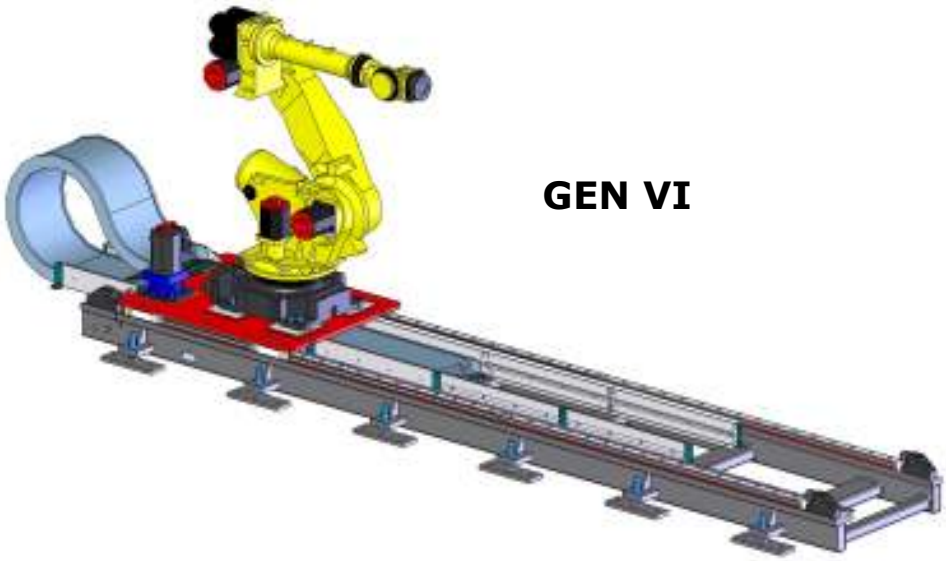
FANUC Robotics

GENERATION VI – ROBOT TRANSPORT UNIT (RTU)

Mechanical Assembly, Operation and Maintenance Manual



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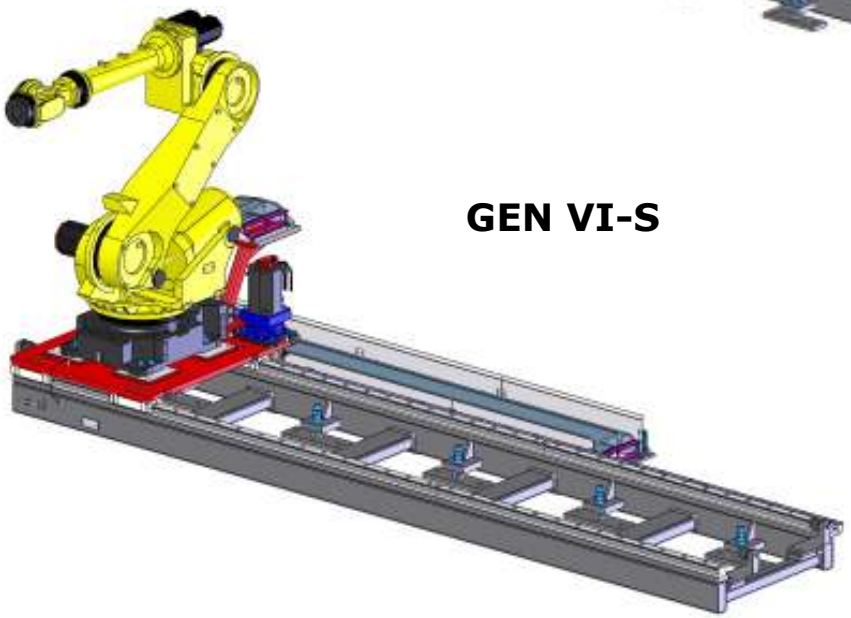

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1 Overview - Mechanical Components

1.1. Overview:

The FANUC Robotics GEN-VI RTU's are electric servo driven linear axis, designed to provide auxiliary axis for transporting robots and other payloads as required for robotic automation. A FANUC Servo Motor powers the RTU with a precision gear reducer. When used with a FANUC Robot, the RTU can be integrated as a programmable auxiliary axis with the Robot.

A typical complete RTU consists of components as shown in the following figure:

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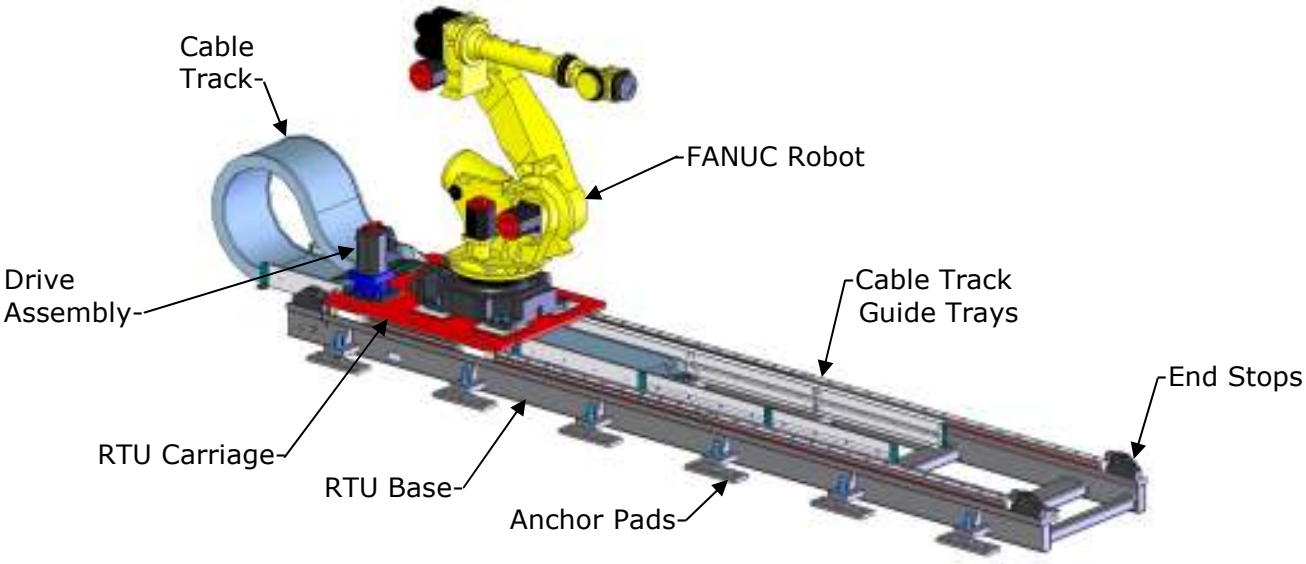

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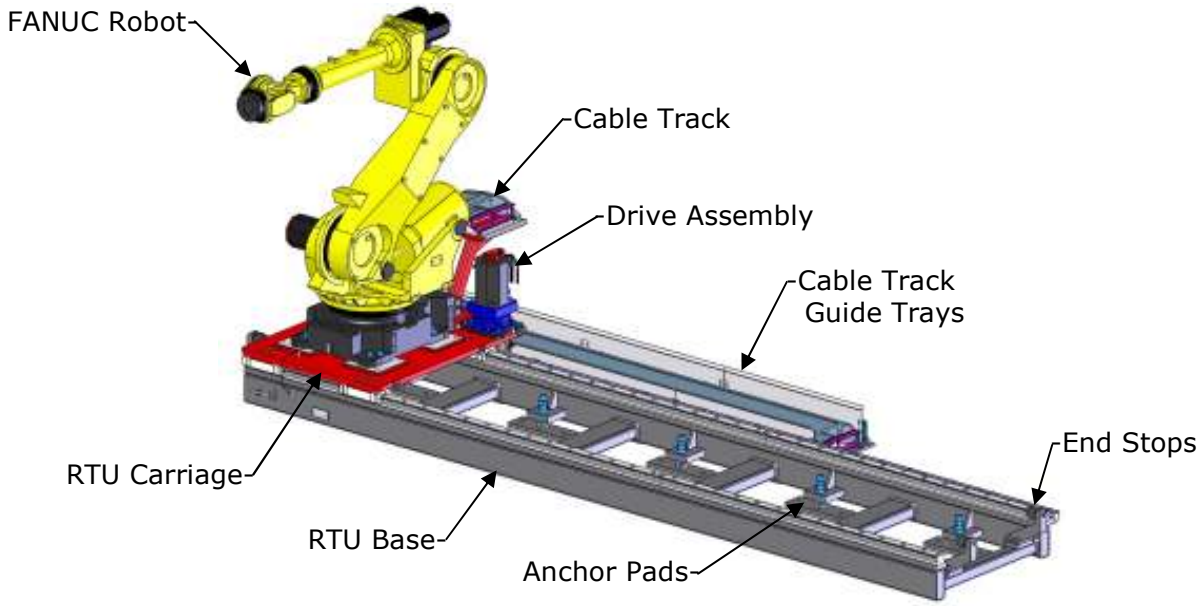

1.2. Mechanical Components: RTU Base

The RTU Base is the main structure of the RTU. It is a tubular steel weldment with precision-machined surfaces. The RTU Base assembly includes Anchor pads with independent leveling screw adjustment.

RTU Bases for 1.0M thru 9.0M [1.0M thru 10.0M S-type] strokes are available in single piece design and the RTU Bases for strokes over 9.0M [10M S-type] are available as an assembly made of shorter Bases.

This assembly includes:
- RTU Base
- Linear Bearings
- Gear Racks
- Anchor/Leveling Pads
- End Stops
- Cable Track System

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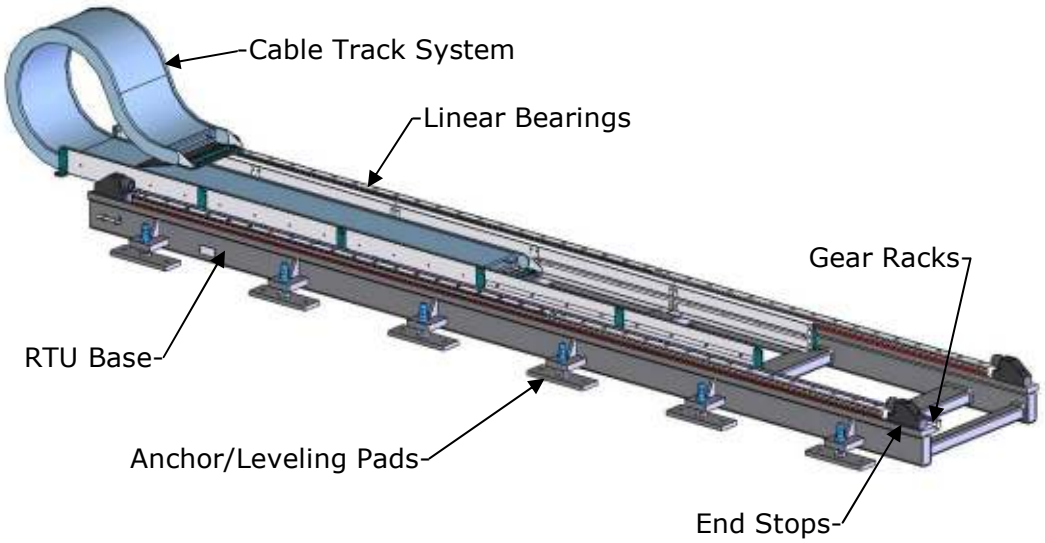

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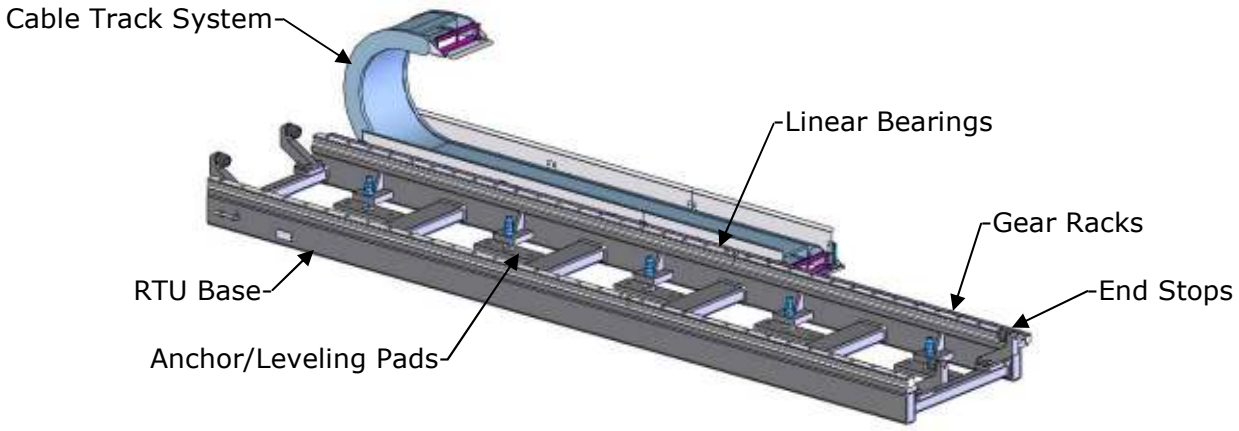

1.3. Mechanical Components: RTU Carriage

The Carriage assembly provides a mounting surface for the robot or payload and the drive package. The assembly consists of a steel plate with precision bearing blocks and is mounted to the linear bearings on the RTU Base. The Carriage moves linearly on the Bases.

This assembly includes:
- Carriage
- Bearing Blocks
- Bearing Lubrication Points
- Cable Track Support Bracket/Strain Relief
- Mastering Pin

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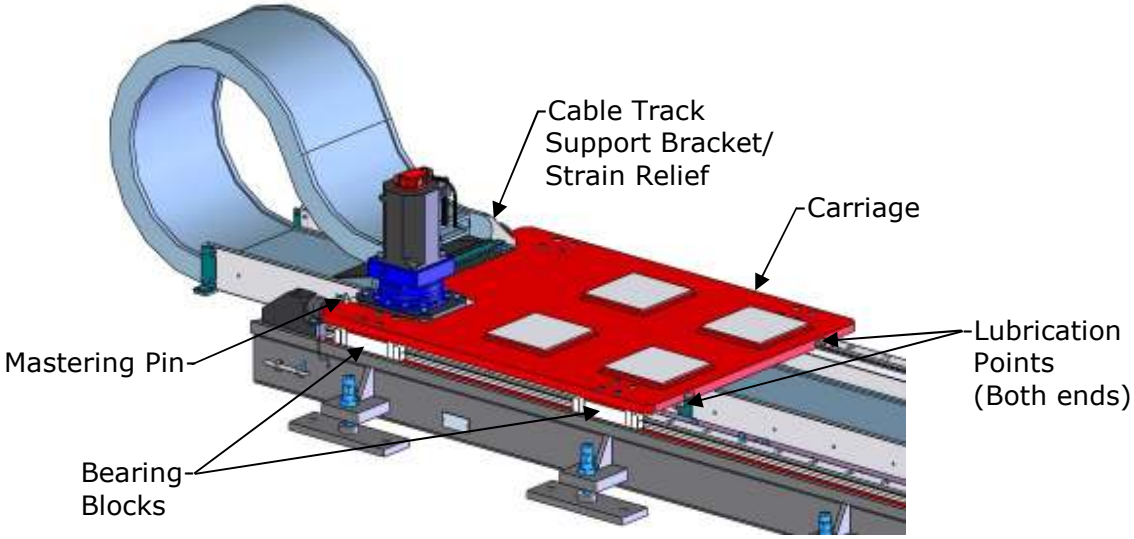

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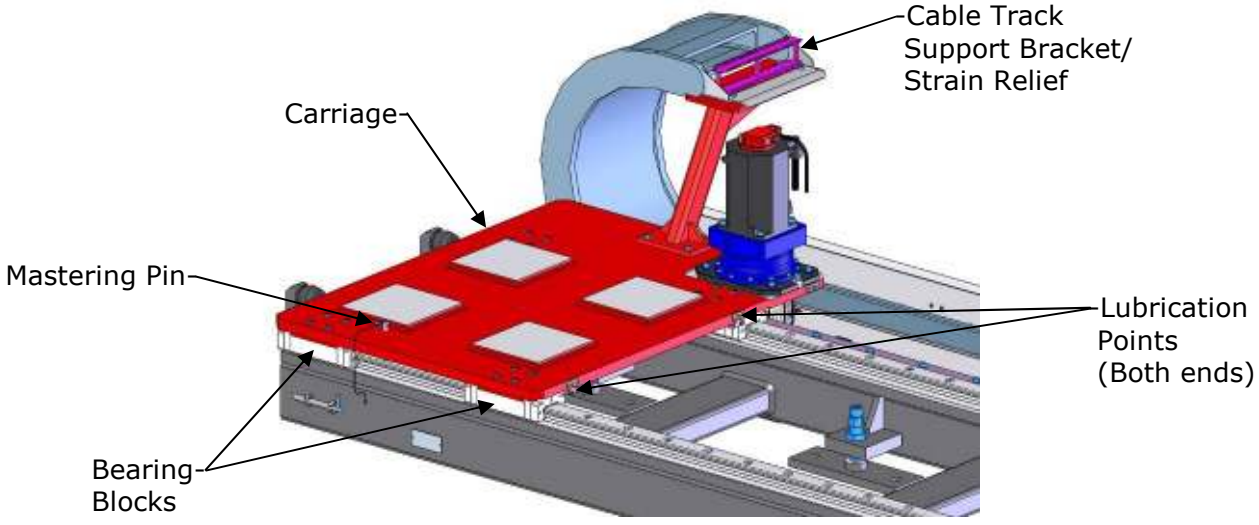
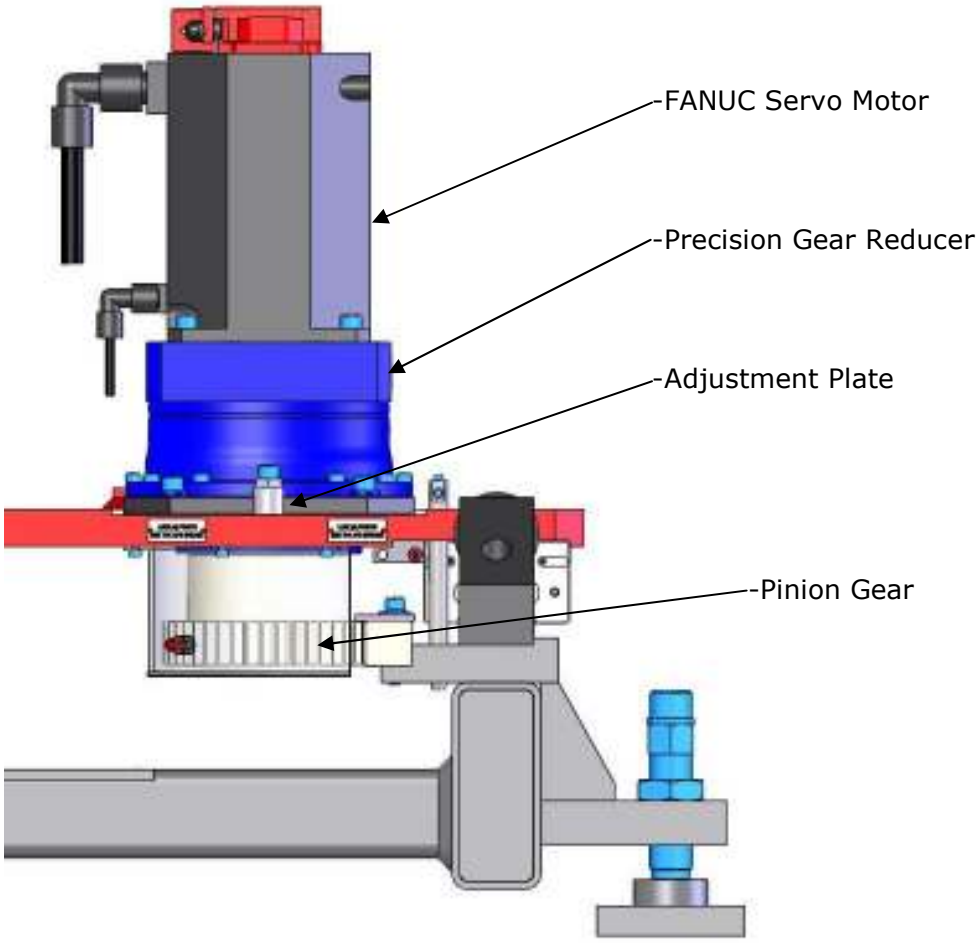


1.4. Mechanical Components: RTU Drive

The Drive Assembly consists of a FANUC Servo Motor, precision gearbox and output pinion. The output pinion and the rack have been designed for a wide range of load conditions.

This assembly includes:

- ♦ FANUC Servo Motor: SD, SD-S RTU Alpha 30/4000is
  SDHS, SDHS-S, HD, HD-S, XD, XD-S RTU Alpha 40/4000is
- ♦ Precision Gear Reducer: SD, SD-S, SDHS, SDHS-S RTU 10:1 reduction
  HD, HD-S, XD, XD-S RTU 16:1 reduction
- ♦ Pinion Gear
- ♦ Adjustment Plate for back-lash adjustment between Pinion and Gear Rack



2 Specifications – Configurations, Options and Performance

2.1. Configurations:

FANUC GEN VI RTU is available in the following configurations:

Standard-Duty Single Carriage, SD = Standard-Duty.
RTU ASSEMBLY #MO-6225-###-SD ### = Stroke in 1.0 meter increments
Ex: -010- =1.0 meter thru -200- =20.0 meter

Standard-Duty Dual Carriage, DSD = Dual-Standard-Duty.
RTU ASSEMBLY #MO-6225-###-DSD ### = Stroke in 1.0 meter increments
Ex: -015- =1.5 meter thru -185- =18.5 meter

Heavy-Duty Single Carriage, HD = Heavy-Duty.
RTU ASSEMBLY #MO-6225-###-HD ### = Stroke in 1.0 meter increments
Ex: -010- =1.0 meter thru -200- =20.0 meter

Heavy-Duty Dual Carriage, DHD = Dual-Heavy-Duty.
RTU ASSEMBLY #MO-6225-###-DHD ### = Stroke in 1.0 meter increments
Ex: -015- =1.5 meter thru -185- =18.5 meter

eXtra-Duty Single Carriage, XD = eXtra-Duty.
RTU ASSEMBLY #MO-6225-###-XD ### = Stroke in 1.0 meter increments
Ex: -010- =1.0 meter thru -200- =20.0 meter

eXtra-Duty Dual Carriage, DXD = Dual-eXtra-Duty.
RTU ASSEMBLY #MO-6225-###-DXD ### = Stroke in 1.0 meter increments
Ex: -015- =1.5 meter thru -185- =18.5 meter

FANUC GEN VI-S RTU is available in the following configurations:

Standard-Duty Single Carriage, SD-S = Standard-Duty, Side Track.
RTU ASSEMBLY #MO-6225-###-SD-S ### = Stroke in 1.0 meter increments
Ex: -010- =1.0 meter thru -200- =20.0 meter

Standard-Duty Dual Carriage, DSD-S = Dual-Standard-Duty, Side Track.
RTU ASSEMBLY #MO-6225-###-DSD-S ### = Stroke in 1.0 meter increments
Ex: -015- =1.5 meter thru -185- =18.5 meter

Heavy-Duty Single Carriage, HD-S = Heavy-Duty, Side Track.
RTU ASSEMBLY #MO-6225-###-HD-S ### = Stroke in 1.0 meter increments
Ex: -010- =1.0 meter thru -200- =20.0 meter

Heavy-Duty Dual Carriage, DHD-S = Dual-Heavy-Duty, Side Track.
RTU ASSEMBLY #MO-6225-###-DHD-S ### = Stroke in 1.0 meter increments
Ex: -015- =1.5 meter thru -185- =18.5 meter

eXtra-Duty Single Carriage, XD-S = eXtra-Duty, Side Track.
RTU ASSEMBLY #MO-6225-###-XD-S ### = Stroke in 1.0 meter increments
Ex: -007- =0.7 meter thru -197- =19.7 meter

eXtra-Duty Dual Carriage, DXD-S = Dual-eXtra-Duty, Side Track.
RTU ASSEMBLY #MO-6225-###-DXD-S ### = Stroke in 1.0 meter increments
Ex: -012- =1.2 meter thru -182- =18.2 meter

2.2. Basic Dimensions:

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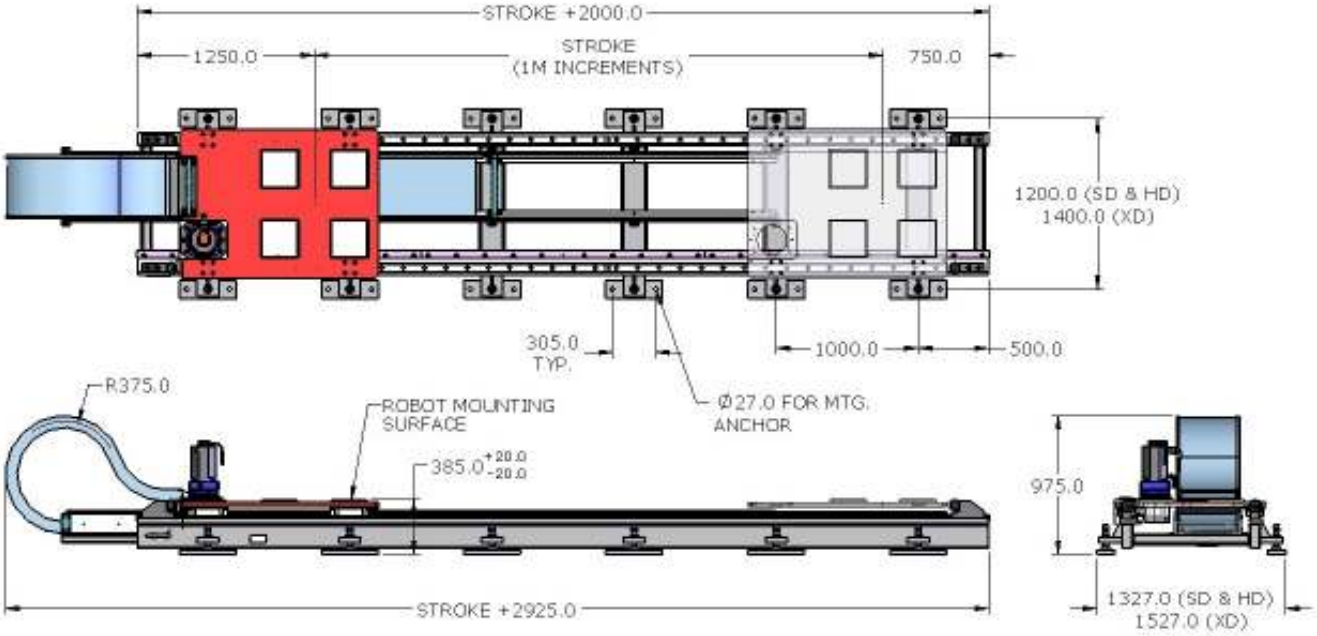

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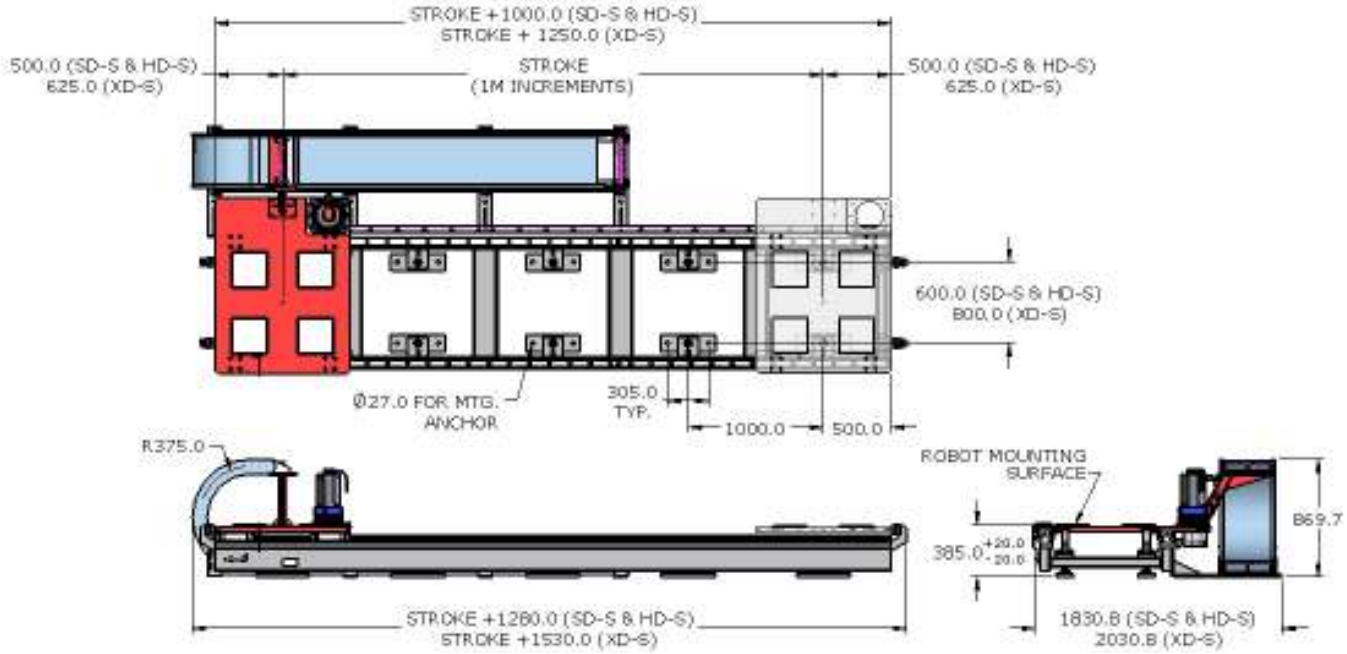


2.3. Available Options:

1. Multiple Carriages:	Facilitates multiple robots on one RTU.
2. Carriage Riser:	Increase Robot height and vertical reach.
3. Rail Side Covers:	Provides Bearing Rail protection for severe environments. (For Center Cable Track Only. Not available for Side Cable Track RTU)
4. Rail Frame Covers:	Provides Covers on center of frame for walkover. (For Side Cable Track Only. Not available for Center Cable Track RTU)
5. Linear Zone Switches:	Provides up to two zones per robot.
6. Over-Travel Switches:	Provides over-travel switch for RTU travel limits.
7. Auto Lube System:	Provides Automatic Lubrication of the RTU Pinion and Bearings.
8. Stroke Limiter:	Provides hard stop stroke reduction up to 2 meters.

2.4. Performance:

1. Stroke	The RTU's for 1.0M thru 9.0M [1.0M-10.0M S-type] strokes are available in single Base design in 1M increments. The RTU's for strokes over 9.0M [10.0M S-type] are available in Multiple Base design in 1M increments.
2. Robots / Capacity	**Standard-Duty** (SD, SD-S, SDHS, SDHS-S) RTU: 2200kg maximum (Robot + Payload + Riser on carriage) R-2000iB Series Robots ("R" Series requires min. 300mm Riser) **Heavy-Duty** (HD, HD-S) RTU: 2600kg maximum (Robot + Payload + Riser on carriage) M-900iA/350, M-900iA/260L Robots **Extra-Duty** (XD, XD-S) RTU: 4100kg maximum (Robot + Payload + Riser on carriage) M-900iA/600 & 700, M-900iA/400L (400L requires min. 150mm Riser) M-410iB Series Robots
3. Linear Velocity (At maximum capacity Robot+Payload+Riser)	SD, SD-S = 2.2 m/s Peak Acceleration = 2.75m/s^2 SDHS, SDHS-S = 2.5 m/s Peak Acceleration = 3.13m/s^2 HD, HD-S = 2.2 m/s Peak Acceleration = 2.75m/s^2 XD, XD-S = 1.8 m/s Peak Acceleration = 2.25m/s^2
4. Repeatability	+/- 0.25mm (Unidirectional) RTU axis only
5. Mastering	Mastering Pin to position the Carriage with the Base
6. Drive Assembly	FANUC Alpha 30/4000is servo motor (SD, SD-S) FANUC Alpha 40/4000is servo motor (SDHS, SDHS-S) FANUC Alpha 40/4000is servo motor (HD, HD-S, XD, XD-S) Wittenstein Alpha Gear Reducer AGMA Q-08 rack and pinion
7. Process Utilities Routing	[16"W x 1.7"H], [10"W x 2.7"H S-type] Cable Track
8. Mfg Environmental	Double-seal Bearing Blocks with laminated and metal scrapers Gear Rack and Pinion covers for rack protection
9. Serviceability	Accessible lubrication for rack, pinion and bearings Gear Reducer lubricated for life
10. Assembly/Installation	Anchor-in-place Anchor Pads, Independent Leveling Screws

3 Installation

3.1. Overview:

Under this procedure it is assumed that the RTU Base is shipped pre-assembled without the Robot. The Robot is shipped separately.

The RTU's with 1.0M thru 9.0M [1.0M thru 10.0M S-type] strokes are of Single Base design and RTU's with strokes longer than 9.0M [10.0M S-type] are of Multiple Base design. After testing of the RTU, the Bases are separated and shipped to the field for final installation.

3.2. Tools and Equipment:

1. Forklift or overhead crane (Capacity to suit RTU weight indicated on RTU tag)
2. RTU leveling instrument: Accuracy - 0.0005" / 12"
3. Wrenches to suit: M6 through M24 fasteners (socket head)
4. Torque wrench: 400 ft-lb capacity
5. Masonry drilling equipment for Hilti anchors
6. Dial gage indicator (accuracy - 0.001") with magnetic base. To be used for back-lash adjustment.
7. Steel Straight edge: 4 ft. long.
8. Master Gear Rack: (8" Long Gear Rack detail)
9. Loc-tite: 242
10. Drill with 10mm reamer for Gear Rack dowel transfer and installation (Multiple Base RTU)

3.3. Floor Construction and Preparations:

The floor must be constructed of concrete with a minimum of 4000 PSI strength and with 6" minimum floor thickness OR the floor must have appropriate steel I-Beams or plates to mount the RTU.

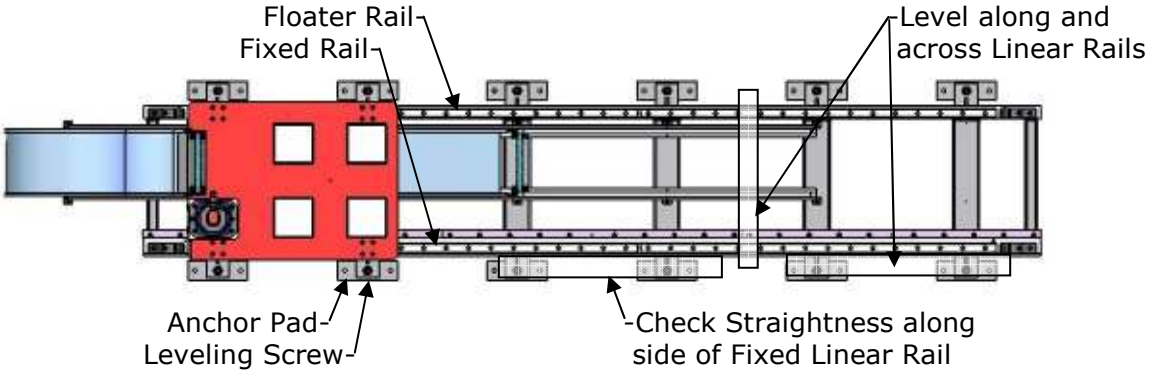
Note: If the RTU has to be mounted on a steel base/frame, consult FRA for strength and rigidity requirements.

The floor must be flat within +/- 1/4" max along the mounting surfaces of the RTU.

3.4. Installation:

Observe the following:

- On each of the RTU Bases there are two Linear Bearing Rails.
- One of the Linear Rails is located fixed against a ledged surface. This rail is called the "Fixed rail".
- The second Linear Rail is not cornered and it is called the "Floater rail".
- Nominal Leveling Height is 385mm from floor to Robot mounting surface.
- On Multiple Base RTU's, one of the Bases has its linear rails protruding on one end. This is the "Adjoining Base". One of the Bases has the bearing surface exposed to connect to the Adjoining Base. This is the "End Base".
- On Single Base RTU's, Gear Rack dowels are installed after runoff testing, prior to shipment. For Multiple Base RTU's, Gear Rack dowels must be transferred and installed after Final Leveling at end user facility. Adjustments may be needed after installation and re-alignment of the bases. (see Gear Rack Installation and Adjustment)



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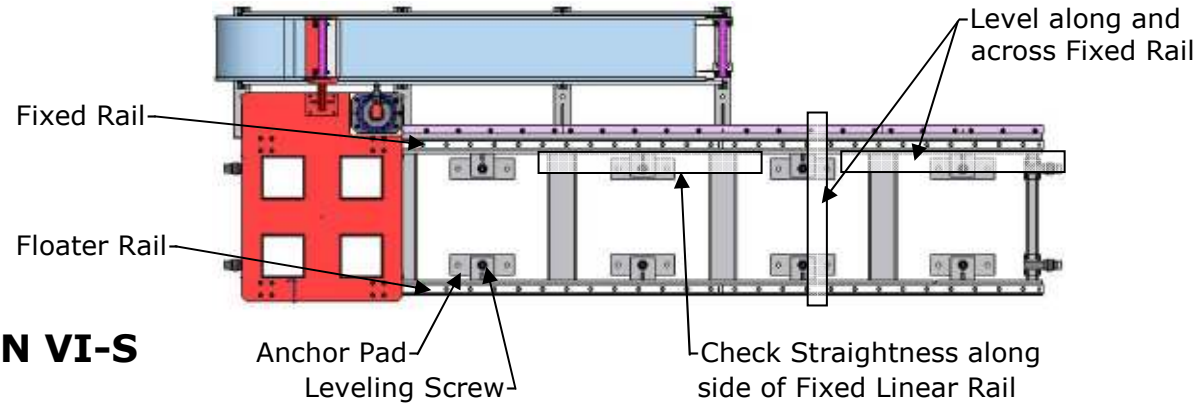

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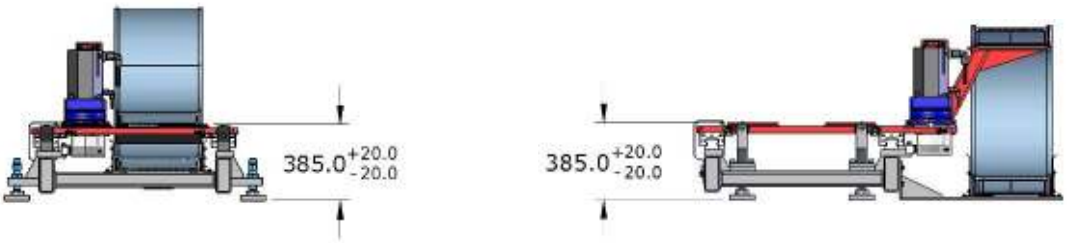
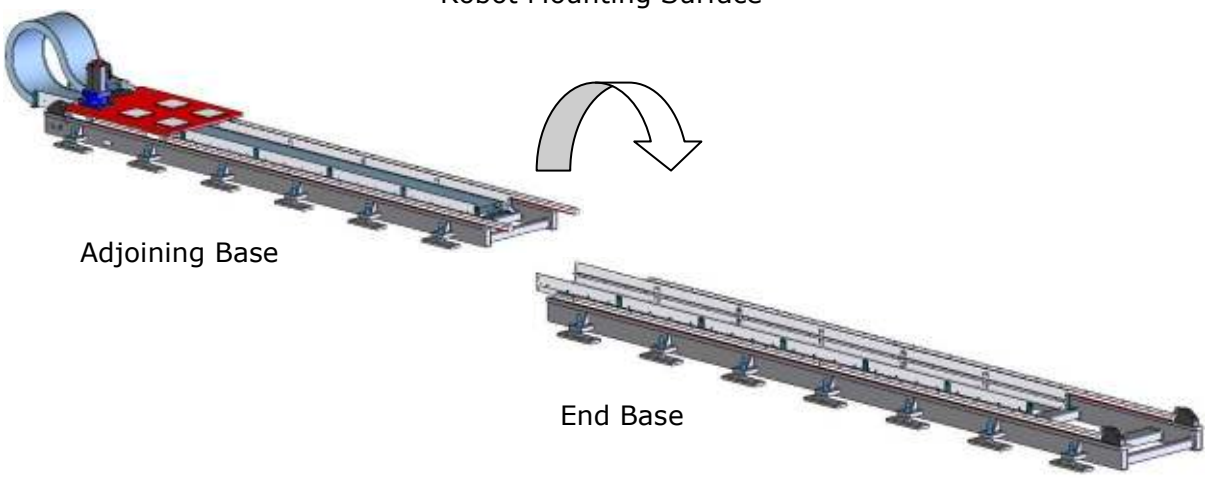


GEN VI Nominal Leveling from Floor to Robot Mounting Surface **GEN VI-S**



3.5. Single Base Installation:

- Locate the RTU Base assembly on the floor.
- Adjust the RTU Robot surface to the Nominal Height.
- For Side Track RTU, raise the Cable Track support brackets up enough to not interfere with the leveling procedure of the RTU. Brackets are slotted for this purpose.
- Use a straight steel edge (Preferably 4 ft. long). Lay it along the inside edges of the fixed rail, and make sure that the Base assembly is straight.
- If the Base is distorted, straighten it to comply with the straight edge. Straightening of the slightly deflected Base can be achieved by pushing lightly with a 'pry-bar' as necessary.
- Rough leveling: Use leveling instrument and level the RTU along the length and across the rails to about 0.005" per 12". The RTU will have to be precisely leveled to 0.0005" per 12" after anchoring to the floor.
- Move to the next procedure "Anchor to the Floor".

3.6. Multiple Base Installation:

- Locate the End Base in position of the RTU's final location.
- Adjust the RTU Robot surface to the Nominal Height.
- For Side Track RTU, raise the Cable Track support brackets up enough to not interfere with the leveling procedure of the RTU. Brackets are slotted for this purpose.
- Use a straight steel edge (preferably 4 ft. long). Lay it along the inside edges of the fixed rail, and make sure that the Base assembly is straight. Pay close attention at the interfaces of the two linear bearing rails.
- If the Base is distorted, straighten it to comply with the straight edge. Straightening of the slightly deflected Base can be achieved by pushing lightly with a 'pry-bar' as necessary.
- Rough leveling: Use leveling instrument and level the RTU along the length and across the rails to about 0.005" per 12". The RTU will have to be precisely leveled to 0.0005" per 12" after anchoring to the floor.
- Position the next Adjoining Base with the Linear Rail roughly aligned.
- Exercise precision and align the Fixed Rail and the Floater Rail to their mating surfaces on the End Base section.
- Check to see if the bottom of the Linear Rails can be slid onto their mating surfaces. Adjust the height of the Adjoining Base slightly higher such that it can be pushed on to the End Base, then lowered onto the End Base surfaces.
- Precisely align the Fixed Rail of the Adjoining Base to the ledge surface on the End Base.
- Align the Master Gear Rack across the assembled Base Gear Racks and clamp against both Gear Racks. Adjust the Adjoining Base in-out distance to the Master Rack.
- **The Combination of the Linear Bearing Fixed Rail, Floater Rail and use of Master Gear Rack are expected to line up the RTU Bases.**
- Install the Linear Bearing Rail Fasteners with Loc-tite, and then install plastic screw caps.
- Align and install other Adjoining Bases to complete assembly of all the RTU Bases.
- Install remaining hardware to attach Cable Track Guide Trays where Bases were joined.
- Cable Track may be rolled up onto one of the Bases for shipping. Unroll the Cable Track and re-attach Fixed End to the provided mounting holes.
- Move to the next procedure to anchor the RTU to the floor.

3.7. Anchor to the Floor:

- Observe the clearance between the floor and bottom of the RTU Anchor Pads.
- If there is clearance, adjust the leveling screws as required to sit the RTU Anchor Pads firmly on the floor. Use anchors as specified and anchor the RTU to the floor.
- Anchors are provided by Installation Contractor.

Recommended Anchoring System:

- Hilti Anchor #HSL-3 M16/50
- Hilti 24.0 dia. Drill Bit #TE-C-T 24/27
- Min. Embedded Depth: 100.0 [4”]
- Min. Concrete Compressive Strength: 4000psi
- Min. Concrete Thickness: 150.0 [6”]
- Installation Torque: 120 Nm [89 ft-lb]

Anchor type may be substituted. Customer or Installation Contractor must contact appropriate anchor manufacturer for equivalent anchor specifications.

3.8. Final Leveling and Adjustments:

Level check across the rails and along the length of the rails. Check at 1 meter distances.

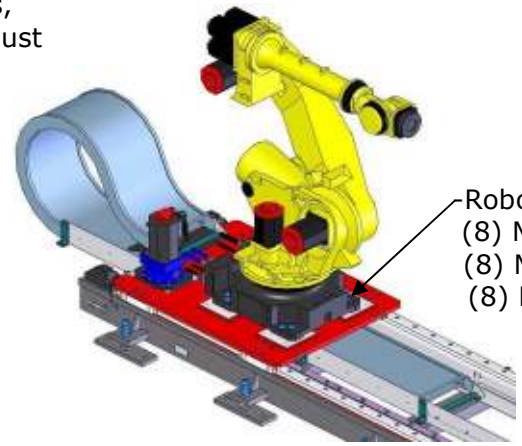
- Lay down the level across the two Linear Rails side ways and check the level of the RTU. The RTU must be leveled to 0.0005” per 12 ”.
- Use the Leveling Screws to level the RTU. Check the level at the interval of 1 meter and verify that the RTU is leveled as specified.
- Lay down the level on the fixed linear rail, along the length and check the level of the RTU. The RTU must be leveled to 0.0005” per 12 ”.
- Use the Leveling Screws to level the RTU. Check the level at the interval of 1 meter and verify that the length level is to specification.
- After completing leveling checks. Torque M36 leveling screw jam nut to 250 ft-lb. Torque Leveling Screw M24 thru bolt to 250 ft-lb.
- For Side Track RTU, lower the Cable Track support brackets to sit firmly on the floor and re-tighten to the Base; brackets are slotted for this purpose. Install Anchors in hole provided in each bracket.

3.9. Robot Installation:

Clean the Robot mounting surface of the RTU Carriage if needed. Install the Robot in the orientation required for the application. Apply Loc-tite and torque Robot Mounting Bolts to 530 Nm [390 ft-lb]. Attach cables from Cable Track exit to base of Robot.

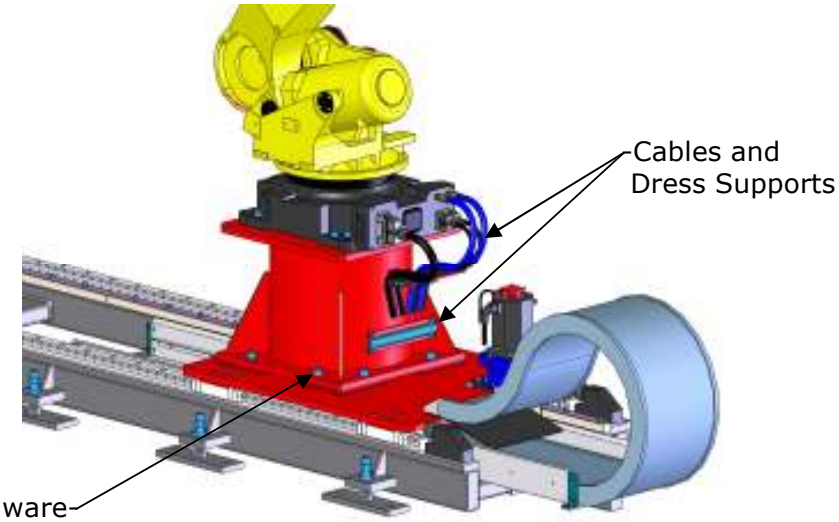
Important Note:
For the following configurations, Robot mounted Fork Pockets must be removed prior to installing Robot on RTU:

SD-S Hip @ 0°
SD-S Hip @ +90°
SD-S Hip @ -90°
SD-S Base @ +90°
SD-S Base @ -90°
HD-S Hip @ 0°
HD-S Hip @ +90°
HD-S Hip @ -90°



3.10. Riser Installation:

Clean the mounting surface of the RTU Carriage if needed. Install the Riser in the orientation required for the application. Apply Loc-tite and torque Riser Mounting Bolts to 944 Nm [696 ft-lb]. Install Robot, see section "Robot Installation". Attach cables from Cable Track exit to base of Robot. Cables must be dressed and supported on Risers above 300mm.



4 Linear Bearing Installation and Adjustments

4.1. Overview:

This procedure applies to assembly of a new RTU or an RTU that requires replacement of the Linear Bearings in the field.

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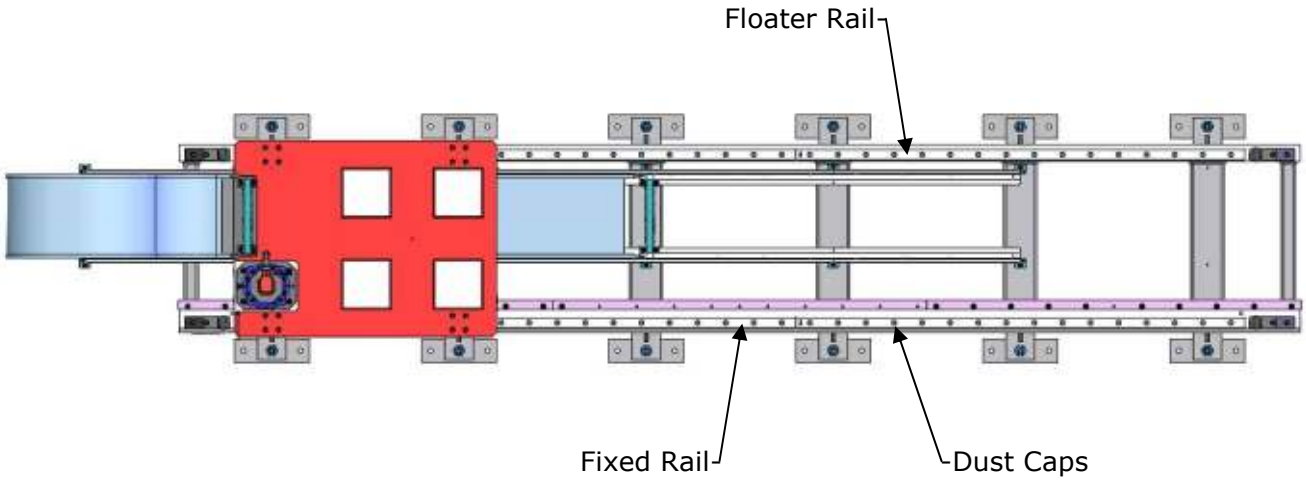

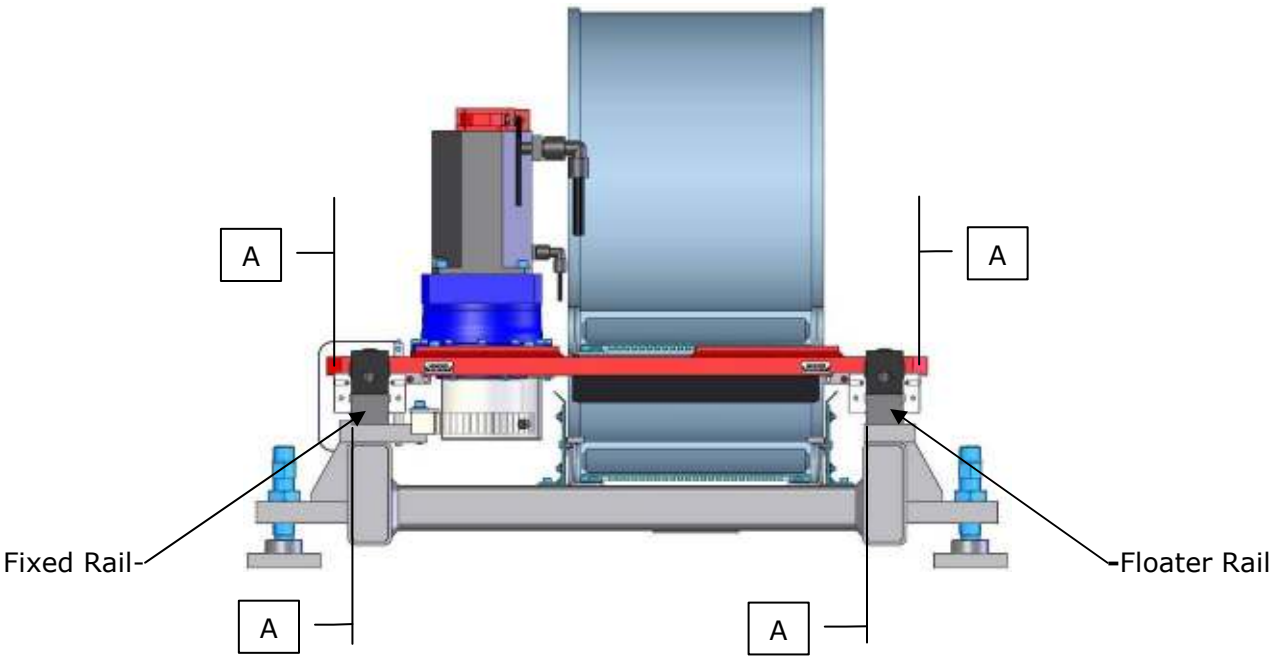

Bearing Datum Side indicated by symbol –A-

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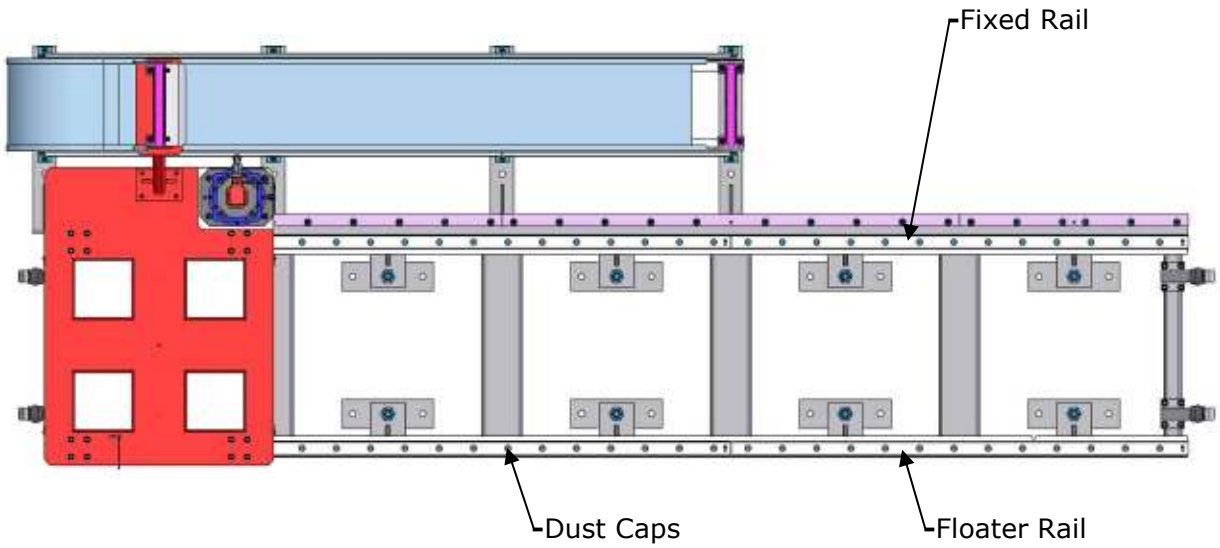
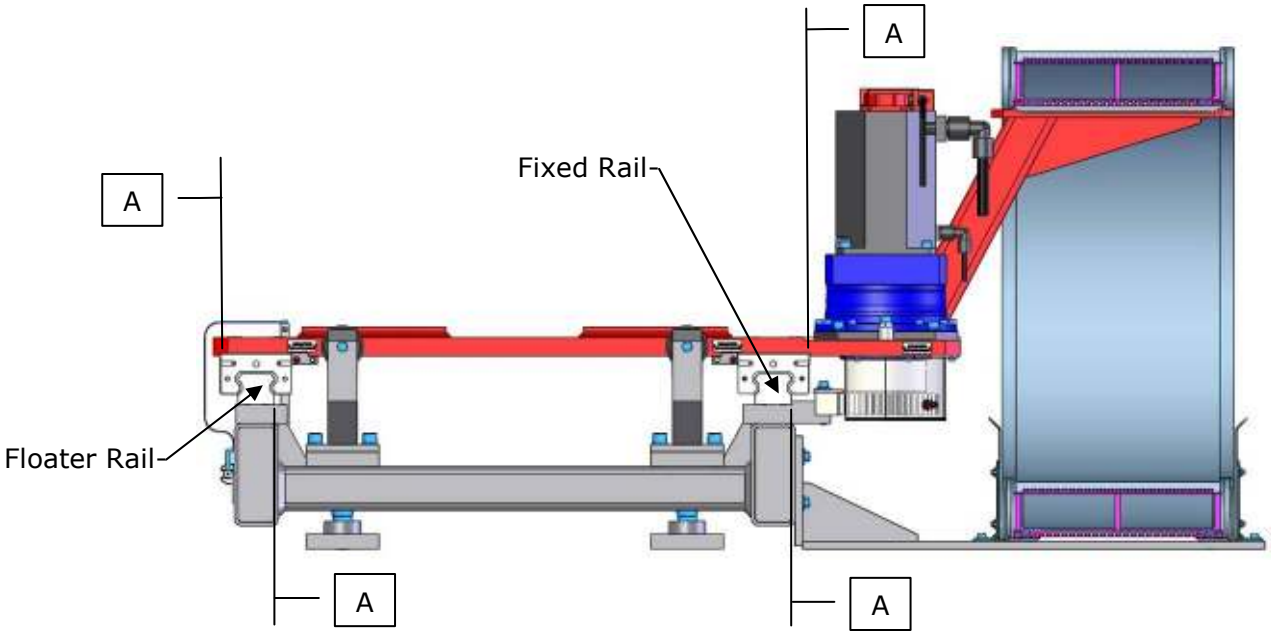




Bearing Datum Side indicated by symbol –A-

4.2. Procedure:

- Make sure that the RTU Base is leveled per installation procedure.
- Observe the "datum" side of the Bearing Rails and Bearing Blocks. The Rails have a small v-groove on the bottom indicating the datum side. The Bearing Block datum side is opposite the grease port.
- Install Fixed Rail datum side against ledged surface on Base and loosely install all mounting bolts.
- Push the rails together from the ends to ensure there are no gaps from one rail section to the next.
- Clamp the bearing rails against the ledged surface and begin tightening the bolts starting from one end and continuing down to the opposite end.
- Torque Fixed Bearing Rail mounting bolts to 196 Nm [145 ft-lb].
- Install Floater Rail on the Base with datum side in the same direction as the Fixed Rail, and loosely install the mounting bolts.
- Slide Bearing Blocks onto the Linear Rails and attach the RTU Carriage. Bearing Block datum must face the ledge surface on the carriage.
- Install Bearing Block Keepers on the underside of the Carriage and tighten all carriage mounting bolts.
- Move the carriage from one end and traverse to the other end.

Note:
If the power to the RTU is connected, slowly jog the RTU to move the carriage.
If the power is not connected, disengage the drive by use of a motor brake box.

- Slowly move the carriage back to the other end. Tighten the bolts on the floater rail as the carriage is moved.
- Move the carriage on the RTU two or three times and make sure that the carriage can move free of mechanical interference or binding.
- Torque remaining Bearing Rail bolts to 196 Nm [145 ft-lb].
- Install mounting screw dust covers on the linear rails.

5 Gear Rack Installation and Adjustments

5.1. Overview:

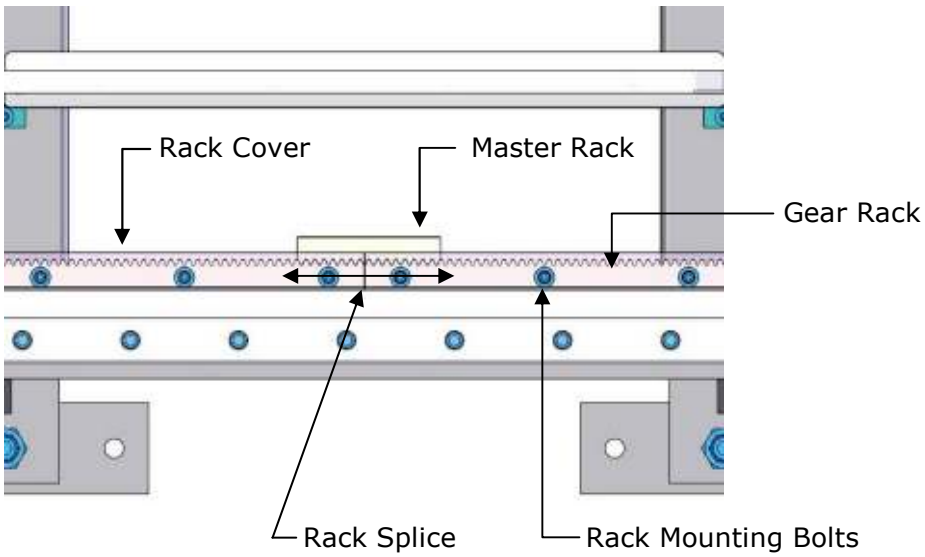
This procedure applies to assembly of a new RTU or an RTU that requires replacement of the Gear Racks in the field, and must be done after the RTU is anchored to the floor and leveled. This procedure will also validate if the adjoining rack splices are mated properly for full pitch distance.

If the mating racks do not have nominal pitch distance between them, then the pinion and or rack will fail prematurely. Under such mismatched condition, the drive will make an abnormal impact noise when the pinion travels over the splice from one gear rack to the next.

5.2. Procedure:

Start from one end of the RTU and install the racks to the Base per the assembly drawings. Tighten the bolts on the first rack only and install the rest of the rack bolts loosely. Use the following procedure to tighten the remaining Gear Racks:

1. With the first rack tightened, use a master rack and hold it firmly against the two adjoining racks to mesh them together.
2. OBSERVE THAT THE TEETH ON THE MASTER RACK ARE IN COMPLETE MESH WITH ALL THE TEETH OF THE TWO ADJOINING RACKS.
3. If the gear racks are meshed as described, tighten down the adjoining rack.
4. If the rack teeth do not mesh, move the adjoining rack closer or further from the tightened rack until proper mesh is achieved.



5. Repeat this procedure along the length of the RTU at all adjoining rack splices.
6. Jog the robot along the length of the RTU at various speeds and check that the pinion meshes properly and smoothly. Pinion travel must be free of binding and noise when it travels from one gear rack to the next.
7. When complete and tested, install dowels by transfer drilling into the RTU base using the dowel hole provided in each rack.

6 Cable Track Installation and Adjustments

6.1. Overview:

This procedure applies to assembly of a new RTU or an RTU that requires replacement of the Cables or Cable Track System in the field, and must be done after the RTU is anchored to the floor and leveled.

6.2. General Requirements:

1. **Min Bend radius requirements**:
   The process lines must meet the minimum bend radius of the Cable Track: 14.7" [373.0mm].
2. **Max Diameter requirements**:
   Maximum diameter of the process line must be <1.3" (33.0 mm).
3. **Hi-flex requirement:**
   All process lines are required to be of hi-flex design.
4. **Material:**
   The process lines are recommended to be of smooth and wear resistant outside surface.
5. **Protection:**
   Provide adequate protection to the process lines and Cable Track avoiding harsh contaminants, chemical or heat exposure.

6.3. Installation:

1. Install the Cable Track Guide Trays, Mounting Brackets, and Runners on the RTU Base per the Assembly drawings.
2. Refer to FANUC **GEN VI RTU Cable Installation Guideline** for completion of cable track and cable installation.
3. For Center Cable Track RTU
   Refer to FANUC Drawing **Attachment-1: MO-6225-CBL-ARR** (GEN VI)
   Cable arrangement for placement of process lines and locations of separators.
4. For Side-Cable Track RTU
   Refer to FANUC Drawing **Attachment-2: MO-6225-CBL-ARR-S** (GEN VI-S)
   Cable arrangement for placement of process lines and locations of separators.

7 Drive Assembly Installation

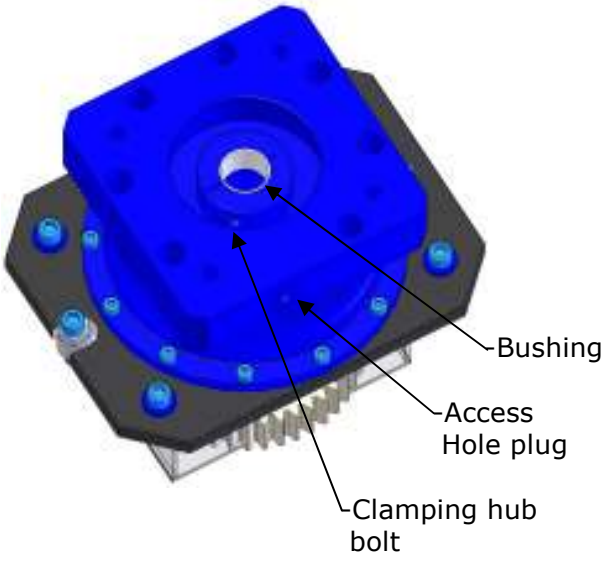
7.1. Overview:

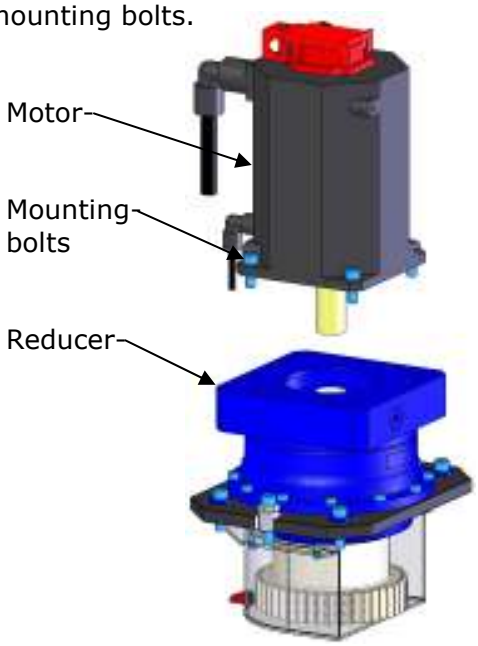
This procedure applies to assembly of a new RTU or an RTU that requires replacement of the Drive components in the field. The RTU Drive Assembly is bench assembled without the motor prior to installation onto the RTU Carriage. Contact FANUC Robotics Customer Service to obtain specific information and instructions on replacing drive assembly components. When the Drive Assembly is removed and then reinstalled onto the RTU Carriage, the Back-lash must be reset, see Section "Back-lash Adjustments" for the procedure.

Do not remove the Drive Assembly except to repair or replace a specific drive component. If the RTU Carriage needs to be moved with the Drive Assembly installed, power-up the unit or use a Brake Box to release the motor brake.

7.2. Motor Replacement:

1. Note: Replacing the Motor does not require resetting the Back-lash.
2. Remove the access hole plug on the side of the gear reducer.
3. With power on the RTU, slowly move the carriage until the reducer clamping hub bolt is aligned with the access hole. Power down the RTU and disconnect cables to the motor.
4. Loosen the M8 bolt on the reducer clamping hub, remove 4x M12 motor mounting bolts, and then slide the motor up and out of the reducer.
5. Thoroughly clean the mounting surfaces of the reducer and the motor. Do not use compressed air. Inspect mounting surfaces for damage or impurities.
6. Check that the reducer bushing is installed in the reducer. Align the motor shaft with the reducer clamping hub and slowly lower the motor into the reducer.
7. With the motor seated firmly against the reducer mounting face, snug tight the reducer clamping hub bolt.
8. Install the motor mounting bolts, apply loc-tite 242, and tighten to 112Nm [82.5 ftlbs].
9. Tighten the reducer clamping hub bolt to 79Nm [58 ftlbs].
10. Reinstall the reducer access hole plug, tighten to 50Nm [37 ftlbs].
11. Apply orange tamper evident paint to motor mounting bolts.





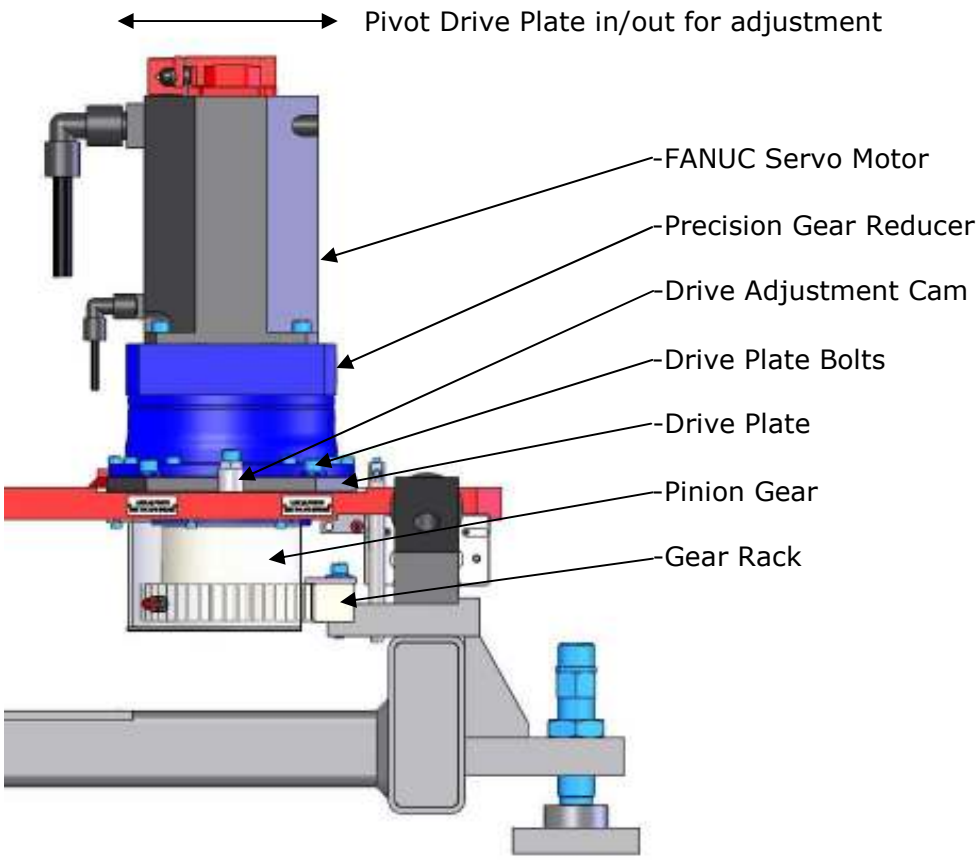
8 Back-lash Adjustments

8.1. Overview:

This procedure applies to assembly of a new RTU or an RTU that requires replacement of the Gear Rack and Drive Assembly in the field, and must be done after the RTU is anchored to the floor and leveled.

8.2. Procedure:

1. Snug tight the Drive Plate bolts such that the plate can still be moved in/out to adjust the back-lash between the Pinion and the Gear Rack. The Drive Plate is doweled on one end so the Drive Plate can rotate in/out by rotating the Drive Adjustment Cam.
2. Loosen the bolt on the Drive Adjustment Cam and push the motor/drive assembly so the Pinion completely meshes with the Gear Rack. Back it off so backlash measures about 0.004". Tighten the Drive Adjustment Cam bolt and the Drive Plate bolts.
3. Power the controller and jog the robot to about 1 meter distances and check the back-lash at these locations. Detect the high point (Location of min. back-lash).
4. Adjust the back-lash at the high point to 0.003".
5. Verify that the back-lash along the length of the RTU is in the range of 0.003"~0.006".

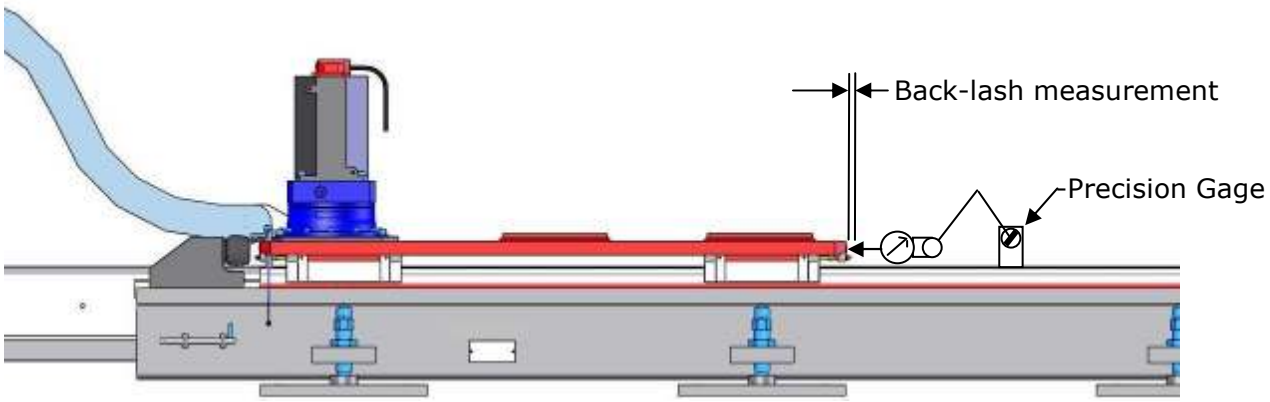


8.3. Method to Measure Back-lash:

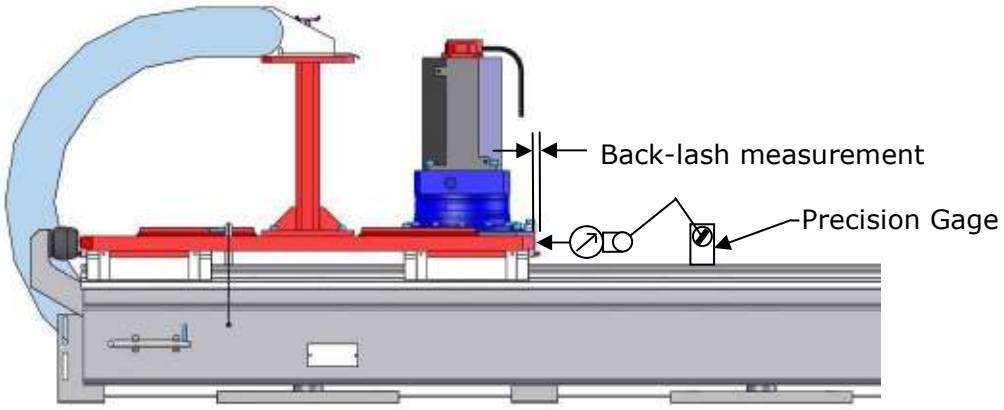
Install a dial gage indicator with magnetic base on Bearing Rail and adjust the dial gage probe to read movement of the carriage along the direction of travel.

1. Locate the Precision Dial Gage with magnetic base on a Bearing Rail.
2. Select a smooth surface on the carriage and Zero the gage by pushing the Carriage to one side.
3. Gently Push the Carriage back-and-forth and read the back-lash measurement.

GEN VI



GEN VI-S



9 Lubrication

9.1. Overview:

This procedure applies to assembly of a new RTU or an RTU that requires Lubrication in the field. Refer to the Section **Maintenance Schedule** in this manual for additional information and lubrication intervals.

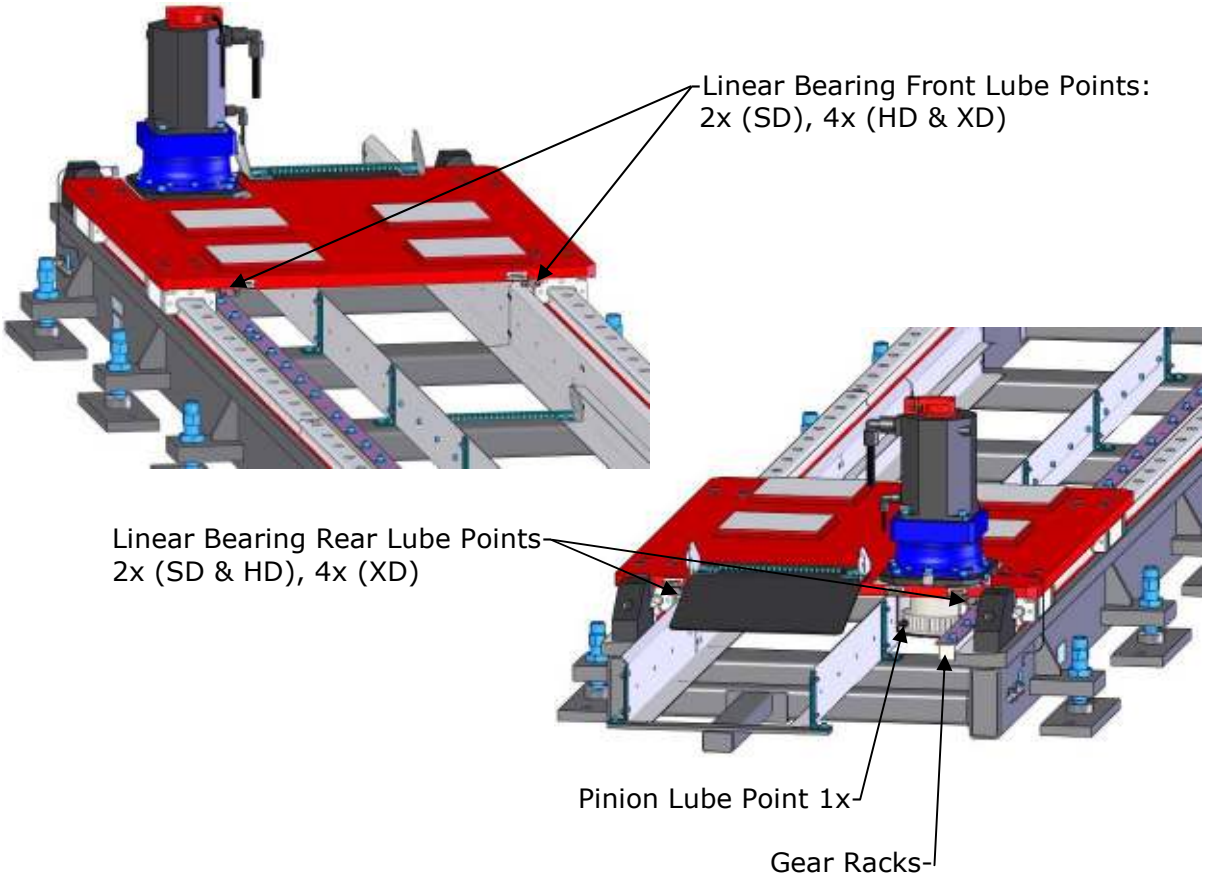
9.2. Procedure:

1. Linear Bearings: THK AFB-LF Grease
   Method: Inject grease to the grease fittings located at the ends of the RTU Carriage. Inject grease until fresh grease comes out of the bearings.
   Bearing capacity is 22cm^3 each.

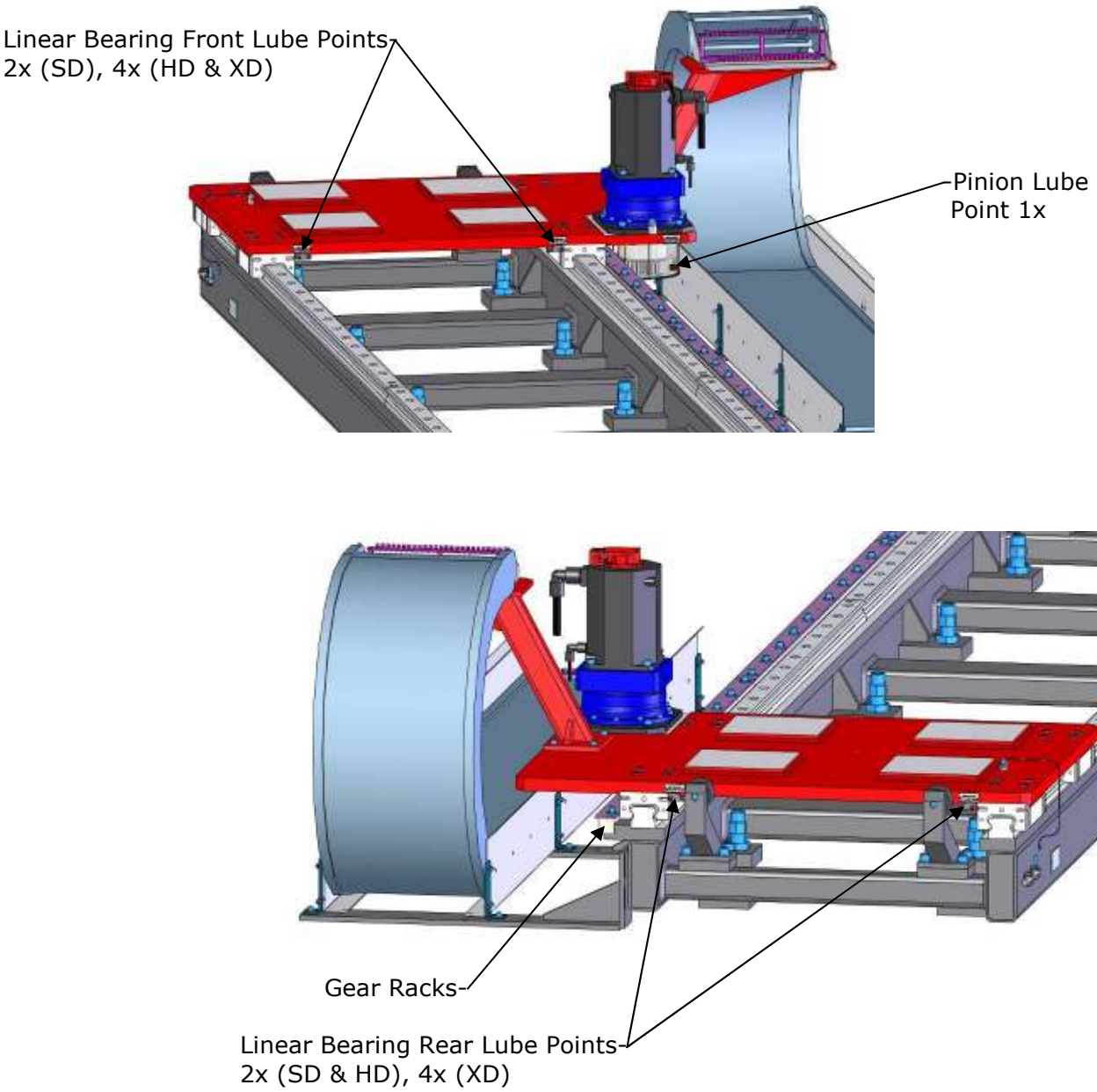
2. Pinion: LG-01-02 Grease (GMF Robotics Specification)
   Method: Inject grease to the grease fitting on the Pinion Cover. Inject Grease until fresh grease is visible on the pinion.

3. Gear Racks: LG-01-02 Grease (GMF Robotics Specification)
   Method: Wipe the Gear Racks clean of old grease, dirt, and other contaminants. Apply new grease to Gear Rack using a Brush.

GEN VI



GEN VI-S


Linear Bearing Front Lube Points
2x (SD), 4x (HD & XD)
Pinion Lube
Point 1x
Gear Racks
Linear Bearing Rear Lube Points
2x (SD & HD), 4x (XD)

10 Linear Axis Set-up and Mastering

10.1. Overview:

The RTU must be configured as a linear axis to function with the Robot. FANUC Robotics offers two options to configure a linear axis: (a) Integrated Axis OR (b) Non-Integrated Axis. If the linear axis is configured as an Integrated Axis with the Robot, then the TOOL TCP is affected by the robot axes positions and linear axis position.
This is the Recommended Option to Configure the Linear Axis.
For further information, reference **Section 4 "Modifying the Extended Axis Setup Manually"** in the FRA Software Installation Manual #MARFISI6406041E.

10.2. Input data for Controller Set-up and Mastering:

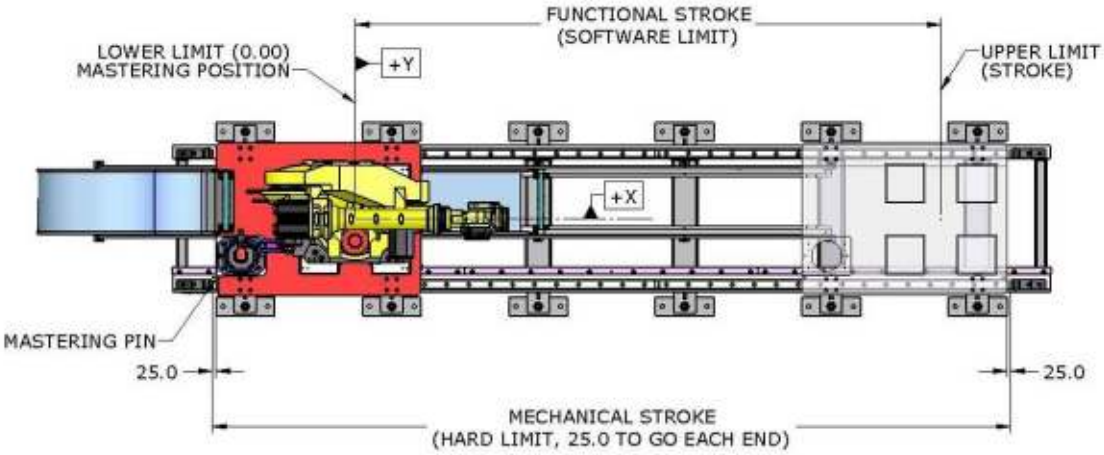
#	Mastering Information	Data
1	Group	1
2	Hardware	7 Typical
3	Motor type	SD, SD-S: ais30/4000 SDHS, SDHS-S: ais40/4000 HD, HD-S: ais40/4000 XD, XD-S: ais40/4000
4	Current Limit	SD, SD-S: 160A SDHS, SDHS-S: 160A HD, HD-S: 160A XD, XD-S: 160A
5	Extended Axis Type	1 (Integrated Rail) = typical 3 (Auxiliary Linear Axis) = optional
6	Extended Axis Direction	Rail Alignment to be with respect to the user frame of the axes of the robot
7	Gear Ratio (SD, SD-S), 10:1 Reducer Gear Ratio (SDHS, SDHS-S), 10:1 Reducer Gear Ratio (HD, HD-S), 16:1 Reducer Gear Ratio (XD, XD-S), 16:1 Reducer	SD, SD-S: 55.0000mm/Motor Rev SDHS, SDHS-S: 55.0000mm/Motor Rev HD, HD-S: 34.3752mm/Motor Rev XD, XD-S: 34.3752mm/Motor Rev
8	Linear Speed (mm/sec) **Note: Do not use the default values from the controller. Set-up the linear speeds as noted in this table.**	SD, SD-S: 2200mm/sec SDHS, SDHS-S: 2500mm/sec HD, HD-S: 2200mm/sec XD, XD-S: 1800mm/sec
9	Motion sign (True or False) Determines which way motor turns when the +ve jog key of the linear axis is pressed.	Select motion sign so that +ve direction of the RTU axis matches with the Robot: +ve X (Robot mounted as shown in Mastering) **Note: Validate this Motion Direction after power down and restart.**
10	Upper limit (mm)	RTU Stroke
11	Lower limit (mm)	0.00
12	Master position	0.00
13	Accel Time_1 (ms)	800 (Can be optimized based on process)
14	Accel Time_2 (ms)	400 (Can be optimized based on process)
15	Min Accel Time (ms)	256
16	Load ratio	5
17	Axis Amp # (Physical location of Aux Amp)	2 (typical), 3 or 4 (optional)
18	Axis Amp type	2 (Alpha i)
19	Brake #	2
20	Servo time out	1 (Enable)
21	Servo time out value (seconds)	20

10.3. Mastering:

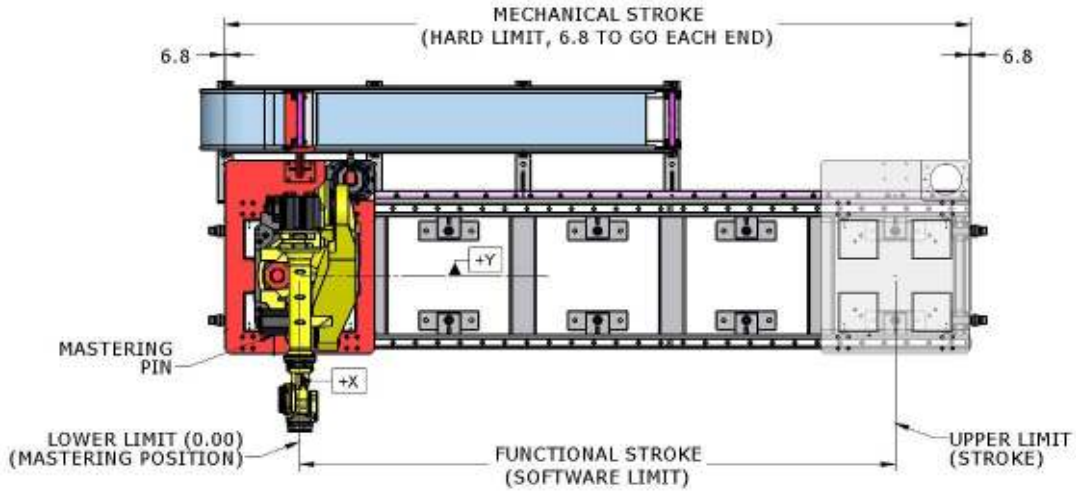
The RTU must be mastered to establish the 'Zero position' of the travel, the work envelope of the RTU, to assign motion directions, and other parameters required for safe operation of the RTU. The Carriage of the RTU and each Base of the RTU are equipped with Mastering Holes and a Mastering Pin. Use the Mastering Hole on the Left end of the Base. Selection of this mastering hole will establish + X and + Y as shown in the figure below.

1. Jog the Carriage to align the mastering hole on the left end Base.
2. This is the mechanical mastering position of the Carriage. Insert the Mastering Pin to align the Carriage with the Base.
3. Refer to FANUC Robotics "Robot Mechanical Unit Operator" manual for the mastering procedure associated with the Robot Controller.
4. Assign Lower Limit and Upper Limit to establish the work envelope of the RTU. Input other data as required in the Linear Axis Set-up Procedure of the RTU.

GEN VI



GEN VI-S



11 Performance Check, Run-Off, and Validation

11.1. Overview:

All RTU's are assembled per product specification and servo tuned for general applications. Upon completion of the RTU assembly and adjustments, the RTU's are programmed for a test run to validate their performance and durability. This validation is required for new RTU's as well as RTU's that have the Motor, Reducer, Pinion, Gear Racks, Linear Bearings, Cable Track or Cables replaced.

11.2. FRA Assembly Checklist:

The FRA Supplier RTU Assembly Check List #FR00398, must be completed at final build and run-off of each RTU.

11.3. Program Test Path:

The programmed test path for validation consists of the following:

1. Begin at Home (Mastering Position)
2. Travel Full RTU stroke, 5 sec delay
3. Travel to Home, 5 sec delay
4. Repeat

11.4. Run-Off Checks:

The Following table identifies the items to be reviewed during the Run-Off of the RTU.
RTU Run-time after build: 20 hours continuous
RTU Run-time after final installation: 8 hours continuous

#	Check Item	Check List/Qualification
1	Mechanical Assembly Check	➢ No evidence of abnormal noise ➢ No evidence of loosening of parts ➢ No evidence of wear at Linear Bearings ➢ No evidence of wear at Gear Rack & Pinion ➢ No evidence of wear at Cable Track items ➢ No evidence of wear at process items: • Cables moving, twisting, or crossing • Cables secured at Cable Track ends ➢ No evidence of lubrication problems ➢ No evidence of installation problems: • The RTU is leveled to specification • The anchor bolts are installed and secured to the floor • The Leveling Screws are secured
2	Motor Performance Check	➢ No evidence of motor over current ➢ No evidence of over temperature ➢ No evidence of encoder errors ➢ No evidence of abnormal noise
3	RTU Repeatability Check	➢ SAMPLE POPULATION 500: • must show max repeatability: +/-0.25mm(Unidirectional)
4	Miscellaneous Check	➢ RTU is clean of assembly debris ➢ Paint is touched-up as required ➢ Tags are installed as required

During the **Run-Off Procedure**, the following detection methods are used:

- Bearing binding: Severe bearing binding can be detected by high pitch noise from the motor.
- Rack and Pinion Back-lash: Severe Gear Rack binding can be detected by high pitch noise from the motor. Loose mesh or mismatched Gear Rack splices can cause "clunking" sound.
- Cable Track binding/rubbing: Check Guide Tray straightness and clearance.
- Cable Twisting: Visual inspection. Refer to **GEN VI RTU Cable Installation Guideline** for detailed information.

11.5. Run-Off Procedure:

1. After Mastering RTU, jog full stroke in slow-speed to verify soft limits are correct and carriage does not contact hard stops.
2. Teach test program (See **Program Test Path**).
3. Run program in T1 mode using step forward/back and perform **Run-Off Checks**.
4. Run program in auto at 15%. Perform Run-Off Checks. Record max torque value for axis 7 from status/monitor screen on teach pendant on form #FR00398 (Supplier RTU Check List). Record start time, date and hour meter reading on the form.
5. If RTU passes initial Run-Off Checks, increase speed to 25% and perform Run-Off Checks again. Run RTU for 20-30 minutes and perform Run-Off Checks.
6. Increase speed by 10-15% and perform Run-Off Checks. Check monitor screen for unusual spikes in avg/max torque values. Continue this process for the next one hour increasing the speed 10-15% at 15 minute intervals while performing Run-Off Checks. Check monitor screen for unusual spikes in avg/max torque values.
7. After 1.5 hours with no issues, set speed to 75%. Run RTU to complete the 20 hour run, periodically performing Run-Off Checks.
8. After 20 hour run is complete, run repeatability tests at 25%, 50% and 100% speeds. Complete form #FR00398 (Supplier RTU Check List) and file in appropriate location.

12 Maintenance Schedule

RTU#:_____
Date:_____

Maintenance Item	Maintenance Task (RTU locked-out)	Frequency	Task Complete
Linear Bearing Visual Inspection	Clean Linear Bearings free of debris, rust and build-up of other contaminants. Inspect Linear Bearings for surface damage. Replace as necessary.	1 month	
Linear Bearing Lubrication	Clean grease fittings free of dirt and inject new grease at each location until fresh grease comes out of the bearings. Refer to **RTU Lubrication** section. Use THK AFB-LF Grease.	6 months or 2000 hrs	
Rack & Pinion Visual Inspection	Clean Rack & Pinion free of debris, rust and build-up of other contaminants. Inspect Rack & Pinion for surface damage. Replace as necessary.	1 Month	
Rack & Pinion Lubrication	Clean Rack & Pinion free of debris, rust and build-up of other contaminants. Apply new grease to Pinion grease fitting and brush on to Gear Rack. Refer to **RTU Lubrication** section. Use LG-01-02 Grease.	6 months or 2000 hrs	
Cable Track & Cable Visual Inspection	Clean debris from the Cable Track. Visually inspect cables for twisting, kinks, worn, or broken outer jackets. Inspect Cable Track for cracked or broken links. Inspect cable clamps at entrance and exit of Cable Track for broken or loose clamps. Replace broken or worn components as necessary.	1 month	
Gear Reducer Visual Inspection	Clean Gear Reducer free of dirt. Visually inspect for oil leaks. Gear Reducer is "lubed for life". Replace if leaking oil.	1 month	

Maintenance Item	Maintenance Task (RTU running)	Frequency	Task Complete
Overall Visual Inspection	Look for debris on and around the RTU structure that could obstruct the movement of the RTU. Lock-out the workcell and remove debris as necessary.	System Start-up	
Overall Audible Inspection	Listen for abnormal noise at Drive. Lock-out the workcell and Refer to **Back-Lash Adjustment** section. Listen for abnormal noise at Cable Track. Lock-out the workcell and Refer to **Cable Track Installation and Adjustments** section.	System Start-up	

13 Recommended Spare Parts

Item	Description	Part Number	Recommended Qty	Vender Information
1a	FANUC Motor Alpha 30/4000is SD, SD-S	A06B-0268-B705	1 per RTU Carriage	FANUC Robotics (248) 377-7159
1b	FANUC Motor Alpha 40/4000is SDHS, SDHS-S, HD, HD-S, XD, XD-S	A06B-0272-B705	1 per RTU Carriage	FANUC Robotics (248) 377-7159
2a	Gear Reducer 10:1 Ratio with Plate and Bushing SD, SD-S SDHS, SDHS-S	TP+110S-MF1-10-0K1/A40-STR	1 per RTU Carriage	Wittenstein Alpha Bartlett, IL 60103 (888) 534-1222
2b	Gear Reducer 16:1 Ratio with Plate and Bushing HD, HD-S, XD, XD-S	TP+110S-MF2-16-0K1/A40-STR	1 per RTU Carriage	Wittenstein Alpha Bartlett, IL 60103 (888) 534-1222
3	Pinion SD, SD-S, SDHS, SDHS-S, HD, HD-S, XD, XD-S	MO-6225-DRV-003	1 per RTU Carriage	FANUC Robotics (248) 377-7159
4	Gear Racks	MO-6225-000-005 (1000mm) MO-6225-000-006 (2000mm)	1 SET per RTU Refer to RTU BOM for quantities	FANUC Robotics (248) 377-7159
5	THK Carriage with Seals and Scrapers	SHS65V1KKHHE	1 SET per RTU Carriage SD RTU Qty (4) HD RTU Qty (6) XD RTU Qty (8)	THK Michigan (248) 858-9330 THK America, Inc. (847) 310-1111
6	THK Linear Rails	GEN VI SHS65+2000LGKE G/g=125/75 SHS65+2400LGKE G/g=75/75 SHS65+3000LGKE G/g=75/75 SHS65+3400LGKE G/g=25/75 GEN VI-S SHS65+1500LGKE G/g=75/75 SHS65+2000LGKE G/g=75/125 SHS65+2500LGKE G/g=75/25 SHS65+3000LGKE G/g=75/75	1 SET per RTU Refer to RTU BOM for quantities	THK Michigan (248) 858-9330 THK America, Inc. (847) 310-1111
7a	THK Grease	AFB-LF Grease	5 Gallons initially and then as determined by maintenance requirements	THK Michigan (248) 858-9330 THK America, Inc. (248) 310-1111
7b	Pinion Grease	LG-01-02 Robot Grease	5 Gallons initially and then as determined by maintenance requirements	Russack Inc. Columbus, OH 43212 (800) 231-6901
8a	Gleason Cable Track	GEN VI PT35G-T6-14.72-10-16/PP051906 GEN VI-S PT45G-T6-14.72-14	1 per RTU Carriage Refer to RTU BOM for length	Alliance Sales Troy, MI 48084 (248) 362-9595
8b	Gortrac Cable Track (RTU Assembly numbers with 'G' after stroke code)	GEN VI GT-10145 GEN VI-S GT-10146 (up to 6M Stroke) GT-10149 (7M+ Stroke)	1 per RTU Carriage Refer to RTU BOM for length	A&A Manufacturing (800) 394-1547

14 Shipping

14.1. Overview:

After completion of the RTU assembly and Run-off validation, the RTU is prepared for shipment. Single base RTU's will be shipped assembled with the Carriage in the center of the base. Multiple base RTU's will be separated at the base intersections and shipped separately. The Cable Track will be unbolted from the Fixed End and rolled up onto the first base. The RTU Carriage will be moved to the center of the first base. Refer to **Installation** section of this manual for installation in the field.

Protect all uncoated metal surfaces (Carriage mounting surface, Linear Bearings, and Gear Racks are lubricated and prepared for shipment and protected).

Use a designated lubricant on unpainted STEEL machined surfaces.

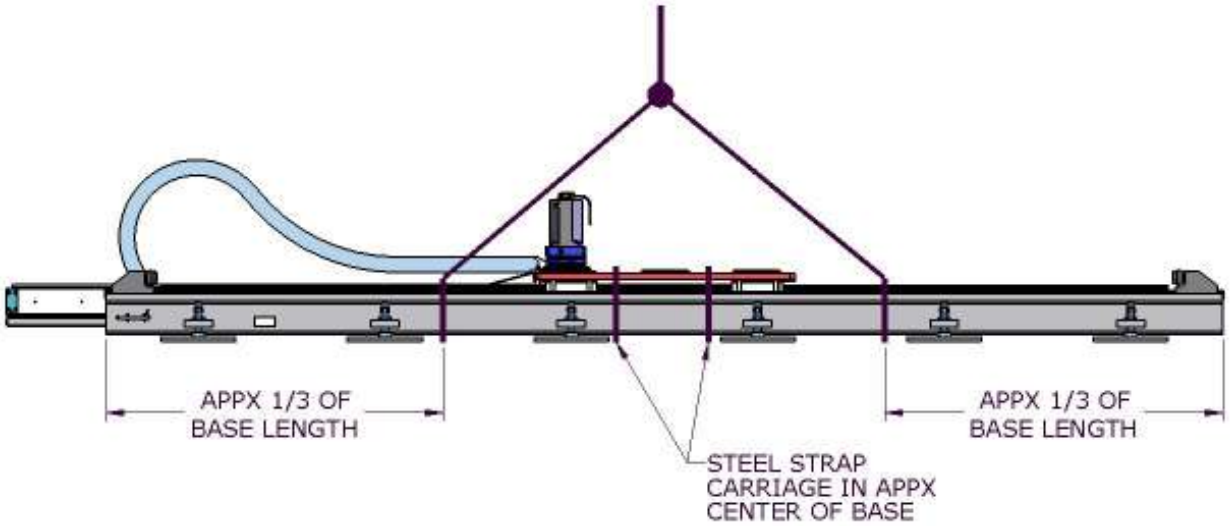
- Water Displacing Rust Inhibitor (WDRI) - A rust preventive with penetrating properties to effectively remove water from metal pores and crevices as well as smooth surfaces.
- Mineral Spirit Based - Fast evaporation, dry film, low flash point during application.
- Oil Based - Slow evaporation, high flash point normally over 300 degrees. A14'

WDRI shall comply with the following specifications:

a) Is water displacing
b) Neutralizes finger prints
c) Does not leave a thick or hard film
d) Is transparent
e) Non-staining
f) Extinguishable by C02 and Dry Chemical.

All moving items are fixed stationery for shipment to prevent damage.

Example lifting diagram:



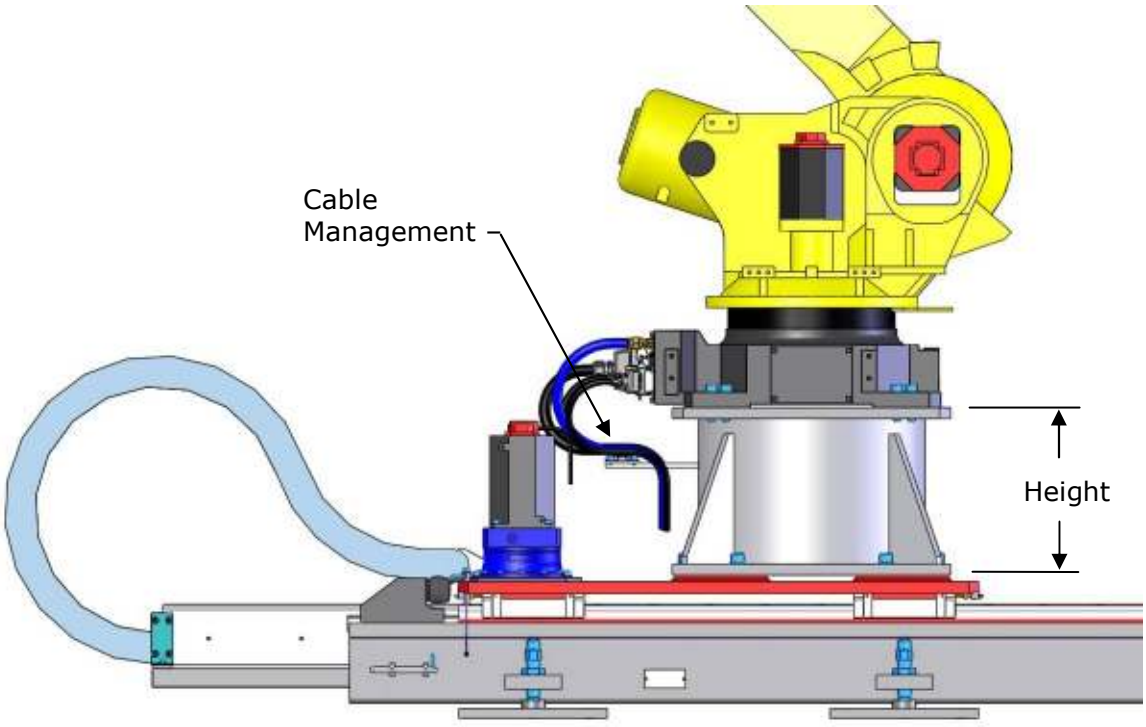
15 Available Options

15.1. Carriage Riser:

The RTU Carriage Riser Option is available to increase the height or reach of the Robot. The Riser is installed between the RTU Carriage and the Robot. It can be mounted in the same orientations that are available with a direct mounted Robot (Std 0°, +90°, -90°. The Riser provides cable management and all required hardware for installation.

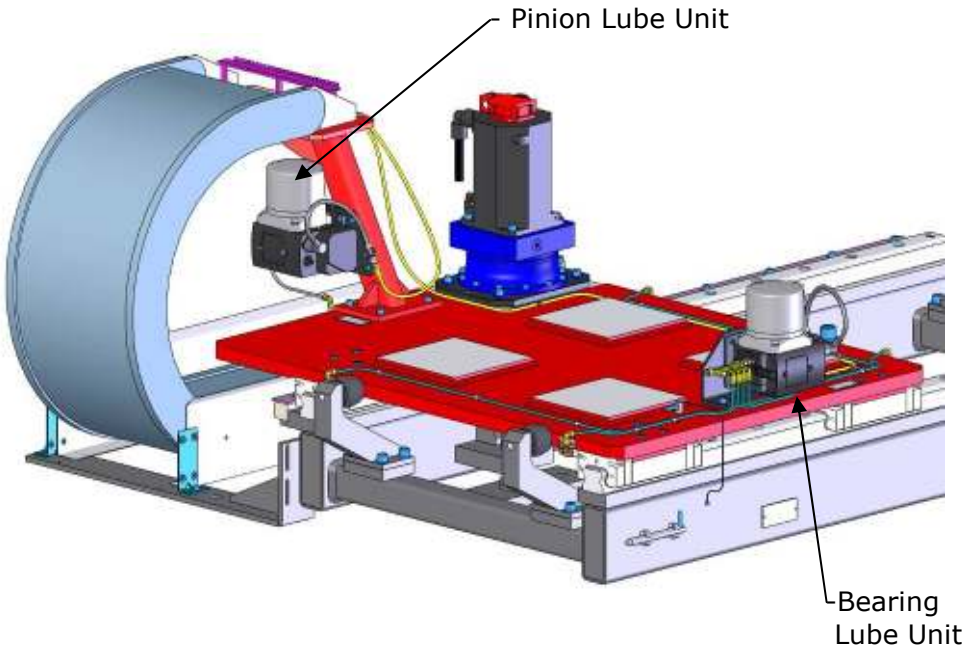
Note: Riser option is required for following Robot models:
R-2000iB "R" Series (300mm min. height Riser)
M-900iA/400L (150mm min. height Riser)

The Carriage Riser is available for all RTU types in the following heights:
150mm (minimum)
300mm
450mm
600mm
750mm
900mm
1050mm
1200mm (maximum)



15.2. Automatic Lubrication System:

The RTU Automatic Lubrication System provides unattended lubrication for the RTU. The system contains two Lube Units, one for the Bearing Rails and one for the RTU drive Pinion. They are controlled by the customer using the provided connection cables.



Refilling Requirements:
The Lube Units are refilled by injecting grease into the refill port. Each Lube Unit requires a specific type of grease and are filled and tested prior to shipment.
Use only the specified grease for refilling, No substitutions or mixing allowed.
Refer to "Recommended Spare Parts" section for grease supplier information.

- Pinion Lube Unit: 1.0 liter (1000 cc), LG-01-02 Robot Grease
- Bearing Lube Unit: 1.4 liter (1400 cc), THK AFB-LF Grease

Operation Parameters:
The end-user is responsible for operating the Lube Units. The programming requirements can vary depending on the RTU application (travel distance, number of cycles, number of shifts, etc.). The information below is based on typical RTU applications and can be used as a guideline to set-up the Auto-Lube system for all RTU types. The parameters can be changed to increase or decrease Lube frequency as required by the application.
The chart is based on 16 hours/day (2-shifts), 2500 km/year.

RTU Stroke	5 meter	10 meter	15 meter	20 meter
Pinion Unit cycles/day	1	2	3	4
Refill frequency	10.9 yrs	5.4 yrs	3.6 yrs	2.7 yrs
Bearing Unit cycles/day	1	1	2	2
Refill frequency (SD)	9.5 yrs	9.5 yrs	4.7 yrs	4.7 yrs
Refill frequency (HD)	6.3 yrs	6.4 yrs	3.2 yrs	3.2 yrs
Refill frequency (XD)	4.7 yrs	4.7 yrs	2.4 yrs	2.4 yrs

Pinion Lube Unit:

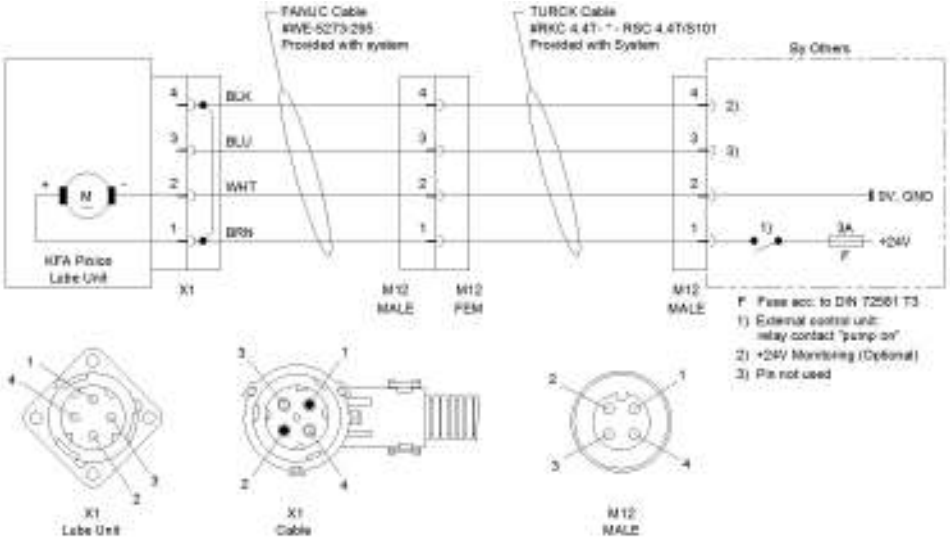
- Power the unit for 15 seconds = (1) complete lube cycle
- Available Lube (All RTU types): 4000 cycles (1000cc / 0.25cc per cycle)
- Cycles must be counted to alert the system that the reservoir is nearing empty.

Bearing Lube Unit:

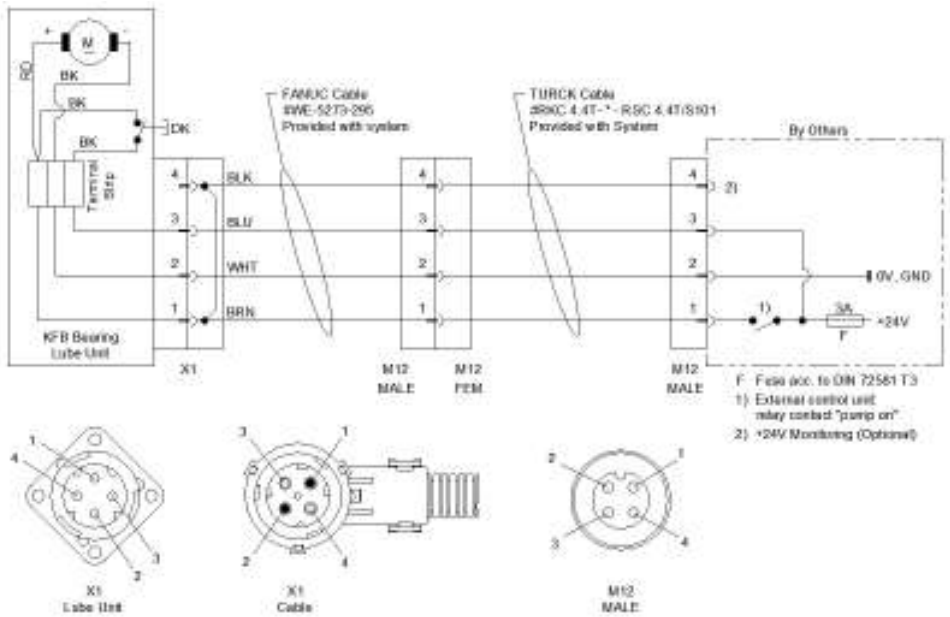
- Power the unit for 15 seconds = (1) complete lube cycle
- Available Lube (SD): 3500 cycles (1400cc / 0.40cc per cycle)
- Available Lube (HD): 2333 cycles (1400cc / 0.60cc per cycle)
- Available Lube (SD): 1750 cycles (1400cc / 0.80cc per cycle)
- Cycles must be counted to alert the system that the reservoir is nearing empty.

Following are schematics for each Lube Unit. Note "By Others" is required by the end-user.

Pinion Lube Unit
(Model KFA)

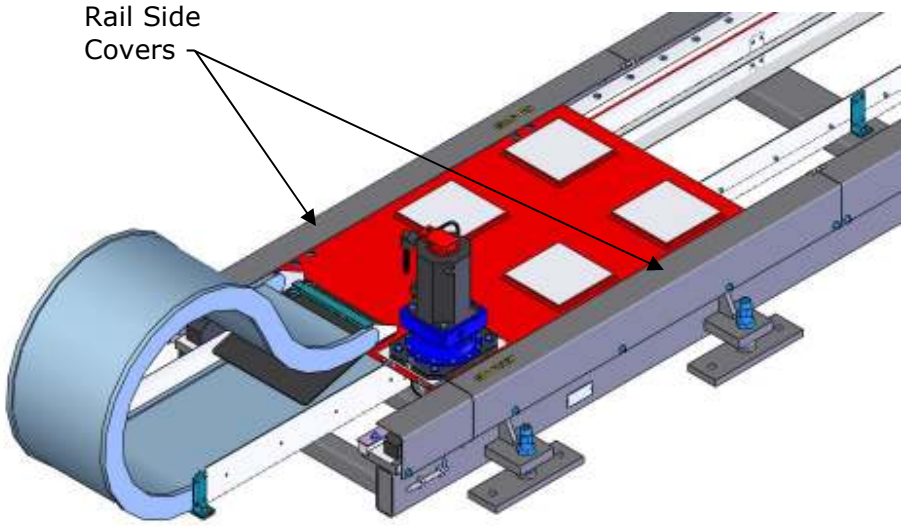


Bearing Lube Unit
(Model KFB)



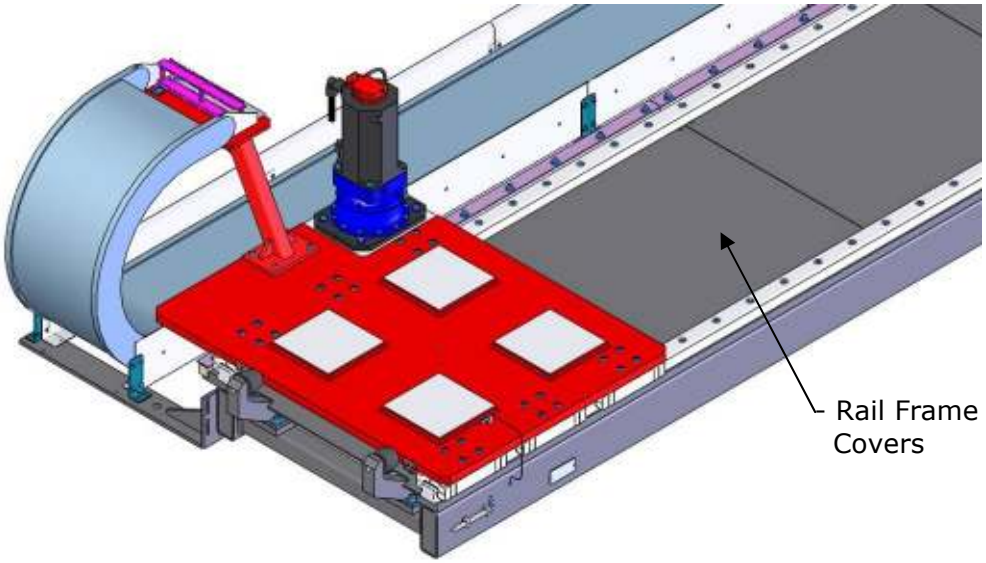
15.3. Rail Side Covers (Center Cable Track RTU Only):

The RTU Rail Side Cover Option is available for Center Cable Track RTU Type only. It provides additional protection to the bearing rails from debris.



15.4. Rail Frame Covers (Side Cable Track RTU Only):

The RTU Rail Frame Cover Option is available for Side Cable Track RTU Type only. It provides additional protection to the RTU frame from debris.



Addendum-1

Linear Axis Set-up and Mastering: FANUC Motor Alpha 30/3000is (Special)
This Addendum is for MO-6225-DRV-SPC1 Drive Assembly only.
See Section 9 for Standard Drive Parameters.

10.1. Overview:

The RTU must be configured as a linear axis to function with the Robot. FANUC Robotics offers two options to configure a linear axis: (a) Integrated Axis OR (b) Non-Integrated Axis. If the linear axis is configured as an Integrated Axis with the Robot, then the TOOL TCP is affected by the robot axes positions and linear axis position.
This is the Recommended Option to Configure the Linear Axis.
For further information, reference **Section 4 "Modifying the Extended Axis Setup Manually"** in the FRA Software Installation Manual #MARFISI6406041E.

10.2. Input data for Controller Set-up and Mastering:

#	Mastering Information	Data
1	Group	1
2	Hardware	7 Typical
3	Motor type	SD, SD-S: ais30/3000
4	Current Limit	SD: 80A
5	Extended Axis Type	1 (Integrated Rail) = typical 3 (Auxiliary Linear Axis) = optional
6	Extended Axis Direction	Rail Alignment to be with respect to the user frame of the axes of the robot
7	Gear Ratio (SD, SD-S), 10:1 Reducer	SD, SD-S: 55.0000mm/Motor Rev
8	Linear Speed (mm/sec) **Note: Do not use the default values from the controller. Set-up the linear speeds as noted in this table.**	SD, SD-S: 1600mm/sec
9	Motion sign (True or False) Determines which way motor turns when the +ve jog key of the linear axis is pressed.	Select motion sign so that +ve direction of the RTU axis matches with the Robot: +ve X (Robot mounted as shown in Mastering) **Note: Validate this Motion Direction after power down and restart.**
10	Upper limit (mm)	RTU Stroke
11	Lower limit (mm)	0.00
12	Master position	0.00
13	Accel Time_1 (ms)	1000 (Can be optimized based on process)
14	Accel Time_2 (ms)	500 (Can be optimized based on process)
15	Min Accel Time (ms)	256
16	Load ratio	5
17	Axis Amp # (Physical location of Aux Amp)	2 (typical), 3 or 4 (optional)
18	Axis Amp type	2 (Alpha i)
19	Brake #	2
20	Servo time out	1 (Enable)
21	Servo time out value (seconds)	20