



MARK ROBERTS MOTION CONTROL

MILO

PRECISE, STABLE AND PORTABLE MOTION CONTROL RIG



QUICK START GUIDE

QSG Product code: MPMC-2124-00

Products Covered: MPMC-2125-00, MPMC-1100-00

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Chapter 1 Assembling the hardware

Overview

Thank you for using the Milo motion control rig from Mark Roberts Motion Control (MRMC). Milo is designed for reliable day-in, day-out use in professional studio and Outside Broadcast environments.

Milo is typically part of a complete motion control system that includes:

- The Milo turret on which the arm is mounted.
- The arm itself.
- A **head** such as an Ulti-Head, Guinness head or Slimline head, on which you mount your video camera.
- A Windows PC running **Flair** Motion Control Software.
- An **RT-14** interface box, which handles the connections between the PC and the Milo rig.
- Additional **controllers** such as a Hand-Held Box (HHB), MSA-20 Handwheels or Pan Bars.



The Milo rig is designed to work with heavy weight precision track and when using it with Long Arm or Titan Arm, it **must** always be used with **outriggers** preventing the rig from toppling over on fast moves.

If a Guinness or Slimline head are to be used with the rig, then the normal Milo arm cables are provided. The head with its own pan slip rings will fit in place of the Ulti-head bucket. The Milo arm driver box sits inside the arm for Standard Milo and Long Arm can be fitted under the rear section of the arm along with the junction box.

General safety procedures for using industrial robots

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. This section emphasises the safety concerns that are especially important around high-speed, high-acceleration, industrial-grade robots which can cause severe injuries.

- See the separate *Precision Track Quick Start Guide* for information on laying the track and mounting Milo onto it.
- 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 Milo 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 Milo (650 kg) plus the weight of the track (95 Kg per section) or anchor weights (750-950kg) without flexing.
- Does the site have access? You need to make sure you can either push the rig 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?
 - Milo with Titan arm requires a **380-415 Volt, three-phase power supply (five-wire including Neutral and Ground)**.
 - Standard Milo requires a **240 Volt, single-phase power supply** (including Neutral and Ground).
 - The computer stack that controls Milo (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.
- 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).
- 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 motions.
- Ensure all safety accessories are securely attached and in working order, including emergency stops, safety sensors, etc.
- Try to take as much care with lights', stands' and accessories' positioning and the motion of the rig.
- 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

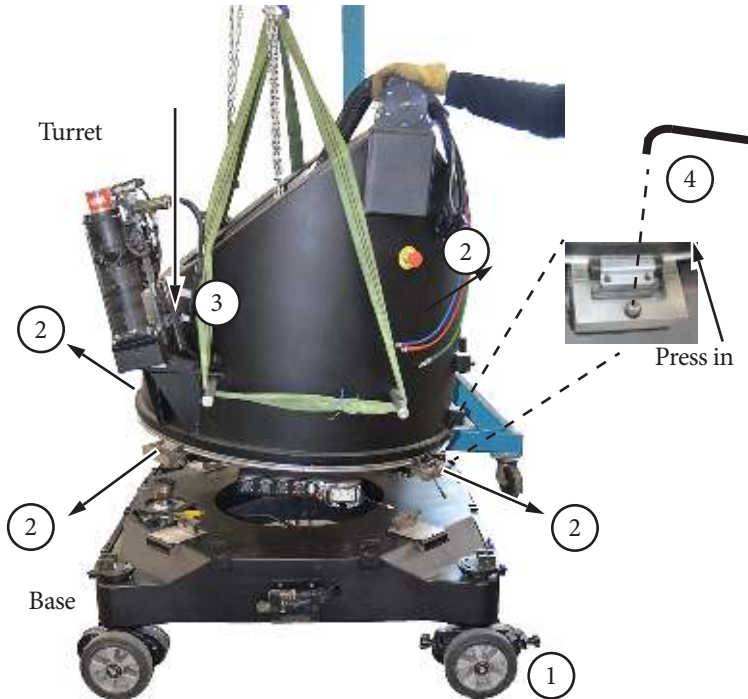
- Do not use around flammable gas. All electrical equipment can generate sparks that can ignite flammable gas.
- Keep the equipment dry. The system has **not** been made weatherproof. Do not use with wet hands.
- Always run moves only when standing within easy reach of the emergency stop.
- Always loudly and clearly indicate to others when the rig is about to move. Shout “Rig Moving!” if no other means exists.
- Always have someone keep an eye on the trailing rig cables to ensure they don’t get caught on anything or anyone.
- 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 near the rig during a move (hand model etc.) ensure that they 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.

General procedure



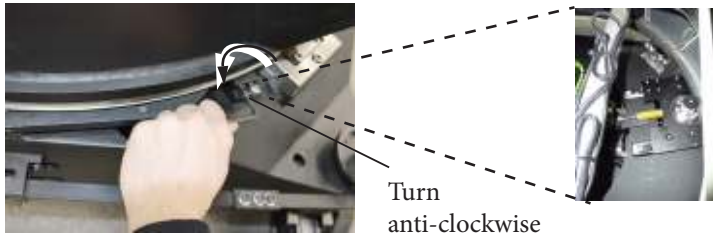
1. Mount the turret - page 7
2. Mount the main shaft on the turret (if it is not already on) - page 9
3. Mount the lift ballscrews- page 10.
4. Mount the power supply unit and the driver box - page 15
5. Mount the Milo main arm - page 16.
6. Mount the Extend Ballscrew - page 18
7. Mount the bucket and the head - page 19
8. Mount the multi-head (optional) - page 22.
9. Mount Milo on a track - page 22.
10. Connect the cables - page 28.

Mounting the turret

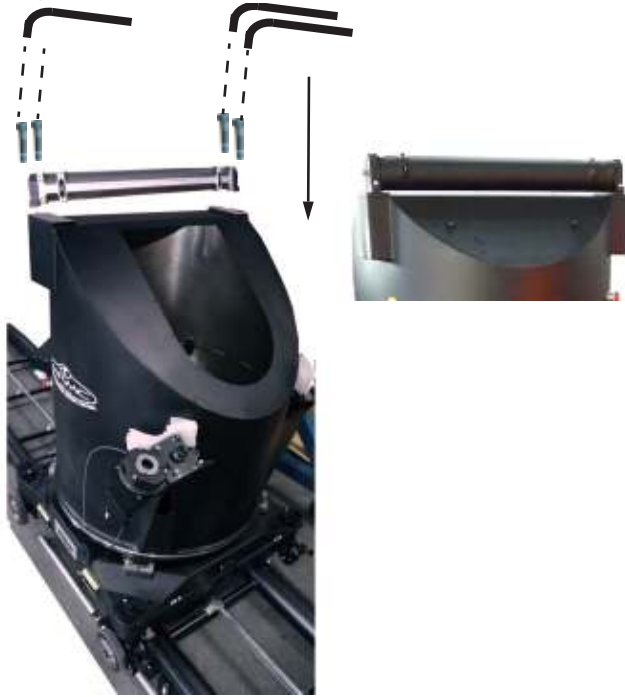


1. Ensure that the Milo base is on a firm ground and that the brakes on the castor wheels are engaged. If your Milo uses the caster systems, then they can be mounted on first before assembling the rest of the parts or just before you need to mount the robot on the precision rail. Follow detailed procedure in *Mounting the rig using the caster system* on page 24.
2. Ensure all four turret bolt retainers are fully extended outward.
3. Insert the mounting bars in the turret cavities and put the straps around them. Using a gantry hoist and the straps carefully lower the turret onto the base. Ensure that connector panel lines up with the umbilical side on the base.

4. Press the four turret bolt retainers all the way into the turret, and tighten the captive bolts down using 6m hex key to secure the turret into the base.
5. Turn the screw in the turret anti-clockwise to bring the turret gear into mesh with the base gear and engage the spring mechanism. Turn the screw until rotating the turret back and forth by hand does not result in any backlash or play in the turret movement.

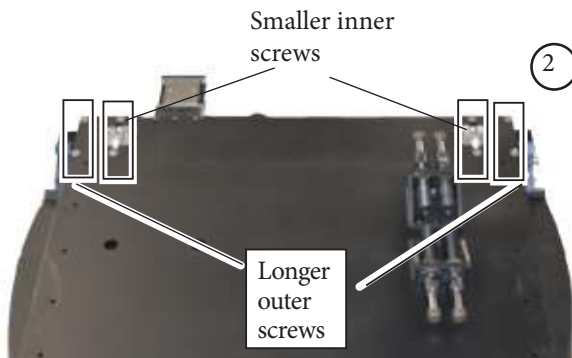
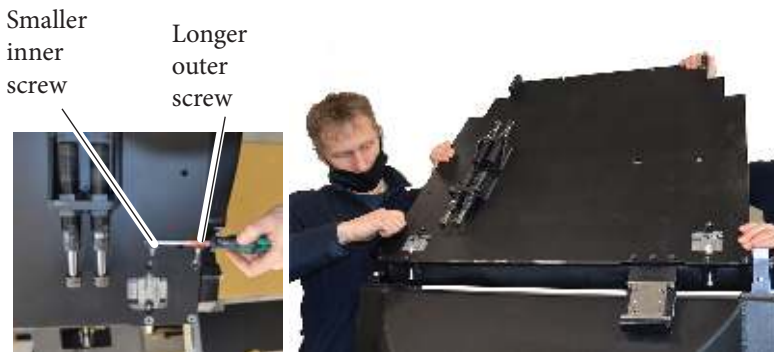


Mounting the main shaft



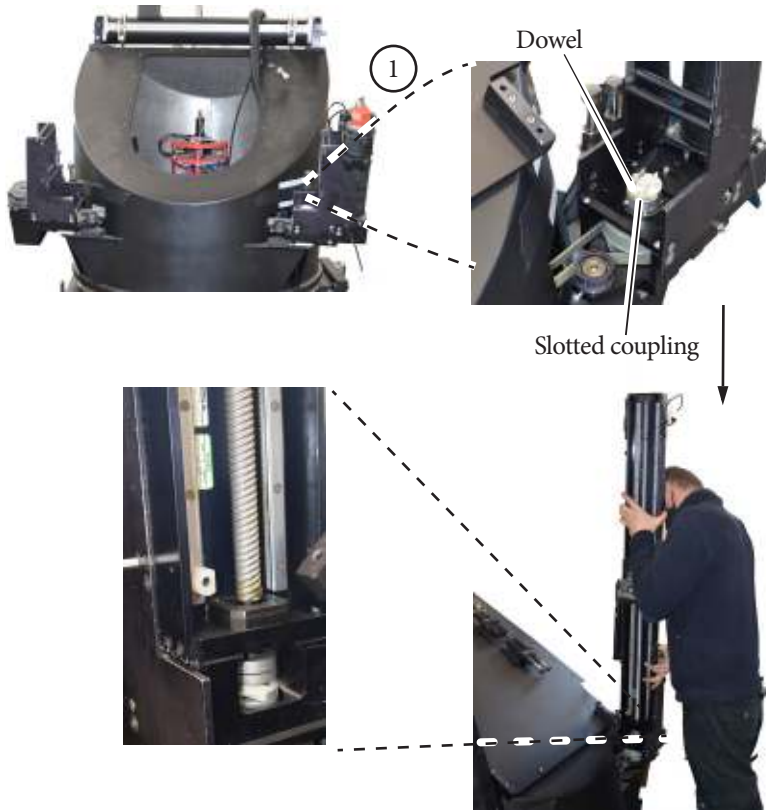
1. Remove the inspection cover from the turret.
2. Place the main shaft on top of the turret aligning the screw slots.
3. Insert and tighten the 2 x screws on each side of the main shaft to secure it to the turret. The front screws should have nylocs underneath after bolting in place.

Mounting the main arm plate



1. Two people lift the plate and place on to the centre shaft aligning the 8x screw cavities on the plate with those on the centre shaft.
2. Tighten the 4xinner screws which are smaller and 4xscrews on the outside which are longer. Use a 6mm hex key.

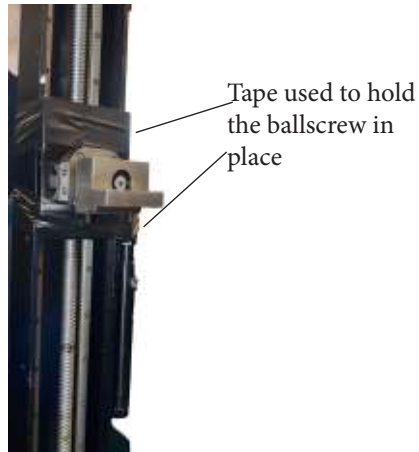
Mounting the 2 x lift ballscrews



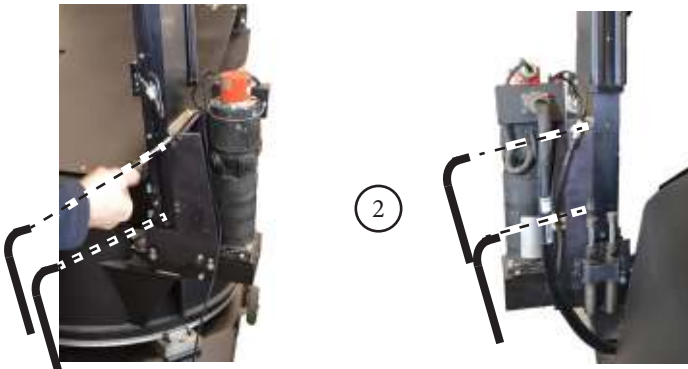
1. Lift a Lift Ballscrew vertically and insert it into the huco coupling in the belt box while aligning the key at the bottom of the ballscrew with the slot in the huco coupling. Use the dowel to help you align properly.

Note

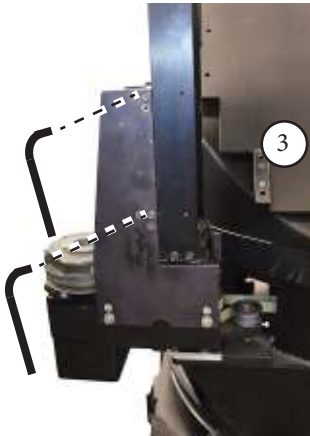
The tape on the Lift Ballscrews is used to keep the ballscrew in place and prevents it from moving down by gravity. This helps with proper alignment of the Lift Ballscrew when mounting on the turret and therefore should not be removed until the Lift Ballscrews are mounted. It is advisable to use a similar method to keep the ballscrew from moving should you need to disassemble the Milo.



2. Tighten the 4 x grub screws using a 6mm allen key (turn anticlockwise) on front and rear of the belt box to secure the lift ballscrew.



- Repeat steps 1-2 for the second lift ballscrew.



- Secure the Centre Plate to the Lift Ballscrew clamps:
 - Push the Lift Ballscrews to align the Centre Plate brackets with the clamps and loosely secure the captive screws one at a time.
 - Once all screws are aligned with the clamps, tightening the 4 x captive screws using a 6mm allen key.



- Once the Lift Ballscrews are secured to the Centre Plate, remove the tape from the clamps.

6. Plug the cable, as shown.



Mounting the Power Supply Unit and the driver box bracket

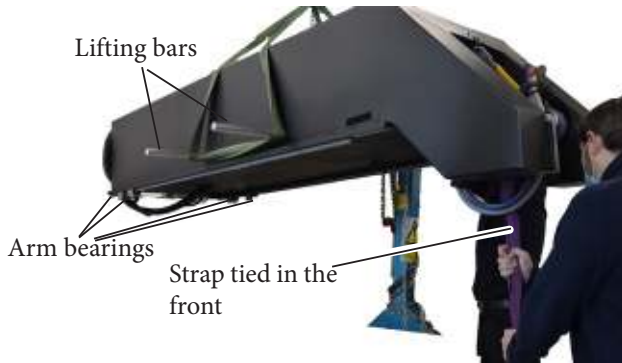
The Gorilla Power Supply must be internally set to the voltage of single phase supply that will be used in that studio or country. There are taps inside the PSU that allow this changeover. This does not apply to the Milo if used only with the Titan Arm, as then it must be 240v phase to neutral, but the PSU must be set internally to this.



1. Add the bracket on the two mounting hooks on the rear of the turret.
2. Lift the PSUs and place them in the bracket.

Mounting the Milo main arm

1. Insert the lifting bars in the arm cavities and tie the lifting straps around these. If the nose is not already mounted on the arm, it is back heavy so for safety purposes tie another strap in the front of the arm and one person hold it while another person lifts the arm using a gantry hoist.

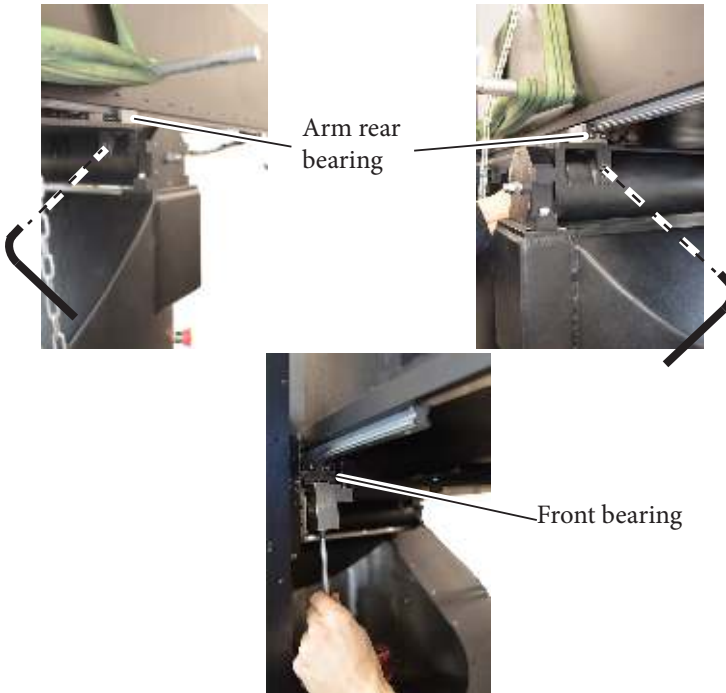


2. Slide the arm bearings towards the centre and lower the arm such that the slots bearings on both sides align with the top of Lift Ballscrew clamps.



3. Line 2 x rear arm bearings on the shoulder of the arm and seat them in the slots on the plate above the centre shaft. Ensure that the shock absorbers are clear of any obstruction.

- Loosely screw the 2 x captive bolts on each arm bearings until all bolts have seated properly in the bearings. Note that the captive bolts in the centre shaft are at about 45 degree angle.



- Once in position, tighten the 8 x captive bolts using a 6mm allen key to secure the 4 x arm bearings.

Mounting the Extend Ballscrew

1. Two people lift the Extend Ballscrew and carefully insert between the plate and arm.



2. Tighten the 4 x captive screws either side of the rear section of the ballscrew up into the holes on the underside of the Arm using 6mm allen key.

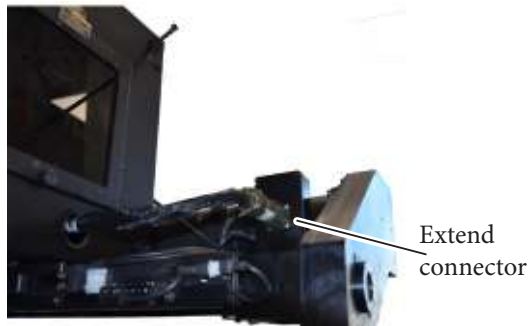


3. Slide the ballscrew and arm along until the ballscrew centre Nut is above the square bracket on the rear of the Main Bearing. Tighten

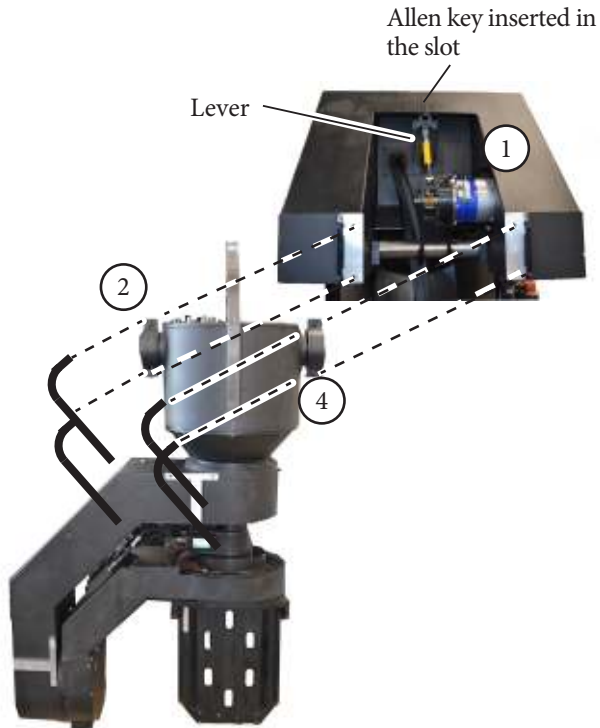
the four captive bolts in the square location plate up into the ballscrew.



4. Plug the cable from the arm to the connector on the extend ballscrew.



Mounting the bucket



1. Remove the safety screw and retract the overcenter lock mesh bracket by pushing the lever backwards and secure it by inserting an allen key into the slot.
2. Two people lift the bucket and head and slide it into the nose bracket from the top so that the keys in the bucket bracket line up within the slots of the nose bracket.
3. When the bucket has slid into the nose from both sides, tighten two bolts on each side of the bracket.



Bucket bracket slid into the nose bracket

4. Remove the allen key and pull the lever to lock the gear into mesh.
You will need to reach in to the lever from below the nose.

Tip

Swing the bucket slightly to ensure that the mesh lines up

5. Replace the safety screw.

Mounting the rig on a track

The procedure used to mount the Milo on track depends on the type of wheel system that your Milo includes. If the Milo is provided with traditional steering wheel system, then it is mounted using the ramp-ups; if it bears the newer caster wheel system, then those are used to wheel the Milo on to the track. Use one of the applicable methods detailed below to mount the rig on to track.

Mounting the rig using ramp-ups

1. Roll the rig to a position just off the end of the track, ensuring that the track pinion on the rig is on the correct side of the track.
2. Mount the ramp-ups on to the side of the track. Roll the rig over to the ramp-ups to raise the rig high enough over the track so that the track motor gear on the underside of the rig completely clears the rack (the middle rail on the track). Push the rig to the position over the ramp-ups so that the track motor gear on the Milo underside is on the toothed side of the rack. **Do not engage the teeth yet; just make sure Milo is the correct way around for the track.**



When mounting the Milo onto the track when using Ramp Ups, it is safer to remove the first section of rack from the Rail first. If the rack is left projecting beyond the end of the rail, it will hit the Track motor and will damage it.

Important

If a complete Milo with a Long Arm or a Titan arm is to be mounted onto the rail with ramp ups, the ramp ups will need extra support, (part of the Titan Kit) and it is **essential** that the arm be facing forward downslope to prevent the rig from tipping backwards when going up or down the ramps.

3. Push the rig to the levelled part of the ramp-ups and whilst in the position push the four track bearings under the four corners of the Milo base making sure that all four bearings are aligned with the corners of the Milo base, and the track motor gear on the underside of Milo clears the rack. (The track motor gear is on bearing rails so you can slide it out of the way to clear the rack.) Using an M8 allen key push the 4 x bearing bolts on their springs and put two turns into each bearing.

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.

4. Push Milo further over the ramp-ups on to the bearings on the track so it drops fully. Tighten the four track bearing mounting bolts at the corners.
5. 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 Milo drags it alongside the track.

Caution

Manually push the rig to ensure there is no resistance in the track. If there is, you might need to level the track.

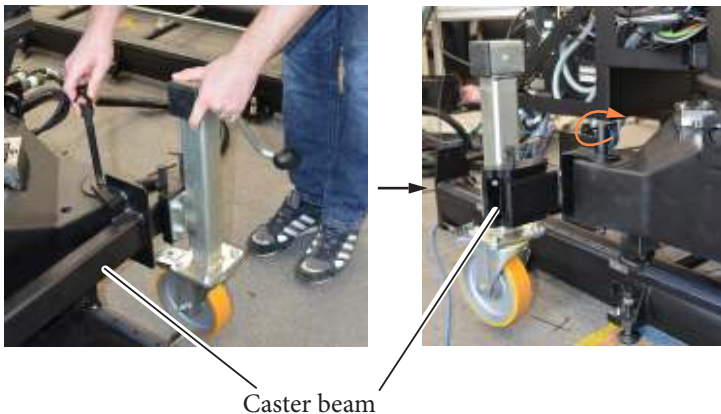
6. Attach the track motor pinch wheel on the underside of Milo, described in the next section.

Mounting the rig using the caster system

1. Two people left one set of castor system assembly and position in front of the Milo.



2. Wheel the castor system towards the Milo base so that clamps on both sides grip the corner of the base and the screw cavities line up. If required, use the jacks to lower the wheels to the ground.
3. Insert the 2 x castor pins on both sides and screw them to secure the castor beam to the Milo base.



- Use steps 1 to 3 to mount the second caster system at the rear of Milo. If you have already mounted the PSU cage, tilt the caster system to wheel from under the cage.

Tip

For ease of mounting, you can even detach the caster wheels from the caster system by removing the 2 x pins and then mounting the beam first and then the caster wheels.



The 2 x pins are not screwed and can just be removed by pulling out.

- Roll the rig to a position just off the end of the track, ensuring that the track pinion on the rig is on the correct side of the track. For smooth movement, when wheeling the rig on and off the track, straighten the wheels so they are parallel to the track.



Wheels should be straight when taking the rig on and off the track

6. Push the rig to the track and whilst in the position push the four track bearings under the four corners of the Milo base making sure that all four bearings are aligned with the corners of the Milo base, and the track motor gear on the underside of Milo clears the rack. (The track motor gear is on bearing rails so you can slide it out of the way to clear the rack.) Drop the four track bearing bolts in their slots in the Milo without tightening them yet ensuring they line up with the track bearings. Lower the casters on each corner to allow the bolts to be tightened by two turns into the bearings.

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.

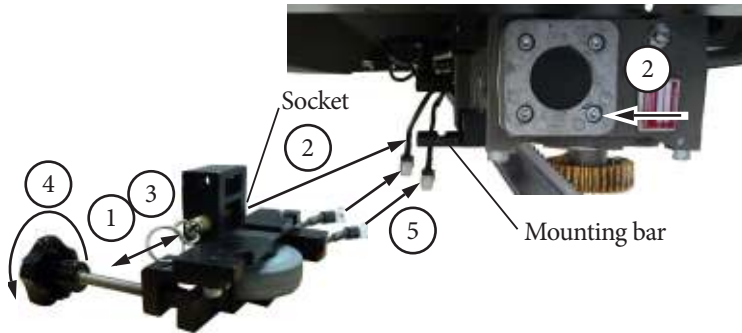
7. Lower Milo further on to the bearings on the track so it drops fully. Tighten the four track bearing mounting bolts at the corners.
8. Feed out enough umbilical cable from your control area to reach the entire length of the track without stretching the cable. Make sure the area alongside the track is clear so that the umbilical cable doesn't catch on anything when Milo drags it alongside the track.

Caution

Manually push the rig to ensure there is no resistance in the track. If there is, you might need to level the track.

9. Attach the track motor pinch wheel on the underside of Milo, described in the next section.

Attaching the track motor pinch wheel and its connectors



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 Milo underside, by sliding the track motor gear against the rack (the motor is on bearing rails) and putting the pinch wheel Socket onto the track motor Mounting bar.
3. Replace the retaining pin in the pinch wheel assembly by pushing on the ring (not the locking sleeve), to hold the assembly in place on the track motor.
4. 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 the toothed side of the rack.

Hint

Do not tighten the pinch wheel too much to prevent damage to the pinch wheel. It should only be so tight that you are able to turn the wheel and then do about an additional half turn.

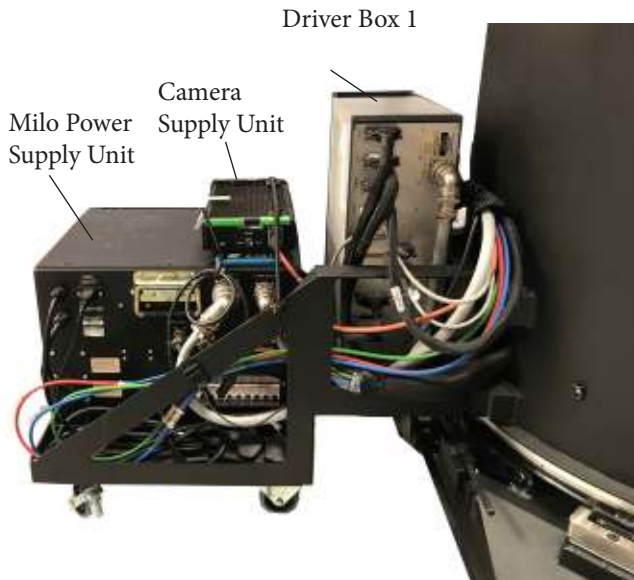
5. The pinch wheel assembly has sensors for detecting the Limit (L) and Datum (D) magnets on the track. Connect the cables for these sensors to the corresponding connectors on the Milo underside, and use cable ties to hold them securely up away from the track.

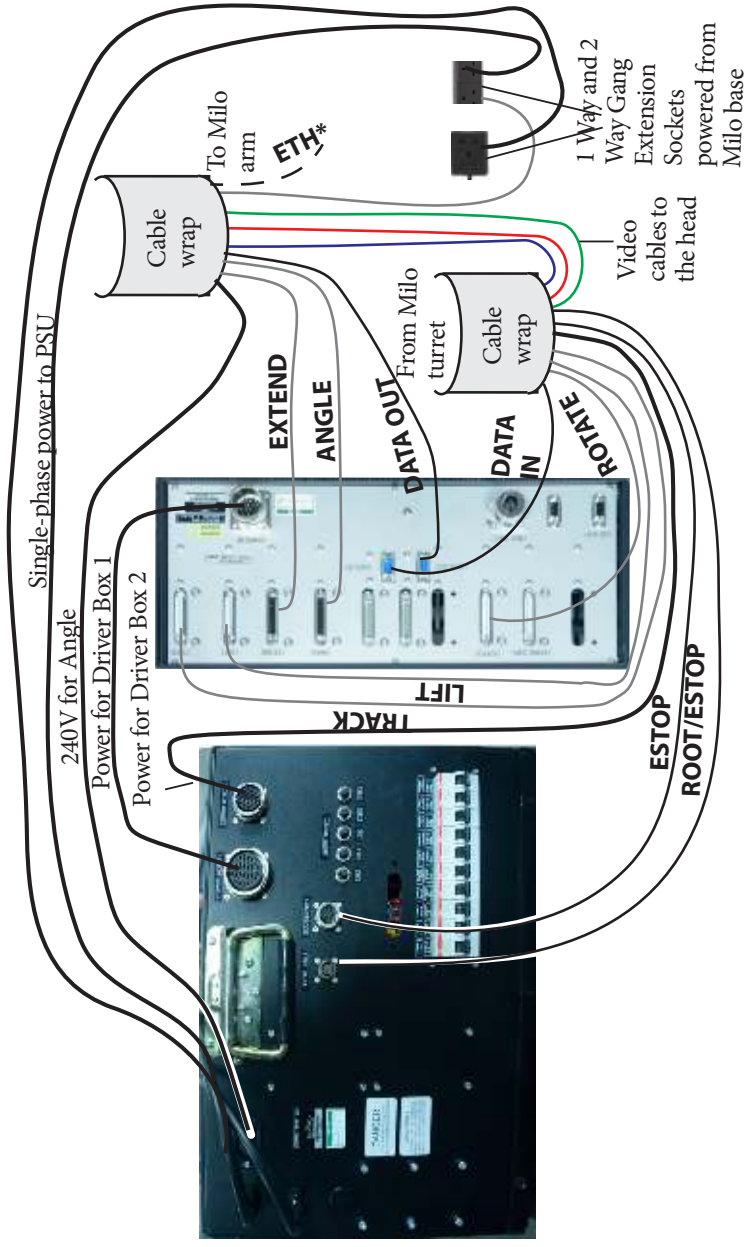
Connecting the cables

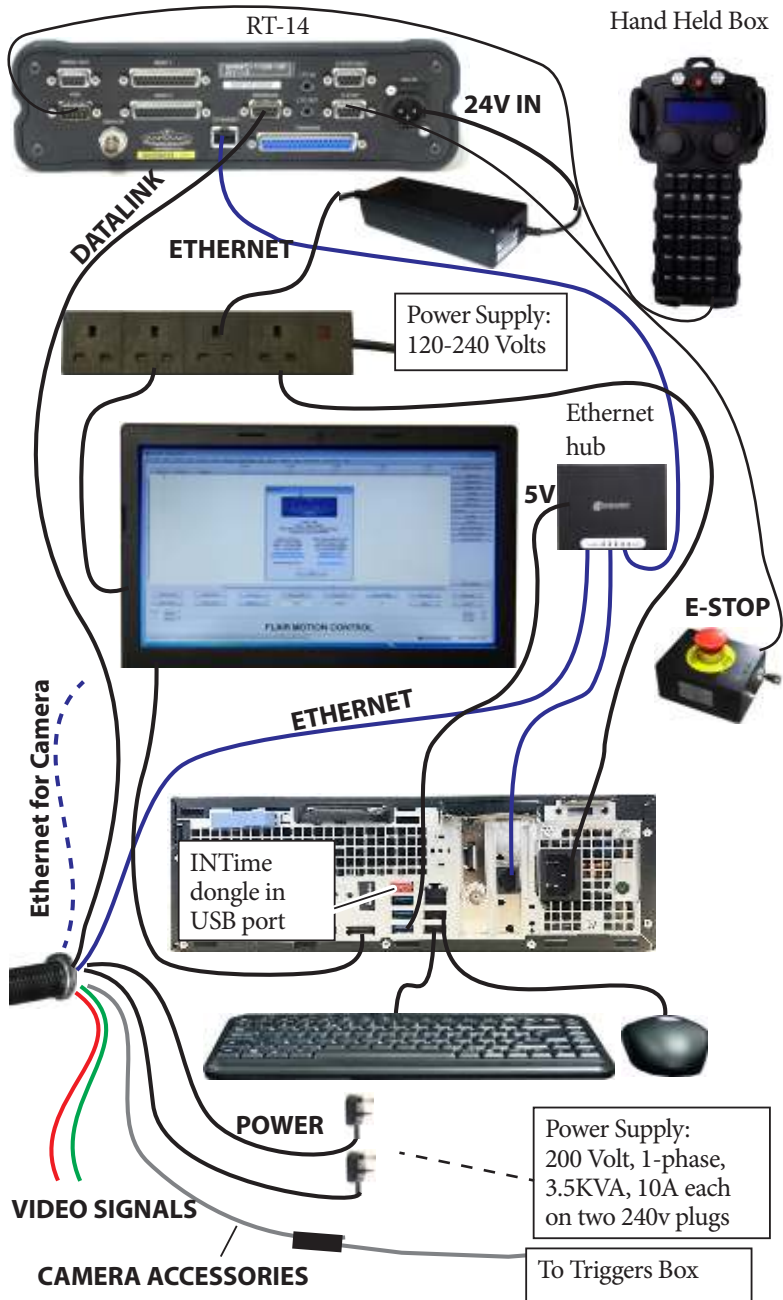
Picture of umbilical - base connections:



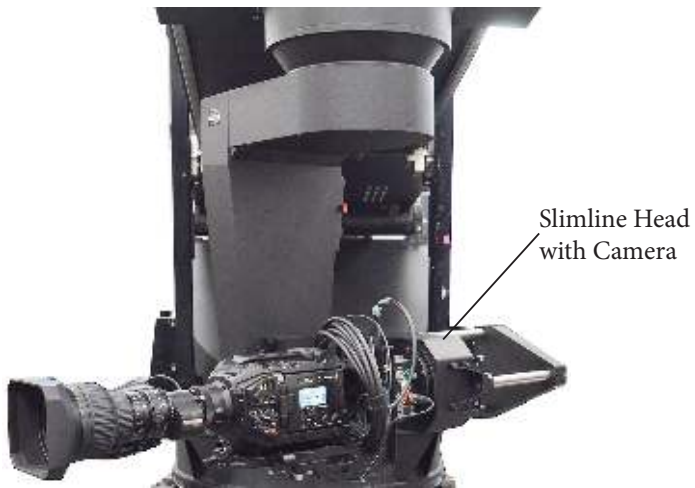
Picture of PSU-Turret-Milo Arm connections







Picture of bucket connections



TRIGGER /SYNC **24V PWR OUT** **12V CAMERA POWER**



CAMERA ETHERNET **VIDEO OUT**

Starting up the Milo system

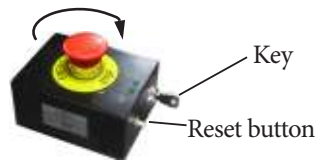
Once you have attached all the cables, you power up the rig by switching on the components in the order described below.

1. Make sure you have secured the area around the rig. Put up guard rails around the rig (and the track) as necessary, and tell others on the set that you are now powering up the rig.
2. Ensure that **the E-stop by the computer stack is pushed in.**
3. Push in all the Mains switches on the PSU.
4. Turn on all the breakers from left to right.
5. Power up the Flair computer system and all of its components, including the RT-14 interface box. You can do this while the rig is powering up (step 3 and 4).
6. 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 boards that runs the large axes motors
 - The Guinness head that is mounted on the Milo arm
 - Any additional interface boxes that are attached to the computer stack
7. 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 Reset button. Also make sure the **key** is in the vertical position.
 8. Zero all the axes in Flair. For example, to zero the Track axis:
 - 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.

9. In Flair, move all the axes to their home position.
10. Set the soft limits for the rig axes in Flair as required:
 - Particular axes (if space is limited)
 - Track limits
 - Lens Control Motor limits (if using external LCMs)

Milo start-up summary

1. Secure the area
2. Release the E-stop on the rig
5. Turn switches on the PSU
5. Switch on the Flair PC and RT-14
6. Start Flair
6. Release the E-stop on the computer stack

In Flair:

7. Zero home all axes
9. Set the soft limits

The rig is now ready to use.

Shutting down the Milo system

1. Move the rig to its Home position, for both the arm and the track.

or...

If you are going to transport the rig to a new location, put the Milo arm into its transport position. You can do this either by using Flair (although you might have to reset the soft limits to reach the transport position) or by moving the arm manually.

2. In the Flair software, disengage all axes.
3. Press down the E-stop button on the computer stack.
4. Close the Flair software. Ensure that you save any unsaved jobs before closing Flair.
5. Shut down Windows on the Flair PC.

To remove the rig from the track see *Mounting the rig on a track* and follow the instructions there in reverse order, detach the pinch motor wheels and remove the rig from the track bearings.

Notes

Appendix 2 Specifications

Rig Weights

Base: 166kg / 365lbs

Turret: 160kg / 352lbs

Main Arm: 130kg / 286lbs

Head with Outer Arm: 63kg / 139lbs

Extend Ballscrew: 28kg / 62lbs

Lift Ballscrews: 39kg / 86lbs

Power Supply & Unit: 124kg / 273lbs

(Optional) Long Arm: 452kg / 995lbs including trolley wheels

Rig Payload: 50kg

Head Payload (camera and counterweights): 20 Kg

Payload counterweights (total): 5kg

Operating Envelope

Maximum Height: 4.1m / 13'5"

Lowest Position: -0.75m / -2'5"

Maximum Height (Long Arm): 6m / 19'6"

Lowest Position (Long Arm): -2.75m / -9'0"

Rig Performance

Track: As required @ 2m/s

Rotate: Unlimited range of travel @ 38°/s

Lift: +/- 45° range of travel @ 24°/s

Arm Extend: 1 metre @ 38cm/s

Outer Arm: 225° range of travel @ 40°/s

Pan: Unlimited range of travel @ 120°/s

Roll: Unlimited range of travel @ 120°/s

Power and Environment

Power requirements:

Standard Milo: 3.5KVA, 20A each on two 115v plugs, or 10A each on two 240v plugs

Milo with Titan arm: 380-415 volts 3-phase (earthed/grounded) and Neutral, 5kVA.

The Gorilla Power Supply must be internally set to the voltage of single phase supply that will be used in that studio or country. There are taps inside the PSU that allow this changeover. This does not apply to the Milo if used only with the Titan Arm, as then it must be 240v phase to neutral, but the PSU must be set internally to this.

Temperature range: 0-45 °C (32-113 °F)

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

Notes

Notes



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