

MH(T)-SERIES SIGMA-5 POSITIONER MANUAL

MH(T)185, MH(T)555, AND MH(T)1655 TOOLING AND MOTOMOUNT

TYPE:
YR-1-06VXHC10-A00

Only personnel with proper training offered by Yaskawa should carry out the procedures described in this manual.

Upon receipt of the product and prior to initial operation, read these instructions thoroughly, and retain for future reference.

MOTOMAN INSTRUCTIONS

DX200 INSTRUCTIONS
DX200 OPERATOR'S MANUAL
DX200 MAINTENANCE MANUAL

YRC1000 INSTRUCTIONS
YRC1000 OPERATOR'S MANUAL (GENERAL) (SUBJECT SPECIFIC)
YRC1000 MAINTENANCE MANUAL
YRC1000 ALARM CODES (MAJOR ALARMS) (MINOR ALARMS)
YRC1000 OPTIONS INSTRUCTIONS OPERATOR'S MANUAL Collaborative Operation

The operator's manual above corresponds to specific usage. Be sure to use the appropriate manual.
The operator's manual above consists of "GENERAL" and "SUBJECT SPECIFIC".
The YRC1000 alarm codes above consists of "MAJOR ALARMS" and "MINOR ALARMS".

Part Number: 168961-1CD
Revision: 4

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General Information

Summary of Warning Information

This manual is provided to help users establish safe conditions for operating the equipment. Specific considerations and precautions are also described in the manual, but appear in the form of Dangers, Warnings, Cautions, and Notice.

It is important that users operate the equipment in accordance with this instruction manual and any additional information which may be provided by Yaskawa. Address any questions regarding the safe and proper operation of the equipment to Customer Support.

Notes for Safe Operation

Read this manual carefully before installation, operation, maintenance, or inspection of the Manipulator.

In this manual, the Notes for Safe Operation are classified as “DANGER”, “WARNING”, “CAUTION”, or “NOTICE”.

**DANGER**

Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury. Safety Signs identified by the signal word DANGER should be used sparingly and only for those situations presenting the most serious hazards.

**WARNING**

Indicates a potentially hazardous situation which, if not avoided, will result in death or serious injury. Hazards identified by the signal word WARNING present a lesser degree of risk of injury or death than those identified by the signal word DANGER.

**CAUTION**

Indicates a hazardous situation, which if not avoided, could result in minor or moderate injury. It may also be used without the safety alert symbol as an alternative to “NOTICE”.

NOTICE

NOTICE is the preferred signal word to address practices not related to personal injury. The safety alert symbol should not be used with this signal word. As an alternative to “NOTICE”, the word “CAUTION” without the safety alert symbol may be used to indicate a message not related to personal injury.

Even items described as "CAUTION" may result in a serious accident in some situations.



WARNING

- This instruction manual is intended to explain mainly on the mechanical part of the Manipulator for the application to the actual operation and for proper maintenance and inspection. It describes on safety and handling, details on specifications, necessary items on maintenance and inspection, to explain operating instructions and maintenance procedures. Be sure to read and understand this instruction manual thoroughly before installing and operating the Manipulator. Any matter not described in this manual must be regarded as "prohibited" or "improper".
- General information related to safety are described in Chapter 1. "Safety" of the Controller instructions. To ensure correct and safe operation, carefully read Chapter 1. "Safety" of the Controller instructions.
- Do not remove the motor, and do not release the brake.

Failure to observe these safety precautions may result in death or serious injury from unexpected turning of the Manipulator's arm.



WARNING

- Before operating the Manipulator, check that servo power is turned OFF pressing the emergency stop buttons. When the servo power is turned OFF, the SERVO ON LED on the Programming Pendant is turned OFF.

Injury or damage to machinery may result if the emergency stop circuit cannot stop the Manipulator during an emergency. The Manipulator should not be used if the emergency stop buttons do not function.

Fig. : Emergency Stop Button



- Once the emergency stop button is released, clear the cell of all items which could interfere with the operation of the Manipulator. Then turn the servo power ON.

Injury may result from unintentional or unexpected Manipulator motion.

Fig. : Release of Emergency Stop



- Observe the following precautions when performing a teaching operation within the Manipulator's operating range:
 - Be sure to perform lockout by putting a lockout device on the safety fence when going into the area enclosed by the safety fence. In addition, the operator of the teaching operation must display the sign that the operation is being performed so that no other person closes the safety fence.
 - View the Manipulator from the front whenever possible.
 - Always follow the predetermined operating procedure.
 - Always keep in mind emergency response measures against the Manipulator's unexpected movement toward a person.
 - Ensure a safe place to retreat in case of emergency.

Failure to observe this instruction may cause improper or unintended movement of the Manipulator, which may result in personal injury.

- Confirm that no person is present in the Manipulator's operating range and that the operator is in a safe location before:
 - Turning ON the Controller power
 - Moving the Manipulator by using the Programming Pendant
 - Running the system in the check mode
 - Performing automatic operations

Personal injury may result if a person enters the Manipulator's operating range during operation. Immediately press an emergency stop button whenever there is a problem.

- Read and understand the Explanation of the Warning Labels before operating the Manipulator.

**WARNING**

- Maintenance and inspection must be performed by specified personnel.
Failure to observe this caution may result in electric shock or injury.
- For disassembly or repair, contact your Yaskawa representative

**CAUTION**

- Read and understand the Explanation of Warning Labels in the Controller instructions before operating the Manipulator.
- In some drawings in this manual, protective covers or shields are removed to show details. Make sure that all the covers or shields are installed in place before operating this product. The drawings and photos in this manual are representative examples and differences may exist between them and the delivered product.
Yaskawa is not responsible for incidents arising from unauthorized modification of its products. Unauthorized modification voids the product warranty.
- Perform the following inspection procedures prior to conducting Manipulator teaching. If problems are found, repair them immediately, and be sure that all other necessary processing has been performed.
 - Check for problems with Manipulator movement.
 - Check for damage to insulation and sheathing of external wires.
- Always return the Programming Pendant to the hook on the cabinet of the Controller after use.
- The Programming Pendant can be damaged if it is left in the Manipulator's work area, on the floor, or near fixtures.

**CAUTION**

This Manipulator Cell has Collaborative Motion functionality:

Collaboration is a special type of operation between a person and robotic system sharing a common workspace. The following are the guidelines for collaborative operation.

1. Used for pre-determined tasks.
 2. Possible when all protective measures are active.
 3. For robotics with features specifically designed for collaborative operation.
- The integrator shall include in the information for use the safeguards and mode selection required for collaborative operation.

CAUTION

- Always return the Programming Pendant to the hook on the cabinet of the Controller after use.

The Programming Pendant can be damaged if it is left in the Manipulator's work area, on the floor, or near fixtures.

NOTICE

- The drawings and photos in this manual are representative examples and differences may exist between them and the delivered product.
- Yaskawa may modify this model without notice when necessary due to product improvements, modifications, or changes in specifications. If such modification is made, the manual number will also be revised.
- If your copy of the manual is damaged or lost, contact a Yaskawa representative to order a new copy. The representatives are listed on the back cover. Be sure to tell the representative the manual number listed on the front cover.
- To ensure safe and efficient operation at all times, be sure to follow all instructions, even if not designated as "DANGER", "WARNING" or "CAUTION".

Maintenance Safety**WARNING**

- Turn the power OFF, disconnect and lockout/tagout all electrical circuits before making any modifications or connections.

Perform only the maintenance described in this manual. Maintenance other than specified in this manual should be performed only by Yaskawa-trained, qualified personnel.

Definition of Terms Used Often in This Manual




The MOTOMAN is the Yaskawa industrial robotic products.

The MOTOMAN usually consists of the Manipulator, the Controller, the Programming Pendant, and supply cables.

In this manual, the equipment is designated as follows:

Equipment	Manual Designation
YRC1000 and DX200 Controller	Controller
YRC1000 and DX200 Programming Pendant	Programming Pendant
MH(T)185, MH(T)555, AND MH(T)1655	Positioner
Cable between the Manipulator and the Controller	Manipulator cable

Descriptions of the Programming Pendant keys, buttons, and displays are shown as follows:

Equipment		Manual Designation
Programming Pendant	Character Keys	The keys which have characters printed on them are denoted with []. ex. [ENTER]
	Symbol Keys	The keys which have a symbol printed on them are not denoted with [] but depicted with a small picture. ex. PAGE key  The Cursor is an exception, and a picture is not shown.
	Axis Keys Numeric Keys	“Axis Keys” and “Numeric Keys” are generic names for the keys for axis operation and number input.
	Keys pressed simultaneously	When two keys are to be pressed simultaneously, the keys are shown with a “+” sign between them. ex. SHIFT key  +COORD key 
	Mode Key	Three kinds of modes that can be selected by the mode key are denoted as follows: REMOTE, PLAY, or TEACH
	Button	Three buttons on the upper side of the Programming Pendant are denoted as follows: HOLD button START button EMERGENCY STOP button
	Displays	The menu displayed in the Programming Pendant is denoted with { }. ex. {JOB}
PC Keyboard		The name of the key is denoted ex. Ctrl key on the keyboard

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1 Introduction

1.1 About this Document

This manual provides the following information:

- **CHAPTER 1 – INTRODUCTION**
Provides general information about the MH(T)-Series Sigma-5 Positioner system and components and customer support contact information.
- **CHAPTER 2 – SAFETY**
Provides general safety information regarding installation, maintenance, and operation.
- **CHAPTER 3 – EQUIPMENT DESCRIPTION**
Provides a description of the major components.
- **CHAPTER 4 – INSTALLATION**
This chapter provides installation procedures.
- **CHAPTER 5 – TOOLING RECOMMENDATIONS**
This chapter provides guidelines for customer-supplied tooling design.
- **CHAPTER 6 – MAINTENANCE**
This chapter provides preventive maintenance requirements for certain components MH(T)-Series Sigma-5 Positioner.
- **APPENDIX A – PERFORMANCE CHARTS**
This appendix provides performance charts for each of the Drive Assemblies.
- **APPENDIX B – ILLUSTRATED PARTS LIST**
This appendix contains the Illustrated Parts List (IPL). The IPL provides detailed views (with part numbers).
- **APPENDIX C – GLOSSARY**
This appendix contains a list and terms that may be needed to know with this system.

1.2 System Overview



WARNING

- Do not use a MotoMount™ with a stand-alone headstock (no tailstock) applications.

Use of a stand-alone application will result in uncontrolled tooling motion.

The assembly is available in four basic mechanical configurations:

- The Drive Assembly
- The Drive Assembly with MotoMount
- The Headstock Positioner Assembly
- The Headstock and Tailstock Positioner Assembly

These assemblies are combined with the appropriate single or multiple external axis control packages to provide a complete Positioner kit.

1.3 System Layout

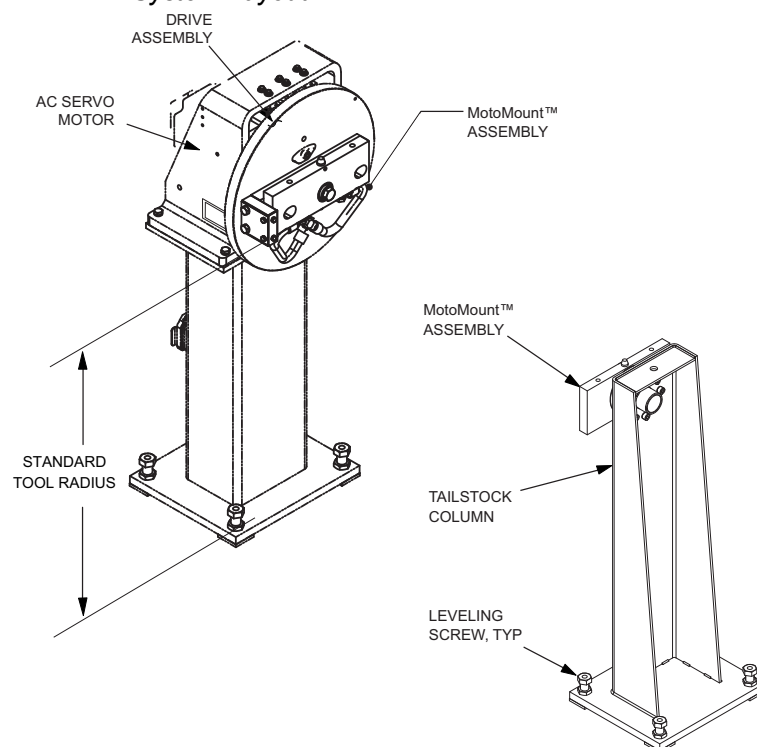
CAUTION

- Do not integrate a non Yaskawa tailstock or MotoMount system to a Yaskawa drive or headstock stock.

Integrating a non Yaskawa tailstock or MotoMount system to a Yaskawa drive or headstock stock will void the warranty.

The major components of a typical Positioner is a headstock and tailstock (MHT) System Layout (*Fig. 1-1*).

Fig. 1-1: MHT System Layout



1.3.1 System Description

The modular drive assembly provides precision-controlled rotary motion and can be mounted in any orientation that the welding, material handling, or dispensing application might require. The standard configuration utilizes an Alternating Current (AC) servo motor, a high ratio gear reducer with integral output bearing, faceplate, and either a fabricated steel housing (MH185) or cast iron housing (MH555 and MH1655). It also includes weld ground brushes.

1.3.1.1 Drive Assembly with MotoMount

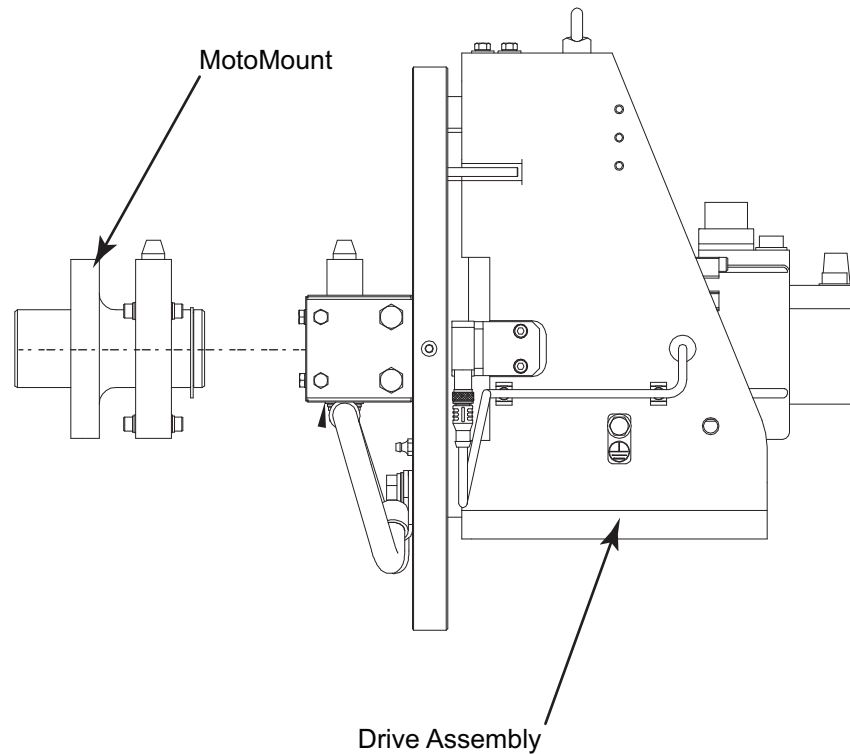
CAUTION

- Do not use MotoMount with a stand-alone (no tailstock) applications.

Using the MotoMount in a stand-alone application will result in uncontrollable tooling fixture motion.

The Drive Assembly combined with the MotoMount compliant tool mounting system provides the headstock and tailstock components for applications requiring custom headstock and tailstock supporting structures. A MotoMount is a modular accessory for the MH Positioners that provides improved repeatability as compared to a hard-mounted tooling systems.

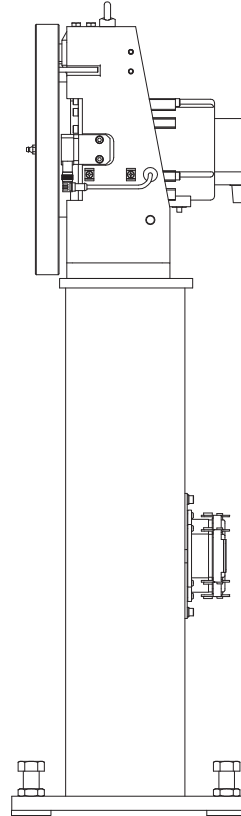
Fig. 1-2: Drive Assembly and MotoMount Assembly



1.3.1.2 Headstock Assembly

The Headstock Assembly integrates a drive assembly with a column that mounts to the floor- or a machine base, for use in cantilevered (stand-alone) applications. Leveling bolts are included with this application though the user supplies suitable anchor bolts. The standard configuration provides connectors in the column for control of the motor and safety circuits.

Fig. 1-3: Headstock Assembly



1.3.1.3 Positioner Assembly (headstock and tailstock)

CAUTION

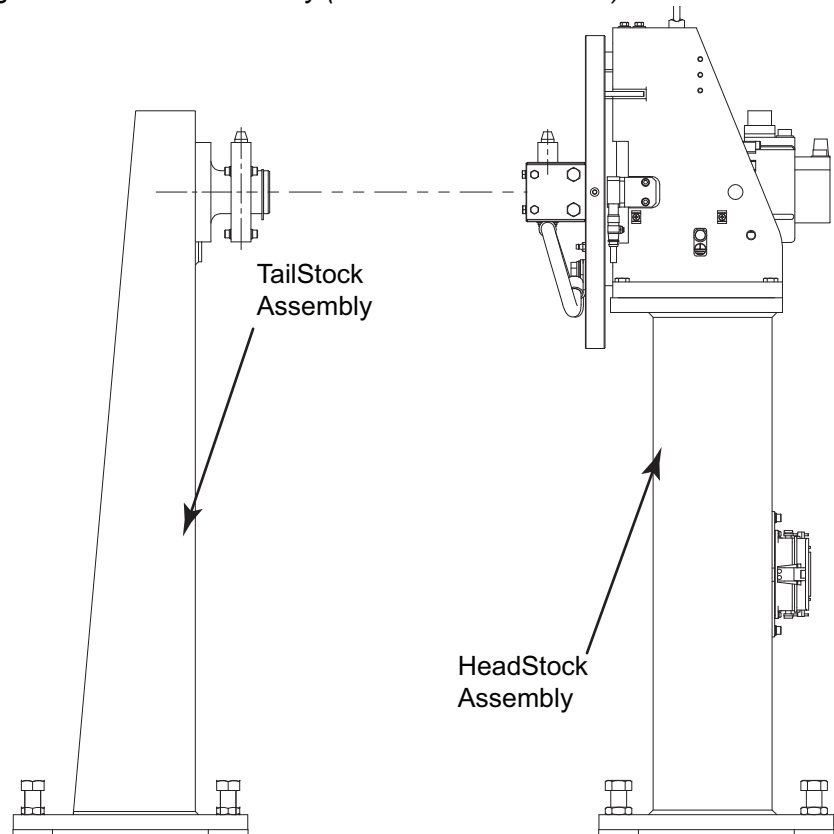
- Do not integrate a non Yaskawa tailstock or MotoMount system to a Yaskawa drive or headstock stock.

Integrating a non Yaskawa tailstock or MotoMount system to a Yaskawa drive or headstock stock will void the warranty.

The Positioner assembly integrates the headstock with a tailstock column and the MotoMount compliant tool mounting system. Mounting of this system is to the floor or machine base. The application determines the Span between the headstock and tailstock. The tooling sweep radius's are;

- MH185 and MH555 - 815 mm
- MH1655 - 1000 mm

Fig. 1-4: Positioner Assembly (headstock and tailstock)



1.4 Customer Support Information

If you need assistance with any aspect of your MH(T)-Series Sigma-5 Positioner system, please contact Customer Support at the following 24-hour telephone number:

(937) 847-3200

For **routine** technical inquiries, you can also contact Customer Support at the following e-mail address:

techsupport@motoman.com

When using e-mail to contact Customer Support, please provide a detailed description of your issue, along with complete contact information. Please allow approximately 24 to 36 hours for a response to your inquiry.

NOTICE

Please use e-mail for **routine** inquiries only. If an urgent or emergency need for service, replacement parts, or information, contact Customer Support at the telephone number shown above.

Please have the following information ready before calling:

• System	MH(T)-Series Sigma-5 Positioner
• Controller	
• Manipulator	
• Positioner	MH(T)185, MH(T)555, or MH(T)1655
• Software Version	Access this information on the Programming Pendant's LCD display screen by selecting {MAIN MENU} - {SYSTEM INFO} - {VERSION}
• Manipulator Serial Number	Located on the Manipulator data plate
• Manipulator Sales Order Number	Located on the Controller data plate

2 Safety

2.1 Introduction

It is the purchaser's responsibility to ensure that all local, county, state, and national codes, regulations, rules, or laws relating to safety and safe operating conditions for each installation are met and followed.

We suggest that you obtain and review a copy of the ANSI/RIA National Safety Standard for Industrial Robots and Robot Systems (ANSI/RIA R15.06-2012). You can obtain this document from the Robotic Industries Association (RIA) at the following address:

Robotic Industries Association

900 Victors Way
P.O. Box 3724
Ann Arbor, Michigan 48106
TEL: (734) 994-6088
FAX: (734) 994-3338
www.roboticsonline.com

Ultimately, well-trained personnel are the best safeguard against accidents and damage that can result from improper operation of the robot system. The customer is responsible for providing adequately trained personnel to operate, program, and maintain the robot cell. **NEVER ALLOW UNTRAINED PERSONNEL TO OPERATE, PROGRAM, OR REPAIR THE ROBOT SYSTEM!**

We recommend approved Yaskawa training courses for all personnel involved with the operation, programming, or repair of the robotic system. This training is designed to familiarize personnel with the safe and correct operation of the robotic system.

2.2 General Safeguarding Tips

All operators, programmers, plant and tooling engineers, maintenance personnel, supervisors, and anyone working near the robotic must become familiar with the operation of this equipment. All personnel involved with the operation of the equipment must understand potential dangers of operation. General safeguarding tips are as follows:

Improper operation can result in personal injury and/or damage to the equipment. Only trained personnel familiar with the operation of this robotic, the operator's manuals, the system equipment, and options and accessories should be permitted to operate this robotic system.

Do not enter the robotic cell while it is in automatic operation.

Programmers must have the Programming Pendant when they enter the robotic cell.

- Improper connections can damage the robotic system. All connections must be made within the standard voltage and current ratings of the robotic I/O (Inputs and Outputs).
- The robotic must be placed in Emergency Stop (E-Stop) mode whenever it is not in use.
- In accordance with ANSI/RIA R15.06-2012, section 4.2.5, Sources of Energy, use lockout/tagout procedures during equipment maintenance. Refer also to Section 1910.147 (29CFR, Part 1910), Occupational Safety and Health Standards for General Industry (OSHA).

2.3 Mechanical Safety Devices

The safe operation of the Manipulator, Positioner, auxiliary equipment, and system is ultimately the user's responsibility. The conditions under which the equipment will be operated safely should be reviewed by the user. The user must be aware of the various national codes, ANSI/RIA R15.06-2012 safety standards, and other local codes that may pertain to the installation and use of industrial equipment. Additional safety measures for personnel and equipment may be required depending on system installation, operation, and/or location. The following safety equipment is provided as standard:

- Safety fences and barriers
- Light curtains and/or safety mats
- Door interlocks
- Emergency stop palm buttons located on operator station, Controller, and Programming Pendant

Check all safety equipment frequently for proper operation. Repair or replace any non-functioning safety equipment immediately.

2.4 Installation Safety

Safe installation is essential for protection of people and equipment. The following suggestions are intended to supplement, but not replace, existing federal, local, and state laws and regulations. Additional safety measures for personnel and equipment may be required depending on system installation, operation, and/or location. Installation tips are as follows:

- Be sure that only qualified personnel familiar with national codes, local codes, and ANSI/RIA R15.06-2012 safety standards are permitted to install the equipment.
- Identify the work envelope of each robotic system with floor markings, signs, and barriers.
- Position all Controllers outside the robotic work envelope.
- Whenever possible, install safety fences to protect against unauthorized entry into the work envelope.
- Eliminate areas where personnel might get trapped between a moving Manipulator and other equipment (pinch points).
- Provide sufficient room inside the workcell to permit safe teaching and maintenance procedures.

2.5 Programming, Operation, and Maintenance Safety

All operators, programmers, plant and tooling engineers, maintenance personnel, supervisors, and anyone working near the robotic system must become familiar with the operation of this equipment. Improper operation can result in personal injury and/or damage to the equipment. Only trained personnel familiar with the operation, manuals, electrical design, and equipment interconnections of this robotic system should be permitted to program, operate, and maintain the system. All personnel involved with the operation of the equipment must understand potential dangers of operation.

- Inspect the robotic system and work envelope to be sure no potentially hazardous conditions exist. Be sure the area is clean and free of water, oil, debris, etc.
- Be sure that all safeguards are in place. Check all safety equipment for proper operation. Repair or replace any non-functioning safety equipment immediately.
- Do not enter the Robotic cell while it is in automatic operation. Be sure that only the person holding the Programming Pendant enters the workcell.
- Check the E-Stop button on the Programming Pendant for proper operation before programming. The robotic system must be placed in Emergency Stop (E-Stop) mode whenever it is not in use.
- Back up all programs and jobs onto suitable media before program changes are made. To avoid loss of information, programs, or jobs, a backup must always be made before any service procedures are done and before any changes are made to options, accessories, or equipment.

2 Safety2.5 Programming, Operation, and Maintenance Safety

- Any modifications to PART 1, System Section, of the Controller concurrent I/O program can cause severe personal injury or death, as well as damage to the Robotic System! Do not make any modifications to PART 1, System Section. Making any changes without the written permission of Yaskawa will VOID YOUR WARRANTY!
- Some operations require standard passwords and some require special passwords. Special passwords are for Yaskawa use only. YOUR WARRANTY WILL BE VOID if you use these special passwords.
- The Controller allows modifications of PART 2, User Section, of the concurrent I/O program and modifications to Controller parameters for maximum robotic performance. Great care must be taken when making these modifications. All modifications made to the Controller will change the way the robotic system operates and can cause severe personal injury or death, as well as damage the robotic system and other parts of the system. Double-check all modifications under every mode of robotic operation to ensure that you have not created hazards or dangerous situations.
- Check and test any new or modified program at low speed for at least one full cycle.
- This equipment has multiple sources of electrical supply. Electrical interconnections are made between the Controller and other equipment. Disconnect and lockout/tagout all electrical circuits before making any modifications or connections.
- Do not perform any maintenance procedures before reading and understanding the proper procedures in the appropriate manual.
- Use proper replacement parts.
- Improper connections can damage the robotic system. All connections must be made within the standard voltage and current ratings of the robotic I/O (Inputs and Outputs).

3 Equipment Description

3.1 General Information

The MH(T)-Series SIGMA-5 Positioner drive assembly consists of an AC servo motor and gear reducer with the an integral output bearing mounted in a fabricated steel housing for the MH185 and a cast iron housing for the MH555 and MH1655. Weld ground brushes are included as standard features. The drive assembly provides programmable motion about the central axis. The drive assembly with endless rotation is available as an option. Faceplate holes provide the ability to mount the MotoMount drive components or parts fixtures in stand-alone (cantilevered) applications.

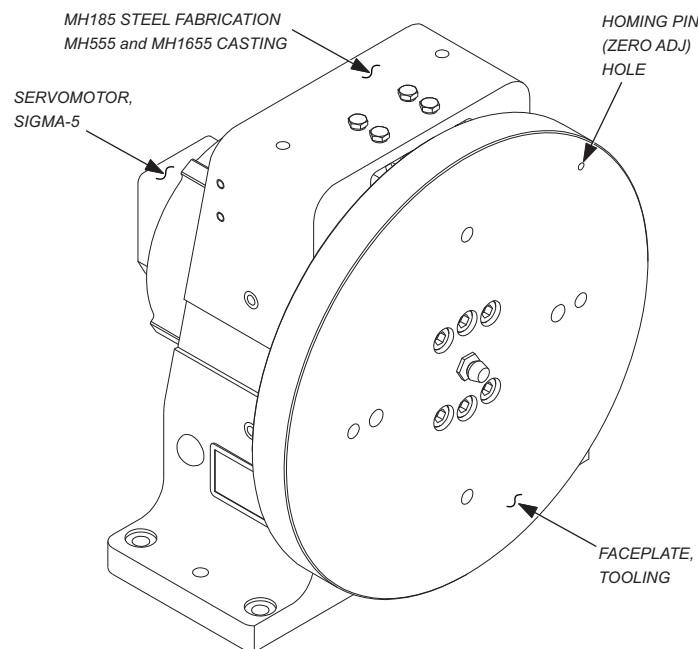
3.2 MH(T)-Series SIGMA-5 Positioner Assembly

The design of the three available drive assemblies are similar; the main differences are the faceplates and sizes. The flexibility of the drive assembly allows for any mounting orientation including vertical (typical), horizontal, or other.

The drive assembly Positioners (*Fig. 3-1*) are available in the following models:

- MH185
- MH555
- MH1655

Fig. 3-5: MH-Series SIGMA-5 Positioner Manual Drive Assembly (MH185 shown)



3.2.1 MH-Series SIGMA-5 Positioner – Specifications

See *Table 3-1* for MH-Series SIGMA-5 Positioner drive assembly specifications.

CAUTION

- Do not operate outside the standard setup, without Yaskawa approval.

Working outside the standard setup may change E-Stop performance and void the warranty.

Table 3-1: MH-Series SIGMA-5 Positioner Specifications

SERIES COMPONENT		MH185			MH555			MH1655		
Drive Assy PN		168938-1			163892-1			163893-1		
Axis Type*		Rotation			Rotation			Rotation		
Rated Load	kgf	185			555			1655		
Max MHT Load @ CG Off Center	kgf@mm	550@50			1075@80			3000@95		
Headstock Speed	rpm	12.4			9.8			10.8		
180 Degree Sweep Time	sec	2.72			3.36			3.28		
Rated CG Off Center	mm	152			152			152		
Rated CG Overhang	mm	250			0			0		
Load @ 500 mm CG Overhang	kgf	75			168			500		
Rated Inertia	kg*m2	47			105			678		
Rated Holding Torque	Nm	268			1125			2826		
Rated Weld Current (Std/Optional)	Amps	400/800			1200			1600		
Allowable Thrust	kgf	400			800			2000		
Motor Power	kW	0.450			1.300			3.7		
Motor PN, YEC*		SGMRV-05ANA-YR11			SGMRV-13ANA-YR11			SGMRV-37ANA-YR11		
Motor Speed*	rpm	2000			1500			2000		
Rated Acceleration Time*	sec	0.3			0.3			0.5		
Motor PN, Yaskawa		156009-1			156009-3			156009-6		
Reducer		RV-20E-161-1B			RV-80E-153			RV-320E-185		
Total Reduction Ratio*	R	161			153			185		
Repeatability	mm/mm	0.00004			0.00003			0.00003		
Tail Stock Through Hole	mm	45			45			45		
Drive Assy Weight	kgf/lbs	59.5/131			158/348			280/617		
E-Stop	Category	0	1	2	0	1	2	0	1	2
E-Stop Response	sec	N/A	N/A	N/A	0.201	0.374	0.526	0.200	0.390	0.787
E-Stop Response	deg	N/A	N/A	N/A	N/A	20.73	36.47	N/A	22.54	59.34

* External axis default settings

3.3 *MotoMount™

MotoMount (see Fig. 3-6:) is a flexible tool fixture mounting system which improves tool repeatability and reduces loads on the headstock/tailstock bearing systems. MotoMount accommodates combined headstock/tailstock/tooling misalignment up to two degrees.

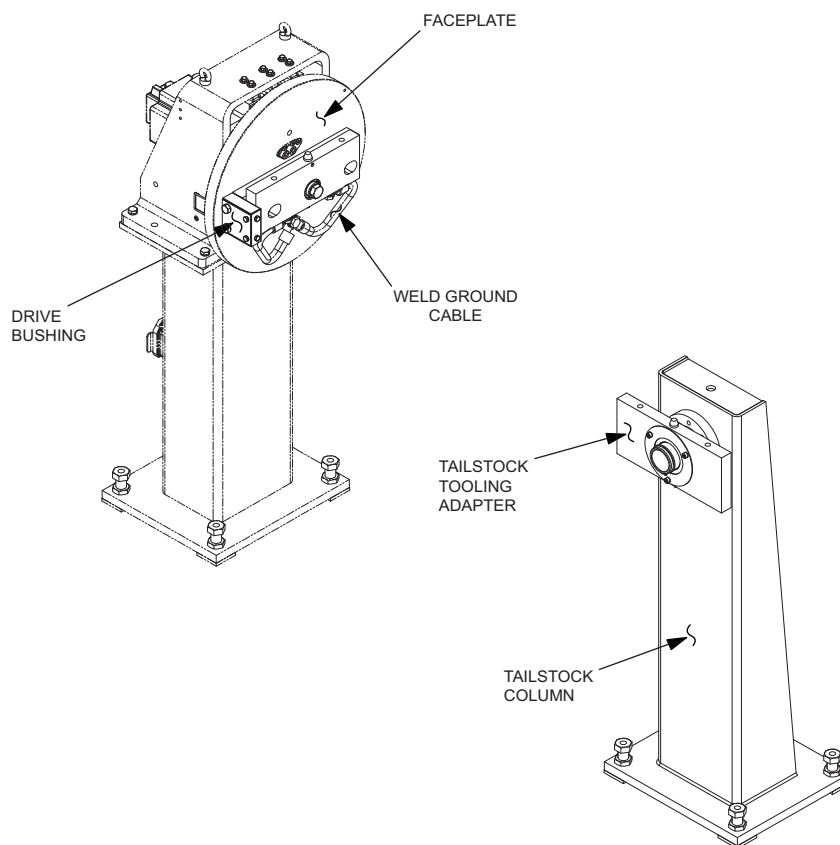
All Motoman MHT-series Positioners require a MotoMount. The MotoMount drive components mount onto the headstock faceplate, while the tailstock components replace earlier tailstock designs.

CAUTION

Do not use MotoMount with stand-alone (no tailstock) applications.

Use in a stand-alone application will result in uncontrollable tooling fixture motion.

Fig. 3-6: MotoMount Layout



4 Installation



CAUTION

- Follow established safety procedures during the installation process.

Failure to use safe work practices can result in damage to the equipment and injury to the workers.

CAUTION

- Handle the MH(T)-Series SIGMA-5 Positioner with care when installing.

Use only personnel familiar with the MH(T)-Series SIGMA-5 Positioner for installation. Handling roughly can cause damage to electronic components.

NOTICE

- All anchoring hardware for the Positioner must be supplied by the customer.

Refer to the “*Robotic Equipment Installation and Lagging Requirements*” and “*Equipment Anchoring*” as a reference.

4.1 Materials Required

This section identifies customer-supplied items and tools required to complete installation.

4.1.1 Customer-Supplied Items

- Servo motion control unit
- Incoming power supply
- Two earth ground cables with two earth ground stakes

4.1.2 List of Tools

- | | |
|---|-------------------------------------|
| • Safety glasses | • Forklift and/or overhead crane |
| • Level | • Open-end wrench set |
| • Adjustable wrench set | • Wrench sets (standard and metric) |
| • Hammer drill with appropriate concrete bits | • Chalk String |

4.2 Installing the MH(T)-Series SIGMA-5 Positioner

4.2.1 Site Preparation

Mount each MH(T)-Series SIGMA-5 Positioner system on a machine base or a reinforced concrete factory floor suitable to withstand the static and dynamic forces.

4.2.2 Unpacking

The headstock and optional tailstock are on a shipping skid. To unpack the equipment, proceed as follows:



WARNING

- See the specification tables for drive assembly weight.

Make sure that the lifting device is capable of handling the weight or injury to personnel can result.

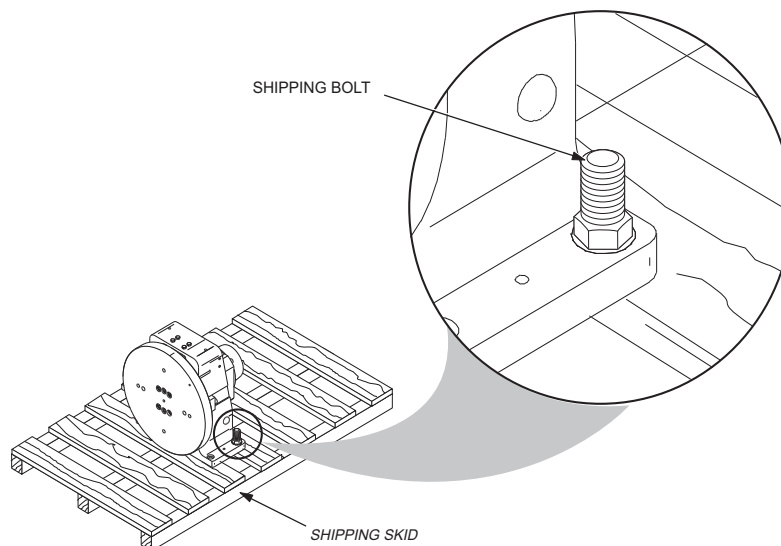
1. Carefully remove protective plastic wrapping from equipment.
2. Inspect equipment for shipping damage.

NOTICE

Notify shipping agent immediately if there is any shipping damage.

3. Unbolt the equipment from the shipping skid (see *Fig. 4-7*).

Fig. 4-7: Unbolting the Drive Assembly



4. Attach a lifting device to the eye bolts on top of the housing and lift the equipment from the shipping skid.

5. Place the equipment in position per the layout prints.

NOTICE

Make sure there is adequate room on all sides of the Positioner for part fixtures.

4.2.3 Headstock Assembly Mounting Hole Pattern – MH185/555/1655

Mount the headstock assembly to the column assembly see *section 4.2.4 “Column Assembly Mounting” on page 4-5* or on the customer-supplied machine base.

For custom orientations base mounting holes and auxiliary mounting holes on top of the drive assembly are available. See *Table 4-2* mounting specification for the Positioners.

Table 4-2: Mounting Specifications for Positioners

Drive Assembly	Bolt Size, Grade HHC	Tightening Torque (N•m/lbf-ft.)
MHT185	M10	44/32
MHT555	M16	190/140
MHT1655	M16	190/140

The following figures show the mounting hole patterns;

- Fig. 4-8 shows the mounting hole pattern for the MH185.
- Fig. 4-9 shows the mounting hole pattern for the MH555.
- Fig. 4-10 shows the mounting hole pattern for the MH1655.

Fig. 4-8: MH185 Mounting Hole Pattern

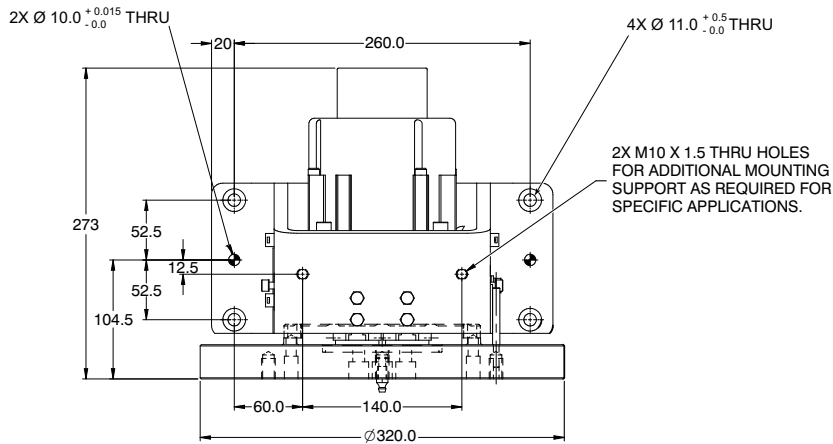
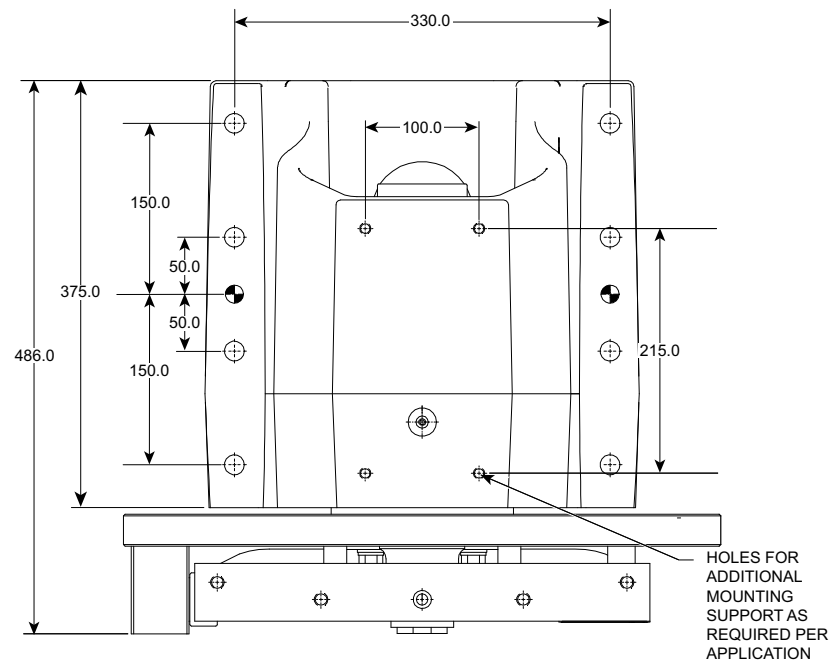
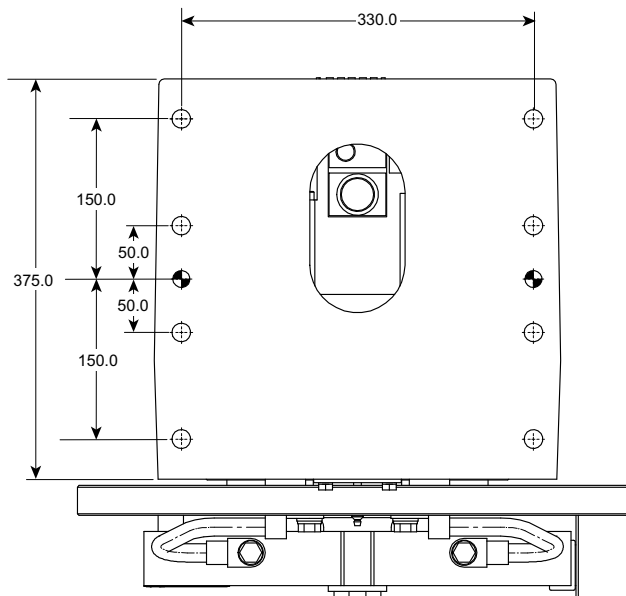


Fig. 4-9: MH555 Mounting Hole Pattern*Fig. 4-10: MH1655 Mounting Hole Pattern*

4.2.4 Column Assembly Mounting

4.2.4.1 Hole Patterns

Mount the column assembly for the Drive Assembly Headstock with MotoMount to the floor or on a base. For placement information, review the hole pattern in *Fig. 4-11* and the specifications in *Table 4-3*.

Fig. 4-11: Column-Mounting Hole Pattern

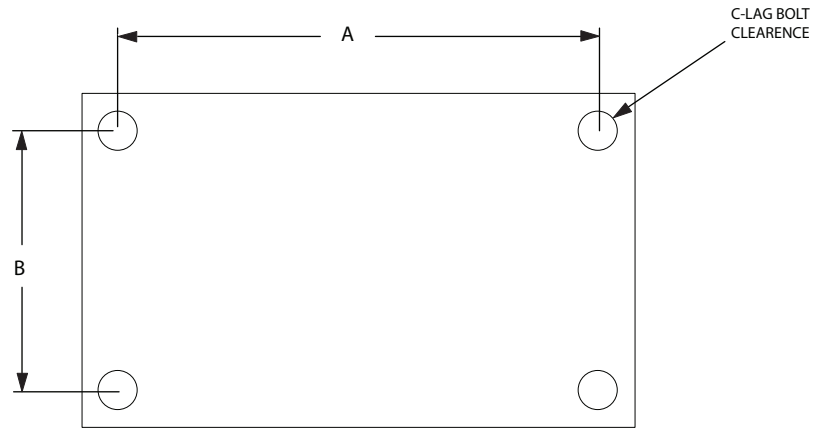


Table 4-3: Mounting Hole Specifications

Drive Assembly	A	B	C
MH185	300	250	M20
MH555	700	420	M30
MH1655	700	420	M30

NOTICE

Due to the variations in floor construction and preferences, this manual will not specify anchoring systems beyond what is listed in *Table 4-3*.

4.2.4.2 Installing the Headstock Column Assembly

Refer to the layout drawings to ensure the set up location. To install the headstock, refer to the required figure and continue;

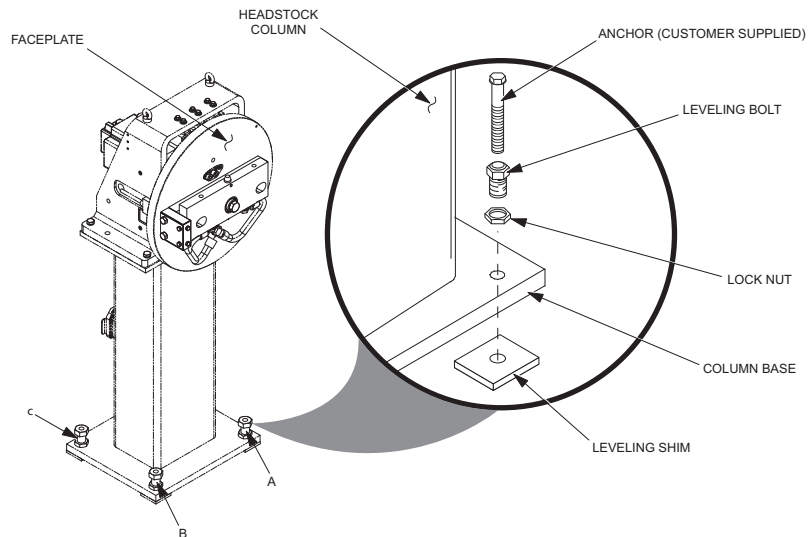
- *Fig. 4-8* shows the mounting hole pattern for the MH185.
 - *Fig. 4-9* shows the mounting hole pattern for the MH555.
 - *Fig. 4-10* shows the mounting hole pattern for the MH1655.
1. Set the column assembly in desired position.
 2. Use the leveling bolt holes as a guide and transfer the hole locations to the concrete.
 3. Remove column assembly.
 4. Install the anchors per the anchor manufacture instructions.
 5. Install a leveling shim at each anchor location and reset the column assembly.
 6. Screw each leveling bolt down until it just contacts the leveling shim and hand tighten the anchor bolts or nuts.

4.2.4.3 Leveling the Headstock

The headstock must be leveled in two directions (see *section 4.3.2 "Leveling the Tailstock" on page 4-10*):

- Parallel to the faceplate
- Perpendicular to the faceplate

Fig. 4-12: Leveling Hardware



Since it only takes three points to define a plane, use only three of the four leveling bolts to level the system. It is important to consistently use the same three leveling bolts throughout each process. Use the fourth leveling bolt for anchoring only.

Before proceeding, make sure that the headstock is in the proper place. Make sure leveling bolt, lock-nut, and leveling shim are on each column base hole.

- **To level the headstock assembly axially, proceed as follows:**
 1. Place a level on top of the housing, perpendicular to the faceplate.
 2. Use the two leveling bolts beneath the faceplate (A and B), and a third beneath motor (C) to level axially. If the faceplate side needs adjustment, A and B must be turned equally.
- **To level the headstock assembly cross-axially, proceed as follows:**
 1. Place a level on top of the housing, parallel to the faceplate.
 2. Use the same three leveling bolts used above and adjust them until the level is balanced, adjusting B and C equally.
 3. Repeat the axial and cross-axial leveling steps until level readings are achieved both ways.
 4. Drive the fourth leveling bolt down to the leveling shim.
 5. Check level axial and cross-axial again. When level, tighten the anchor system (customer supplied) to the specified torque.
 6. Tighten the four lock-nuts to the column base.

4.2.5 Connecting the Cables

Do not connect the encoder, power, and ground cables until after the drive assembly is securely in place.

NOTICE

When installing stand-alone drive assemblies, user will need to mount the junction boxes close to the drive assembly for motor cables.

4.2.5.1 Connection to Controller

The MH(T)-Series SIGMA-5 Positioner assembly with a Manipulator delivered together usually has the connections made between the two. If the connections are not made connections can be found in the system manual by referring to the specific documentation for your system.

4.2.5.2 Ground Cables

See *Fig. 4-13* for MH185 and *Fig. 4-14* for MH555 and MH1655 for attaching the weld ground cable. If required remove paint from the lug contact surface on the housing system.

Fig. 4-13: MH185 Ground Cable Connection

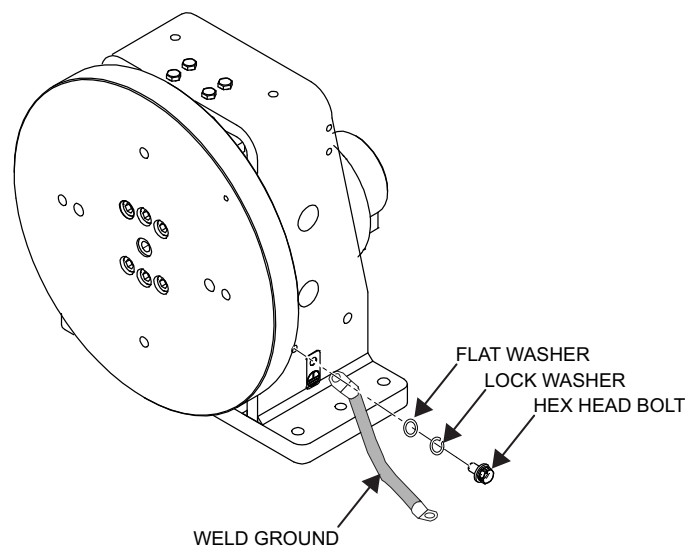
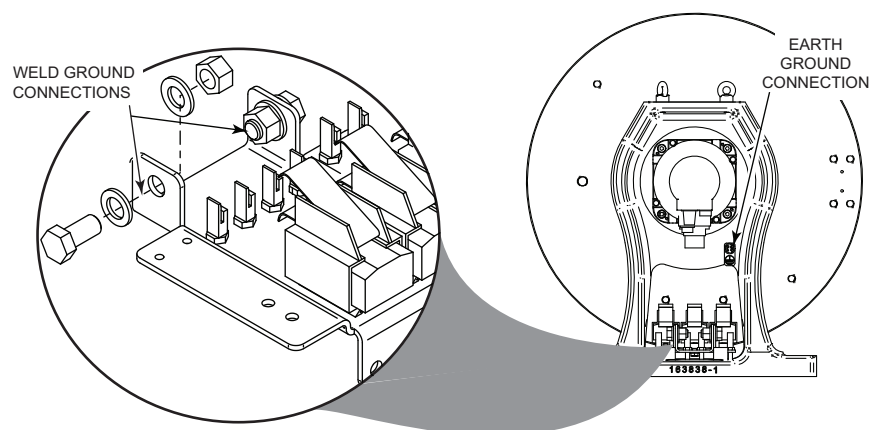


Fig. 4-14: MH555 and MH1655 Ground Cable Connection



MH(T)-Series Sigma-5
Positioner

4 Installation

4.2 Installing the MH(T)-Series SIGMA-5 Positioner

4.2.6 Home Position

The HOME position is set at the factory for the MH(T)-Series SIGMA-5 Positioner. See *chapter 6 “Maintenance”*, if adjustment is necessary.

4.3 Tailstock Column Installation

4.3.1 Tailstock Installation

Check headstock anchoring to the floor before installing tailstock. Refer to *section 4.2 “Installing the MH(T)-Series SIGMA-5 Positioner” on page 4-2* if anchoring headstock is required.

To install the tailstock onto a cell base or floor, proceed as follows:

1. Ensure the proper position of the headstock assembly per system layout. The headstock must be permanently anchored to the floor/base.
2. Using a carpenter's chalk string, strike a chalk line on the floor from the edge of the headstock base toward the location of the tailstock.

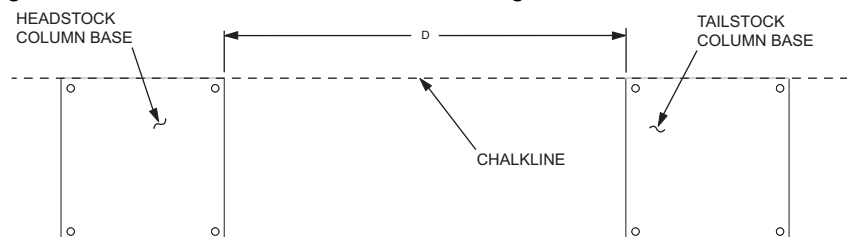
Fig. 4-15: Strike a Chalk Line



3. Set the tailstock in its approximate position on the floor using the chalk line. The headstock and tailstock are now facing each other.
4. Measure the distance (D) between the headstock and tailstock base. To find the distance (D) use the following tailstock mounting formula:
 - D = Distance between the headstock and tailstock base
 - PD = Tooling pin-to-pin distance
 - X = MotoMount Offset

$$D = PD + X$$

Fig. 4-16: Tailstock Placement without Tooling



NOTICE

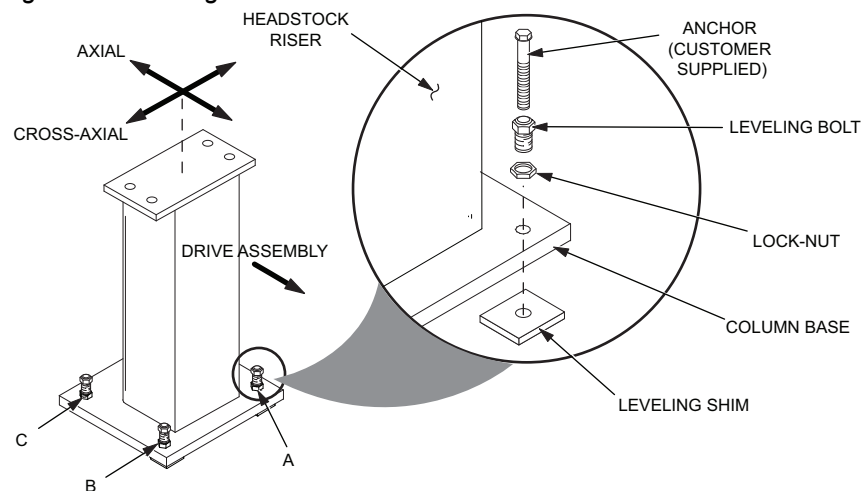
The placement position resulting from this formula will position the tailstock in the nominal center position.

4.3.2 Leveling the Tailstock**4.3.2.1 Leveling Procedures**

Tailstock leveling must use axially and cross-axially directions. Since it only takes three points to define a plane, use only three of the four leveling bolts to level the system. It is important to consistently use the same three leveling bolts throughout each process. The fourth leveling bolt is for anchoring only.

Before proceeding, make sure that the tailstock is in the proper place and the leveling bolts, lock-nuts and leveling shims are on each column base hole.

Fig. 4-17: Leveling the Tailstock



■ **Leveling the Tailstock Assembly Axially:**

1. Place a level on top of the tailstock column in the axial direction.
2. Use the leveling bolts A, B, and C to adjust the axial level. Adjust bolts A and B equally.

■ **Leveling the Tailstock Assembly Cross-axially:**

1. Place a level on top of the tailstock in the cross-axial direction.
2. Use the same three leveling bolts used above and adjust them until the level is balanced, adjusting B and C equally.
3. Repeat the axial and cross-axial leveling steps until level readings are achieved both ways
4. Drive the fourth leveling bolt down to the leveling shim.
5. Check level axially and cross-axially again. When level, tighten the anchoring system (customer-supplied) to the specified torque.
6. Tighten the four lock-nuts to the column base.

4.3.3 Tooling Fixture Installation (initial)

Complete Initial Tooling Installation before aligning the headstock/tailstock.

1. Jog the headstock to the Home position. The tooling mounting holes and locating pin must be pointing up. If not, remove the MotoMount drive components and re-install in the proper orientation.

**WARNING**

Make sure servo power is OFF for the remainder of the installation.

If servo power is not off serious operator injury and/or equipment damage may result.

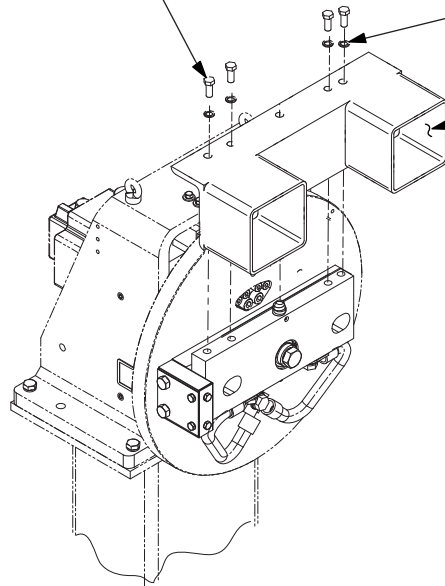
2. Use a suitable lifting device to position the tooling above the headstock/tailstock assemblies.
3. Slowly lower tooling fixture while aligning with the headstock and tailstock locating pins.

Fig. 4-18: Tooling Fixture Installation - Headstock/Tailstock

CUSTOMER SUPPLIED BOLTS
M12 GRADE 8.8

HARDENED WASHERS
(CUSTOMER SUPPLIED)

CUSTOMER SUPPLIED
TOOLING FIXTURE



4. Continue lowering the tooling until the hoisting straps are loose.
5. Secure the tooling to the drive assembly with customer supplied M12, grade 8.8 (or better) bolts and hardened washers. Eight hardened washers are included with the MotoMount kit for this purpose.
6. Remove the hoisting straps.

4.3.4 Tooling Fixture Installation (regular)

1. Jog the headstock until MotoMount is horizontal. The tooling mounting holes and locating pin must be pointing up.

**WARNING**

Make sure servo power is OFF for the remainder of the installation.

If servo power is not off serious operator injury and/or equipment damage may result.

2. Use a suitable lifting device to position the tooling above the headstock assembly.
3. Slowly lower one side of the tooling fixture onto the headstock using the locating pin.
4. Install the M12 tool mounting bolts and washers onto the headstock (customer-supplied grade 8.8 bolts), and torque the bolts to 76N•m (56lbf-ft).

4.3.5 Final Alignment Check

The MotoMount system helps reduce the load on bearings due to tooling fixture misalignment with the headstock and tailstock. However, optimum performance is achieved when the alignment is as close as possible. Horizontal and vertical misalignment is possible. Both the horizontal and vertical alignment procedures require the measurement of the same gap on the MotoMount drive components. A tooling fixture must be installed to align the system.

4.3.5.1 Horizontal Alignment

Check the horizontal alignment by measuring the gap (see *Fig. 4-19 "Measurement Point for Horizontal Alignment, Bottom View Vertical Alignment" on page 4-13*) between the mounting fixture and mounting block. The measurement of this gap must not change more than 1 mm after the headstock is rotated 180 degrees. To check MotoMount's horizontal alignment, proceed as follows:

1. Jog the Positioner until MotoMount is horizontal.

NOTICE

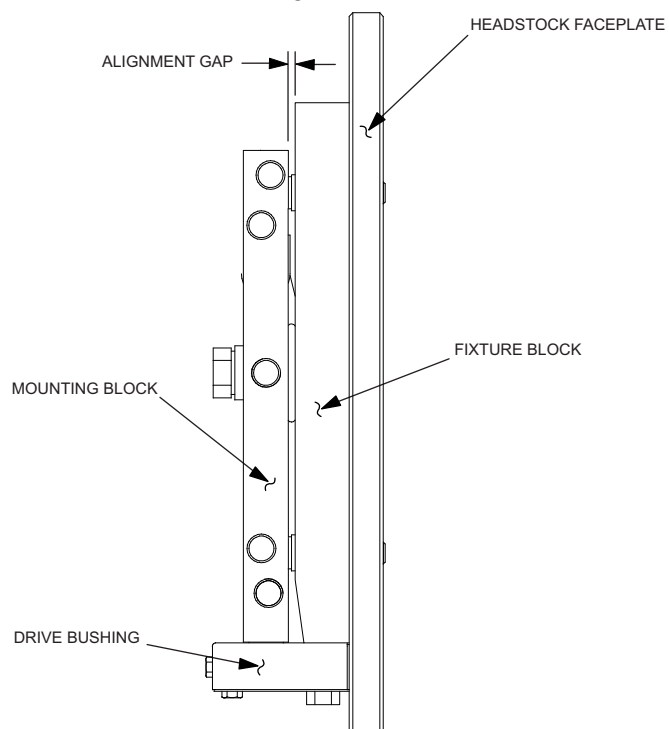
The alignment procedure may be easier if the weld ground cable is removed.

CAUTION

- Make sure the measure the alignment gap at the same location.
Not checking the alignment gap at the same location may damage to equipment.

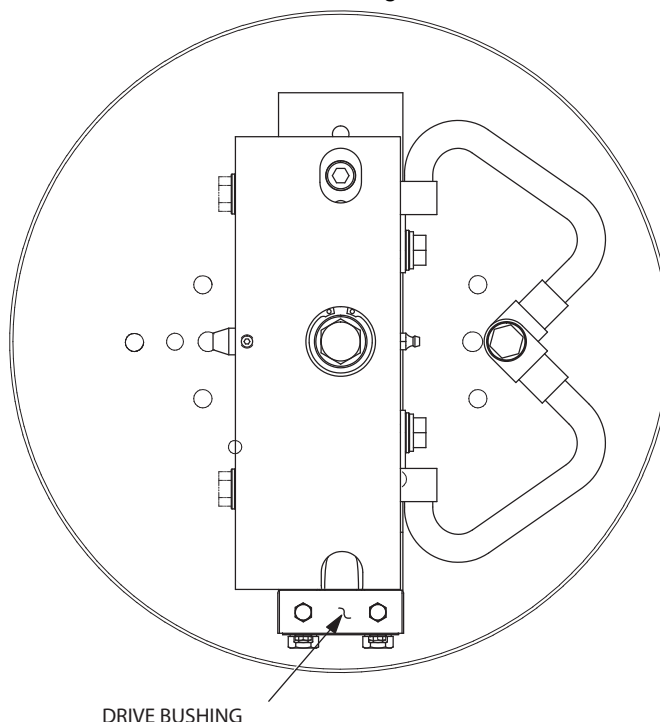
2. Using calipers, measure the alignment gap.
3. Rotate the Positioner 180 degrees.
4. Measure the alignment gap at the second position. If the gaps differ by more than 1mm, the horizontal alignment must be adjusted. Use the following procedure to adjust horizontal alignment:
 - a) Calculate the average gap between the two positions, by adding both measurements together and dividing by two.
 - b) Loosen the bearing mounting bolts and move the tailstock bearing housing towards the direction of the larger gap until the gap is at the average value.
 - c) Ensure the bearing housing is perpendicular to the tailstock adapter within 1/2 degree (a visual check with a square is acceptable).
 - d) Repeat this process until the gap at both positions is within 1mm. If moving the bearing housing cannot provide the desired results, the columns are out of basic alignment and must be repositioned.
 - e) Tighten the bearing mounting bolts to 76N•m (56lbf-ft).

*Fig. 4-19: Measurement Point for Horizontal Alignment,
Bottom View Vertical Alignment*



MotoMount must be at a vertical position to check the vertical alignment.

Fig. 4-20: Vertical Position - Drive Bushing on Bottom



The vertical alignment is checked by measuring the gap between the mounting fixture and mounting block. The measurement of this gap must not change more than 1mm after the headstock is rotated 180 degrees.

To align MotoMount vertically, proceed as follows:

1. Jog the Positioner to vertical position until the drive bushing is at the bottom.

CAUTION

- Make sure to measure the alignment gap at the same location.

Not checking the alignment gap at the same location may damage equipment.

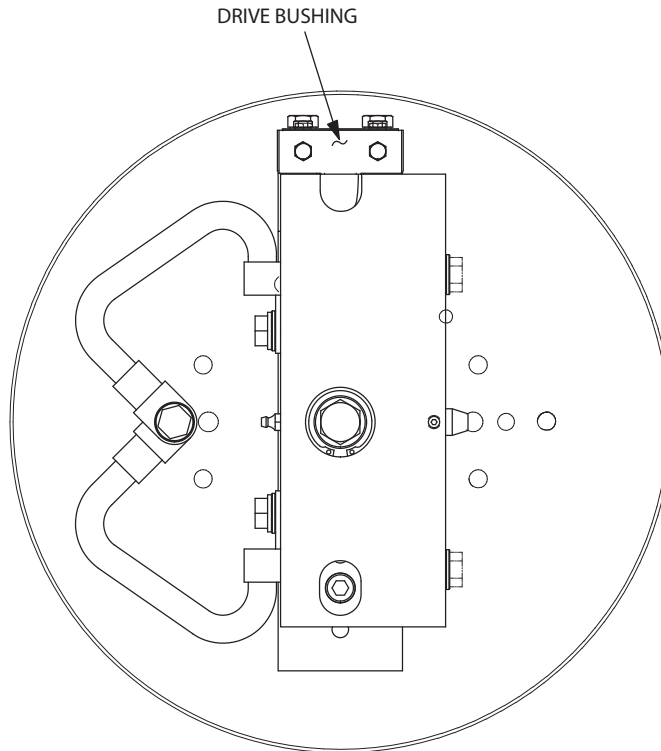
2. Using calipers, measure the alignment gap.
3. Rotate the Positioner 180 degrees until the drive bushing is at the top.
4. Measure the alignment gap at the second position. If the gaps are different by more than 1mm, the vertical alignment must be adjusted. Use the following procedure:
 - Calculate the average gap between the two positions by adding both measurements together and dividing by two.
 - If the first measurement (with drive bushing at the bottom) is **greater than** the second measurement, the **headstock must be raised** until the gap is at the average gap value. Raise the headstock by making equal clockwise turns on the headstock leveling bolts.

4 Installation

4.3 Tailstock Column Installation

- If the first measurement (with drive bushing at the bottom) is **less than** the second measurement, the **tailstock must be raised** until the gap is at the average gap value. Raise the tailstock by making equal clockwise turns on the tailstock leveling bolts.

Fig. 4-21: Vertical Position - Drive Busing on Top



- Recheck the alignment gap and verify that both gaps are within 1mm. If multiple attempts fail to reduce the gap difference below 1mm, contact Customer Support.
- Recheck the horizontal alignment.
- Insure ground cable is installed and properly secured.
- When horizontal and vertical alignment is complete, ensure all bolts are tightened to the appropriate torque, including tailstock bearing mounting bolts.

4.3.6 Tooling Fixture Removal

1. Jog the headstock until the MotoMount is horizontal, with the tool mounting bolts and locating pin pointed up.

**WARNING**

- Make sure servo power is OFF for the remainder of the removal.

If servo power is not OFF serious injury and/or equipment damage may result.

2. Position a suitable lifting device and hoisting straps above the tooling. Attach the hoisting straps to the tooling fixture.
3. Remove the tool fixture mounting bolts and tailstock bearing cap.
4. Slowly lift the tooling fixture off the headstock/tailstock assemblies.

4.4 MotoMount Installation

The MotoMount drive components are usually delivered assembled to the drive assembly (MH555 and MH1655). However, if retrofitting MotoMount on a system already installed in the plant, follow these instructions:

4.4.1 Preparation

Successful installation requires the MotoMount drive components be firmly mounted to the headstock faceplate. Before installation, ensure the faceplate is clean and is not warped or deformed.

4.4.2 Unpack and Assemble

The MotoMount system will be shipped in a box with the following components (unless it is part of a larger system):

- MotoMount drive components
- Dowel pins (2)
- Mounting hardware
- Weld ground cable

Carefully remove plastic wrapping from components and inspect them for shipping damage.

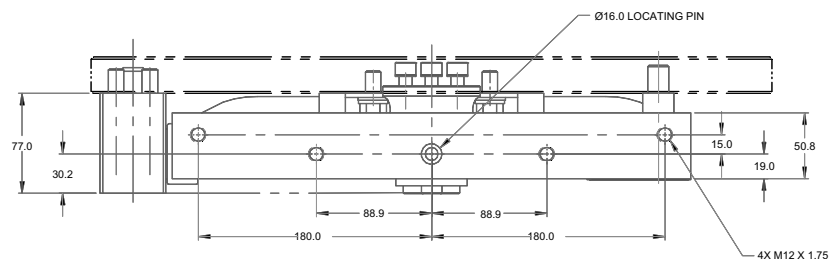
NOTICE

Notify shipping contractor if there is any shipping damage.

4.4.2.1 Installing Fixture Dowel Pins

The dowel pins must be installed into the back of the mounting block before the assembly is mounted onto the faceplate. There are four holes in the back of the mounting block. See *Fig. 4-22* to determine which holes to use for your application. If your headstock faceplate does not have the matching dowel holes, it must be modified per the following template.

Fig. 4-22: MotoMount Mounting Hole Pattern



To install the dowel pins, proceed as follows:



CAUTION

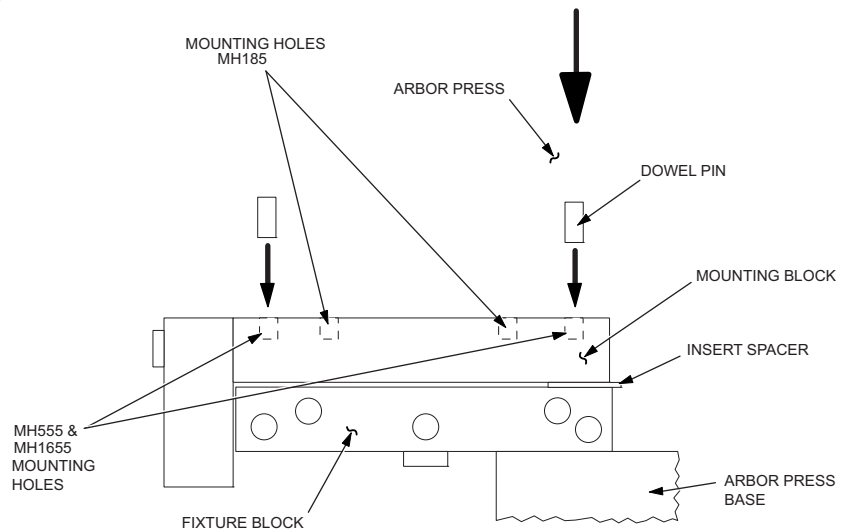
Handle MotoMount components carefully

Injury or damage to equipment can occur if the MotoMount is not handled carefully.

1. Use a small, 3-mm thick metal spacer (a 1/8-in. thick washer will work) to transfer the press force from the mounting block to the fixture block.
2. Place the spacer between the mounting block and the fixture block so that it is located behind the appropriate dowel hole.
3. Use an arbor press to force the dowel pins into the appropriate dowel pin hole in the mounting block. It is important that the dowel pin is pressed in as far as possible.
4. Relocate the spacer behind the other dowel hole and install the second dowel pin.
5. After the dowel pins are inserted properly, remove the spacer.

The MotoMount drive components are now ready to install onto the faceplate.

Fig. 4-23: Dowel Pin Installation

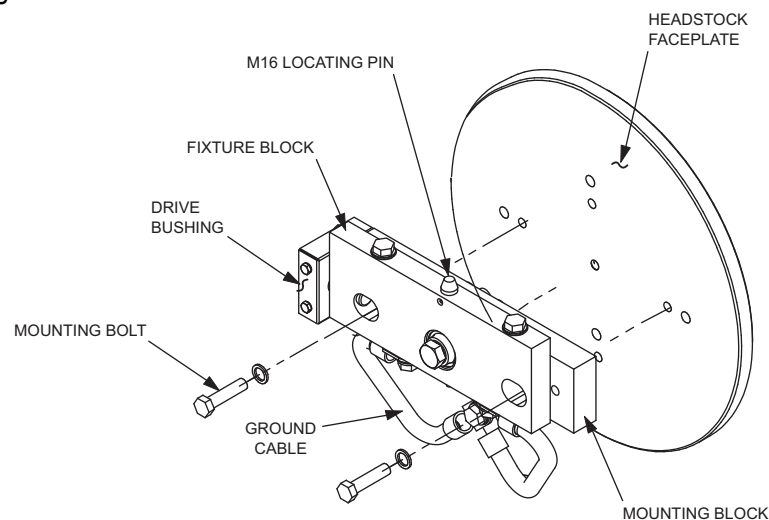


4.4.3 Securing MotoMount Drive Components onto Faceplate

Use the previously inserted dowel pins to locate the exact position for the MotoMount drive components to the faceplate. To mount the fixture block onto the faceplate, proceed as follows:

1. Jog the face plate to the Home position.
2. Align the previously installed dowel pins with the proper holes in the faceplate and push fixture block in as far as possible.
3. Insert both mounting bolts through the fixture block and tighten into the faceplate holes. Torque bolts to 76-N•m (56 lbf-ft.).
4. Install the ground cable with one lug secured to the fixture block. Use the fixture block hole nearest to the drive bushing. The other lug is secured to the appropriate hole in the headstock face plate.

Fig. 4-24: MotoMount Fixture Installation

**4.4.4 Retrofitting Tailstock Assembly**

Remove old tailstock and replace with new.

4.5 Conducting a Safety/Operation Check

Before operating either MH-Series SIGMA-5 Positioner take a few minutes to perform a safety/operation check. To perform a safety/operation check, proceed as follows:

1. Check that all cable connections are tight.
2. Verify the headstock and tailstock are level and parallel.

5 Tooling Recommendations

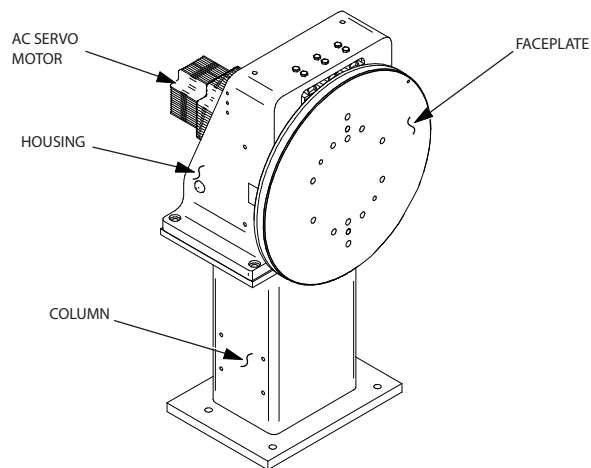
Installation of tooling and fixtures should be performed by personnel who are familiar with the operation of this system. Tooling and fixtures are supplied by the customer.

There are two system configurations possible with the MH(T)-Series Sigma-5 Positioner headstock only and headstock/tailstock with MotoMount. To ensure optimal performance from the MH(T)-Series Sigma-5 Positioner tooling system, Yaskawa makes the following recommendations for each configuration.

Headstock Only – Tooling Recommendations

The stand-alone headstock assembly provides the only support for tooling and production parts. Proper tooling design directly effects the headstock performance and longevity. All tooling practices apply to the headstock assembly whether it is accompanied by a column or not.

Fig. 5-25: Headstock Assembly



5.1 Customer-supplied Tooling Fixture

The customer-supplied tooling hangs from the faceplate as it supports production parts for welding. Customers control/change the design of tooling fixtures to match the design of the production parts.

5.1.1 Recommendations

To ensure optimum performance from the customer-supplied tooling fixture, please read the following recommendations:

- Use all bolt holes on the faceplate to mount the tooling fixture.
- Use the dowel pins.

5.1.2 Mounting Holes – Faceplate

The customer-supplied tooling must be designed to fit the MH(T)-Series Sigma-5 Positioner faceplate mounting holes. See the following figures for the faceplate mounting hole pattern;

- Fig. 5-26 for MH185 faceplate
- Fig. 5-27 for MH555 faceplate
- Fig. 5-28 for MH1655 faceplate

Fig. 5-26: Mounting Holes on Faceplate MH185

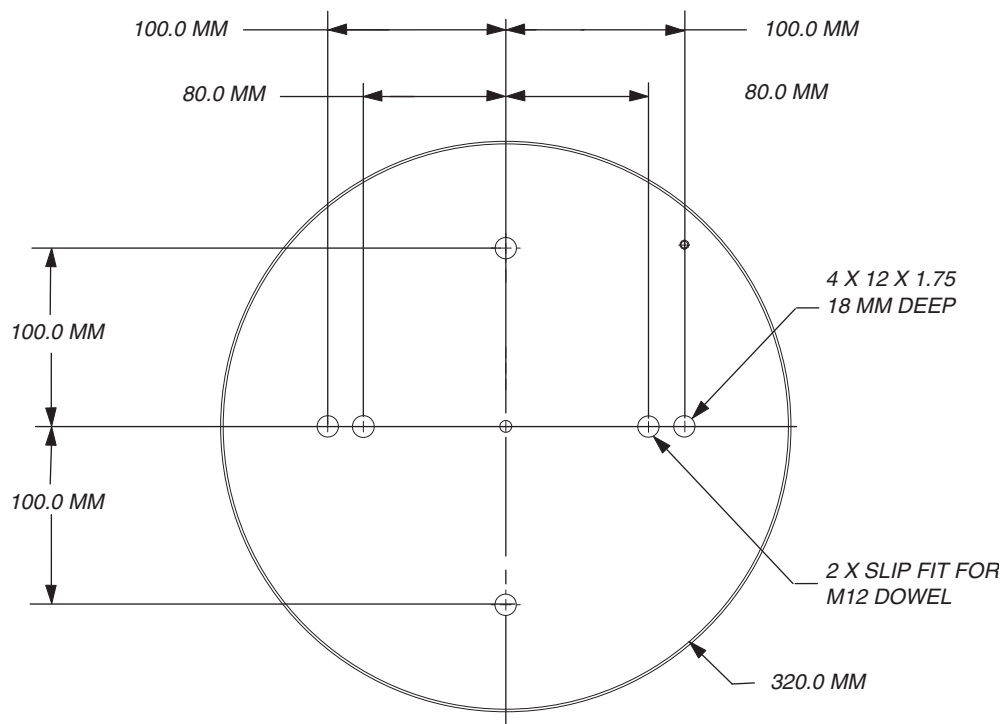


Fig. 5-27: Mounting Holes on Faceplate MH555

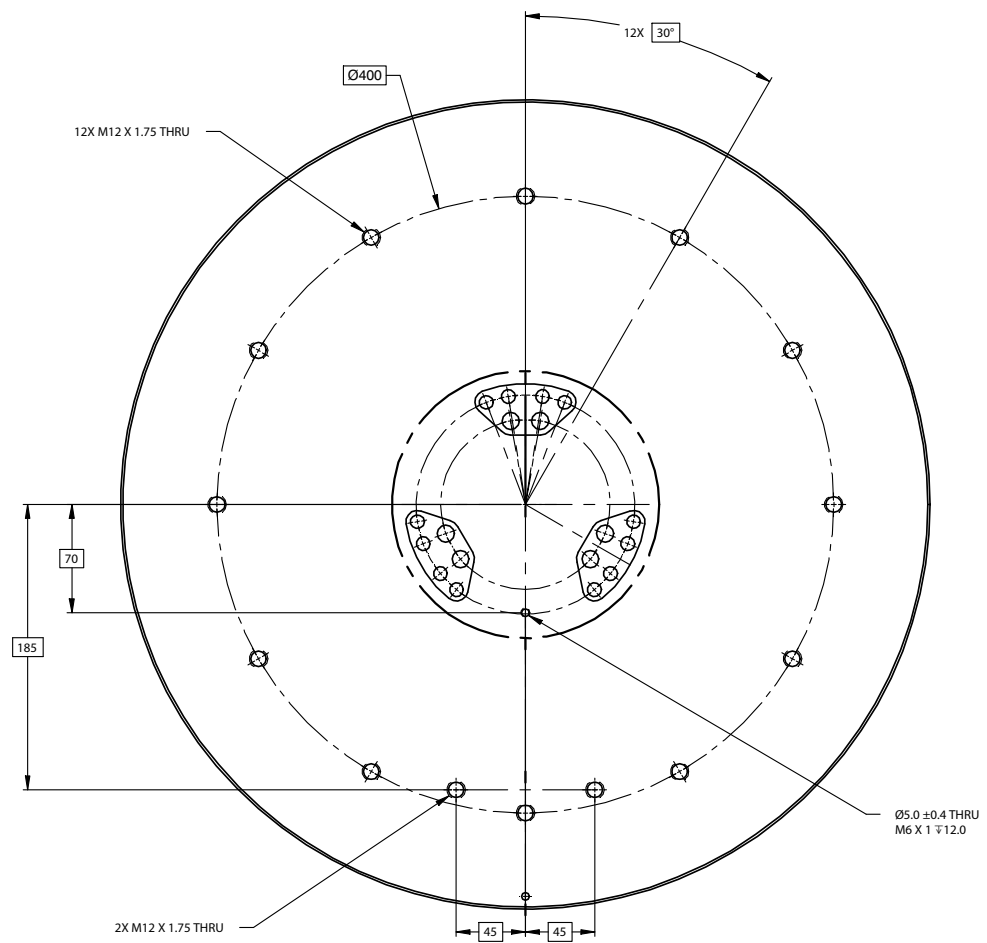
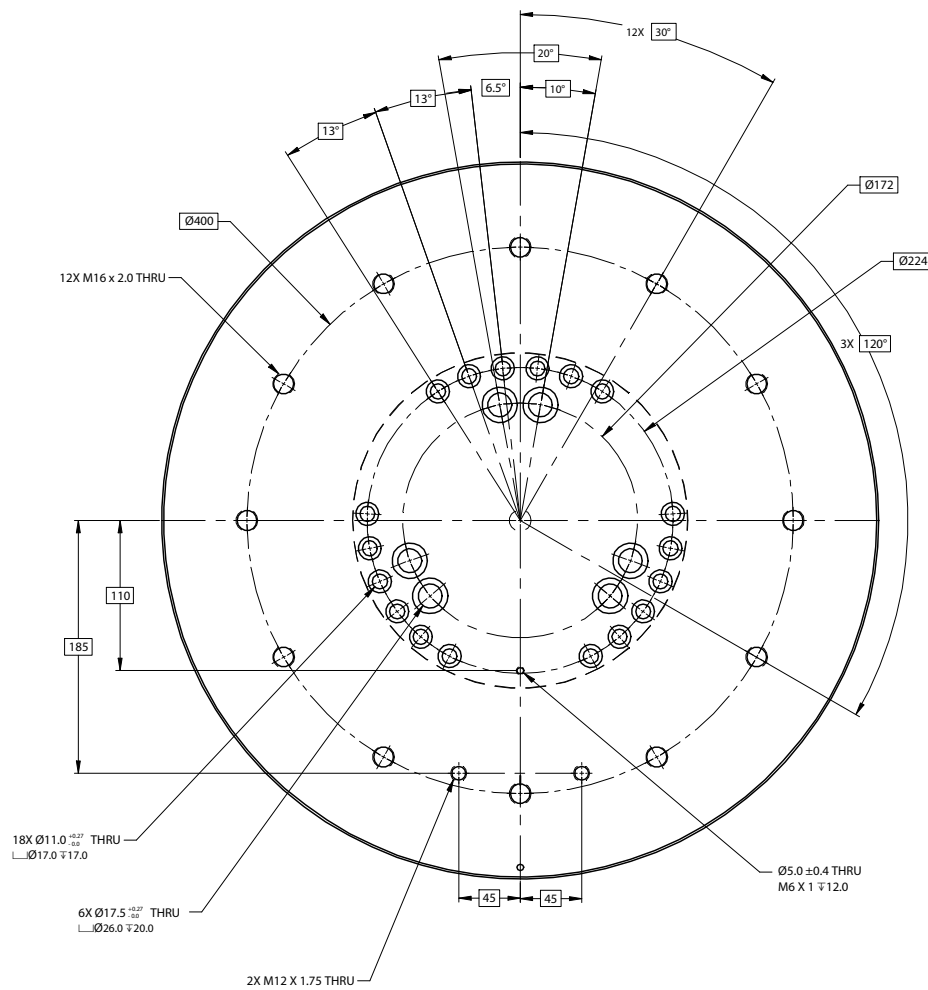


Fig. 5-28: Mounting Holes on Faceplate MH1655



5.2 Headstock/Tailstock with MotoMount

5.2.1 Customer-supplied Tooling Fixtures

With MotoMount, the customer-supplied tooling fixture bridges the headstock and tailstock together as it supports production parts for welding. Customer designs their tooling fixtures to fit their specific needs. Modifications to existing tooling fixtures will be minimal as long it fits the current headstock/tailstock configuration (retrofit application)

5.2.2 Multiple Tooling Fixtures

Some applications require multiple tooling fixtures that are switched in and out of the Positioner as production needs change. To prepare these extra fixtures to work with MotoMount, the following spare parts are needed:

- Bearing adapter
- Bearing

Contact Customer Support at (937) 847-3200, to purchase these parts.

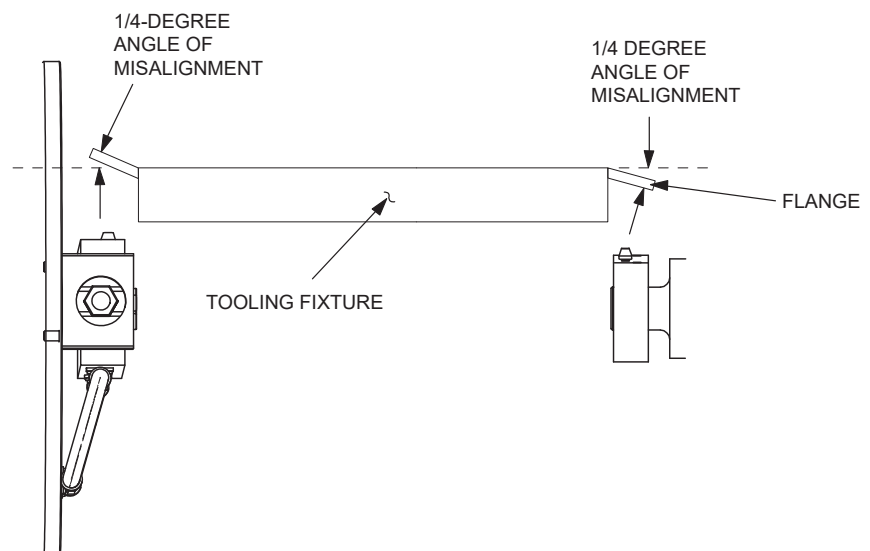
5.2.3 Specifications

To ensure that the customer-supplied tooling fixture fits properly to MotoMount, the following specifications must be met.

5.2.3.1 Parallelism

Inspect both mounting flanges for parallelism to one another. The combined angle of misalignment for both flanges should not exceed a 1/2 degree (see *Fig. 5-29*).

Fig. 5-29: Parallelism of Mounting Flanges



5.2.3.2 Hole Pattern on MotoMount

The tooling fixture flange that attaches to MotoMount must have the following hole pattern (*Fig. 5-30* and *Fig. 5-31*).

Fig. 5-30: Tooling Template - MH185 MotoMount

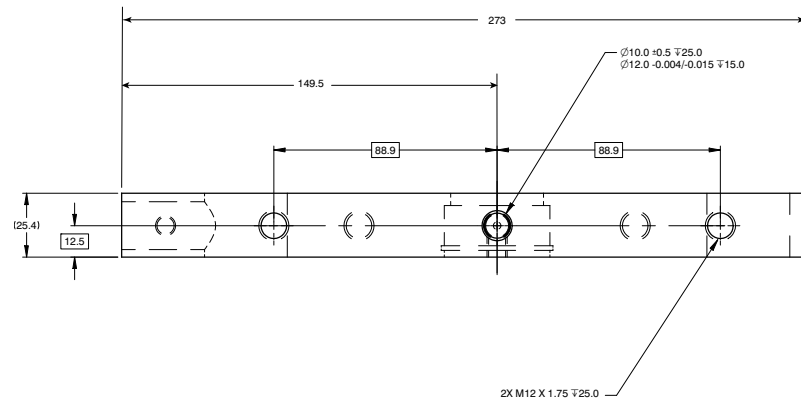
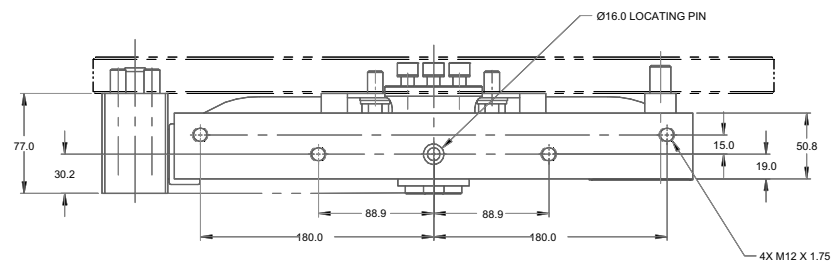


Fig. 5-31: Tooling Template - MH555 and MH1655 MotoMount



5.2.3.3 Headstock Flange Specifications

The tooling fixture flange specifications that secure to the MotoMount is shown in *Fig. 5-32* for MH185 and *Fig. 5-33* for MH555 and 1655. *Fig. 5-33 "555 and 1655 Drive Component Clearance" on page 5-7* shows the specifications for the tooling fixture flange that is secured to MotoMount.

Fig. 5-32: MH185 Drive Component Clearance

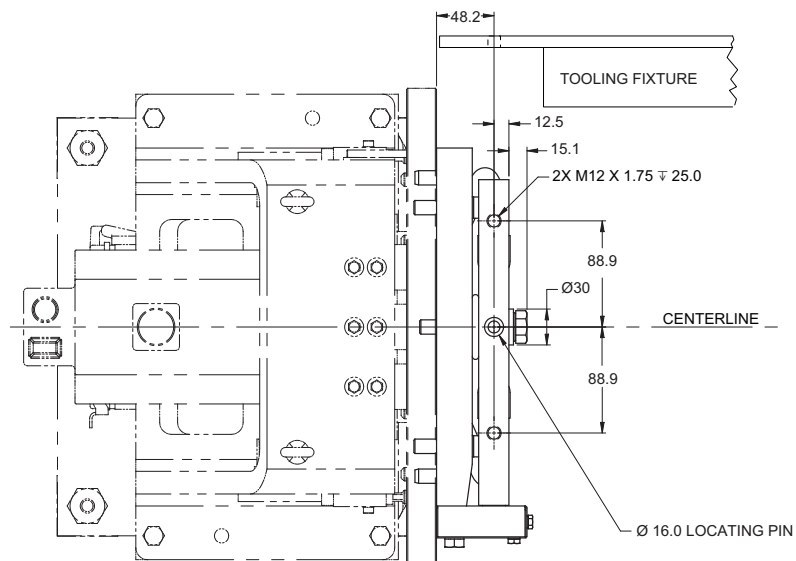
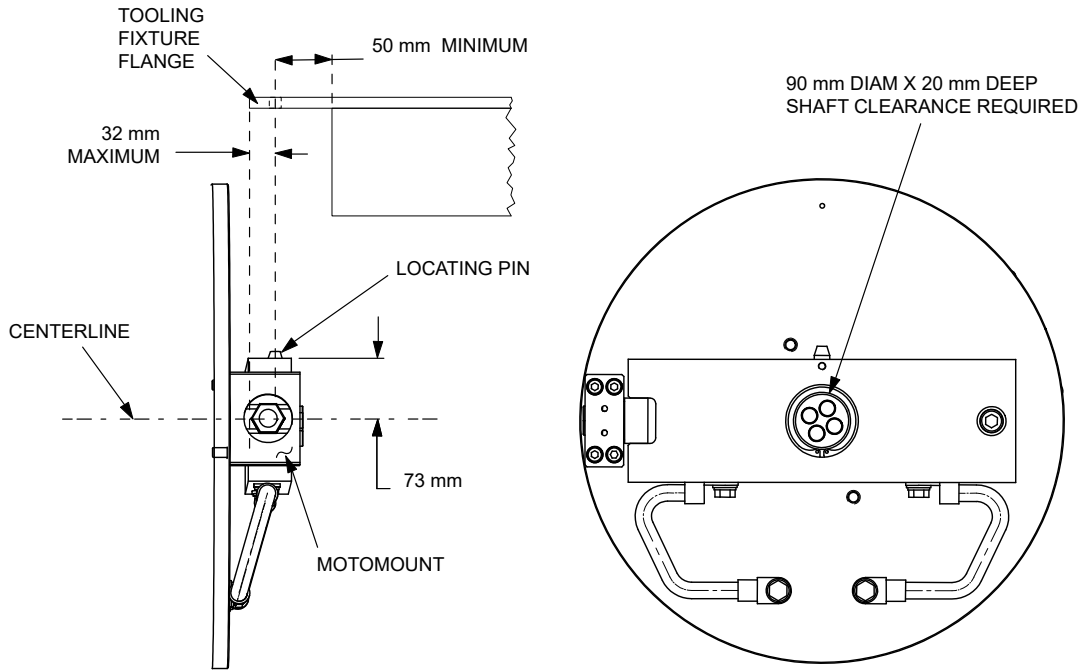


Fig. 5-33: 555 and 1655 Drive Component Clearance



5.2.4 Tailstock Flange Specifications

Fig. 5-34: Tailstock Adapter

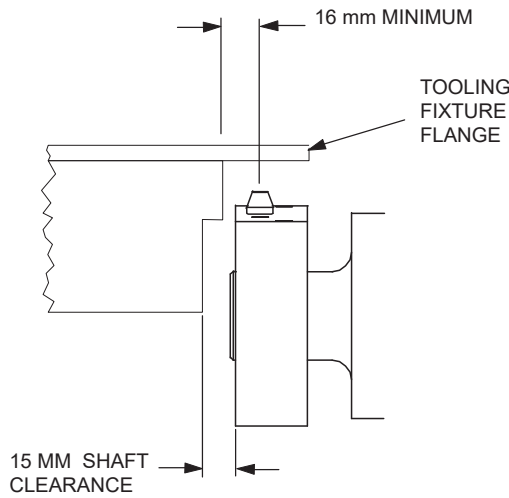
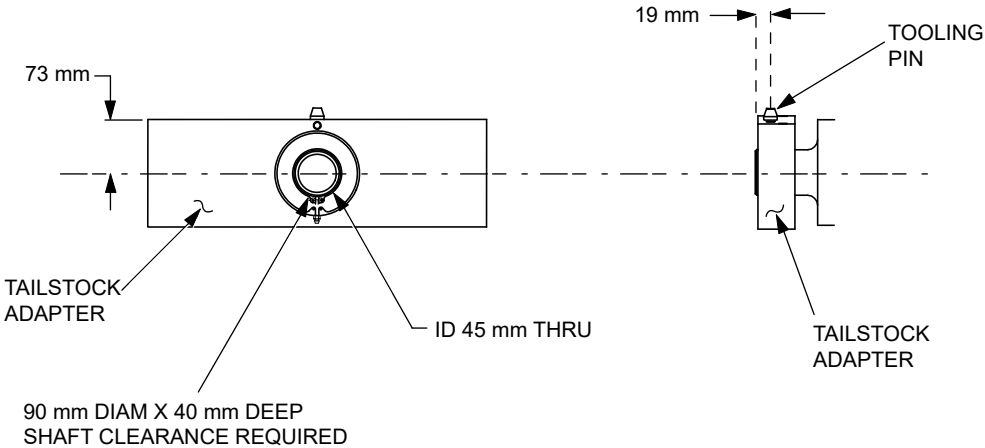


Fig. 5-35: Tailstock Component Clearance



6 Maintenance



WARNING

- Turn OFF the main power supply and put up warning signs before performing maintenance or inspections.

Failure to observe this warning may result in electrical shock or injury.



CAUTION

- Maintenance and inspections must be performed by specified personnel.

Failure to observe this Caution may result in electrical shock or injury.

- Contact a Customer Support for disassembly or repair.

Failure to observe this Caution may cause injury or equipment damage.

- Do not remove the motor or release the brake.

Failure to observe this caution may result in injury from unexpected turning of the table.

Maintenance of the MH(T)-Series Sigma-5 Positioner components should be performed only by authorized personnel who are familiar with the design and construction of this Positioner. The following procedures should be performed only as needed. Read through the instructions completely before performing any maintenance procedure. Be sure to understand the procedure, have the proper tools, and observe all applicable safety precautions.

6.1 Spare Parts

When a part malfunctions, it is helpful to have replacement parts in stock for quick replacement. *Table 6-1* lists the recommended spare parts with Yaskawa part numbers. Yaskawa recommends keeping the following parts on hand:

Table 6-1: Recommended Spare Parts

Component	MH185/555/1655	Recommended Quantity
Terminal, Quick Disc. Weld Ground Lug	144370-1	1
Brush Holder, 1"X1.5"X2", Weld Grounding	144372-1	1
Brush, Ground, Metal, Graphite	144371-1	1
Grease	Moly white RE00 132412-1	1

NOTICE

Yaskawa does not recommend the motor and reducer for field service. Return the unit to Yaskawa for repairs of these components.

6.2 Servomotor

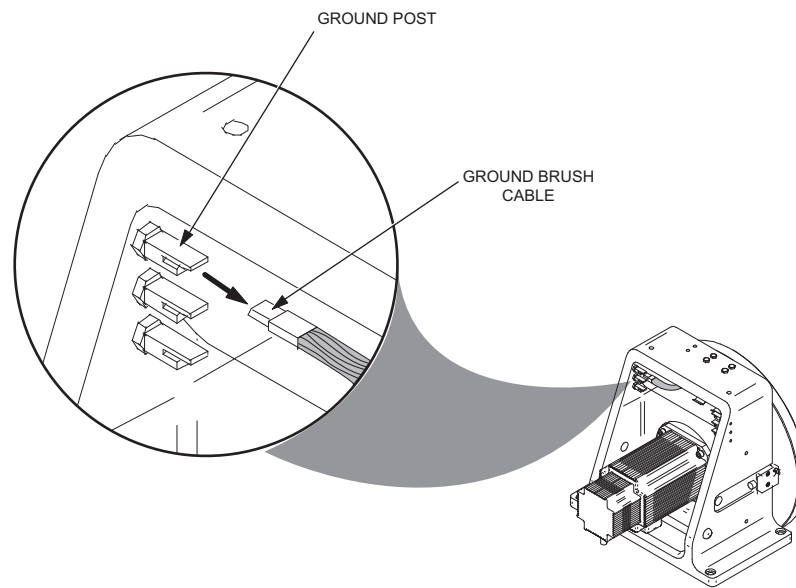
The AC servomotor has no wear parts (i.e. brushes), so a simple daily inspection is sufficient. *Do not disassemble the motor.* Contact Customer Support at (937) 847-3200 when an overhaul becomes necessary.

6.3 Weld Ground Brush Replacement

6.3.1 MH185

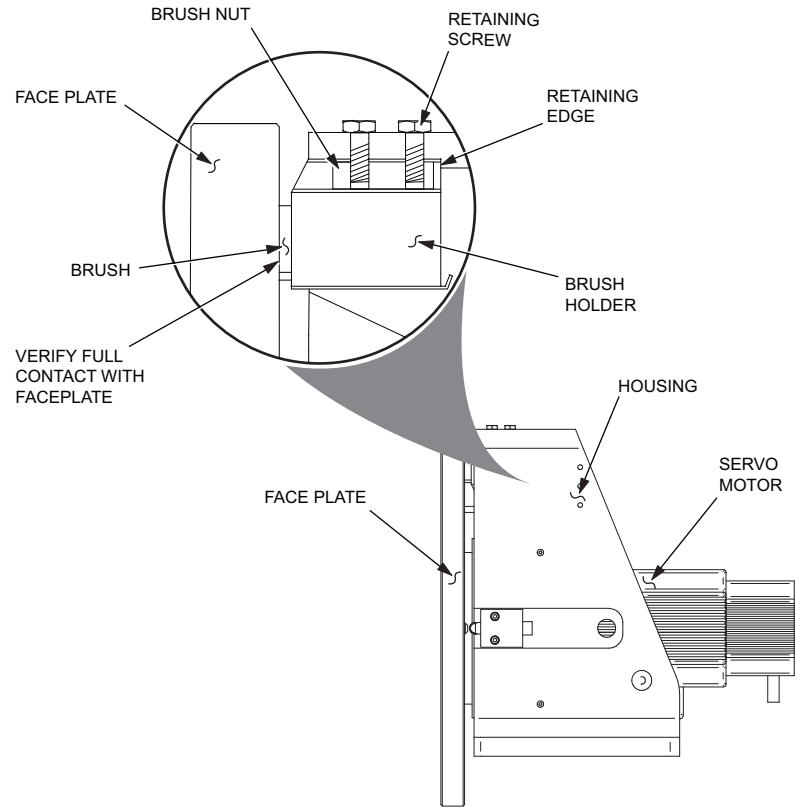
To replace the grounding brush(s) proceed as follows:

1. Shut down cell using main disconnect.
2. Use a flathead screwdriver to disconnect the brush cable(s) from the ground post (*Fig. 6-1*).

Fig. 6-1: Brush Cable Removal

3. Release the spring tensioner on the back of the brush by squeezing both black spring levers and pulling away from the faceplate.
4. Reach in and steady the brush case with one hand.
5. Use a 7/16-in. wrench to loosen and remove the two screws on top of the housing (*Fig. 6-2*) that retains the case.

Fig. 6-2: Brush Assembly

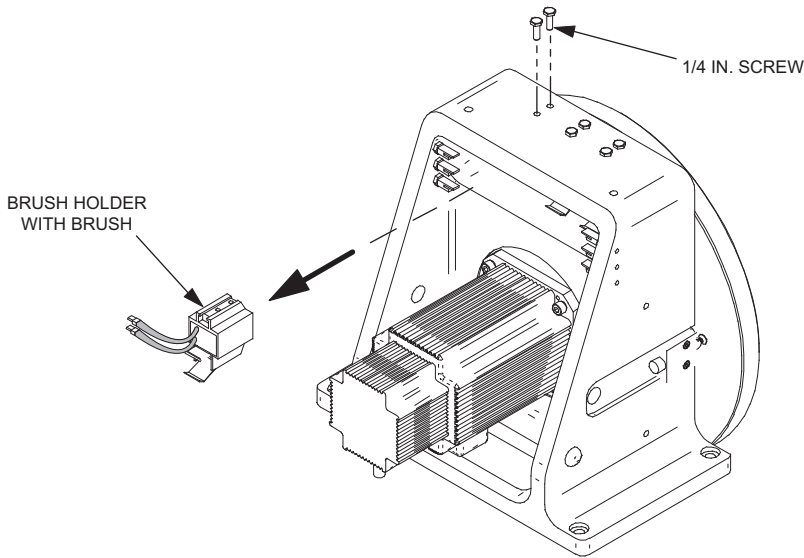


NOTICE

When pulling the brush holder out, identify and secure the nut plate that slides in the top side of the case.

6. Lower the case below the retaining edge, and slowly pull the brush holder out of the housing (Fig. 6-3).

Fig. 6-3: Brush removal MH185



6 Maintenance

6.3 Weld Ground Brush Replacement

7. Slide the old brush out of the housing and replace it with the new one.
8. Put the brush holder back into housing compartment until the both holes on the nut plate are aligned with holes in the housing.
9. Insert both screws through housing and into nut plate. Thread the screws into nut plate loosely.
10. Push the brush holder up in front of the retaining edge and hold steady.

CAUTION

- Attach the weld ground brush evenly against the faceplate. Uneven contact can subject the gear reducer bearing to weld current.

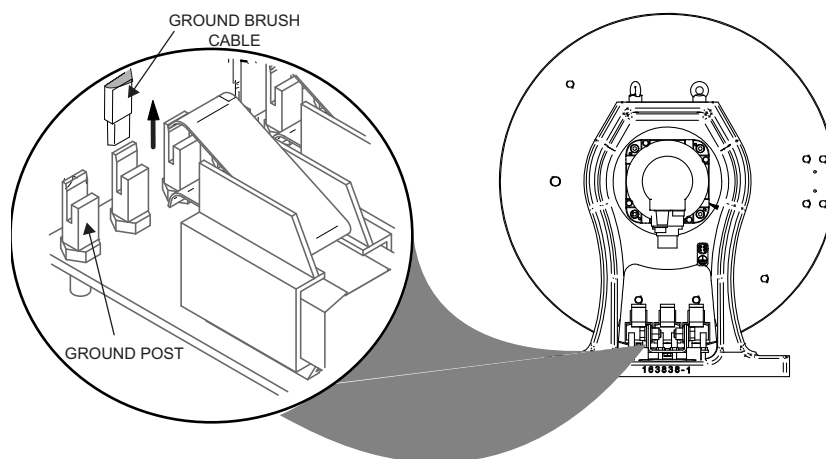
11. Squeeze the brush retaining spring and push the brush against the faceplate then release. The spring must hold the brush firmly against the face plate (*Fig. 6-2*).
12. Tighten the screws to 6.0 N•m (4.4 lbf-ft.).
13. Insert the ground cables onto the ground posts.

6.3.2 MH555 and MH1655

To replace the grounding brush(s) proceed as follows:

1. Shut down cell using main disconnect.
2. Remove the back panel of the drive assembly.
3. Use a flathead screwdriver to disconnect the brush cable(s) from the ground post (*Fig. 6-4*).

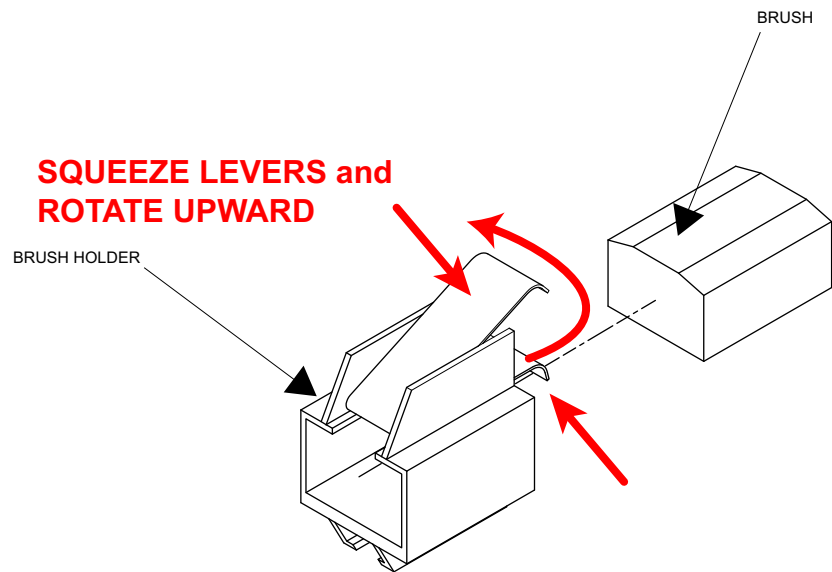
Fig. 6-4: Brush Cable Post



4. Release the spring tensioner on the brush by squeezing both spring levers and pulling away from the faceplate.

5. Slide the old brush out of the housing and replace it with the new one.

Fig. 6-5: Brush Assembly



CAUTION

- Attach the weld ground brush evenly against the faceplate. Uneven contact can subject the gear reducer bearing to weld current.

6. Squeeze the brush retaining spring and push the brush against the faceplate then release. The spring must hold the brush firmly against the face plate (*Fig. 6-5*).
7. Insert the ground cables onto the ground posts.

6.4 Reset Headstock To Home Position

The home position on the drive assembly is set in the Controller by the operator. Any position of the headstock can be programmed as home. The factory setting of home position is found using the alignment tool, an alignment tool, and the Programming Pendant.

Resetting of the home position is typically done before installing new tooling and fixturing, or when servicing the motor.

6.4.1 Homing

The factory home position for Positioners is located by aligning the homing pin against the housing, after installing the pin in the faceplate hole. Once Home position is found, some minor programming with the Programming Pendant is required. To reset a headstock, proceed as follows:

1. Make sure Manipulator(s) is in home position.
2. Using the Programming Pendant in TEACH MODE, jog the faceplate **slowly** until the homing hole is near the home position located on the housing (MH185 Fig. 6-6)(MH555 and MH1655 Fig. 6-7).

Fig. 6-6: Home Position - MH185

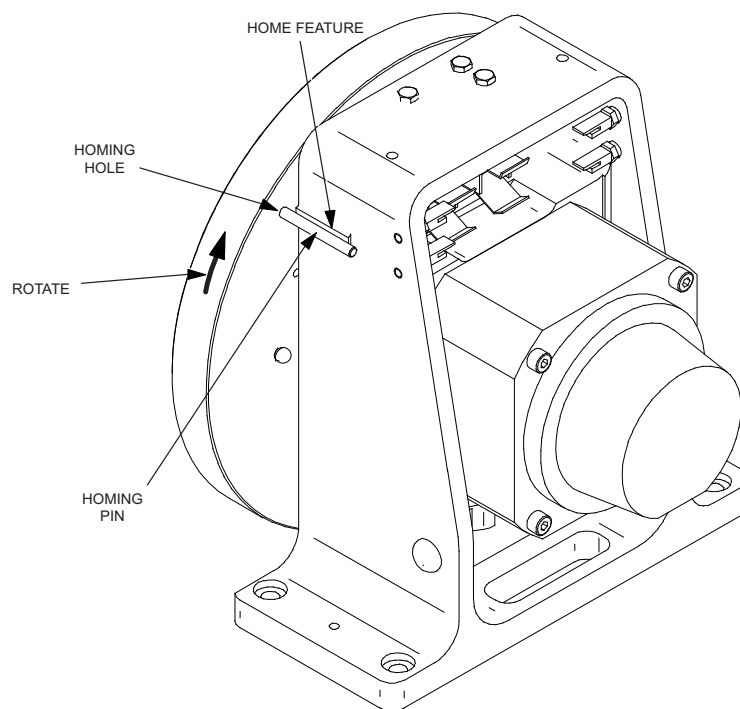
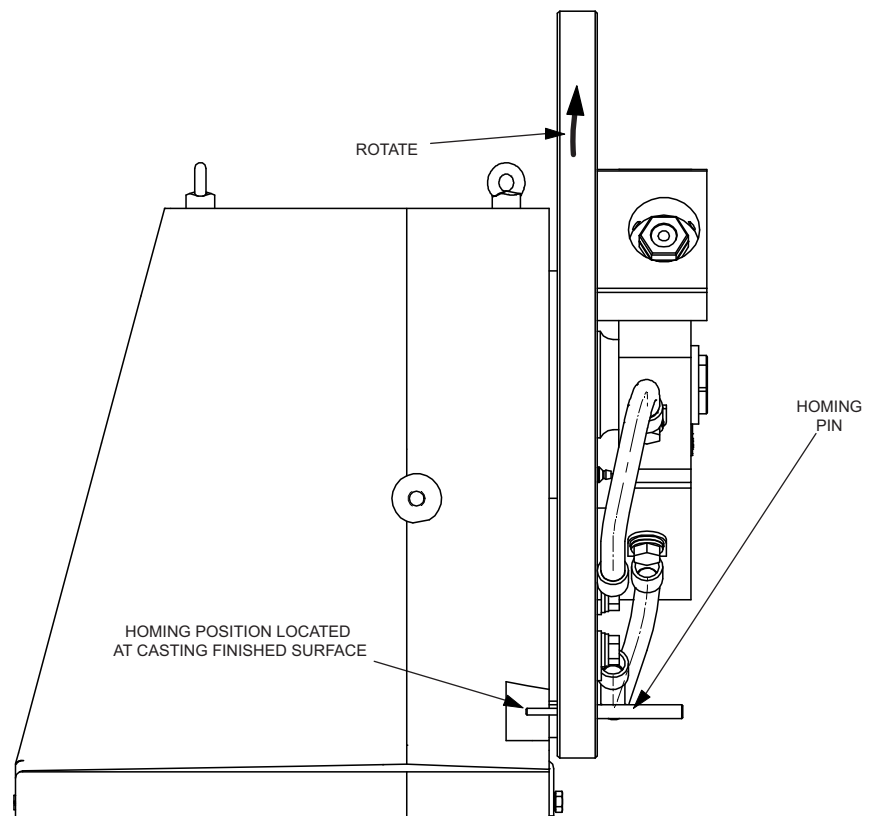


Fig. 6-7: Home Position - MH555 and MH1655

3. Once the faceplate has been jogged close to the Home position, install the homing pin through the hole in the faceplate. The pin may need to be tapped in with a hammer.
4. Slowly jog the drive assembly until the plastic pin just touches the home feature (*Fig. 6-6*) on the housing. If you go too far the pin will bend, causing a gap at the other end of the pin. Slowly jog the faceplate in reverse rotation until the gap closes.
 - Now that the faceplate has been set to home position, proceed with *Step 5* of resetting instructions:
5. Switch the Programming Pendant to MAINTENANCE MODE and proceed:
 - Press TOP MENU key on Programming Pendant.
 - Cursor to ROBOT and press SELECT.
 - Cursor to HOME POSITION and press SELECT.
 - Press the PAGE OVER key to the desired station (indicated in the top right corner).
 - Make sure the headstock is in the position that you want to teach as home and press SELECT.
 - Cursor to YES and press SELECT. The headstock is now reset to zero Maintenance Schedule.
6. Continue to:
 - **MH185** - *Step 9*.
 - **MH555 and MH1655** - *Step 7*.

7. Jog to the EX050 position variable using the [FORWARD] key. This should level the MotoMount.
8. Once at the EX050 re-home the headstock by repeating *Step 5*.
9. Reboot the Controller into “Maintenance Mode” and “Flash Reset” if FSU is applicable.

Table 6-2: Mounting Specifications for Positioners

	Angular Offset	EX50	EX51
Variable Name	N/A	Homing Pin to “Level Home”	“Level Home” to Homing Pin
Variable Function	Some Positioners come from sub-assembly with home not level. This is the starting position:	Pulse count to get from homing pin to “B-side at robot” (-125.043 deg.)	Pulse count to get from B-side at robot” back to homing pin (+125.043 deg.)
MH-555	25.23 degrees	43,920	-43,920
MH-1655	32.71	68,850	-68,850

6.4.2 MH-Series SIGMA-5 Positioner

See Table 6-3: for the periodic maintenance schedule.

Table 6-3: Maintenance Schedule

Inspection Item	Frequency	Inspection Operation
Physical damage	Daily	Check for physical damage; this indicates a load collision and is evidence of misuse.
Excessive or unusual noise	Daily	Listen for grinding, excessive or irregular noise. Contact Customer Support at (937) 847-3200.
Weld Brushes	First Week	Check for dirt and ensure full contact with faceplate.
	Weekly	Check for dirt and ensure full contact with faceplate.
Cleaning	As required	Clean with dry cloth or compressed air.
Lubrication	Every 20,000 hours or 5 years	Flush and relubricate using Moly white grease.

6.4.3 MotoMount

See Table 6-4: for periodic maintenance procedures.

Table 6-4: Periodic Maintenance

Frequency	Procedure
Daily	Using compressed air or a suitable brush, remove any weld spatter and dirt from the drive components with particular attention to the drive bushing area.
	Verify tooling bolts are tight.
Monthly	Provide 2-3 pumps of grease (Yaskawa, 133174-2, Kluber #039067, Lubriplate 3000, or equivalent) to the main bearing zerk fitting.
	Verify the leveling and lag bolts are tight on the headstock/ tailstock columns

6.5 Troubleshooting

6.5.1 MH-Series SIGMA-5 Positioner

Table 6-5: Troubleshooting

Symptom	Probable Cause	Corrective Action
Motor does not start	Loose connection	Check all wire connections.
	Incorrect wiring	Check that system has been wired correctly.
	Overload	Reduce load or reduce unbalanced load.
Unstable operation	Incorrect wiring	Inspect and correct wiring across motor terminals L1, L2, L3, and PE.
Motor overheats	Excessive ambient temperature	Reduce ambient temperature below 40°C (104° F). Positioner has an operating range of 0 to 45°C (32 to 113°F).
	Motor surface is dirty	Clean motor surface.
	Motor overloaded	Reduce load or unbalanced load.
Unusual noise	Motor loosely mounted	Tighten mounting bolts.
	Positioners misaligned	Realign headstock/tailstock (see <i>section 4.3.2 "Leveling the Tailstock" on page 4-10</i>)
	Noisy bearing	Check alignment, noise of bearing, lubrication. Call Customer Support.
Weld quality bad	Brushes misaligned	Remove brush(s) and reinstall them properly. Recheck as needed.

6.5.2 MotoMount

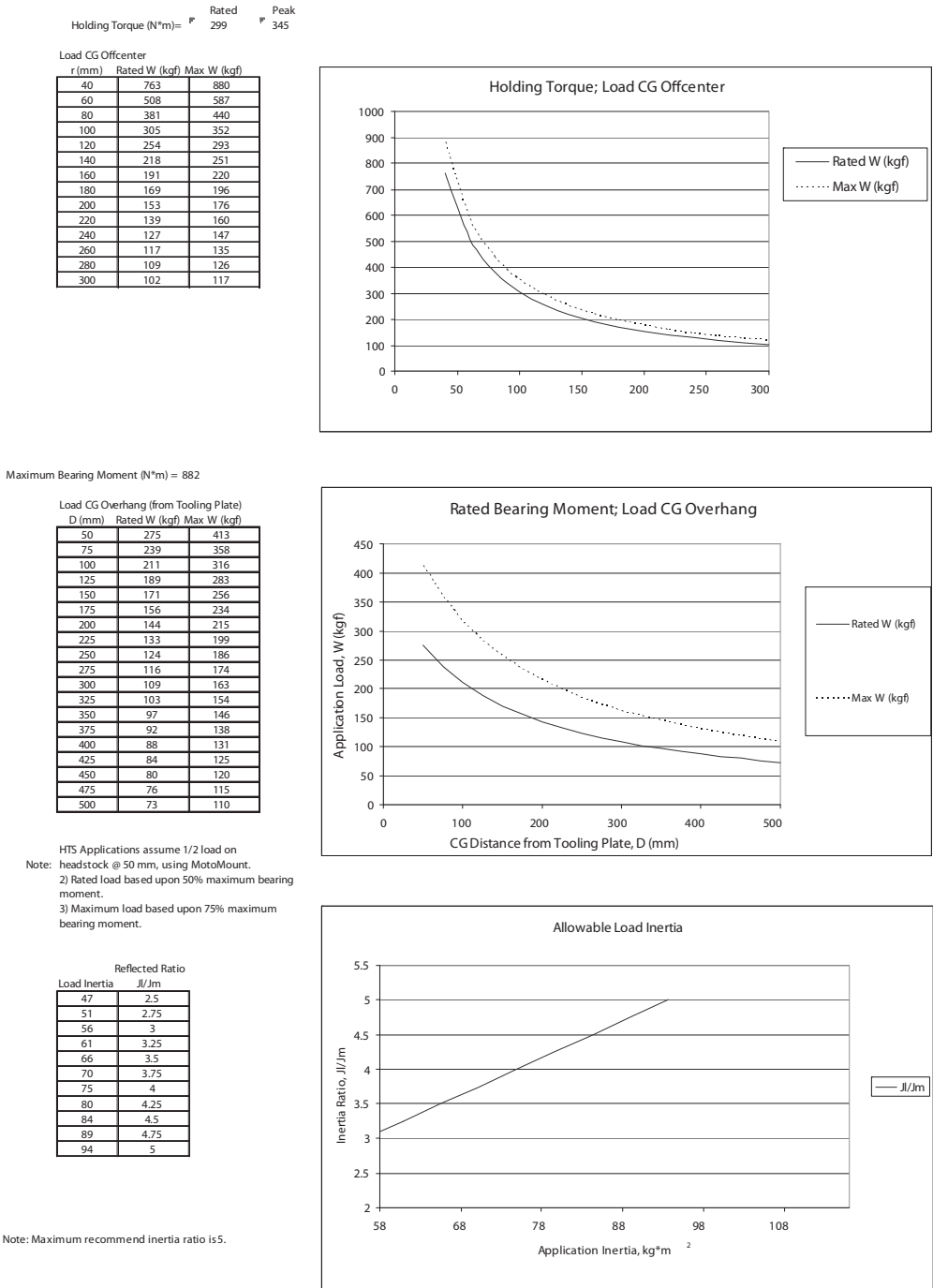
High duty cycles under heavy loads and/or dirty operating conditions may cause the drive bushing to wear. This may be indicated by a decrease in the tooling position repeatability. Call Customer Support for details.

Appendix A Performance Charts

A.1 MH-Series Positioner Assemblies

A.1.1 MH185

Fig. A-1: MH185 Performance Charts



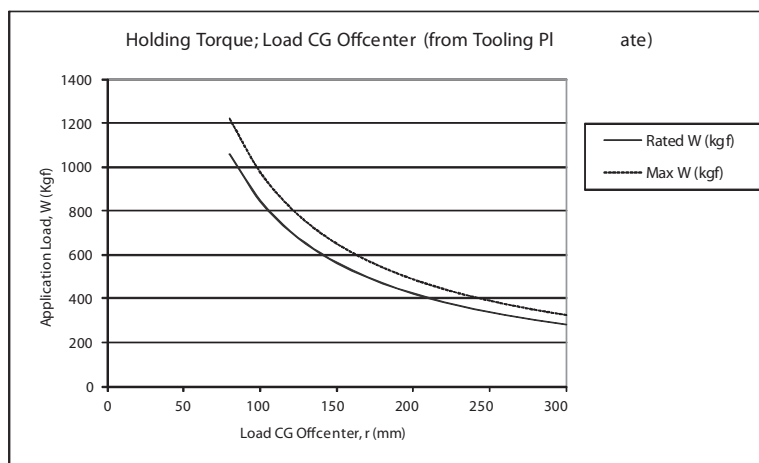
MH(T)-Series Sigma-5 Positioner

Appendix A Performance Charts A.1 MH-Series Positioner Assemblies

A.1.2 MH555

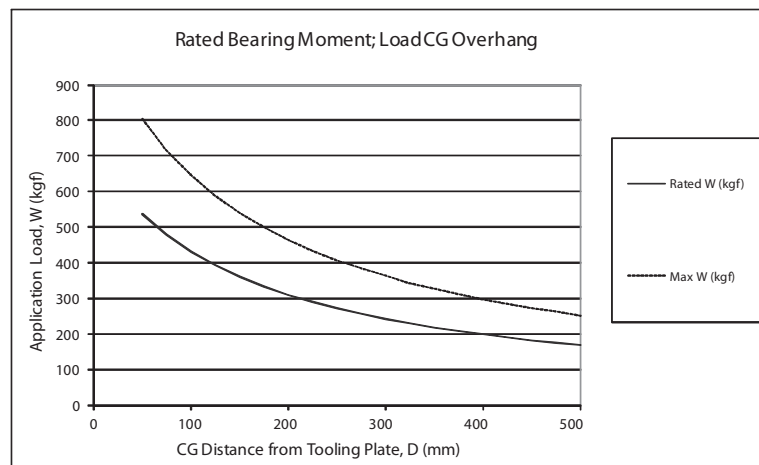
Fig. A-2: MH555 Performance Charts

Holding Torque (N*m)=		Rated 829	Peak 957
Load CG Offcenter from Tooling Plate			
r (mm)	Rated W (kgf)	Max W (kgf)	
80	1057	1219	
100	845	976	
120	705	813	
140	604	697	
160	528	610	
180	470	542	
200	423	488	
220	384	443	
240	352	406	
260	325	375	
280	302	348	
300	282	325	



Maximum Bearing Moment (N*m) = 2156

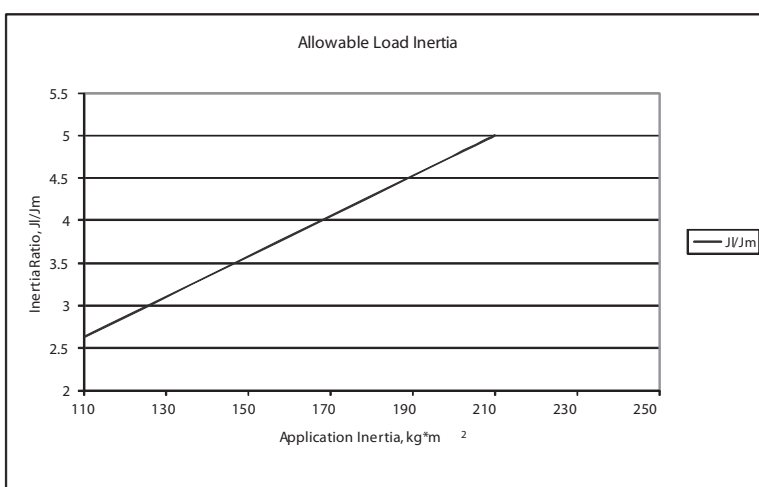
Load CG Overhang (from Tooling Plate)		
D (mm)	Rated W (kgf)	Max W (kgf)
50	537	805
75	478	717
100	431	647
125	393	589
150	361	541
175	333	500
200	310	465
225	289	434
250	271	407
275	256	384
300	242	362
325	229	344
350	218	327
375	207	311
400	198	297
425	190	284
450	182	273
475	174	262
500	168	252



Note: HTS Applications assume 1/2 load on headstock @ 50 mm, using MotoMount.
2) Rated load based upon 50% maximum bearing moment.
3) Maximum load based upon 75% maximum bearing moment.

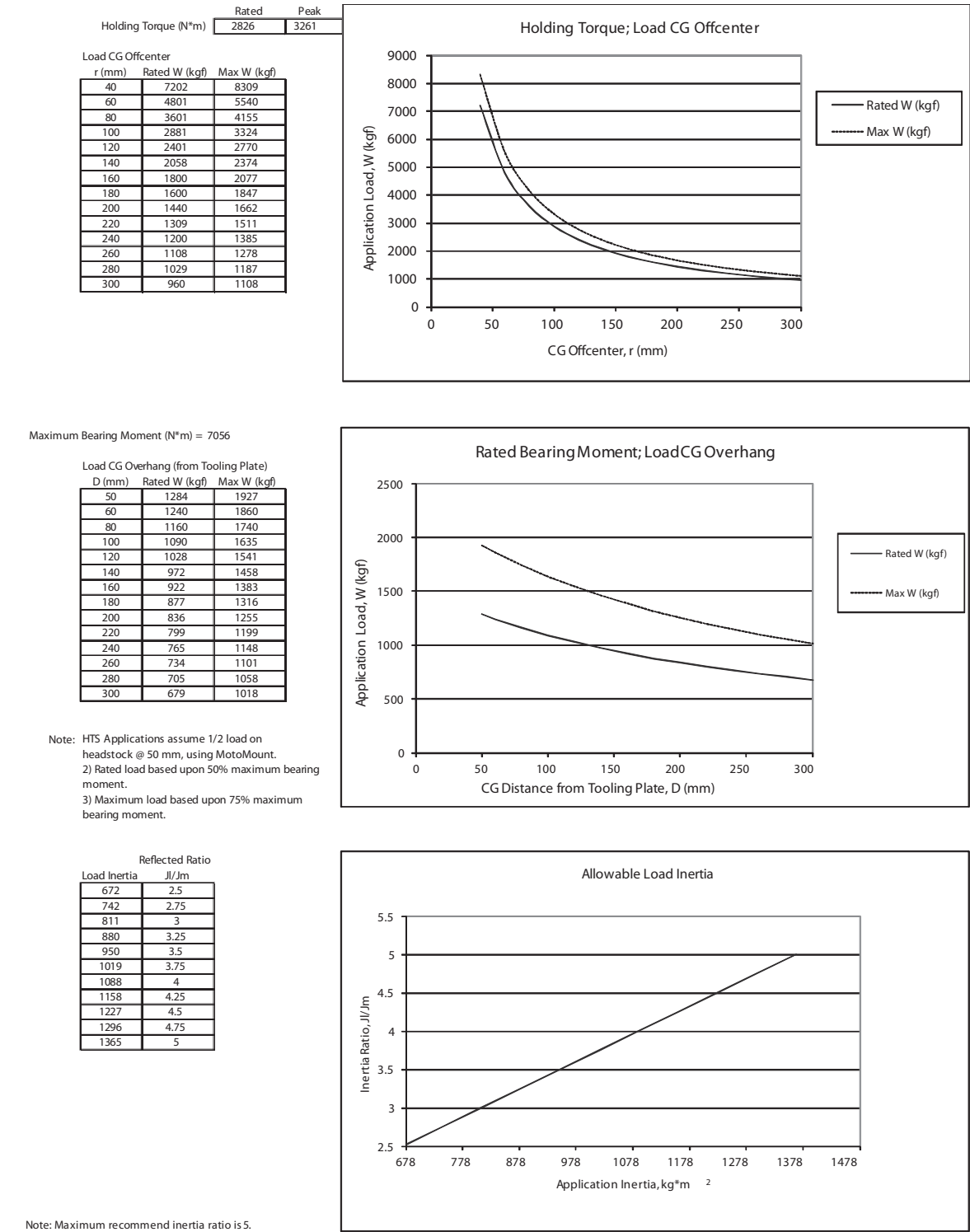
Reflected Ratio	
Load Inertia	Jl/Jm
105	2.5
115	2.75
126	3
136	3.25
147	3.5
157	3.75
168	4
178	4.25
189	4.5
200	4.75
210	5

Note: Maximum recommend inertia ratio is 5.



A.1.3 MH1655

Fig. A-3: MH1655 Performance Charts



Note: Maximum recommend inertia ratio is 5.

Appendix B Illustrated Parts List

B.1 Introduction

This Illustrated Parts List identifies, describes, and illustrates detail parts of the main assemblies for the MH(T)-Series Sigma-5 Positioner manufactured by Yaskawa.

This list provides parts identification and descriptive information for use in provisioning, requesting, purchasing, storing, and issuing spare parts.

B.1.1 Areas of the Illustrated Parts List

■ Contents

The parts list contains a breakdown of the equipment into detail parts. All parts of the equipment are listed except the following:

1. Standard hardware items (attaching parts) such as nuts, screws, washers, etc., which are available commercially.
2. Bulk items such as wire, cable, sleeving, tubing, etc., which are also commercially available.
3. Permanently attached parts which lose their identity by being welded, soldered, riveted, etc., to other parts, or assemblies.

■ Parts List

This form is divided into four columns as follows:

- “Figure - Item Number” Column
 - This column lists the figure number of the illustration applicable to a particular parts list and also identifies each part in the list by an item number. These item numbers also appear on the illustration. Each item number on the illustration is connected to the part to which it pertains by a leader line and arrow. Thus, the figure and item numbering system ties the parts list to the illustrations and vice versa
- “Yaskawa Part Number” Column
 - All part numbers appearing in this column are Yaskawa part numbers.
- “Description” Column
 - The item nomenclature appears in this column.
- “QTY” Column
 - This column indicates the quantity of parts required for an assembly or subassembly in which the part appears. This column does not necessarily reflect the total used in the complete end item.

■ Symbols and Abbreviations

The following is a list of symbols and abbreviations used in the parts list or drawings.

- amp – ampere
- AC – alternating current
- cyl – cylinder
- DC – direct current
- fig – figure
- hex – hexagon
- ID – inside diameter
- in – inch
- m – meter
- mm – millimeter
- Nm - Newton meters
- No– number
- psi – pounds per square inch
- v – voltage

B.2 Illustrated Part List

Fig. B-1: MH185 Head Stock

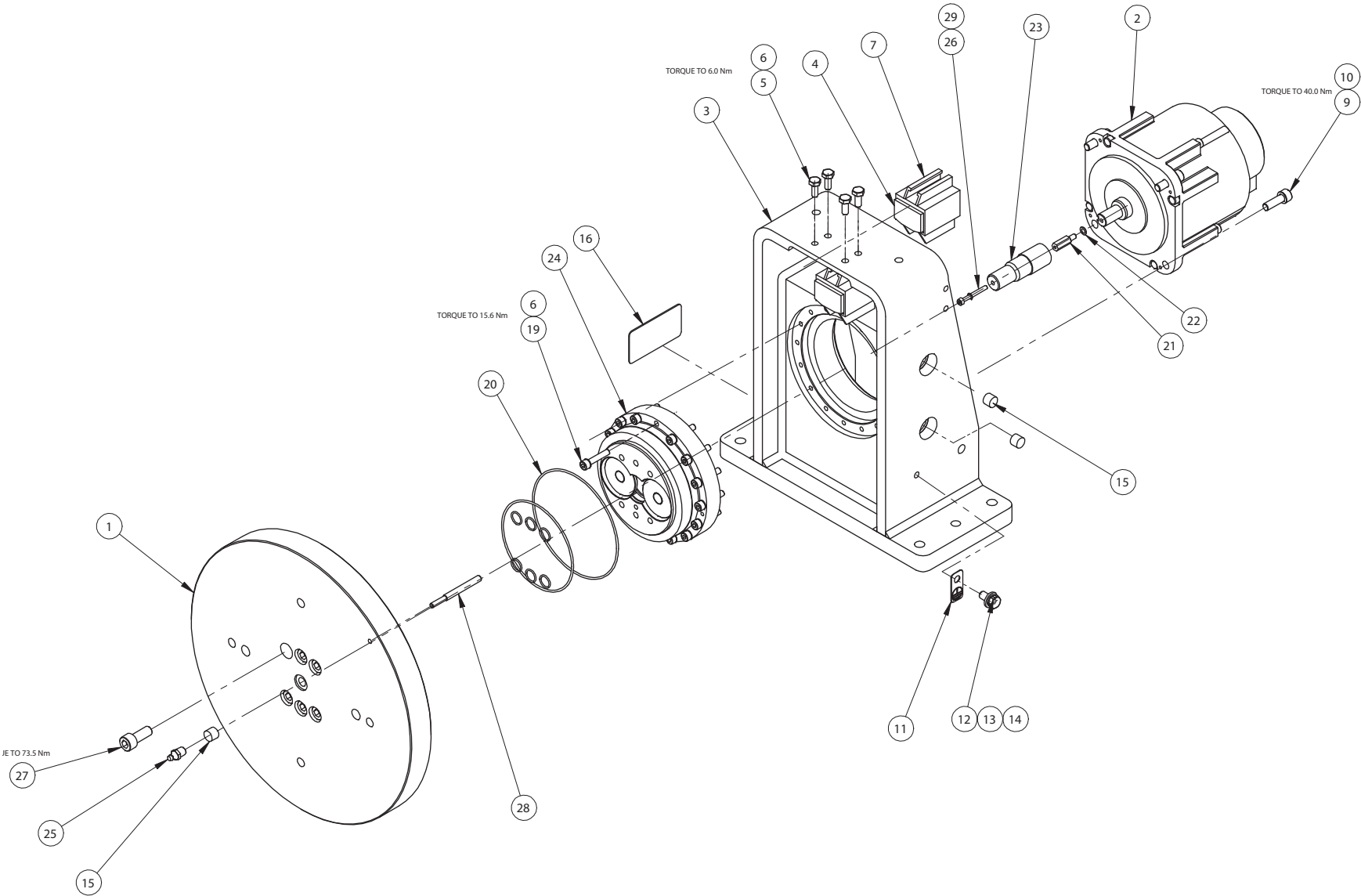
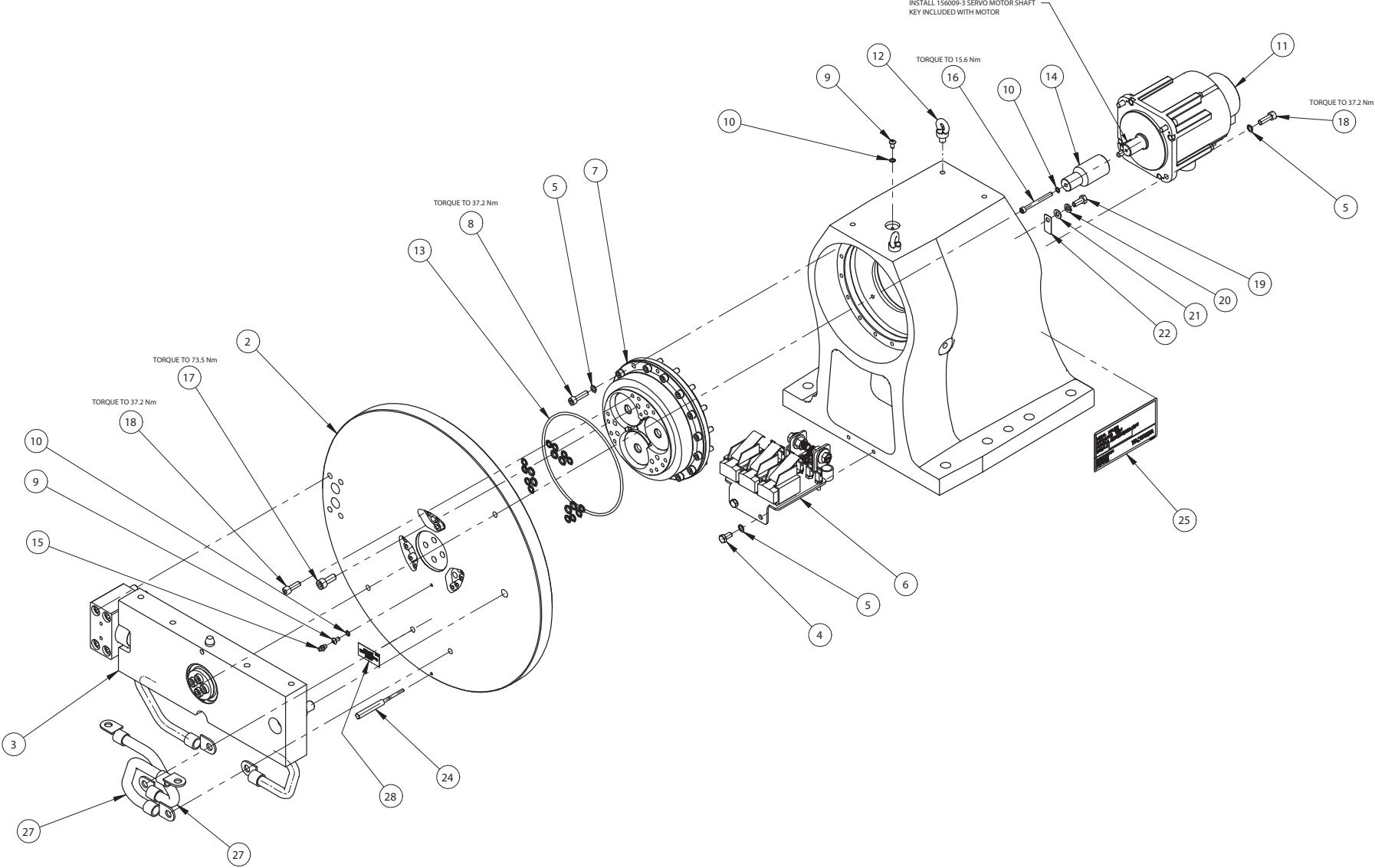


Table B-1: MH185 Head Stock Parts List

Item	P/N	Title	Qty
B-1	168938-1	DRIVE ASSY, MH185 HEADSTOCK,W/O SWITCHES	REF
1	168941-1	PLATE,FACE,TOOLING DRIVE,W MOTOMOUNT	1
2	156009-1	MOTOR, AC SERVO, 450W, SIGMA V	1
3	168940-1	HOUSING, MH185 HEADSTOCK DRIVE ASSY	1
4	144371-1	BRUSH, GROUND, METAL, GRAPHITE	1
5	130235-3	SCREW,HHC,1/4-20X5/8,ZP,GR5	4
6	470602-1	WASHER, CONICAL, SPRING, M6	20
7	144372-1	BRUSH HOLDER, 1" X 1.5" X 2"	1
8	144370-1	TERMINAL, QUICK DISC, WELD GROUND LUG	2
9	407248-6	SCREW,SHC,M6x12	4
10	470617-1	WASHER, CONICAL, SPRING, M8	4
11	133984-1	NAMEPLATE, GROUND	1
12	132616-3	SCREW,HHC,M8 X 16	1
13	479148-5	WASHER_LOCK_M8	1
14	479147-5	WASHER_FLAT_M8	1
15	479281-105	FITTING, PLUG, 1/8BSPT, BLACK	3
16	158941-10	LABEL, PRODUCT ID	1
18	133963-3	BOLT,EYE,M10,DIN 580	1
19	407249-7	SCREW,SHC,M6X30,CLASS 12.9	2
20	146122-1	SEAL KIT,RV-20E,O-RING,S120,S100 &S12.5	16
21	158858-1	ADAPTER,PINION TO MOTOR	1
22	471009-1	WASHER, CONICAL, SPRING, M5	1
23	158686-2	GEAR, PINION, INPUT, RV REDUCER, 161:1	1
24	145913-2	REDUCER,RV,RV-20E-161	1
25	133937-1	FITTING,ZERK	1
26	479295-10	SCREW,SHC M4 X 35	1
27	479297-4	SCREW, SHC,M10X1.5X25, CLASS12.9	6
28	145896-1	PIN, HOMING	1
29	470606-1	WASHER, CONICAL, SPRING, M4	1

Fig. B-2: MH555 Head Stock



B-5

168961-1CD

Table B-2: MH555 Head Stock Parts List

Item	P/N	Title	Qty
B-2	163892-1	DRIVE ASSY,MH555 HEADSTOCK,W/ MOTOMOUNT	Ref
1	163838-1	HOUSING, HEADSTOCK, TOOL DRIVE'	1
2	163879-1	PLATE,FACE,TOOLING DRIVE W/ MOTOMOUNT	1
3	164116-1	BLOCK ASSY, HEADSTOCK MOTOMOUNT	1
4	132616-3	SCREW,HHC,M8X16	2
5	470617-1	WASHER,CONICAL,SPRING M8	22
6	164485-1	BRUSH ASSY, GROUND, MTG BRKT 3 POS	1
7	151594-5	REDUCER,RV,RV-080E	1
8	407248-7	SCREW,SHC,M8X30 CLASS12.9	16
9	130425-2	SCREW,BHSC,M6XM10	2
10	470602-1	WASHER, CONICAL SPRING M6	3
11	156009-3	MOTOR, AC SERVO, 1.3KW, SIGMA V	1
12	133963-3	BOLT,EYE,M10,DIN 580	2
13	146123-1	SEAL KIT	1
14	166944-1	GEAR INPUT,GEAR REDUCER	1
15	133937-3	FITTING,ZERK,M6X1	1
16	407249-20	SCREW,SHC,M6X65	1
17	479297-4	SCREW,SHC,M10X1.5X25 CLASS12.9	6
18	407248-6	SCREW,SHC,M8X25 CLASS12.9	16
19	132616-1	SCREW,HHC,M8X1.25X20 CLASS8.8	1
20	479148-5	WASHER,LOCK,M8	1
21	479147-5	WASHER,FLAT,M8	1
22	133984-1	NAMEPLATE GROUND	1
24	145896-6	PIN, HOMING	1
25	164530-1	LABEL, PRODUCT IDENTIFICATION, SINGLE AXIS POSITIONER	1
27	130887-11	CABLE,WELD,4/0,1FT	2
28	180544-1	LABEL,GREASE,MOLY-WHITE RE 00	1

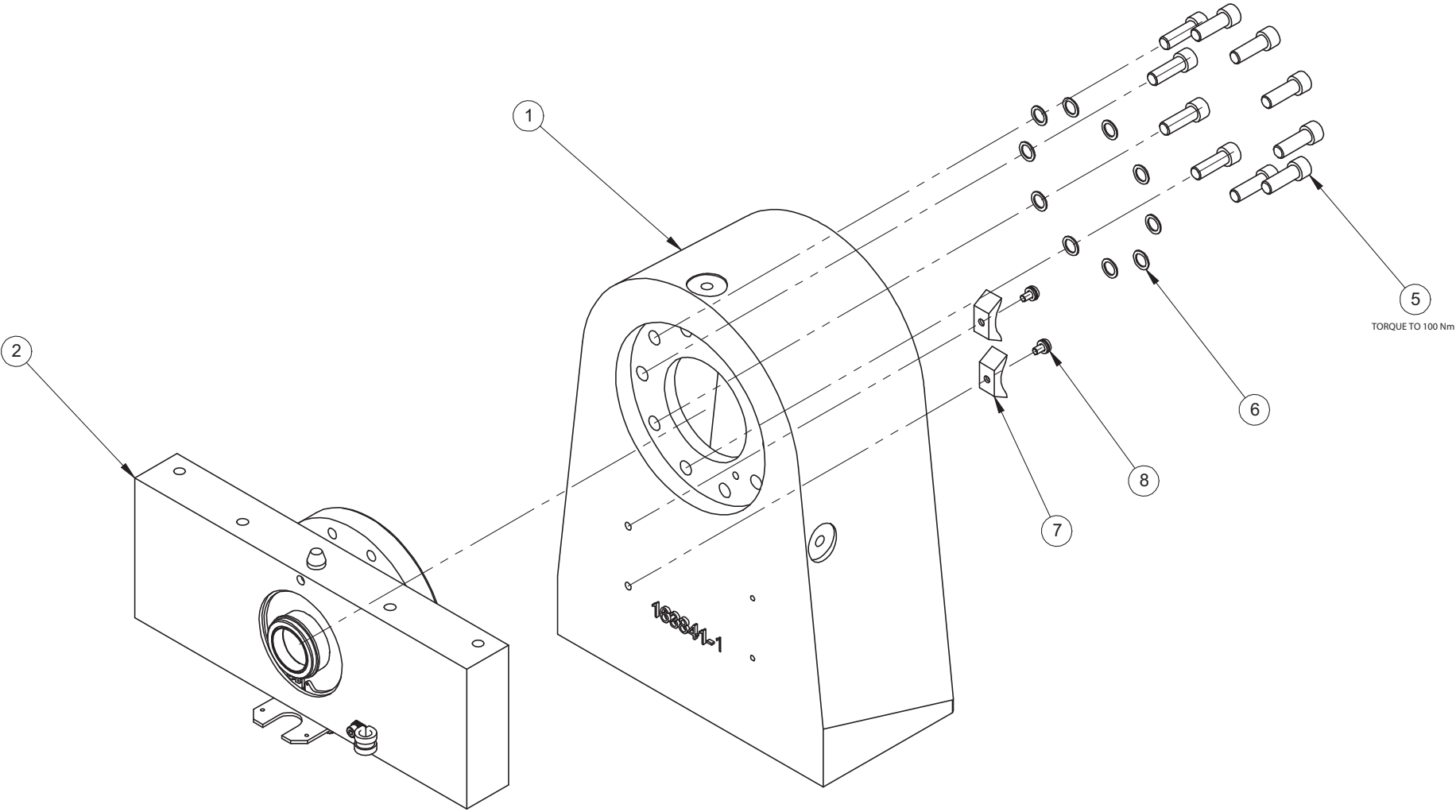
B-7



Table B-3: MH1655 Head Stock Parts List

Item	P/N	Title	Qty
B-3	163893-1	DRIVE ASSY, MH1655 HEADSTOCK, W/ MOTOMOUNT	Ref
1	163839-1	HOUSING, HEADSTOCK, TOOLING DRIVE	1
2	163880-1	PLATE, FACE, TOOLING DRIVE W/ MOTOMOUNT	1
3	164116-1	BLOCK ASSY, HEADSTOCK, MOTOMOUNT	1
4	479297-4	SCREW, SHC, M10x1.5 X 25, CLASS 12.9	18
5	470541-1	WASHER, CONICAL SPRING, M10	18
6	130532-2	SCREW, SHC, M16 X 35	6
7	132049-1	WASHER, CONICAL SPRING, GTS16	6
8	132616-1	SCREW, HHC, M8x1.25 X 20, ZC, CLASS 8.8	2
9	479148-5	WASHER_LOCK_M8	3
10	164484-1	BRUSH ASSY, GROUND MTG BRKT, 4 POS	1
11	151592-7	REDUCER, RV, RV-320E, 185	1
12	472303-9	SCREW, SHC, M12 X 50, CLASS 12.9	16
13	471075-1	WASHER, CONICAL SPRING, M12	20
14	130425-2	SCREW, BHSC, M6 X 10	16
15	470602-1	WASHER, CONICAL, SPRING, M6	2
16	133963-4	BOLT, EYE, M16, DIN580	2
17	156009-6	MOTOR, AC SERVO, 3.7kW, SIGMA 5	1
18	152538-1	ADAPTER, FLYWHEEL, MRM2-250/750-M3X	1
19	146924-1	SEAL, O-RING, INPUT	1
20	151593-7	GEAR, INPUT, PINION, 185	1
21	133937-3	FITTING,ZERK M6 X 1	1
22	407248-21	SCREW, SHC, M8 X 100	1
23	470617-1	WASHER, CONICAL, SPRING, M8	1
24	145428-2	WASHER, FLAT, M8 X 16 OD X 3 THK	1
25	472303-7	SCREW,SHC,M12X40,CLASS 12.9	4
26	145896-6	PIN, HOMING	1
27	133984-1	NAMEPLATE, GROUND	1
28	479147-5	WASHER,FLAT,M8	1
29	132616-3	SCREW,HHC,M8 X 16	1
30	164530-2	LABEL, PRODUCT IDENTIFICATION, SINGLE AXIS POSITIONER	1
32	130887-11	CABLE,WELD,4/0,1FT	2
33	180544-1	LABEL,GREASE,MOLY-WHITE RE 00	1

Fig. B-4: MotoMount™ Tailstock Components – MHT1655



B-9

168961-1CD

Table B-4: MotoMount™ Tailstock Components - MHT-555/1655

Item	P/N	Title	Qty
B-3	1634890-1	HOUSING ASSY, TAILSTOCK ADAPTER, MOTOMOUNT, MH-555/1655	REF
1	163841-1	HOUSING, TAILSTOCK TOOLING AXIS	1
2	164933-1	ADAPTER ASSY, TAILSTOCK, MOTOMOUNT	1
5	472303-6	SCREW, SHC, M12X35, CLASS 12.9	10
6	471075-1	WASHER, CONICAL SPRING, M12	10
7	479154-1	CLAMP, CABLE SUPPORT	2
8	137177-4	SCREW_PPH_M6X12	2

Fig. B-5: headstock Block Assembly - MH555, MH1655s

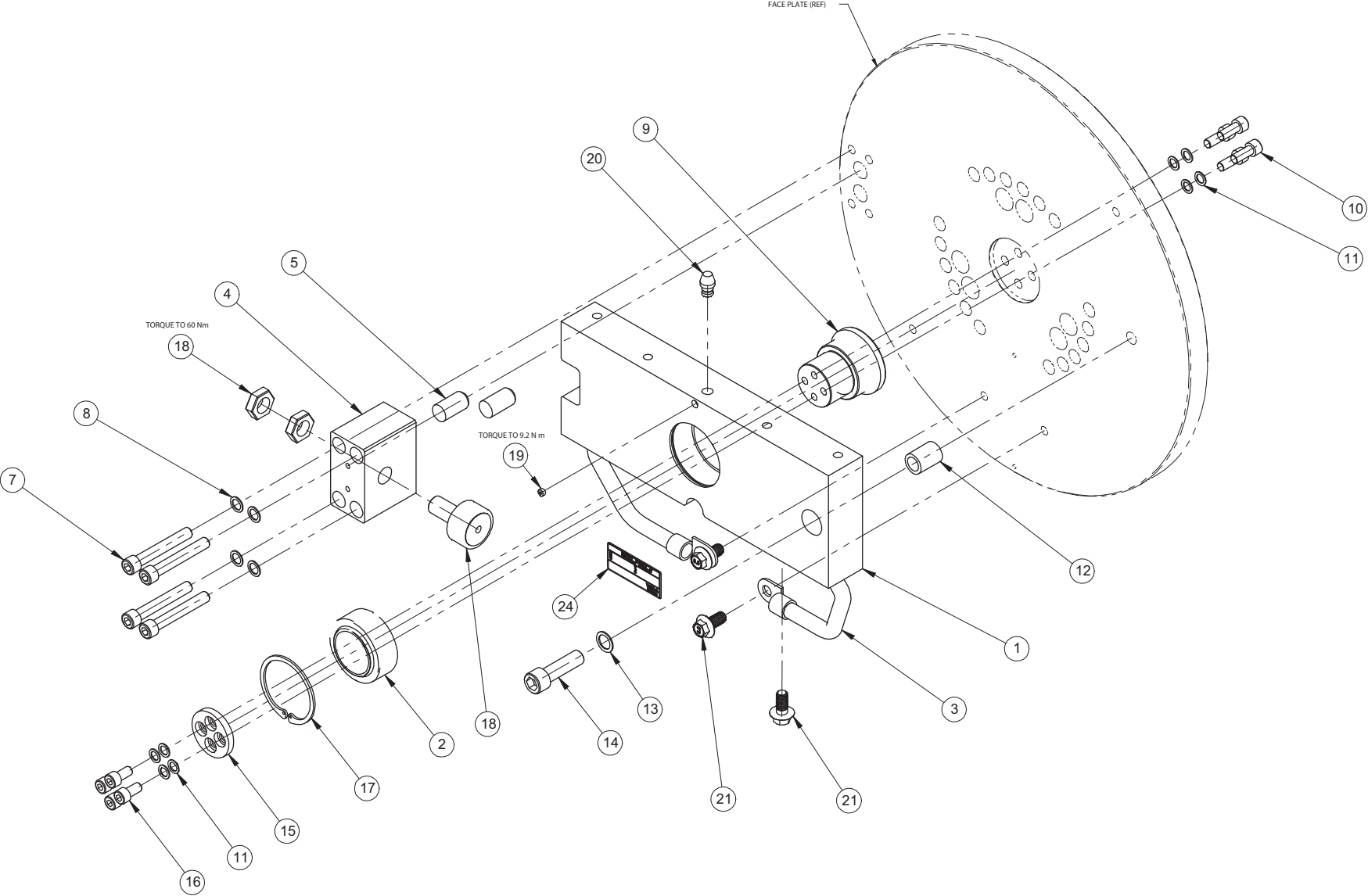


Table B-5: headstock Block Assembly - MH555, MH1655s

Item	P/N	Title	Qty
B-5	164116-1	Block Assy, Headstock Motomount	Ref
1	163881-1	BLOCK, FIXTURE, HEADSTOCK, MOTOMOUNT	1
2	145753-3	BUSHING, SHPERICAL, 50 ID	1
3	130887-11	CABLE, WELD, 4/0, 1FT	2
4	163883-1	BLOCK, CAM, HEADSTOCK, MOTOMOUNT	1
5	132652-9	PIN, DOWEL, M20X40	2
7	472303-15	SCREW, SHC, M12X80, CLASS 12.9	4
8	471075-1	WASHER, CONICAL SPRING, M12	4
9	163882-1	SHAFT, BEARING, HEADSTOCK, MOTOMOUNT	1
10	479297-4	SCREW, SHC, M10x1.5 X 25, CLASS 12.9	4
11	470541-1	WASHER, CONICAL SPRING, M10	8
12	147200-1	SPACER	1
13	132049-1	WASHER, CONICAL SPRING, GTS16	1
14	130532-24	SCREW, SHC, M16x2 X 55, CLASS12.9	1
15	148830-1	CAP, BEARING, MOTOMOUNT, M3X	1
16	479297-3	SCREW_SHCS_M10X20	4
17	146940-5	RING, RETAINING, INTERNAL, 75mm	1
18	146928-1	BEARING, CAM FOLLOWER, 47MM OD, W/2 NUTS & 2 CAPS	1
19	148135-1	SCREW, SET, CONE PT, M8 X 6	1
20	148124-1	PIN, LOCATOR, 16mm	1
21	176214-2	SCREW, HHC, FLANGE, M12X1.75X25, ZP, CLASS 8.8	4
24	168080-1	LABEL, PATENT YASKAWA	1

Appendix C

C.1 Glossary

3

3D Graphic Display Function

The 3D Graphic Display Function (this will be called 3D Display Function) is that, a 3D model of the Manipulator is displayed on the Programming Pendant window, and the current value of the Manipulator can be confirmed. By using the multi-window function, the job's teaching position displayed in the job content can also be confirmed on the 3D display window. When the functional safety function is valid, the functional safety range can also be displayed.

A

Absolute Data (ABSO Data)

Absolute Data (ABSO Data) is a correction factor for data that establishes an indicated value of zero when the robot is at the predetermined Home (calibration position).

Accuracy

Accuracy is the measurement of the deviation between the command characteristic and the attained characteristic (R15.05-2), or the precision with which a computed or calculated robot position can be attained. Accuracy is normally worse than the arm's repeatability. Accuracy is not constant over the workspace, due to the effect of link kinematics.

Active Compliant Robot

An active compliant robot is one in which motion modification during the performance of a task is initiated by the control system. The induced motion modification is slight, but sufficient to facilitate the completion of a desired task.

Actual Position

The position or location of the tool control point. Note that this will not be exactly the same as the demand position, due to a multitude of unsensed errors, such as link deflection, transmission irregularity, tolerances in link lengths, etc.

Actuator

A power mechanism used to effect motion, or maintain position of the robot (for example, a motor which converts electrical energy to effect motion of the robot) (R15.07). The actuator responds to a signal received from the control system.

ANSI/RIA R15.06-2012 American National Standard for Industrial Robots and Robot Systems

This standard provides guidelines for the manufacture and integration of Industrial Robots and Robot Systems with emphasis on their safe use, the importance of risk assessment and establishing personnel safety. This standard is a national adoption of the International Standards ISO 10218-1 and ISO 10218-2 for Industrial Robots and Robot Systems, and offers a global safety standard for the manufacture and integration of such systems.

ArcWorld

Robotic welding systems delivering flexible integrated robotics into the welding processes. ArcWorlds can be configured with multiple Manipulators, a heavy-duty Positioner or servo-controlled external axes for coordinated motion.

Automatic Mode

See *"Play Mode"*.

Axis

A direction used to specify the Manipulator motion in a linear or rotary mode. (ISO 8373)

Axis Backlash

Play between drive train gears

Axis Interference

The Axis Interference Area is a function that judges the current position of each axis and outputs a signal based on whether the current position is within a predefined range.

B**Base**

The stable platform to which an industrial robotic arm is attached.

Base Coordinate System

The Base Coordinate System (sometimes referred to as World Coordinate System) defines a common reference point for a cell or application. This is useful when using multiple Manipulators or devices as positions defined in Base Coordinates will be the same for all Manipulators and devices.

Burn-in

Burn-In is a robot testing procedure where all components of the robot are operated continuously for an extended period of time. This is done to test movement and movement programming of the robot at early stages to avoid malfunctions after deployment.

C**Computer Aided Design (CAD)**

Computer Aided Design (CAD). Computer graphic applications designed to allow engineering of objects (or parts), which are to be manufactured. A computer is used as a tool to design schematics and produce blueprints, which enable the accurate production of the object. The CAD system enables the three dimensional drawings of basic figures, exact sizing and placement of components, making lines of specified length, width, or angle, as well as satisfying varying geometric shapes. This system also allows the designer to test a simulated part under different stresses, loads, etc.

Cartesian Coordinates

Cartesian Coordinates is a type of coordinate system that specifies the location of a point in two dimensional space by a pair of numerical numbers, which further specify the distance to fixed axes that are perpendicular to each other. In simple terms, an XY graph represents a two dimensional Cartesian Coordinate System. When a point is specified in a three dimensional space (XYZ graph), it constitutes a three dimensional Cartesian coordinate system. A robot's TCP position is specified in a Cartesian Coordinate.

Cartesian Manipulator

A Cartesian Manipulator is a Manipulator arm with prismatic joints, which allows movement along one or more of the three- axes in the X, Y, Z coordinate system.

Cartesian Topology

A topology, which uses prismatic joints throughout, normally arranged to be perpendicular to each other.

Cartesian-coordinate Robot

A Cartesian-coordinate Robot is a robot whose Manipulator-arm degrees of freedom are defined by Cartesian Coordinates. This describes motions that are east-west, north-south and up-down, as well as rotary motions to change orientation.

Category 3 (Cat3)

Category 3 (Cat 3) means that the safety related parts of the control system will be designed so that:

- Single faults will not prevent the safety function from working correctly.
- Single faults will be detected at or before the next demand of the safety function.
- When a single fault does occur, a safe state shall be maintained until the detected fault is corrected.
- All reasonably foreseeable faults are detected.

Caution

Indicates a hazardous situation, which if not avoided, could result in minor or moderate injury. It may also be used without the safety alert symbol as an alternative to "NOTICE".

Centrifugal Force

When a body rotates about an axis other than one at its center of mass, it exerts an outward radial force called centrifugal force upon the axis, which restrains it from moving in a straight tangential line. To offset this force, the robot must exert an opposing torque at the joint of rotation.

Circular Motion Type

A calculated path that the robot executes, and is circular in shape.

Clamp

An end-effector which serves as a pneumatic hand that controls the grasping and releasing of an object. Tactile, and feed-back force sensors are used to manage the applied force to the object by the clamp. See ["End-effector"](#).

Clamping

The maximum permissible force acting on a body region, resulting from a Manipulator collision where the period of contact results in a plastic deformation of a person's soft tissue.

Clamping Force

When contact can cause a body part(s) to be clamped.

Closed-loop

Control achieved by a by means of feedback information. As a Manipulator is in action, its sensors continually communicate information to the Controller, which is used to further guide the Manipulator within the given task. Many sensors are used to feed back information about the Manipulator's placement, speed, torque, applied forces, as well as the placement of a targeted moving object, etc. See *"Feedback"*.

Command Interpreter

A module or set of modules that determines what the received command means. The command is broken down into parts (parsed) and processed.

Command Position

The endpoint position of a robot motion that the Controller is trying to achieve.

Compliance

Displacement of a Manipulator in response to a force or torque. A high compliance means the Manipulator moves a good bit when it is stressed. This is called spongy or springy. Low compliance would be a stiff system when stressed.

Configuration

The arrangement of links created by a particular set of joint positions on the robot. Note that there may be several configurations resulting in the same endpoint position.

Contact Sensor

A device that detects the presence of an object or measures the amount of applied force or torque applied on the object through physical contact with it. Contact sensing can be used to determine location, identity, and orientation of work pieces.

Continuous Path

Describes the process where by a robot is controlled over the entire path traversed, as opposed to a point-to-point method of traversal. This is used when the trajectory of the end-effector is most important to provide a smooth movement, such as in spray painting etc. See *"Point-to-Point"*.

Control Algorithm

A monitor used to detect trajectory deviations in which sensors detect such deviations and torque applications are computed for the actuators.

Control Command

An instruction fed to the robot by means of the human-to-machine input device. See Pendant (Teaching). This command is received by the Controller system and is interpreted. Then, the proper instruction is fed to the robot's actuators, which enable it to react to the initial command. Many times, the command must be interpreted with the use of logic units and specific algorithms. See *"Input Devices"* and *"Instruction Cycle"*.

Control Device

Any piece of control hardware providing a means for human intervention in the control of a robot or robot system, such as an EMERGENCY STOP button, a START button, or a selector switch. (R15.06)

Control Mode

The means by which instructions are communicated to the robot.

Controllability

The property of a system by which an input signal can take the system from an initial state to a desired state along a predictable path within a predetermined period of time.

Controller

An information processing device whose inputs are both the desired and measured position, velocity or other pertinent variables in a process and whose outputs are drive signals to a controlling motor or actuator. (R15.02)

Controller System

The control mechanism is usually a computer of some type, which is used to store data (both robot and work environment), and store and execute programs, which operate the robot. The Controller System contains the programs, data, algorithms; logic analysis, and various other processing activities, which enable it to perform. See *"Robot"*.

Coordinate System or Frame

A Coordinate System (or Frame) defines a reference position and orientation from which a robot position can be measured. All robot positions are defined with reference to a Coordinate System. Yaskawa robots utilize the following Coordinate Systems:

- *"Base Coordinate System"*
- *"Robot Coordinate System"*
- *"User Coordinate System"*
- *"Cartesian Coordinates"*

Central Processing Unit (CPU)

The Central Processing Unit (CPU) is the main circuit board and processor of the Controller System.

Cubic Interference Area

This area is a rectangular parallelepiped, which is parallel to the base coordinate, Manipulator coordinate or user coordinate. The Controller judges whether the current position of the Manipulator's TCP is inside or outside this area, and outputs this status as a signal.

Cycle

A single execution of a complete set of moves and functions contained within a robot program. (R15.05-2)

Cyclic Coordinate System

A coordinate system that defines the position of any point in terms of an angular dimension, a radial dimension and a height from a reference plane. These three dimensions specify a point on a cylinder.

Cyclo Drive

A brand name for a speed reduction device that converts high speed low torque to low speed high torque, usually used on the major (larger) axis.

Cylindrical Topology

A topology where the arm follows a radius of a horizontal circle, with a prismatic joint to raise or lower the circle. Not popular in industry.

D**Danger**

Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury. Safety Signs identified by the signal word DANGER should be used sparingly and only for those situations presenting the most serious hazards.

Dead Man Switch

Deprecated term. See "*Enabling Device*".

Degrees of Freedom

The number of independent directions or joints of the robot (R15.07), which would allow the robot to move its end effector through the required sequence of motions. For arbitrary positioning, six degrees of freedom are needed: three for position (left-right, forward-backward and up- down), and three for orientation (yaw, pitch and roll).

Direct-drive

Joint actuation, including no transmission elements (i.e., the link is bolted onto the output of the motor.)

Downtime

A period of time, in which, a robot or production line is shut down, due to malfunction or failure. See "*Uptime*".

Drive

A speed (gear) reducer to convert high speed low torque to low speed high torque. See "*Harmonic Drive*", "*Cyclo Drive*" and "*Rotary Vector Drive (RV)*".

Drop Delivery

A method of introducing an object to the workplace by gravity. Usually, a chute or container is so placed that, when work on the part is finished, it will fall or drop into a chute or onto a conveyor with little or no transport by the robot.

Dynamics

The study of motion, the forces that cause the motion and the forces due to motion. The dynamics of a robot arm are very complicated as they result from the kinematical behavior of all masses within the arm's structure. The robot arm kinematics are complicated in themselves.

E**Emergency Stop**

The operation of a circuit using hardware-based components that overrides all other robot controls, removes drive power from the robot actuators, and causes all moving parts to stop. (R15.06)

Enable Switch

See "*Enabling Device*".

Enabling Device

A manually operated device which when continuously activated, permits motion. Releasing the device shall stop robot motion and motion of associated equipment that may present a hazard. (R15.06)

Encoder

A feedback device in the robot Manipulator arm that provides current position (and orientation of the arm) data to the Controller. A beam of light passes through a rotating code disk that contains a precise pattern of opaque and transparent segments on its surface. Light that is transmitted through the disk strikes photo-detectors, which convert the light pattern to electrical signals. See "*Feedback*", "*Closed-loop*" and "*Feedback Sensor*".

Envelope

Is the range of movement available . This range is determined by the length of a robot's arm and the design of its axes. Each axis contributes its own range of motion.

EOAT

See "*Gripper*" or "*End-effector*".

End-effector

An accessory device or tool, specifically designed for attachment to the robot wrist or tool mounting plate to enable the robot to perform its intended task. (Examples may include: gripper, spot weld gun, arc weld gun, spray point gun or any other application tools.) (R15.06)

Endpoint

The nominal commanded position that a Manipulator will attempt to achieve at the end of a path of motion. The end of the distal link.

Error

The difference between the actual response of a robot and a command issued.

Expandability

Being able to add resources to the system, such as memory, larger hard drive, new I/O card, etc.

External Force Limit

The threshold limit where the robot moves to or retains position, even when external forces are applied (provided that forces do not exceed limits that would cause an error).

F**Feedback**

The return of information from a Manipulator or sensor to the processor of the robot to provide self-correcting control of the Manipulator. See *"Feedback Control"* and *"Feedback Sensor"*.

Feedback Control

A type of system control obtained when information from a Manipulator or sensor is returned to the robot Controller in order to obtain a desired robot effect. See *"Feedback"*, *"Closed-loop"* and *"Feedback Sensor"*.

Feedback Sensor

A mechanism through which information from sensing devices is fed back to the robot's control unit. The information is utilized in the subsequent direction of the robot's motion. See *"Closed-loop"* and *"Feedback Control"*.

Flexibility

The ability of a robot to perform a variety of different tasks.

Force Feedback

A sensing technique using electrical signals to control a robot end-effector during the task of the end-effector. Information is fed from the force sensors of the end-effector to the robot control unit during the particular task to enable enhanced operation of the end-effector. See *"Feedback"*, *"Feedback Sensor"* and *"Force Sensor"*.

Force Sensor

A sensor capable of measuring the forces and torque exerted by a robot and its wrist. Such sensors usually contain strain gages. The sensor provides information needed for force feedback. See *"Force Feedback"*.

Forward Kinematic Solution

The calculation required to find the endpoint position, given the joint positions. For most robot topologies this is easier than finding the inverse kinematic solution.

Forward Kinematics

Computational procedures which determine where the end-effector of a robot is located in space. The procedures use mathematical algorithms along with joint sensors to determine its location.

Frame

A coordinate system used to determine a position and orientation of an object in space, as well as the robot's position within its model.

Functional Safety Unit (FSU)

The Functional Safety Unit (FSU) is a component of the Manipulator Controller that provides programmable safety functions that enable collaborative operation of the robot. As these safety functions are programmable, the FSU allows the minimization of nearby overall equipment footprint, as well as human accessible areas. The FSU consists of two parallel Central Processing Units (CPUs) run concurrently, thereby providing dual channel checking. In addition, the FSU acquires robot position from its encoders independently from the motion control system of the robot. Based on this feedback, the FSU monitors the Manipulator and tool's position, speed and posture.

G**Gravity Loading**

The force exerted downward, due to the weight of the robot arm and/or the load at the end of the arm. The force creates an error with respect to position accuracy of the end effector. A compensating force can be computed and applied bringing the arm back to the desired position.

Gripper

An end effector that is designed for seizing and holding (ISO 8373) and "grips" or grabs an object. It is attached to the last link of the arm. It may hold an object using several different methods, such as: applying pressure between its "fingers", or may use magnetization or vacuum to hold the object, etc. See "*End-effector*".

H**Hand**

A clamp or gripper used as an end-effector to grasp objects. See "*End-effector*", and "*Gripper*".

Hardstop

Physical block that defines the movement stop positions

Harmonic Drive

Compact lightweight speed reducer that converts high speed low torque to low speed high torque. Usually found on the minor (smaller) axis.

Harness

Usually several wires, bundled together to deliver power and/or signal communications to/from devices. For example, the robot motors are connected to the Controller through a wire harness.

Hazardous Motion

Unintended/unexpected robot motion that may cause injury.

Headstock

Positioner column containing the driving mechanism

Hold

A stopping of all movements of a robot during its sequence, in which some power is maintained on the robot. For example, program execution stops, however power to the servo motors remain on, if restarting is desired.

Home Position

A known and fixed location on the basic coordinate axis of the Manipulator where it comes to rest, or to an indicated zero position for each axis. This position is unique for each model of Manipulator. On Motoman® robots there are indicator marks that show the Home position for the respective axis.

I

IEC

International Electrotechnical Commission

Inductive Sensor

The class of proximity sensors, which has half of a ferrite core, whose coil is part of an oscillator circuit. When a metallic object enters this field, at some point, the object will absorb enough energy from the field to cause the oscillator to stop oscillating. This signifies that an object is present in a given proximity. See "*Proximity Sensor*".

Industrial Robot

A re-programmable multi-functional Manipulator designed to move material, parts, tools or specialized devices through variable programmed motions for the performance of a variety of tasks (R15.06). The principle components are: one or more arms that can move in several directions, a Manipulator, and a computer Controller that gives detailed movement instructions.

INFORM

The robot programming language for Yaskawa robots. INFORM language allows the robot user to: instruct the robot to use its basic capabilities to fulfill a defined set of expectations and also to describe to the robot, through a definition of parameters and conditions, what the expectations are in some given situations or scenarios. In simple terms, the INFORM programming language allows the user to instruct the robot on what to do, when to do it, where to do it and how to do it.

Input Devices

A variety of devices, which allow a human to machine interface. This allows the human to program, control, and simulate the robot. Such devices include Programming Pendant, computer keyboards, a mouse, joy-sticks, push buttons, operator panel, operator pedestal etc.

Instruction

A line of programming code that causes action from the system Controller. See "*Command Position*".

Instruction Cycle

The time it takes for a robot Controller system's cycle to decode a command or instruction before it is executed. The Instruction Cycle must be analyzed very closely by robotic programmers to enable speedy and proper reaction to varying commands.

Integrate

To fit together different subsystems, such as robots and other automation devices, or at least different versions of subsystems in the same control shell.

Integrator

A company that provides value added services that results in creation of automation solutions by combining a robot and other automation and controls equipment to create an automation solution for end users.

Intelligent Robot

A robot that can be programmed to make performance choices contingent on sensory inputs with little or no help from human intervention. See "*Robot*".

Interference Area

Interference Area is a function that prevents interference between multiple Manipulators or the Manipulator and peripheral device. The areas can be set up to 64 areas. Three types of methods to use each interference area are as follows: Cubic Interference, Outside of Cubic Area and Axis Interference.

Interpolation

The method by which endpoint paths are created. In general, to specify a motion a few knot points are defined before all the intermediate positions between them are calculated by mathematical interpolation. The interpolation algorithm used therefore has a dramatic effect of the quality of motion.

ISO

International Organization for Standardization

ISO 10218-1 Robots and robotic devices — Safety requirements for industrial robots — Part 1: Robots

A robot specific safety specification that addresses manufacturer requirements, functionality, required safety performance, hazards, protective measures and documentation for the robot itself.

ISO 10218-2 Robots and robotic devices — Safety requirements for industrial robots — Part 2: Robot systems and integration

A companion document to ISO 10218-1. This safety specification provides guidance to both end users and robot integrators as it pertains to the safe design, Installation and commissioning of robot systems, as well as recommended procedures, safeguarding and information required for use.

ISO TS 15066(ANSI RIA 15.606): Robots and robotic devices - Collaborative robots

Provides detailed guidance not found in ISO 10218 parts 1 or 2 for the safe use of industrial robots operating collaboratively.

J**Jacobian matrix**

The Jacobian matrix relates the rates of change of joint values with the rates of change of endpoint co-ordinates. Essentially it is a set of algorithm calculations that are processed to control the positioning of a robot.

JOB

JOB is the name for a robot program created using INFORM programming language. Typically, a JOB consists of instructions that tell the Controller what to do and data that the program uses when it is running.

Joint

A part of the Manipulator system, which allows a rotation and/or translational degree of freedom of a link of end-effector.

Joint Interpolated Motion

A method of coordinating the movement of the joints, such that all joints arrive at the desired location simultaneously. This method of servo control produces a predictable path regardless of speed and results in the fastest pick and place cycle time for a particular move.

Joint Motion Type

Also known as Point-to-Point Motion, Joint Motion Type is a method of path interpolation that commands the movement of the robot by moving each joint directly to the commanded position so that all axis arrive to the position at the same time. Although the path is predictable, it will not be linear.

Joint Space

a. Joint Space (or Joint Coordinates) is just a method of defining the position of the robot in terms of the value of each axis instead of as a TCP position. For example, the Home Position of a robot is often defined in Joint Space as each axis being at 0 degrees.

b. The set of joint positions.

Joints

The parts of the robot arm which actually bend or move.

K**Kinematics**

The relationship between the motion of the endpoint of a robot and the motion of the joints. For a Cartesian Robot this is a set of simple linear functions (linear tracks that may be arranged in X, Y, Z directions), for a revolute topology (joints that rotate) however, the kinematics are much more complicated involving complicated combinations of trigonometry functions. The kinematics of an arm is normally split into forward and inverse solutions.

L**Laser**

Acronym for Light Amplification by Stimulated Emission of Radiation. A device that produces a coherent monochromatic beam of light which is extremely narrow and focused but still within the visible light spectrum. This is commonly used as a non-contact sensor for robots. Robotic applications include: distance finding, identifying accurate locations, surface mapping, bar code scanning, cutting, welding etc.

Linear Interpolated Motion

Is a method of path interpolation that commands the movement of the robot by moving each joint in a coordinated motion so that all axis arrive to the position at the same time. The path of the Tool Control Point (TCP) is predictable and will be linear.

Linear Motion Type

Is a method of path interpolation that commands the movement of the robot by moving each joint in a coordinated motion so that all axis arrive to the position at the same time. The path of the Tool Control Point (TCP) is predictable and will be linear.

Link

A rigid part of a Manipulator, which connects adjacent joints.

Load Cycle Time

A manufacturing or assembly line process term, which describes the complete time to unload the last work piece and load the next one.

M**Magnetic Detectors**

Robot sensors that can sense the presence of ferromagnetic material. Solid-state detectors with appropriate amplification and processing can locate a metal object to a high degree of precision. See "*Sensor*".

Manipulator

A machine or robotic mechanism of which usually consists of a series of segments (jointed or sliding relative to one another) for the purpose of grasping and/or moving objects (pieces or tools), usually in several degrees of freedom. The control of the Manipulator may be by an operator, a programmable electronic Controller or any logic system (for example cam device, wired, etc.) (ISO 8373)
See "*Wrist*" and "*End-effector*"

Manual Mode

See "*Teach Mode*".

Material Handling

The process by which an industrial robotic arm transfers materials from one place to another.

Mirror Shift Function

With the Mirror Shift Function, a job is converted to the job in which the path is symmetrical to that of the original job. This conversion can be performed for the specified coordinate among the X-Y, X-Z or Y-Z coordinate of the robot coordinates and the user coordinates. The Mirror Shift Function is classified into the following three: the Pulse Mirror Shift Function, the Robot Coordinates Mirror Shift Function and the User Coordinates Mirror Shift Function.

Mode Switch

As per safety standards, an industrial robot has three distinct modes of operation. These are TEACH (also called Manual) and PLAY (also called Automatic) and REMOTE. Switching between these modes is performed using a key switch on the Programming Pendant and is called Mode Switch.

Modularity

The property of flexibility built into a robot and control system by assembling separate units, which can be easily joined to or arranged with other parts or units.

Module

Self-contained component of a package. This component may contain sub-components known as sub-modules.

Motomount

Yaskawa proprietary mounting block allowing for limited play on multiple axis

Motion Axis

The line defining the axis of motion either linear or rotary segment of a Manipulator.

Motor

See "*Servo Motor*".

Muting

While testing a robot program, the deactivation of any presence sensing safeguarding devices during the full robot cycle or a portion of the cycle.

N**Notice**

NOTICE is the preferred signal word to address practices not related to personal injury. The safety alert symbol should not be used with this signal word. As an alternative to "NOTICE", the word "CAUTION" without the safety alert symbol may be used to indicate a message not related to personal injury.

O**Off-line Programming**

A programming method where the task program is defined on devices or computers separate from the robot for later input of programming information to the robot. (ISO 8373)b. A means of programming a robot while the robot is functioning. This becomes important in manufacturing and assembly line production due to keeping productivity high while the robot is being programmed for other tasks.

Operator

The person designated to start, monitor and stop the intended productive operation of a robot or robot system. An operator may also interface with a robot for productive purposes. (R15.06)

Optical Encoder

A detection sensor, which measures linear or rotary motion by detecting the movement of markings past a fixed beam of light. This can be used to count revolutions, identify parts, etc.

Optical Proximity Sensors

Robot sensors which measure visible or invisible light reflected from an object to determine distance. Lasers are used for greater accuracy.

Orientation

The angle formed by the major axis of an object relative to a reference axis. It must be defined relative to a three dimensional coordinate system. Angular position of an object with respect to the robot's reference system. See "*Roll*", "*Pitch*" and "*Yaw*".

P**Palletizing**

The process of stacking packages (i.e., boxes, bags, containers, etc.) in an organized fashion on a pallet.

PAM Function – Position Adjustment by Manual

Position Adjustment by Manual allows position adjustment by simple operations while observing the motion of the Manipulator, and without stopping the Manipulator. Positions can be adjusted in both teach mode and play mode.

Parallel Shift Function

parallel shift function Parallel Shift refers to the shifting of an object from a fixed position in such a way that all points within the object move an equal distance. In the model for Parallel Shift shown in the following, the shift value can be defined as the distance L (three dimensional coordinate displacement). The Parallel Shift Function is relevant to the actual operation of the Manipulator because it can be used to reduce the amount of work involved in teaching by shifting a taught path (or position). In the example in the figure below, the taught position A is shifted in increments of the distance L (this is actually a three dimensional XYZ displacement that can be recognized by the robot).

Path

The continuous locus of positions (or points in three dimensional space) traversed by the tool center point and described in a specified coordinate system. (R15.05-2)

Payload - Maximum

The maximum mass that the robot can manipulate at a specified speed, acceleration/deceleration, center of gravity location (offset), and repeatability under continuous operation over a specified working space. Maximum payload is specified in kilograms. (R15.05-2)

Pendant [Programming Pendant]

See "*Programming Pendant*"

Pendant Teaching

The mapping and recording of the position and orientation of a robot and/or Manipulator system as the robot is manually moved in increments from an initial state along a path to a final goal state. The position and orientation of each critical point (joints, robot base, etc.) is recorded and stored in a database for each taught position the robot passes through on its path toward its final goal. The robot may now repeat the path on its own by following the path stored in the database.

Performance Level d (PLd)

ISO Performance Level (PL) “d” means that the average probability of dangerous failure per hour of the safety related parts of the control system falls within $= 10^{-7}$ to $< 10^{-6}$. Additionally, other factors such as proper installation, maintenance and protection against environmental factors also apply. This is the minimum performance level specified in ISO 10218-2 section 5.2.2, unless a risk assessment would allow a lower value to be used.

Performance Level e (PLe)

ISO Performance Level (PL) “e” means that the average probability of dangerous failure per hour of the safety related parts of the control system falls within $= 10^{-8}$ to $< 10^{-7}$. Additionally, other factors such as proper installation, maintenance and protection against environmental factors also apply.

Pick and Place Cycle

The amount of time it takes for a Manipulator to pick up an object and place it in a desired location, then return to its rest position. This includes time during the acceleration and deceleration phases of a particular task. The robot movement is controlled from one point location in space to another in a Point-to-Point (PTP) motion system. Each point is programmed into the robot's control memory and then played back during the work cycle.

Pick-and-Place Task

A repetitive part transfer task composed of a picking action followed by a placing action.

Pinch Points

A pinch point is any point at which it is possible for a person or part of a person's body to be caught between moving parts of a machine, or between the moving and stationary parts of a machine, or between material and any part of the machine. A pinch point does not have to cause injury to a limb or body part, although it might cause injury – it only has to trap or pinch the person to prevent them from escaping or removing the trapped part from the pinch point.

Pitch

Rotation of the end-effector in a vertical plane around the end of the robot Manipulator arm. See and “Yaw”.

Pitch Line

Ideal line of the gear

Play Mode

After a robot is programmed in Teach Mode, the Controller can be switched to Play Mode to execute the robot program. In Play Mode, the robot program is played back. This is the mode in which robots are used in production.

Playback Operation

Playback is the operation by which the taught job is played back. This function is used to decide where to resume the playback on the start operation after suspending the playback and moving the cursor or selecting other jobs. 0: Starts operation where the cursor is located in the job displayed at the moment. 1: The playback continuation window appears. Select "YES" and the playback resumes where the cursor has been located when the playback suspended. If "NO" is selected, the playback resumes where the cursor is located in the job displayed at the moment. Modes Switch on the Programming Pendant: PLAY – job is started up by [START] on the Programming Pendant and REMOTE job is started by a peripheral device (external start input).

Point-to-Point

Manipulator motion in which a limited number of points along a projected path of motion is specified. The Manipulator moves from point to point rather than a continuous smooth path.

Pose

Alternative term for robot configuration, which describes the linear and angular position. The linear position includes the azimuth, elevation and range of the object. The angular position includes the roll, pitch and yaw of the object. See "*Roll*", "*Pitch*" and "*Yaw*".

Position

The definition of an object's location in 3D space, usually defined by a 3D coordinate system using X, Y and Z coordinates.

Position Level

The position level is the degree of approximation of the Manipulator to a taught position. The position level can be added to move instructions MOVJ (joint interpolation) and MOVL (linear interpolation). If the position level is not set, the precision depends on the operation speed. Setting an appropriate level moves the Manipulator in a path suitable to circumferential conditions and the workpiece.

Position Variables

Position Variables are used in a robot program (JOB) to define a location in 3D space, usually defined by a 3D coordinate system using X, Y and Z coordinates. As it is a variable, the value can change depending on conditions or on information passed to the JOB.

Positioner

Complete device used to position parts for welding

Presence-sensing Safeguarding Device

A device designed, constructed and installed to create a sensing field to detect an intrusion into such field by people, robots or objects. See "*Sensor*".

Programmable Logical Controller (PLC)

A solid-state control system, which has a user programmable memory for storage of instructions to implement specific functions such as: I/O control logic, timing, counting arithmetic and data manipulation. A PLC consists of a central processor, input/output interface, memory and programming device, which typically uses relay equivalent symbols. The PLC is purposely designed as an industrial control system, which may perform functions equivalent to a relay panel or a wired solid-state logic control system, and may be integrated into the robot control system.

Programmable Robot

A feature that allows a robot to be instructed to perform a sequence of steps and then to perform this sequence in a repetitive manner. It can then be reprogrammed to perform a different sequence of steps if desired.

Programming Pendant

A hand-held input device, linked to the control system with which a robot can be programmed or moved. (ISO 8373) This enables the human operator to stand in the most favorable position to observe, control and record the desired movements in the robot's memory.

Proximity Sensor

A non-contact sensing device used to sense when objects are a short distance away, and it can determine the distance of the object. Several types include: radio frequency, magnetic bridge, ultrasonic and photoelectric. Commonly used for: high speed counting, sensing metal objects, level control, reading coding marks and limit switches. See "*Inductive Sensor*".

Pulse Coordinates

Yaskawa robots define robot joint axes position in degrees for revolute joints. Pulse is also another way to specify robot joint position, and it does so in robot motor encoder pulse counts.

Q**Quality Assurance (QA)**

Describes the methods, policies and procedures necessary to conduct quality assurance testing during design, manufacturing and deliver phases of creating, reprogramming, or maintaining robots.

Quasi-static Clamping

A type of contact between a person and part of a robot system where the body part can be clamped between the moving part of the robot system & another fixed or moving part of the robot cell

R**Range of Motion**

The full movement potential of the robot.

Reach

The volume of space (envelope), which a robot's end-effector can reach in at least one orientation.

Real-time System

A computer system in which the computer is required to perform its tasks within the time restraints of some process simultaneously with the system it is assisting. The computer processes system data (input) from the sensors for the purpose of monitoring and computing system control parameters (outputs) required for the correct operation of a system or process. The computer is required to do its work fast enough to keep pace with an operator interacting with it through a terminal device (such as a screen or keyboard). The operator interacting with the computer has access, retrieval and storage capability through a database management system. System access allows the operator to intervene and alter the system's operation.

Record-playback Robot

A Manipulator for which the critical points along desired trajectories are stored in sequence by recording the actual values of the joint-position encoders of the robot as it is moved under operational control. To perform the task, these points are played back to the robot's servo-system. See "*Servo-system*".

Rectangular-Coordinate Robot

A robot whose Manipulator arm moves in linear motions along a set of Cartesian or rectangular axis in X, Y and Z directions. The shape of the work envelope forms a rectangular figure. See "*Work Envelope*".

Reliability

The probability or percentage of time that a device will function without failure over a specified time period or amount of usage (R15.02). Also called: the robot's uptime or the Mean Time Between Failure (MTBF).

Remanufacture

To upgrade or modify robots to the revised specifications of the manufacturer. (R15.06)

Remote Mode

Remote Mode is a type of Play Mode where the automatic execution of robot program is initiated from an external device (not the Programming Pendant). During this mode, the use of the Programming Pendant is disabled.

Repeatability

A measure of how close an arm can repeatedly obtain a taught position. For instance: once a Manipulator is manually placed in a particular location and this location is resolved by the robot, the repeatability specifies how accurately the Manipulator can return to that exact location. The degree of resolution within the robot control system determines the repeatability. In general, an arm's repeatability can never be better than its resolution. See "*Teach*" and "*Accuracy*".

Resolution

The amount of robot joint motion required for the position sensing to change by one count. Although the resolution of each joint feedback sensor is normally constant, the resolution of the endpoint in world coordinates is not constant for revolute arms, due to the non-linearity of the arm's kinematics.

Revolute Joint

The joints of a robot, which are capable of rotary motion.

Risk Assessment

The process of evaluating the intended use of a machine or system for foreseeable hazards and then determining the level of risk involved for the tasks identified.

Risk Mitigation

A secondary step in the risk assessment process that involves reducing the level of risk for the identified tasks, by applying risk reduction measures in order to eliminate or mitigate the hazards.

Robot

A re-programmable, multi-functional Manipulator designed to move material, parts, tools or specified devices through variable programmed motions for the performance of a variety of tasks. Common elements which make up a robot are: Controller, Manipulator and end-effector. See "*Manipulator*", "*Controller*" and "*End-effector*".

Robot Coordinate System

The Robot Coordinate System is defined in the base axis of a Robot, and points in the Robot Coordinate System will be relative to the base of the robot. Note that by default the Base Coordinate System and Robot Coordinate System are the same.

Robot Integrator

See "*Integrator*".

Robot Programming Language

An interface between a human user and a robot, which relates human commands to the robot.

Robot Range Limit Monitoring

Monitors the Manipulator arm or its tool to be in the designated safety area

Robot Simulation

A method for emulating and predicting the behavior and the operation of a robotic system based on the model (i.e., computer graphics) of the physical system. (R15.07)

Roll

Rotation of the robot end effector in a plane perpendicular to the end of the Manipulator arm. See "*Pitch*" and "*Yaw*".

Rotary Joint

A joint which twists, swings or bends about an axis.

Rotary Vector Drive (RV)

A brand name for a speed reduction device that converts high speed low torque to low speed high torque, usually used on the major (larger) axis . See "*Cyclo Drive*" and "*Harmonic Drive*".

Rotational Motion

A joint which twists, swings or bends about an axis. An example of this is the elbow of a human arm.

S**Safeguard**

A barrier guard, device or safety procedure designed for the protection of personnel. (R15.06)

Safety Integrity Level

Safety Integrity Level (SIL) is IEC's method for determining the performance level of a safety system. SIL 2 corresponds to ISO Performance Level "d", and SIL 3 corresponds to ISO Performance Level "e". ISO 10218 allows for the use of either.

Safety Logic Circuit

The safety logic circuit monitors safety critical external devices such as the light curtains and FSU generated signals. The safety logic circuit is programmed via an intuitive user interface that is supported on the Yaskawa Programming Pendant. It enables to set up the logical operations, such as stopping the Manipulator or outputting a signal if the servos are on.

Safety Monitored Stop

Collaborative feature designed to allow safe human-robot interaction. Only when robot motion ceases can the human safety enter the collaborative workspace. Servos can remain energized in accordance with a category 2 stop in accordance with ISO 10218-1:2011, 5.4. A risk assessment shall be used to determine if any additional safeguarding is necessary to mitigate risks within the robot system.

Second Home Position

Apart from the "home position" of the Manipulator, the second home position can be set up as a check point for absolute data. The initial value of the second home position is the home position (where all axes are at pulse 0). The second home position can be changed.

Security Mode

Levels of operator modes on the Controllers, include: Operation Mode, Edit Mode, Management Mode, Safety Mode and One Time Management mode.

Sensor

Instruments used as input devices for robots, which enable it to determine aspects regarding the robot's environment, as well as the robot's own positioning. Sensors respond to physical stimuli (such as heat, light, sound, pressure, magnetism and motion), and they transmit the resulting signal or data for providing a measurement, operating a control or both. (R15.06)

Sensory Feedback

Variable data measured by sensors and relayed to the Controller in a Closed-loop System. If the Controller receives feedback that lies outside an acceptable range, then an error has occurred. The Controller sends an error signal to the robot. The robot makes the necessary adjustments in accordance with the error signal.

Servo Control

The process by which the control system of the robot checks if the attained pose of the robot corresponds to the pose specified by the motion planning with required performance and safety criteria. (ISO 8373)

Servo Motor

An electrical power mechanism used to effect motion or maintains position of the robot (for example, a motor which converts electrical energy to effect motion of the robot) (R15.07). The motor responds to a signal received from the control system and often incorporates an encoder to provide feedback to the control loop.

Servo Pack

An alternating, current electrical power mechanism that is controlled through logic to convert electrical supply power that is in a sine wave form to a Pulse Width Modulated (PWM) square form, delivered to the motors for motor control: speed, direction, acceleration, deceleration and braking control.

Servo-controlled Robot

The control of a robot through the use of a Closed-loop Servo-system, in which the position of the robot axis is measured by feedback devices and is stored in the Controller's memory. See Closed-loop System and Servo-system.

Servo-system

A system in which the Controller issues commands to the motors, the motors drive the arm, and an encoder sensor measures the motor rotary motions and signals the amount of the motion back to the Controller. This process is continued many times per second until the arm is repositioned to the point requested. See "*Servo-controlled Robot*"

Shock Detection Function

Shock detection is a function supported by the Controller that reduces the impact of a robot collision by stopping the Manipulator without any external sensor when the tool or the Manipulator collide with a peripheral device.

SIL

See "*Safety Integrity Level*"

Simulation

A graphical computer program that represents the robot and its environment, which emulates the robot's behavior during a simulated run of the robot. This is used to determine a robot's behavior in certain situations, before actually commanding the robot to perform such tasks. Simulation items to consider are: the 3D modeling of the environment, kinematics emulation, path-planning emulation and simulation of sensors. See "*Sensor*", "*Forward Kinematics*" and "*Robot*".

Singularity

A configuration where two joints of the robot arm become co-axial (aligned along a common axis). In a singular configuration, smooth path following is normally impossible and the robot may lose control. The term originates from the behavior of the Jacobian matrix, which becomes singular (i.e., has no inverse) in these configurations.

SLURBT

SLURBT are terms that Yaskawa Motoman uses to describe each axis of the robot for convenience. The definition of each value is as follows:

S – Swing or Swivel

L – Lower Arm

U – Upper Arm

R – Rotate

B – Bend

T – Twist

Softlimit Setting Function

The Softlimit Setting Function is a function to set the axis travel limit range of the Manipulator motion in software.

Speed and Separation Monitoring

Collaborative feature that allows both the operator and robot to work in proximity to one another by ensuring the robot will slow down and stop before a contact situation occurs. In order for this feature to be safely implemented, functional safety and additional detection hardware must be used. A risk assessment shall be used to determine if any additional safeguarding is necessary to mitigate risks within the robot system.

Spline

A smooth, continuous function used to approximate a set of functions that are uniquely defined on a set of sub-intervals. The approximating function and the set of functions being approximated intersect at a sufficient number of points to insure a high degree of accuracy in the approximation. The purpose for the smooth function is to allow a robot Manipulator to complete a task without jerky motion.

Spline Motion Type

A calculated path that the robot executes-that may be parabolic in shape. A spline motion may also accomplish a free form curve with mixtures of circular and parabolic shapes.

Standstill Monitoring

Using the Axis Speed Monitor function will activate an emergency stop condition if a motion occurs.

Stop Position Monitoring

See "*Standstill Monitoring*"

Sweep Axis

Positioner axis that sweeps back and forth

Swing Arm

Casting or weldment attached headstock or tailstock column containing secondary axes

System Integrator

See "*Integrator*"

T**Tailstock**

Positioner column containing the driven or idler side.

Teach

To program a Manipulator arm by manually guiding it through a series of motions and recording the position in the robot Controller memory for playback.

Teach Lock

While the Teach Lock is set, the mode of operation is tied to the Teach Mode and the machines cannot be played back using either [START] or external input. For safety purposes, always set the mode switch to "TEACH" before beginning to teach.

Teach Mode

A Controller mode in which a Manipulator is programmed by manually guiding it through a series of motions and recording the position in the Controller memory for playback. Industrial robots that do not have an active Power and Force Limiting Function require the use of a Three Position Enabling Device in Teach Mode.

Teach Pendant

See "*Programming Pendant*"

Teaching Window

Teaching Window is a user interface screen on the Programming Pendant. This window contains the JOB CONTENT window and teaching is conducted within this window. The JOB CONTENT window contains the following items: line numbers, cursor, instructions, additional items, comments, etc.

Through-beam

An object detection system used within a robot's imaging sensor system. A finely focused beam of light is mounted at one end and a detector at the other. When the beam of light is broken, an object is sensed.

Time Measuring Function

Time measuring function measures the execution time for the specified section in the job or the signal output time of the specified signal.

Tool

A term used loosely to define a working apparatus mounted to the end of the Manipulator arm, such as a hand, gripper, welding torch, screw driver, etc. See "*Gripper*" and "*End-effector*".

Tool & arm Interference

In a system with one Controller and multiple Manipulators, the Tool & Arm Interference Check Function can be used to detect possible interference to avoid collision during operation. The following three patterns can be checked:

- Arm against arm
- Arm against tool
- Tool against tool

Tool against tool

Interference is checked by using a cylinder that is slightly larger than the arm or tool. A sphere is placed on both ends of the cylinder. If the cylinder and spheres of one Manipulator have any contact with those of the other while moving, the Manipulators stop because interference was detected.

Tool Center Point (TCP)

The Tool Center Point (TCP) defines the tip of the current tool as defined relative to the tool flange. For example, for a welding robot, the TCP will generally be defined at the tip of the welding gun. After defining and configuring the TCP, the robot motion will be defined relative to this frame (i.e., rotation in the Rx direction would cause rotation around the X-axis and positions will be taught in this frame).

Tool Control Point

See "*Tool Center Point (TCP)*"

Tool Coordinates

When the tool attached to the Manipulator moves, so does its tool coordinate system in reference to a fixed coordinate system, for example, world coordinates. In general, the tool coordinates do not align with the world XYZ coordinates.

Tool Frame

A coordinate system attached to the end-effector of a Manipulator (relative to the base frame).

Total Index Time

Sum of the main axis sweep time and the secondary axis sweep times

Tooling Envelope

Volume in which the tooling can be present when rotated on its own axis

Tooling Fixture

Tooling designed for the application to be mounted on a Positioner axis where parts will be loaded and processed

Tooling Plate

Plate used to attach tooling to motomounts

Tooling Sweep

Time necessary to rotate tooling between positions

Trajectory Generation (Calculation)

The computation of motion functions that allow the movement of joints in a smooth controlled manner.

Transducer

A device that converts energy from one form to another. Generally, a device that converts an input signal into an output signal of a different form. It can also be thought of as a device which converts static signals detected in the environment (such as pressure) into an electrical signal that is sent to a Manipulator's control system.

U**Uptime**

A period of time in which a robot or production line is operating or available to operate, as opposed to downtime.

User Coordinate Setting

User coordinates are defined by three points that have been taught to the Manipulator through axis operations. These three defining points are ORG, XX, and XY, as shown in the diagram below. These three points of positional data are registered in a user coordinate file. ORG is the home position, and XX is a point on the X-axis. XY is a point on the Y-axis side of the user coordinates that has been taught, and the directions of Y- and Z-axes are determined by point XY.

User Coordinate System

The User Coordinate System is any reference point that a user has defined for their application. This is often attached to an object such as a pallet and allows a user to teach points relative to this object. For example, a set of position could be taught relative to a User Coordinate System attached to a pallet and then easily transferred to a different User Coordinate System on another pallet. This allows for positions to be reused efficiently. See also, "*User Coordinate Setting*"

V**Vision Sensor**

A sensor that identifies the shape, location, orientation, or dimensions of an object through visual feedback, such as a television camera.

W**Warning**

Indicates a potentially hazardous situation which, if not avoided, will result in death or serious injury. Hazards identified by the signal word WARNING present a lesser degree of risk of injury or death than those identified by the signal word DANGER.

Work Envelope

The set of all points which a Manipulator can reach without intrusion. Sometimes the shape of the work space, and the position of the Manipulator itself can restrict the work envelope.

Work Envelope (Space)

The volume of space within which the robot can perform given tasks.

Work Home Position

The Work Home Position is a reference point for Manipulator operations. It prevents interference with peripheral device by ensuring that the Manipulator is always within a set range as a precondition for operations such as starting the line. The Manipulator can be moved to the set Work Home Position by operation from the Programming Pendant, or by signal input from an external device. When the Manipulator is in the vicinity of the Work Home Position, the Work Home Position signal turns ON.

Work Piece

Any part which is being worked, refined or manufactured prior to its becoming a finished product.

Workspace

The volume of space within which the robot can perform given tasks.

World Coordinates

A reference coordinate system in which the Manipulator arm moves in linear motions along a set of Cartesian or rectangular axes in X, Y, and Z directions. The shape of the work envelope forms a rectangular figure. See *"Rectangular-Coordinate Robot"*.

World Model

A three dimensional representation of the robot's work environment, including objects and their position and orientation in this environment, which is stored in robot memory. As objects are sensed within the environment the Controller system continually updates the World Model. Robots use this World Model to aid in determining its actions in order to complete given tasks.

Wrist

A set of rotary joints between the arm and the Manipulator end-effector that allow the end-effector to be oriented to the work-piece. In most cases the wrist can have degrees of freedom which enable it to grasp an object with roll, pitch, and yaw orientation. See *"End-effector"*, *"Roll"*, *"Pitch"*, *"Yaw"* and *"Work Piece"*.

Wrist [Secondary Axis]

An interconnected set of links and powered joints between the arm and end-effector, which supports, positions and orientates the end effector. (ISO 8373)

X**Y****Yaw**

Rotation of the end-effector in a horizontal plane around the end of the Manipulator arm. Side to side motion at an axis. See *"Roll"* and *"Pitch"*.

Z

MHT-SERIES SIGMA-5 POSITIONER MANUAL

MHT185, MHT555, AND MHT1655 TOOLING AND MOTOMOUNT

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