MRMC

Mark Roberts Motion Control

TITAN

QUICK START GUIDE

Product code: MRMC-1479-00
Part number: MRMC-1489-00

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Contents

Chapter 1 **Assembling the hardware**

Overview

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

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

- The Milo turret on which the Titan arm is mounted. Therefore, the rig is referred as **Titan Milo** combination system.

- The Titan 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 Titan rig.

- Additional **controllers** such as a Hand-Held Box (HHB), MSA-20 Handwheels or Pan Bars.

The Titan Milo combination system is designed to work with heavy weight precision track which **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 can be fitted under the rear section of the Titan arm along with the normal arm junction box.

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 Titan.

- Unlike traditional motion control equipment, Titan arm can extend with speed in the blink of an eye - too fast for someone to be able to quickly move out of the way.

- See the separate *Precision Track Quick Start Guide* for information on laying the track, securing it to the floor, and mounting Milo and Titan combination system 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 Titan 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 Extended Milo along with Titan arm (650 kg of the Titan arm itself when retracted) 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?

    - Titan and Milo combination system requires a **400 Volt, three-phase power supply** (five-wire including Neutral and Ground), and can **not** be configured to run on less.

    - The computer stack that controls Titan (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.

- Ensure the track is properly bolted to the floor. No amount of counterweight will stop the track from moving and twisting if the track isn't secured, especially with short lengths of track.

- 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 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 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 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 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
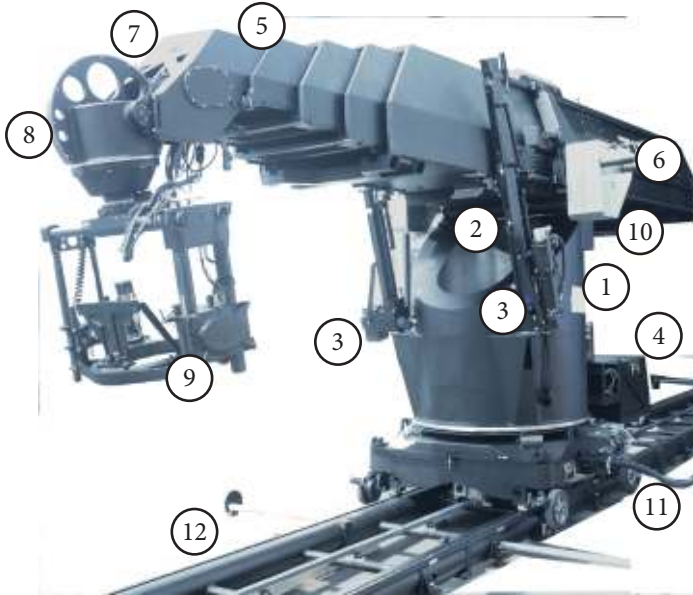
1.   Mount the turret - page 8

2.   Mount the main shaft on the turret (if it is not already on) - page 9

3.   Mount the lift ball screws- page 10.

4.   Mount the power supply unit and the driver box - page 11

5.   Mount the Titan main arm - page 12.

6.   Mount the counter-weight mounting bars - page 13

7.   Mount the nose - page 13.

8.   Mount the bucket - page 15

9.   Mount the head - page 17.

10.   Add the counter-weights - page 14

11.   Connect the cables - page 18.

12.   Mount Titan on a track - page 21.

Mounting the turret
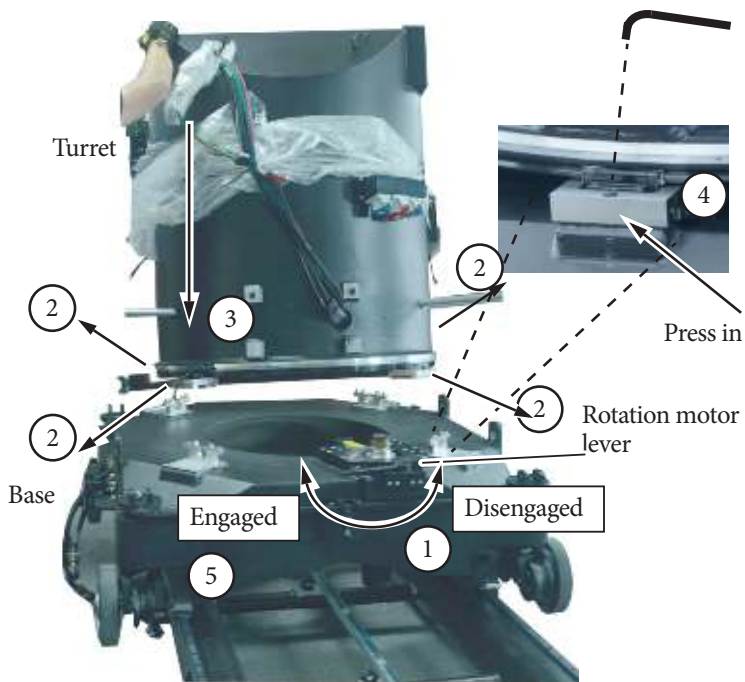
1.   Make sure the rotation motor lever is in the anti-clockwise (Disengaged) position.

2.   Make sure all four turret bolt retainers are fully extended outward.

3.   Lower the turret onto the base. Ensure that the slip rings line up with the motor connectors.

4.   Press the four turret bolt retainers all the way into the turret, and tighten the bolts down into the base.

5.   Move the rotation motor lever to the Engaged position taking care that the gears underneath the turret mesh correctly.

Mounting the main shaft
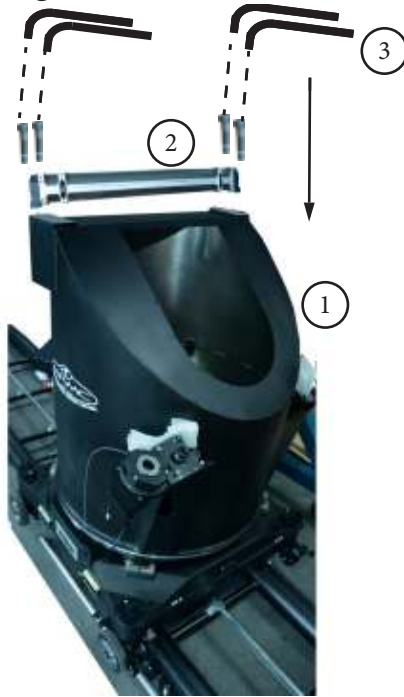
1. Remove the inspection cover from the turret.

2. Place the main shaft on top of the turret aligning the screw slots.

3. Insert and tighten the two bolts on each side of the main shaft to secure it to the turret. The front bolts should have nylocs underneath after bolting in place.

Mounting the lift ball screws
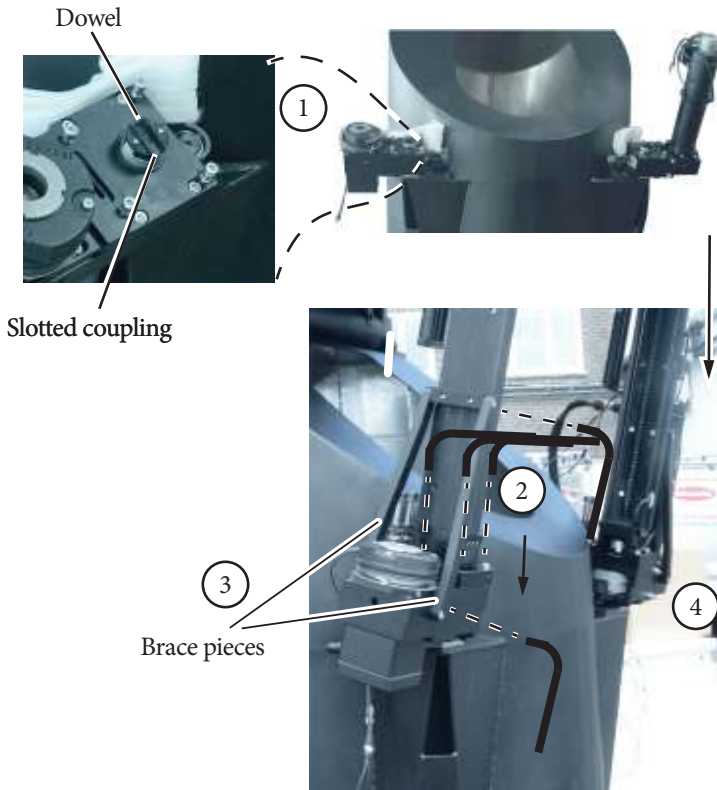
1. Insert the lift ball screw down into the slotted coupling on the belt box. Ensure that the hole lines up with the dowel on the gear box housing.

2. Tighten the four bolts on the belt box to hold it in place.

3. Add the two brace pieces to further secure the lift ball screws to the belt box.

4. Repeat these steps for the second lift ball screw.

# Mounting the Power Supply Unit and the driver box

1.   Put 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 Titan main arm

Place the retracted arm
on the main bearing
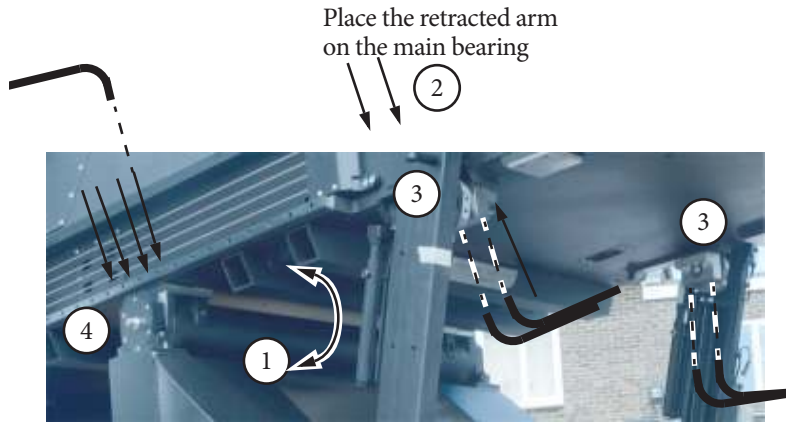
1. Rotate the main shaft on top of the turret so the brackets on the main shaft face up.

2. Using a gantry lift, place the retracted arm without mounting bars onto the brackets on the main shaft.

3. Insert and tighten the eight bolts that hold the arm on the main shaft.

4. Line the mounting block on the lift ball screws on either side to the shoulder of the arm and tighten the captive bolts.

Mounting the counter-weight mounting bars
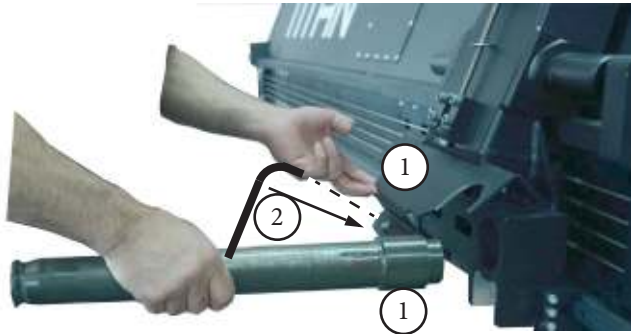
1.   Lift up the weight clamp on the Titan arm and insert the counter-weight mounting bars in the two slots on each side.

2.   Release the clamp and tighten the single bolt to secure the counter-weight mounting bars.

Mounting the nose
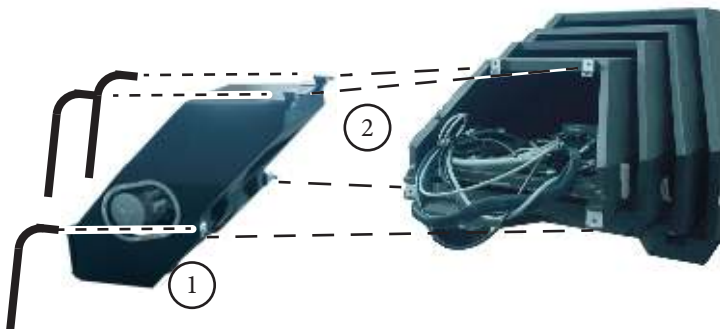
1.   Lift nose to align it to the mounting bracket on the main arm.

2.   Insert and tighten the four bolts that hold the nose and the arm.

Adding the counter-weights
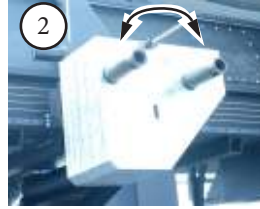
1. Add the counter-weights to the counter-weight mounting bars. These should be about 16 when using the Ulti-head and 20 when using the Guinness head.

> **Note**
>
> Ensure that the sloping sides of the counter weights are towards the rear end of the Titan arm.

2. Lower the clamp and tighten the nut to secure the counter-weights.

Mounting the bucket

Allen key inserted in the slot
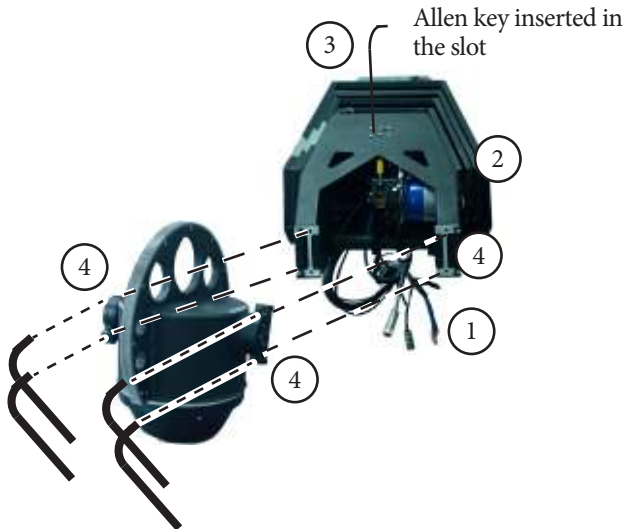
1. Pull out the cables from the Titan arm through to the nose.

2. Plug the connectors for the outer arm into the nose. These are the power connector, the encoder connector for the outer arm and the limit switches.

3. Retract the overcenter lock mesh bracket and secure it by inserting an allen key into the slot.

4. Align the bucket to the nose bracket and tighten two bolts on each side of the bracket.

5.   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

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6.   Replace the safety bolt.

Mounting the head

Slot

Key

Example: Ulti-Head
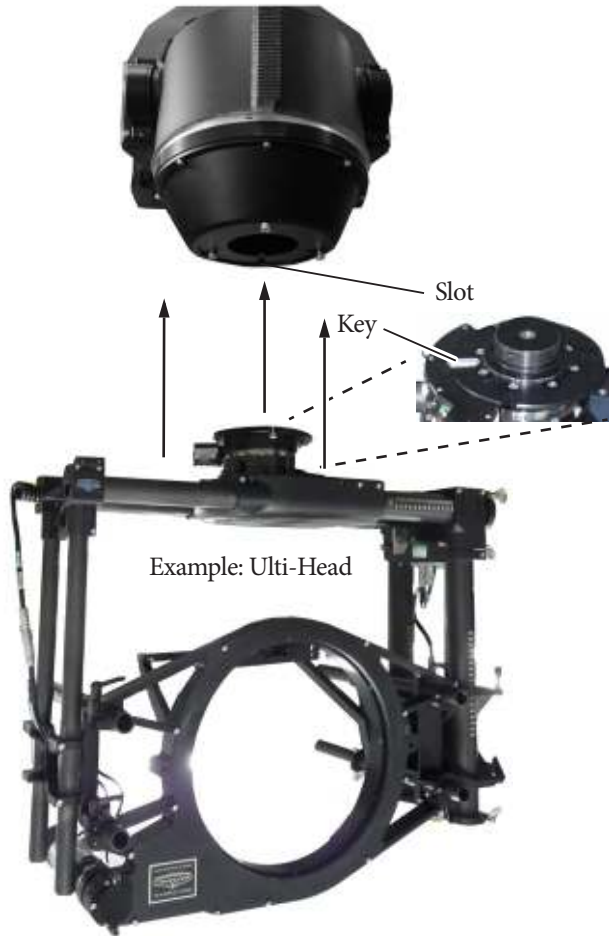
♦   Mount the head to the bucket using the three bolts, making sure that the key on the head fits into the slot in the bucket.

Connecting the cables

Picture of umbilical - base connections:

Milo Base

Umbilical cable wrap

Picture of PSU-Turret-Titan Arm connections

Lift ball screws connections

Lift motor connections

1. Attach the cable to the Limit and Datum connector.

2. Attach the brake and speed sensor cable to the connector and tighten it.

3. Attach the lift motor cable to the lift motor.

4. Attach the break and speed sensor cables to the connectors on the other side of the turret.

Connections to the slip ring base on the Ulti-head

Attach the cables to the head and camera. Here is an example of the cables attached to the Ulti-head.

Mounting the rig on a track

Mounting the rig on the track bearings

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.**

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.)Drop the four track bearing bolts in their slots in the Milo without tightening them yet ensuring they line up with the track 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 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.

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6. 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
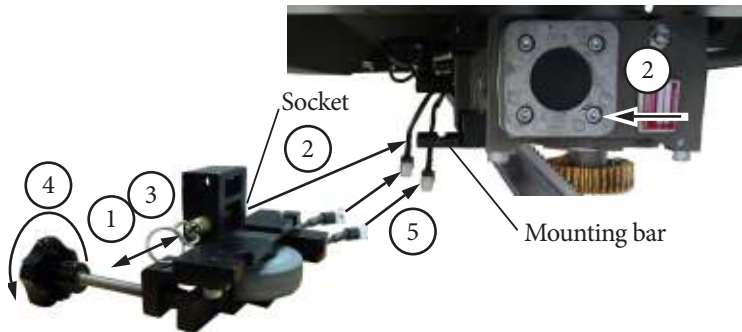
1. On the separately supplied pinch wheel assembly, remove the brass retaining pin by pulling on the ring.

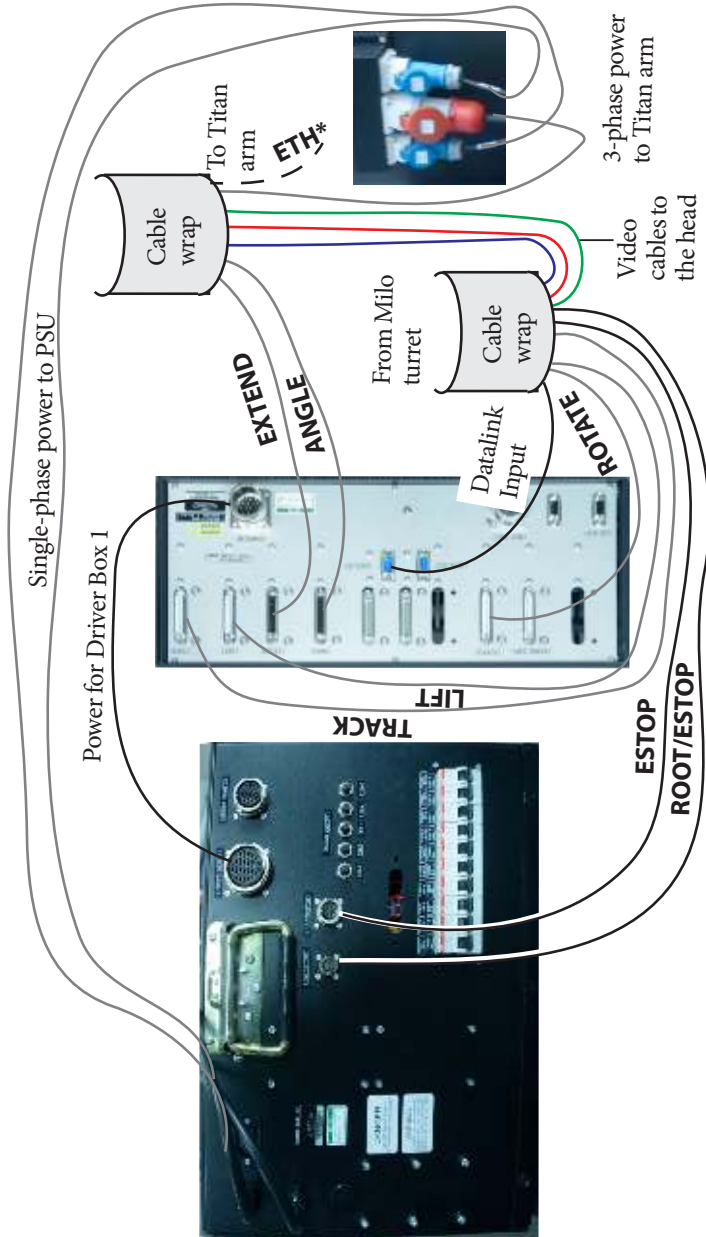2. Mount the pinch wheel assembly onto the track motor on the Milo underside, by sliding the track motor gear against the rack (the motor is on bearing rails) and putting the pinch wheel Socket onto the track motor Mounting bar.

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.

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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 Titan underside, and use cable ties to hold them securely up away from the track.

Connecting the cables

To Titan arm

ETH*

3-phase power to Titan arm

Cable wrap

Video cables to the head

From Milo turret

Cable wrap

Single-phase power to PSU

EXTEND

ANGLE

ROTATE

Datalink Input

Power for Driver Box 1

LIFT

TRACK

ESTOP

ROOT/ESTOP

RT-14

Hand Held Box

24V IN

DATALINK

ETHERNET

Power Supply: 120-240 Volts

Ethernet hub

5V

E-STOP

Ethernet for Camera

ETHERNET

Flair dongle cable in USB port

POWER

VIDEO SIGNALS

Power Supply: 400 Volt, 3-phase, 5-wire including Neutral and Earth

Starting up the Milo-Titan 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 board that runs the track motor

   - The Ulti-head that is mounted on the Titan 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.

   Key
   Reset button

8. Zero the axes as required 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**
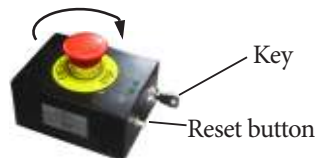
> **wide-angle** (zoomed out all the way), **iris/aperture to wide open** and then use the relevant **Zero > Direct Zero Axis** menu option to set those lens positions as the zero points in Flair.

9. In Flair, move the Titan arm to its home position.

Hint

- Manually move the arm close to its home position before Homing it.

- When you home the rig, have one hand ready on the E-stop in case you need to stop the rig quickly.

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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-Titan 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 the track and Lens Control Motor axes
8. Home all axes
9. Set the soft limits

The rig is now ready to use.

Shutting down the Milo-Titan 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 Titan 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.

Appendix 2 **Specifications**

Weight: 1700kg including trolley wheels and 32 sliding weights on each side

Weight (without counter-weights): 675kg

Payload (camera and head): 50 Kg

Power requirements: 400 Volts 3-phase (earthed/grounded) 7KW.

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

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

Rotate 360 degrees

Lift 1m

Angle 138.5 degrees

Dimensions:

Length (Arm fully extended):   11.5m
Length (Arm retracted):   4.5m

Width (With counter-weight mounting bars): 1.85m

Height (horizontal arm): 2.46m
Height (arm fully extended at maximum height): 7.9m

Notes

Notes