GRIFFIN MOTION

User Manual

RTS, Standard Options

Document Notice

This manual contains pertinent safety information for the proper integration, use, maintenance, and decommissioning of certain RTS motion products provided by Griffin Motion, LLC. Please first verify the applicability of this manual to the equipment in use prior to following its guidance. If you have any questions whatsoever, please do not hesitate to reach out to a Griffin Motion representative.

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This manual is subject to change without notice and is superseded by any new revision. All previous and current revisions of this manual may be made available upon request.

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1.2 LIST OF TABLES

2 SCOPE

2.1 FOREWORD

This manual contains product information for a broad range of offerings, under the designation “RTS”. With the intent to provide a more concise user manual, most illustrations and figures depict a standard configuration (Griffin Motion Part Number: RTS-DD-200-Y-C-A-S-0-00) which has common features that can be applied across the entire product lineup. If you are unsure of any information provided or how it may apply to your product or requirements, please contact a Griffin Motion representative.

In addition, through continual improvement of its products, Griffin Motion may change the listed ordering options or make small changes to the stated specifications without notice. For previous customers, the best point of reference for your equipment is the documentation you had received at the time of your delivered order.

2.2 INTENDED USE

This manual is intended for use by a qualified technician or knowledgeable system integrator.

The RTS series of single axis rotary stages are intended for use in a laboratory or light industrial application. A typical use environment for an RTS is in a temperature-controlled room that is free of dirt, oil, and condensing moisture.

An RTS’s intended primary purpose is to provide high precision rotary positioning and adjustment of externally mounted shifting loads within its designed machine limits. Implementation examples include, but are not limited to, microscope inspection machines, laser engraving, 3d printing, automatic dispensing equipment, and general-purpose positioning. Safety guidance and installation procedures are strictly related to the positioning capabilities of the RTS, and not the applied use thereof.

Where not provided directly from the manufacturer, suitable controls and cabling should be selected or manufactured to control the various aspects of the stage to provide maximum safety of the equipment and any potential user. Moreover, the RTS was designed to be integrated into a control system with the intent of hands-free operation requiring no direct human intervention while energized. Simply complying with the hazards and caution notices of this manual may not satisfy the regulatory requirements of your intended application or your jurisdiction.

2.3 HAZARDS AND WARNINGS

This user manual, when followed by a knowledgeable person, will direct an individual on how to safely install, operate, or service this stage. It is required that the user of a RTS stage strictly adhere to the provided instructions and guidance provided in this manual and perform risk evaluations where this manual does not cover a specific end-user application. If any portion of the information provided herein is not understood, please contact a Griffin Motion representative.

A list of identified human and machine safety factors directly related to the operation of an RTS are compiled below. While guidance is provided below for the identified hazards, it may not be sufficient to adequately identify, reduce, or remove the risks associated with a specific user application; therefore, a risk assessment for your intend application against the applicable standards in your local jurisdiction must be conducted prior to use.

DANGER: This product may contain potentially lethal voltages. To reduce the risk of shock to a human operator, the following precautions must be followed:

1. Controllers and cabling fully de-energized before connecting to stage.
2. De-energize and Disconnect power sources before servicing.
3. Use an appropriate grounding scheme to preclude accidental shock under fault conditions.
4. Install control systems that can detect fault voltages and provide an alarm.
5. Where direct human intervention is expected during operation, install additional non-conductive safety guards or power interruption equipment (e.g., sensor curtain) to de-energize the equipment as required.
6. Create and post operating instructions and warning labels on the final equipment.

DANGER: While this product does not specifically pose a shearing or crushing hazard unto itself, applications where a load is mounted externally such hazards may exist. To reduce the risk of crushing or shearing, the following precautions must be followed:

1. Install equipment as outlined in mechanical installation chapter.
2. Where potential for touching is expected during operation, perform some or all of the following, depending on the application:
    a. Install additional warning labels.
    b. Install additional guards or enclose the equipment.
    c. Install a power interruption control system (ex. sensor curtain) to de-energize the equipment.
3. For control systems, consider lowering motor currents as low as practical.
4. Create and post operating instruction and warning labels on the final equipment.

CAUTION: This product may produce potentially hazardous temperatures. To reduce the risk of burns to a human operator, the following precautions must be followed:

1. Where potential for touching is expected during operation, perform some or all of the following:
    a. install temperature warning signs on motor housings
    b. install temperature monitoring equipment or additional thermal guards.
2. Control systems shall monitor for overcurrent conditions.
3. Control systems shall monitor for overvoltage conditions.
4. Create and post operating instructions and warning labels on the final equipment.

CAUTION: This product may emit electromagnetic radiation. To reduce the risk of interference with other electrical equipment, the following guidance may apply:

1. Assess the motor amplifier topology in your control system.
2. Construct shielded motor cables and feedback cables as outlined in this user manual.
3. Create RF shields for any other sensitive equipment in the vicinity of the RTS stage.
4. Contain final equipment in RF conducting meshes or enclosures.
5. Utilize filters, transformers, or other impedance equipment to mitigate radiation from power sources as outlined in supporting controller manuals.

ATTENTION: This product may emit uncomfortable noise levels depending on how it is operated. To reduce the discomfort level due to radiated noise, the following guidance may apply:

1. Change the motor amplifier topology.
2. Re-tune the current control loop gains in the amplifier.
3. Isolate the equipment with a sound barrier.
4. Turn off machines that are not required to be in operation.
5. Limit the amount of time operator is in vicinity of equipment.

ATTENTION: This product is intended to be incorporated as part of a complete control system; some key operating factors and control system considerations are listed:

1. Warn user of abnormal machine operation.
2. Secure power to machine when an unsafe condition exists.
3. Arrest or halt motion as required.
4. Prevent unexpected start-up or motion.

3 PRODUCT OVERVIEW

3.1 ORDERING OPTIONS

This product manual contains information applicable to the RTS products in the multiple frame sizes offered as outlined in Table 1. Note that each frame size has encoder options that the other frame sizes do not have. If there are any standard listed ordering options that do not fit your set of requirements, please contact a Griffin Motion representative who may then provide clarification or information regarding our other offerings that would best suit your needs.

Table 1. RTS Ordering Options

Example Part Number								
RTS	DD	100	M	C	A	S	0	00
Part Number Ordering Options								
Product Series	**Drive Type**	**Frame Size**	**Encoder Type**	**Interpolation Factor**	**Hub Material**	**Precision Level**	**Additional Option**	**Custom Option**
RTS – Rotary Stage	DD – Direct Drive	100	M – Glass Disk (10k Line Pair)	C – 25X, Quadrature	A – Alum. S – Steel	S – Standard P – High U – Ultra ***(Note 1)***	0 – no additional options A – Wide temperature range ***(Note 1)*** C – Clean room Prepped ***(Note 1)*** K – Travel Limits ***(Note 1)*** V – Vacuum Prepped ***(Note 1)***	00 – no custom options Any other value 01 through 99 ***(Note 1)*** ***(Note 2)***
				D – 100X, Quadrature				
				E – None, Sinusoidal				
			Q – Mylar Disc (2966 Line Pair)	G – None, Quadrature				
			V – Metal Ring	M – None, ABSOLUTE				
		150	BB – Glass Disk (18k Line Pair)	C – 25X, Quadrature				
				D – 100X, Quadrature				
				E – None, Sinusoidal				
		200	Y – Glass Disk (21.6k Line Pair)	C – 25X, Quadrature				
				D – 100X, Quadrature				
				E – None, Sinusoidal				
			P – Mylar Disc (4536 Line Pair)	G – None, Quadrature				
			S – Metal Ring	M – None, ABSOLUTE 26-Bit				

Note 1: Non-standard options are noted for user information only. These setups may include various alterations that may incur additional requirements not fully covered in this technical manual; an amended user manual, addendum sheets, technical drawings, and other supporting documents will be provided with these orders. Please contact Griffin Motion representative if you have questions about these ordering options, or you need document support.

Note 2: Some Griffin Motion products have been evaluated to meet specific regulatory requirements. If your application requires proof of compliance to any standard, please inquire with a Griffin Motion representative. Please be aware that inclusion of regulatory examples in this manual do not prove compliance; an appropriate certificate will be provided at the time of order fulfillment.

Figure 1. Example Compliance Standards

3.2 ENVIRONMENTAL SPECIFICATIONS

Operating and storage environment consistent with Table 2.

Table 2. Environmental Specifications

Ambient Temperature (Operating)	Indoor controlled temperature environment between 17˚C to 27˚C
Ambient Temperature (Non-Operating)	Indoor long-term exposure to temperatures between -5˚C and 50˚C in original packaging.
Humidity	15% to 85% relative humidity, non-condensing
Altitude	0ft to 6000ft above sea level
Vibration	Low Vibration Environment
Protection Rating	IP40
Use	Partly assembled machine intended for indoor use, properly integrated as part of a control system; no direct human contact expected while in operation. Used by a trained operator or integrator.

3.3 BASIC SPECIFICATIONS

Some of the orderable stage configuration for the RTS-100, RTS-150, and RTS-200 are shown in the following tables of this section. Note that not every permutation of the orderable options of Section 3.1 are provided; please contact a Griffin Motion representative with your inquiries with regard to an ordering configuration not listed.

Listed accuracy specifications assume the stage is mounted in a similar fashion and environment to which it was tested at the factory. The factory test environment of 20°C air-temperature controlled room with the stage mounted on a stable flat granite surface.

Every unit is tested and verified to the specifications listed in the associated datasheet and provided with a formal test report.

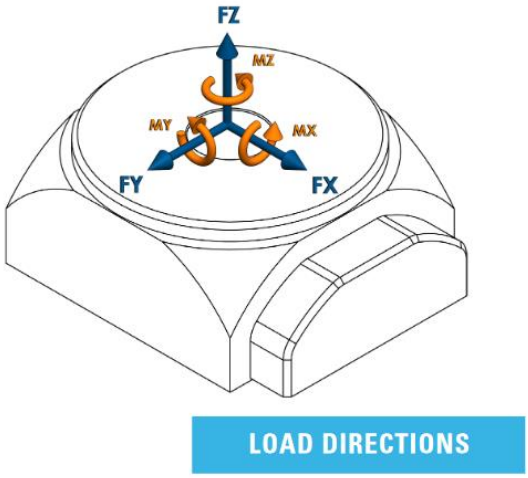


Figure 2. RTS Load Direction Reference

Table 3. Basic Product Specifications for RTS-DD-100-*

Stage Size	**100**				
Travel Range (deg)	360 continuous				
Encoder Type	Glass Disk 10k Line Count			Mylar Disk 2966 Line Count	Metal Ring Resolute 26-Bit
Interpolation	25X	100X	None	None	None
Encoder Output Type	Quad.	Quad.	1Vpp	Quad.	Serial
Encoder Res. (cts/rev)	1M	4M	[1]40k	11864	67108864
Encoder Res. (arc-sec/ct)	1.296	0.324	[1]32.4	109.2380	0.0193
Hub Material	Aluminum or Steel				Steel
Height (mm)	55.0				
Length (mm)	133.2				
Width (mm)	110.0				
Rot. Inertia (kg*m^2)	0.000485 Al. Hub (0.00136 Steel Hub)				0.00128
Stage Mass (kg)	1.70 Al. Hub (2.34 Steel Hub)				2.70
Rotary Velocity (deg/s)	3120	720	[1]4800	4800	4800
[2]Force X / Y (N)	110				
[2]Force Z (N)	250				
[2]Moment X / Y (N·m)	10				
[2]Torque Z (N·m)	0.65 Continuous (1.30 Peak)				
[3]MTBF (hours)	20000				

Note 1: Final encoder resolution and velocity dependent upon use of proper controls with ability to interpolate the sinusoidal signal.
Note 2: Refer to Figure 2 for axis orientation and for force values.
Note 3: Expected life provided that a RTS is employed in a reasonable application of its intended use at moderate velocities, payloads, and duty cycles with respect to the stated limits. For high duty cycles or OEM applications requiring extra data, please contact a Griffin Motion representative.

Table 4. Basic Product Specifications for RTS-DD-150-*

Stage Size	**150**		
Travel Range (deg)	360 continuous		
Encoder Type	Glass Disk 18k Line Count		
Interpolation	25X	100X	None
Encoder Output Type	Quad.	Quad.	1Vpp
Encoder Res. (cts/rev)	1.8M	7.2M	[1]72k
Encoder Res. (arc-sec/ct)	0.72	0.18	[1]18
Hub Material	Aluminum		
Height (mm)	58.0		
Length (mm)	174.9		
Width (mm)	150.0		
Rot. Inertia (kg*m^2)	0.0025		
Stage Mass (kg)	2.7		
Rotary Velocity (deg/s)	1750	430	[1]2650
[2]Force X / Y (N)	180		
[2]Force Z (N)	350		
[2]Moment X / Y (N·m)	15		
[2]Torque Z (N·m)	1.56 Continuous (3.12 Peak)		
[3]MTBF (hours)	20000		

Note 1: Final encoder resolution and velocity dependent upon use of proper controls with ability to interpolate the sinusoidal signal.
Note 2: Refer to Figure 2 for axis orientation and for force values.
Note 3: Expected life provided that a RTS is employed in a reasonable application of its intended use at moderate velocities, payloads, and duty cycles with respect to the stated limits. For high duty cycles or OEM applications requiring extra data, please contact a Griffin Motion representative.

Table 5. Basic Product Specifications for RTS-DD-200-*

Stage Size	**200**				
Travel Range (deg)	360 continuous				
Encoder Type	Glass Disk 21.6k Line Count			Mylar Disk 4536 Line Count	Metal Ring Resolute 26-Bit
Interpolation	25X	100X	None	None	None
Encoder Output Type	Quad.	Quad.	1Vpp	Quad.	Serial
Encoder Res. (cts/rev)	2.16M	8.64M	[1]86.4k	18144	67108864
Encoder Res. (arc-sec/ct)	0.6	0.15	[1]15	71.4286	0.0193
Hub Material	Aluminum or Steel				Steel
Height (mm)	65.0				
Length (mm)	214.9				
Width (mm)	190.0				
Rot. Inertia (kg*m^2)	0.00659 Al. Hub (0.0171 Steel Hub)				0.0194
Stage Mass (kg)	4.76 Al. Hub (8.12 Steel Hub)				8.84
Rotary Velocity (deg/s)	1460	360	[1]1600	1600	1600
[2]Force X / Y (N)	250				
[2]Force Z (N)	500				
[2]Moment X / Y (N·m)	25				
[2]Torque Z (N·m)	3.44 Continuous (6.88 Peak)				
[3]MTBF (hours)	20000				

Note 1: Final encoder resolution and velocity dependent upon use of proper controls with ability to interpolate the sinusoidal signal.
Note 2: Refer to Figure 2 for axis orientation and for force values.
Note 3: Expected life provided that a RTS is employed in a reasonable application of its intended use at moderate velocities, payloads, and duty cycles with respect to the stated limits. For high duty cycles or OEM applications requiring extra data, please contact a Griffin Motion representative.

3.4 PRODUCT VIEWS AND LABELS

3.4.1 GENERIC VIEW

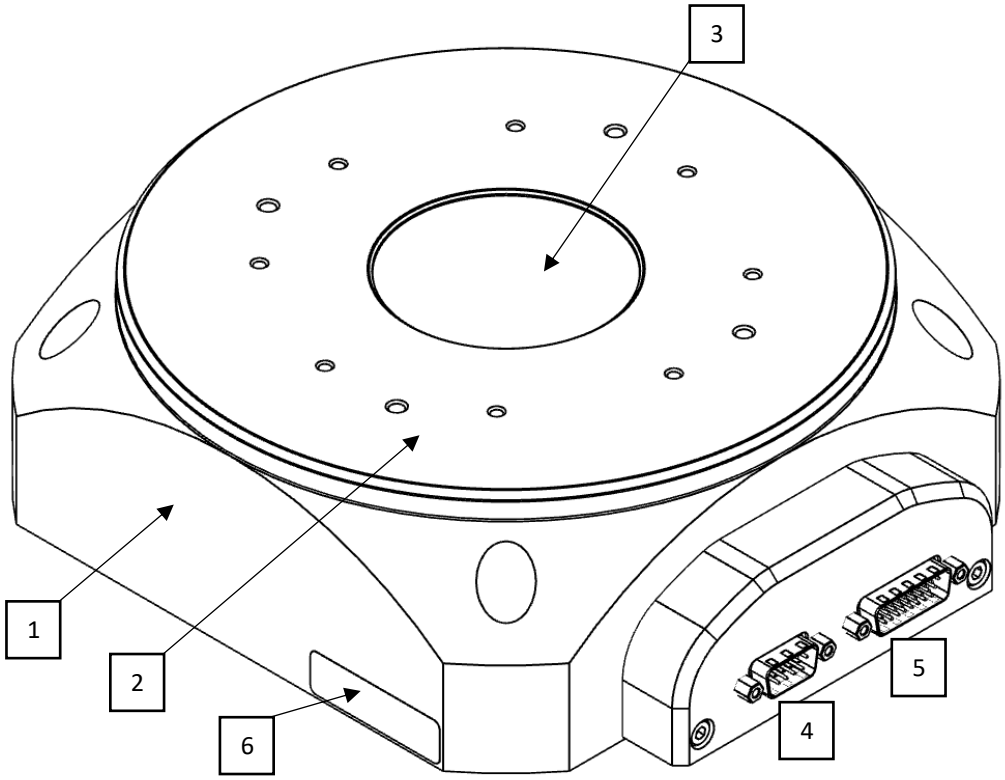


Figure 3. Generic RTS View (RTS-200 Pictured)

1. Motor Housing
2. Hub / Loading Plate
3. Through bore
4. Motor Connector
5. Feedback Connector
6. Product Series and Serial Number Label

3.4.2 VIEW OF MECHANICAL HAZARDS

CAUTION: If motor current is not monitored properly, the housings (as pointed out in Figure 4) may reach temperatures that could burn an operator during operation or service. Labels are not provided on the product for this specific hazard.

The recommendation is that motor currents should be limited to the minimum threshold practical for the application profile; if high duty cycles are required, then external temperature sensors may be required as part of the control and monitoring system.

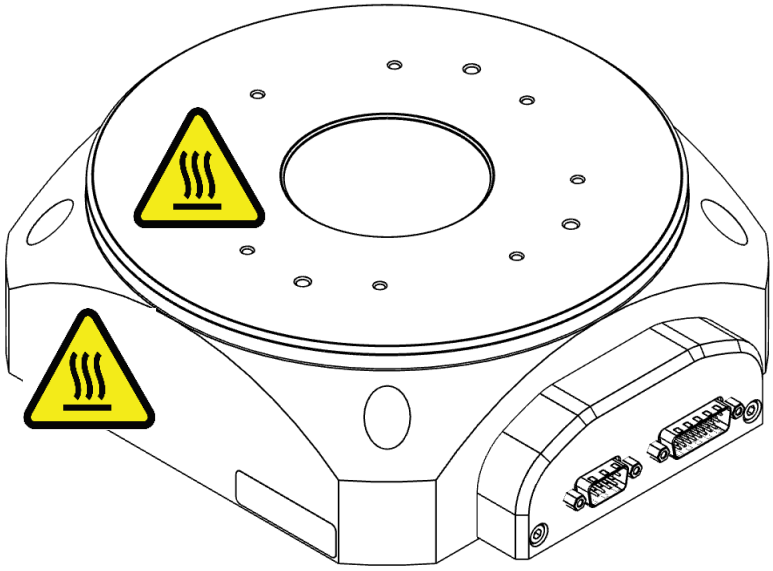


Figure 4. RTS High Contact Temperature Hazard Locations

3.5 DIMENSIONS

The sub-sections of this chapter will illustrate the primary dimensions of the different sizes a RTS may come in. Illustrated are the overall dimensions of the product, loading plate patterns, and mounting patterns.

3.5.1 RTS-DD-100 DIMENSIONS

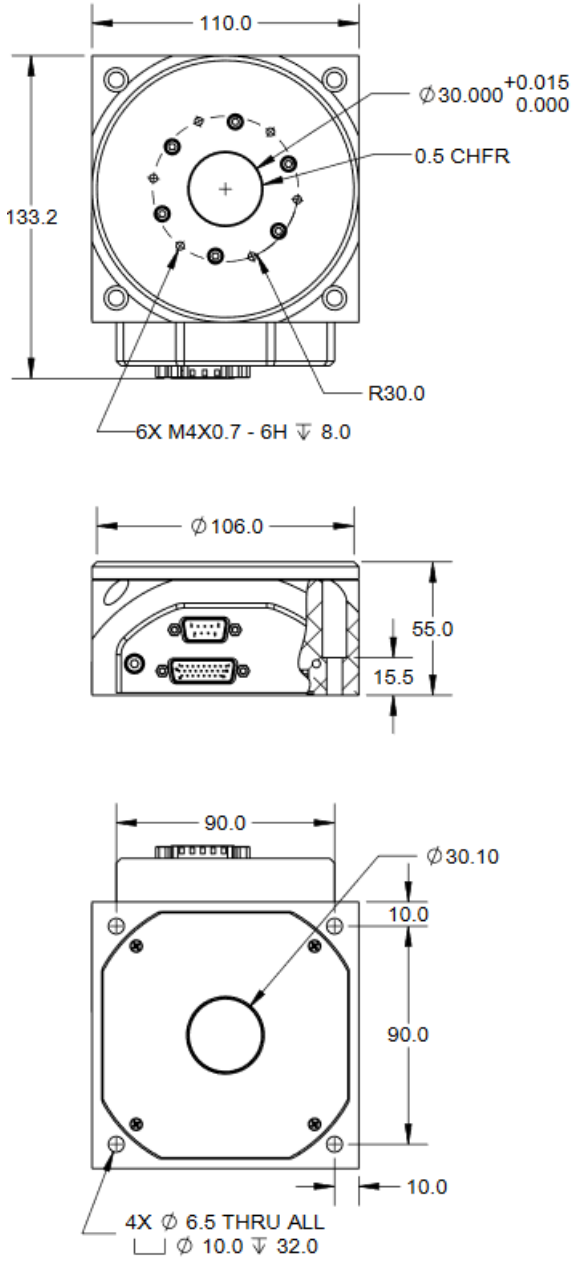


Figure 5. RTS-100 nominal dimensions

3.5.2 RTS-DD-150 DIMENSIONS

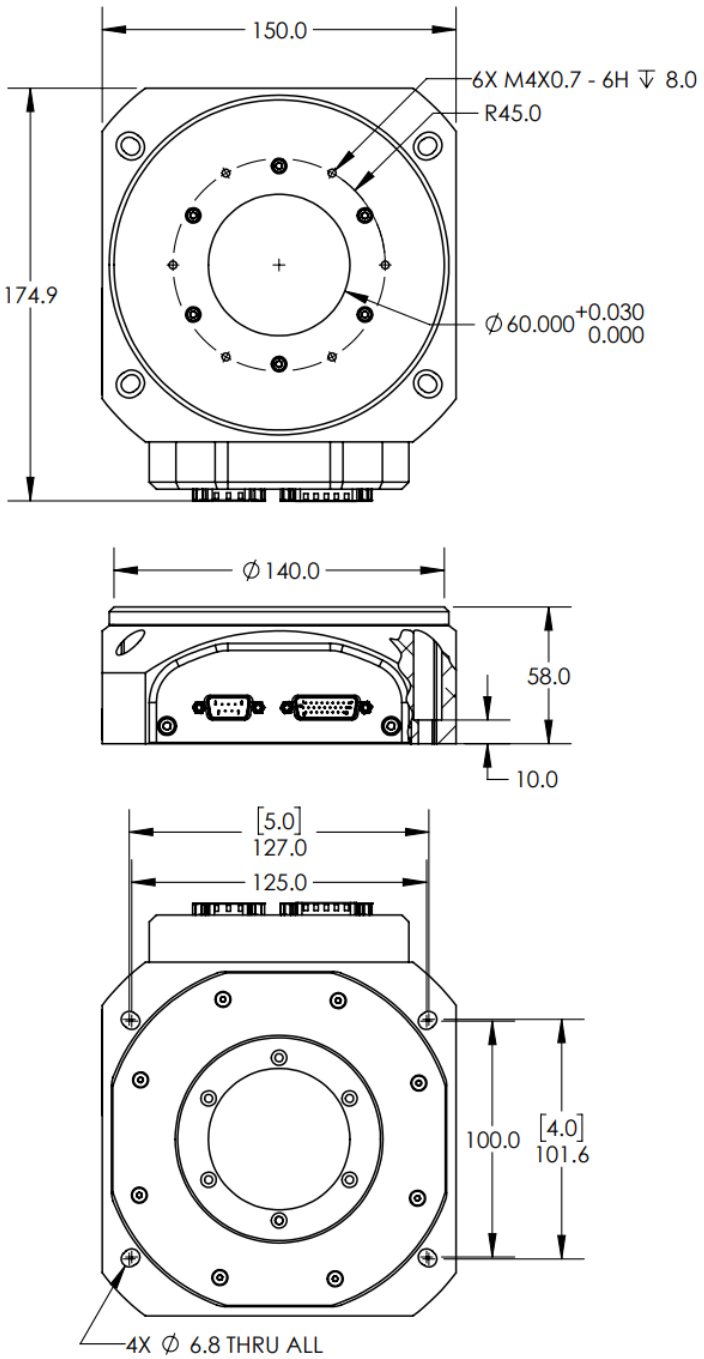


Figure 6. RTS-150 nominal dimensions

3.5.3 RTS-DD-200 DIMENSIONS

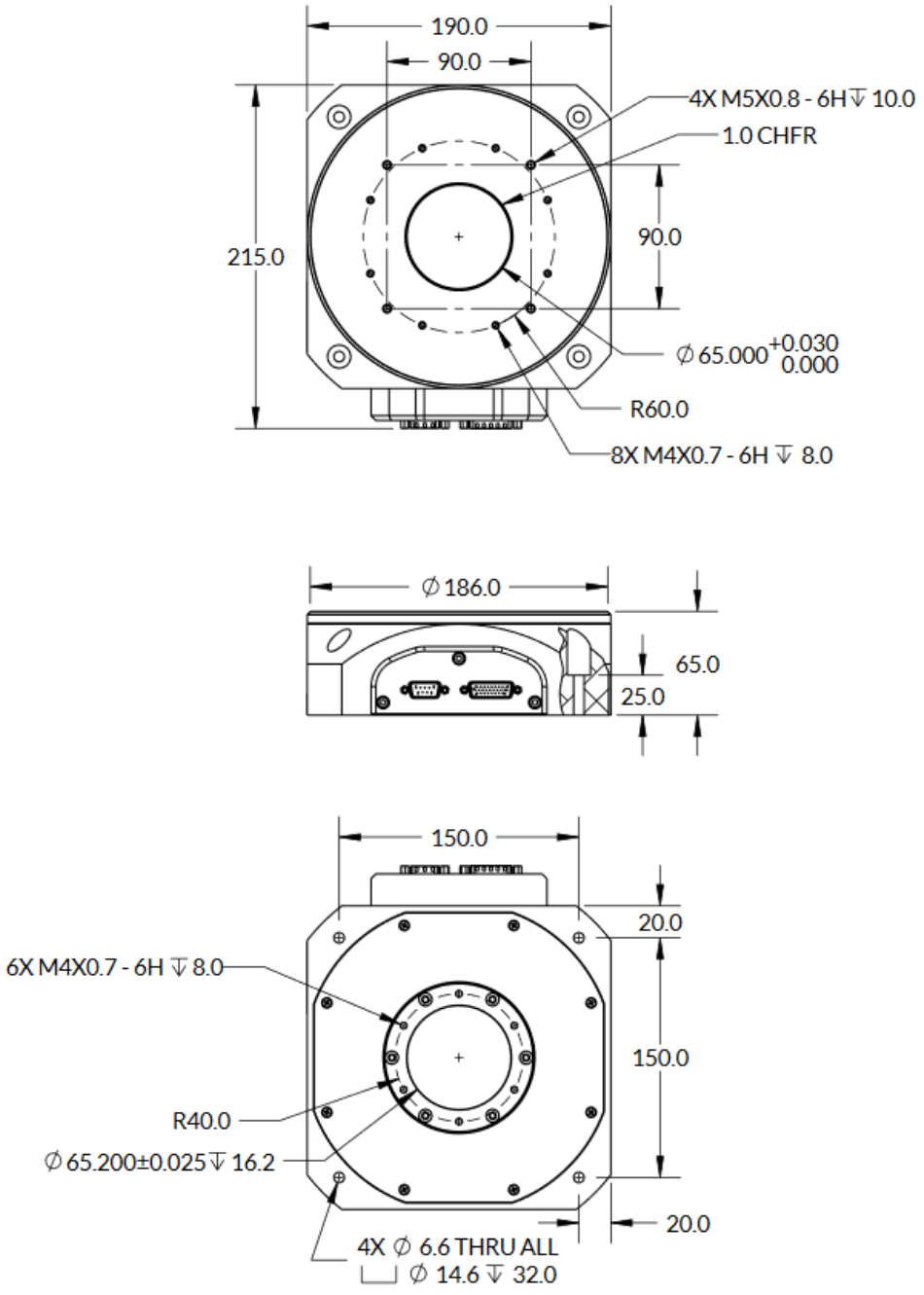


Figure 7. RTS-200 nominal dimensions

3.6 ELECTRICAL SPECIFICATIONS

3.6.1 MOTOR SPECIFICATIONS

The motor specifications for the different frame sizes are provided in Table 6. Please verify that you are utilizing the correct motor values for the frame size of your stage.

Table 6. RTS Standard Servo Motor Specification

Motor Parameter	Stage Size		
	RTS-DD-100	RTS-DD-150	RTS-DD-200
Motor Type	3 phase Brushless DC		
BEMF Constant (V/Krpm)	20.685	50.0	141
Electrical Time Constant (ms)	0.882	1.9	2.13
Nominal Bus Voltage (Vdc)	24	48	72
Max Bus Voltage (Vdc)	100	300	300
Continuous Current (Apk)	[1]4.51	[2]4.43	[3]3.45
Peak Current (Apk)	9.02	8.86	6.90
[4]Thermal Resistance (C/W)	0.90	0.55	1.00
Motor Force Constant (Nm/Apk)	0.171	0.414	1.17
Pin to Pin Inductance (mH)	2.308	7.48	12.71
Pin to Pin Resistance (ohm)	2.616	3.86	6.250
Poles per Revolution	12	28	24

Note 1: assumes maximum motor temperature of 120°C when the stage is rigidly mounted to a 330 mm x 330 mm x 25 mm aluminum heat sink in 27°C ambient still air.

Note 2: assumes maximum motor temperature of 100°C when the stage is rigidly mounted to a 540 mm x 540 mm x 25 mm aluminum heat sink in 27°C ambient still air.

Note 3: assumes maximum motor temperature of 130°C when the stage is rigidly mounted to a 600 mm x 600 mm x 25 mm aluminum heat sink in 27°C ambient still air.

Note 4: thermal resistance from motor coil to housing of equipment at steady state conditions.

3.6.2 FEEDBACK SPECIFICATIONS

The basic electrical feedback specifications of the RTS are listed in the tables below for the different encoder ordering options. For proper integration with your controls, phase and signal tables are illustrated in the installation chapter.

Table 7. Combined Feedback Specification (All Encoder Types)

	Feedback Encoder Types			
	Glass Disk Sinusoidal Output	Glass Disk With Interpolation	Mylar Disk	Metal Ring
Supply Voltage	5Vdc ± 10%			
Supply Current Max (mA)	350			
Encoder Feedback Type	Incremental			Absolute
Encoder Output	1Vpp Sinusoidal; A,B,Z Differential Pairs	Square Wave Quadrature, RS-422 compatible, A/B/Z/E Diff. Pair	Square Wave Quadrature, RS-422 compatible, A/B/Z Diff. Pair	Serial, BiSS-C Protocol
Encoder Resolution	Refer to Specifications Section for your selected Encoder			
Hall Switch Output Type	Open collector, with 1k internal pullup to supply			Open collector, no internal pullup
Hall Switch max current (mA)	-20			
Limit Switch Output Type	No limit switches in standard configurations			
Error Output	n/a		Differential Pair	n/a
Error Output Current (mA)	n/a		± 20	n/a

4 MECHANICAL INSTALLATION

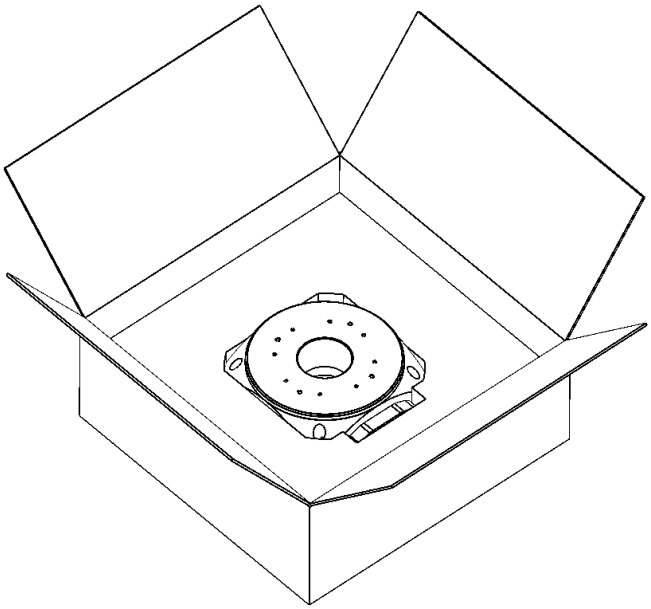
4.1 UNPACKING AND HANDLING

4.1.1 RECEIPT INSPECTION

CAUTION: An RTS stage is a very sensitive device! Handle with great care as to minimize the risk of damage to the precision surfaces, bearing alignments, and feedback mechanisms.

CAUTION: Do not disassemble any portion of the equipment unless specifically directed by this user manual. Improper installation will cause the stage to no longer hold the promised accuracy specifications or cause damage rendering the device inoperable.

Prior to removal of the RTS stage from its packaging, please check the integrity of the box it was shipped in. Any excessive dirt or debris, crushed corners, or general weathering may indicate improper handling during shipment. After inspection, please verify the contents of the package for any missing materials.



Items included in packaging:

1. The RTS Stage
2. Cut-to-size foam.
3. Performance Test Report
4. Instruction manual
5. Other data sheets

Should any of these materials be missing, please contact a Griffin Motion Representative so we may convey them to you.

Figure 8. Packaging Material List and View

NOTE: Please keep all packaging materials with your equipment for a reasonable period. For warranty or service requests, please ship the equipment back to Griffin Motion in the original packaging for maximum safety of the equipment.

4.1.2 REMOVAL FROM PACKAGING

With the stage in its included plastic packaging, pick up and move the stage to a clean stable surface; afterwards carefully remove it from the plastic packaging with clean hands or while using gloves to minimize the contamination on the bottom mounting surface. If bottom surface becomes dirty, clean it with a damp cloth soaked in IPA prior to final mounting.

Maintaining cleanliness is key to proper installation in its final configuration. Particles like dust and hair cannot be compressed under final torque and will cause distortion of the base plate and cause the stage to not hold promised accuracy values.

CAUTION: During handling, install, or removal, pay attention as to not strike the hub or bottom surface of the housing with tools or edges of other equipment. The nearly imperceptible surface imperfections caused by these mishaps will affect stage performance.

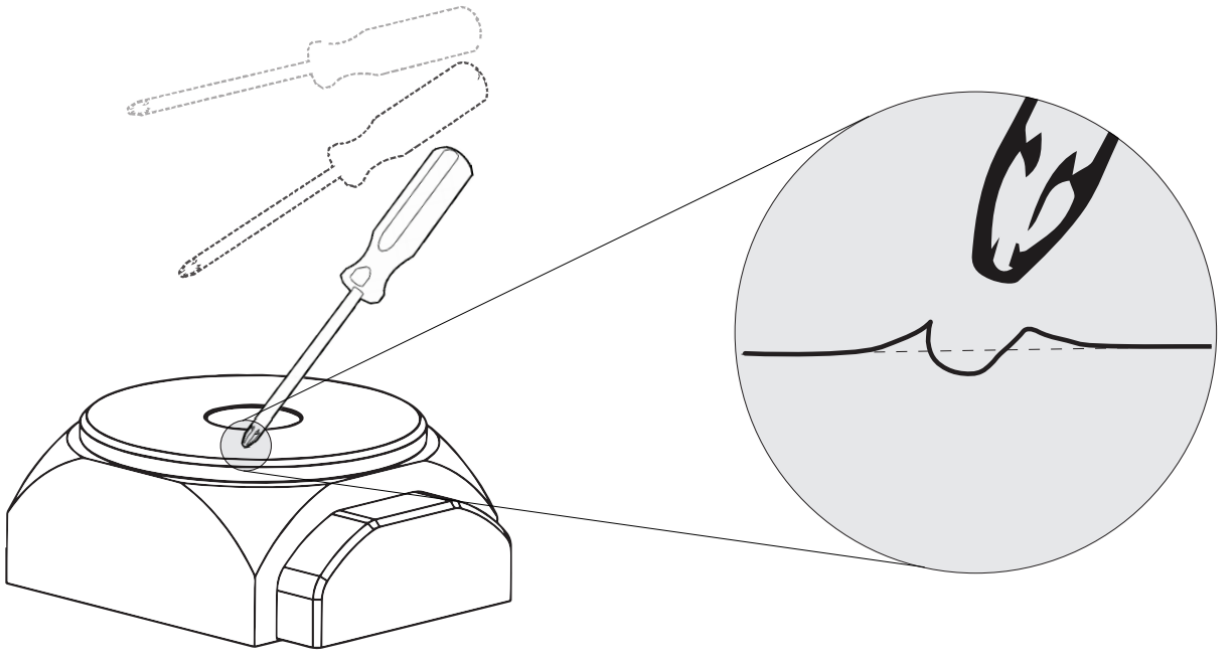


Figure 9. Damage to RTS surface due to striking

4.1.3 BACKDRIVING THE STAGE

CAUTION: Never handle the stage when connected to a controller. This is to preclude accidental shock to the user, and to avoid potentially damaging the controller amplifier due to the BEMF generated by the motor (reverse power).

DANGER: When back driving, move the stage slowly and in a controlled manner. The BEMF generated by the motor may be higher than the permitted safety limits if the motor speed is sufficiently high. Connection of a temporary shunt network to the motor connector may be used to limit generated voltages.

Stages may be slowly back driven, when not connected to controls. As discussed in precious sections, follow the precautions listed below when manipulating the stage by hand:

1. Never touch the stage under servo control, de-energize and disconnect first.
2. When back driving the stage, apply slow gradual pressure by hand.
3. Do not strike the stage.
4. Minimize contact and maintain cleanliness of mounting surfaces prior to installation.

4.2 MOUNTING TO SURFACES

4.2.1 MOUNTING SURFACE REQUIREMENTS

Mounting surfaces for which an RTS stage is intended to be affixed must be stable, clean, flat, and adequately stiff to support the anticipated load. Any compromise to these mounting surface requirements will distort the housing of the device and decrease the overall accuracy. The RTS will generally conform to the shape of the mounted surface as shown in Figure 10.

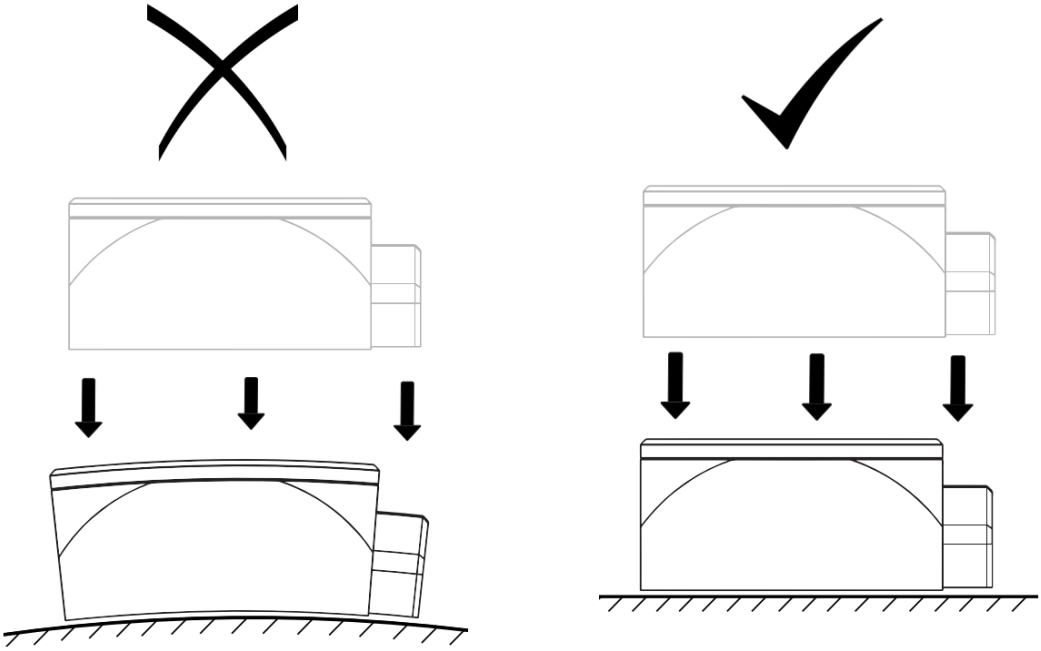


Figure 10. RTS warping to mounting surface contour

A surface flatness maximum recommendation is provided in Table 8. Note that a mounting flatness better than that listed will increase the accuracy performance of the machine.

Table 8. Mounting Surface Flatness Specifications

RTS Series	Specification
RTS-100	5um / 100mm
RTS-150	
RTS-200	

4.2.2 GENERAL INSTALL

The procedure below assumes that the proper mounting surface has been prepared for use; taking into consideration the mounting hole pattern, mounting hole depth, flatness specification, cleanliness, and surface stability.

1. Ensure that the stage is not connected to a controller or power source.
2. Clean the mounting surface if not already done so.
3. Mount the stage using the mounting holes.
    a. Refer to mounting patterns in previous section.
    b. Ensure proper length M5 bolts with a thread engagement depth of at least 10mm.
    c. Torque in a star pattern to a recommended torque of 45 in-lbs.
4. Unless otherwise intended, check that the stage has full range of motion and will not contact any other surface or hardware.

4.3 MOUNTING OF PAYLOADS

4.3.1 PAYLOAD REQUIREMENTS

CAUTION: The payload plate is free to rotate when not under servo control; care should be taken to stabilize shifting loads that are mounted to the payload plate. Use of external return springs, brakes, or hard stops may be needed to prevent sudden drops or rotations when power is secured to the stage.

Payloads intended to be affixed to the RTS payload plate must be stable, clean, flat, and adequately stiff to support the anticipated load. Any compromise to mounting the payload properly will distort the payload plate of the RTS and decrease its overall accuracy.

A payload surface maximum flatness recommendation is provided in Table 9.

Table 9. Payload Flatness Specifications

RTS Series	Specification
RTS-100	5um / 100mm
RTS-150	
RTS-200	

In addition, considerations for mounting orientation of the stage with respect to payload mass, payload position, and other forces should be made with respect to the stages listed specifications.

CAUTION: Ensure that retaining bolts for mounted payloads are the proper size and engagement depth. Improper installation may cause damage to the payload plate and reduce system performance or potentially render the stage inoperable.

5 ELECTRICAL INSTALLATION

5.1 CONNECTORS AND PINOUTS

The interface between a stage axis and a controller is provided through a D-sub 9 pin motor connector and a D-sub 26 high density feedback connector.

Cabling with retainer screws is highly recommended.

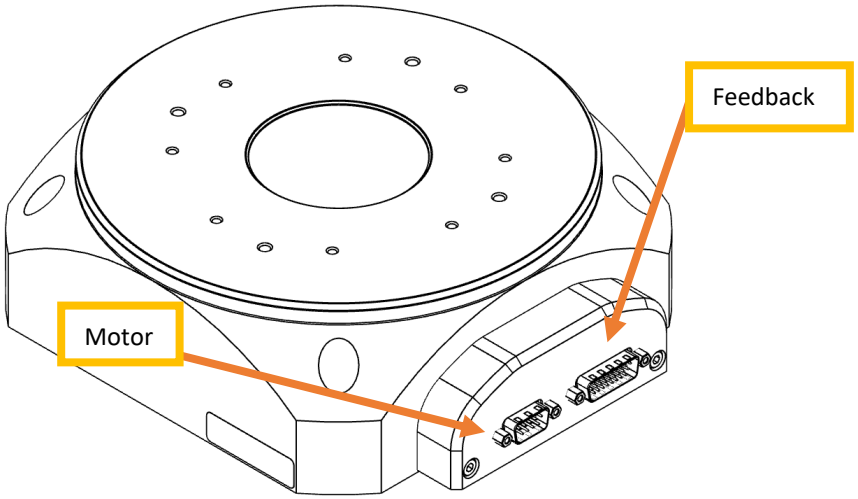


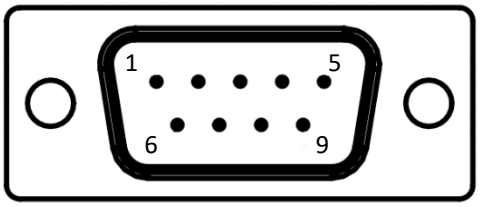
Figure 11. RTS Feedback Connectors View

5.1.1 MOTOR CONNECTOR

Pin out for the male gendered motor connector, on the stage, is provided in Table 10.

Table 10. Motor Connector Pinout

PIN	DESCRIPTION
CASE	Protective Earth
1	Protective Earth
2	Reserved
3	Reserved
4	Reserved
5	Reserved
6	Phase A
7	Phase B
8	Phase C
9	Reserved



Note: do not connect any signal wire, power source, or ground to any pin labeled “Reserved”.

An example female gendered mating part for motor cable is provided in Table 11.

Table 11. Mating Motor Connectors

Part Description	Manufacturer	Part Number
CONN D-SUB RCPT 9POS PNL MNT	Norcomp Inc.	171-009-203L001
CONN BACKSHELL SHLD	FCT Electronics	FMK1G

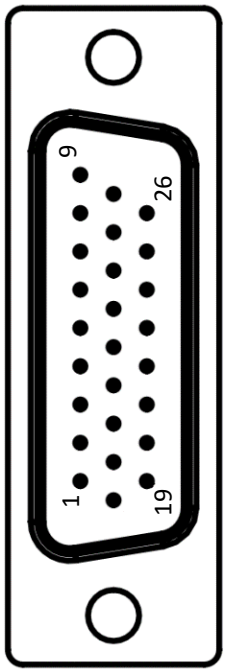
5.1.2 FEEDBACK CONNECTOR (INCREMENTAL)

NOTE: This section details the connection to encoder setups with an incremental encoder. The ordering options applicable to this section are Glass Disk sinusoidal, Glass Disk quadrature and Mylar Disk quadrature. For phasing relationships of the named signals, please refer to Section 5.4 for the appropriate feedback topology.

The feedback connector is the interface between all the primary feedback elements of the stage to a controller. Pin out for the male gendered feedback connector on the stage is provided in Table 12. Note that the different incremental configurations (glass disk sinusoidal, glass disk quadrature, and mylar disk quadrature) share similar pins.

Table 12. Incremental Feedback Connector Pinout

PIN	DESCRIPTION		
	Glass Sin.	Glass Quad.	Mylar Quad.
CASE	Protective Earth		
1	+5Vdc		
2	Sin+	A+	
3	Cos+	B+	
4	IDX+		
5	Reserved		
6	Reserved	ERR+	Reserved
7	Reserved		
8	Reserved		
9	Reserved		
10	Reserved		
11	Sin-	A-	
12	Cos-	B-	
13	IDX-		
14	Reserved		
15	Reserved	ERR-	Reserved
16	Reserved		
17	Reserved		
18	Reserved		
19	GND		
20	HALL A		
21	HALL B		
22	HALL C		
23	Reserved		
24	Reserved		
25	Reserved		
26	Reserved		



Note: do not connect any signal wire, power source, or ground to any pin labeled “Reserved”.

Example female gendered mating parts for the feedback connections is provided in Table 13.

Table 13. Mating Feedback Connectors

Part Description	Manufacturer	Part Number
CONN D-SUB HD RCPT 26POS PNL MNT	Norcomp Inc.	180-026-203L001
CONN BACKSHELL SHLD	FCT Electronics	FMK2G

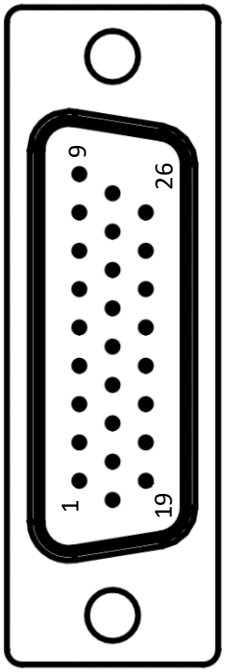
5.1.3 FEEDBACK CONNECTOR (ABSOLUTE)

NOTE: This section details the connection to encoder setups with a serial encoder interface. For additional information on the interface with the BiSS Protocol, please refer to Section 5.4.3.

The feedback connector is the interface between all the primary feedback elements of the stage to a controller. Pin out for the male gendered feedback connector on the stage is provided in Table 14. Details on the serial protocol can be found in Section 5.4.3, located on page 40.

Table 14. Serial Feedback Connector Pinout

PIN	DESCRIPTION Serial Encoder
CASE	Protective Earth
1	+5Vdc
2	Reserved
3	Reserved
4	Reserved
5	Reserved
6	Reserved
7	CLOCK+ (MA+)
8	DATA+ (SLO+)
9	Reserved
10	Reserved
11	Reserved
12	Reserved
13	Reserved
14	Reserved
15	Reserved
16	CLOCK- (MA-)
17	DATA- (SLO-)
18	Reserved
19	GND
20	HALL A
21	HALL B
22	HALL C
23	Reserved
24	Reserved
25	Reserved
26	Reserved



Note: do not connect any signal wire, power source, or ground to any pin labeled “Reserved”.

Example female gendered mating parts for the feedback connections is provided in Table 15.

Table 15. Mating Feedback Connectors

Part Description	Manufacturer	Part Number
CONN D-SUB HD RCPT 26POS PNL MNT	Norcomp Inc.	180-026-203L001
CONN BACKSHELL SHLD	FCT Electronics	FMK2G

It is recommended that a properly shielded twisted pair cable no longer than 8 meters be utilized in the construction of the feedback cable; this will permit the use of a 2 MHz master clock to attain optimal performance from the encoder.

5.2 WIRING OVERVIEW

The diagrams found in this section elaborate on the basic interface requirements pictorially, which are representative of the previously specified characteristics as tabulated in Section 5.1. Example supporting circuit elements expected from the user's controller are also shown.

For details on the phasing relationships between motor BEMF, halls, and other feedback signals, refer to Section 5.4 of this user manual.

5.2.1 MOTOR ELECTRICAL DIAGRAM

The RTS brushless DC motor connections are shown in Figure 12.

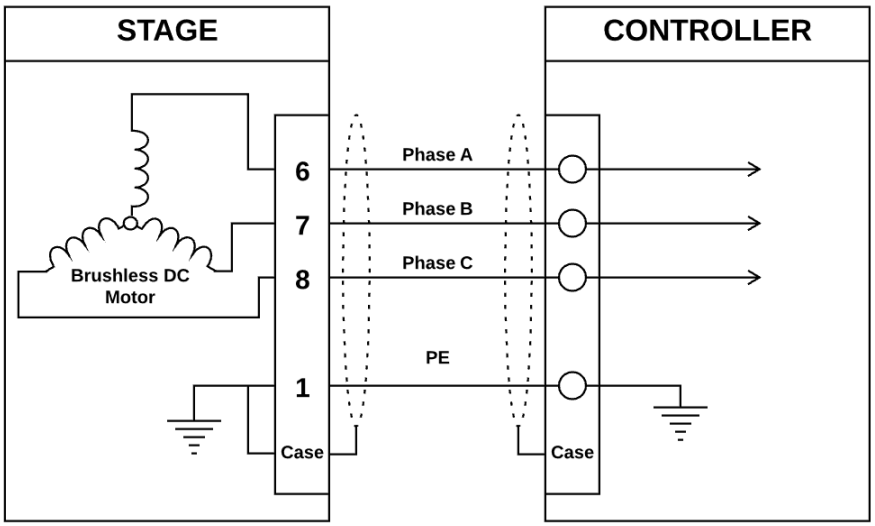
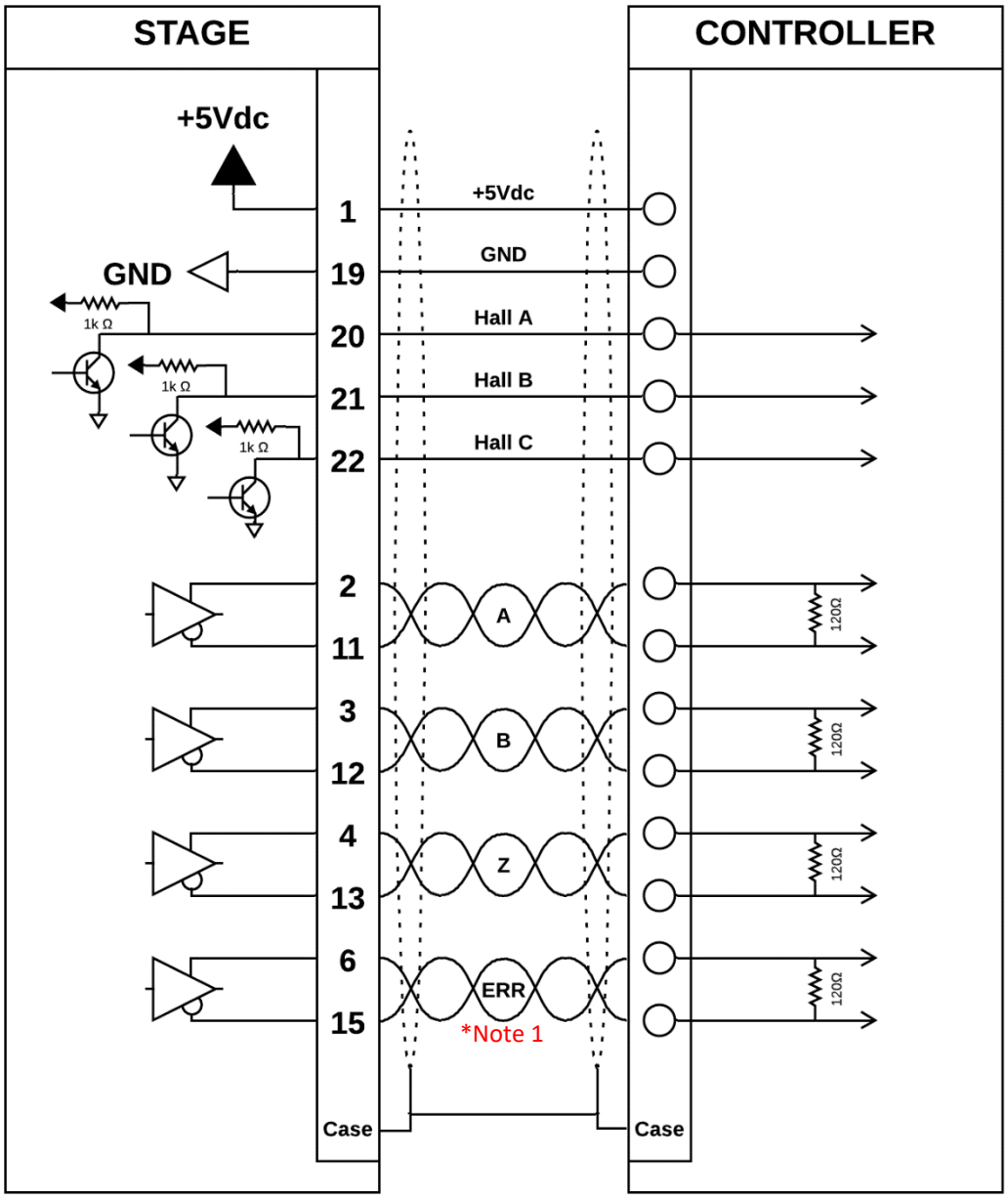


Figure 12. RTS Motor Connector Wiring Diagram

5.2.2 INCREMENTAL ENCODER ELECTRICAL DIAGRAM

The RTS feedback connections for the variants using an incremental encoder (glass disk sinusoidal, glass disk quadrature, and mylar disk) is shown in Figure 13 as connected to a typical controller setup.



Note 1: The "ERR" signal is not present on mylar disk or glass disk sinusoidal output encoder options.

Figure 13. Incremental Encoder Electrical Diagram

5.2.3 SERIAL ENCODER ELECTRICAL DIAGRAM

The RTS feedback connections for the variants using a serial encoder setup, is shown in Figure 14.

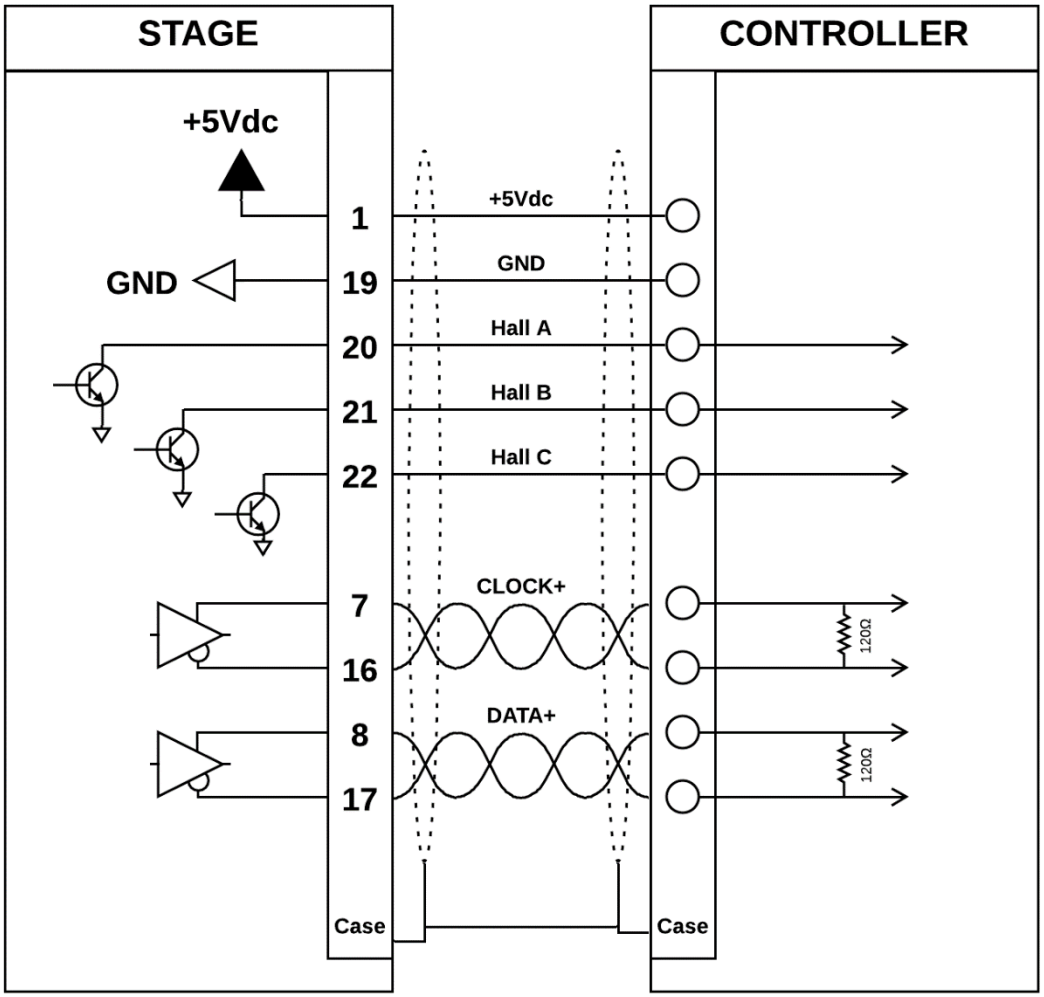


Figure 14. Serial Encoder Wiring Diagram

5.3 SHIELDING AND GROUNDING

As shown in Figure 15, the protective earth ground pin on the motor connector and shielding connection points are shown. These are the primary connections provided to the user to interface with.

For proper operation, the user must connect the shielding and protective earth grounding points as shown in the example electrical wiring diagrams of Section 5.2. This will ensure safety to the user, and high reliability of the motor and feedback systems of the stage to achieve optimal performance.

CAUTION: The user should not attempt to use any bolt hole not labeled “PE” if additional grounding is desired. Improperly using bolt holes on the RTS chassis may provide an unreliable safety ground point and may cause damage to the alignment of the bearing, encoder, or precision surfaces.

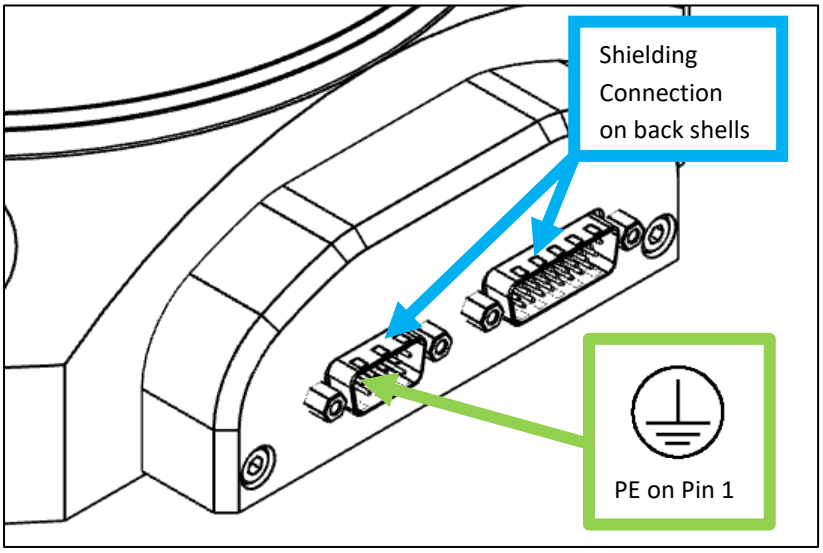


Figure 15. RTS Protective Grounding and Shielding Locations

5.4 MACHINE DIRECTION AND PHASING

5.4.1 MACHINE DIRECTION

The machine direction is the mechanical traversal of an axis in a specified direction, such that the associated electrical signals are phased and aligned in a defined and repeatable manner. Advanced controllers have the capability of easily reading and redefining the machine direction to a user's needs, however, for those controllers which do not have this capability, Section 5.4 elaborates on the expected electrical signal sequences that the hardware is expected to produce.

For conciseness, all phasing diagrams in this section will represent forward rotation traversal of the rotary axis, positive rotation being depicted as shown in Figure 16.

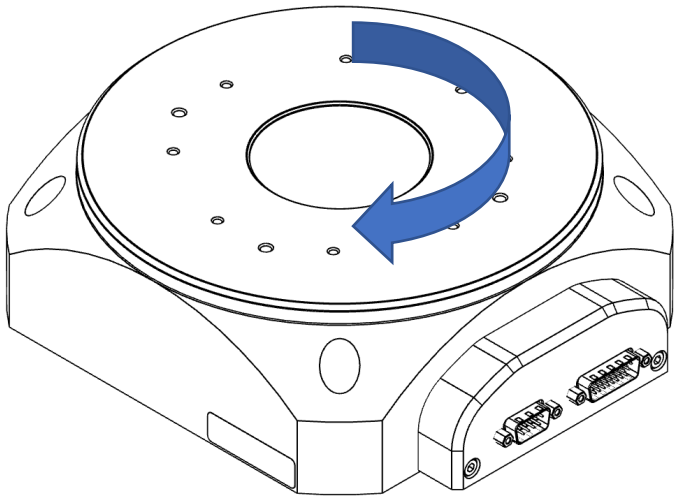


Figure 16. RTS Positive Rotation Direction

5.4.2 MOTOR, ENCODER, AND HALL PHASING

Figure 17 details the Motor BEMF with respect to the Hall outputs in the sequence that would be observed in the forward direction from left to right. BEMF waveforms are referenced to the respective phases as indicated, and the Hall signal levels are shown as pulled up by an external resistor and referenced to ground.

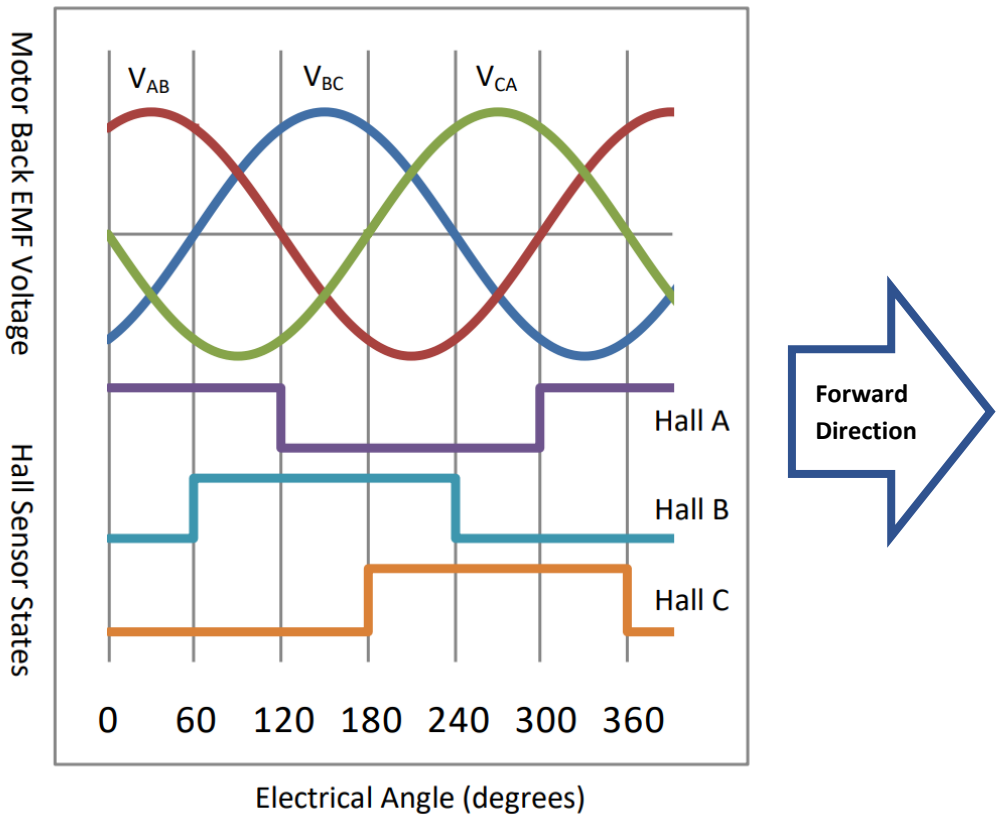


Figure 17. Motor and Hall Output in Forward Direction (CW Rotation)

Figure 18 details the quadrature and sinusoidal phasing as the stage travels in the forward rotation direction. Waveforms are measured from the Positive Signal (A+ / B+ / Sin+ / Cos+) with respect to the negative counterpart (A- / B- / Sin- / Cos-, respectively).

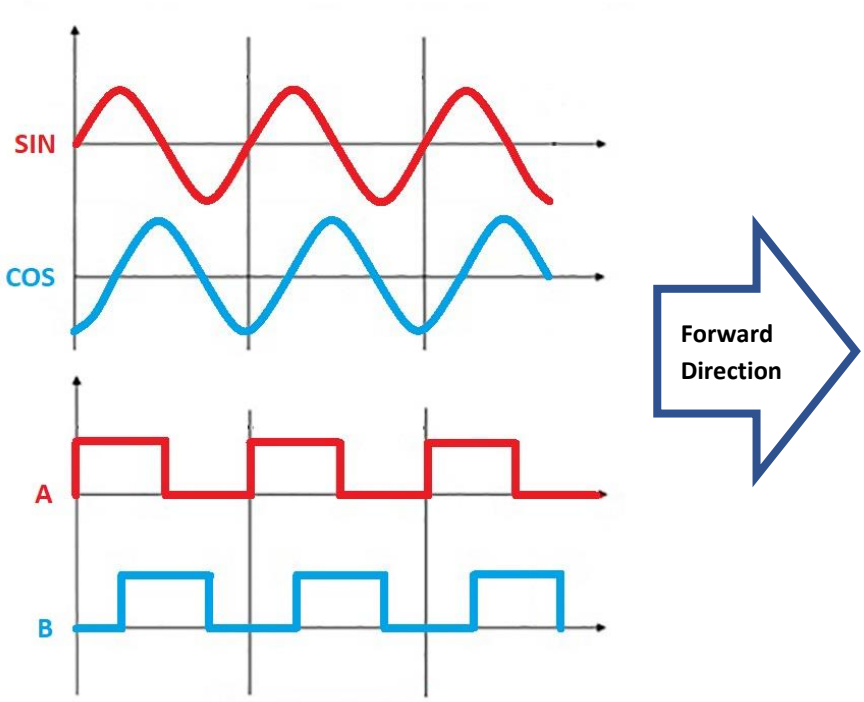


Figure 18. Quadrature and Sinusoidal Output in Forward Direction (CW Rotation)

As shown in Figure 19, the encoder index pulse for both the sinusoidal output and quadrature output encoder options is a synchronized pulse with a highly repeatable edge, which occurs once in 360 degrees of travel. The width varies with each encoder type, temperature, and other conditions, but the encoder index length is generally 25% to 100% of an encoders fundamental pitch period. Because of this variability, it is always suggested that a homing sequence approach the index from one direction and scan relatively slowly and at the same speed every time.

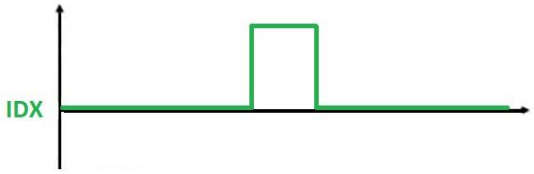


Figure 19. Quadrature and Sinusoidal Index Output

5.4.3 BISS INTERFACE

The serial communication interface as implemented in the RTS rotary stage is the BiSS-C (unidirectional), point-to-point protocol as defined by iC-Haus GmbH; for conciseness, this interface will be referred to as simply 'BiSS'. Additional information on the protocol can be found at www.biss-interface.com.

BiSS is an asynchronous data interface where a clock output from a master receives serial streamed bits from a slave device. The data is packed into a defined sequence which is then logically separated and processed by the master. It is recommended that the master drive the MA clock frequency at 2MHz to achieve optimal performance from the encoder. Note that cable length will impact signal propagation delay; utilize as short a cable as required.

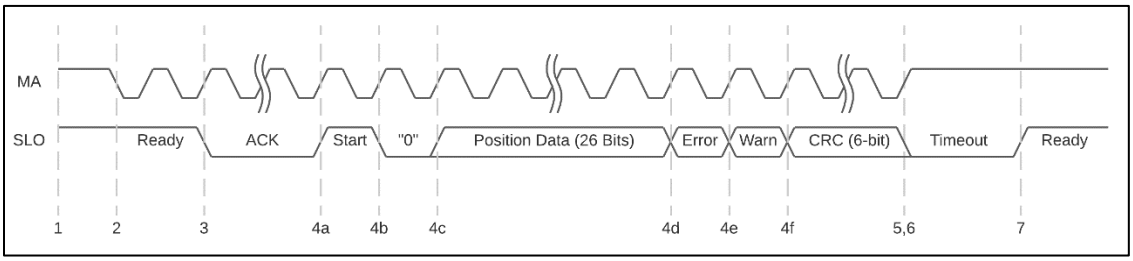


Figure 20. BiSS Protocol Diagram

To transfer the data from a slave, a timing summary of the protocol events of Figure 20 are described:

1. When in the idle state, the master holds MA high. The slave indicates it is ready by holding SLO high.
2. The master requests data by starting to transmit clock pulses on MA.
3. Upon the second clock pulse, slave drives SLO low to acknowledge the data request.
4. When the slave is ready to start transmission the following sequence beings:
    a. First bit is a high start bit.
    b. Second bit is a zero bit.
    c. The next 26 stream bits represent the encoder position in encoder counts.
        i. The reported position is an absolute position of the rotor shaft.
        ii. Full resolution at 26-bits, correlates with ~67 million counts/revolution.
    d. Error bit. (active low; "0" indicates encoder failure)
    e. Warning bit. (active low; "0" indicates signal degradation, not an encoder failure)
    f. Next 6 bits are CRC error checking.
5. After all data has been collected, the master will stop the MA clock pulse train.
6. If the slave is not yet ready for the next request cycle, the SLO line will remain low.
7. When the slave is ready again for another data request, SLO will be driven high by the slave.

Following the recommended cable length, clock speeds, and data sequence information should be sufficient information to get you setup with most BiSS interface controllers. Should you need any additional assistance, please contact us.

5.5 CABLE CONSTRUCTION CONSIDERATIONS

In assisting the integrator, a couple design considerations are discussed below which will help prevent common system failures and help increase reliability concerning cable construction and use in a control system.

Twisted Pairs – encoder signals (A, B, Z or Index) are provided as differential outputs. It is highly recommended that these signals are connected to the controller from the stage using twisted pair wires to increase noise immunity and terminated at an appropriate differential input channel on the controller.

Shielding – shield the feedback cable and motor cable to prevent induced susceptibility and radiated emissions problems. Connect ground and PE connection points from the stage to controller for maximum safety and EMC considerations.

Protection – note that the top axis motor and feedback connectors are attached to the compound plate which moves during operation of the bottom axis. Care should be taken to account for possible cable rubbing, chafing, flexing, and pinching during operation.

Retainers – connectors with retaining screws are highly recommended to prevent incidental disconnection during operation.

5.6 CONTROL SYSTEM CONSIDERATIONS

There is a myriad of suitable controllers on the market today which have the capability of driving the Griffin Motion RTS stage. Listed below are a few recommended fault and limit functions which should be implemented to maintain safe and efficient operation of the stage:

Verification and Tuning – It is highly recommended that the installer firstly verifies operation of the stage with a controller of their choice, with no payload attached in the lying flat orientation. After which dummy payloads simulating their device can be used to tune the system and verify requirements prior to installing sensitive equipment.

Velocity Limit – set in a manner as to not exceed machine mechanical limits and electrical limits; for example, set velocity limit to prevent overrun of the quadrature output of the encoder or the capability of the controller to read the quadrature input.

Position Error Limit – prevent runaway conditions should a cable, feedback mechanism, or current control fail to operate as desired.

Continuous and Peak Current Limits – the controller is responsible for implementing safe current regulation. Simple peak and continuous current limitations may not be sufficient, whereas protection algorithms such as I2T should be implemented.

Electrical and Software End-of-Travel Limits – operation should never occur beyond the electrical limits; additionally, the user application at certain velocities may require a smaller operating envelope so that a controller may have sufficient time and distance to decelerate the stage before hitting a hard stop; consider implementing software limits where applicable.

6 MAINTENANCE

6.1 INSPECTION

Depending on the cleanliness of your operating environment or system process, the general inspection interval may need to increase. For normal laboratory use, not involving the creation of debris, the following minimum inspection interval and criteria are suggested.

Inspection Interval: Monthly
Inspection Criteria:

- Check Cables for:
  - Visually inspect cables for fraying.
  - Check cables for loose connections.
  - Replace damaged cables.
  - Check resistance of protective earth bonding to controller.
- Check general cleanliness and for evidence of bearing contamination.

6.2 CLEANING AND LUBRICATION

Cleaning of large accessible surfaces can be achieved by use of a lint free cloth dampened with denatured alcohol.

Avoid getting cleaning agents or water into the rotary bearing, as this will breakdown the lubricants, embed contaminants into seals and crevices, and ultimately affect machine life.

Cleaning and lubrication of the precision bearing requires disassembly beyond the scope of this document and is not recommended to be attempted by a technician without proper training.

Lubricants used in the assembly of Griffin Motion RTS stages are intended to last the useable life of the device, given that the cleanliness of the environment is maintained consistent with the expected use and the duty cycle is moderate with respect to the listed specifications.

For applications in which the RTS is used at high duty cycles, or for OEM applications, please contact a Griffin Motion Representative.

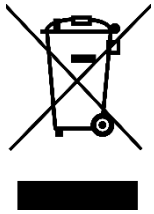
6.3 TROUBLESHOOTING

Some common troubleshooting issues, with resolutions are listed below in Table 16.

Table 16. Troubleshooting common RTS issues

Problem	Root Cause and/or Proposed Solution
Stage Runaway or erratic behavior	• Encoder feedback wrong direction • Encoder not connected or failed. • Improper current or servo tune loop gains. • Improper shielding of feedback cable causing erroneous encoder or hall effect sensor signals.
Missing or additional feedback counts	• Improper shielding of feedback cable or motor cable. • Loose connection on feedback cable. • Machine velocity too high, missing counts. • Encoder not connected or failed.
Stage power lower than expected	• Check current gains and monitor current admitted to motor. • Motor current phase angle offset is incorrect.
Excessive Vibration	• Servo or current tune loop gains need adjustment. • System setup has a resonant frequency that must be damped.
Intermittent failure or operation	• Loose cable connections to stage or controls • Amplifier VBUS unstable or too low • Encoder read head damaged • Motor hall effect sensors damaged. • Motor winding damaged.
Motor noise during operation	• Current loop gains set too high. • Contamination in bearing.

6.4 SCRAPPING AND DISPOSAL



The RTS Stage is electrical and electronic equipment that should be disposed of in a proper manner. Dispose of old equipment in accordance with the appropriate international, national, and local rules and regulations.

If you need assistance in proper disposal, or you would like to send the machine back to Griffin Motion for disposal, please reach out to a representative for RMA information.

7 SERVICE AND SUPPORT

7.1 SERVICE

If you need any assistance regarding product integration, application, identification, inspection, repairs, or new business opportunities, please contact a Griffin Motion Representative so that we may better assist you. Contact information is displayed at the beginning of this document.

7.2 GENERAL WARRANTY

Griffin Motion, LLC [hereafter GM] warrants that, for a period of one year from the date a [machine] is delivered to the Buyer, such [machine] will be free from material defects in workmanship and materials provided by GM. Buyer's sole and exclusive remedy for a breach of this warranty will be, at GM's option, either (i) credit in the amount of the purchase price of the defective [machine], or (ii) repair or replacement, at GM's expense, of the defective [machine] within [twenty (20)] days after receipt by GM of written notice of the defect from Buyer. Costs in connection with GM's repair or replacement of any defective [machine], including, parts, labor, cost of standard return transport from GM to buyer, will be borne by GM. If available, GM will provide Buyer a temporary loaner [machine] while repairs are made to any defective [machine]. This warranty will continue as to the repaired or replaced [machines] for the remainder of the original 1-year warranty period. This warranty will not apply to defects arising from neglect, accidental damage, repair, or maintenance not performed by GM, or use of the [machine] for any purpose other than the purpose for which it was designed. GM DISCLAIMS ANY AND ALL OTHER WARRANTIES, WHETHER EXPRESS OR IMPLIED, WITH RESPECT TO THE [MACHINES]. GM WILL HAVE NO LIABILITY FOR CONSEQUENTIAL, INDIRECT, SPECIAL, INCIDENTAL, EXEMPLARY, OR SIMILAR DAMAGES ARISING OUT OF OR RELATING TO THE [MACHINE] OR THE USE THEREOF BY BUYER, INCLUDING, WITHOUT LIMITATION, DAMAGES FOR LOSS OF PROFITS, BUSINESS INTERRUPTION, OR OTHER PECUNIARY LOSS, EVEN IF GM HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES.