



MARK ROBERTS MOTION CONTROL

BOLT™ JR+

COMPACT LIGHTWEIGHT HIGH SPEED CINEBOT™ RIG



QUICK START GUIDE

QSG Product Code: MRMC-2257

Products covered: MRMC-2083-04, MRMC-2073-02

Bolt™ Jr+ Quick Start Guide

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Chapter 1 Quick Start

Overview

Thank you for using the Bolt™ Jr+ Cinebot™ rig from Mark Roberts Motion Control (MRMC). Bolt Jr+ is designed for reliable day-in, day-out use in professional studio and Outside Broadcast environments. It has a small, lightweight robotic arm which can be used either as camera rig or model mover. There are two versions of Bolt Jr+:



Bolt™ Jr+ on Track has a base designed for moving along Precision Track, which can be bolted to the ground and can also be held down with weights at temporary locations. It has removable trolley wheels for moving between sets.



Bolt™ Jr+ on Pedestal has a stationary base which you either hold down with weights or, for more permanent installations, attach to the floor.

Safety procedures for using industrial robots, including high speed track

Note that the words **Robot** and **Rig** are completely interchangeable and identical in meaning, for the purposes of this document.

Motion Control rigs are potentially dangerous. It is important that you and everyone else on the set understand the safety notes on the following pages in order to stay safe.

You should use this document in addition to the normal Safety Manual instructions that are applicable to all motion control rigs, such as Milos. This section emphasises the safety concerns that are especially important around high-speed, high-acceleration, industrial-grade robots which can cause severe injuries, such as Bolt Jr+.

- Unlike traditional motion control equipment, Bolt Jr+ can get to maximum speed in the blink of an eye - too fast for someone to be able to quickly move out of the way.
- ⇔ If you are using Bolt Jr+ on Track, you need to take extra steps during installation and use due to the additional risks involved in using track. See the separate *Precision Track Quick Start Guide* for information on laying the track, securing it to the floor, and mounting Bolt Jr+ onto it. The notes given below for track users are marked with this symbol: ⇔.
- It is ultimately the **operator** of the rig who is responsible for the safe use of the equipment so never bypass any of the safety points listed here.
- No one other than a highly trained operator should use the robot, no matter how simple it looks or is.
- This document is for the use of robots for carrying cameras or props, not people. Additional safety steps should be taken prior to using a rig to carry people.

Assessing a site

Before setting up Bolt Jr+ you need to **assess the site**, paying particular attention to the following points:

- Is the ground or floor firm enough and level enough? You might have to use boards or bricks to create a level surface. The surface needs to be strong enough to take the weight of Bolt Jr+ itself (390kg) plus the weight of the track (95 kg per section) or for Bolt Jr+ on Pedestal 264kg plus weights 280kg of weights (2x140kg).
- Does the site have access? You need to make sure you can either push Bolt Jr+ into position on its wheels or carry it there using a pallet truck or forklift.
- Does the site have a power source with sufficient capacity for the robot and the correct mains voltage?
 - The BOLT Jr+ on Track is delivered with **2 x power cables and is designed to run from 2x240VAC 15A supplies only. Both cables must be used.**
 - Bolt Jr+ on Pedestal requires a **230V, single-phase power supply via a 13A power connector.**
 - The computer stack that controls Bolt Jr+ (that is, the desktop computer and the power supply brick for the RT-14 interface box) are auto-switching and can run on 120-240 Volts AC.
- Does the site have unusual environmental attributes that require specialised protection from extreme temperatures, humidity, rain, or dust?

Installation safety

- Due to the large mass of the rigs and the accelerations they achieve it is important that they are securely mounted, with the recommended plates and bolts to a secure and concrete floor.
- ⇔ When using track, ensure that it is properly bolted to the floor. If bolting the track is not possible, use 140kg of counter weights on each corner of the track totalling to 560kg.

- ↔ Make sure there is plenty of clearance around the length of the track for the trailing cables of the rig to slide along the floor. Ensure that they are not mounted in such a way so that they can catch on the track or robot as it moves along the full length.
- Ensure the floor can support the load and the stresses (see above).
 - Ensure the power supply is properly earthed (grounded) and of the correct voltage (see above).
 - If the rig is mounted to something other than the floor then the mount should be heavy and strong enough to take the forces and not move or fall over during sudden starts and stops. Use the recommended minimum thickness steel plates. Check with MRMC if you are unsure of the exact requirements for your robot.
 - Check that all cables are securely fixed and are not going to catch during motion.
 - Ensure the camera, lens, focus motor, accessories, power supplies/batteries, etc. are all very securely mounted and will not come off during sudden motions, to become lethal missiles.
 - Ensure all safety accessories are securely attached and in working order, including emergency stops, safety sensors, etc.
 - Clearly mark the area around the robot in which no persons are allowed to enter. As a bare minimum, use brightly marked tape on the floor, outside the reach of the robot, to indicate the “No Go Zone”. Ideally, use physical safety barriers, and light guards/curtains.
 - Keep stands, lights and accessories out of the No Go Zone, if possible. If not possible then try to take as much care with their positioning and the motion of the rig, as if they were a person. Remember a light, accidentally hit at high speed by the robot, can be just as dangerous to someone standing outside the No Go Zone as the robot is to someone standing in the zone.
 - Where physical safety barriers are impractical, light guards should be used or similar alternatives such as laser scanners, to stop anyone entering the No Go Zone during motion.

- Ideally have the robot surrounded on all four sides by a safety barrier, but where that is not practical, ensure that the maximum number of sides feasible are closed off, and that any person having to stand within reach of the robot is located as far away as possible for the shot.
- ⇔ Never let anyone cross the robot's track when the track motor is powered up. In fact, it is a good idea to get into the routine of walking around the track instead of over it so that you don't cross the track out of habit when the track motor is powered up.

Software setup

- Always ensure you have the right configuration for the robot you are using, such as maximum axis speeds and accelerations.
- Prior to running moves, enter in and keep to a minimum all software axis and Cartesian limits. For example if the main axis only needs to travel +/-40 degrees then reduce the limit to +/-40 degrees even though it could do +/-180 degrees. This keeps the likelihood of operator or software errors to a minimum.
- Also check the Cartesian speed and acceleration limits are set to reasonable values.

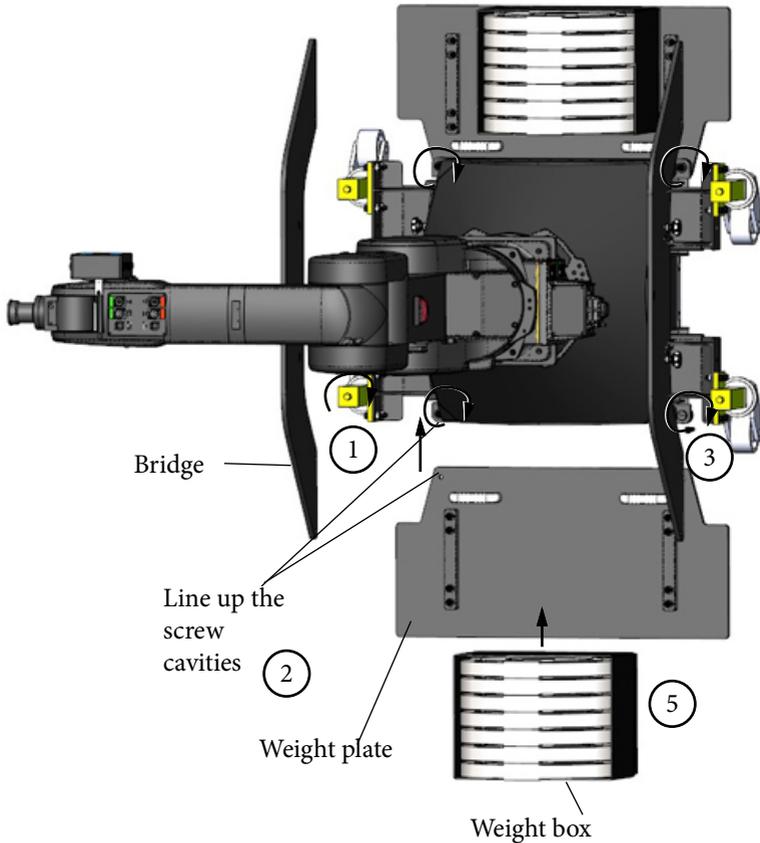
Operational safety

- Do not use around flammable gas. All electrical equipment can generate sparks that can ignite flammable gas.
 - Keep the equipment dry. The system has **not** been made weatherproof. Do not use with wet hands.
 - Always run moves only when standing within easy reach of the emergency stop.
 - Always tell the production company and the crew to keep away from the robot and not approach it when any of its red lights are on which indicates it is powered up. Have them sign the appropriate safety documents and disclaimers to ensure they understand this and are indemnifying MRMC if anything happens.
 - Always loudly and clearly indicate to others when the rig is about to move. Shout “Rig Moving!” if no other means exists.
- ⇔ When using track motion always have someone keep an eye on the trailing rig cables to ensure they don’t get caught on anything or anyone.
- Always ensure the rig is disabled when someone has to enter the No Go Zone.



- Always run any move or adjusted move slowly at first to check the motion. Even if you have checked the move previously, if you make a minor change to it then you need to recheck it.
- Keep the software in “slow mode” unless the move has been tested and is now specifically doing a high speed pass.
- In the event that a person or Actor has to be within the no-go zone during a move (hand model etc.) ensure that they are fully briefed on the safety requirements and that they know not to change their position or do anything other than the rehearsed moves without fully warning the operator. Any such person is to have a clear escape route to allow them to move safely away from the robot.
- During use, repeatedly check the rig mounting points, cables, camera mount, accessories etc. to ensure nothing has, or is, working its way loose.
- Never bypass any safety hardware or software.

Mounting the Weight Plates (Bolt™ Jr+ on Pedestal)

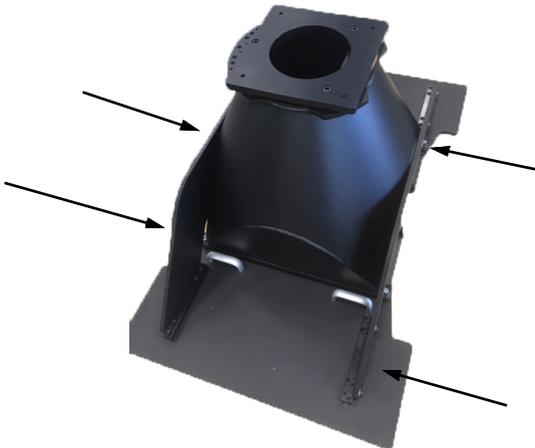


1. Use the jack screws on the castor wheels to lift the base high enough to insert each of the weight plates on either side of the Bolt Jr+ Base lining up the screw cavities.
2. Lower the base close to the wing but not quite resting on it, close enough for the two retaining bolts to reach the wings through the base.

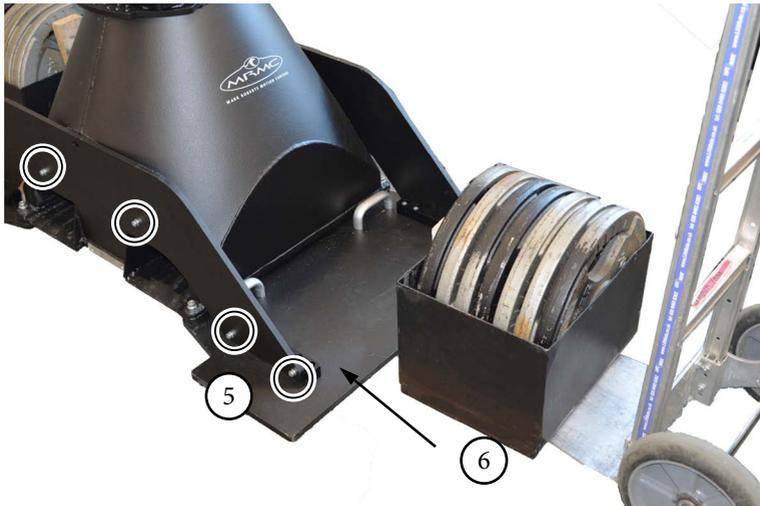
3. Lower the base completely so it is resting on both wings. Secure the weight plates using the 2xM10 screws on either plate. The screws should be wedged to the ground to secure the weight plate completely.
4. At this point, you can remove the castor wheels.



5. Attach the bridges with two weight plates on one side using the 4xM10 screws that attach to the weight plates and 2xM10 screws that attach to the pedestal base.
Repeat this to secure the bridge on the opposite side.



- Put the weights onto the wings. Bolt Jr+ requires 2 boxes of weights — one on each side. Each box contains 140kg of weights ($7 \times 20\text{kg}$).



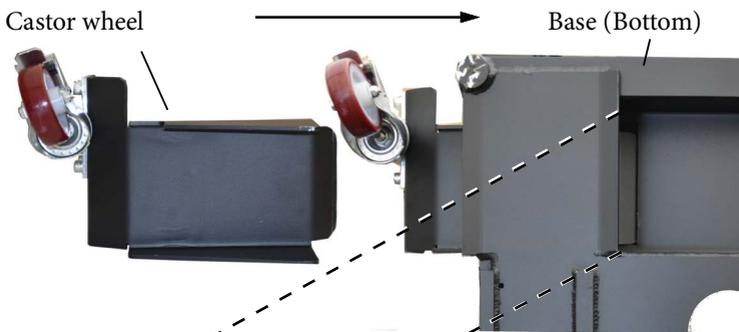
Hint

You can use a pallet truck to move Bolt Jr+ without removing the wings and bridges if you want, as long as you take the weights off first.

Mounting the Castor Wheels (Bolt™ Jr+ On Pedestal)

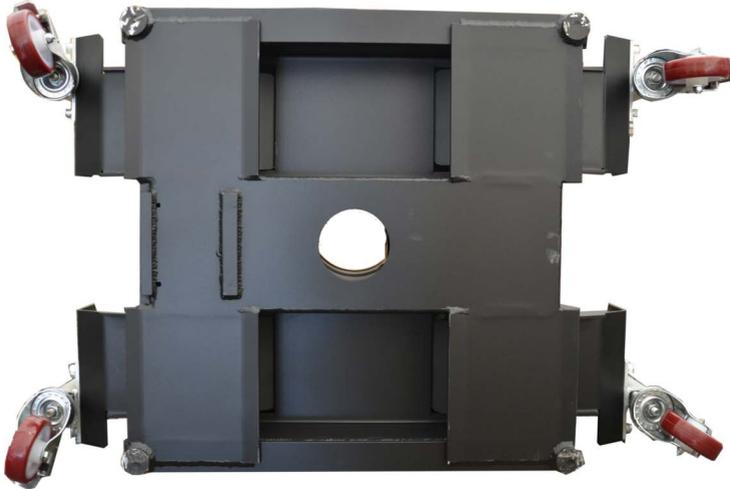
If you need to move the Bolt Jr+ on Pedestal around, use the following procedure to mount the castor wheels:

1. Remove the bridge plates.
2. Slide one castor wheel into the base ensuring that edge of the plate in the wheel assembly is inserted in the slot in the base.



Note that the wedge in the castor plate should be slotted properly under the base.

3. Similarly insert all the castors into the base ensuring the plates are inserted into the slots.



4. Secure and tighten the castor wheels to the base and use the four jack screws to lift it off the floor (24mm socket/wrench).

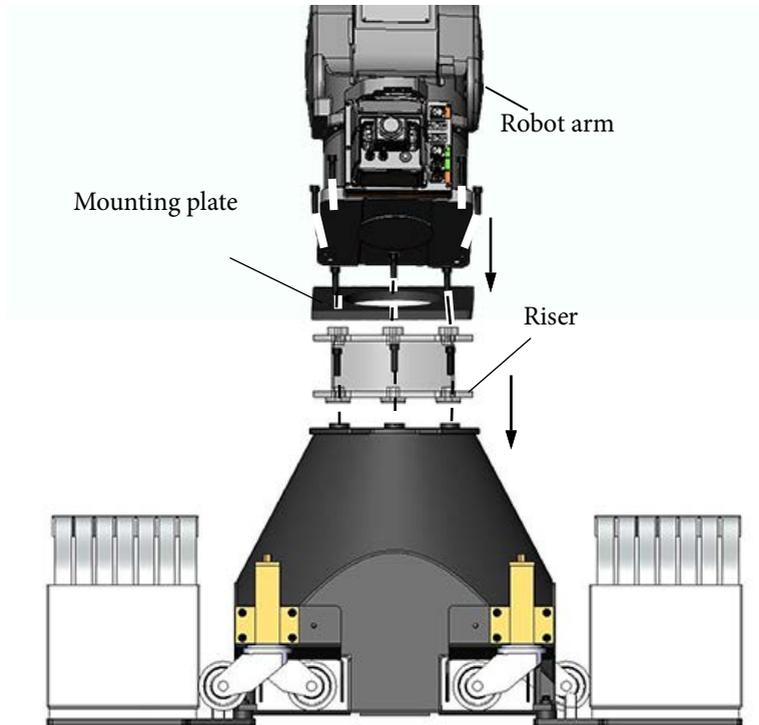


Notes

Mounting the Optional Riser(s)

Bolt Jr+ can include optional risers if higher arm reach is required. These come in two sizes: 150mm and 300mm; either or both of them can be used. Use the following instructions to mount any riser on the pedestal:

1. Remove the arm from the base by unscrewing the 4xM12 screws and using a gantry hoist to lift the arm.
2. Remove the mounting plate from the base by unscrewing the 3xM12 screws.
3. Lower the riser on the base aligning the three screw cavities and tighten the 3xM12 screws to secure the riser on the base.
4. Mount the mounting plate on the riser using 3xM12 screws.
5. Carefully lower the arm on the base aligning the screw cavities on the mounting plate and those on the robot arm. Screw 4xM12 to secure the arm on the base.



Note

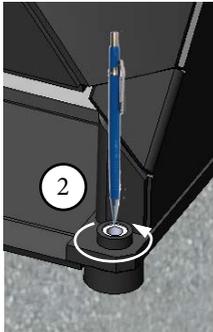
If you are using the 300mm riser, anchor the Bolt Jr+ on Pedestal down to the floor. Refer to the next section for details.

Limitations when using weights

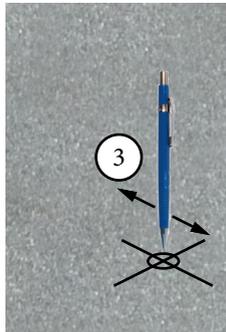
If you are using weights, reduce the top-speed by 50% when you have the 300mm riser added. With the small riser, reduce the speed by 25%. If you are using both the risers together, then the rig can only be used at slow speeds.

Anchoring Bolt™ Jr+ on Pedestal to the floor

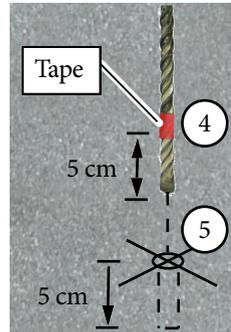
If you are setting up Bolt Jr+ on Pedestal in a permanent (or semi-permanent) location, you can anchor the pedestal to the floor as an alternative to holding it down with weights. The following procedure tells you how to anchor the pedestal to a concrete floor.



× 4 corners



× 4 corners



× 4 corners

1. Wheel the Bolt Jr+ on Pedestal to the spot where you want to bolt it to the ground and lower it using the jacks on the castor wheels.
2. At one corner of the pedestal, use the hole to draw a circle on the concrete with a pencil, to mark the position of the hole. You can use either hole.

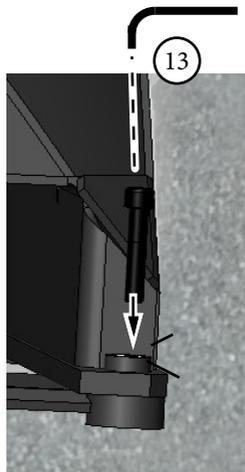
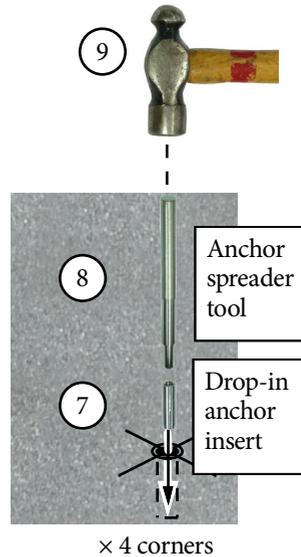
Repeat for the other three corners of the pedestal.

3. Temporarily remove Bolt Jr+ on Pedestal (jack the castor wheels up) and at the four circles that you have drawn, draw cross centred on the circle, to help you precisely locate the drill bit.
4. On the 15mm diameter drill bit, put tape around the bit 5 cm from the tip. This will help you gauge the depth of the hole in the next step.
5. At one of the corner circles, drill a hole 5 cm deep into the concrete, centred on the cross. When the tape on the drill bit reaches the floor, drilling is complete.

Repeat for the other three corners.

6. Clean the four holes.

7. At one of the holes insert the drop-in anchor insert, threads upward, all the way to the bottom.
8. Insert the anchor spreader tool into the drop-in anchor insert.
9. Hit the top of the anchor spreader tool with a hammer until the anchor is fully spread in the concrete.
10. Remove the anchor spreader tool.
11. Repeat steps 7 to 10 for the other three corners.
12. Put Bolt Jr+ on Pedestal in place over the holes.
13. Insert the four retaining bolts through the corners of the base and into the drop-in anchor inserts, and tighten.



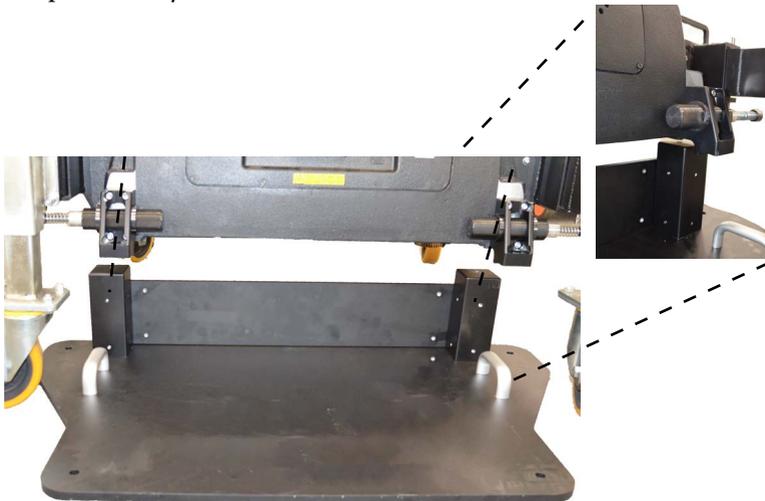
Mounting Weight Plates on Bolt Junior+ On Track

Bolt Jr+ on Track can be used off the track with the base mounted on the weight plates.

1. Release the 2 x plate side supports from the 2 x weight plates by unscrewing 4x screws.



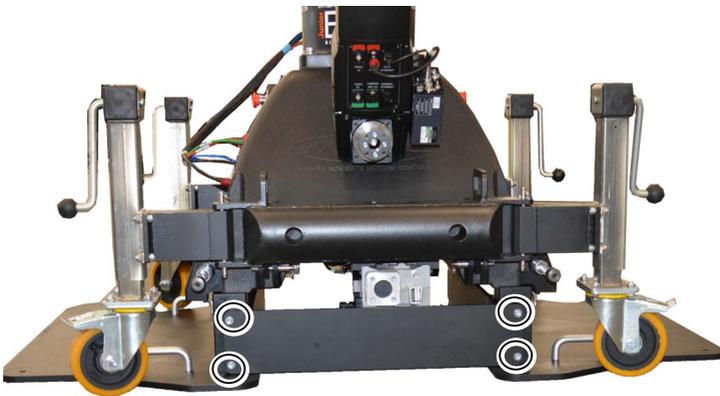
2. Raise the Bolt Jr+ Base by jacking up the castors. Place the weight plate under the side of the Bolt Jr+ base so that the screw cavity in the plate lines up with the captive screw in the Bolt Jr+ base. Two persons may be needed to do this.



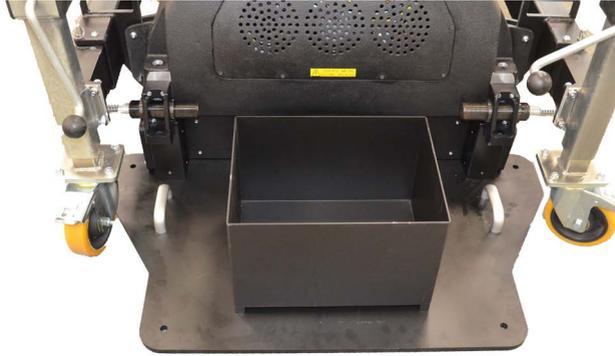
3. Similarly line up the second weight plate under the opposite side of the Bolt Jr+ base.
4. Lower the Base on one side to align the screw with the plate cavity. Nipping the spring in the screw will help with proper alignment. Once aligned lower the Base completely and tighten the screw.



5. Similarly, mount the weight plate on the opposite side.
6. Mount the plate side supports by tightening the 4 x screws.



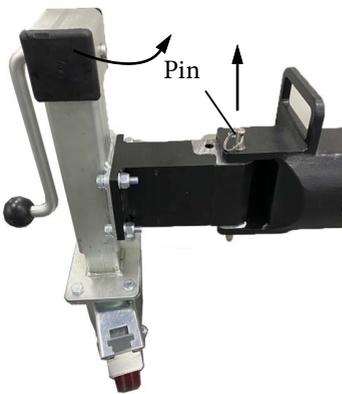
7. Similarly, mount the plate side support on the opposite side. Then, place the weight each plate add 140kg of weights on each weight bucket.



Modifying Wheel Orientation

If the Bolt Jr+ is required to be wheeled through narrow doorways or corridors, the wheel orientation can be changed to wheels in.

Simply pull the pin out to release the wheel from the beam and swivel it left or right, as required. Reattach the pin to secure in position.



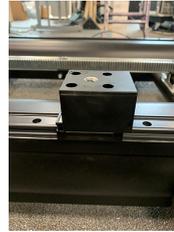
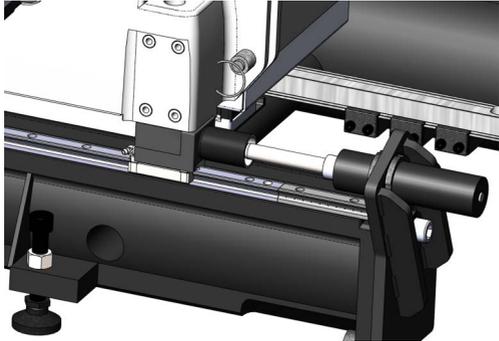
Castor wheels out



Castor wheels in

Fixing Bearing Blocks on Bolt Jr+ on Track

Note that the bearing spacers on the narrow rail are off centre on the actual bearing blocks and need to be facing **outward** in order to connect with the buffers, as shown below.

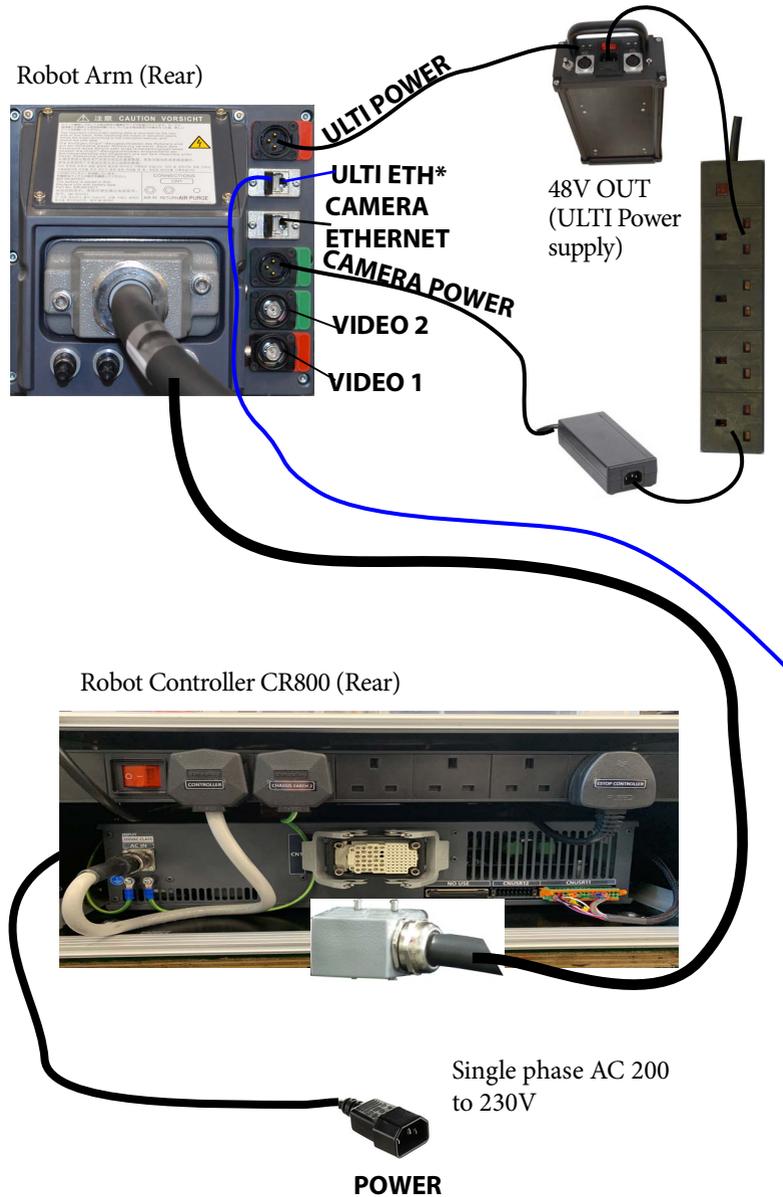


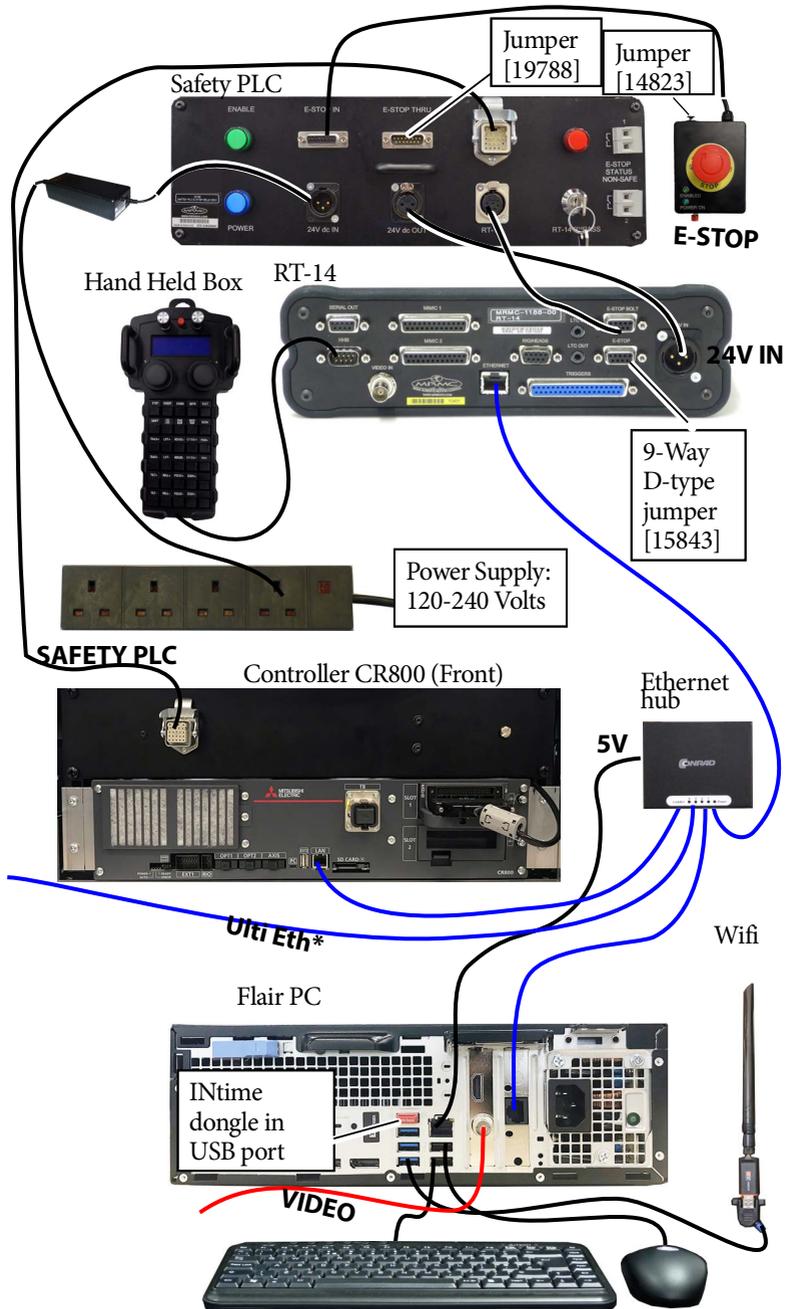
Bearing spacer off centre towards the buffer

They should **NOT** be installed as follows

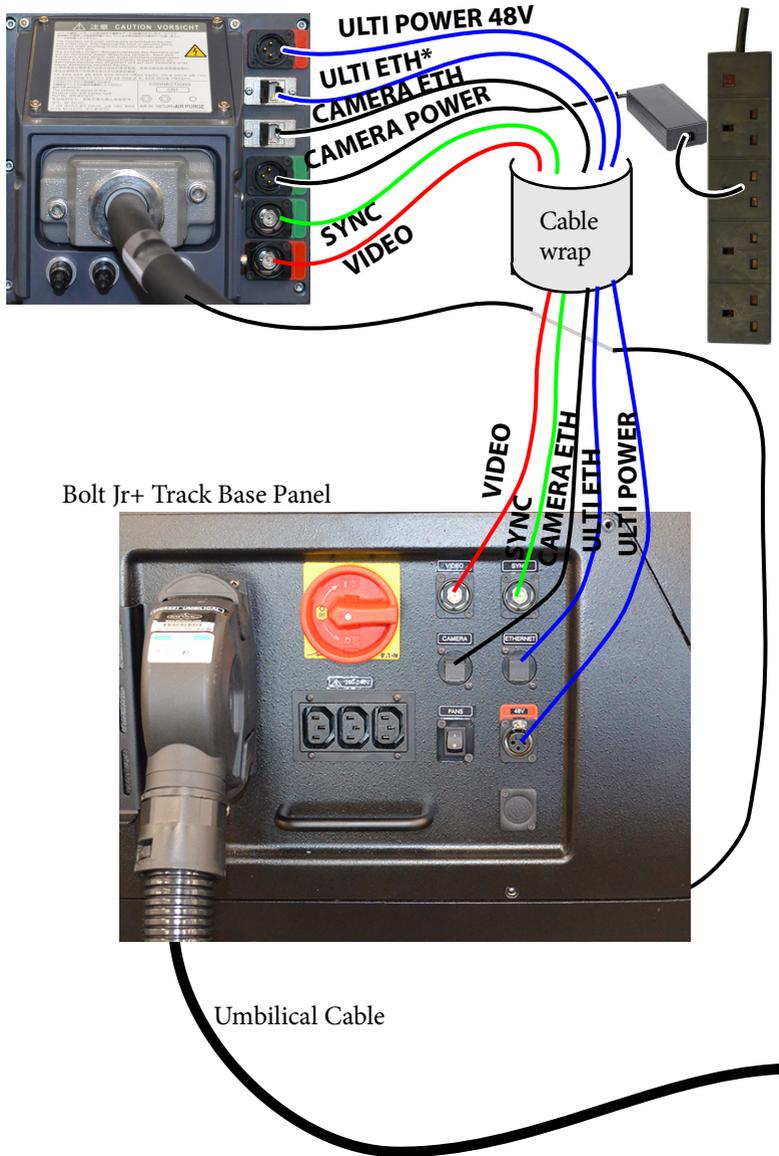


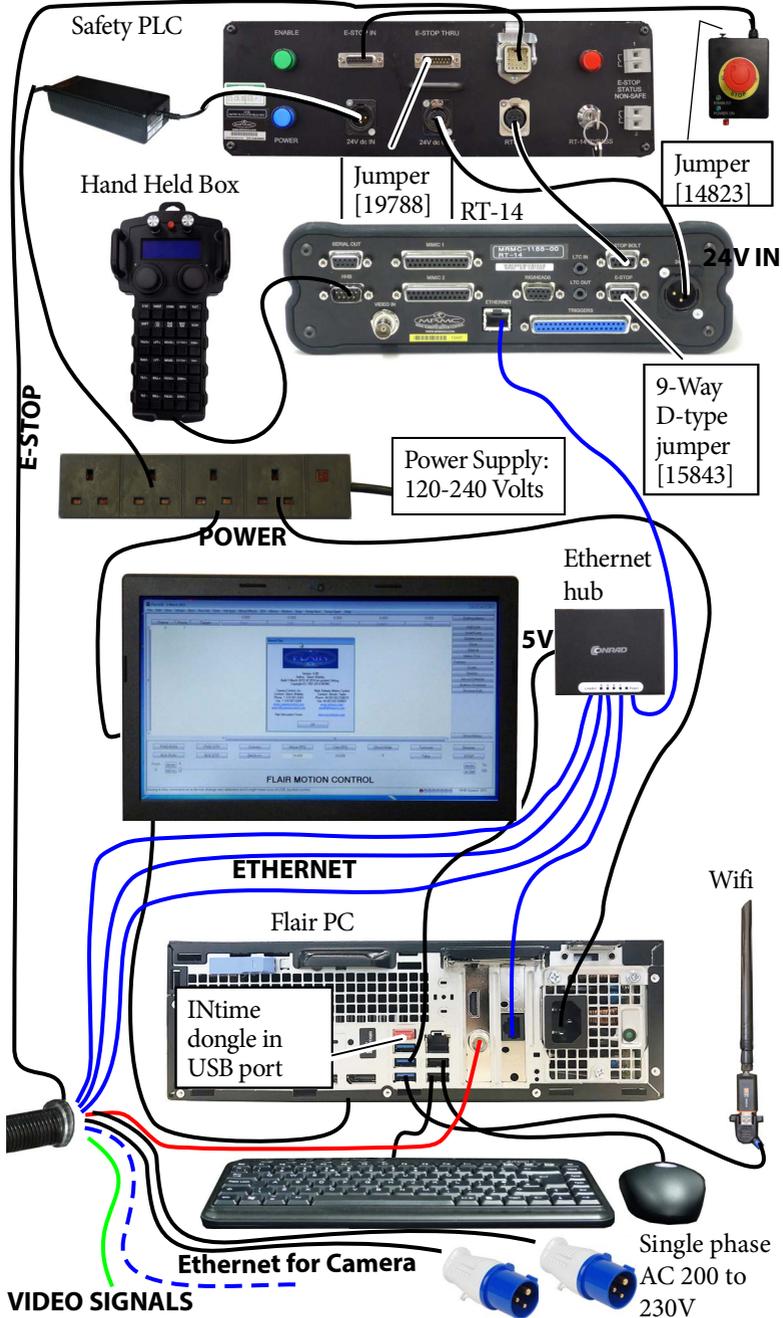
Connecting the cables (Bolt™ Jr+ on Pedestal)





Connecting the cables (Bolt Jr+ on Track)





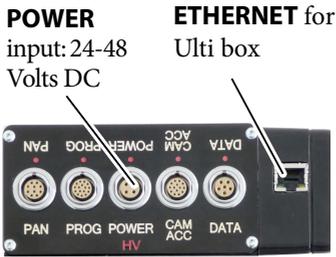
Important

The Jumper* in the Safety PLC applies when using this robot as a single robot operation. For more information on using the Universal Robot system with multiple robots, refer to the Universal E-stop System Quick Start Guide.

The desk top E-stop box can also be daisy-chained to multiple E-stop buttons. For more information, refer to Universal E-stop System Quick Start Guide.

Bolt Jr+ arm connectors for Ulti-box and camera

The connections that go through the Bolt Jr+ arm are shown below. These are for the Ulti-box mounted on the arm, and for the camera that you mount in the cage at the end of the arm.



Ulti-box, which provides various connectors for camera and lens controls. For details see *Ulti-box connector summary* on page 42.



POWER output:
48 Volts DC

Video 1

Video 2



Starting up the Bolt™ Jr+ on Pedestal system

Once you have attached all the cables, you power up the rig by switching on the components in the order described below.

1. Make sure you have secured the area around Bolt Jr+. Put up guard rails around Bolt Jr+ (and the track) as necessary, and tell others on the set that you are now powering up the rig.
2. Power up the CR800 controller. Wait for the robot to boot up for a few seconds.



Hint

Ensure that the Flair PC is not plugged to the same power strip as the CR800 Controller.

The booting up sequence of the CR800 controller is as follows

Booting sequence	Time (sec)	Power	Auto	Error	Ready
1	20	I	I	I	I
2	11	I	I	I	F
3	5	I	F	F	F
4	fraction	I	I	I	I
5	3	I	I	O	O
6	3	I	O	F	O
7	2	I	F	O	F
8	5	I	I	O	I
Booting complete					

(I=On; O=Off; F=Flashing)

- Power up the Flair computer system and all of its components, including the RT-14 interface box. You can do this while the robot is powering up (step 2).
- On the Flair PC, start the Flair application by double-clicking on the Flair icon on the Desktop.

Flair automatically loads the relevant firmware into all attached axis boards, including:

- The Ulti-box that is mounted on the Bolt Jr+ arm
- Any additional interface boxes or model movers that are attached to the computer stack such as Turntable

Robot status	Power	Auto	Error	Ready
Robot engaged	I	I	O	F (Slow)
Robot disengaged	I	I	O	F (Fast)
ESTOP	I	I	F	F

5. Release the E-stop that is plugged into the computer stack, by turning the button clockwise until the red button pops up and then pressing the Enable button.
6. In Flair, click on the **Engage Robot** button.
7. Zero the axes as required in Flair. The Bolt Jr+ arm itself does not require zeroing but you need to zero other axes such as:



ENABLE button

- Any external Lens Control Motors (LCMs) that you are using. To zero these you first set the **focus to infinity** (∞), **zoom to wide-angle** (zoomed out all the way), **iris/aperture to wide open** and then use the relevant **Zero > Direct Zero Axis** menu option to set those lens positions as the zero points in Flair.
 - Any model mover axes like Turntable.
8. In Flair, move the Bolt Jr+ arm to its home position (rotated straight forward and tucked under).
 9. Set the soft limits for the rig axes in Flair as required:
 - Lens Control Motor limits (if using external LCMs)
 - Any model mover limits
 - It is not recommended that you change the soft limits on the arm; if not done correctly it can lock up the arm.

Bolt™ Jr+ start-up summary

1. Secure the area
2. Switch on Bolt Jr+
3. Switch on the Flair PC
4. Check networking lights for robot in Ready state
5. Start Flair
6. Release the E-stop on the computer stack

In Flair:

7. **Engage Robot**
8. Zero the track and Lens Control Motor axes
9. Home the arm, carefully
10. Set the soft limits

The rig is now ready to use.

Starting up the Bolt™ Jr+ on Track system

Once you have attached all the cables, you power up the rig by switching on the components in the order described below.

1. Make sure you have secured the area around Bolt Jr+. Put up guard rails around Bolt Jr+ (and the track) as necessary, and tell others on the set that you are now powering up the rig.
2. Release the E-stop on the **Bolt Jr+ Base** by turning the red button clockwise until the button pops up. **Do not release the other E-stop by the computer stack yet.**
3. Power up Bolt Jr+ itself as follows:



Turn on the power switch on the side of the Bolt Jr+ Base.



For more details on the LEDs during power up on CR800 controller that is housed inside the base, refer to page 30.

4. Power up the Flair computer system and all of its components, including the RT-14 interface box. You can do this while the robot is powering up (step 2).
5. On the Flair PC, start the Flair application by double-clicking on the Flair icon on the Desktop.

Flair automatically loads the relevant firmware into all attached axis boards, including:

- The Quad Board that runs the track motor
 - The Ulti-box that is mounted on the Bolt Jr+ arm
 - Any additional interface boxes that are attached to the computer stack and any model movers
6. Once the CR800 start-up sequence is complete, release the E-stop that is plugged into the computer stack, by turning the button clockwise until the red button pops up and then pressing the Enable button.
 7. Zero the axes as required in Flair. The Bolt Jr+ arm itself does not require zeroing but you need to zero other axes such as:
 - The Track: To do this you use the **Zero > Home Axis > Track** menu option.
 - Any external Lens Control Motors (LCMs) that you are using. To zero these you first set the **focus to infinity** (∞), **zoom to wide-angle** (zoomed out all the way), **iris/aperture to wide open** and then use the relevant **Zero > Direct Zero Axis** menu option to set those lens positions as the zero points in Flair.
 - Any model movers
 8. In Flair, click on the **Engage Robot** button.



ENABLE button

Hint

You use the **Track** button in Flair to toggle the track on and off, independently of the **Engage Robot/Disengage Robot** button that you use to toggle the Bolt Jr+ arm on and off.

9. In Flair, move the Bolt Jr+ arm to its home position (rotated straight forward and tucked under).
10. Set the soft limits for the rig axes in Flair as required:
 - Track limits
 - Lens Control Motor limits (if using external LCMs)

Bolt™ Jr+ start-up summary

1. Secure the area
 2. Release the E-stop on the rig
 3. Switch on Bolt Jr+
 4. Switch on the Flair PC
 5. Start Flair
 6. Release the E-stop on the computer stack
- In Flair:
7. Zero the track and Lens Control Motor axes
 8. **Engage Robot**
 9. Home the arm, carefully
 10. Set the soft limits

The rig is now ready to use.

Shutting down the Bolt™ Jr+ system

1. Move Bolt Jr+ to its Home position, for both the arm and the track.

or...

If you are going to transport Bolt Jr+ to a new location, put the Bolt Jr+ arm into its Transport position. You can do this by using Flair (although you might have to reset the soft limits to reach the Transport position).

2. In the Flair software, click on the **Disengage Robot** button.
3. In the Flair software, disengage the track by toggling off the **Track** button.
4. Press down all E-stop buttons:
 - On the computer stack
 - On the **Bolt Jr+ Base**
5. Close the Flair software.
6. Shut down Windows on the Flair PC.
7. Turn off Bolt Jr+ as follows:

Turn off the power switch on the side of the Bolt Jr+ Base.



Note

To remove Bolt Jr+ from the track see *Mounting Bolt (family of robots) on the track* in the separate *Precision Track Quick Start Guide* and follow the instructions there in reverse order, to attach the trolley wheels, detach the pinch motor wheels and remove the rig from the track bearings.

Bolt™ Jr+ shut-down summary

1. Move Bolt Jr+ to the Home or Transport position
2. In Flair: **Disengage Robot**
3. In Flair: Toggle off the **Track**
4. Press down all E-stops
5. Close Flair
6. Shut down Windows
7. Switch off Bolt Jr+



Bolt Jr+ on Track
Transport position:

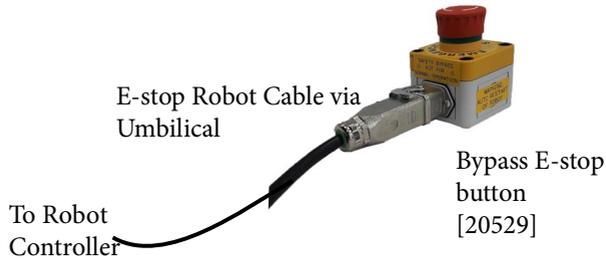
- Arm rotated forward and tucked under.
- Arm about 45 degrees to base slope, above the wheel unit, with about 3cm clearance between it and the base.

Bolt Jr+ on Pedestal Transport position:

- Arm rotated forward and tucked under.
- Arm about 45 degrees to base slope, above the wheel unit, with about 12cm clearance between it and the base.

Universal E-stop Bypass Operation

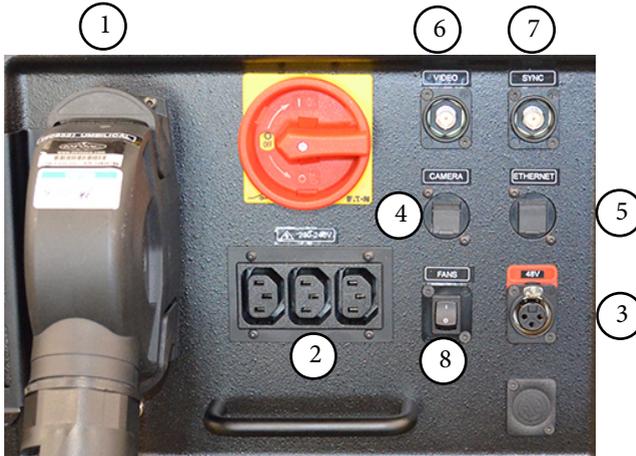
You can bypass the Universal E-stop system temporarily for troubleshooting a fault in the system. To do so, connect the Bypass E-stop button via E-stop Robot Cable in the umbilical to the Robot Controller.



Bypassing the Universal E-stop System is for temporary use only. Robot will enable as soon as E-stop button is reset. This will also bypass the software E-stop and any other hardware E-stops and the robot will have no controlled E-stop action.

Appendix 1 Bolt™ Jr+ panels

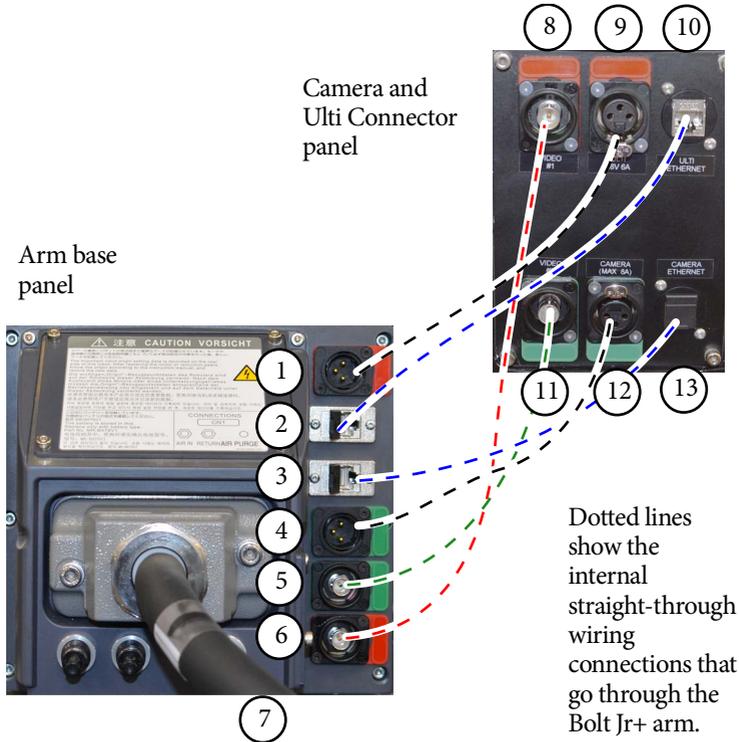
Bolt™ Jr+ Track Base panel connector summary



1. **UMBILICAL IN** connector is the main connector that provides 240V single phase power for the controller unit, robot arm and other units on the arm such as Ulti-box and camera. It also includes other connectors for E-stop, video out, sync out, Ulti power and Ulti Ethernet.
2. **240V AC** output (x3), for general use by additional devices, such as camera PSUs, that you want to mount on the rig. For pin-out information, refer to *Mains Out connector* on page 40.
3. **48V OUT** power connector. You usually use this to power the Ulti-box (and its attachments) on the Bolt Jr+ arm. For pin-out information, refer to *Mains Out connector* on page 40.
4. **ETHERNET** connector to connect to the Ethernet connector on the base of the arm to service the camera mounted on the arm.
5. **ETHERNET** connector to connect to the Ethernet connector on the base of the arm to service the Ulti-box mounted on the arm.
6. **VIDEO** connector for the video signal from the camera. For pin-out information, refer to *Video/Sync connector* on page 40.

7. **SYNC** connector for the sync signal from the camera. For pin-out information, refer to *Video/Sync connector* on page 40.
8. **FANS** switch. For switching the fans on/off.

Bolt Jr+ arm panels connector summary



- 1, 9. **ULTI POWER** input power connector supplies 48 Volts DC output to the Ulti box on the Bolt Jr+ arm. This has a straight-through internal connection to the **Ulti 48V 6A** connector (9) at the far end of the arm. For pin-out information, refer to *Power 48V 6A connector* on page 41.
- 2, 10. **ULTI ETHERNET** connector is an Ethernet connector or communications between the Ulti box on the robot arm and the rest of the system. The connection between connectors 3 and 10 is a straight-through internal connection through arm, and you ordinarily attach connector 2 to the Ethernet hub that services the

Ulti-box (for Bolt On Pedestal) or to one of the Ethernet connectors in Bolt Jr+ base (for Bolt Jr+ On Track).

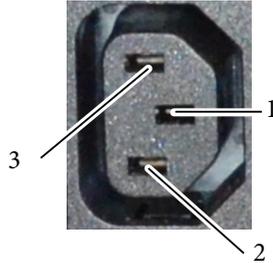
- 3, 13. **CAMERA** connector is an Ethernet 10GB connector for communications between the camera and the rest of the system. The connection between this and the **CAMERA ETHERNET** connector is a straight-through internal connection through arm.
- 4, 12. **CAMERA POWER** is a 12-24V DC XLR male connector. You can use this to power the camera or other devices mounted on the camera platform. **CAMERA POWER MAX 8A** (Connector 12) on the end of the arm is a straight through connector and supplies the same power as is connected to connector 4. For pin-out information, refer to *Power 12V connector* on page 41.
- 5, 11. **VIDEO 2 OUT** connector for the video/sync signal from/to the camera, if required. This has a straight-through connection to the **VIDEO #2 IN** connector (11) at the end of the arm. For pin-out information, refer to *Video/Sync connector* on page 40.
- 6, 8. **VIDEO 1 OUT** connector for the video/sync signal from the camera. This has a straight-through connection to the **VIDEO #1 IN** connector (8). You can connect **VIDEO 1** to the **VIDEO** connector on the Bolt Jr+ base using a coaxial cable. For pin-out information, refer to *Video/Sync connector* on page 40.
7. **CR800 power and controller** connector. This is for the encoder and power cable that runs between the Bolt Jr+ arm and the CR800 controller unit, which supplies control to the arm.

Connector pin-out information

Mains Out connector

Power output connector for connecting any external devices. It is a 3-Way (Male) C14 IEC connector. 240 Volts AC.

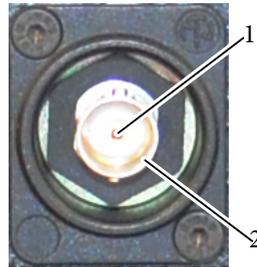
1. Earth
2. Live
3. Neutral



Video/Sync connector

The **VIDEO** and **SYNC** are multi-purpose connectors on the arm and base and connected to each other through the internal wiring, allowing the video signal from the camera to go into the arm, through The arm SYNC connector is connected to the Video#2 connector on top of the arm via internal wiring where it can be connected to the camera. They can be used for synchronization signals between the camera and controller in either direction.

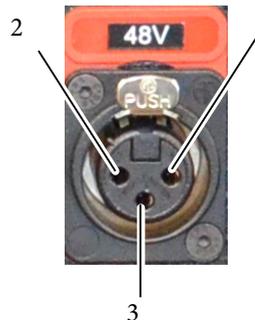
1. VIDEO (inner)
2. GND (outer)



48V Out connector (3-way XLR)

General purpose 48V DC outlet on the base and far end of the Bolt Jr+ arm.

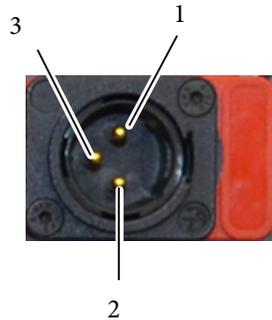
1. GND
2. N/C
3. 48V OUT



Power 48V 6A connector

48V Power input for the Ulti box at the base of the arm.

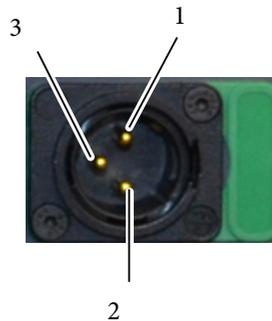
1. GND
2. N/C
3. 48VIN



Power 12V connector

12V (max 8A) Power input (on Arm base) for the camera or any other device mounted on the arm.

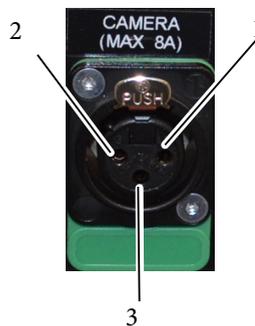
1. GND
2. 12VIN
3. N/C



Camera (Max 8A)

12-24V (max 8A) Power output (on the end of the Arm) for the camera or any other device mounted on the arm.

1. GND
2. 12VOUT
3. N/C



Ulti-box connector summary

The Ulti-box that is mounted on the Bolt Jr+ arm is a multi-purpose interface box that is used to control servo motors on many MRMC heads and Lens Control Motor (LCM) units. The Ulti-box offers versatile connections for many camera and lens configurations although some of the axes connectors such as **PAN**, **TILT**, and **DATA** are not ordinarily used in the context of Bolt Jr+, as Bolt Jr+ itself provides these features.



1. **PAN** connector for the Pan servo motor on a head. For pin-out information see *Servo motor connector* on page 45.
2. **PROG** serial connector for connection to a controller using a Serial RS232 connection (as an alternative to an Ethernet or DataLink

connection), and for updating the firmware in the Ulti-box. For pin-out information see *Program serial connector* on page 45.

3. **POWER** DC input for the Ulti-box and its attached devices. The standard unit uses a power input of 24-36 Volts. The high-power variant (marked **HV**, for **H**igh **V**oltage) uses 24-48 Volts. For pin-out information see *Power connector* on page 46.
4. **CAM ACC** Camera Accessory input/output connector. It has pins for three stepper motors, two serial lens controls, two trigger in controls, and two trigger out controls. For pin-out information see *Camera Accessory connector* on page 46.
5. **DATA** DataLink In (Up Link) connector for controlling the Ulti-box and its attached devices using a DataLink connection, as an alternative to an Ethernet or Serial RS232 connection. You connect this to a device that is further up the DataLink daisy-chain, such as:
 - The **DATA OUT** (or **DOWN LINK**) connector on a controller such as the MSA-20 Handwheels or Large Format Panel (LFP).
 - The **RIG/HEAD** connector on an RT-14 interface box which is in turn connected to a PC running Flair Motion Control Software.

Note that because there is no DataLink Out connector on the Ulti-box, the Ulti-box must be connected at the end of the DataLink daisy-chain rather than the middle. For pin-out information see *Data In connector* on page 47.

6. **ETHERNET** RJ45 connector for controlling the Ulti-box and its connected devices from a Flair PC. This Ethernet port is rated at 100 Mbits/sec but can operate at lower speeds of 10 Mbits/sec or less.
- 7, 8. **ZOOM, FOCUS** connectors for external servo LCMs mounted on the camera platform. For pin-out information see *Servo motor connector* on page 45.
9. **TILT** connector for a Tilt servo motor on a head. For pin-out information see *Servo motor connector* on page 45.

10, 11 **AUX-1**, **AUX-2** connectors for control of auxiliary servo motors.
For pin-out information see *Servo motor connector* on page 45.

Note

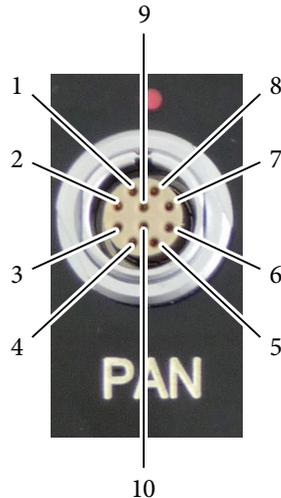
Connectors 1, 7, 8, 9, 10 and 11 are identical and are labelled only for ease of use.

Ulti-box connector pin-out information

Servo motor connector

This type of connector is used for six servo motor connectors on the Ulti-box:
Pan, Zoom, Focus, Tilt, Aux-1, Aux-2.

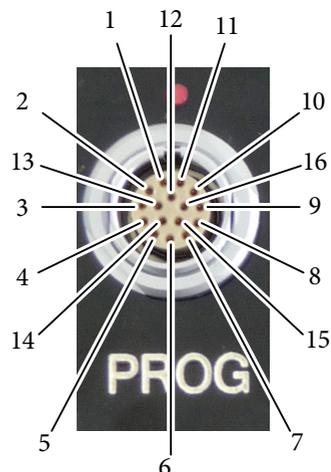
1. DATUM
2. A+
3. B+
4. Z+
5. Brake/Enable output
6. MOTOR_B
7. MOTOR_A
8. LIMIT
9. +5V
10. GND



Program serial connector

Serial connector for connection to a controller using a **Serial RS232** connection, and for updating the firmware in the Ulti-box.

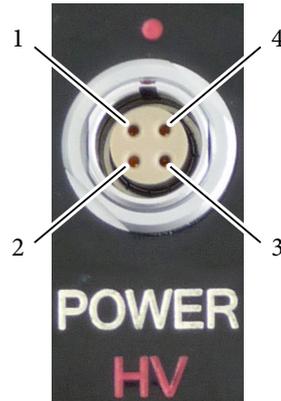
1. SerialTxA
2. SerialRxA
3. +5V
4. FGPIO
5. DSP_TRSTN
6. TCK
7. TMS
8. DSP_TDI
9. DSP_TDO
10. DSP_EMU0
11. DSP_EMU1
12. FPGA_TDI
13. FPGA_TDO
14. BOOT_SEL
15. +3.3V
16. GND



Power connector

The power input connector for the Ulti-box. For usage see page 43.

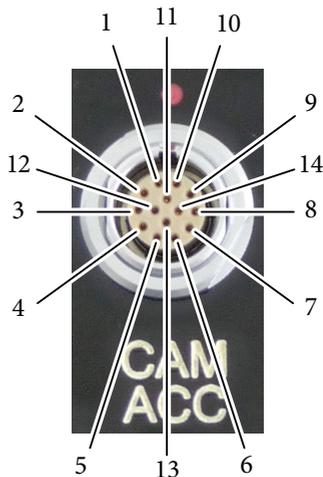
1. GND
2. GND
3. +35V for Basic and +48V for HV
4. +35V for Basic and +48V for HV



Camera Accessory connector

This is a multi-purpose camera accessory connector with connections for three stepper motors, two serial lens controls, two trigger in controls, and two trigger out controls.

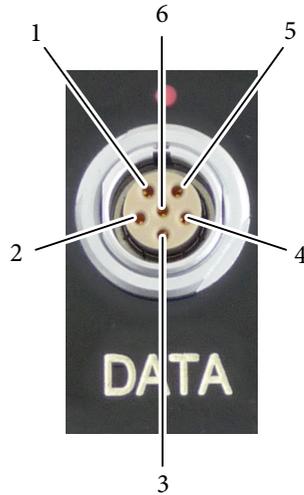
1. Step1
2. Gp2In (Trigger In 2)
3. Step2
4. SerialTxB serial lens control
5. Step3
6. SerialRxB serial lens control
7. Dir3
8. GND
9. +5V
10. Gp1In (Trigger In 1)
11. Dir1
12. Dir2
13. Gp2Out (Trigger Out 2)
14. Gp1Out (Trigger Out 1)



Data In connector

This is a DataLink In connector for connection to a controller using a DataLink connection. DataLink In (Up Link) connector for connection to a DataLink device higher up in the DataLink daisy-chain. For usage see, page 43.

1. Watchdog-
2. Link1Out-
3. Link1Out+
4. Link1In-
5. Link1In+
6. Watchdog+



Appendix 2 Specifications

Rig Weights

Dimensions	Bolt Jr+ on Track	Bolt Jr+ on Pedestal
Total weight (base+arm+2xcastor wheels)	290kg	262kg
Weight- Arm	132kg	132kg
Weight - Base	151kg (including 2 x castor system and power supply unit)	130kg (including 2 x weight plates, 4 x castor wheels, 2 x bridges and 2 x weight buckets)
Weight - anchor weights for track (when track is not bolted to the ground)	4x140kg	-
Weight - Anchor weights for each side of base when base not secured to ground	-	2x140kg (not included in total weight above)
Maximum camera payload	10kg (28.6lbs)	10kg (28.6lbs)

Rig Performance

Axis	Travel (degrees)	Max Speed (degrees/s)
Rotate	370(±185)	234
Lift	230 (-55 to +175)	164
Arm	160 (-65 to +95)	219
Pan	390 (±195)	375
Tilt	230 (-205 to +25)	375
Roll	1420(±710)	720
Track	Unlimited	2.9 m/s

Note

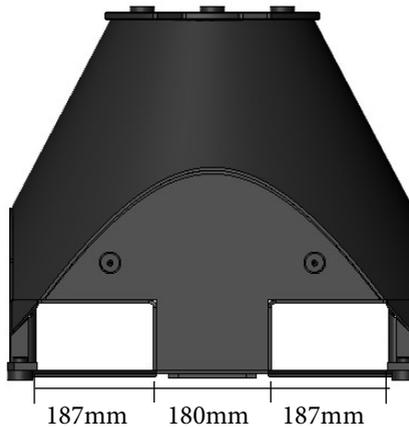
The Roll limits can be extended further but will require caution for the external cables

Temperature range: 0-40 °C

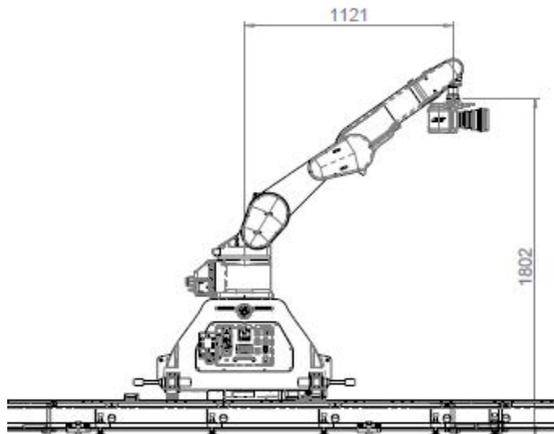
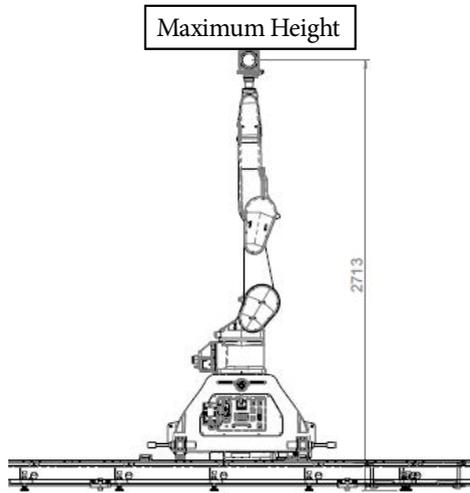
Humidity tolerance: 0% to 85% relative humidity, non-condensing

Dimensions

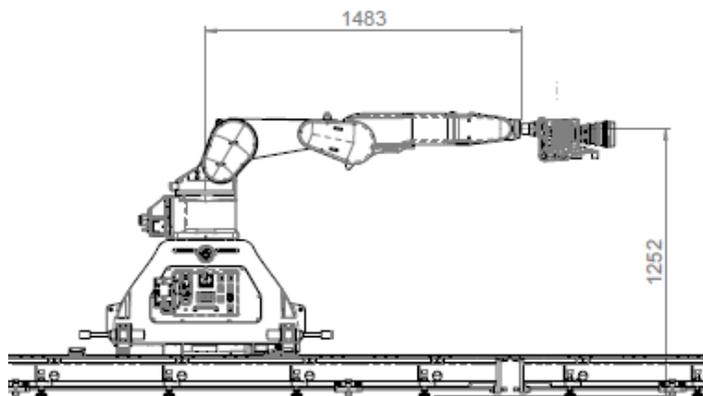
Bolt Jr+ on Pedestal Base Cavities



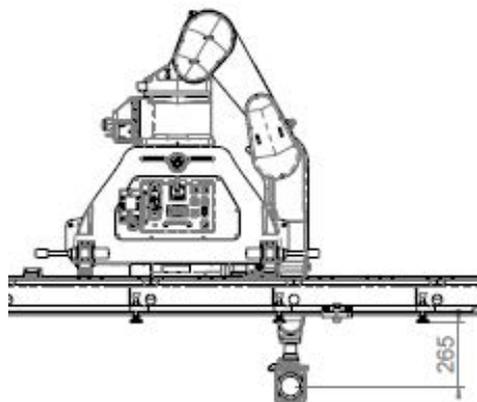
Bolt Jr+ on Track



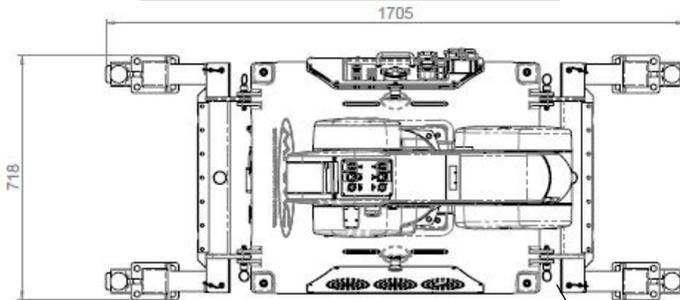
Maximum Reach



Lowest Camera Position

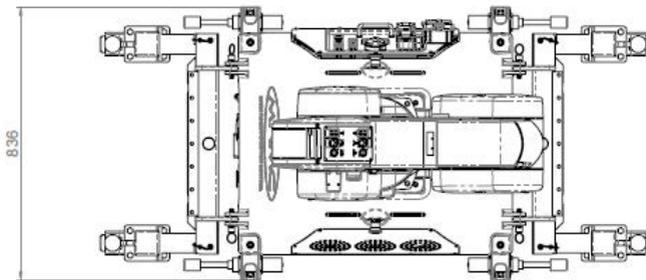


Bolt Jr+ on Track with front wheels in

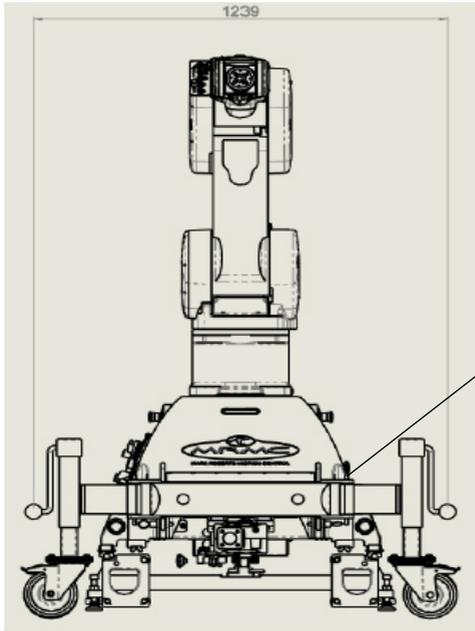


Remove pin to detach and change orientation to wheels out

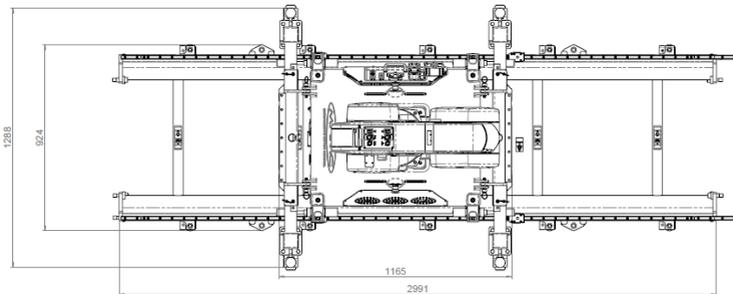
Bolt Jr+ on Track with front wheels in with buffers mounted



Bolt Jr+ on Track with wheels out

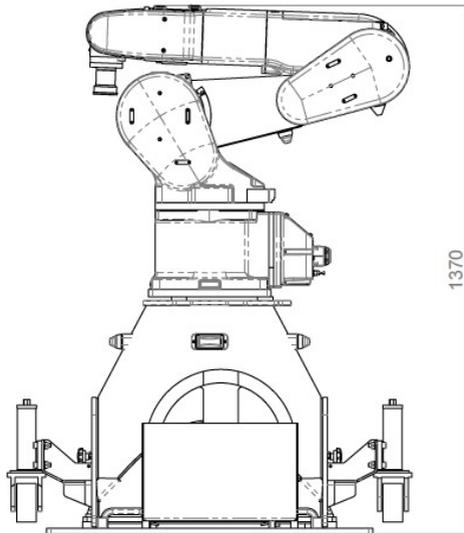
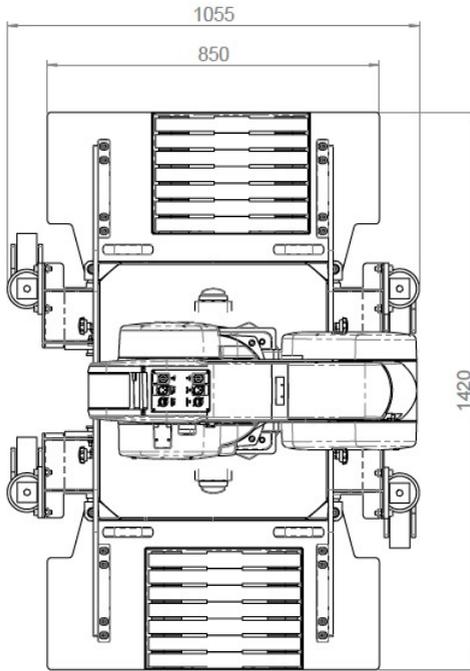


Remove pin
to detach and
change
orientation to
wheels in

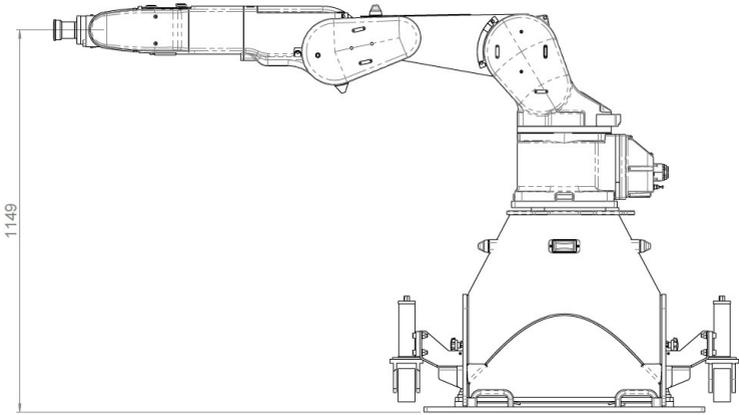


Bolt Jr+ on Track can be wheeled on to the track with wheels out.

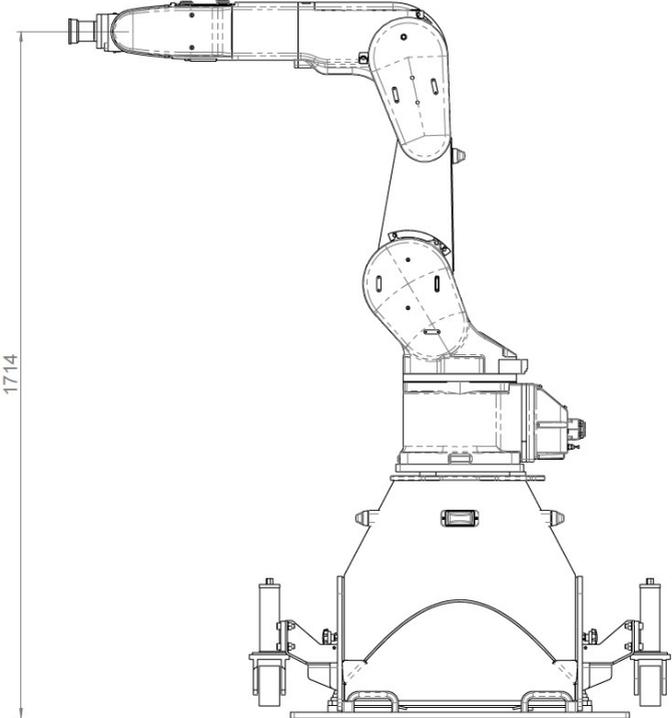
Bolt Jr+ on Pedestal



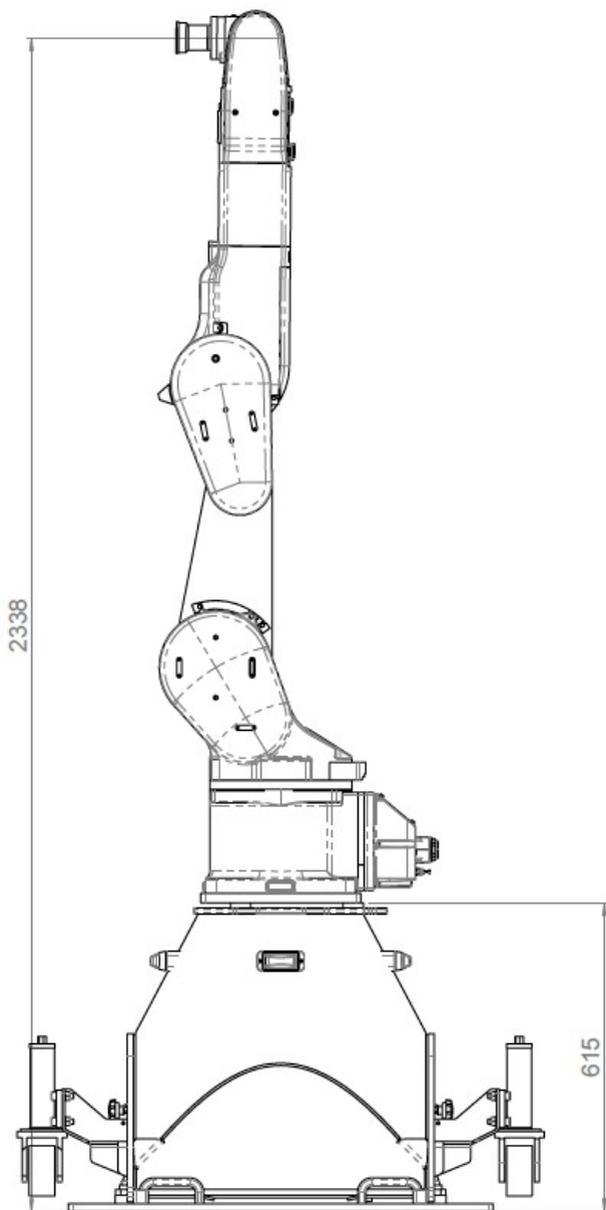
No Riser. Transport Config
Weight 555kg



Arm Horizontal



Arm Square



Power Data by Country

UK/EU - Single Phase

MRCM RIG MODEL (V)	Theoretical Momentary Demand Max Power KVA	Required Terminal Config.	Supply Voltage	Theoretical Momentary Max Demand Current A	Typical Demand Current A (0.7)	Supplied Connector	Transformer Continuous Rating KVA	RCD
Bolt Jr+ on Pedestal (200/230)	2	1+N+E	230	9	6.1	BLUE 16A 240V	N/A	300mA
Bolt Jr+ on Track (200/230)	4	1+N+E	230	17	12.2	2 x BLUE 16A 240V	N/A	300mA

North America - Single Phase

MRCM RIG MODEL (V)	Theoretical Momentary Demand Max Power KVA	Required Terminal Config.	Supply Voltage	Theoretical Momentary Max Demand Current A	Typical Demand Current A (0.7)	Supplied Connector	Transformer Continuous Rating KVA	RCD
Bolt Jr+ on Pedestal (200/230)	2	1+N+E	230	9	6.1	BLUE 16A 240V	N/A	300mA
Bolt Jr+ on Track (200/230)	4	1+N+E	230	17	12.2	2 x BLUE 16A 240V	N/A	300mA

Notes:

1. Nominal input voltage of the Mitsubishi arm is 230VAC +/- 10%. The transformer must be designed to provide a nominal 230VAC output, in this case from 120V ± 6% to keep the output within the maximum allowed. Its is more cost effective to supply the 4KVA transformer with the pedestal rig as it is also suitable for a future track upgrade, if required.
2. The BOLT Jr+ on Track (ARM plus TRACK UNIT) is delivered with two power cables and is designed to run from two power outlets each of which must be capable of supplying at least 8A. Both cables must be used. A converging unit with 15A breakers on each cable, that brings the two connectors to a single L14-30P connector, is supplied for convenience.

Japan - Single Phase

MPMC RIG MODEL (V)	Theoretical Momentary Demand Max Power KVA	Required Terminal Config.	Supply Voltage	Theoretical Momentary Max Demand Current A	Typical Demand Current A (0.7)	Supplied Connector	Transformer Continuous Rating KVA	RCD
Bolt Jr+ on Pedestal (200/230)	2	1+N+E	100	20	14.0	5-20P	4	300mA
Bolt Jr+ on Track (200/230)	4	1+N+E	100	40	28.0	As supply config	4	300mA

Notes:

1. Nominal input voltage of the Mitsubishi is 230VAC +/- 10%. The transformer must be designed to provide a nominal 230VAC output, in this case from 120V ± 6% to keep the output within the maximum allowed. Its is more cost effective to supply the 4KVA transformer with the pedestal rig as it is also suitable for a future track upgrade if required.
2. The Bolt Jr+ on Track (arm plus track unit) is delivered with two power cables and is designed to run from two power outlets each of which must be capable of supplying at least 8A. Both cables must be used. A converging unit with 15A breakers on each cable, that brings the two connectors to a single L14-30P connector, is supplied for convenience.

Notes

Notes

Appendix 3 Troubleshooting and Maintenance

Troubleshooting

Symptoms	Cause and/or action
<p>INtime on the Bolt Jr+ PC fails to initialise the network cards if the PC was shut down previously</p> <p>(This issue is specific to Bolt Jr+ with RV12 arm, Windows 11 and INtime7 combination.)</p>	<p>Restarting the PC should resolve this issue.</p> <p>To prevent this from occurring in future:</p> <ol style="list-style-type: none"><li data-bbox="437 491 913 517">1. Open Control Panel → Power Options.<li data-bbox="437 539 913 628">2. Select “Choose what the power buttons do” and uncheck the “Turn on fast startup” option. <p>In addition to this, the robot must first be powered up for 15 seconds before powering up the Flair workstation.</p>

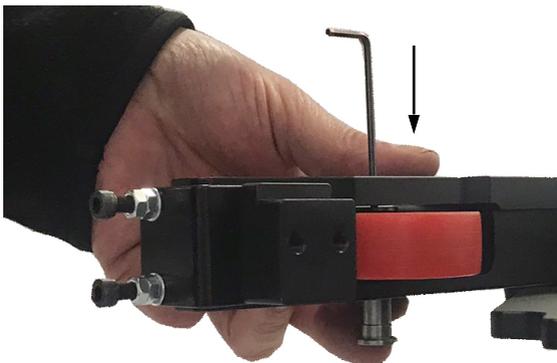
Replacing the Pinch Wheel

The worn out pinch wheel can be replaced in the pinch wheel assembly using the following procedure:

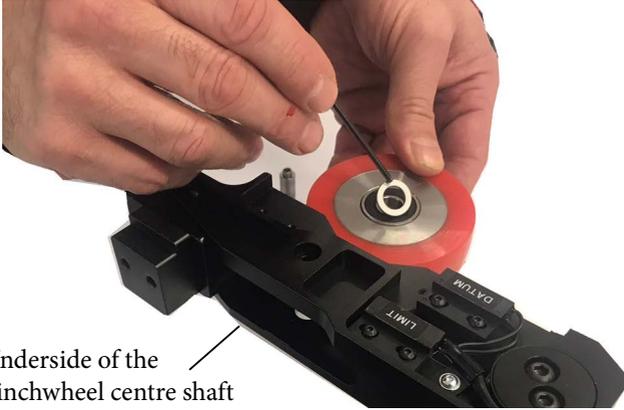
1. Unscrew the small screw on the pinch wheel on the underside of the pinch wheel assembly. The pinch wheel is not completely detached yet.



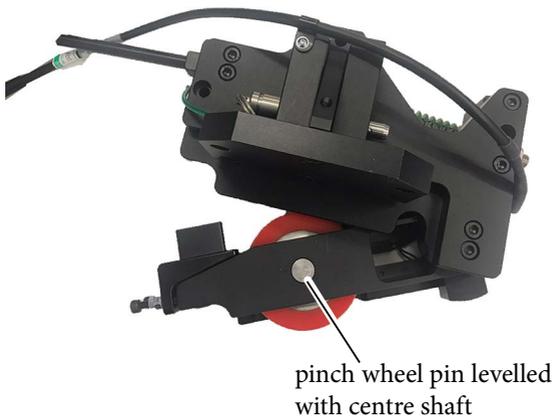
2. Using the same allen key push in the screw cavity to release the pin securing the pinch wheel.



3. Notice a washer above the pinch wheel; keep it aside. Discard the worn out pinch wheel.



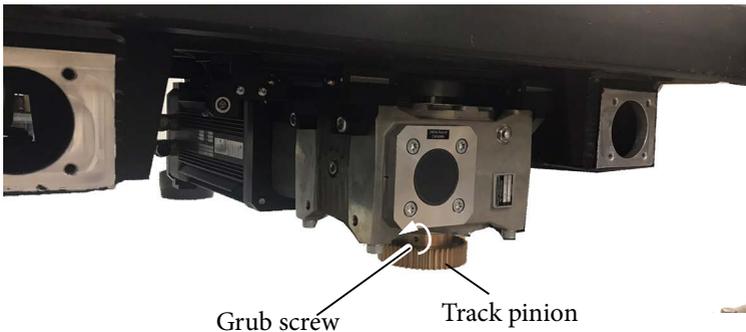
4. Replace the washer on the new pinch wheel carefully and inserting it lined with the screw cavities in the centre shaft of the pinch wheel assembly. Ensure that the washer is inserted towards the underside of the shaft and not on the top.
5. When the pinch wheel is centred on the cavities insert the pin. (Refer to step 2 for alignment and pin position). Push the pin enough so it is flush with shaft and is not protruding.
6. Replace the screw and washer to secure the pinch wheel to the assembly.



Replacing Track Pinion

This procedure can be performed either while the robot is on track or while the robot is on jacking wheels.

1. If the robot is mounted on the track, remove the pinchwheel assembly from the track motor and move the track motor away from the rail racking. Using bare fingers, observe the underside of the pinion to perceive the position of the pinion on the shaft.
2. Remove the grub screw from the track pinion.



3. You should now be able to release without applying pressure. If it is not released easily, use Flair to run the track motor at a slow speed, eg 20rpm. While the track pinion is rotating, use a heat gun to heat the pinion to allow it to expand.

Caution

- Take care when heating the pinion with the heat gun to only direct the gun downwards onto the sides and central when underneath. If the heat gun is directed at the gearbox seal above the pinion it can cause damage and create leaks.
- Do not hit the pinion or gearbox with any tools to detach it from the gearbox. Hammering can cause permanent damage to the pinion and gearbox.



4. Once the pinion is sufficiently expanded, using heat-proof gloves, try removing the pinion; again without using much pressure.
5. Replace the new track pinion by inserting it onto the shaft. If it doesn't fit easily, heat it using the heat gun and then slide it on to the track motor shaft. The position of the pinion should be the same as you had observed before removing the worn out pinion; approximately only 1-2mm of shaft projecting from the pinion centre.
6. Replace the grub screw to secure the pinion.

Replacing the Encoder Batteries

The arm uses encoder batteries to store the position when powered off. These batteries are installed when the robot is shipped from the factory, but should be replaced periodically by the customer. The guideline for replacing the battery is 1-2 years, but this may differ according to the robot's usage.

As part of your spares you should have received 1 set of 4 encoder batteries.

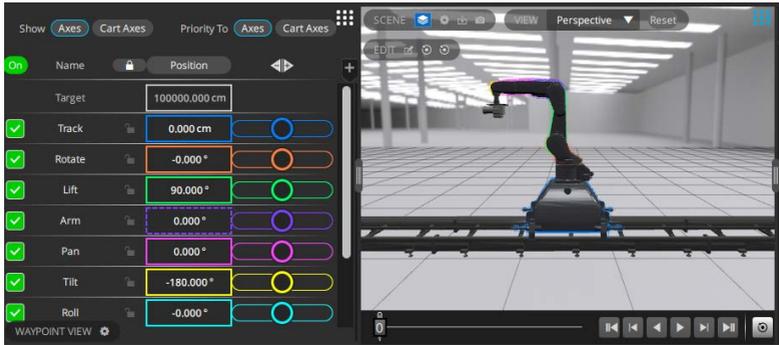
Before replacing the batteries, it is important to move the robot into the calibration position.



Calibration Position Flair

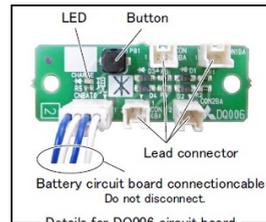
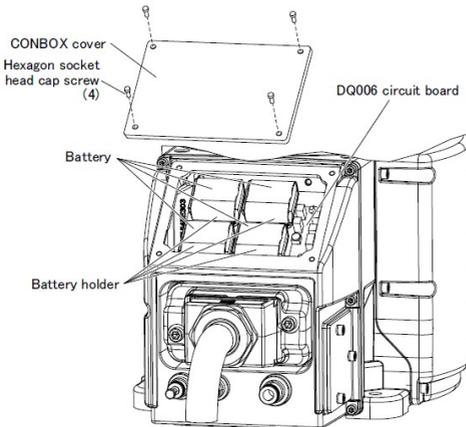
Move the robot in the position as shown below. This is a precaution in case the encoder positions are lost and the robot needs to be manually reconfigured.

If for any reason the origin is lost, contact MRMC for directions on how to re-calibrate it.



You **MUST** replace the battery one by one. If all batteries are removed the encoder data will be lost, and resetting the origin is necessary.

You **MUST** replace the whole set of 4 batteries. Do not leave an old battery in place with newer batteries.



Note) Although the figure is the example of RV-4FR other types are the same also.

1. Turn the controller control power OFF.
2. Remove the CONBOX cover.

3. Check that the capacitor is fully charged. Press the button on the DQ006 circuit board and check that the LED on the same circuit board turns on.
4. Replace the battery within 15 minutes after checking that the LED turns on.
5. If the LED does not turn on when the button is pressed, the capacitor needs to be charged. Turn on the controller and charge the capacitor for approximately 30 minutes.
6. Replaces the backup battery one by one. The battery holder is located inside the CONBOX cover. Remove the old battery from the holder, and disconnect the lead connector.
7. Insert the new battery into the holder, and connect the lead connector. Replace all batteries with new ones at the same time.
8. Ensure that all batteries have been replaced. If the old battery is contained, generating heat and damaging may occur.
9. Install the CONBOX cover as before. Ensure that any cable is not caught.

If the old battery is replaced because it has been used up, it is necessary to set the origin again.

Re-homing the Arm after Changing Batteries

In the case of lost encoder positions, the most accurate way to reset the origin is to re-use the encoder data origin file. Contact MRMC to request for the encoder origin file for the robot. The file would simply need to be loaded to the controller, using the 'origin data input' menu on RT Toolbox.



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MARK ROBERTS MOTION CONTROL

PRECISION TRACK

TRACK FOR LARGE MOTION CONTROL RIGS



QUICK START GUIDE

Product code: MRMC-1182-06

Precision Track Quick Start Guide

Product code: MRMC-1182-06

Last updated on: 23 March 2022

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Chapter 1 Assembling the track

Safety

- Due to the size and weight of track sections, it is recommended that you use at least **two** people to assemble it.



- Motion control rigs have powerful motors that can injure, so take care not to get near the rig while it is switched on.
- Do not step over the track when the rig is switched on — walk around it instead.

Overview

Thank you for using Precision Track from Mark Roberts Motion Control (MRMC). The track is designed to help you achieve pixel-perfect repeatability of your camera moves by supplying smooth, rigid support when using large, heavy motion control robots such as the Milo, Titan, and Bolt over long distances.

Before you start

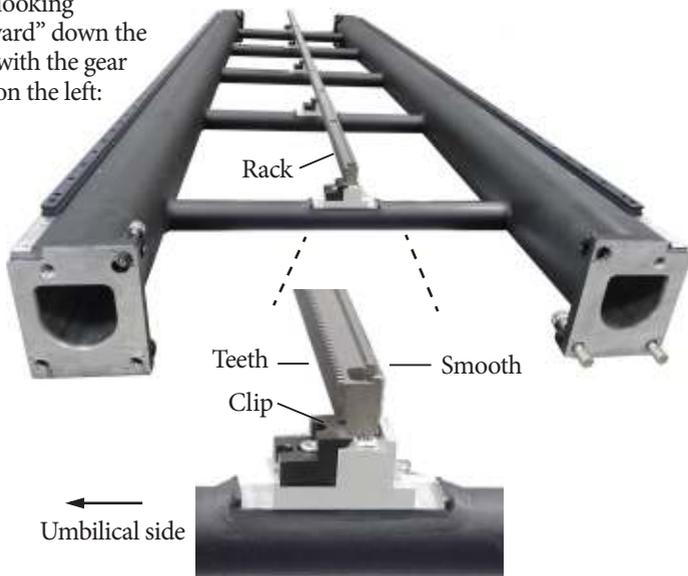
When deciding on the location and orientation of the track, keep in mind the following important points:

- Before laying the track, **assess the site** to see how level and firm the ground or floor is. You might need to use boards, bricks, or crates to create a level surface or stop the track feet sinking into soft ground. If you will be laying more than two track sections on a reasonably level floor, laying the middle section first and working outward can help prevent any unevenness of the floor from accumulating from section to section, beyond the ability of the track height adjustment range

to cope. Beyond this range you will need to use additional supports to keep the track flat and level.

- The track is **not reversible** due to the rack, which has teeth on one side. You must lay all sections the same way around. If your track does not have the rack installed yet, look at the rack clips on the track, which will grip the rail on the teeth side when you install the rail later.

View looking
“Forward” down the
track with the gear
teeth on the left:



- Some rigs have a sense of **Forward** and **Reverse** on the track. A Bolt High-Speed Cine-bot, for example, executes moves going Forward. Because its track motor gear is on the front left underside of the rig, the teeth of the rack are on the left side as you look in the Forward direction down the track.
- Keep in mind where the **umbilical cable** comes out on the rig (if this is important for your shot) and whether you can change it by re-routing the cables on the rig. For example the umbilical cable on Bolt comes out on the same side of the track as the track motor gear (which is the same side as the rack teeth).

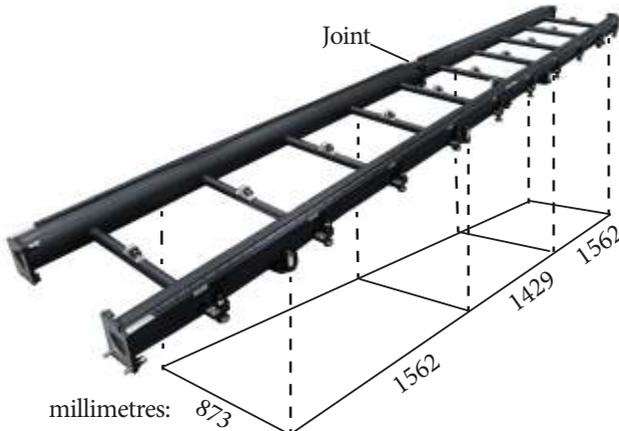
- Each Precision track section has ten **feet** for supporting and levelling the track, and four **anchor brackets** for holding the track down if you are using a high-speed rig such as Bolt.



Foot, which takes the weight of the track and rig

Anchor bracket, which holds the track down on the ground.

- If you are using a fast rig such as Bolt On Track then you must **hold the track down**. You can either anchor the track to the floor to get the best repeatable stability (page 7), or if this is not feasible you can use weights on the ends of the track to give you the safety margin that you need to perform the shoot (page 42). Anchoring the track to a concrete floor involves drilling holes in the floor. If the floor is wood you can screw directly into it. The anchor hole spacing is shown below but it is more accurate to drill through the anchor brackets once the track is in place using the procedures later in this guide.



- If you are using a fast rig with a long arm such as Bolt X on Track and anchoring the track to the floor is not feasible then it should be mounted using weight plates.

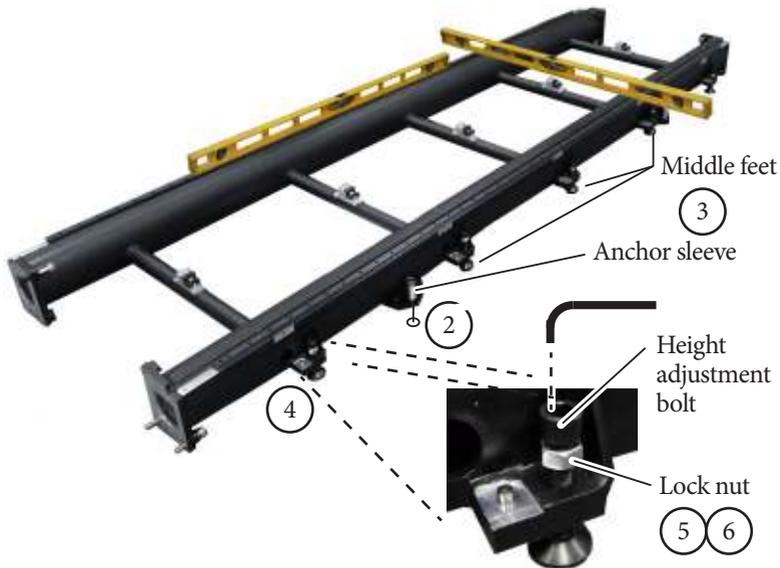


Laying the first track section

Note

This procedure applies to laying first track section for all large rigs except Bolt X on Track. For laying precision track for Bolt X on Track, use the procedure on *Laying the First Track Section – Bolt X on Track (with Weight Plates)* on page 12.

1. Lay the first track section on the ground, on its feet.
2. If you will be using a fast rig such as Bolt and the floor already has anchor holes from a previous installation then you would obviously put the track anchor brackets over the existing holes.
3. Raise the six middle feet of the track section (three on each rail) and the four threaded anchor sleeves so they do not touch the ground, leaving the rail to rest on the four corner feet.



4. Level the track in both length and width directions using a spirit level, by adjusting the four corner feet of the track. Make sure all four corner feet are touching the ground (no wobble).

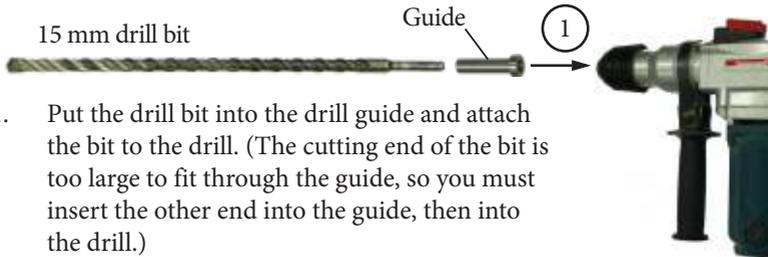
Hint

The four corner feet also determine the track height. If you are laying track on a level floor, try to use the middle of the height adjustment range so that subsequent sections have some leeway (in their feet) to cater for any unevenness in the floor.

5. Tighten the lock nuts down against the track on the corner feet, being careful not to change the height.
6. Lower the six middle feet until they touch the ground (finger tight against the ground) and then tighten the lock nuts on them.

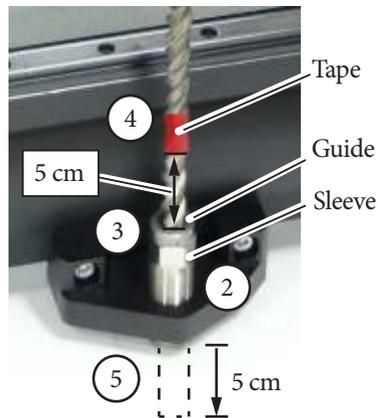
Anchoring the track

If you are using a fast rig such as Bolt On Track you must either hold the track down with weights (see page 42) or secure the track to the floor by using bolts or screws through the four track anchor brackets. Anchoring the track to the floor gives you more repeatable stability than using weights. The following procedure tells you how to anchor the track to a concrete floor.



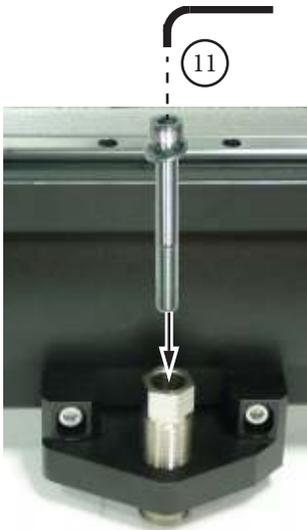
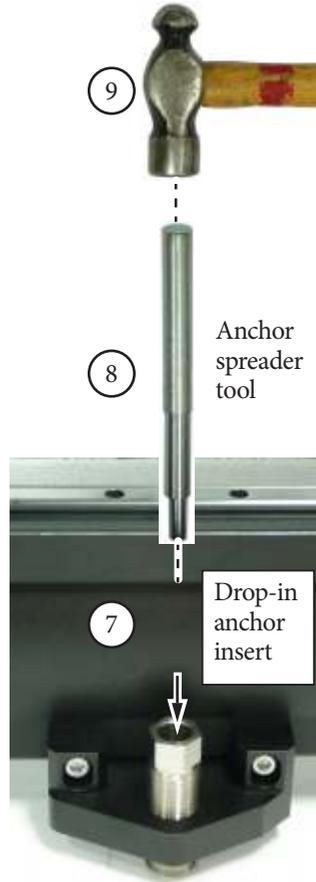
1. Put the drill bit into the drill guide and attach the bit to the drill. (The cutting end of the bit is too large to fit through the guide, so you must insert the other end into the guide, then into the drill.)

2. On one of the track anchor brackets, screw the sleeve all the way down to the floor, finger tight.
3. Insert the drill bit and guide into the threaded sleeve on the anchor bracket, so the drill bit is against the floor.
4. Put tape around the drill bit 5 cm above the guide. This will help you gauge the depth of the hole in the next step.



5. Drill a hole 5 cm deep into the concrete. When the tape reaches the top of the guide, drilling is complete.
6. Remove the drill bit and guide from the sleeve and clean the hole.

7. Put the drop-in anchor insert, threads upward, through the sleeve and into the hole in the concrete, all the way to the bottom.
8. Insert the anchor spreader tool into the drop-in anchor insert.
9. Hit the top of the anchor spreader tool with a hammer until the anchor is fully spread in the concrete, **being careful not to hit the track**.
10. Remove the anchor spreader tool.
11. With the sleeve still finger-tight against the floor, insert the retaining bolt through the sleeve and into the drop-in anchor insert, and tighten.



12. Repeat steps 2 to 11 for the other three anchor brackets on the track section.

Note

If you are not laying the track for Bolt X Track, for further instructions, proceed to *Laying subsequent track sections* on page 16.

Using Weight Plates with Bolt X on Track

If you are using a fast robot with a long arm, such as Bolt X on Track, it is recommended that you hold the track down by bolting it to the ground as above. If that is not feasible, use the weight plates to lay under and then bolt the track on to the weight plates.

They are not a full substitute for a rigid fixing to a ground anchor and will not provide the same stability. Caution should therefore be exercised when using weight plates alone to stabilise a system.

MRMC have empirically tested the Bolt X to a **maximum speed of 180deg/s** on Joint 1 of the rig. A 6-plate system will provide the required safety at this speed.

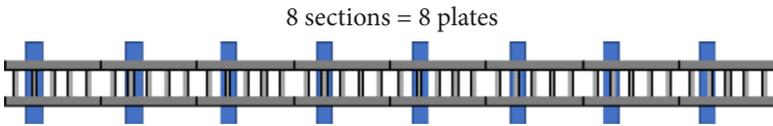
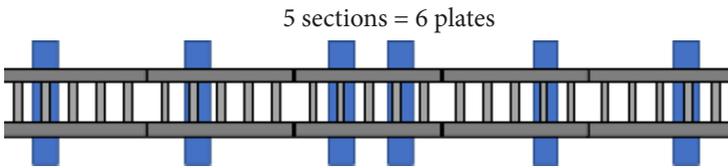
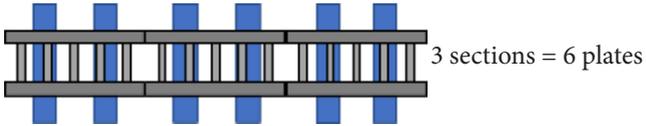
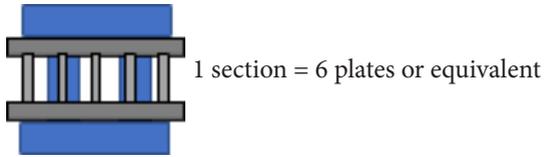
Note that this speed is highly unlikely to be practical in normal operation of the rig with weight plates only due to the movement which will occur, making it unsuitable for filming.

To avoid any significant gaps in the weight plate system for longer runs greater than 6 lengths an additional 1 plate per length of rail is required.

Number of plates

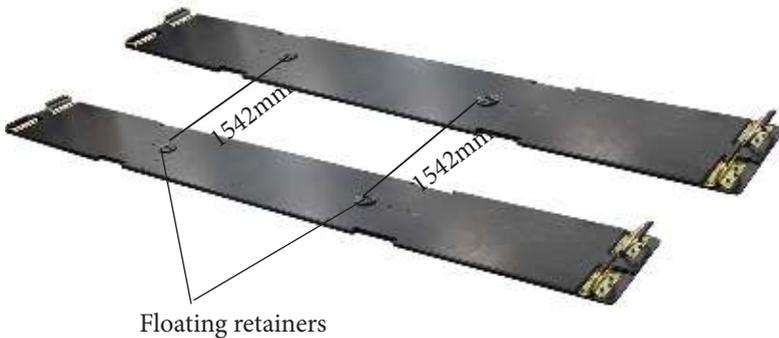
- Two plates for each 3m section of precision rail up to 3 sections.
- For systems with more than 3 sections of 3m rail 6 plates should be used up to a maximum of six sections, spaced evenly
- For more than 6 sections 1 additional plate per section is required
- For systems with less than 3 rail sections additional stabilising weights must be used, equivalent to 6 plates.

Rail Sections	Plates Required
Upto 3	Equivalent of 6 plates
3 to 6	6
More than 6	One plate per rail section, spaced evenly



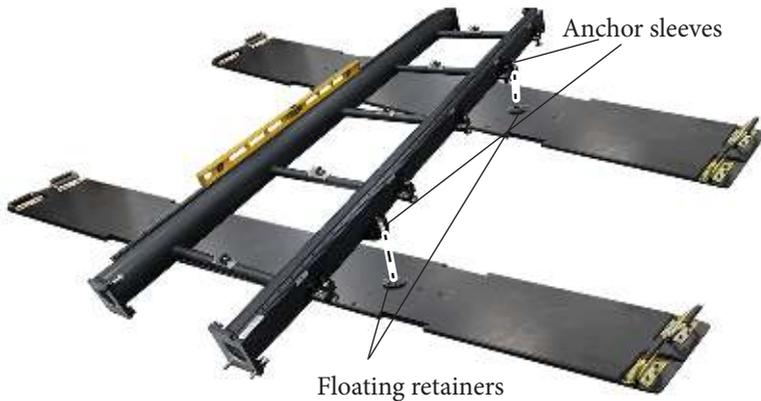
Laying the First Track Section – Bolt X on Track (with Weight Plates)

1. Carefully, 2 persons lift a weight plate from the crate and lay it such that it is perpendicular to the position of where the first track section is to be installed. (The position of the weight plate should be decided bearing in mind that the floating centre retainer on the floor plates would be directly under that first pair of anchor screws on the track.)



2. Similarly, 2 person lift the second weight plate centred to the approximate position of the second pair of anchor screws on the track. The second pair of anchor screws on the track section are 1542 mm from the first one.

3. Lay the first track section, placing the 4 x anchor screws on the track directly above the 4 x floating retainers on the floor plates.



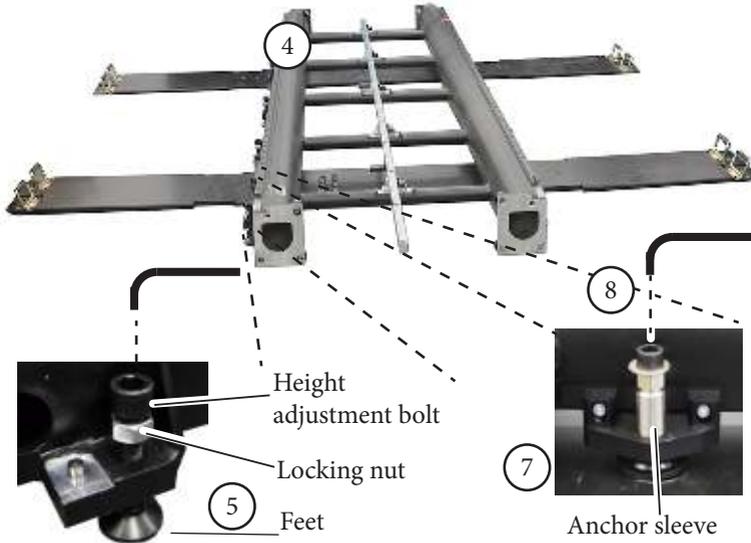
4. Level the track in both lengthways and widthways using a spirit level, by adjusting the four corner feet of the track. Make sure all four corner feet are touching the ground (no wobble).

Hint

The four corner feet also determine the track height. If you are laying track on a level floor, try to use the middle of the height adjustment range so that subsequent sections have some leeway (in their feet) to cater for any unevenness in the floor.

5. Tighten the lock nuts down against the track on the corner feet, being careful not to change the height.
6. Lower the six middle feet until they touch the ground (finger tight against the ground or the weight plate) and then tighten the lock nuts on them.
7. Screw one of the anchor sleeves all the way down to the floating centre retainers on the floor plate, finger tight.

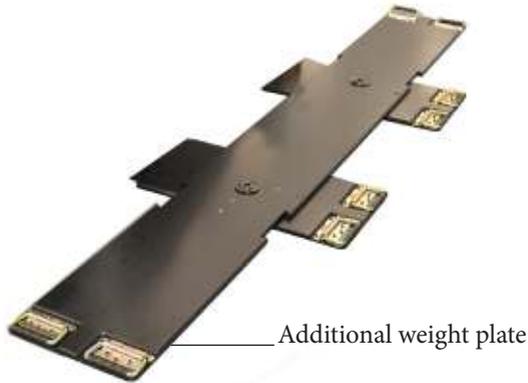
8. Insert the retaining bolt in the anchor sleeve and tighten it. Note that the floating centre retainers on the floor plates can be adjusted sideways slightly to match the retaining bolt.



- Repeat Step 7 and 8 for the remaining 3 anchor sleeves for the first track section.

Note

If you are using only one track section, use the above procedure to lay the track section and the weight plates and then place additional two weight plates across the weight plates already laid as additional weight.



Laying the Second Track Section – Bolt X on Track (with Weight Plates)

- Again two-person lift the third floor plate in position next to the first track section such that the floating retainers of the third weight plate are 1429mm away from those of the second one.
- Lay the fourth weight plate parallel to the third one with floating retainers of the two 1542mm apart.
- Add the second track section and follow steps 3-9 in the *Laying the First Track Section – Bolt X on Track (with Weight Plates)* on page 12 section.
- The subsequent instructions for laying tracks are similar as that for other large rigs except that each track section require two floor

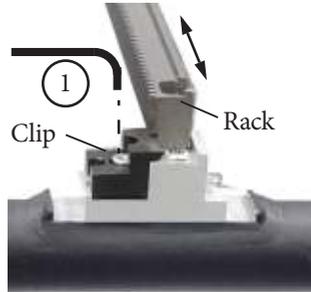
plates to go under first. Follow the subsequent sections in this Quick Start Guide for further instructions.

Note

Once the track is secured using weight plates, no other weights need to be added to the corners of the track.

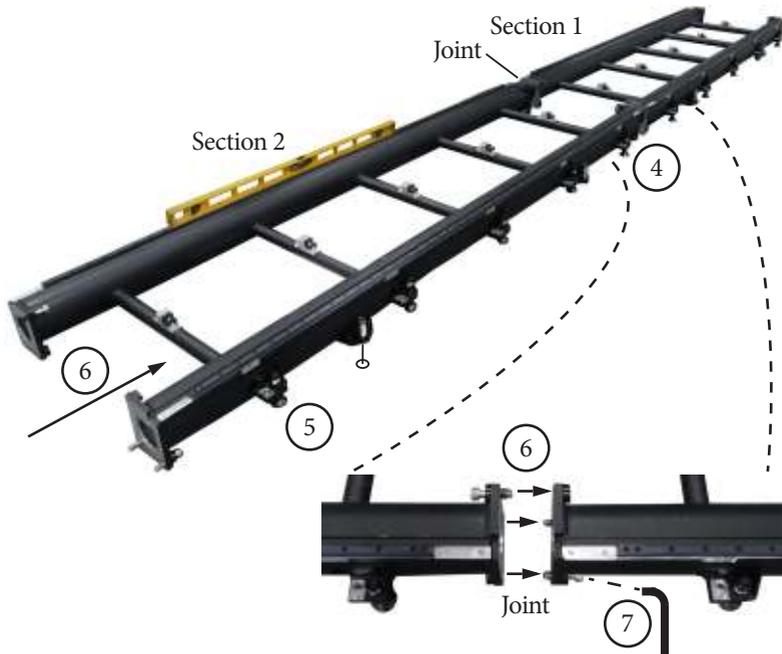
Laying subsequent track sections

1. If any of your track sections already have a rack installed, loosen the rack clips so you can temporarily slide the rack along the track and out of the way when you are joining the track sections.
2. Lay the next track section in line with the previously laid track section and as close to it as possible, making sure it is the right way around (see the notes on page 2).



Again, if you will be using a fast rig such as Bolt and the floor already has anchor points from a previous installation, put the track anchors as close as possible to the existing holes.

3. Raise the middle feet and anchor sleeves of the new track section so they do not touch the ground.



4. Adjust the height of the new track section to match that of the previous section by adjusting the two corner feet nearest to the joint (one on each rail).
5. Level the new track section with a spirit level by adjusting the two corner feet furthest from the joint (one on each rail).
6. Slide the new track section along the floor against the previous track to firmly engage the ends of the rails. (Slide the new section — not the previous section.)

You might need to repeat steps 4 to 6 until you get good alignment of the rails at the joint.

7. Firmly tighten the six large bolts that hold the track sections together at the joint (three on each rail). You can also use these to help pull the track sections together, once they are at the same height.
8. On the new track section, tighten the lock nuts down against the track on the four corner feet.

9. On the new section, lower the six middle feet until they touch the ground (finger tight against the ground) and then tighten the lock nuts on them.
10. If you are using a fast rig such as Bolt, anchor the new track section to the floor as you did for the previous track section, using the procedures in *Anchoring the track* on page 7.

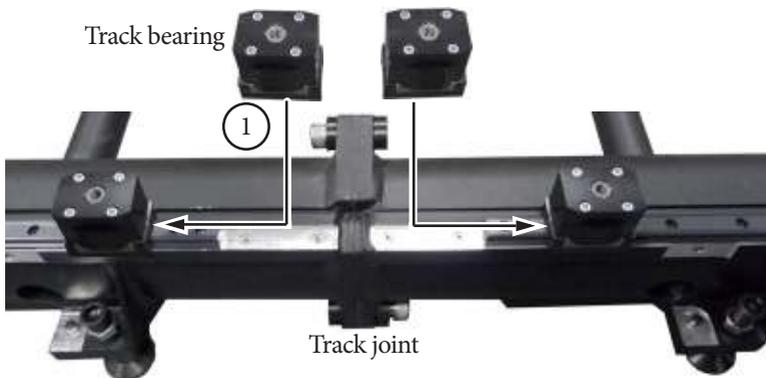
Repeat steps 1 to 10 in this section to lay additional sections of track.

The track section are shipped with the rack mounted on them. If you have removed the rack for transportation, see Appendix 3 *Mounting the rack* for instructions on mounting it on the track.

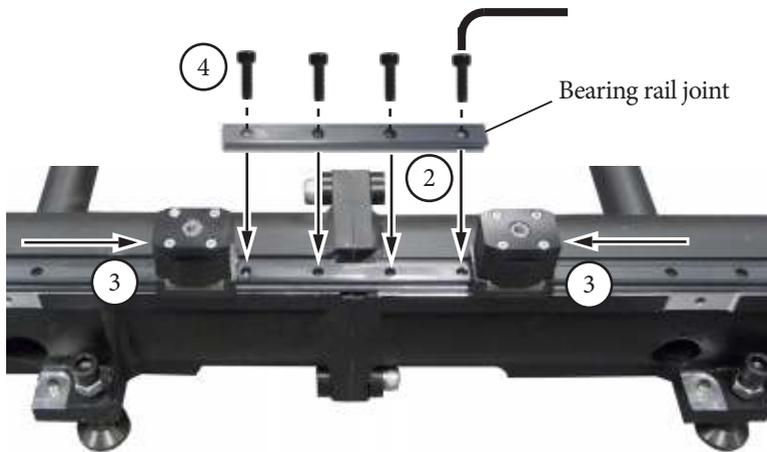
Mounting the bearing rail joints

Hint

Always mount and remove the track bearings with care. Try to keep them squared up and in-line with the bearing rail to avoid damaging them or loosing a bearing.



1. At one of the track joints, slide two track bearings over the ends of the bearing rails. Note that the track bearings for **Bolt X on Track** are different from these pictures.



2. Put one of the long bearing rail joints onto the track.

Note – Bolt X on Track

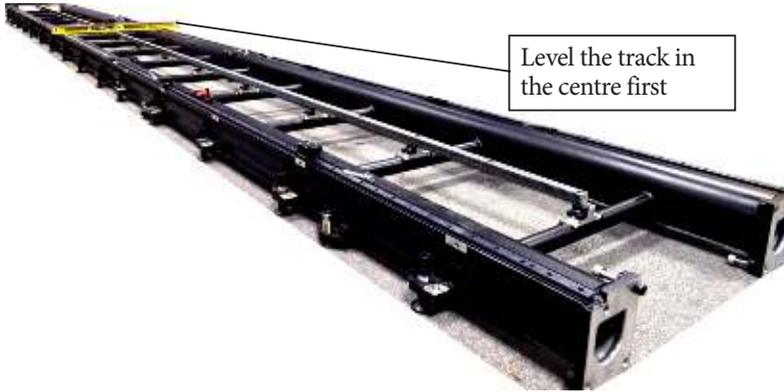
The rail joints for Bolt on Track have four additions threaded holes which require corresponding holes in the rails themselves. If they haven't been done already, use the rail joint holes as guides to drill holes in the rails.

3. Align the bearing rail joint with the existing rail by sliding the track bearings partially over the joint at each end.
4. Insert the bolts and tighten them.
5. Slide the track bearings along the rail to the next joint and repeat steps 1 to 4 for all remaining joints. For the track ends you use the short bearing rail pieces (with only two holes) and only one track bearing to help with alignment.

Multiple Lengths of Track

1. Lay the first three lengths of track and join them together.
2. Treat the three lengths of track as one. Use the end corner feet of the multiple length with all intermediate feet of the floor.

3. Level the multiple length as one unit measuring the end to end level only in the centre of the entire group.

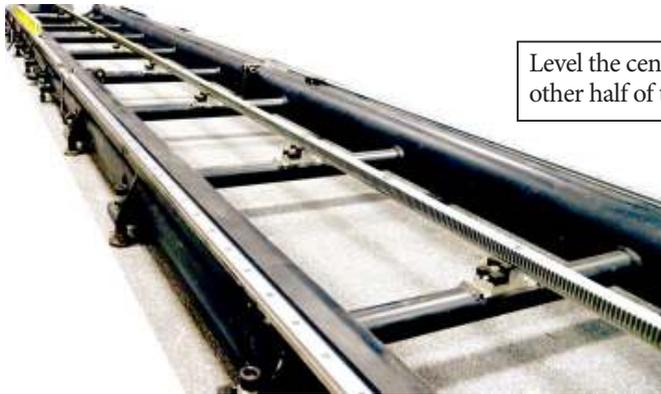


- Using only the middle pair of feet, bring the centre of the rail up to the level with the ends by measuring the level at the centre of the first half.



Level the centre of one half of the group





Level the centre of the
other half of the group



5. Push the rest of the feet down.
6. Extra lengths of the rail can then be added and individually levelled.

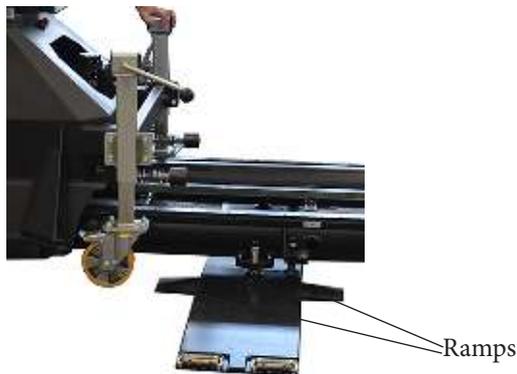
Mounting Bolt (family of robots) on the track

This section tells you how to mount Bolt On Track onto Precision Track.

Mounting Bolt on the track bearings



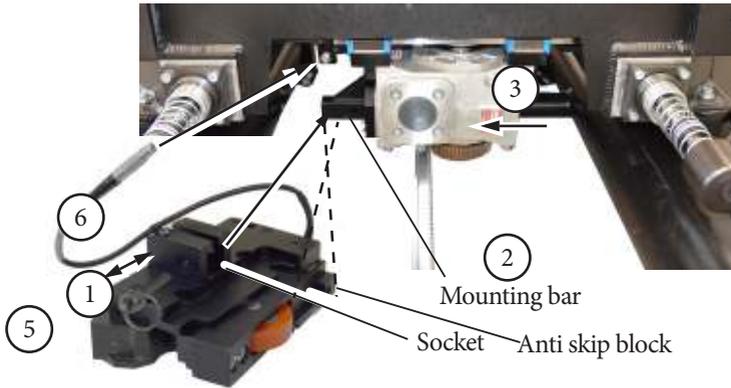
1. Roll the rig to a position just off the end of the track, raise the rig on its wheels high enough to go over the track using the wheel cranks, and rotate the rig on its wheels to be the correct way around so that the track motor gear on the rig underside is on the toothed side of the rack. **Do not engage the teeth yet; just make sure the rig is the correct way around for the track.**
2. On the underside of the rig, remove the pinch wheel if you haven't already done so and push the track motor out of the way on its sliding bearings, so that the track motor gear will not interfere with the Rack on the track. (For details of removing the pinch wheel, follow the procedure on page 26 in reverse order.) **Do not slide the pinion gear too far away from the rack when moving it into place, the rear (inner) track motor mounting bolt will hit the racking as you drop the rig down, preventing it from settling onto the bearings.**
3. Bolt X on Track: Add the supplied 4 x ramps on the first weight plate on the side where you are mounting the robot from.



4. Push the rig on its wheels over the track about a metre, being careful not to push the track motor gear against the rack while moving. For Bolt X on Track the ramps help slide the rig on the track with ease. Be careful that the wheels do not pivot sideways away from the ramp while pushing the rig on the track.
5. Push the four track bearings onto the ends of the track (two on each rail) and into position under the four corners of the rig base.

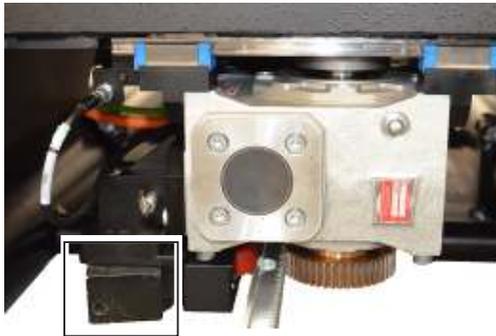
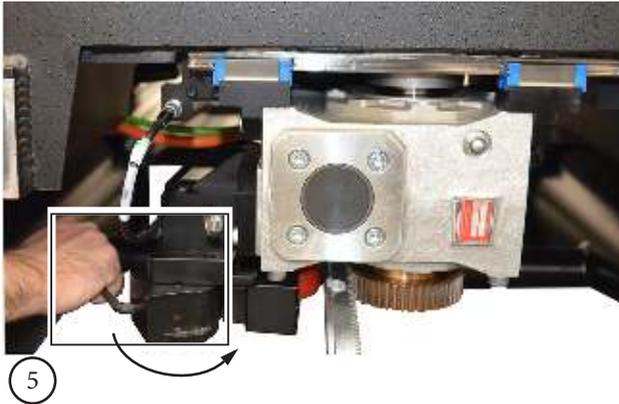
6. Carefully lower the rig onto the four track bearings, making sure that all four bearings are aligned with the corners of the rig base, and the track motor gear on the underside of the rig clears the rack.
7. Tighten the four track bearing mounting bolts at the corners.
8. Apply the brakes to the wheels to keep them from pivoting against the track (the brakes affect both rotation and pivot), and raise the wheels off the ground so the full rig weight is taken by the track. For Bolt X on Track, remove the ramps and store in a safe place to use them while taking the rig off the track and mounting again.
9. Feed out enough umbilical cable from your control area to reach the entire length of the track without stretching the cable. Make sure the area alongside the track is clear so that the umbilical cable doesn't catch on anything when the rig drags it alongside the track.
10. Attach the track motor pinch wheel on the underside of the rig, described in *Attaching the track motor pinch wheel to Bolt (Family of Robots) On Track* on page 26.

Attaching the track motor pinch wheel to Bolt (Family of Robots) On Track



1. On the separately supplied pinch wheel assembly, remove the brass retaining pin by pulling on the ring.
2. Mount the pinch wheel assembly onto the track motor on the rig underside, by sliding the track motor gear against the rack and putting the pinch wheel Socket onto the track motor Mounting bar.
3. Push the track motor slightly towards the rail racking so that the track motor gear is in mesh with the rack.
4. Replace the retaining pin in the pinch wheel assembly by pushing on the ring (not the sleeve), to hold the assembly in place on the track motor.

5. Use the lever or an allen key into the pinch wheel CAM to pull it towards the rack until it snaps into position. This holds the track motor gear firmly against toothed side of the rack.

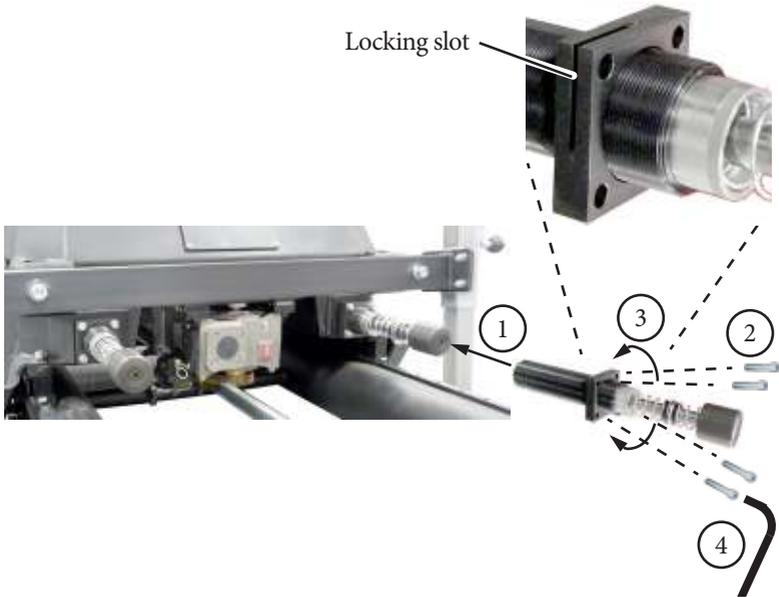


6. Connect the pinch wheel cable and use cable ties to hold it securely up away from the track.

Hint

The Limits and Datum magnets on the track are physically swappable (see page 40). Make sure you connect the Limit cable from the rig to the pinch wheel switch that is over the Limit magnet position on the track, and ditto for the Datum cable.

Mounting the bumpers on Bolt (Family) of Robots on Track



1. Insert one of the bumpers into the hole in the base of the rig.
2. Insert the four retaining bolts through the bumper bracket and into the base, but do not tighten yet.
3. If you want, adjust how far the bumper extends from the rig by screwing it in or out of its threaded bracket.
4. Tighten the four retaining bolts on the bumper.

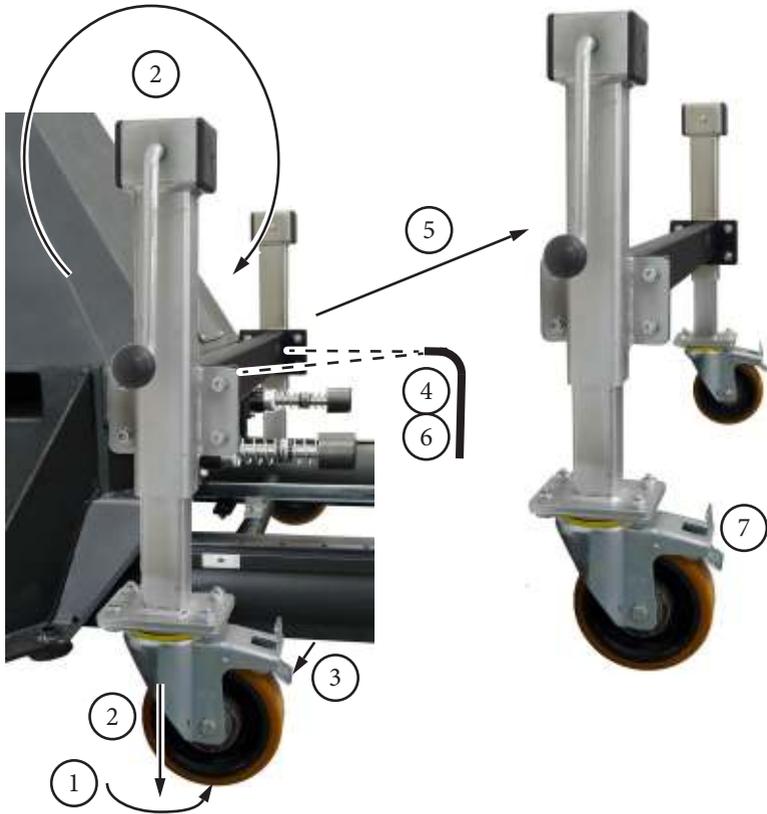
5. Repeat steps 1 to 4 to mount the other three bumpers.

Hint

One of the corners on the bumper bracket has a locking slot cut into it. Tightening the bolt on this corner flexes the bracket, which in turn locks the threaded cylinder of the bumper to prevent it from turning. To adjust the amount of bumper extension after the bumper is mounted you only need to loosen the bolt on the bracket corner with the locking slot. You can then turn the bumper in its bracket to adjust the amount of extension, and re-tighten the bolt when you have finished.

Removing the trolley wheels from Bolt (Family of Robots) On Track

After mounting the rig on the track you can remove the two trolley wheel units that are on either side of the rig.



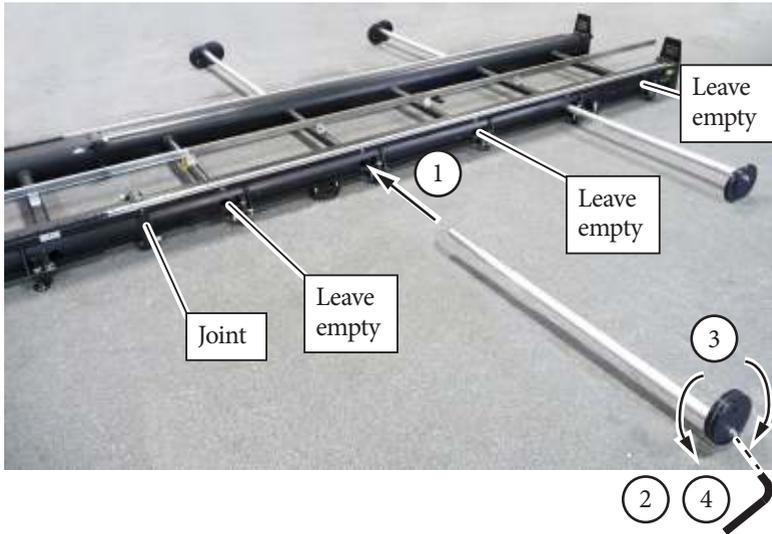
1. With the base of the rig supported by the track, pivot the wheels away from the rig.
2. Turn the cranks to lower the wheels to the ground.
3. Apply the wheel brakes.
4. Remove the two bolts holding the wheel trolley unit on the rig.
5. Lift the wheel unit away from the rig.
6. Insert the two wheel trolley retaining bolts back into the rig base, for safe keeping.
7. If you are going to store the wheels for weeks or months, release the wheel brakes so they don't leave a dent in the wheel rubber.

Notes

Mounting a Milo or Titan on the track

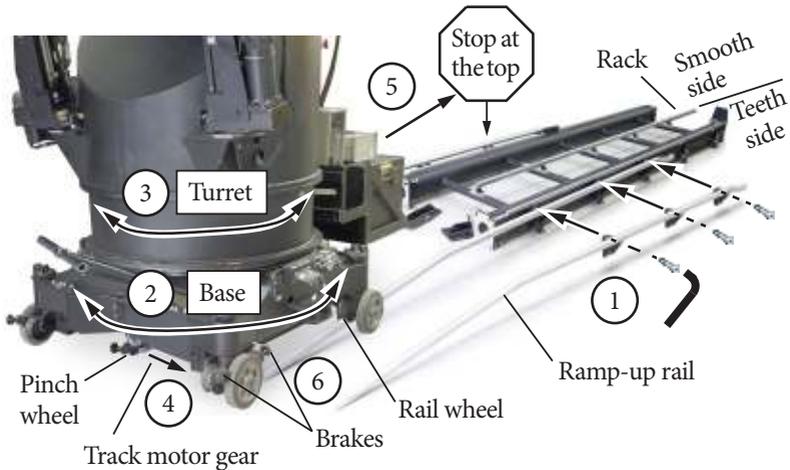
Mounting outriggers on the track

The outriggers for Precision Track are a safety feature and **must** be always used for safety to prevent the rig tipping when assembling, disassembling or using a Milo Long Arm or Titan. You install four outriggers in each section of track. Leave the centre hole and end holes empty.

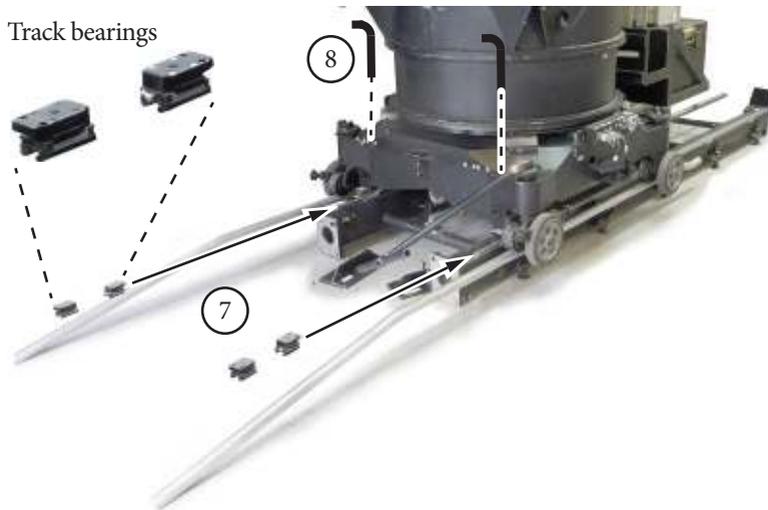


1. Insert the outrigger into an appropriate hole in the side of the track as far as it will go — this is about 340 mm, or about twice the length of the shiny tip of the outrigger.
2. Loosen the bolt on the end of the outrigger to allow the off-centre disks to rotate on the shaft.
3. Rotate the off-centre discs on the shaft in opposite directions until they both press against the floor, hand tight.
4. Re-tighten the bolt.
5. Repeat for the other three outriggers for the section, and for each section of track.

Mounting a Milo or Titan on the track bearings



1. Attach the pair of ramp-up rails to one end of the track, using three bolts on each rail.
2. Roll the rig to a position just off the end of the track, making sure the base is the correct way around. The track motor gear on the underside of the rig must be on the toothed side of the Rack.
3. You can rotate the Turret later if you need to point the arm in the other direction along the track during the shoot. For now, point the arm parallel to the track to make sure the rig is balanced over the track.
4. On the underside of the rig, remove the pinch wheel if you haven't already done so and push the track motor out of the way on its sliding bearings, so that the track motor gear will not interfere with the Rack on the track. (For details of removing the pinch wheel, follow the procedure on page 36 in reverse order.)
5. Roll the rig on its wheels up the ramp, making sure that the rail wheels (with concave edges) are centred on the ramp-up rails. **Stop the rig when it is centred over the highest point on the ramp-up rails**, and **before** the rig reaches the small down-slope at the other end of the ramp-ups.
6. Apply the brakes.

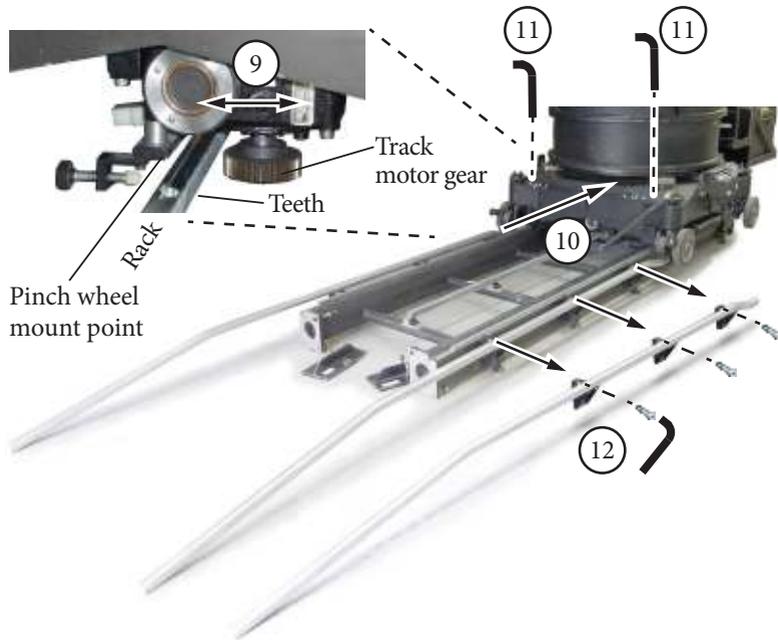


7. With the rig at the highest point on the ramp-up rails, carefully push the four track bearings onto the ends of the bearing rails (two on each rail) and into position under the four corners of the rig base.

Hint

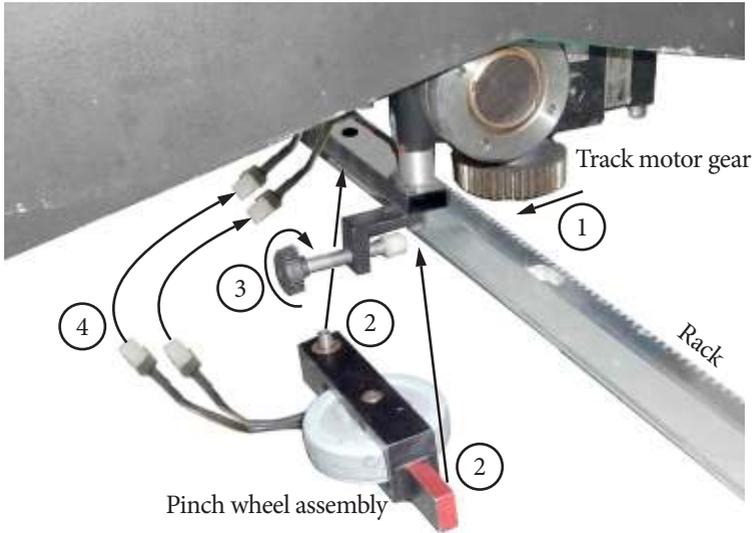
Always mount and remove the track bearings with care. Try to keep them squared up and in-line with the bearing rail to avoid damaging them or losing a bearing.

8. At each corner of the rig, use a hex key to push the captive bolt down into the track bearing and tighten to make sure the track bearing is lined up with the corner of the rig. You will not be able to tighten it completely yet because the rig is still sitting on the ramp-up rails and not on the track bearings.
9. Under the rig, move the track motor on its sliding bearings so that the Rack is centred between the track motor gear and the pinch wheel mount point. The purpose is to make sure that no part of the rig touches or interferes with the Rack when you push the rig the rest of the way onto the track in the next step.



10. Let off the brakes and push the rig further along the ramp, down the small slope, and the rest of the way onto the track. When you do this, make sure that each of the four track bearings fits into the recess at the corners of the rig.
11. Tighten the four track bearing mounting bolts at the corners.
12. Remove the ramp-ups from the track so that the rig has the full run of the track.
13. Feed out enough umbilical cable from your control area to reach the entire length of the track without stretching the cable. Make sure the area alongside the track is clear so that the umbilical cable doesn't catch on anything when the rig drags it alongside the track.
14. Attach the track motor pinch wheel on the underside of the rig, described in *Attaching the track motor pinch wheel to a Milo or Titan* on page 36.

Attaching the track motor pinch wheel to a Milo or Titan

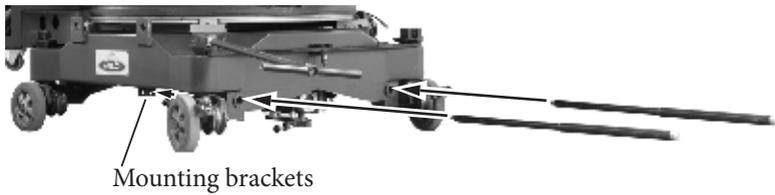


1. On the underside of the rig, slide the track motor gear against the rack.
2. Bolt the pinch wheel assembly onto the mounting point on the underside of the track motor and tighten the bolt.
3. Hand-tighten the pinch wheel adjustment bolt so that the rubber wheel presses firmly against the smooth side of the rack. This holds the track motor gear firmly against toothed side of the rack.
4. Connect the pinch wheel cables for the Limit Switch and Datum Switch to their corresponding connectors (usually labelled **L** and **D**) on the rig underside, and use cable ties to hold them securely up away from the track.

Hint

The Limits and Datum magnets on the track are physically swappable (see page 40). Make sure you connect the Limit cable from the rig to the pinch wheel switch that is over the Limit magnet position on the track, and ditto for the Datum cable.

Mounting the bumpers on a Milo or Titan



1. Insert one of the bumpers through the appropriate hole in the base of the Milo or Titan, and then into the mounting bracket until it clicks into place.
2. Repeat step 1 to mount the other three bumpers at the other three corners.

Notes

Mounting the Limit Switch and Datum Switch magnets on the rack

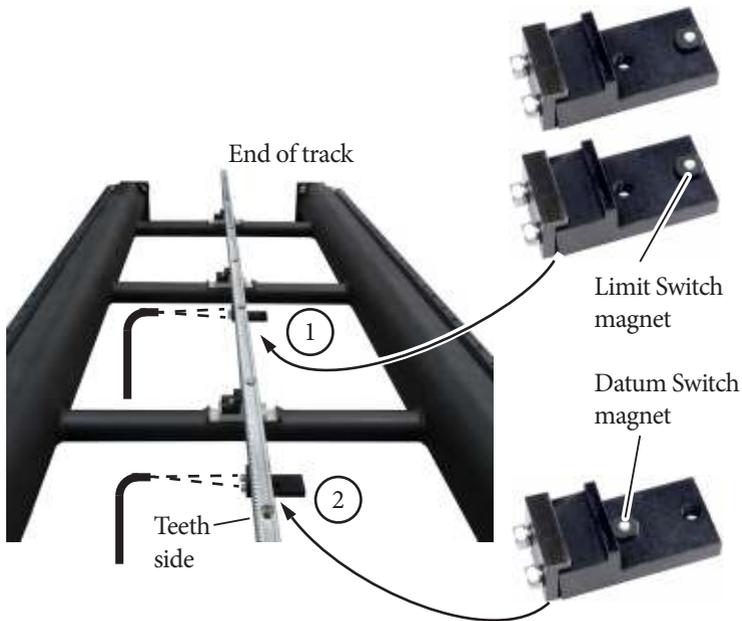
About track limits

In a track-mounted rig there are typically three devices for limiting movement along the track to prevent the rig going off the end of the track:

- **Soft limits** - You configure these in the Flair Motion Control Software that controls the rig. When the system is working correctly the soft limits act as a barrier to other parts of the software such as programmed moves or live commands, so that no part of the software can move the rig beyond the soft limits.
- **Limit and Datum Switches** - The **Limit Switch** consists of a magnetic sensor located on the track motor pinch wheel on the underside of the rig, and two magnets which you mount at each end of the rack. The position of the magnets along the rack defines the ultimate limits, along the track, for the rig electronics. You define the soft limits within the range of the Limit Switch magnets, so that if the soft limits fail for some reason and the rig reaches one of the Limit Switch magnets, the system electronics automatically shut down any further movement and apply the brakes. A similar switch called the **Datum Switch** is used in combination with a single Datum magnet which you also mount on the rack but at a different distance from it. The Datum Switch defines a fixed reference point on the track for the electronics. The Flair software can then use this position as the home position or zero point, from which all movements and soft limits along the track are measured.
- **Buffers** - These are steel plates that physically prevent the rig from going off the end of the track if the previous two limits fail. Spring-loaded bumpers on the rig help to prevent damage to the rig or track, but you should never intentionally use the buffers to stop the rig. Mounting instructions are in *Mounting the buffers without weights* on page 44. For the Narrow Rail, the bumpers are mounted the Buffer bracket. For details, see *Mounting Buffers on Narrow Rail* on page 45.

Mounting the magnets

Although you can mount the magnets for the Limit Switch and Datum Switch on the rack at any time, you ordinarily do this after mounting the rig on the track so that you can precisely adjust the height of the magnets relative to the magnet sensors on the pinch wheel on the underside of the rig.



The bracket that holds the magnet has two holes, and there is no convention regarding which hole to use for the Limit magnets and which to use for the Datum magnet. Whichever arrangement is used, the two brackets with an identical arrangement are used for the Limits at the ends of the track, and the bracket with the magnet in the other hole is used for the Datum which is between the Limits.

The track motor pinch wheel on the underside of the rig has two switches (sensors) that run over these two magnet positions — one switch for the Limits and one for the Datum.

When you install the pinch wheel and connect the rig's Limit and Datum cables to the switches on the pinch wheel (page 26 for Bolt or page 36 for Milo or Titan), you must make sure that you connect the Limit cable to

the switch that is in the Limit magnet position, and the Datum cable to the switch that is in the Datum magnet position.

1. Mount the two Limit Switch magnets (the two brackets that have the magnet in the same hole) onto the underside of the rack — one at each end of the track about a metre from the end. The actual distance depends on your requirements and on which side of the rig your Limit Switch is on (located on the track motor pinch wheel on the underside of the rig). Position the magnet along the rack so the Limit Switch on the pinch wheel goes over the magnet before the rig hits the physical end of the track with plenty of room to spare.
2. Mount the Datum Switch magnet (the bracket that has the magnet in the other hole) onto the underside of the rack, usually about 0.2 metres in from one of the Limit Switch magnets depending on your requirements.
3. Power up the rig and roll it slowly over each magnet, checking for clearance between the magnet on the rack and the sensor on the pinch wheel assembly on the underside of the rig. Adjust the height of the magnet (by loosening and re-tightening the bracket, and screwing or unscrewing the magnet in the threaded hole) to give 1 to 2 mm of clearance between the magnet and the sensor.

Caution

Mounting the magnets too high can damage them, as they can come into contact with the pinch wheel assembly on the underside of the rig.

To adjust the magnet when the rig is over it, remember to observe safety procedures to disengage the robot and make use of the E-stops so that the rig does not move when you are working under it.



Mounting the weight wings and buffers

If you are using a fast rig such as Bolt On Track but anchoring the track into the floor is not feasible, you can alternatively attach optional weight wings (supplied with specific rigs only) to the ends of the track and hold the track down with weights. The weight wings fit between the track ends and the buffers.

Hint

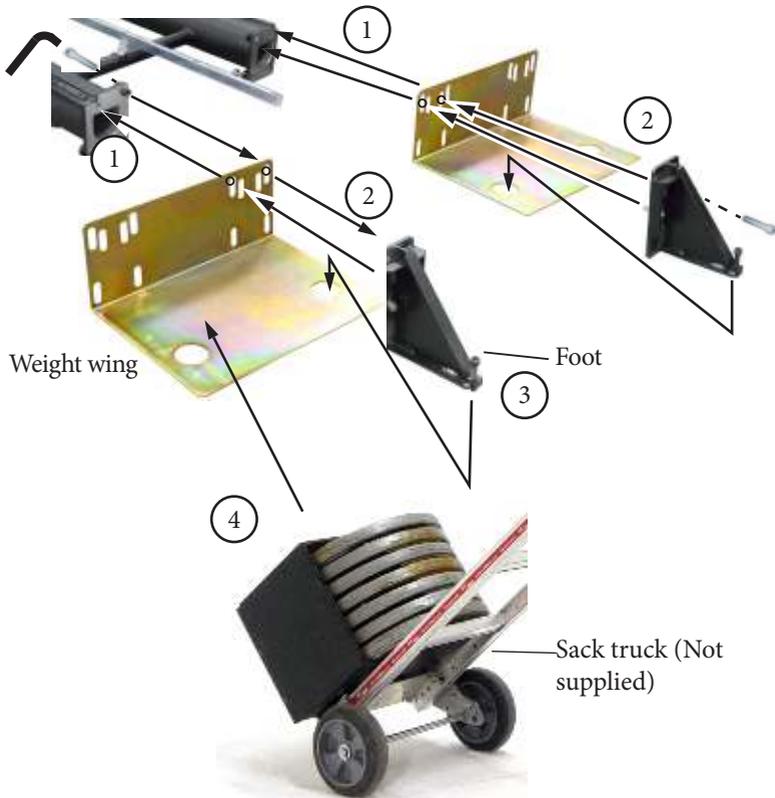
Using weight wings will not give you the same level of repeatable stability as anchoring the track to the floor, but will give you enough stability to operate Bolt On Track safely without tipping the rig over.

You ordinarily mount the weight wings and buffers after you have mounted the rig on the track, although you can mount the rig on the track later if have a forklift that can lift the rig high enough to go over the track from the side.

If you are going to mount the rig later, slide the track bearings onto the bearing rails now, before mounting the weight wings and buffers. If you forget to do this then when you mount the rig onto the track you will need to temporarily remove the bearing rail end pieces in order to get the track bearings onto the bearing rails.

Note

Weight buckets are only supplied with certain rigs. Contact MRMC to learn if your rig accompanies weight buckets.



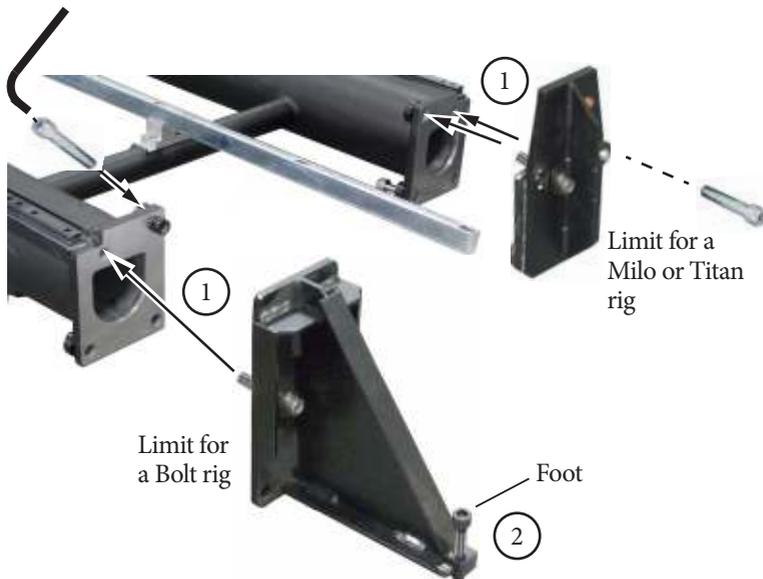
1. Put the first weight wing into place on the end of the track, resting on the floor.
2. Bolt the left buffer onto the end of the track, using one bolt from the buffer side and another from the end of the track. You might need to remove bolts from the track joint to make room for the bolts coming through from the buffer side. Bolts are not necessary at the bottom of the limits.
3. Screw the foot down against the floor, finger tight only.
4. Wheel the weight bucket onto the wing. Each box contains 140 Kg of weights (7×20 kg).
5. Bolt the right buffer onto the end of the track using the two bolts from side of the buffer.

- Repeat steps 1 to 5 for the other two weight wings and buffers on the other side of the track so you have two boxes of weights mounted at each end of the track.

Mounting the buffers without weights

You ordinarily mount the buffers after you have mounted the rig on the track, although you can mount the rig on the track later if you have a forklift that can lift the rig high enough to go over the track from the side.

If you are going to mount the rig later, slide the track bearings onto the bearing rails now, before mounting the buffers. If you forget to do this then when you mount the rig onto the track you will need to temporarily remove the bearing rail end pieces in order to get the track bearings onto the bearing rails.



- Bolt one of the four buffers (mechanical limits) onto one end of the track, using two bolts in the upper holes. You might need to remove bolts from the track joint to make room for the bolts coming through from the buffer side. Bolts are not necessary at the bottom of the limits.

2. If you are mounting a limit for a Bolt On Track rig, screw the foot down against the floor, finger tight only. The buffer for a Milo or Titan rig doesn't have a foot.
3. Repeat steps 1 to 2 for the other three buffers so you have two limits mounted at each end of the track.

Mounting Buffers on Narrow Rail



1. Bolt one of the four buffers (mechanical limits) onto one end of the track, using two bolts in the upper holes. You might need to remove bolts from the track joint to make room for the bolts coming through from the buffer side.
2. Repeat steps 1 to 2 for the other three buffers so you have two limits mounted at each end of the track.

3. If the bumpers are not already mounted, add the bumpers on all buffers by tightening them using a C-spanner.



Notes

Notes

Appendix 1 Specifications

Precision Track

Weight: 95 Kg per section including the rack
21 Kg per pair of ramp-ups
140 Kg for each box of weights \times 4 boxes if using weight wings.
186 kg for each floor weight plates (only for Bolt X on Track)

Dimensions: All measurements are in mm:

Bearing rail
spacing
centre-to-centre

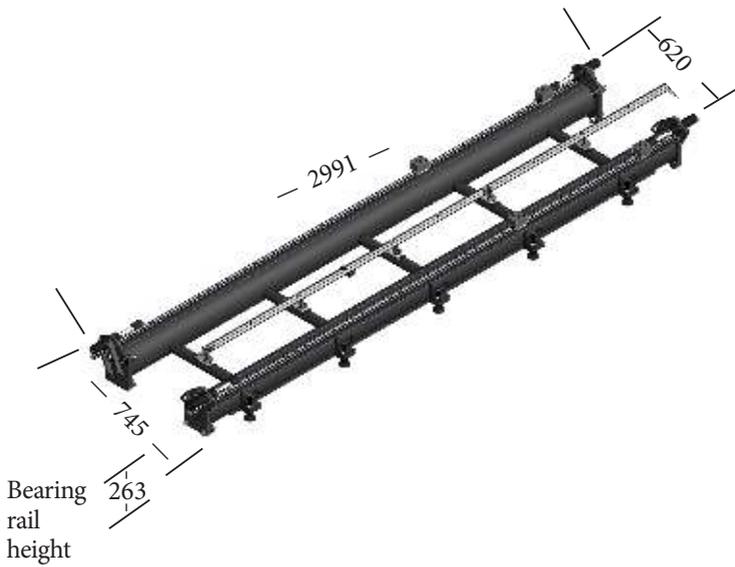


Narrow Rail

Weight: 112kg per section including the rack

Dimensions: All measurements are in mm:

Bearing rail
spacing
centre-to-centre



Appendix 2 **Cleaning and Maintenance**

General Care

Precision rail is very tough but needs some regular attention to keep it in good condition.

Do not leave wood screws or board screws on the rail when set building, if they are driven over with a rig they can destroy a bearing and seriously damage the rail.

Cleaning

Rail

The rail should be cleaned occasionally, especially after a dirty shoot or and outdoor shoot. It is usually best to clean with a normal surface cleaning spray, but it is wise to give a coat of WD40 or equivalent after this to protect the surfaces. The rack may need frequent cleaning with a fine brush to remove dirt and grit, especially after outside or beach shoots.

Any surface wetness such as after a rain shoot, should be wiped off immediately after the shoot, and a coating of WD40 used on the Precision Bearing Rail. During a rain shoot, the surface water should be wiped off the bearing rail as often as possible, as any water build-up in the precision bearings will cause them to jam. The hard coating on the bearing rail will only fail if subjected to severe temperature gradients over a long time. Do not leave precision rail out in your local desert.

Bearing Rail

It is not necessary to lubricate the bearing rail other than as above as the bearings themselves of the rig will leave a deposit of grease if they are properly greased.

Feet Bolts and Anchor Sleeves

It will be necessary occasionally to grease the threads of the feet bolts to ensure they do not seize over time and make levelling difficult. The same applies to the anchor sleeves if they have been used for fixing to a floor.

Joiner Pieces

The 10cm long cutout on the fabrication for the joiner pieces should be carefully cleaned every time a rail joiner is placed.

Track Bearings

The Track Bearings should be frequently greased using a good quality grease gun, again from a motor factor; the grease is Brown Low Melting grade. This should be done at least once per month if the machine is busy and especially in sandy or gritty environments. The bearings should be pumped with grease into one end grease nipple with the bearing on the rail moving slowly along; until the dirty grease stops coming out around the sides onto the rail.

Running with dry bearings will be noisy and produce loose shaky shoots, and will considerably shorten the life of the bearings and the bearing rail. As soon as any track bearing becomes slightly loose on the rail or noisy, or has been damaged or has any balls missing from its four raceways, it should be replaced.

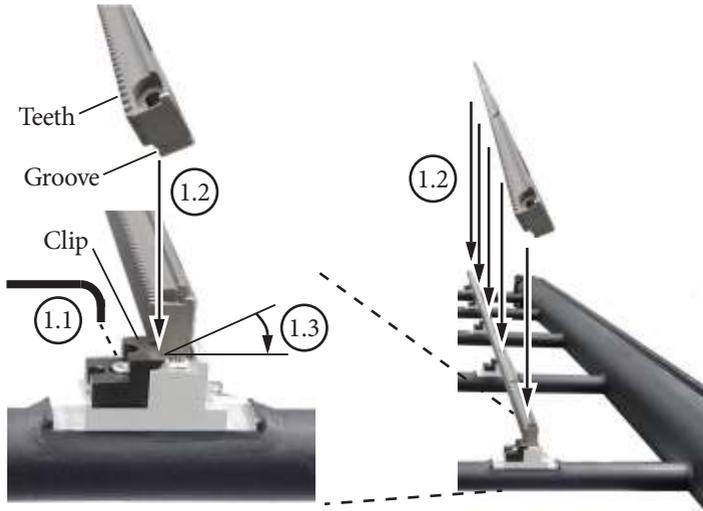
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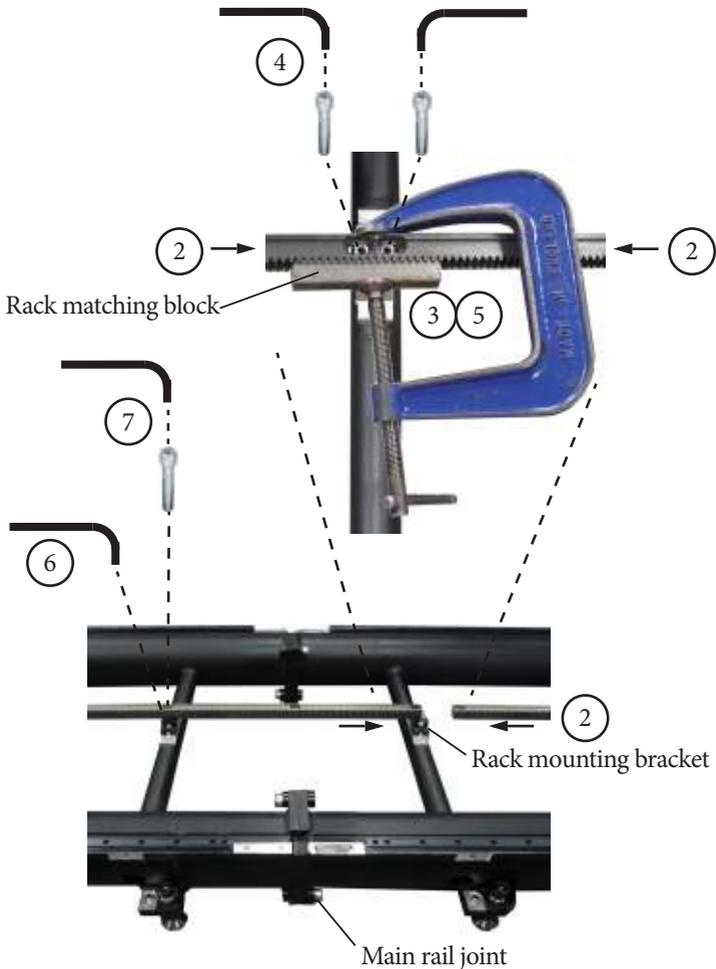
Appendix 3 Mounting the rack

Mounting the rack

1. If your track sections do not yet have the racks mounted on them, do this now for each track section as follows:
 - 1.1 Loosen all the rack clips on the track section.



- 1.2 Lay the rack into the brackets on the track, tilted as shown, making sure that the clips on the track go into the groove on the rack, just under the teeth.
 - 1.3 Twist the rack to lay flat in the brackets. Do not tighten the clips yet.
 - 1.4 Repeat steps 1.1 to 1.3 for each track section.
 2. In the middle of the track, slide two of the racks together end-to-end, so that the joint between them is centred over one of the rack mounting brackets near the main rail joint.
 3. Make sure the rack joint has the correct spacing by clamping a rack matching block to it, teeth meshed, using a vice.
 4. Insert the two retaining bolts through the ends of the racks and into the mounting bracket (one on each side of the joint), and tighten.



5. Remove the vice and rack matching block.
6. Tighten all rack clips on the two adjoining sections of track.
7. If you are using a high-speed rig such as Bolt, also secure the rack with an extra bolt through the rack at every mounting bracket. This is not usually necessary for slower standard rigs.
8. Repeat steps 1 to 7 to mount the rack on all remaining sections of track, working outwards from the centre track section.

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