (RDSMK)

#### Description

The Secondary Motor Kit, RDSMK, which includes limit switches, can be retrofitted to the RD2 rotary linear drive only. The RD224 secondary motion cannot be motorised.

The motor is an 8 lead, 4 phase hybrid stepper motor, VACGEN ref. 23HS108E. A full description of the motor and connections is given in Appendix A. The motor can be driven by any of the VACGEN stepper motor control units type SDU or SMC. Other controller types can be used, but the performance will be affected. VACGEN cannot advise on alternative controller selection or be held responsible for loss of performance. For bakeout, the motor unit can be removed.

For high precision repeatability, always approach measured positions from the same direction.

The motor gear ratio provides a 45:1 gear reduction. The pitch of the thimble is 1.0 mm, so 1 motor revolution gives 0.022 mm of linear motion. If the motor is driven in halfstep mode (400 hsteps 1 rev), then 18 hsteps gives 1 micron of axial movement.

Maximum linear thrust 20 N

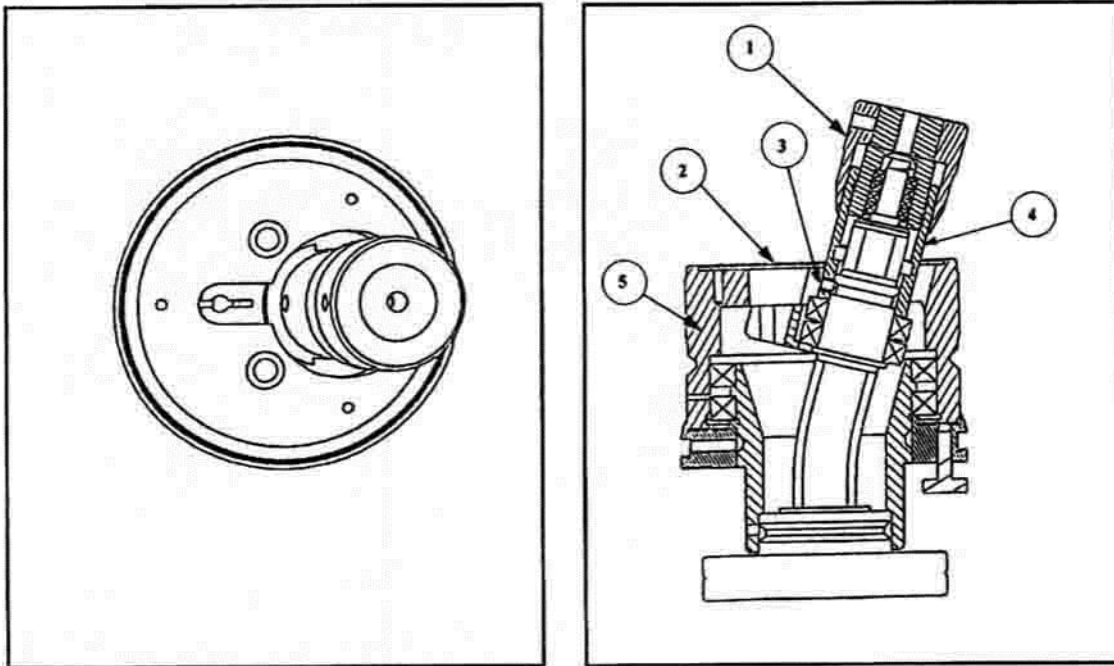
**Warning:** To comply with EU directives, emergency stops must be fitted in location(s) that safeguard the user at all times.

#### Fitting the Secondary Axis motor kit



Numbers in ( ) refer to item numbers in figure 3.

a. Unscrew the linear motion thimble (1) anti-clockwise and remove from the RD2 rotary drive.



**Figure 3 - Top view and cross section of RD2 rotary drive**

b. Remove the three cover plate screws, and the cover plate (2).

c. To align the access slot with the set screw (3), rotate the handwheel (5). Unscrew the set screw 2 - 3 turns, repeat for the two remaining screws and then withdraw the barrel

(4).

Numbers in ( ) in the following text refer to item numbers in figure 4.

d. Ensure that the set screws of the motor mount barrel (4) do not project into bore of barrel.

e. Insert the barrel (1) over the bellows assembly. Note: The barrel end face must locate against bearings (2).

f. To align the access slot with the barrel set screw (4), rotate the handwheel (3) and tighten the screw. Repeat for the two remaining screws.

g. Fit the motor mounting unit and clamp in position. Note: The motor unit must be located against shoulder 'A' and the clamping screw (5) must be tightened with care. Tighten this screw with the minimum torque that will clamp the motor, mount in position.

h. Rotate the handwheel (3) by one full revolution to ensure that the motor mounting assembly does not foul the handwheel or any other obstruction. If necessary, slacken the screw (5) and rotate the motor mount to a position that clears the obstruction.

i. Check for correct operation of the microswitches

**Warning:** Keep clear of moving parts

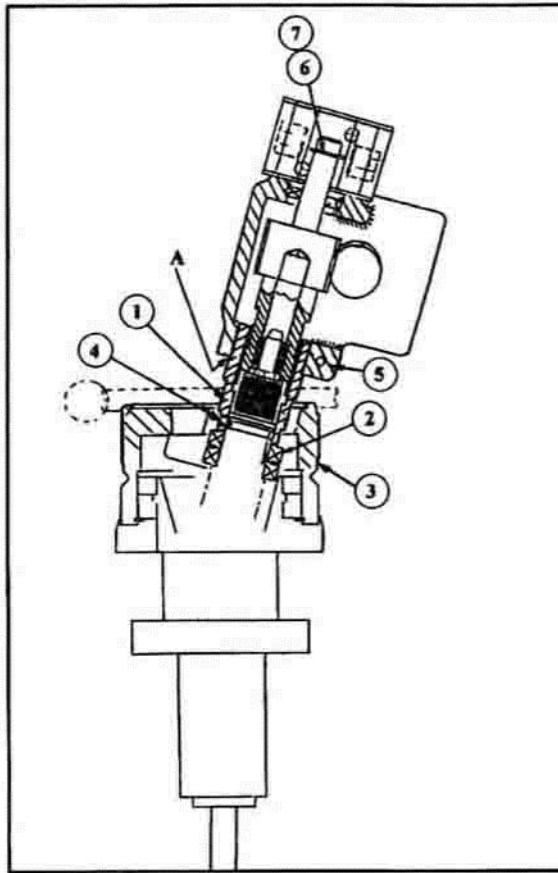


Figure 4 - Sectioned view of RD2 drive with secondary (linear) Axis motorisation kit, RDSMK, fitted

## 2.2.1 RD6 and RD7 motor options

### Description

The RD6 and RD7 rotary motion drives can be supplied with either a direct acting stepper motor (RD6M1 or RD7M1), or a stepper motor-driven 9:1 reduction gear (RD6MGI or RD7MGI). See figures 8 and 9.

The common motor is an 8 lead, 4 phase hybrid stepper motor, VACGEN ref 23HSI08E. A full description of the motor and connections is given in Appendix A. The motor can be driven by any of the VACGEN stepper motor control units type SDU or SMC. Other controller types can be used, but the performance will be affected. VACGEN cannot advise on alternative controller selection or be held responsible for loss of performance.

For bakeout, the motor unit can be removed.

Performance with VACGEN controllers:

	Direct motor (M1)	Geared motor (MGI)
Gear reduction:	1:1	9:1
Motor connection:	Coils in parallel	Coils in parallel
Maximum speed:	300 rpm	166 rpm
Movement per halfstep:	0.9°	0.1°
Torque*:	43 Ncm @ 50 rpm 38 Ncm @ 300 rpm	See figure 5

- Other torque-speed performance may be possible by series motor connection, or by fitting alternative motors.
- 

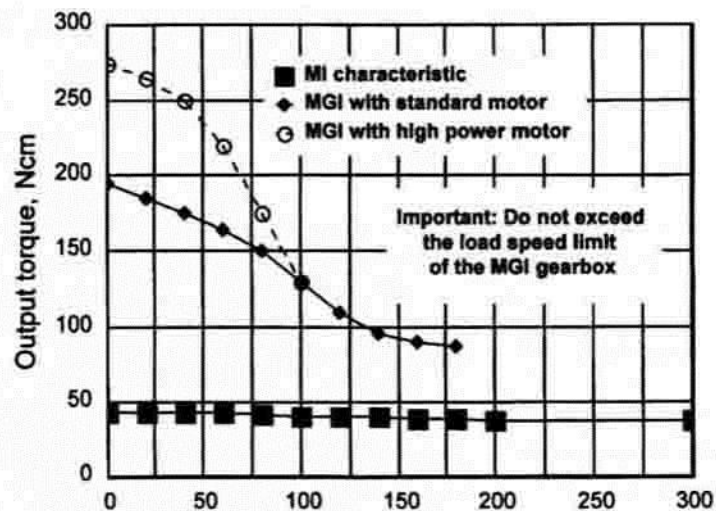


Figure 5 - RD6 and RD7 speed-torque performance

### 3. OPERATION

#### 3.1 RDI, RD2, RD224, RD6 & RD7

##### 3.1.1 Primary axis rotation

(Please refer to figure 6).

A locking ring (3), fitted with a locking screw (A) allows the rotary motion to be locked in any desired position.

**Caution:** Always release the locking screw before rotating the drive.

The locking ring may be rotated to reset the zero position, or to reposition the lock screw. To reposition this ring, slacken the three M4 socket set screws (B). Reposition the ring and tighten screws B evenly.

Rotation stops are available for these drives (except the RD6), and can be fitted to limit the rotation between approximately 0° and 334°; they are easily removed if continuous rotation is later required. The stops are fitted to the locking ring.

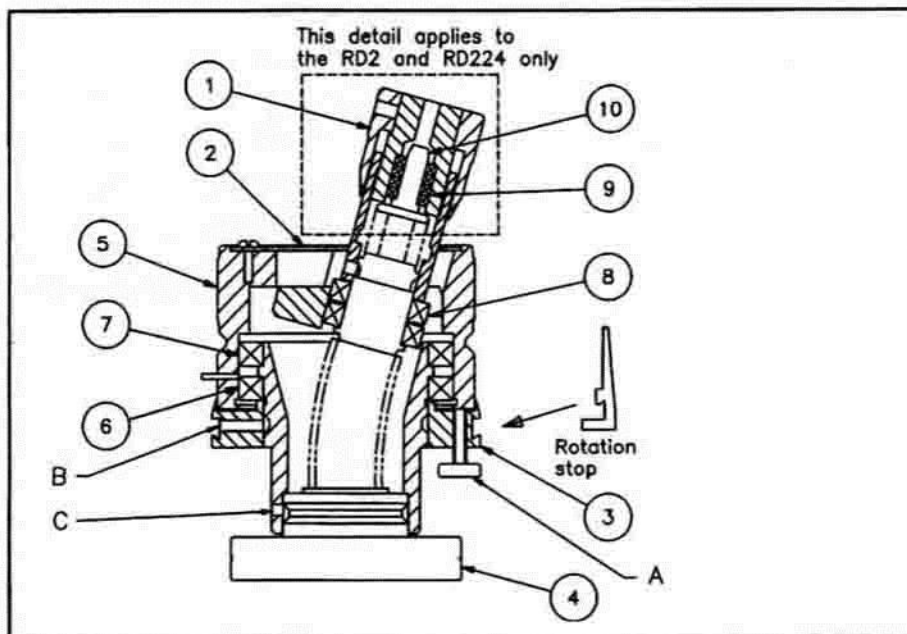


Figure 6 -

components of manual drives

Main

##### 3.1.2 Secondary (linear) axis movement

The RD2 and RD224 drives are fitted with an additional actuator that provides linear motion of a shaft which is co-axial to the primary axis. This may also be described as secondary movement.

The RD2 has a maximum axial movement of 12 mm, whilst the RD224 has a maximum axial movement of 24 mm. This motion is provided by a 1 mm pitch micrometer thread. The motion is transmitted through a push rod acting through a stainless steel bellows to the co-axial shaft. The shaft is spring-loaded to keep it in contact with the push rod.

**Caution:** When using the secondary motion do not exceed the maximum travel (12 mm for the RD2 and 24 mm for the RD224).

##### 3.1.3 Motorised Drives

The operation of motorised drives will depend largely on the motor controller used. Please consult the appropriate documentation.

**Warning:** Be aware of the danger of trapping hair or fingers in this equipment. Keep clear of moving parts. Emergency stops should be fitted by the installer of this equipment.

**Caution:** Where stepper motors are fitted, the motor connectors 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 for use as over travel limit stops only. Do not use as position stops or indicators. Depending on the controller used, the motor will attempt to stop immediately a limit switch is activated, and it is likely that steps will be lost due to motor overrun.

For accurate positioning, allow all motors to reach a stable temperature before starting work and arrange the drive so that the direction of any motion should be consistent to avoid backlash errors.

### 3.2 RD5

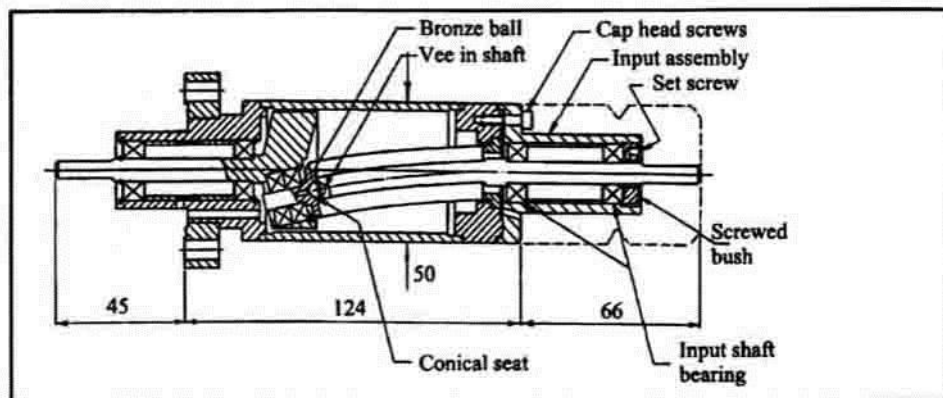


Figure 7 - RD5 rotary drive

If the handwheel option is fitted, release the locking screw before use. If the drive is motorised, refer to Motorised Drives above. For new RD5's, increase the speed gradually to allow the bearings to run in.

**Caution:** Never operate the RD5 rotary drive with a motor unless the drive is under vacuum.

### 3.3 BAKEOUT

#### 3.3.1 Bakeout limitations

The bakeout limits of all drives are stated in Specifications, section 1.4. VACGEN cannot accept any responsibility for any damage to equipment arising from failure to observe the following notes:

- a. Heat by convection only.
- b. The sensing element of the VACGENcouple controlling the heaters must be suspended in air near to the rotary drive and approximately 50 mm below the uppermost portion of the drive.
- c. Under NO circumstances should the sensing element be attached directly to (i.e. be in thermal contact with) the rotary drive or any other part of the vacuum system.

**Warning:** Surfaces on this equipment will remain hot for long periods after bakeout. Do not force cool. Use gloves when handling.

#### 3.3.2 Baking to 230°C

- a. Where fitted, release the rotation lock before baking the device. Note that the RD5 plastic lock screw must be removed for bakeout.
- b. Where fitted, remove all motors, microswitches and wiring from the bakeout zone. Specific instructions on removal of each motor unit are included in the following sections:

##### **Bakeout procedure for the Primary Axis motor kit**

The motors, microswitches and all wiring must be removed from the bakeout zone for bakeout as follows:

Refer to figure 2.

- a. Make a note of the angular scale reading of the rotary drive
- b. Undo the clamp (2) and disengage the drive unit from the rotary drive.
- c. Mark the position of the stop arms (5) that carry the microswitches. Slacken the arm clamping screw and remove the arm complete with microswitches. If the secondary linear motion (RD2) is motorised this must also be removed before bakeout.
- d. After bakeout set the microswitches and rotary drive to the angular position noted before removal.
- c. Locate the motor mounting assembly to the rotary drive so that the clamp bracket face is against the shoulder (A); ensure that the worm gear and worm wheel are meshed. Clamp in position with the split clamp (2). Do not over tighten the clamp screws.
- f. Check for correct functioning of the drive and verify that the microswitches operate correctly.



### **Bakeout procedure for the Secondary Axis motor kit**

Numbers in parenthesis ( ) refer to item numbers in figure 4.

To remove the motor and microswitches, proceed as follows:

- a. Remove the screw (6) and striker disc (7).
- b. Mark the position of the motor mount and barrel (1) at shoulder 'A' to aid the correct realignment on re-assembly after bakeout.
- c. Slacken the clamping screw (5) and withdraw the motor mount and switch unit over the motion gear, and remove.
- d. If primary rotary motion is also motorised this motor and microswitches must also be removed (see Bakeout procedure for the Primary Axis motor kit above). The unit is now ready for bakeout.
- e. After bakeout ensure that the motion gear movement is free and has adequate lubrication. Check the tightness of the barrel set screws (4).
- f. For re-assembly, reverse the above procedure. Note: The motor unit must be located against shoulder 'A' and the clamping screw (5) must be tightened with care. Tighten this screw with the minimum torque that will clamp the motor mount in position.
- g. Rotate the handwheel (3) by one full revolution to ensure that the motor mounting assembly does not foul the handwheel or any other obstruction. If necessary, slacken the screw (5) and rotate the motor mount to a position that clears the obstruction.
- h. Check for correct operation of the microswitches

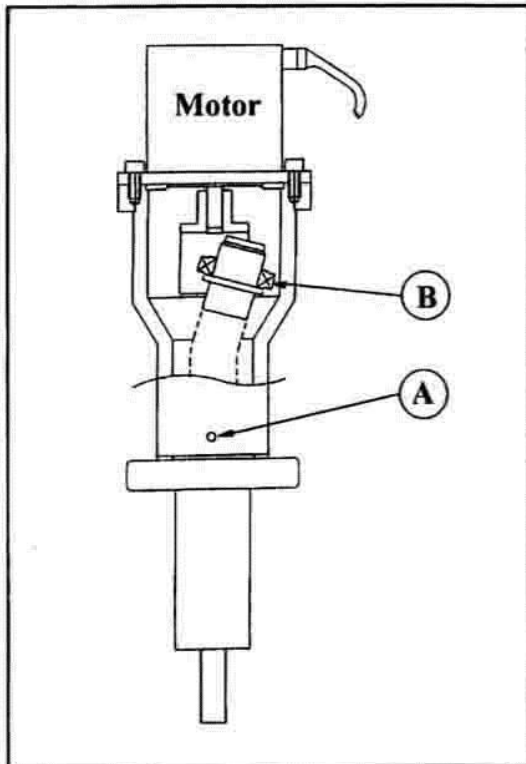
### **Bakeout procedure for the RD6 and RD7 motor kits**

Refer to figures 8 and 9:

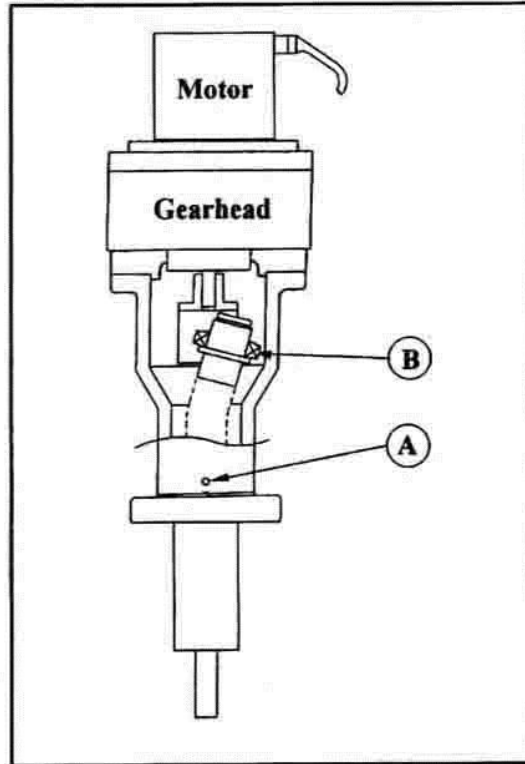
Remove the motor/gearbox assembly before starting by loosening the three radial set screws (A) that secure the body to the flange unit. The motor/gearbox assembly can then be separated from the rotary drive for normal bakeout.

For bakeout to 400°C, remove bearing (B) also. Note: When refitting the motor assembly ensure that the slot offset is aligned with bearing (B).

**Warning:** To comply with EU safety directives, emergency stops must be fitted in location(s) that safeguard the user at all times



**Figure 8: Direct motor drive  
RD6MI and RD7MI**



**Figure 9: Reduction drive  
RD6MGI and RD7MGI**

### 3.3.1 RD5 only: bakeout procedure to 350°C

- a. Note the instructions for baking up to 230°C
- b. Remove graduated handwheel, where fitted.
- c. Remove the three cap head screws and withdraw the input drive assembly together with the 6 mm diameter phosphor bronze ball.
- d. Clean all lubricant from the conical ball seating before bakeout.

**Warning:** Failure to remove all lubricant can cause harmful gases to be evolved in bakeouts above 230°C

- e. After bakeout, replace the components in the reverse order, relubricating the 6 mm ball and the vee at the end of the input shaft with high temperature 'Carbafluo' grease.

### 3.3.2 RD6 and RD7 only: bakeout procedure to 400°C

- a. Note the instructions for baking up to 230°C
- b. Slacken the 3 radial set screws (marked C in figure 6) by two complete turns and gently withdraw the handwheel assembly from the flange unit.
- c. Using circlip pliers, remove the circlip and bearing from the bellows end. Take care not to damage the bellows.
- d. The drive is now ready for 400°C bakeout.
- e. Re-assembly is simply a reversal of the above procedure, but note that the offset slot in the handwheel must match the offset of the bellows and that they are also rotationally aligned.

## 4. MAINTENANCE

### 4.1 ROUTINE INSPECTION SCHEDULE

The following inspections and procedures should be performed at 6 monthly intervals, or after 150 to 200 hours of accumulated bakeout, or when any movement becomes less smooth than normal. Disconnect any power supplies and check the fixing screws of all drives, most of which should be secure, i.e. neither slack nor excessively tight. This is particularly important for motorised drives.

The exceptions to this are:

- the wobble bearing retainer set screw on the RD 1, RD2 and RD224 drives. This must only be tightened sufficiently to grip and minimise the radial clearance in the wobble bearings (item 8 in figure 6) which are located under the cover plate. This should only be done when the rotary drive is under vacuum. Do not over tighten.
- The RDPMK and RDSMK motor mount clamp screws: Do not over tighten.
- the worm gear lock nuts on the primary axis motor kit which should be adjusted so as to just remove axial play.

Check the RDS for excessive backlash between the input and output drive shafts. This can be corrected as described in section 4.3: RD5 backlash adjustment The lubrication should be checked and renewed if necessary as described below.

## 4.2 LUBRICATION

### 4.2.1 Lubrication overview

It is necessary to renew the lubricants used on the moving parts that are external to the vacuum envelope after approximately 400 to 500 hours accumulated bakeout, or when any of the motions appear to require more effort to operate than previously. This period may vary depending on the bakeout temperature and amount of normal use. The lubricant should cover the bearing surfaces and should be free of wear debris, which is normally seen as a blackening of the lubricant.

Note that 'Carbaflo' high temperature grease, used to lubricate all drives, discolours with time, becoming brown in colour. This is accelerated where regular bakeouts are applied to the equipment, but this does not affect the performance of the lubricant.,

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

**Warning:** Keep clear of moving parts on motorised units - Switch off electrical supply before commencing maintenance.

The standard VACGEN lubrication kit (order code ZLUBEK) contains all necessary lubricants.

### 4.2.2 RD1, R-D2, RD224 primary axis lubrication

The bearings within the vacuum enclosure are treated with a solid film lubricant which is sealed in for life. The bearings that are external to the vacuum enclosure can be lubricated in-situ as follows: Numbers in ( ) refer to the items indicated in figure 6.

- a. Remove the drive from the vacuum system.
- b. Remove the three screws retaining the cover plate (2) and remove.

- c. Slacken off the three ring retaining screws (B) and reposition the ring (3) to lie against the drive mounting flange (4).
- d. Use solvent to wash out old lubricants from the handwheel drive end assembly (5).

**Caution:** If ultrasonic cleaning is used, limit the ultrasonic time to 3 or 4 seconds, otherwise permanent bearing damage may occur.

- c. Ensure that the drive is dry and free of solvents.
- f. Stand the drive vertically with the output shaft up. Lubricate bearing (6) with eight drops of high temperature lubricating fluid. Rotate the handwheel several turns to distribute the fluid.
- g. Reposition the vernier ring (3) to its working position, and lightly tighten the three retaining screws (B).
- h. Stand the drive vertically with the output shaft down. Lubricate bearing (7) with 8 drops of lubricating fluid.

**Note:** that the secondary drive of the RD2 and RD224 will largely obscure this bearing. It can be just seen if viewed from the top. These drives require the fluid to be applied via a pipette/drip stick, one drop at a time, rotating the handwheel 90° between each drop.

Apply 4 drops of lubricating fluid to bearings (8). Note: The RD1 has one bearing only, the RD2 or RD224 has two bearings.

- j. Rotate the handwheel to distribute the fluid to all the bearings. Wipe away excess fluid and replace the end cover (2) and screws.
- k. Clean off unwanted lubrication marks with solvent.

If the axis is motorised, apply high temperature grease to the worm and wheel gears, and a few drops of fluid to the bearing that support the worm gear shaft.

#### 4.2.3 RD2, RD224 linear (secondary) axis lubrication

Numbers in ( ) refer to the items indicated in figure 6.

- a. Unscrew the motion thimble (1) anti-clockwise and withdraw.
- b. Use solvent to wash out old lubricants from the thimble unit (1). Rotate bearings (9) and repeat.

**Caution:** If ultrasonic cleaning is used, limit the ultrasonic time to 4 seconds maximum, otherwise permanent bearing damage will occur.

- c. Clean the thread with solvent.
- d. Ensure the drive is dry and free of cleaning solvents. Stand thimble on end, bearings uppermost. Apply 6 drops of lubricating fluid to bearings (9) and allow time to permeate down to lower bearing.
- e. Apply high temperature grease sparingly to female thread.
- f. Locate bellows end (10) within bearings (9) and screw clockwise to assemble.

If the secondary axis is motorised, it may become necessary to re-lubricate the drive components after a number of bakeouts. Remove the motor unit from the rotary drive (as for bakeout - refer to Bakeout procedure for the Secondary Axis motor kit in section 3.3.2), unscrew the motion screw from the barrel and remove the microswitch mounting bracket. Immerse all gears, drive screws and ball races in a suitable cleaning solvent. Clean off old lubricants and ensure that microswitch actuator spindle moves freely through its support bearing. Re-lubricate the bearings with a few drops of high temperature lubricating fluid. Lubricate the male and female motion threads, gears and microswitch actuator spindle with high temperature grease.

#### 4.2.4 RDS lubrication procedure

Only bearings external to the vacuum enclosure can be re-lubricated. The bearings within the vacuum enclosure are treated with a solid film lubricant which is sealed in for life.

Numbers in ( ) refer to the items indicated in figure 7.

- a. Remove graduated handwheel, where fitted.
- b. Remove the three cap head screws and withdraw the input assembly together with the 6 mm diameter phosphor bronze ball.
- c. Apply 3 drops of high temperature lubricant on the face of each bearing with the bearings in the horizontal plane.
- d. Leave for two minutes to allow the oil to penetrate the bearings; gently rotate the bearing to distribute the oil.
- e. Clean all lubricant from the conical ball seating. Apply 'Carbaflo' grease to the 6 mm ball and the vee at the end of the input shaft.
- f. Adjust if necessary. See section 4.3: RD5 backlash adjustment.

#### 4.2.5 RD6 and RD7 lubrication procedure

The bearings within the vacuum enclosure are treated with a solid film lubricant which is sealed in for life. The bearings that are external to the vacuum enclosure can be lubricated in-situ as follows:

Numbers in ( ) refer to the items indicated in figure 6.

- a. Slacken the 3 radial set screws (C) by two complete turns and gently withdraw the handwheel assembly from the flange unit.
- b. For the RD7 only, slacken off the three ring retaining screws (B) by 3 complete turns, and remove ring (3).
- c. Use solvent to wash out old lubricants from the handwheel drive end assembly (5)

**Caution:** If ultrasonic cleaning is used, limit the ultrasonic time to 4 seconds maximum, otherwise permanent bearing damage will occur.

- d. Lubricate bearing (6) with eight drops of high temperature lubricating fluid. Rotate the handwheel several turns to distribute the fluid.
- e. For the RD7 only, reposition the locking ring (3) to its working position, and lightly tighten the three retaining screws (B).
- f. Apply 4 drops of high temperature lubricating fluid to bearings (8).
- g. Rotate the handwheel to distribute the fluid to all the bearings. Wipe off excess lubrication and re-assemble the drive.

#### 4.3 RD5 BACKLASH ADJUSTMENT

If backlash develops between the input and the output shaft, adjust as follows: (Refer to figure 7)

- a. Slacken the hexagon socket set screw located in the split in the bush.
- b. Gradually screw the bush inwards (clockwise) until the backlash is almost eliminated.
- c. Re-tighten the set screws ensuring that a small amount of backlash is still present.

**Caution.** If the backlash is completely removed the bearings could be damaged.

#### 4.4 FACTORY SERVICING OF ROTARY DRIVES

Rotary Drives may be returned to the factory or local service agent. It is not recommended that the user attempts to dismantle or repair a damaged drive. Items for return should be accompanied by an order giving full details of the service required and a completed 'Declaration of Contamination' form (a copy of which can be found at the end of these Operating Instructions).



## 5. SPARES AND ACCESSORIES

### 5.1 GENERAL

Gaskets: The large selection of gasket types shown below is available for standard CF flange sizes.

- 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 for general use. Includes a wide range of spanners and ball-ended hexagon keys, circlip pliers, small screwdriver and nylon gloves,

Lubrication kit: ZLUBEK for general use. Includes high temperature grease and lubricant, non-ozone depleting solvent, thread lubricant and nylon gloves.

### 5.2 ROTARY DRIVE SPARES AND ACCESSORIES

Order Code	Description
MRDPMK	Stepper motor primary rotation kit (RD1, RD2 and RD224) with microswitches included.
MRDSMK	Stepper motor secondary (linear) motion kit (RD2 only) with microswitches included.
SDU and SMC ranges	Stepper motor controllers
ZRD5TC	Graduated top cap for the RD5 drive
MRDRSP	Rotation stops for RD7 drive
SH and SM ranges	Specimen manipulators of various types for attachment to Rotary Drive tips.
Motor wiring accessories	Refer to Motor Spares in Appendix A for cables and connectors used with VACGEN motor controllers.

For other parts, please contact VACGEN with your model type and serial number, stating requirements clearly.

## APPENDIX A. STEPPER MOTOR CONNECTIONS

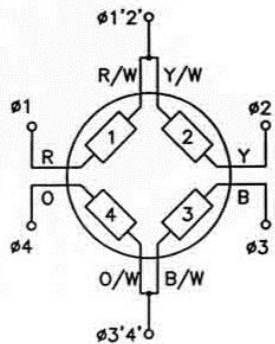
### AI. OVERVIEW

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.

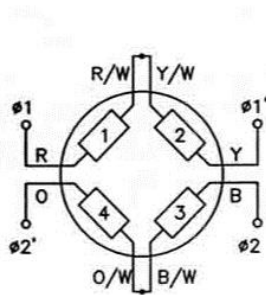
For attachment to VACGEN controllers, the motors (and encoders if applicable) can be supplied wired with suitable connectors. Otherwise, motors are supplied without connectors to allow connection to alternative drive and controller systems.

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.

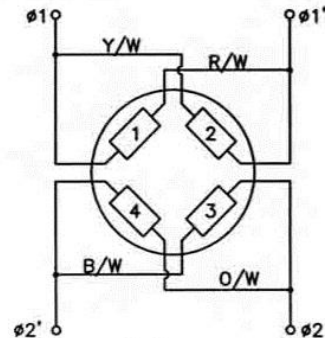
For motors fitted with incremental encoders, the VACGEN SMC-E range of controllers is required to provide passive feedback. If the motor has no encoder fitted, the controller cannot be used in the "Loop Active" mode. Note that encoders cannot be retrofitted to motors.



**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.**

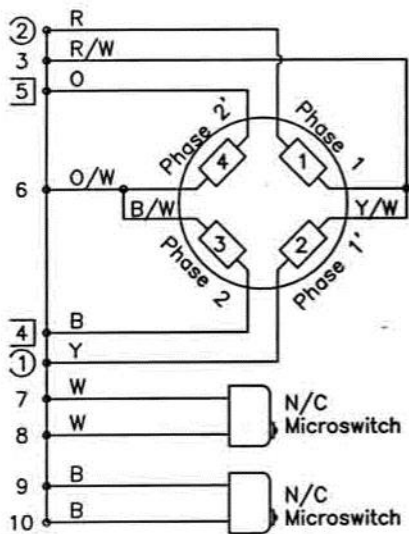
	As drawn	Alternative 1	Alternative 2
Phase 1	R	R	R
	R/W	B	Purple
Phase 1'	Y	R/W	Y
	Y/W	W	Blue
Phase 2	B	G/W	Pink
	B/W	B/W	Grey
Phase 2'	O	G	B
	O/W	O	W

## A4. MOTOR WIRING DIAGRAMS

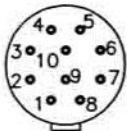
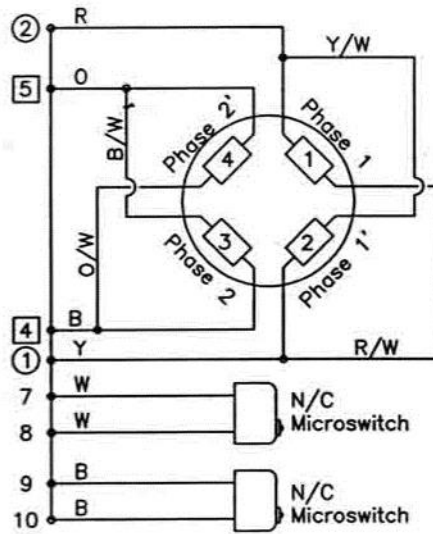
**Caution:** When wiring motors, care must be taken to make all connections secure. Failure to do so may result in disconnection during use and this can permanently damage the motor drive. For the same reason, never disconnect a motor from its drive unless the power has first been switched off.

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.

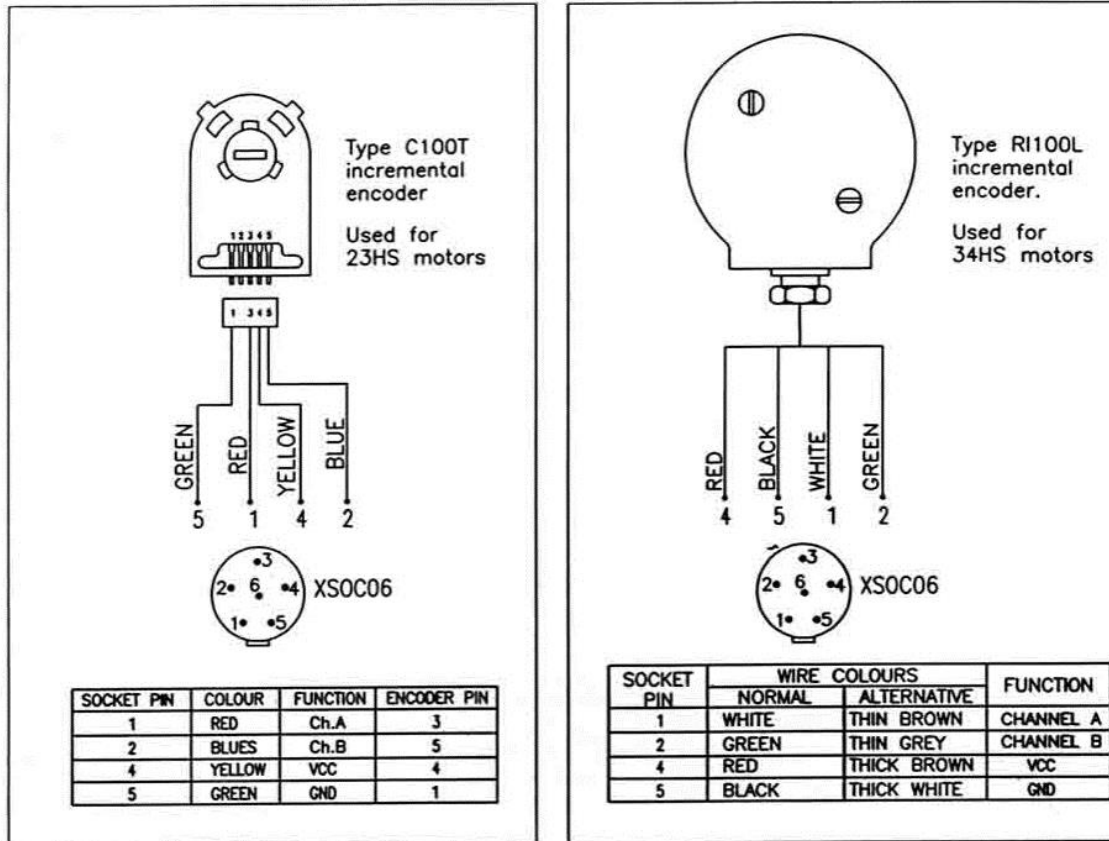
Where microswitches are not used, links must be made between pins 7 and 8, and between pins 9 and 10.

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.

VACGEN  
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 Castleham Industrial Estate  
 East Sussex  
 TN38 9NN  
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 Tel: +44 (0) 3424 851291  
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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:

**Rotary Drives on DN35CF flanges**

**RD1, RD2, RD224, RD5, RD6, RD7**

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:**

Machinery Directive:	89/392/EEC Version.93/68/EEC
Low Voltage Directive:	72/23/EEC Version. 92/31/EEC
Electromagnetic Compatibility Directive:	89/336/EEC Version. 93/68/EEC

**Appropriate harmonised or national standards.**

BS EN292-1	Safety of machinery – Terminology and Methodology
BS EN292-2	Safety of machinery – Principles and Specification
BS EN61010-1	Safety requirements for electrical equipment for measurement control and laboratory use
BS EN50081-2	Generic Emissions Standard, industrial equipment
BS EN50082-2	Generic Immunity Standard, industrial equipment



