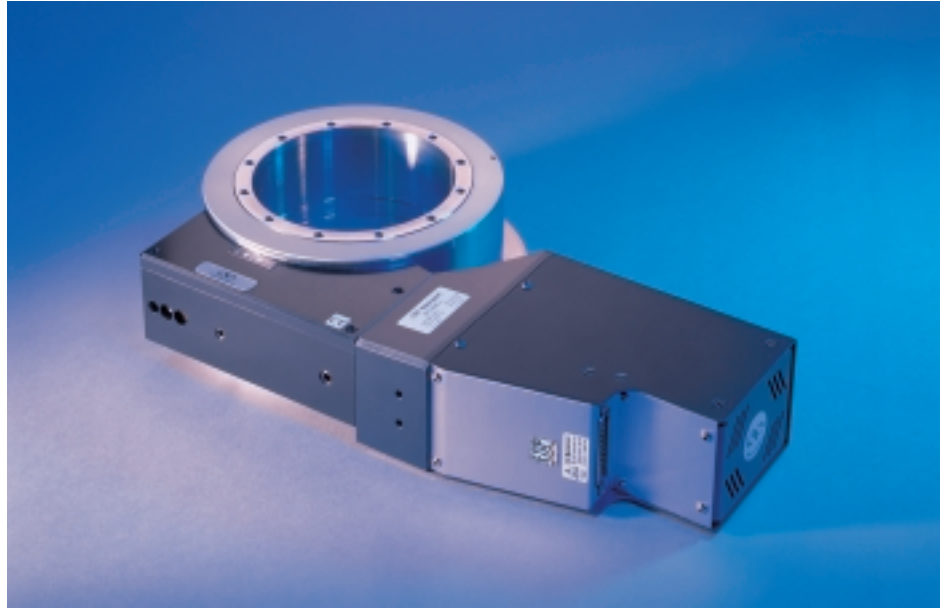


## RV Series

# High-Performance Precision Rotation Stages

## Key Features

- Precision 80–350 mm diameter rotation stages for high-speed and high load applications
- Monolithic design with double row ball bearings ensures high structural stiffness
- Flexible preloaded worm gear provides high reliability with 20,000 hours MTBF
- Direct reading encoder versions offer better than  $0.0001^\circ$  (0.36 arc sec) resolution for superior sensitivity and repeatability



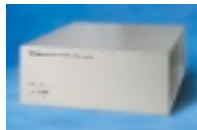
**The RV Series rotation stages provide high-precision angular positioning accuracy** combined with high load capacity in a compact, annular design. We offer five stage sizes and seven drive configurations enabling a variety of operating conditions for optimizing load capacity, torque, speed, and resolution.

**All RV stages are constructed of tool steel** with the rotation accuracy ensured by a double row of preloaded ball bearings on hardened surfaces. This allows for high off-center loads within a reduced footprint. The single monolithic design offers improved stiffness without compromising dynamic performance characteristics. The largest member of the RV product family can bear up to 650 kg or rotate up to  $80^\circ/\text{second}$  while maintaining eccentricity of less than  $4\ \mu\text{m}$ .

**Precise rotation is ensured by a precision ground, hardened worm gear drive.** A worm mounted rotary encoder provides  $0.001^\circ$  resolution position feedback on the standard configurations. For more demanding applications, the HAT and HAHLT options are available on the RV120 to RV350 models. These stages are equipped with a direct reading optical encoder attached to the moving platen for superior resolution and accuracy.

## Motion Controller Options

For optimum performance and seamless compatibility, we recommend using one of the following Motion Controllers/Drivers:



**XPS**  
(page 1024)



**ESP6000 with UNIDRIV6000**  
(page 1034) (select driver option 02 for RV-HAT and RV-HAHLT)  
Except V6 versions



**ESP300**  
(page 1039)



**ESP100**  
(page 1045)  
Only RV80PP, RV80PE, RV120PE, RV80CCHL

## Stepper Drive Versions

Stepper motor-driven versions are available in 2 variations:

- One mini-step drive version (PP) with 1/10-step per encoder count enabling high angular speed motions up to 20°/sec.
- One full-step version (PE) equipped with an additional step-down gear in order to obtain higher torque values. This version causes no motor heating in static position, and maintains the position, when the power is switched off. It is the recommended motor option for operation in a vacuum.

	Resolution (°)	Maximum Speed (°/s)	
		PP	PE
RV80 to RV350	0.001	20	2

## DC-Servo Drive Versions

DC motor-driven stages are offered in four variations:

- Two high-speed DC-servo versions (CC and HAT) enabling speeds up to 80°/s. The HAT features a high-resolution direct reading encoder and tachometer for superior repeatability, position stability and speed regulation.
- Two high-torque DC-servo versions (CCHL and HAHLT) equipped with a step-down gear to provide superior torque and maximum inertia values. The HAHLT features a high-resolution direct reading encoder and tachometer for superior repeatability, position stability and speed regulation.

	Resolution (°)	Maximum Speed (°/s)		Resolution (°)	Maximum Speed (°/s)		
		CC	CCHL		HAT	HAHLT	
RV80	0.001	80	2.5				
RV120	0.001	80	16	RV120	0.0001	80	16
RV160	0.001	80	16	RV160	0.000075	80	16
RV240	0.001	80	16	RV240	0.00005	80	16
RV350	0.001	80	16	RV350	0.000035	80	16

## Manual Drive Versions

The RV Series rotation stages are also available with manual drive (MS) and rotary encoder providing 0.001° resolution. The manual knob permits a rotation of 2°/rev. (RV80MS) or 4°/rev. (RV120MS to RV350MS).

## Motor Information

Model	Motor
RV80CC	UE404S
RV80CCHL	UE31CC
RV80PP	UE41PP
RV120PE	UE41PP
RV120CCHL	UE404S
RV120HAHLT	UE404S-T
RV120PP to RV350PP	UE63PP
RV160PE to RV350PE	UE63PP
RV80PE	UE31PP
RV120CC to RV350CC	UE511S
RV120HAT to RV350HAT	UE511S-T
RV160CCHL to RV350CCHL	UE511S
RV160HAHLT to RV350HAHLT	UE511S-T

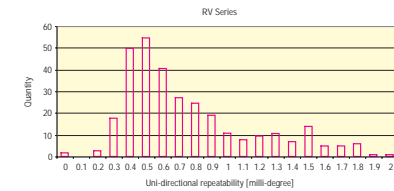
## Design Details

Base Material	Stainless Steel
Bearings	Double row of ball bearings
Drive Mechanism	Ground worm gear with self compensating preload
Worm Gear Ratio	RV80: 1:180 RV120–RV350: 1:90
Reduction Gear	Reduction gear before encoder on some versions (please contact Newport for details)
Feedback	HAT and HAHLT: Direct reading optical encoder on the rotating platen Others: Worm mounted rotary encoder, 2,000 pts/rev., Index pulse (RV80) or Worm mounted rotary encoder, 4,000 pts/rev., Index pulse (RV120-350)
Limit Switches	Optical, at $\pm 170^\circ$ , can be disabled for continuous 360° rotation (except HAT and HAHLT)
Origin	Optical
Cable	3 m long cable included
Vacuum Compatibility	Vacuum compatible versions are available up to $10^{-4}$ Torr using full-step motor (PE)
MTBF (h)	20,000
Weight	see page 1085

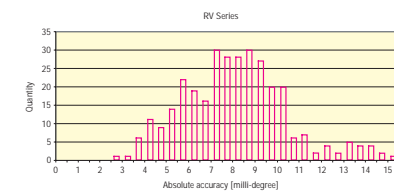
## Specifications

Diameter (mm)	240, 240, 160, 240, 350	
Travel Range	360° continuous $\pm 170^\circ$	With disabled limits, except HAT & HAHLT HAT & HAHLT
Resolution	0.001° 0.00005° 0.000075° 0.00005° 0.00005°	Except HAT & HAHLT versions RV120HAT & HAHLT RV160HAT & HAHLT RV240HAT & HAHLT RV350HAT & HAHLT
Uni-directional Repeatability	0.001° typical, 0.00011° typical	0.002° guaranteed 0.0002° guaranteed HAT & HAHLT versions
Reversal Value (Hysteresis)	0.001° typical, 0.0006° typical	0.002° guaranteed 0.001° guaranteed HAT & HAHLT versions
Absolute Accuracy	0.001° typical, 0.007° typical, 0.003° typical	0.015° guaranteed 0.010° guaranteed 0.005° guaranteed HAT & HAHLT versions
Wobble ( $\mu$ rad)	16 typical, 10 typical, 8 typical, 10 typical, 8 typical	40 guaranteed 20 guaranteed 16 guaranteed 20 guaranteed 16 guaranteed RV80 RV120 & RV160 RV 240 & RV350 RV120HAT & RV160HAT RV240HAT & RV350HAT
Eccentricity ( $\mu$ m)	1.4 typical, 8 typical	4 guaranteed 16 guaranteed RV240HAT & RV350HAT

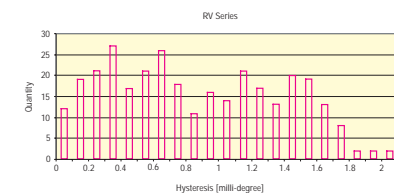
See the Metrology Tutorial section (see page 1073) for more information on typical and guaranteed specifications



Uni-directional repeatability plot for RV Series stages. The typical (mean) uni-directional repeatability is 0.001°. The guaranteed value is 0.002°.

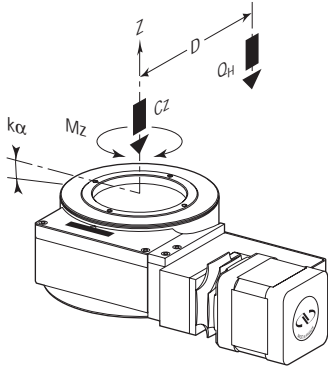


On-axis accuracy plot for RV Series stages. The typical (mean) on-axis accuracy is 0.001°. The guaranteed value is 0.002°.



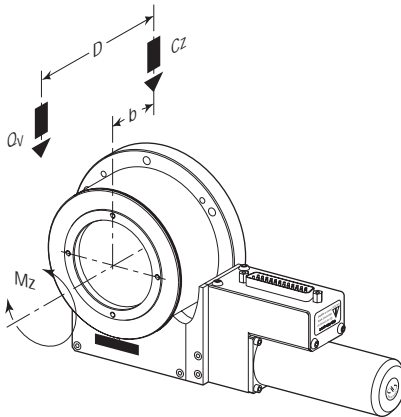
Reversal value (Hysteresis) plot for RV Series stages. The typical (mean) reversal value is 0.001°. The guaranteed value is 0.002°.

### Horizontal Load Characteristics



$Q_H$	Off-center load
$Q_H \leq \frac{C_z}{(1 + D/a)}$	
$C_z$	Normal center load capacity on bearings
$D$	Off-center distance in mm.
$a$	Construction parameter
$k_\alpha$	Angular Stiffness

### Vertical Load Characteristics



$Q_V$	Off-center load
$Q_V \leq \frac{C_z}{[2 \times (1 + D/a)]}$	
$C_z$	Normal center load capacity on bearings
$D$	Off-center distance in mm.
$a$	Construction parameter
$b$	Construction parameter = Distance between the top surface and the bearings center.

### Ordering Information

The RV Series rotation stages are numbered as follows:

Series	Ø Stage (mm)	Drive	Folded Motor <sup>(1)</sup>	Vacuum Preparation <sup>(2)</sup>
RV	[ 80 120 160 240 350 ]	PP	-F	V6
		PE		
		CC		
		HAT <sup>(1)</sup>		
		CCHL		
		HAHLT <sup>(1)</sup>		
	MS			

**Example**  
The **RV240HAT-F** is a Ø 240 mm RV rotation stage with a DC folded motor drive and an integral optical encoder.

PP: Mini-step PE: Full-step CC: DC HAT: DC & integral optical encoder  
CCHL: DC & gear reduction HAHLT: CCHL version & integral optical encoder MS: Manual

- 1) All except RV80.
- 2) Vacuum compatible to 10<sup>-6</sup> Torr. In this case max. speed and load capacity have to be divided by two.

### Load Characteristics

	RV80	RV120	RV160	RV240	RV350
$C_z$	(N) 900	1800	2700	4000	6500
$a$	(mm) 30	40	50	70	100
$b$ (except HAT & HAHLT)	(mm) 39	53	57	59	73
$b$ (HAT & HAHLT)	(mm)	71	75	77	91
$k_\alpha$ (3-point mounting)	(µrad/Nm) 5	2.5	1.2	0.6	0.25
$k_\alpha$ (5-point mounting)	(µrad/Nm) 3.5	1.5	0.6	0.3	0.1

Example:

$Q_V$  at a distance (D) of 100 mm, for RV160 rotation stage.

$$Q_V = \frac{2700}{[2 \times (1 + 100/50)]} = 450 \text{ N}$$

In this example, the load  $Q_V$  is placed at 43 mm (100–57) from the mounting plane on the rotating plane of the stage.

Example:

$Q_H$  at a distance (D) of 100 mm, for RV160 rotation stage.

$$Q_H = \frac{2700}{(1 + 100/50)} = 900 \text{ N}$$

## Torque (Mz)/Speed

The torque provided by each RV rotation stage depends on the following elements:

- Drive mechanism
- Selected Motor
- Speed requirements

In order to obtain the best performance from your RV rotation stage, please reference the stage specifications listed in the accompanying tables for each version.

## Maximum Inertia Tables

The tables specify the maximum inertia value for each RV stage. These values represent the maximum kinetic energy that the rotation stage can absorb in the event of a sudden halt at the maximum speed. This inertia is also in agreement with the capability of the stage to accelerate from a halted state to the maximum speed in 250 msec. The inertia is expressed in  $kg.m^2$  and is given with respect to the rotation axis of the RV rotation stage (1  $kg.m^2$  is the inertia of a 1 kg load placed at a distance of 1 m from the rotation axis).

### RV80 Rotation Stages

	$Mz_{Max}$ (Nm)	$V_0$ (°/s)	$Mz_0$ (Nm)	$V_{Max}$ (°/s)	Inertia ( $kg.m^2$ )
RV80PP	1.8	20	1.8	20	0.1
RV80PE	2.5	2	2.5	2	12
RV80CC <sup>(1)</sup>	1	80	1	80	0.02
RV80CCHL <sup>(2)</sup>	2.2	2.5	2.2	2.5	7.5

### RV120 Rotation Stages

	$Mz_{Max}$ (Nm)	$V_0$ (°/s)	$Mz_0$ (Nm)	$V_{Max}$ (°/s)	Inertia ( $kg.m^2$ )
RV120PP	15	20	15	20	1
RV120PE	20	2	20	2	70
RV120CC <sup>(1)</sup>	10	80	10	80	0.2
RV120CCHL <sup>(2)</sup>	20	8	15	16	7

### RV160 Rotation Stages

	$Mz_{Max}$ (Nm)	$V_0$ (°/s)	$Mz_0$ (Nm)	$V_{Max}$ (°/s)	Inertia ( $kg.m^2$ )
RV160PP	20	20	20	20	3
RV160PE	35	2	35	2	100
RV160CC <sup>(1)</sup>	11	80	11	80	0.7
RV160CCHL <sup>(2)</sup>	30	8	20	16	24

### RV240 Rotation Stages

	$Mz_{Max}$ (Nm)	$V_0$ (°/s)	$Mz_0$ (Nm)	$V_{Max}$ (°/s)	Inertia ( $kg.m^2$ )
RV240PP	22	20	22	20	4
RV240PE	60	2	60	2	150
RV240CC <sup>(1)</sup>	13	80	13	80	1.5
RV240CCHL <sup>(2)</sup>	50	8	30	16	38

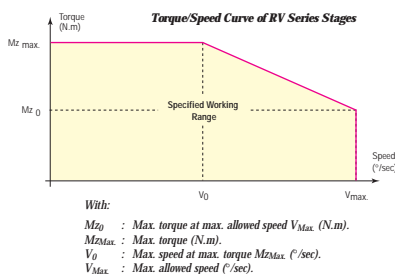
### RV350 Rotation Stages

	$Mz_{Max}$ (Nm)	$V_0$ (°/s)	$Mz_0$ (Nm)	$V_{Max}$ (°/s)	Inertia ( $kg.m^2$ )
RV350PP	25	20	25	20	4
RV350PE	80	2	80	2	220
RV350CC <sup>(1)</sup>	14	80	14	80	1.5
RV350CCHL <sup>(2)</sup>	50	8	30	16	56

1) same for HAT versions.

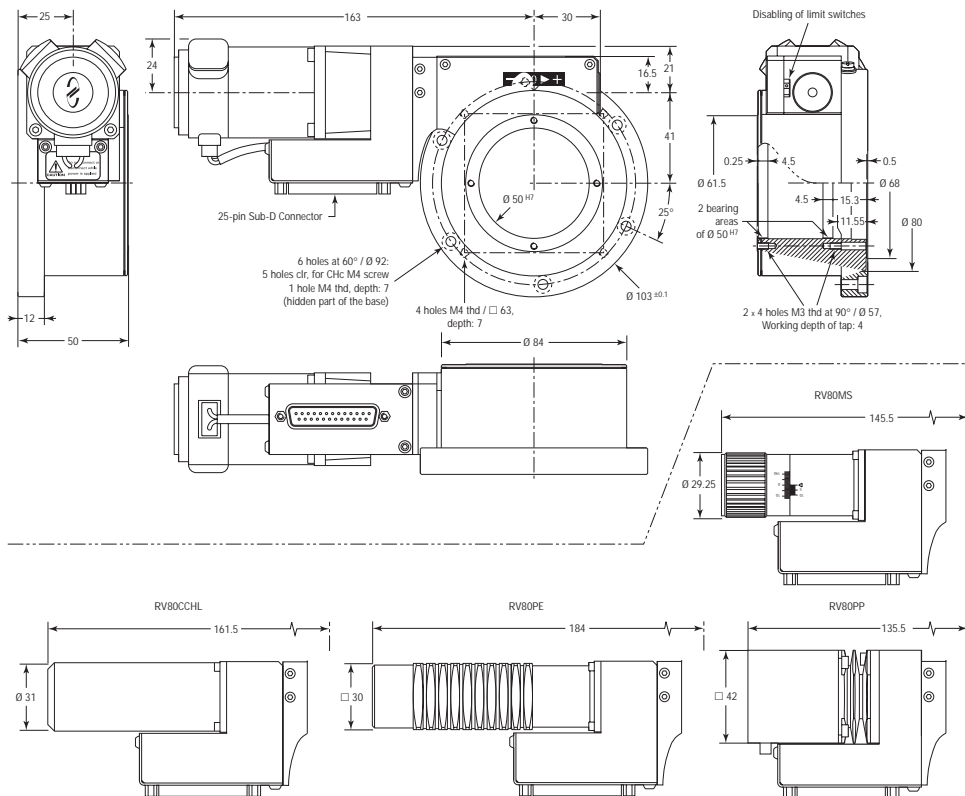
2) same for HAHLT versions.

Note: RV versions with direct motor and folded motor have same limit values.



## RV80 Models

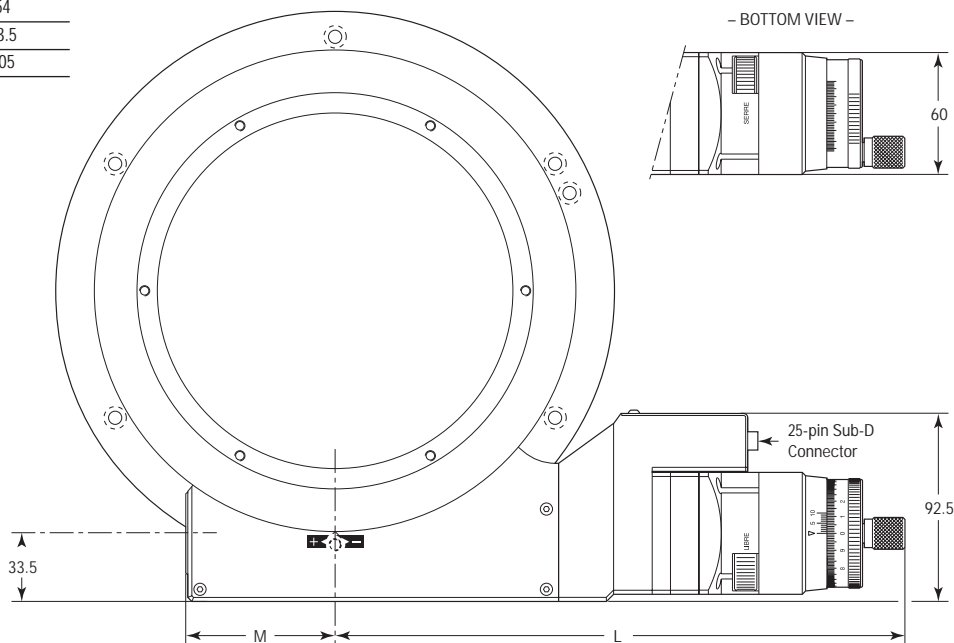
### Model RV80CC Shown Dimensions in millimeters



## RVMS Models

### Model RV240MS Shown Dimensions in millimeters

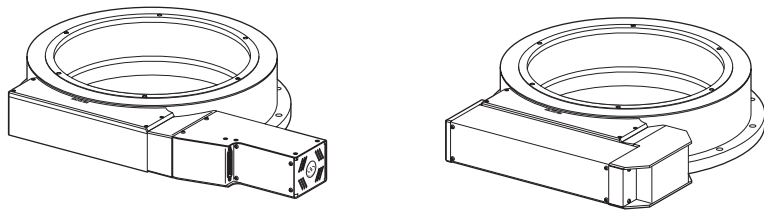
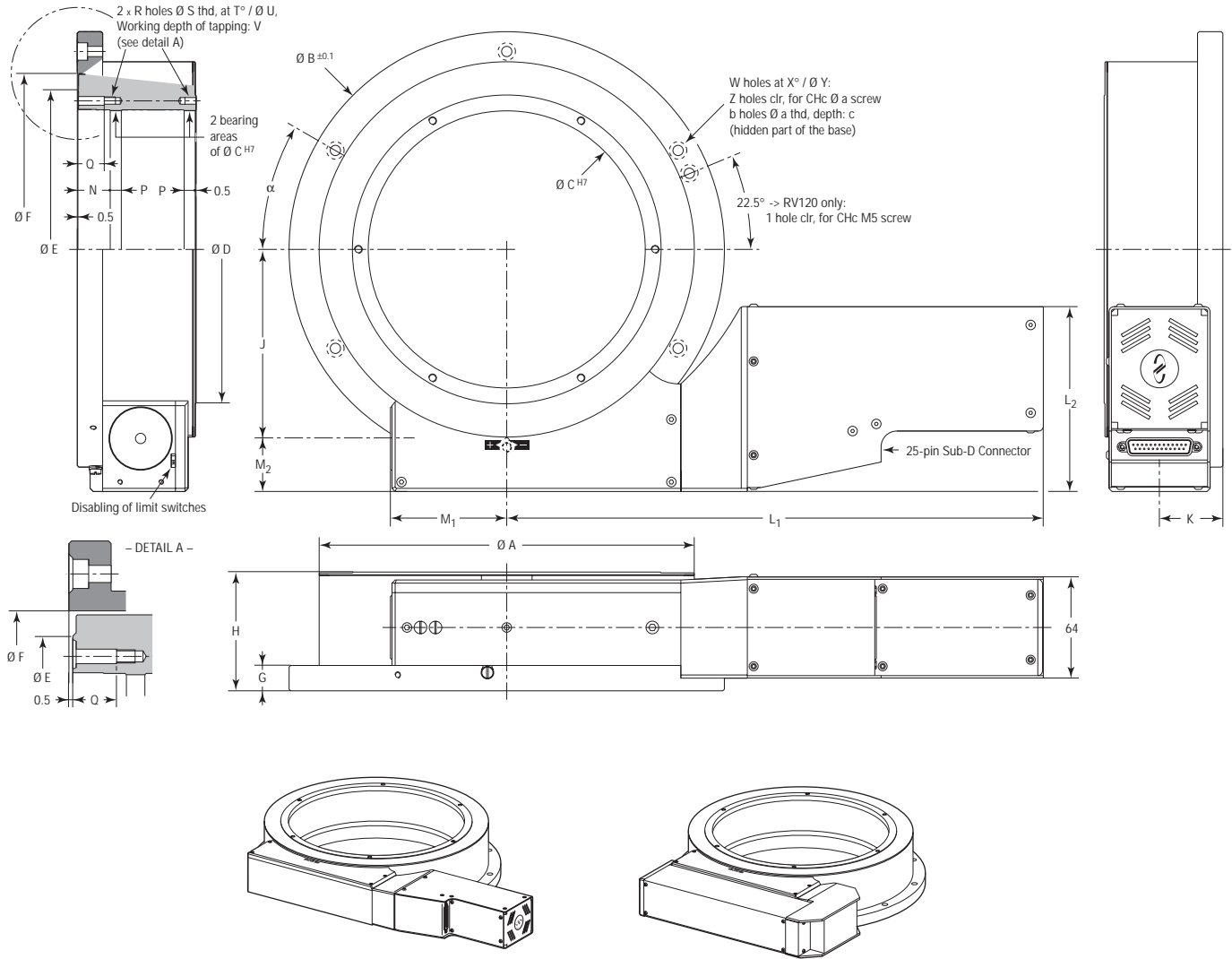
Model	Dimension (mm)	
	L	M
RV120MS	243	45.5
RV160MS	255.5	54
RV240MS	280.5	73.5
RV350MS	306.5	105



# RV120 to RV350

## Model RV240CCHL Shown

Dimensions in millimeters



Dimension													
Model	A	B	C	D	E	F	G	H	J	K	N	P	Q
RV120	126	155	78	93	99	115.5	14	68	63	34	19	4	15
RV160	163	192	110	129	134	152	14	71	81.5	36	18.5	5	14.5
RV240	237	275	175	194	204	222	16	75	119.5	40	20.3	7	16.6
RV350	356	395	280	302	315	331.5	17.5	90	179	50	21.3	8	17.3

Dimension													
Model	R	S	T	U	V	W	X	Y	Z	a	b	c	$\alpha$
RV120	4	M4	90	87.5	6	6	60	137	5	M5	1	7	17.5
RV160	6	M5	60	120	7	6	60	174	5	M5	1	7	25
RV240	6	M5	60	187.5	7	6	60	250	5	M6	1	10	30
RV350	6	M6	60	295	7	12	30	372	10	M8	2	12	10

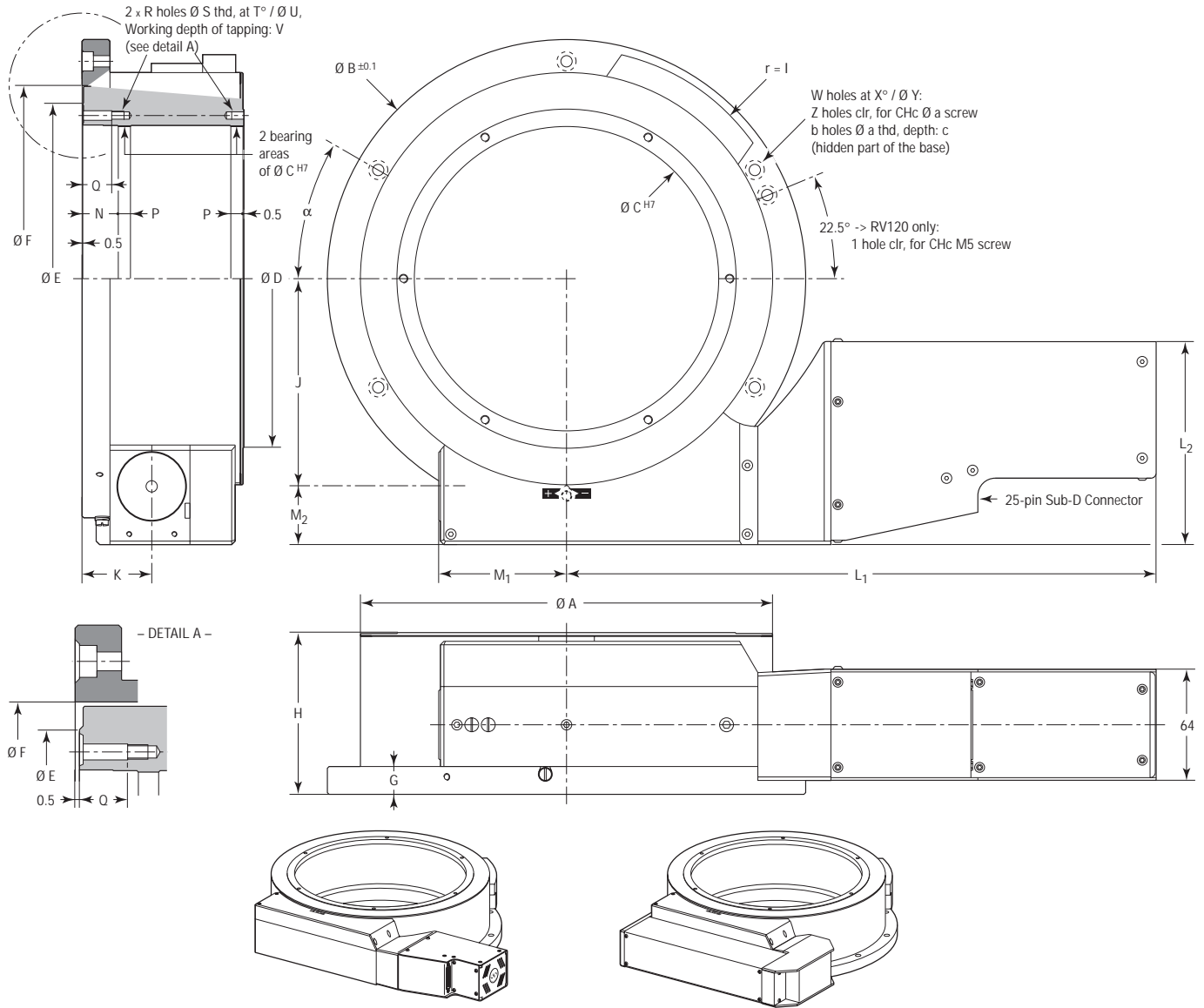
Rotation Stages, Direct Motor						
Model	L <sub>1</sub>			M <sub>1</sub>	L <sub>2</sub>	M <sub>2</sub>
	PP	PE	CC	CCHL		
RV120	251.5	251.5	251.5	301.5	45.5	117
RV160	264	314	264	314	54	
RV240	289	339	289	339	73.5	
RV350	315	365	315	365	105	

Rotation Stages, Folded Motor				
Model	L <sub>1</sub>	M <sub>1</sub>	L <sub>2</sub>	M <sub>2</sub>
RV120	155.5	54.5	160.5	110.5
RV160	168	63		
RV240	193	82.5		
RV350	219	114		

# RVHAT & RVHAHLT

## Model RV240HAT Shown

Dimensions in millimeters



Model	Dimension													
	A	B	C	D	E	F	G	H	I	J	K	N	P	Q
RV120	126	155	78	93	99	115.5	14	86	80	63	34	19	4	15
RV160	163	192	110	129	134	152	14	89	98	81.5	36	18.5	5	14.5
RV240	237	275	175	194	204	222	16	93	132.5	119.5	40	20.3	7	16.6
RV350	356	395	280	302	315	331.5	17.5	108	189	179	50	21.3	8	17.3

Model	Dimension												
	R	S	T	U	V	W	X	Y	Z	a	b	c	α
RV120	4	M4	90	87.5	6	6	60	137	5	M5	1	7	17.5
RV160	6	M5	60	120	7	6	60	174	5	M5	1	7	25
RV240	6	M5	60	187.5	7	6	60	250	5	M6	1	10	30
RV350	6	M6	60	295	7	12	30	372	10	M8	2	12	10

Model	Rotation Stages, Direct Motor				
	L <sub>1</sub>		M <sub>1</sub>	L <sub>2</sub>	M <sub>2</sub>
	HAT	HAHLT			
RV120	301.5	301.5	45.5	117	33.5
RV160	314	357	54		
RV240	339	382	73.5		
RV350	365	408	105		

Model	Rotation Stages, Folded Motor			
	L <sub>1</sub>	M <sub>1</sub>	M <sub>1</sub>	M <sub>2</sub>
		HAT-F	HAHLT-F	
RV120	155.5	54.5	75.5	110.5
RV160	168	63	107.5	
RV240	193	82.5	82.5	
RV350	219	114	114	