CONSTRUCTION ROBOTICS™

MULE ML150

OWNER'S MANUAL

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NOTE

All assembly and operation instructions located on the MULE units and accessories take precedence over information contained in this manual. Should there be any discrepancies discovered throughout any published documentation issued by Construction Robotics or its authorized affiliates, the following order of precedence shall prevail:

1. **Written documents issued by Construction Robotics (Technical Bulletins, letters, etc.)**
2. **Recall instructions**
3. **Supplemental assembly or operational instructions provided with the MULE or MULE accessories**
4. **Owner's Manual**

Any use of a MULE unit, in a configuration or manner not explicitly described in this manual is not recommended without the prior written permission of Construction Robotics, LLC.

Revision Sheet

Release No.	Date	Revision Description
Rev A	4/5/21	Initial Release

CR Customer Support: (844) 476-2684

Table of Contents

A INTRODUCTION

WARNINGS

1. All users should read the Owner's Manual before operating the unit.
2. The installation and operation of MULE is subject to hazards that can be avoided only by using extreme care and common sense. It is essential that the competent person be appropriately trained in the installation, dismantlement, proper use and safe operation of the MULE and its accessories. Construction robotics can assist owners/employers in providing this training.

1 Safe Operating Guidelines

There is no one single factor that is more important for minimizing the possibility of personal injury to the operator and those working in the area, or damage to property, equipment, or material than being familiar with the equipment and using Safe Operating Practices.

The MULE is designed for lifting and transporting of material only. Under no circumstances, either during initial installation or in any other use, should the hoist be used for lifting or transporting personnel.

No operator should be permitted to use the equipment that is not familiar with its operation, is not physically or mentally fit, or has not been schooled in safe operating practices. The misuse of MULE can lead to certain hazards which cannot be protected against by mechanical means; hazards which can only be avoided by the exercise of intelligence, care, and common sense.

Safe Operating Practices also involve a program of periodic inspection and preventative maintenance (covered in a separate section). Part of the operator's training should be an awareness of potential malfunctions/hazards requiring adjustments or repairs, and bringing these to the attention of supervision for corrective action.

Supervision and management also have an important role to play in any safety program by ensuring that a maintenance schedule is adhered to, and that the equipment provided for the operators is suitable for the job intended without violation of one or more of the rules covering safe operating practices and good common sense.

Do's and Don'ts (Safe Operation of MULE)

The following are Do's and Don'ts for safe operation of MULE. A few minutes spent reading these rules can make an operator aware of dangerous practices to avoid and precautions to take for their own safety and the safety of others. Frequent examinations and periodic inspections of the equipment as well as a conscientious observance of safety rules may save lives as well as time and money.

DON'TS:

- Never lift or transport a load until all personnel are clear and do not transport the load over personnel.
- Do not allow any unqualified personnel to operate hoist.
- Never pick up a load beyond the capacity rating appearing on the MULE. Overloading can be caused by jerking as well as by static overload.
- Never carry personnel on the gripper, the hook or the load.
- Do not operate MULE if you are not physically fit.
- Do not operate MULE to extreme limits of travel of cable without first checking for proper limit switch action.
- Do not tamper with or adjust any parts of the MULE unless specifically authorized to do so.
- Never use the wire rope as a sling.
- Do not divert attention from load while operating hoist.

- Never leave a suspended load unattended.
- Never operate a MULE that has an inherent or suspected mechanical or electrical defect.
- Do not jog controls unnecessarily.
- Do not operate MULE if cable is twisted, kinked, or damaged.
- Do not remove or obscure label.

DO's:

- Read and follow manufacturer's instruction, installation, and maintenance manuals. When repairing or maintaining a MULE, use only manufacturer's recommended parts and materials.
- Read and follow all instruction and warning information on or attached to the MULE.
- Remove the MULE from service and thoroughly inspect and repair, as necessary, if unusual performance or visual defects (such as peculiar noise, jerky operations, travel in improper direction, or obviously damaged parts) are noticed.
- Establish a regular schedule of inspection and maintain records for all MULEs with special attention given to hooks, grippers, wire rope, brakes, and limit switches.
- Check operation of brakes for excessive drift.
- Never lift loads over people, etc.
- Check for damaged hooks, grippers and wire rope.
- Keep wire rope clean and well maintained.
- Check the wire rope for improper seating, twisting, kinking, wear, or other defects before operating the MULE.
- Make sure a load clears neighboring stockpiles, machinery, or other obstructions when raising, lowering, or traveling the load.
- Avoid swinging of load or load gripper when traveling the MULE.
- Be sure the load attachment is properly seated in the saddle of the gripper or hook. Balance load properly before handling. Avoid gripper tip loading.

2 System Overview

MULE is a work area tool used to assist in the lifting and placement of units and material up to 150lb over an 11' vertical distance.

Grippers and hook devices are developed for many specific applications. Specialized gripper or attachment devices can be developed upon requests. Please contact Construction Robotics (CR) for more information.

3 Owner's Manual Use

This manual is for use with the following Construction Robotics products:

- MULE ML150 (Arm, Power Pack and Control Box)
- Ground Base Package
- MCWP Package
- Basic Accessories

This manual provides instructions for operating within the typical uses of MULE.

If the desired setup exceeds any of the requirements or limits described throughout this manual, contact Construction Robotics with specific details for non-standard engineering approval. Additional engineering charges may apply.

If any uncertainties with the contents of this manual arise or clarifications are required, contact Construction Robotics immediately.

4 Product Warranty

4.1 Warranty Period

Refer to your purchase agreement for the warranty period of your MULE and accessories.

4.2 Warranty Policy

All warranty claims will be determined after inspection at a designated facility. A Returned Material Authorization (RMA) is required for all warranty claims. Contact Construction Robotics Customer Support at 844-476-2684 for a RMA.

5 Acronyms and Abbreviations

CMU:	Concrete Masonry Unit	MULE:	Material Unit Lift Enhancer
CR:	Construction Robotics	MCWP:	Mast Climbing Work Platform
GFCI:	Ground-Fault Circuit Interrupters	RMA:	Returned Material Authorization
HM:	Hydro Mobile		

B SYSTEM SUMMARY

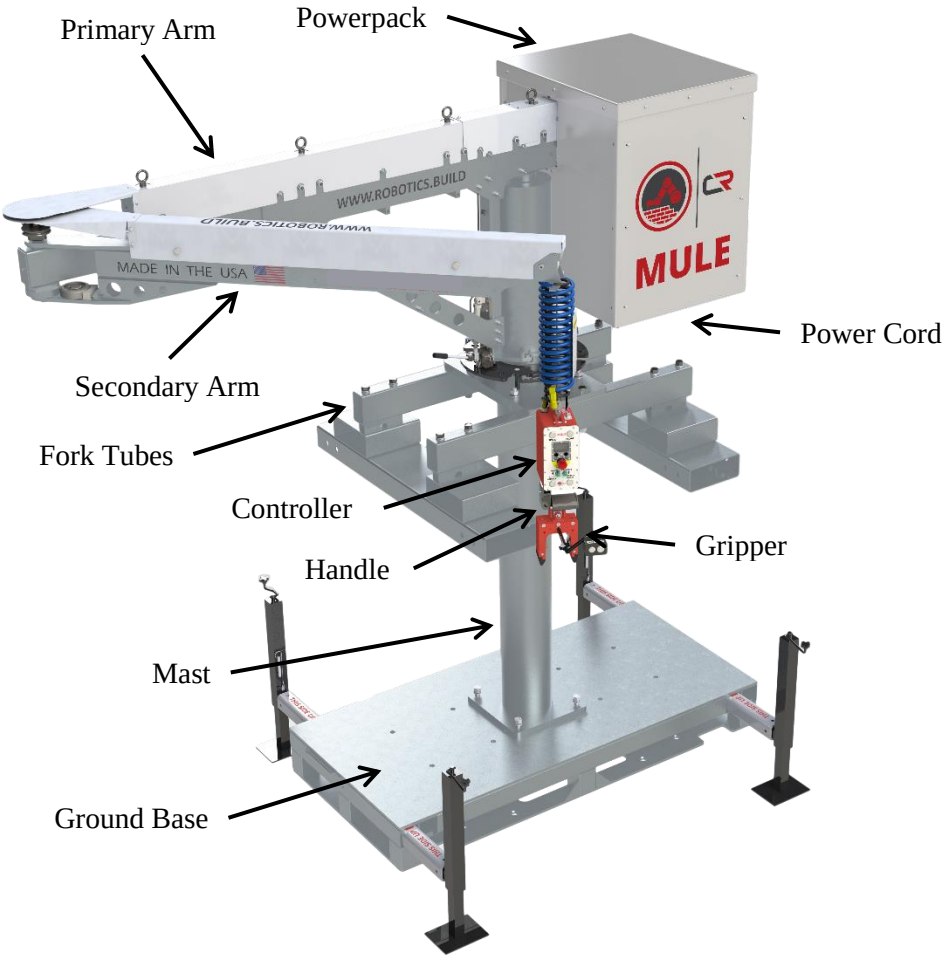
1 Meet MULE

The MULE is a smart material handling tool designed for construction that does the heavy lifting for you.

Features and benefits:

- MULE makes materials up to 150 pounds seem weightless (depending on the specific gripper configuration)
- Eliminates the fatigue and physical wear and tear associated with repetitive heavy lifting
- Designed for efficiency and comfort in the construction working environment
- Simple control and operation
- Increased productivity
- Flexible deployment, multiple base configurations, works from the ground, traditional scaffold or mast climbing work platforms
- Can free stand up to 20+ feet
- Runs off 120V AC power

2 Standard System Components



2.1 Component Names

Powerpack – Houses power management and distribution devices, air compressor and Lifting Cable actuator.

Primary Arm – 1st Boom element closest to the mast. The Powerpack is attached to the Primary Arm and rotates around the rotation mast.

Secondary Arm – 2nd Boom element. Rotates around the end of the Primary Arm. Data coil cord, coil airline and Wire Rope come down from the end of the Secondary Arm.

Fork Tubes – The Fork Tubes is attached to the bottom of the rotation mast and is used to pick, transport, and lift MULE. Cross pockets allow the Fork Tubes to be picked from all four sides. System can rest on level ground on the Fork Tubes. The Fork Tubes can be disconnected to decrease weight or remove obstacles.

Ground Base – The Ground Base is the platform MULE is built on. It can be picked in all 4 directions for easy transport. Its slim size allows for it to fit through 36" openings while the incorporated outriggers and jacks provide for a level and stable footprint.

Power Cord – MULE comes standard with a 50' power cord that can be plugged into most wall or generator outlets.

Mast – The mast sections allow for MULE to be built to different heights depending on the situation. During transport the mast sections can be removed to create a compact package, which can then be assembled to a variety of heights on the jobsite.

Controller – The main operational interface for MULE where most of the functions are located. The Controller attaches to the working end of the Wire Rope.

Handles – The Handle provides a convenient grip to operate MULE from. These handles attach to the bottom of the Controller. There are multiple handle options available to support different preferences and button configurations. Grippers attach to the bottom of the Handle and can be configured in multiple orientations and installed using a quick-change pin.

Grippers – The gripper or hook type device attaches to the Handle through a U-Joint connection. Different grippers allow for grabbing of different materials and the incorporated U-Joint allow for the tilt of the load to be precisely controlled during placement.

2.2 Weights

2.2(a) *MULE 150*

Figure B-1 - As shown: 1160lb

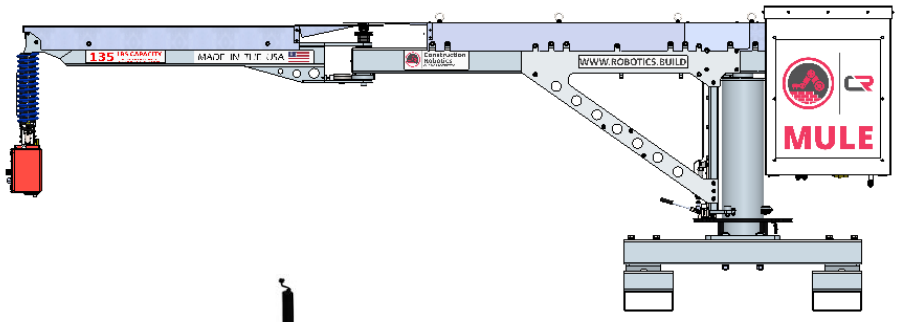


Figure B-1

2.2(b) *BASES*

Ground Base

Figure B-2 - As shown: 950 lb

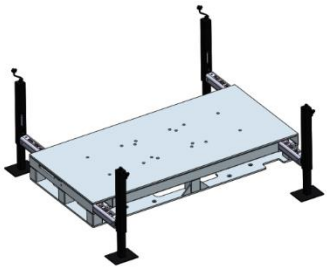


Figure B-2

Fork Tubes

Figure B-3 - As shown: 290 lb

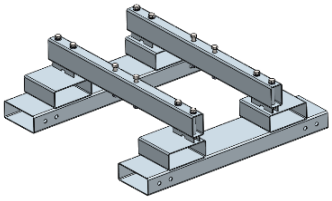


Figure B-3

2.2(c) *MASTS*

Figure B-4

Length	Weight
2'	135 lb
2.5'	145 lb
4'	180 lb
5'	200 lb
6'	225 lb

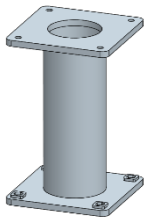


Figure B-4

3 MULE Accessories

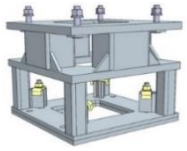
Below is a list of some basic MULE accessories. Construction Robotics offers a variety of additional options, and is developing new ones. Custom accessories can be developed upon request, contact Construction Robotics for more information.

3.1 Ground Base Wheel Set

Installs onto the bottom of the Ground Base, allows for MULE to be rolled between setup locations on jobsite. Capacity of 3200 lb

Weight: 530 lb

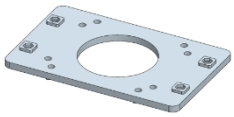
3.2 Hydro Mobile Mast Adapters



Allow for using HM mast as the mast for MULE, also can be used to attach MULE to the top of a HM mast supported by something other than a CR base.

Weight of adapter pair: 205 lb

3.3 Fork Tubes Adapter Plate



Allows Mast Sections to be directly mounted to the Fork Tubes. Without special engineering approval, this is only for use with Strap-over style MCWP mounts.

Weight of adapter plate: 75 lb

3.4 Two-Button Handle

This handle has the *GRIP* and *SET* buttons built in for easy access when the Gripper is unloaded. This allows for a typical place cycle to be done without releasing the handle.

3.5 CMU Gripper 1” - 2 1/4”

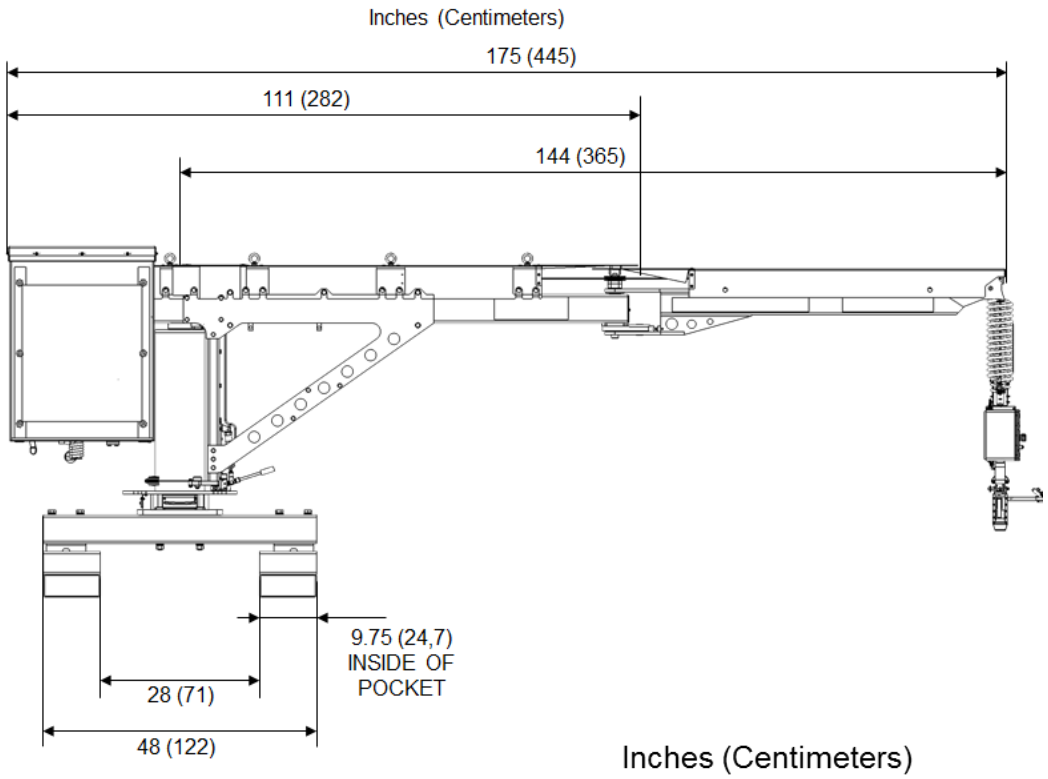
The CMU Gripper 1” - 2 1/4”. This gripper is capable of picking CMU with center webs between 1” and 2-1/4” thick.

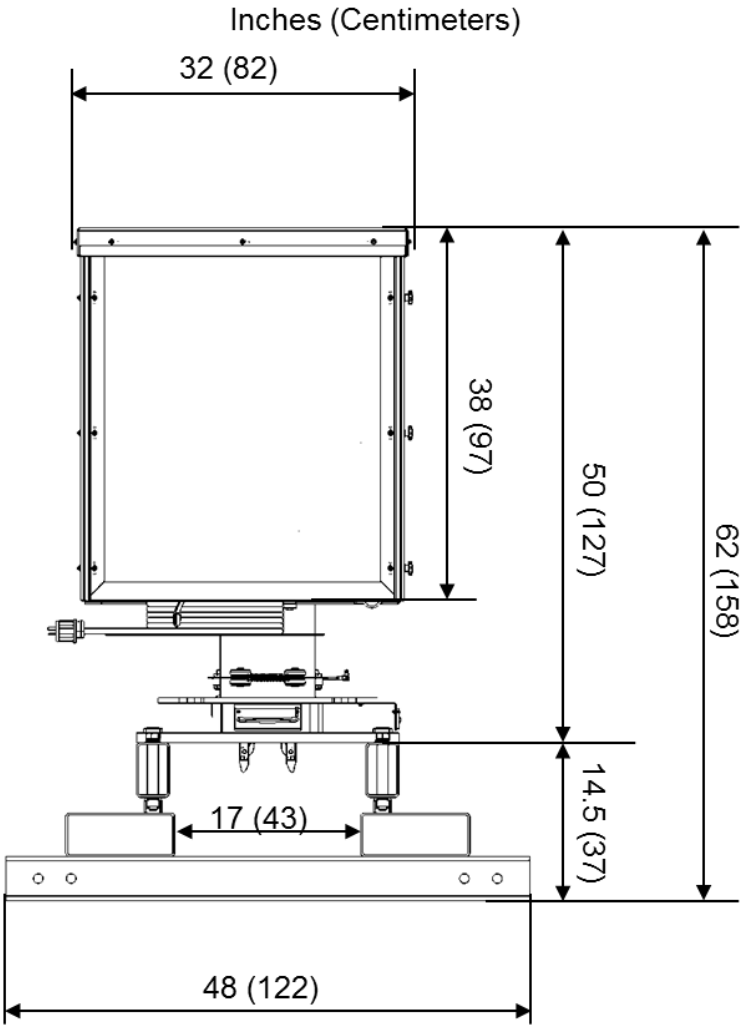
3.6 Wire Rope Extensions

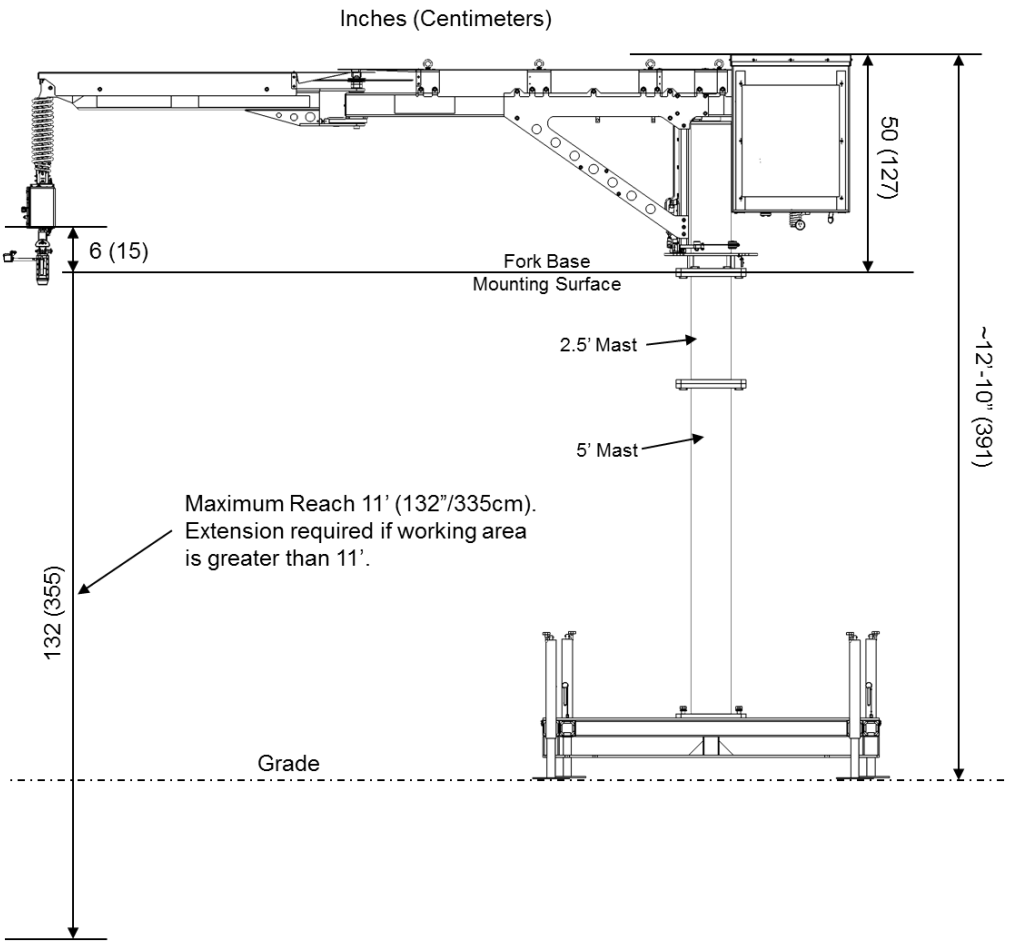
Wire Rope Extensions allow for vertically moving the 11’ working zone further from MULE. They attach to the Wire Rope and coil cords the same way that the Controller does. The Controller is then attached to the extensions. Multiple extensions can be hooked together for long reaches.

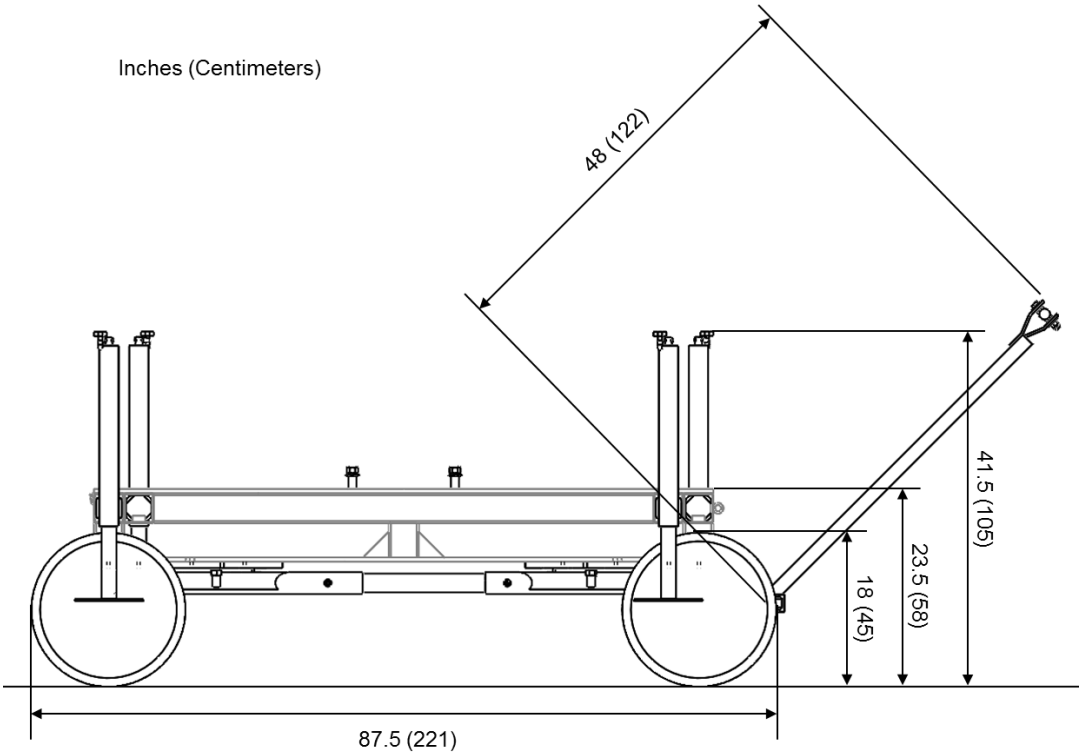
The extensions will decrease the allowable load by the weight of the extension.

4 System Dimensions

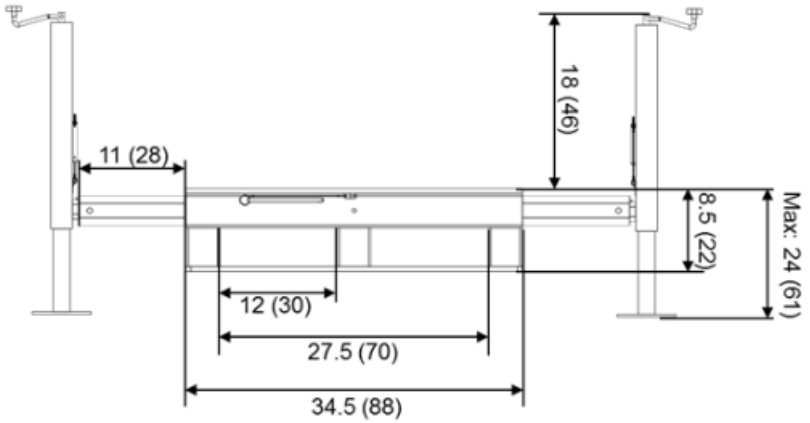


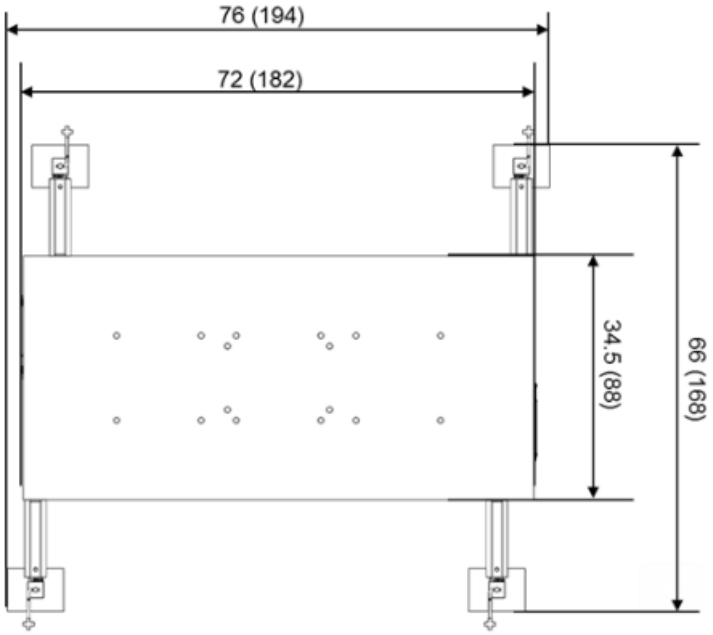



Inches (Centimeters)
50 (127)
6 (15)
Fork Base
Mounting Surface
2.5' Mast
5' Mast
~12'-10" (391)
Maximum Reach 11' (132"/335cm).
Extension required if working area
is greater than 11'.
132 (355)
Grade


Inches (Centimeters)
48 (122)
41.5 (105)
23.5 (58)
18 (45)
87.5 (221)

Inches (Centimeters)





5 Safety Features

Rotation Lock

When power is removed from MULE, a pin is engaged to lock the rotation of the Primary Arm. This is primarily used in 2 situations; when building/dismantling MULE and moving MULE.

When MULE is being transported between sites, there is a pin that can be inserted to prevent the lock from coming disengaged.

Preventing the Load from Dropping

When MULE is placing a load utilizing the *GRIP* button, it will not release the block until it senses that the load weight is being carried by something else. This prevents a load from dropping unexpectedly when the *GRIP* button is accidentally triggered.

Loss of Air

If air pressure is lost for any reason MULE is still in a safe condition. When air pressure is lost, the Primary Arm Rotation Lock will engage keeping the arm and any possible load from drifting away. Also the design of the Grippers prevents loads from being dropped by requiring air pressure to release. If air is not available, the unit will no longer operate but will be in a safe condition.

Overload Protection

The software running MULE is constantly monitoring the load on the Wire Rope. If the capacity of 150lb is exceeded the software will only allow for the controller to be lowered at a slow speed. This feature prevents heavy loads from being lifted and possibly damaging the unit or risking a tip-over. Repeated overload will cause premature failure of components.

6 Basic Requirements

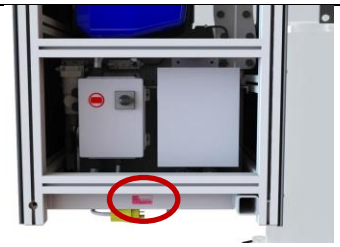
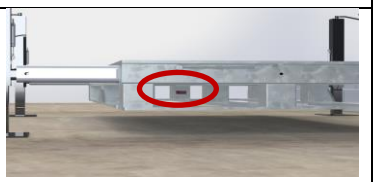
Power: 20A@120V AC, 60Hz

Load to be placed: 10-135 lb

7 Your Machine

As each MULE is made up of several main components, there are multiple serial numbers on each machine to allow for product tracking. For your records it is smart to record these numbers upon receipt.

Serial Number Stickers can be found in the following locations:

Equipment	Part Number	Serial #	Picture
Controller			
Arm			
Powerpack			
Ground Base			 Note: This sticker is in a protected location and therefore difficult to access.

C SYSTEM SETUP

1 Owner's Manual Limitations

If the desired setup exceeds any of the requirements or limits described throughout this manual, contact Construction Robotics with specific details for non-standard engineering approval. Additional engineering charges may apply.

If any uncertainties with the contents of this manual arise or clarifications are required, contact your Dealer.

2 Powering MULE

MULE requires clean, steady power to run. When running off a standard wall outlet with no extension cord, no issues should be encountered during standard operation.

If a generator or extension cord is being used, be sure to follow the guidelines in the sections below to ensure smooth operation of MULE.

2.1 Power Requirements

Voltage: 120V (+/- 6V) (if voltage is out of range, see section G6.1 on page 45 to adjust MULE)

Amperage: 20A (at full speed and full capacity)

Frequency: 60 Hz

OSHA requires that MULE be powered through a GFCI receptacle when using temporary site power or generators over 5000W (1926.404).

Be sure to follow all OSHA procedures for all power connections.

2.2 Generator Power

When site conditions require the use of a generator, it is important to have capable equipment available.

Many standard jobsite generators with less than 4000 Starting Watts do not have the power to handle the peak loads of MULE without creating power conditions that will cause faults. The newer inverter style generators provide cleaner power than standard generators.

When using a generator CR recommends using Honda EB2800i with Eco mode turned off.

2.3 Using Additional Extension Cords

Ensure MULE is fully assembled and the Controller is connected prior to plugging MULE in

MULE comes standard with 50' of power cord. Whenever possible, it is best to bring the power source into the range of MULE's power cord.

If it is necessary to add an extension cord, refer to the chart below for the proper gauge based on the length that is needed. Use of a smaller gauge cord than specified may lead to errors that prevent machine function.

Extension Cord Length	Minimum Extension Cord Size
Up to 50'	12AWG
50'-75'	10AWG
75'-100'	8AWG

3 Setup Process

3.1 Base Distance from Wall

The distance MULE sits from the wall face determines how many lineal feet of wall can be worked in a single setup.

In some cases, MULE must be set further back than desired due to site obstacles. The arms must remain free to rotate as the wall is worked. No problems will typically be encountered if the area in Figure C-1 is free from obstructions.

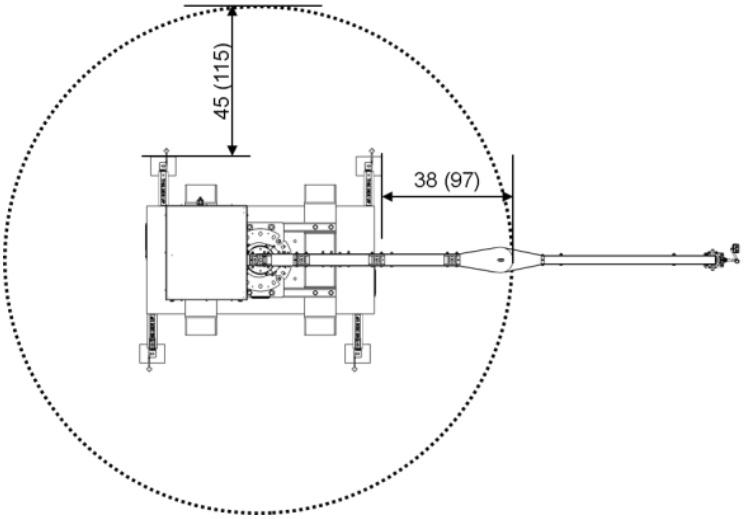
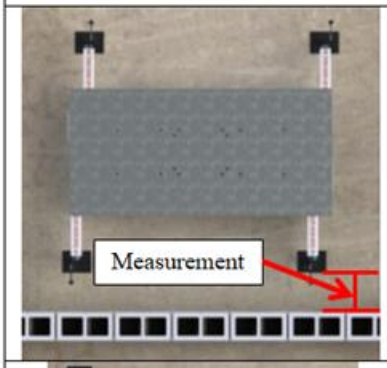
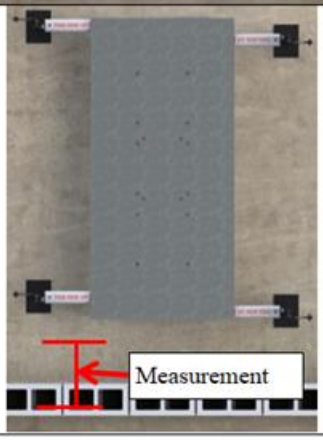


Figure C-1 – Required MULE Clearance

The following table illustrates how much wall can be reached by one MULE:

Distance From Face	Lineal Reach								
	1’	1’-6”	2’	2’-6”	3’	3’-6”	4’	4’-6”	5’
	21’-8”	21’-4”	20’-11”	20’-5”	19’-11”	19’-3”	18’-7”	17’-10”	16’-11”
	21’-6”	21’-1”	20’-8”	20’-2”	19’-7”	18’-11”	18’-2”	17’-4”	16’-5”

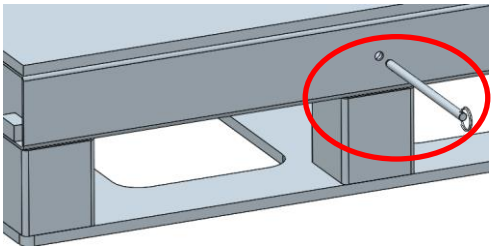
MULE must be mounted in the center of the Ground Base. Contact CR for approval on specific setups as required.

Be sure to follow all Local, State and Federal regulations on clearance distances to Electrical Lines. As a reference, North American regulations typically require a minimum of 10' of clearance on lines less than 50,000V.

Consult OSHA standards 1926.1407, 1926.1408 and 1926.1409 for more information.

3.2 Outrigger Position

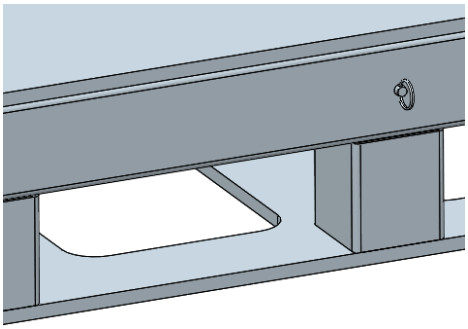
Before assembling MULE the outriggers within the Ground Base have to be extended and locked into position. These allow MULE to be stable while making the Ground Base able to fit through a 36" opening.



To extend the outriggers, pull the center pin out completely, this will allow both outriggers on one end of the Ground Base to slide freely.

Once the outrigger is free to move, slide it out until the line on the outrigger is lined up with the edge of the Ground Base. Be sure that the correct side of the outrigger is facing up.

Once the outrigger is extended to the correct position slide the center pin back in to lock them in place.



This procedure needs to be done on both ends of the Ground Base for all 4 outriggers.

Install the jacks in the outriggers, with the handle pointing up.

3.3 Base Leveling and Capacity

The maximum capacity of the Ground Base is 3700 lb. Do not exceed this capacity; use the weights above in the document to determine how much non-MULE weight can be supported at any time.

Ensure the ground or bearing surface under the jacks has the necessary capacity to support the total load. Follow the table below based on system weight for bearing surface requirements:

System Weight	Required Bearing Surface (psi)
2000-2399	33.0
2400-2799	38.2
2800-3199	43.4
3200-3599	48.6
3600-3999	53.8

Cribbing may be needed under each jack foot to increase the bearing surface capacity.

When using cribbing, ensure that the height never exceeds the width.

Using a 2’ or 4’ level, level the base in both directions using the jacks.

Ensure that the jacks are not extended more than 22” below the bottom of the outrigger. See Figure C-2

To fully extend the jacks, a pin adjustment is required. Remove the pin shown in Figure C-3, extend the jack by 1 position and insert the pin. It is not permitted to extend the jack past the 2nd position.

When leveling is complete, check that all 4 jacks are contacting the ground and carrying weight.

Figure C-3 - Jack Adjustment

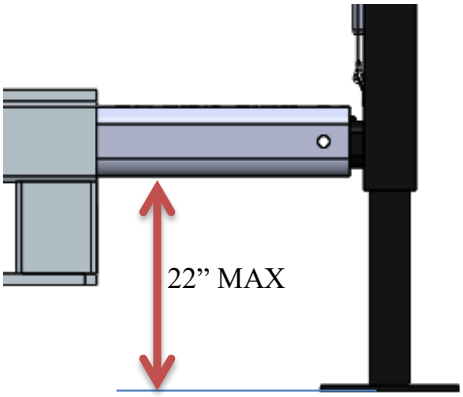


Figure C-2 – Max Jack Extension

3.4 Wire Rope Extensions

When work is required below the reach of the standard cable, extensions are required. The extension includes a strain relief fixture that is coupled to a section of wire rope/data cable/air line that is available in a variety of lengths. Multiple extensions may be hooked together for tall setups.

3.5 Controller Installation

The Controller MUST be connected before MULE is plugged in.

Attach the Controller to the Wire Rope loop using the clevis pin at the top. Secure the clevis pin with the lock pin.

Strain Relief - The black coil cord is secured to a fixture that is attached to the wire rope to provide strain relief.

Communications Cable – The cable connector is keyed with markings for proper alignment.

Connect the blue air supply hose to the top of the Controller using the quick connect fitting.

See Figure C-4 for diagram of connections.

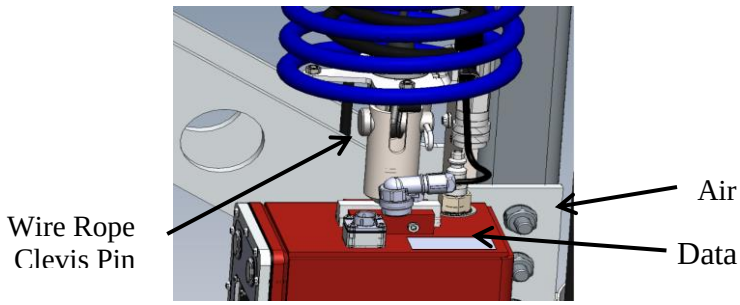


Figure C-4 – Controller

3.6 Handle Installation

Select the preferred Handle for the application, attach to the bottom of the controller using the (4) provided M5 screws and specified Loctite. Figure C-3

Run the switch cable according to the directions provided with your particular handle and connect into the bottom of the controller.

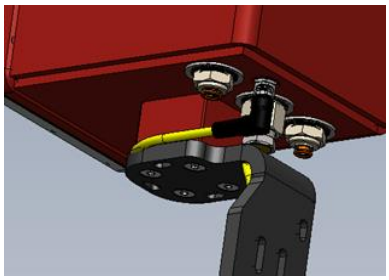


Figure C-3 – Handle Mounting

3.7 Gripper Installation

Select and attach the appropriate Gripper for the application.

Remove the quick change pin from the U-Joint located at the bottom of the Handle. Align the U-Joint connections on the Handle and Gripper and reinsert the pin.

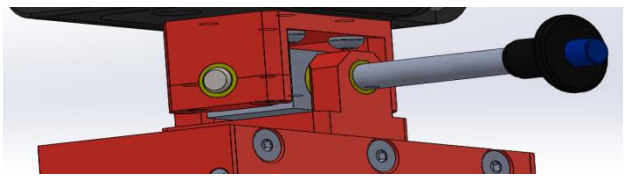


Figure C-4 - Gripper Installation

If applicable, run the external switch cable according to the directions provided with your particular handle. Connect the cable to the Handle.

If applicable, run the plastic air tubing according to the directions for your particular Handle.

3.8 Ground Base Wheel Set Installation

For MULE to be assembled to the Wheel Set, the mast must be no taller than 6 ft.

To lift the Ground Base, move the pin in the jacks to the 2nd position and crank the jacks evenly to lift the pallet high enough to allow the Ground Base Wheels to roll under, never exceed 3° of tilt (on both inclinometers) during this process.

Figure C-5 - Inclinometer during setup

Once the Wheel Set is under the Ground Base, align the 4 holes in the set with the holes in the bottom of the Ground Base. Insert provided plow bolts and install washer, lock washer and nut on the bottom of the set. Tighten to 80 ft-lbs. Once the bolts have been tightened, the jacks can be raised so that the assembly can roll.

The wheeled assembly has a maximum capacity of 3200 lb. Do not exceed this capacity; use the weights above in this document to help determine the total weight of the setup.

When in operation, no wheels may be touching the ground. They should be able to spin freely. All 4 jacks should contact the ground, with weight evenly distributed among them. All of the base surface and leveling requirements previously described in section C3.3 must be followed.

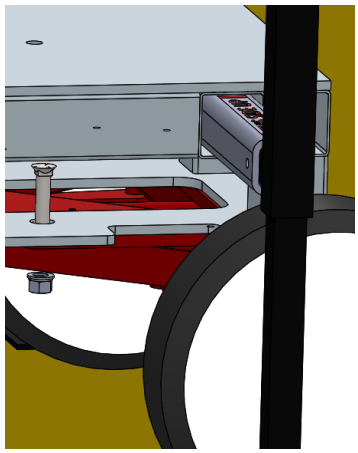


Figure C-6 - Cart Installation

3.9 Fork Tube Disassembly

On some setups, it can be beneficial to remove the Fork Tubes for either capacity or head height reasons. When the Fork Tubes are removed MULE will not sit unsupported.

To remove the Fork Tubes from MULE, remove the 4 bolts highlighted in Figure C-7.

Once the Fork Tubes have been removed MULE can be lifted into place using the rigging points or the Fork Tubes can be lowered down around the mast.

If further disassembly is desired, the Fork Tubes can be broken down into 4 pieces that can be carried by hand by removing the bolts in Figure C-8.

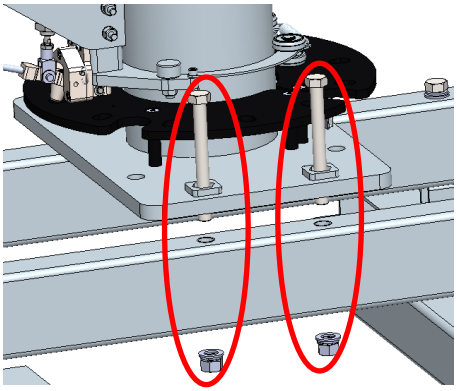


Figure C-7 – Fork Tube Removal

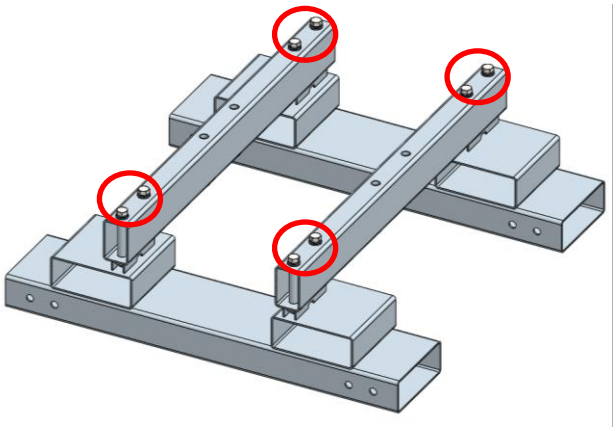


Figure C-8 – Fork Tube Disassembly

4 Maximum Mast Height

This manual provides the standard cases for using MULE. Contact CR for approval on special scenarios not outlined in this manual.

	Mast Type	
Base Type	**CR Mast**	**HM Mast**
Ground Base – Freestanding (Section C4.1)	22' of Mast	4 Sections (21' including adapters)
Ground Base – Wall Ties (Section C5)	41' of Mast	8 Sections (41' including adapters)
Standard Wheel set (Section C4.2(a))	6' of Mast (11' with specific approval)	1 Section – 6' including adapters (2 Sections – 11' including adapters with specific approval)
Fork Tubes (Section C4.3)	Not Permitted for Operation	

If a combination of CR and HM mast is required consult with CR for approval on details of your specific setup.

4.1 Ground Base

When operating on the Ground Base, the wind requirements are:

- Operation: Maximum 30 mph
- Not in Operation: Maximum 45 mph
- Remove MULE from top of Mast: above 45 mph

In all cases the Ground Base must be supported by all 4 jacks with the outriggers extended and locked into position. When not in operation, there should be no load on the gripper.

Before any mast assembly is started ensure that the Ground Base is setup per Sections C3.1 – 0

4.1(a) *CR Mast*

Free-Standing

When utilizing MULE in a single location with CR Mast it can Free-Stand up to 22 ft of mast.

Wall Ties

When site conditions require MULE to be built taller than Free Standing will allow, the Mast can be tied into existing structure. See Section C5 for details.

4.1(b) *HM Mast*

Free-Standing

When utilizing MULE in a single location with HM Mast it can Free-Stand up to 4 sections (21 ft including adapters)

Wall Ties

When site conditions require MULE to be built taller than Free Standing will allow, the Mast can be tied into existing structure. See Section C5 for details.

4.2 Mounted to Wheel set

When operating on the Wheel set, the wind requirements are:

- Operation: Maximum 30 mph
- Not in Operation on Wheels: Maximum 30 mph
- Not in Operation on Jacks: Maximum 45 mph
- Remove MULE from top of Mast: above 45 mph

When not in operation, there should be no load on the gripper.

Wall ties may not be used on setups with the Ground Base Wheels.

4.2(a) *Typical Use*

The Wheel Set is ideal for sites that have solid, flat and consistent surfaces so that MULE can be moved without the need of a Forklift or Crane.

The Wheel Set is rated to operate on surfaces with less than 10% of grade (6°) with sufficient bearing capacity (see table below). The running surface must be smooth; free from ditches, divots or similar.

System Weight	Required Bearing Surface (psi)
2000-2399	79.2
2400-2799	91.7
2800-3199	104.2
3200-3700	119.8

When in operation, no wheels may be touching the ground. They should be able to spin freely. All 4 jacks should contact the ground, with weight evenly distributed among them. All of the base surface and leveling requirements previously described in section C3.3 must be followed.

Moving speed must be kept below 4 ft/sec (average walking speed) when on the Ground Base Wheels.

CR Mast

When moving MULE on the Wheel Set with CR Mast, it can Free-Stand up to 6 ft (11ft with specific approval from CR Engineering).

When on the Wheel Set, order of the mast sections does matter. The shortest mast section must be on the bottom, getting progressively longer at the top of the stack.

HM Mast

When moving MULE on the Wheel Set with HM mast, it can Free-Stand up to 1 section (6 ft including adapters) (11ft with specific approval from CR Engineering).

4.3 Fork Tubes

Operation is not permitted when supported only by the Fork Tubes

The Fork Tubes may **only** be used to support a MULE **when not in operation**.

CR has created a special exception for use on a MCWP when properly restrained; see Section D2 for more information.

5 Working with Mast Ties

When site conditions require MULE to be built taller than Free Standing will allow, the Mast can be tied into existing structure. Wall ties are required every 15 ft beginning 3-10ft from the base. There must be no more than 15 ft of mast above the last tie. A minimum of 3 ties are required in each location per the diagram below.

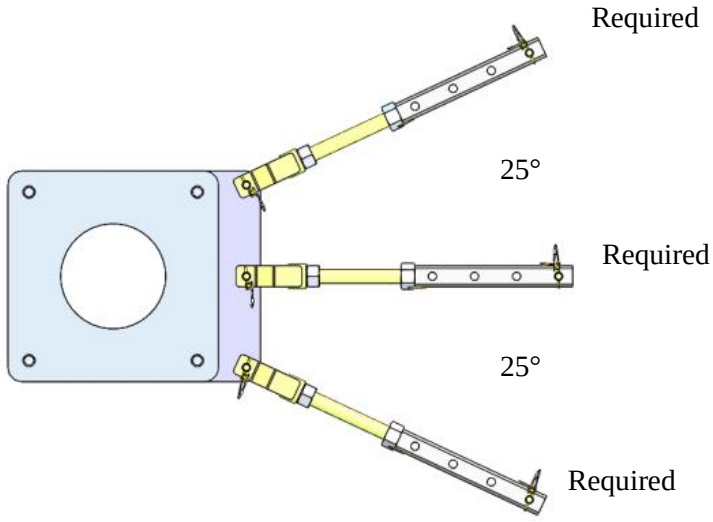


Figure C-9 - Mast Tie Layout

Each anchor point must be capable of 3000 lb of tension/compression and 1500 lb of shear.

Once the ties are installed, verify mast plumb in both directions prior to operation.

5.1(a) *CR Mast*

When working with the CR Mast in a tied configuration, additional components are required. Wall ties can only attach at the interface of 2 mast sections. At that interface the standard 3" bolts are switched with fully threaded 4" bolts keeping the standard washer, lock washer and nut. This connection is tightened in the same fashion as all other connections, using the same order and torques.

Then install the CR Mast Tie Plate with another lock washer and nut. These are then tightened following the typical specifications. See Section C6.1(a) on Page 22

These plates provide attachment points for ties to the wall. CR suggests using HM mast ties but others are acceptable if they fit and can support the same loads.

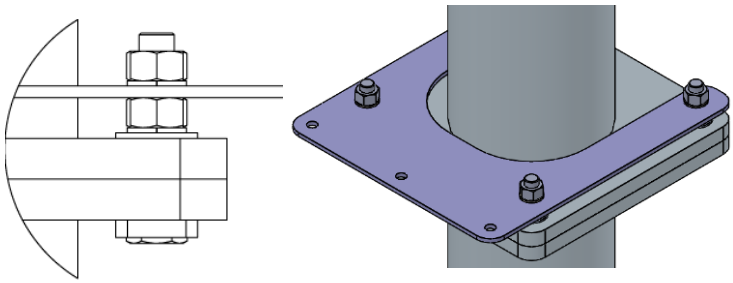


Figure C-10 - Installed Mast Tie Plate

5.1(b) *HM Mast*

When using HM Mast, the tie schedule is unchanged (See Page 21). Please refer to your HM manual for installation instructions of each tie.

6 Assembling the Mast and Installing MULE

Once you have determined how high you are building MULE and if you are required to use wall ties, it is time to assemble.

As a rule of thumb, MULE can build as high as the top of the upper mast section.

***** CR suggests that MULE be powered on to ensure the Primary Arm Rotation Lock disengages prior to raising MULE. If the lock does not disengage, see Section G7 for quick things to check. *****

Once the rotation lock is functional, unplug MULE.

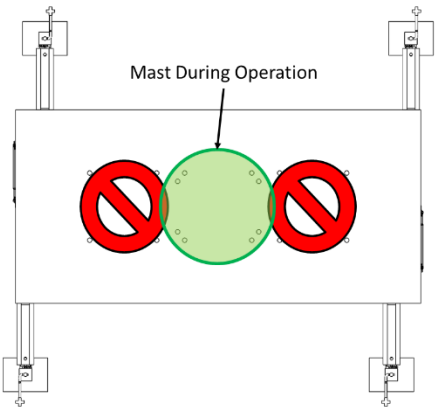
Ensure that MULE is unplugged and the Primary Arm rotation lock is engaged to prevent movement; restrain the Secondary Arm from swinging using a rope or bungee cord. It is highly recommended to remove the Controller for this process.

MULE must be mounted in the center of the Ground Base.

When installation/dismantling or rigging requires the iinstaller to exceed safe working heights allowable per OSHA or site specific regulations the use of approved fall protection is required.

6.1(a) *CR Mast*

Bolt a single mast section to the center of the Ground Base using (4) Grade 5 or higher ¾”-10 x 3” bolts up through the bottom and a ¾” washer, a ¾” lock washer, and a ¾”-10 nut on top of each. Nuts require a 1-1/8” wrench or socket. Tighten bolts to a torque of 80 ft-lb in the cross pattern shown in Figure C-11.



Building from the Top-Down (typically preferred)

If wall ties are being used, this section will not apply. Follow the guidelines in Error! Reference source not found. **below.**

Assuming more than one 5 ft section of mast is being used, lift MULE up with the Fork Tubes. If no Fork Tubes are installed, refer to the rigging limitations described in the next section (building from bottom up). Bolt a single mast section to the bottom of MULE using the same hardware and procedure as previously described.

Lift MULE and attach another mast section to the bottom of the previous mast. Repeat this procedure for as many mast sections as required up to the max free stand height, being sure to follow the tightening order and torque for each.

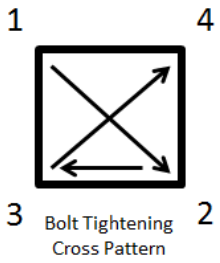


Figure C-11 - Mast Bolt Tightening

Once the mast stack has been assembled on MULE, bolt the stack to the mast pre-installed on the Ground Base. A taper wrench is very helpful in getting these sections to align.

If the Ground Base is or will be installed onto the Wheel Set, the mast stack MUST be assembled in order of ascending height with the shortest mast at the bottom and the tallest mast at the top.

Use the jacks on the Ground Base to level MULE to within 1/2° of plumb using the indicators mounted above the Fork Tubes. If the indicators are not visible, check mast plumb with a 4' level.

Figure C-12 - Inclinometer during Operation

When complete ensure that all 4 jacks are contacting the ground and have similar amounts of weight on them. When in operation on the jacks, Section 0 must be followed.

Building from the Bottom-Up

When building from the Bottom-Up, the entire mast stack is assembled to the Ground Base prior to adding MULE. The mast stack can be assembled on the ground and lifted into place on top of the pre-installed mast section on the Ground Base. All of the typical hardware applies to this assembly with the same tightening sequence and torque specifications.

To lift the mast stack CR suggests attaching ¾" eye bolts (rated for lifting) to the mast (through the standard mast bolt holes) as shown in Figure C-13. Each eye should use an individual strap/chain to prevent slippage. Be sure to follow all manufacturer instructions and ratings for all rigging equipment.

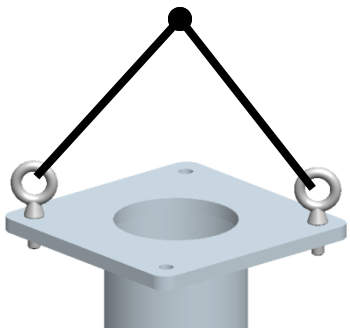


Figure C-13 - Mast rigging diagram

Once the mast stack is assembled and installed, MULE can be installed on top of it using either the Fork Tubes or rigging points. Follow the same tightening sequence and torque specifications using the typical hardware.

If using rigging to attach MULE, use the rigging points as shown in Figure C-14 (FOLLOW STANDARD RIGGING PRACTICES). As the rigging points on MULE have a maximum capacity of 500 lb in addition to the arm and powerpack (Fork pocket, mast sections, plates etc), the entire mast stack cannot be assembled in the same fashion as when assembling from the Top-Down.

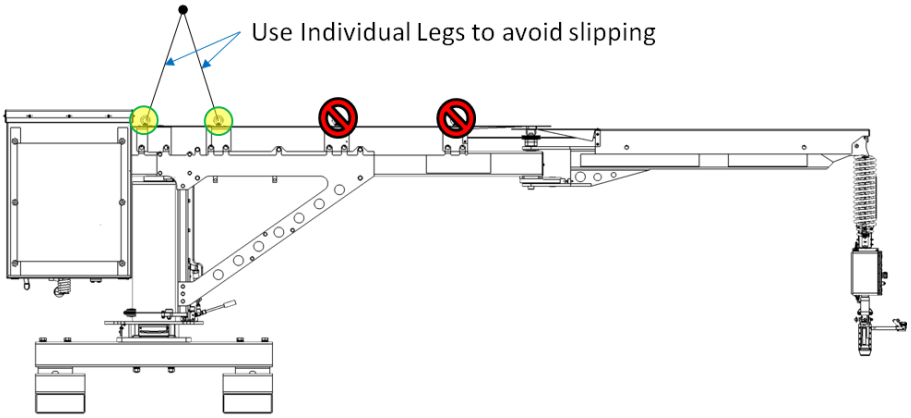


Figure C-14 - MULE rigging diagram

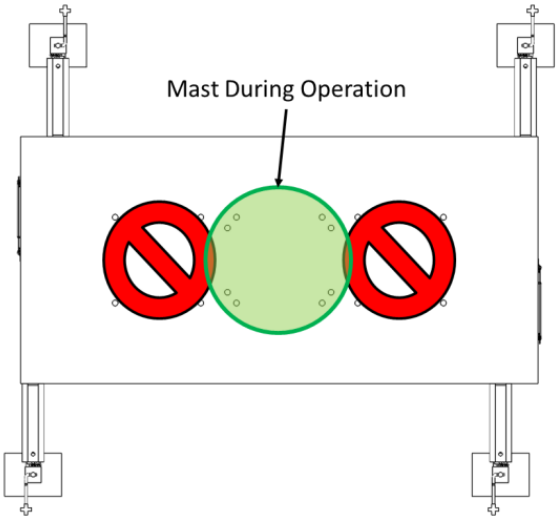
Use the jacks on the Ground Base to level MULE to within 1/2° of plumb using the indicators mounted above the Fork Tubes. If the indicators are not visible, check mast plumb with a 4' level.

Figure C-15- Inclinometer during Operation

When complete ensure that all 4 jacks are contacting the ground and have similar amounts of weight on them. When in operation on the jacks, Section 0 (Page 15) must be followed.

6.1(b) *Hydro Mobile Mast*

When utilizing the HM mast on the CR Ground Base, no climbing of the HM mast is allowed



If you are utilizing Hydro Mobile Mast for MULE the adapters need to be installed on the Ground Base and at the bottom of MULE.

The base adapter is a 2 piece assembly that gets bolted onto the Ground Base using the rectangular hole pattern in the center of the pallet. Be sure the bolts that interface with the HM mast are installed prior to attaching the assembly to the Ground Base.

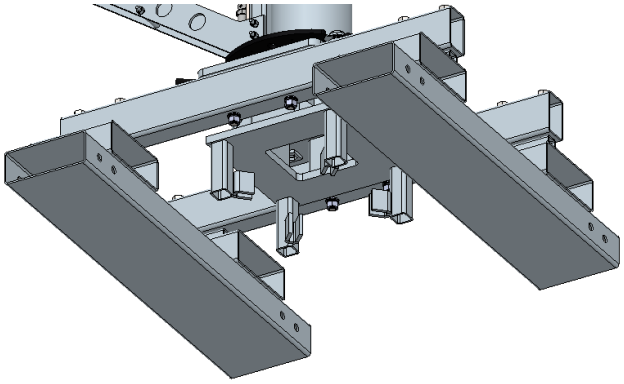


Figure C-16 - Installed upper HM mast adapter

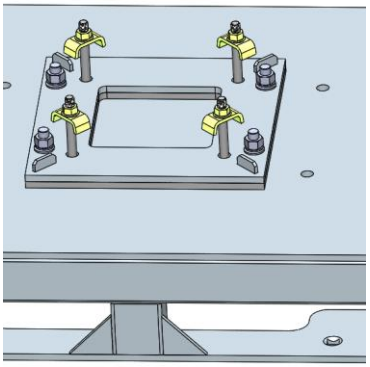


Figure C-17 - Installed lower HM mast adapter

Bolt the mast adapter to the center of the base using (4) Grade 5 or higher ¾”-10 x 3” bolts up through the bottom and a ¾” washer, a ¾” lock washer, and a ¾”-10 nut on top of each. Nuts require a 1-1/8” wrench or socket (Taper and ratchet wrenches are provided). Tighten bolts to a torque of 80 ft-lb in a cross pattern (shown in Figure C-11).

Install the upper adapter to the base plate of MULE (same plate that the Fork Tubes attaches to). Using the standard ¾”-10 x 3” bolts, washer, lock washer and nut, bolt the connection together following the same tightening procedure and torque specifications as used for all of the mast connections.

Building from the Top-Down

If wall ties are being used, this section will not apply. Follow the guidelines in Building from the Bottom-Up below.

Lift MULE up with the Fork Tubes; attach a single HM mast section to the bottom of MULE using the hardware built into the HM Mast. Tighten these bolts according to your HM manual.

Lift MULE and attach another mast section to the bottom of the previous mast. Repeat this procedure for as many mast sections as required being sure to follow the tightening order and torque for each.

Once the mast stack has been assembled on MULE, bolt the stack to the pre-installed mount on the Ground Base.

Building from the Bottom-Up

When building from the Bottom-Up, the entire mast stack is assembled to the Ground Base prior to adding MULE. The mast stack can be assembled on the ground and lifted into place on top of the pre-installed mast section on the Ground Base. All of the hardware needed is part of the HM mast or the Ground Base adapter.

Once the mast stack is assembled and installed, MULE can be installed on top of it. Use the rigging points as shown in the diagram below. Follow the tightening sequence and torque specifications found in your HM manual.

Once the mast stack is assembled and installed, MULE can be installed on top of it using either the Fork Tubes or rigging points. Follow the tightening sequence and torque specifications found in your HM manual.

If using rigging to attach MULE, use the rigging points as shown in Figure C-18 (FOLLOW STANDARD RIGGING PRACTICES). As the rigging points on MULE have a maximum capacity of 500 lb in addition to the arm and powerpack (Fork pocket, mast sections, plates etc), the entire mast stack cannot be assembled in the same fashion as when assembling from the Top-Down.

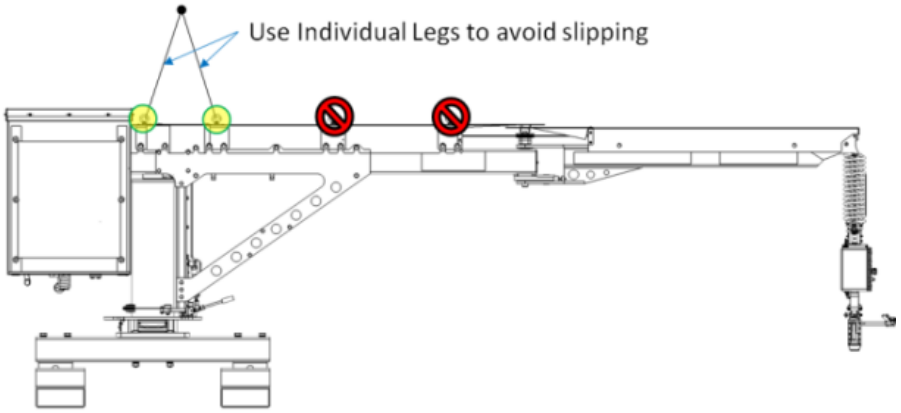


Figure C-18 - MULE rigging diagram

7 Raising MULE Height (Adding Mast Sections)

Once MULE is assembled and needs to be raised to change the work zone, Mast sections need to be added.

Before unplugging MULE, raise the Controller as high as possible to avoid excessive slack in the rope.

Ensure that MULE is unplugged and the Primary Arm rotation lock is engaged to prevent movement; restrain the Secondary Arm from swinging using a rope or bungee cord. It is highly recommended to remove the Controller for this process.

When adding Mast Sections be sure to follow the Free Stand Height or Wall Tie Requirements found in Section C4!

When using the Ground Base Wheel Set, the mast stack MUST always be assembled in ascending order (shortest on bottom, longest on top)

7.1(a) *Using Fork Pockets*

Carefully maneuver your Forklift into the Fork Tubes mounted on MULE from any of the 4 directions. Take load on the forklift but do not lift the unit. Remove the bolts holding the bottom mast section to the Ground Base (in the case of HM mast, disconnect the mast from the adapter on the Ground Base). Lift the Fork Tubes up to allow for a new section of Mast to be added. Attach the new mast to the Ground Base following the torque and tightening procedures found in Section C6 (Page 22). Then attach MULE to this newly inserted Mast following the same torque and tightening procedures.

7.1(b) *Using Rigging Points*

When installation/dismantling or rigging requires the installer to exceed safe working heights allowable per OSHA or site specific regulations the use of approved fall protection is required.

In order to use this procedure, the mast and Fork Tubes attached to MULE arm while lifted must weigh less than 500 lb. Consult the included weights chart (see Sections B2 & B3 on pages 4 – 5) to ensure that the lift is within capacity.

Attach your rigging to the points on MULE shown in Figure C-19, **FOLLOWING ALL STANDARD RIGGING PRACTICES**.

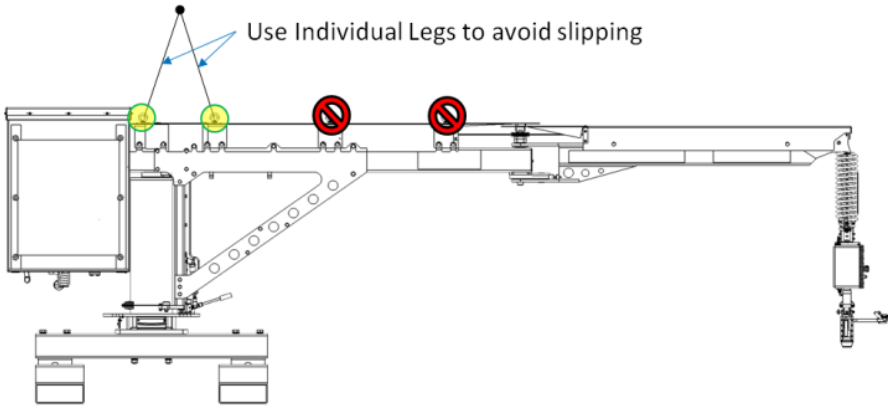


Figure C-19 - MULE rigging diagram

Lift the rigging so that there is tension on it but you are not lifting more than 500 lb in addition to the arm and powerpack (Fork pocket, mast sections, plates etc). Remove the bolts at the junction you intend to add mast to and lift the unit. Attach the new mast on the bottom side (either to the existing mast stack or the Ground Base) and follow the torque and tightening procedures found in Section C6. Lower the unit and attach it to the new mast section following the same torque and tightening procedure.

8 Moving MULE on a Jobsite

As work is completed MULE will need to be relocated to keep producing.

Before moving MULE, make sure that the wind conditions are within the operational requirement of 30 mph.

Ensure that MULE is unplugged and the Primary Arm rotation lock is engaged to prevent movement; restrain the Secondary Arm from swinging using a rope or bungee cord. It is highly recommended to remove the Controller for this process.

8.1 General Location Requirements for MULE

Before moving the Ground Base, ensure that the ground or bearing surface under the jacks at the new location has the necessary capacity to support the total load. Follow the table below based on system weight for bearing surface requirements:

System Weight	Required Bearing Surface (psi)
2000-2399	33.0
2400-2799	38.2
2800-3199	43.4
3200-3599	48.6
3600-3999	53.8

Cribbing may be needed under each jack foot to increase the bearing surface capacity.

When using cribbing, ensure that the height never exceeds the width.

8.2 Free Standing Ground Base

It is not permitted to move an assembled MULE with anything other than the MULE Ground Base Wheel Set or a Fork Lift (No Pallet Jacks)

When MULE is built on the Ground Base the entire assembled system can be moved provided that certain criteria are met. If the values below are exceeded, MULE must be partially disassembled to be moved.

- Travel Grade is less than 8% (5°)
- Mast must remain plumb within 5° in all directions during transit
- The amount of mast does not exceed 22’
- The final position of MULE is on flat and level ground.
- Move must be made with a capable lifting device (a pallet jack is not permitted)
- System Weight does not exceed 3500lb

If the move meets all of the requirements, MULE can be moved using the Fork Tubes at the top of the mast.

When moving an assembled MULE, MULE must be chained to the basket of the Fork Truck!

Once the move is complete, do not move the Fork Truck until releveling. Re-level MULE to within 1/2° using the built in indicators above the Fork Tubes.

Figure C-20 - Inclinometer during operation

If it is necessary to move an assembled MULE with a Fork Truck using the Ground Base, the amount of mast may not exceed 8'.

If **any** of the requirements are not met then MULE needs to be separated from the Mast/Ground Base and reconnected once the setup procedure in Sections C3.1- 0 (Pages 13 – 15) has been completed.

8.3 Wheel Set

The Wheel Set is ideal for sites that have solid, flat and consistent surfaces so that MULE can be moved without the need of a Forklift or Crane.

The wheels are rated to operate on surfaces with less than 10% of grade (6°) with sufficient bearing capacity (see table below). The running surface must be smooth; free from ditches, divots or similar.

System Weight	Required Bearing Surface (psi)
2000-2399	79.2
2400-2799	91.7
2800-3199	104.2
3200-3599	116.7
3600-3700	119.8

To move the Ground Base Wheel Set, lower the jacks evenly until there is no weight on them. While doing this, be sure to keep MULE level; do not exceed 3° on the indicators above the Fork Tubes during this process.

Figure C-21 - Inclinometer during operation

Roll the Ground Base to the new working position. Ensure that the travel surface has less than 10% of grade (6°) with sufficient bearing capacity. The running surface must be smooth; free from ditches, divots or similar.

Raise the jacks evenly. While doing this, be sure to keep MULE level; do not exceed 3° on the indicators above the Fork Tubes during this process.

Use the jacks on the Ground Base to level MULE to within 1/2° of plumb using the indicators mounted above the Fork Tubes.

When in operation, no wheels may be touching the ground. They should be able to spin freely. All 4 jacks should contact the ground, with weight evenly distributed among them. All of the base surface and leveling requirements previously described in section C3.3 must be followed.

8.4 System with Wall Ties

If the maximum free stand height is exceeded and wall ties are required, MULE cannot be moved without some level of disassembly.

If the mast length is less than or equal to 15 ft (if moving with an overhead crane in a fixed position, any mast length up to 20 ft is acceptable), then the Ground Base and mast stack can be moved as 1 piece. Remove MULE from the top of the mast with either the Fork Tubes or Rigging points. At this point the wall ties can be removed. The Ground Base and mast stack can be moved through the Ground Base fork pockets or by rigging from the top mast section in the same way as lifting an assembled mast stack. Be sure to follow all manufacturer instructions and ratings for all rigging equipment. If moving by the Ground Base, pick the Ground Base by the built-in fork pockets and move it to the new position.

Once the Ground Base has been relocated, follow the setup procedure in Sections C3.1- 0(Pages 13 – 15) and tie the mast into the wall being sure that the anchorage point and tie schedule meets the requirements in Section C5 (Page 21). Once the base is prepared and the mast is plumbed, MULE can be reinstalled.

If the mast length exceeds 15 ft more disassembly is required. Remove MULE from the top of the mast with either the Fork Tubes or Rigging points. In this case the mast stack needs to be split into sections of no longer than 20 ft; as the stack is split apart, the wall ties can be removed. Once the remaining mast is less than 15 ft the remaining mast can be left assembled on the Ground Base and moved via the built in fork pockets. Once the Ground Base has been relocated, follow the setup procedure in Sections C3.1- 0 (Pages 13 – 15)and tie the mast into the wall being sure that the anchorage point and tie schedule meets the requirements in Section C5 (Page 21). Once the base is prepared and the mast is plumbed, MULE can be reinstalled.

9 MULE Dismantling and Packing for Transport

When MULE is finished working on a site it can be packed into a convenient package for transport. This packaging is solely for convenience; see Section F for shipping requirements.

Remove Controller and place in Transport box.

Remove MULE from the top of the mast and place on ground. Move rotation lock pin into the locked position.

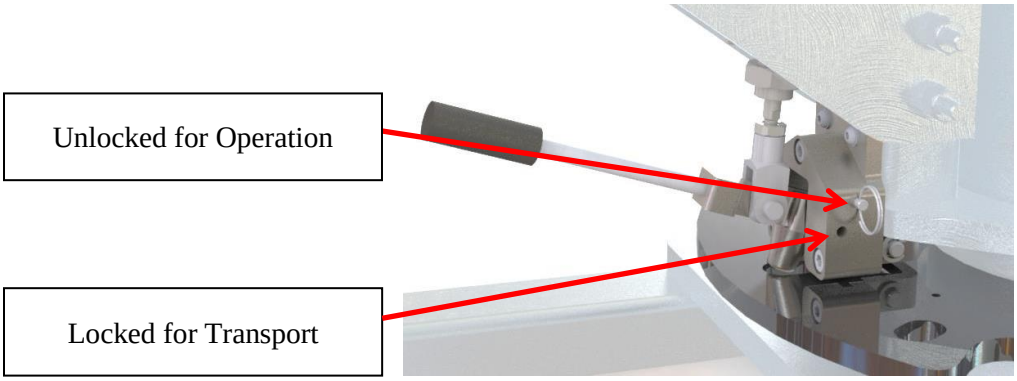


Figure C-22 - Locking Rotation Lock

Remove mast sections from the Ground Base. To pack MULE for transport a 2.5’ and 5’ mast is recommended.

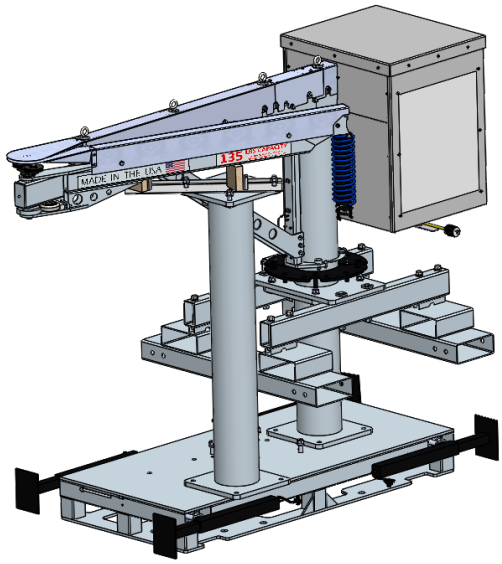


Figure C-23 - MULE in Transport Configuration

Attach the 2.5’ mast to one end of the Ground Base; install MULE on top of it.

Add the 5’ mast to the opposite side of the Ground Base, offset from the center (see diagram)

Install shipping support bracket that came with your unit to the 5’ mast. Tie arms down to support.

Rotate the jacks to the “stowed position”

The assembled package weighs approximately 2500 lb.

Transport any additional mast in desired fashion.

D SYSTEM SETUP ON MAST CLIMBING PLATFORM

1 Introduction

As Mast Climbing Work Platforms' (MCWP) are so critical in construction, CR has made special mounting solutions to optimize the valuable deck space and decrease overall system weight.

CR has different styles of dedicated MCWP mounts. Refer to the documentation that came with your specific mount for details.

All MCWP mount styles support up to 21 lineal feet of reach (when utilizing a 2-board setup) and are capable of setting the unit back from the wall when working against a backer.

All of these mounts can be used with CR or HM mast sections.

For all mounts, MULE must be removed from the scaffold if the winds may exceed 45mph

When utilizing the HM mast on a CR MCWP mount, no climbing of the HM mast is allowed!

2 Strap-over Deck Mount

2.1 Overview

The Strap-over deck mount allows for MULE to be mounted in multiple positions on the scaffold with no permanent modifications required.

Utilizing this mounting kit MULE can be installed quickly to the scaffold.

Check with CR for the appropriate hardware set for your scaffold.

2.2 Installation

To install this mount the MCWP deck guarding must be adjusted. When doing this you must use the appropriate PPE and comply with all Local, State and Federal rules and regulations.

Deck guarding is loosened in the selected location and slightly lifted. The mount is then placed over the deck, slid under the guarding and clamped to the front and back of the scaffold. Guarding is then lowered to rest on the mount and tightened in place.

2.3 Leveling the Base

This base does not allow for MULE to be leveled. If the deck is not level some drifting of the arms and increased effort of moving material may be experienced.

2.4 Adding Masts and MULE

The Fork Tubes must be well supported on a level surface.

Remove MULE from the Fork Tubes using the rigging points. Add the mast adapter plate to the Fork Tubes and install the standard mast sections to it. **Total mast height is limited to 7.5'**. Add MULE on the top.

In winds exceeding 30 mph this assembly will not sit on its own and must be dismantled or strapped down using the Fork Tubes.

2.5 Moving MULE and Mount

The Strap-over Deck Mount can be moved while attached to MULE using the Fork Tubes or the rigging points. If using the rigging points; ensure that the mount, mast and mast adapters (if installed) are under the 500lb limit and all rigging rules are followed.

During the move, MULE may not sit or operate without being supported by a Fork Truck or appropriate lifting device.

3 On Existing Hydro Mobile Mast Tower

In some cases it may be desired to mount MULE directly to a HM mast that is also supporting the scaffold deck. Hydro Mobile has approved this special use of their product when being used with MULE.

When using either the M or P-Series units MULE can be attached directly to the top of the mast that is supporting the scaffold. The only additional requirement for use is that MULE may not be any further above the top tie than the approved maximum overhang.

MULE must always be removed from the mast prior to the scaffold being moved to a different location (horizontal moves) and when scaffold operational wind limits are reached.

For efficient use of MULE, a wall tie should not be installed between the scaffold deck and MULE.

E SYSTEM OPERATION

1 Controller Buttons

1.1 RUN STOP

The *RUN STOP* button disables all functionality on the Controller and Actuator. When pressed the screen will show "E-STOP ENGAGED"

1.2 Manual/Calibrate Up/Down

Typically used as the calibration for the load weight in Float Mode.

This is also the method to directly drive the Wire Rope Up or Down at a variable speed (the further the button is depressed the faster it moves).

1.3 Speed

The *SPEED* button changes MULE between fast and slow speed in speed dependent modes. For typical operation this button only changes the speed at which the load is placed (after the *GRIP* button is pressed but before the Gripper releases). This button also changes the speed at which the *MANUAL/CALIBRATE UP/DOWN* buttons function. Fast and slow speeds are configurable within the Controller menu (See Section G4 for details).

1.4 Float

The *FLOAT* button turns on Float Mode, which makes the load feel weightless. In typical operation the *FLOAT* button will always be pressed in. The main reason to release this button is to get into the Controller menu.

Figure E-1 - Controller Faceplate Layout

The blue light below the screen is typically illuminated when *FLOAT* is enabled.

1.5 Auto Retract

The *AUTO RETRACT* button turns on Auto Retract, which raises the Controller/Gripper after the load is placed. In typical operation the *AUTO RETRACT* button will always be pressed in, unless you want the Controller/Gripper to stay in position once the load is released.

The Auto Retract function will only work when a load is placed (through the *GRIP* button) while in Float Mode. The Controller/Gripper will never retract to a point lower than the release height.

If the Controller is grabbed or snagged while retracting, it will stop.

1.6 Retract Height

The *RETRACT HEIGHT* button sets the current height of the Controller to the height that the Auto Retract function will move the Controller to. The Auto Retract function will not lower the Controller if the retract height is set below where the load was placed.

To set the height, move the Controller to the desired height and press the *RETRACT HEIGHT* button once.

2 External Buttons - Gripper and Handle

Depending on the configuration of your unit, you may have 1 or 2 buttons on your handle and possibly 2 buttons on the gripper. Buttons on the gripper and handles are labeled with their function.

2.1 Grip

The *GRIP* button engages and disengages the clamping mechanism on the Gripper. When the *GRIP* button is pressed for the 1st time the clamping mechanism will close on the load. The function of the *GRIP* button past that depends on what "mode" MULE is running in.

If the controller screen shows "Float Mode" (typical operation) then pressing GRIP while loaded will begin the Place Sequence, where the load is slowly lowered at a constant speed until MULE is no longer carrying the weight. At this point the clamping mechanism will disengage. If GRIP is pressed again before unclamping, the place sequence is canceled and the load will go back to feeling weightless.

If the controller screen shows "LIFT READY" (manual operation) then GRIP will disengage the clamping mechanism if MULE is not carrying the weight of a load. When in this mode, the Wire Rope will not move to release the weight from MULE.

2.2 Set

The *SET* button changes the load from feeling weightless to having some weight when the Controller screen shows "RUN MODE FLOAT". Pressing *SET* again changes the load back to feeling weightless.

When placing a load on a soft material (i.e. setting a block in a mortar bed) this feature is very advantageous.

The Set weight (Negative Tare within menu) is configurable within the Controller Menu (See Section **Error! eference source not found.** for details).

3 Typical Use Cycle

- Ensure the screen shows a weight. If not press in the *FLOAT* button on the Controller and wait for the Blue light below the screen to appear.
- Gripper is placed over the load and the *GRIP* button is pressed to engage the clamps.
- If the load does not act weightless, use the *MANUAL/CALIBRATE UP* button to lift the load several inches. Remove hands.
- Once the blue light appears under the Controller screen, the load will act weightless. Move by manipulating the load or Controller Handle.
- When the load is nearly in position, press the *SET* button. The load will now have some weight and will go down if not supported. This is an optional step that is sometimes not used.
- Set the load in the final position and press the *GRIP* button once, the load will slowly lower and release when the load is being supported.
- If the *AUTO RETRACT* button is pressed in, the Controller will retract to the preset Retract Height.
- Repeat steps. The *MANUAL/CALIBRATE* buttons should not be needed unless the weight of the load changes (higher or lower).

3.1 Common User Errors

The gripper will not release the load

Typically this is caused by pressing the *GRIP* button multiple times.

When in Float Mode, once the *GRIP* button is pressed MULE will slowly lower the load until it senses that it is no longer holding it, this causes a delay between the button press and load release. If the grip button is pressed again before the release, the release operation is canceled.

To solve this, be sure to only hit the *GRIP* button once.

The gripper will not retract although the *AUTO RETRACT* button is pressed

This is typically caused by one of two conditions:

1) The gripper binding on the load or being held after placing.

2) The retract height is set below the place height

When in Float Mode with *AUTO RETRACT* pressed, once the load is placed the gripper will try to move up to the programmed Retract Height.

If the gripper is held by the load, operator or other obstruction, MULE will stop the retract sequence.

If the gripper is attempting to retract to a position that is lower than place height, retract is disabled.

To solve this be sure that the gripper is free from obstructions (including hands) and that the retract height is set above the place height.

The loaded gripper "stutters" when the *SET* button is pressed

Typically this is caused by pressing the *SET* button multiple times.

When in Float Mode, once the *SET* button is pressed MULE will give the load some weight (adjustable in the menu, see Section G4) and the load will begin to go down if not supported. If the *SET* button is pressed multiple times the gripper will slightly lower then stop moving.

To solve this be sure to only press the *SET* button 1 time.

4 Hook Mode

Hook Mode is used to move materials of varying weight that do not require an actuated gripper to secure the load. The gripper is typically replaced with a hook or mechanical clamping device. The Mode of operation is switched between "Hook" and "Gripper" within the Controller Program (refer to section G 4.6).

When in Hook Mode, the *GRIP* and *SET* buttons on the handle function differently.

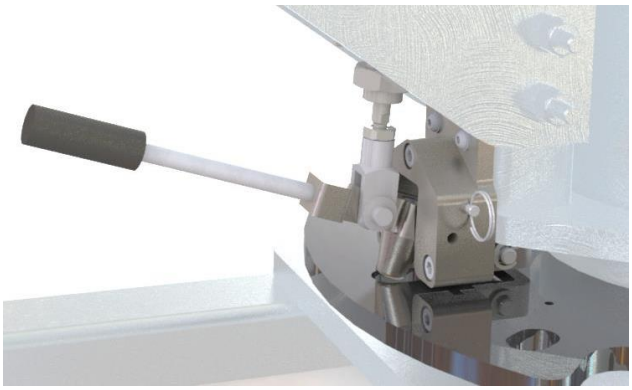
4.1 Set Button

Pressing and holding the *SET* button moves the load up at a fixed speed. If the *FLOAT* button on the controller has been depressed ("Float Mode"), the load will be weighed as soon as the *SET* button is released (remove your hands at this stage). The load can then be moved freely by hand.

4.2 Grip Button

Pressing and holding the *GRIP* button moves the load down at a fixed speed. If the *FLOAT* button on the controller has been depressed ("Float Mode"), the load will be weighed as soon as the *GRIP* button is released (remove your hands at this stage). The load can then be moved freely by hand.

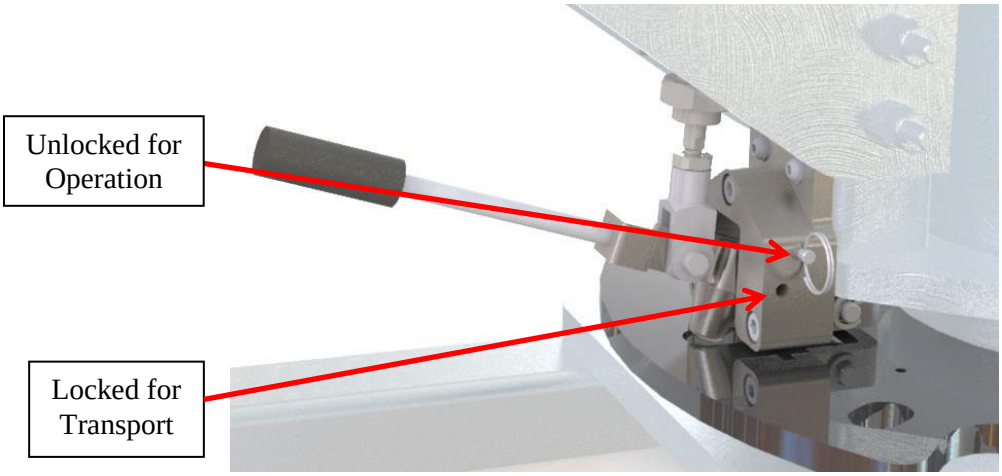
5 Primary Arm Rotation Lock



The Primary Arm is equipped with a locking mechanism to prevent the arm from swinging when MULE is not powered. The lock is driven by the pneumatic system and can be manually operated if desired.

Sometimes it is necessary to rotate the arm while not powered. Lift up on the attached handle and the lock will be disengaged, if it will not move check that the locking pin is not installed. Once the handle is released the lock will extend and lock in at the next available slot.

When MULE is transported between sites, this lock should be pinned so that it cannot release accidentally. After the power has been removed, move the cross pin into the lower hole. After doing this the rotation lock cannot be released until the pin is moved.



F TRANSPORT AND STORAGE

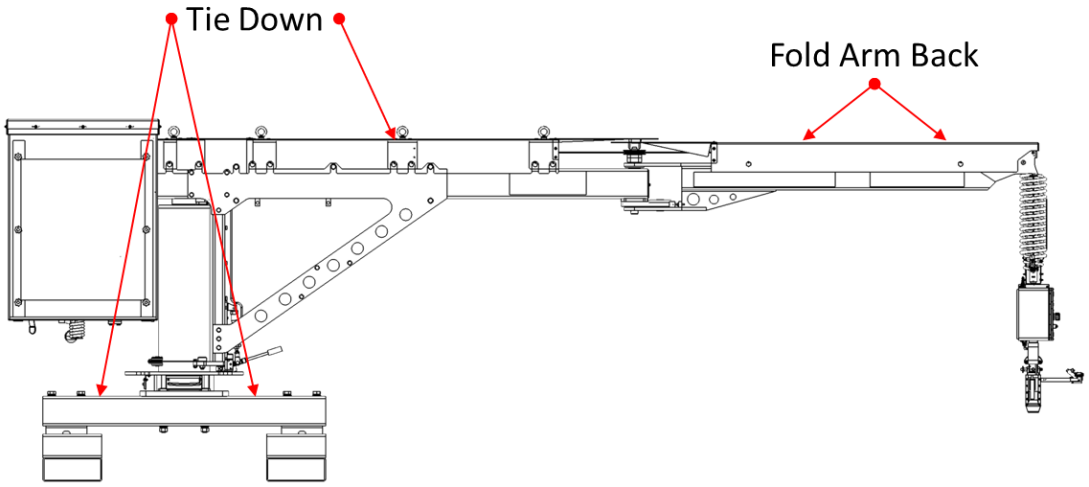
1 Shipping Position

MULE can be shipped attached only to the Fork Tubes or assembled with masts and the Ground Base as it was initially received. In either case, it is important to support both of the arms in both the up and down directions.

Ensure that the Primary Arm rotation lock is engaged and that the lock pin is preventing the lock from releasing (See Section E5). Pull up on the release handle to verify.

1.1 Tie Down Locations

MULE should only be tied down using the specified locations. Any other locations may cause permanent damage to MULE.



1.2 Orientation on Open Trailer

When possible, the Powerpack should always be at the front of MULE when moved on an open trailer.

When that is not possible, additional steps should be taken to prevent contamination of the actuator by road debris. In this case, wrap the Primary-Secondary Arm joint with a tarp or similar.

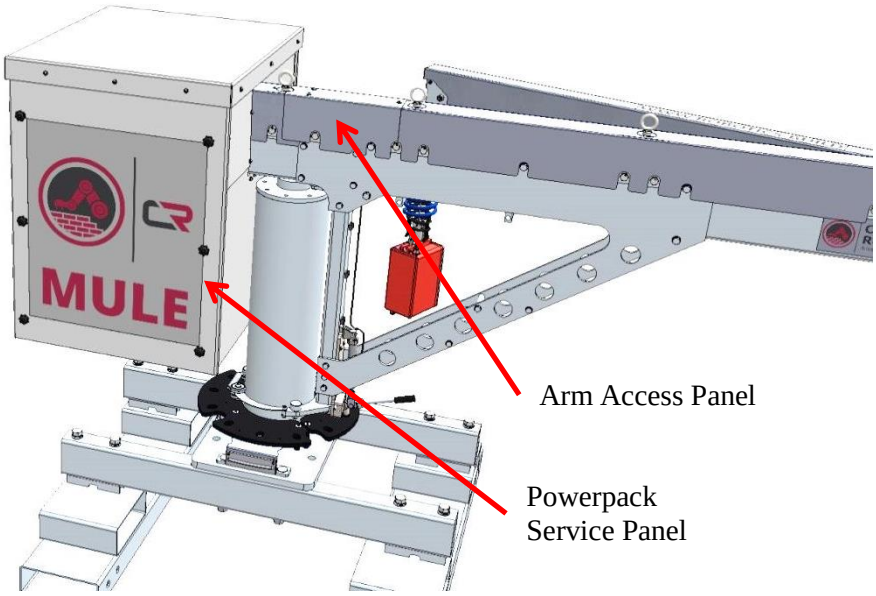
2 Controller Transport

After the controller has been removed from MULE, it should be stored and transported within the provided case. CR recommends storing the Controller above 40° for optimal operation.

This case also provides storage for additional mast hardware, wrenches, Wire Rope lubricant and this manual.

G SETTINGS AND TROUBLESHOOTING

1 Key Access Areas



2 Friction Brake Adjustment

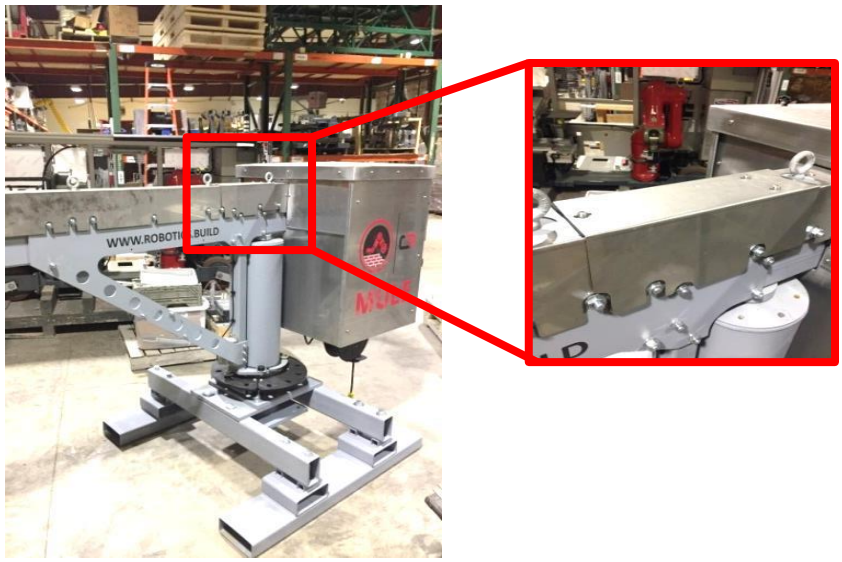
The friction brakes control how fast the arms move and how quickly they start and stop. Looser friction brakes allow the arm to move easier but also allow for more unintended movement. Tight friction brakes take more effort to move but will not drift away as easy.

2.1 Primary Arm

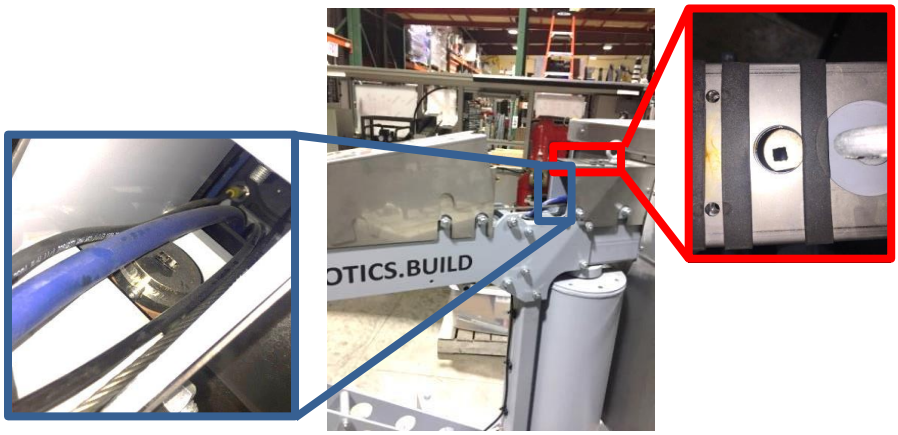
Tools:

- 4mm Allen key
- ½" drive socket extension at least 6" long
- ½" drive ratchet or breaker bar

The Primary Arm friction brake is located at the top of the Rotation Mast. To access it, the Arm Access Panel must be removed using the 4mm Allen key.



With the panel removed, a hole near the rigging eye is exposed. Insert the extension into the silver piece below and attach the breaker bar or ratchet.



Little adjustment is needed to change the feel of the arm, adjust the nut no more than 1/8 of a turn at a time.

Do not loosen or tighten more than 1 turn from factory delivered setting.

Once the adjustment has been completed reinstall the Arm Access Panel.

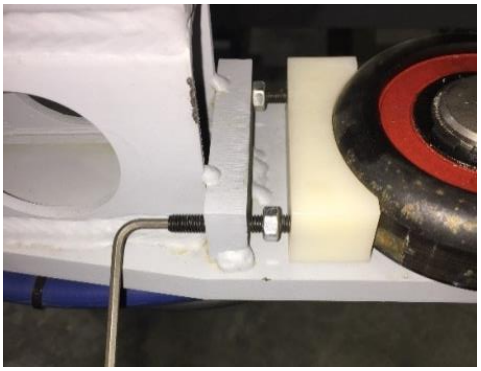
2.2 Secondary Arm

Tools:

- 3mm Allen key
- 10mm open end wrench

The Secondary Arm friction brake is located at the bottom of the Primary-Secondary Arm joint.

To adjust hold one of the screws with the Allen key and loosen the locking nut. Tighten or loosen the screw as needed, the adjustment is very sensitive and will only require a small turn (less than 1/8th of a turn at a time). Both screws should be adjusted evenly.



When the brake is adjusted as desired, hold the screw stationary and tighten the locknut with the 10mm wrench. Re-check adjustment to confirm it did not change after tightening.

3 Virtual Limits

If work is being performed repeatedly in the same height range, limits can be set to prevent the Controller from travelling up or down further than intended.

To set and adjust Virtual Limits see the Controller Menu in section G4.

4 Controller Menu

The current software version is V1.02, for any other versions refer to information specific for that version.

The two button menu provides the ability to change user, application and system specific settings. Through this menu some troubleshooting information is also available. FLOAT MODE MUST BE DISABLED BEFORE THE MENUS CAN BE ACCESSED.

4.1 Virtual Limits (V-limits)

Software limits that prevent the controller from leaving a certain range, this can be useful if work is always at the same height.

To set, drive the Controller to the position of the desired limit, then navigate in the menu to the limit and select. The screen will flash and return to “GRIPPER READY” when the sequence is complete.

4.2 Speed Menu

Allows for changing the speeds that control Auto-Retract, RUN MODE PENDANT and placing a load. By default slow is set to 30% and fast to 50%. Auto-Retract will always run at the fast speed.

4.3 SET Weight

Allows for the adjustment of the “SET” weight. The SET weight can be adjusted in 2 lb increments from 2-30lb.

4.4 Anti-Drop Tool Weight

Teaches the weight of the unloaded tool (empty gripper). To recalibrate the tool weight, press and hold the Left Menu Button in, and remove hands when prompted to do so.

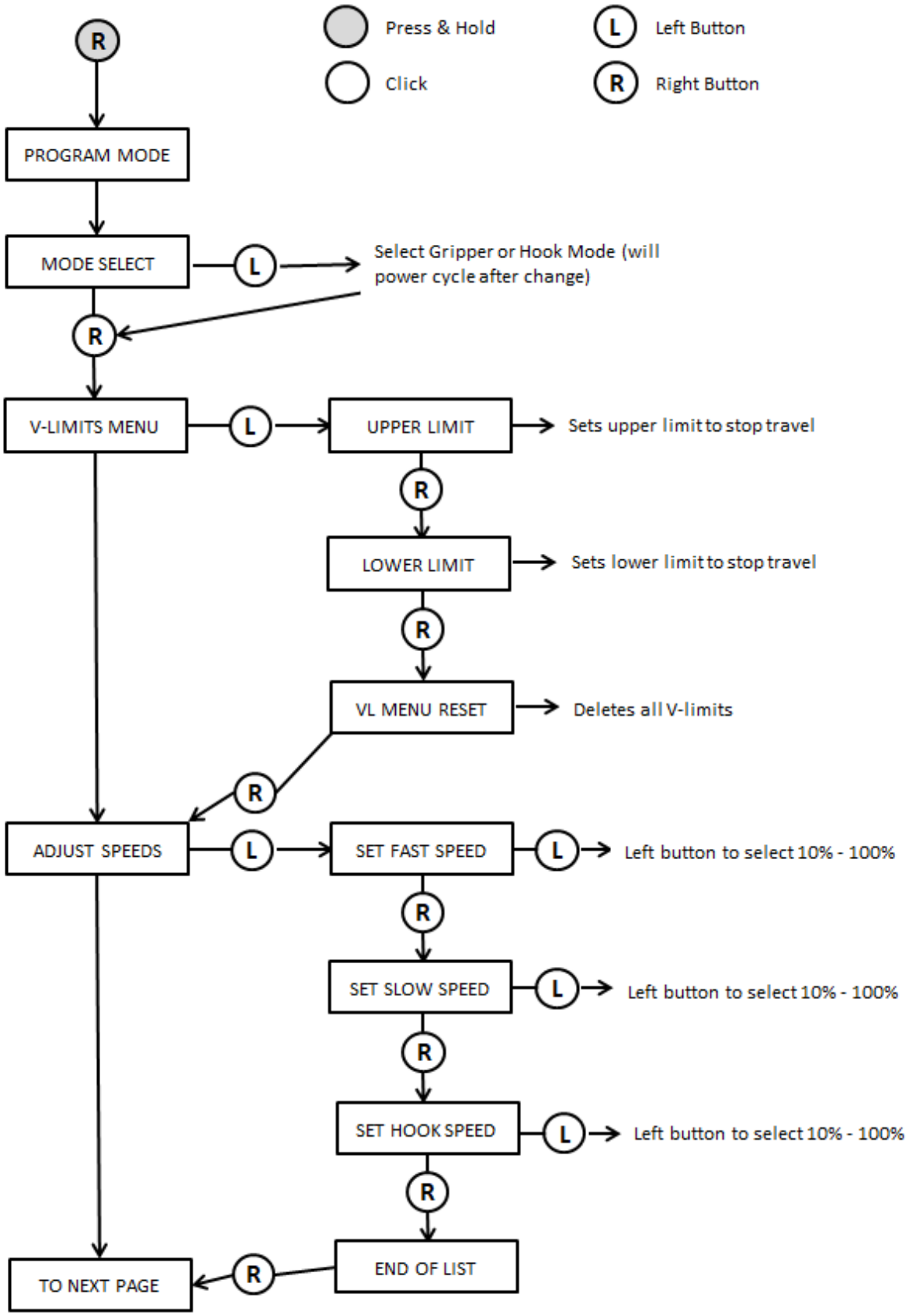
4.5 Diagnostics

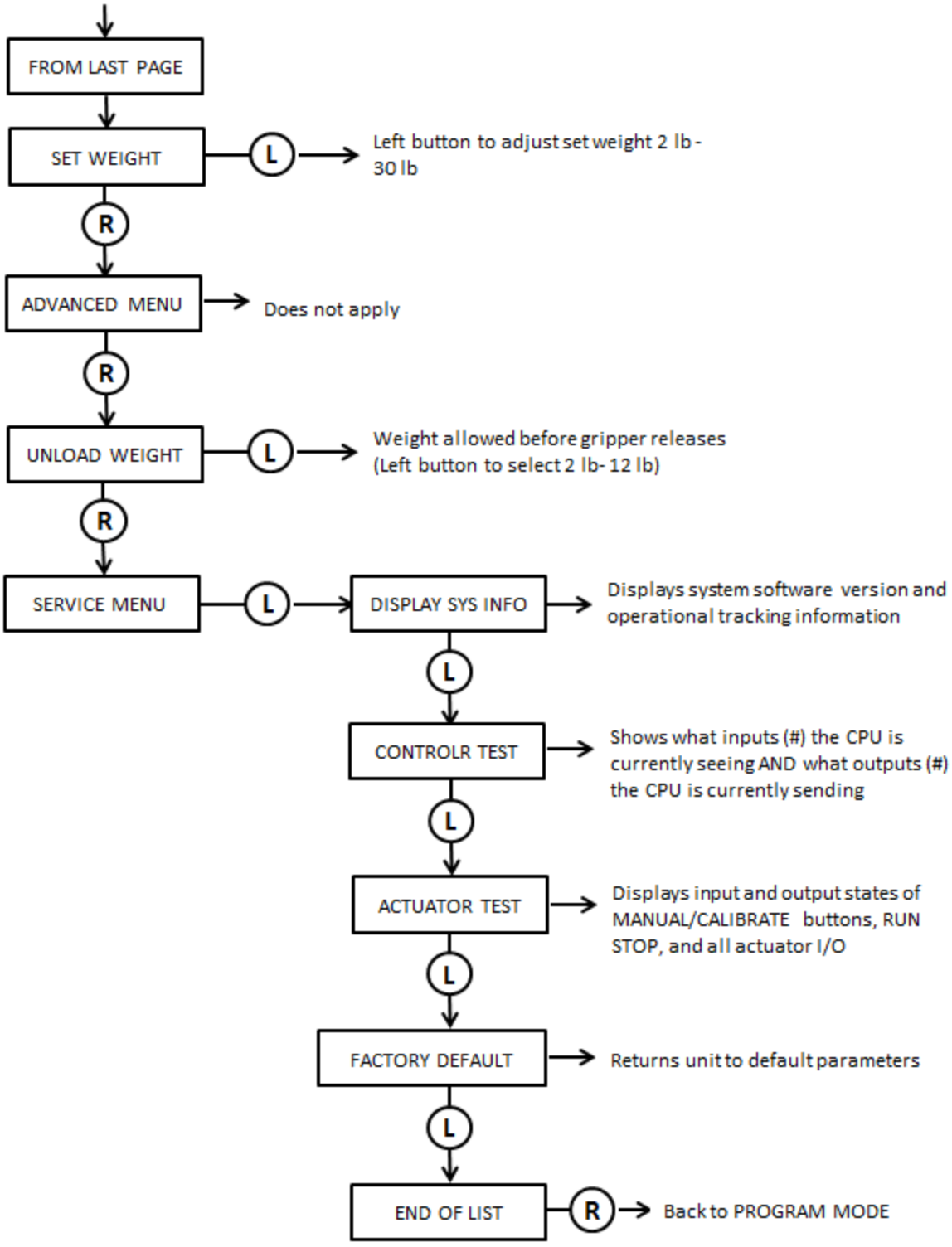
ACTUATOR TEST and CONTROLLER TEST within the SERVICE MENU allow for checking what signals MULE is receiving if there are issues.

ACTUATOR TEST shows the state of I/O inside the actuator and the *MANUAL CALIBRATE* buttons. If there are issues related to travel limits, slack or some Controller buttons, this is the best way to understand what is going on.

CONTROLLER TEST shows the state of the main Controller functions. This includes the 4 silver button on the front, 2 buttons on the handle and the grip/un-grip signal. The diagram in Section G6.2 shows which I/O point each function is.

4.6 Software Flowchart



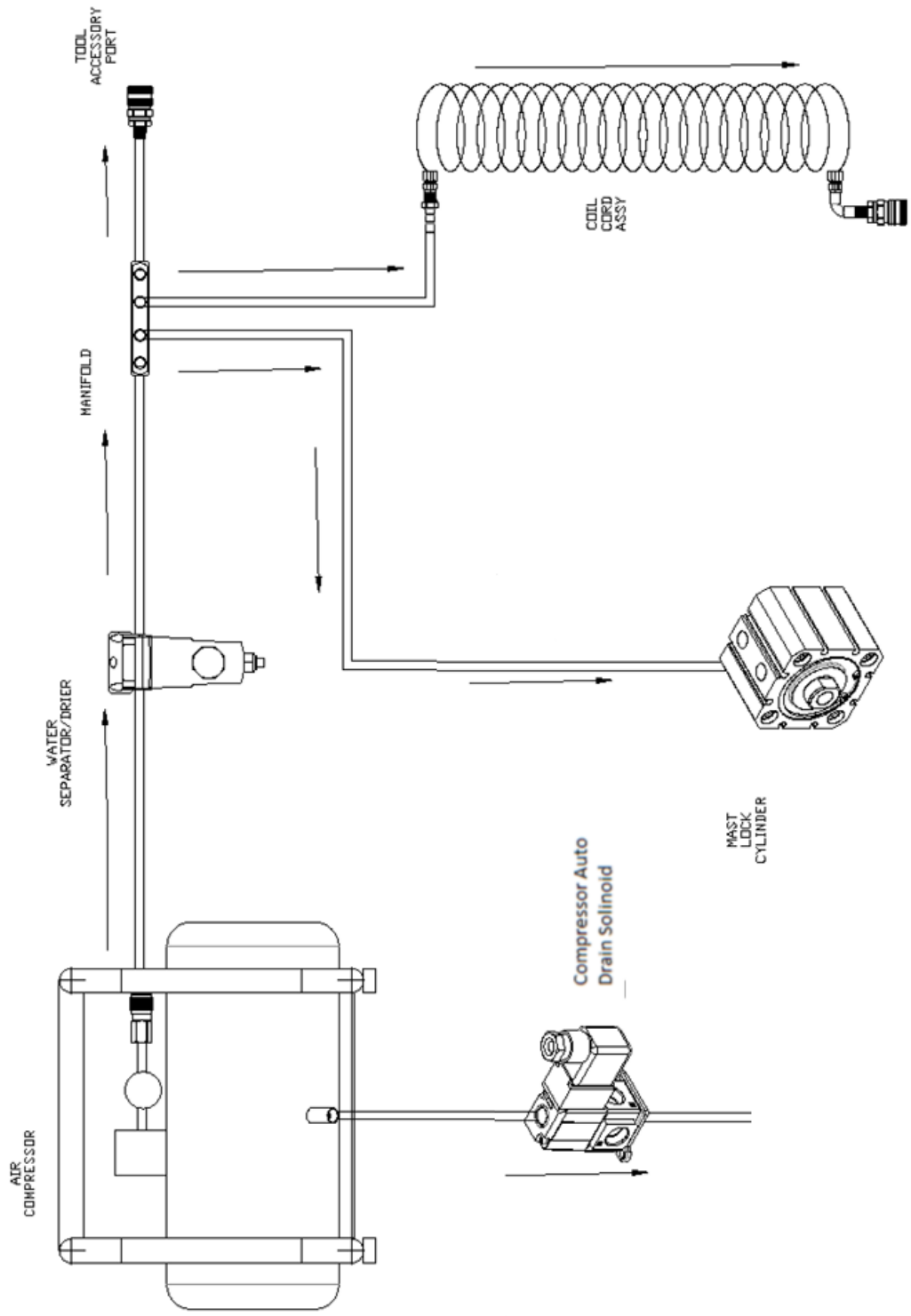

FROM LAST PAGE
SET WEIGHT
L
Left button to adjust set weight 2 lb - 30 lb
R
ADVANCED MENU
Does not apply
R
UNLOAD WEIGHT
L
Weight allowed before gripper releases (Left button to select 2 lb- 12 lb)
R
SERVICE MENU
L
DISPLAY SYS INFO
Displays system software version and operational tracking information
L
CONTROLR TEST
Shows what inputs (#) the CPU is currently seeing AND what outputs (#) the CPU is currently sending
L
ACTUATOR TEST
Displays input and output states of MANUAL/CALIBRATE buttons, RUN STOP, and all actuator I/O
L
FACTORY DEFAULT
Returns unit to default parameters
L
END OF LIST
R
Back to PROGRAM MODE

5 Pneumatic System

5.1 Air Compressor

MULE contains an integrated Air Compressor to power the gripper and rotation lock. This compressor's integrated regulator is set to 80 psi.

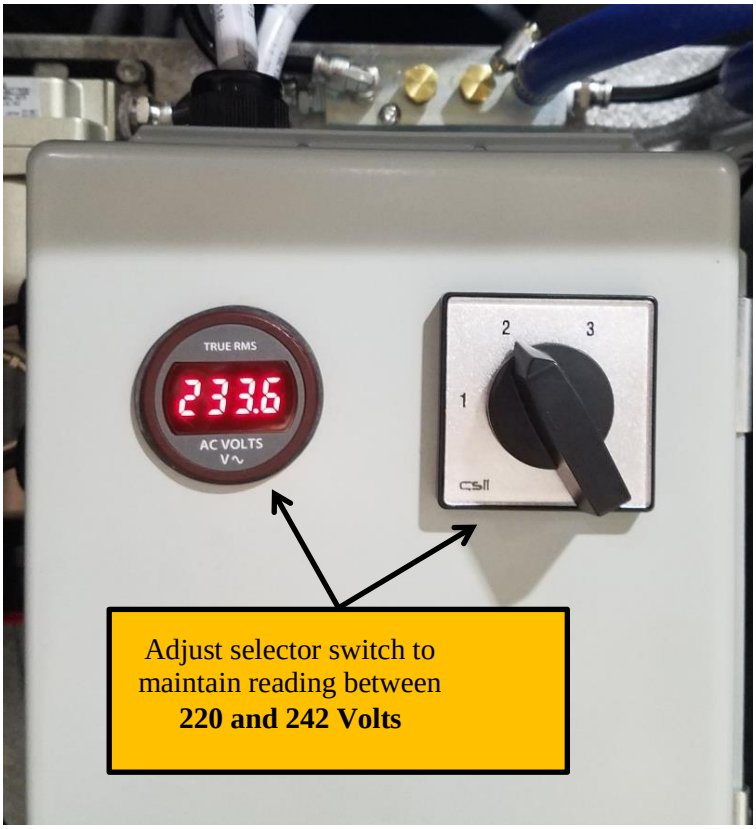
5.2 Pneumatic Connection Diagram



6 Electrical Information

6.1 Transformer Adjustments

MULE requires a specific voltage range in order to function. In the event that your voltage supply does not match the listed requirements, there is an adjustable transformer on board to compensate for this.



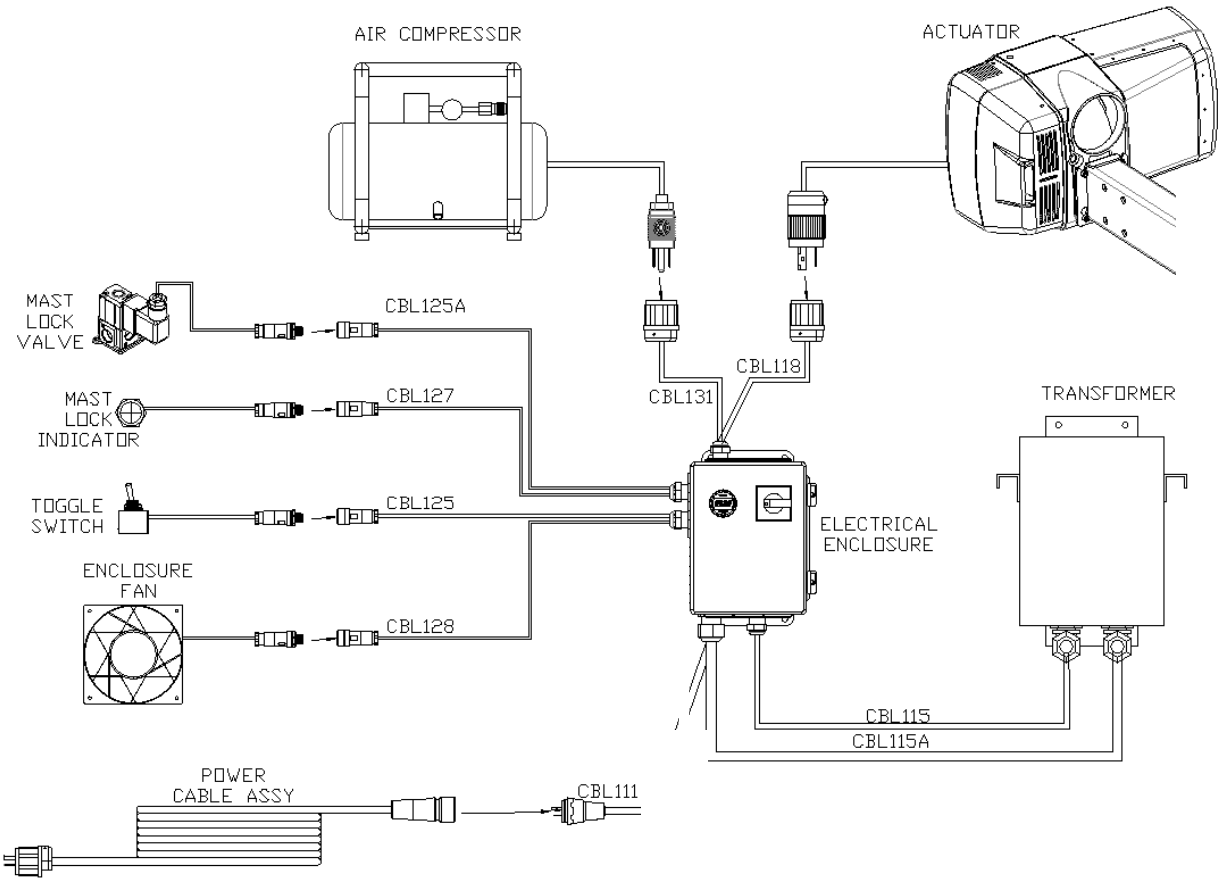
If the Powerpack Service Panel is removed, you will notice a digital readout on the electrical enclosure. For MULE to operate properly this number needs to read between 220 and 242 Volts at all times. Based on your specific power supply scenario the voltage may decrease when additional load is quickly added by MULE (such as when the Air Compressor starts) or external sources.

If voltage errors are being encountered (See Section G8.2), adjust the switch on the right of the display.

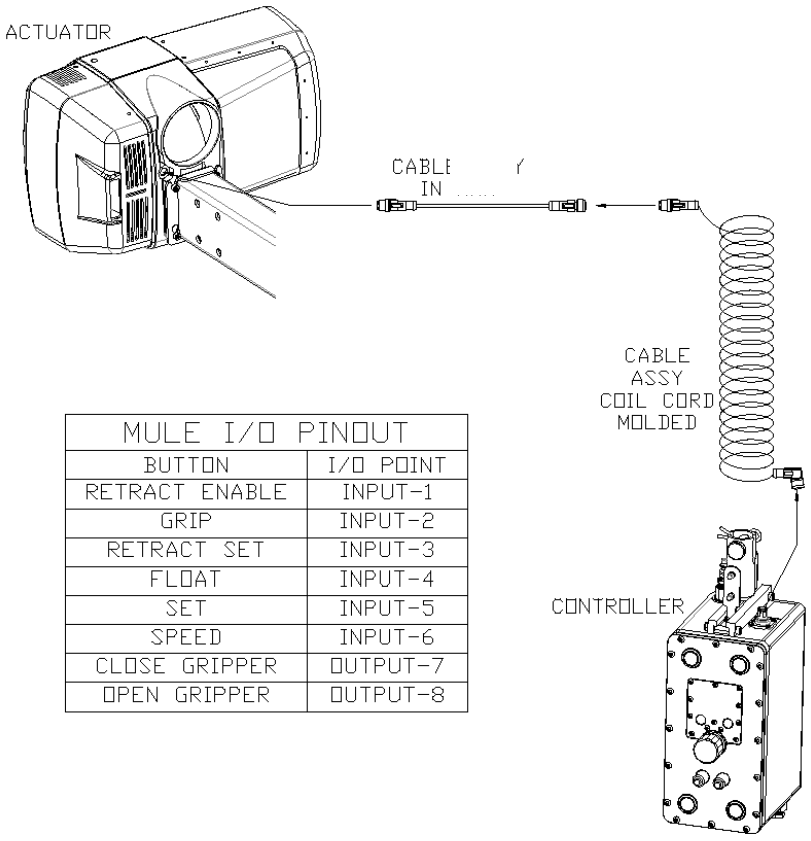
The switch is set at the factory to position 2. Turn the switch to position 1 to decrease voltage and position 3 to increase it. Each step of the switch will change the display up or down by approximately 12V. When adjusting the switch it is best to get the readout as close to 240V as possible, as this will provide the most constant power.

6.2 Electrical Connection Diagram

Power



Control

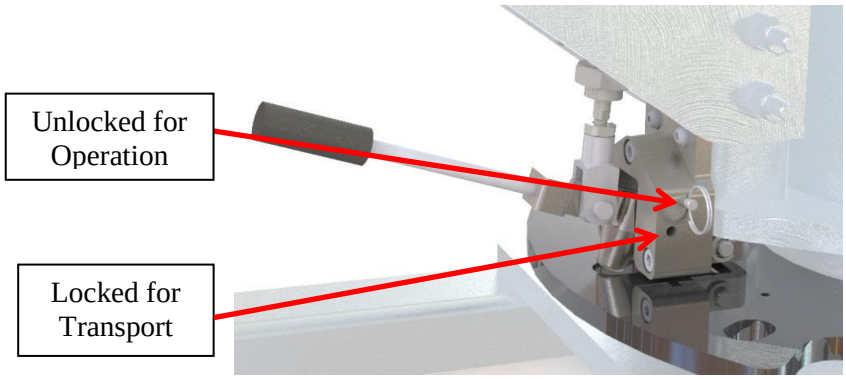


MULE I/O PINOUT	
BUTTON	I/O POINT
RETRACT ENABLE	INPUT-1
GRIP	INPUT-2
RETRACT SET	INPUT-3
FLOAT	INPUT-4
SET	INPUT-5
SPEED	INPUT-6
CLOSE GRIPPER	OUTPUT-7
OPEN GRIPPER	OUTPUT-8

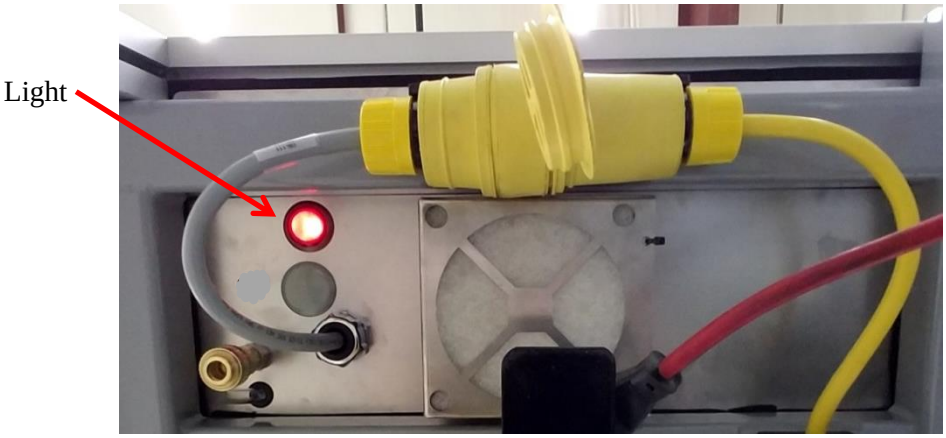
7 Primary Arm Rotation Lock

The Primary Arm Rotation Lock should be disengaged when MULE is powered on. If it fails to release, there are a couple of items to check.

Check that the lock can be manually raised. If it does not release, the lock pin is likely still engaged from transport.



On the bottom of the Powerpack near the fan, there is a Red light that is illuminated to verify that there is power going to the MULE.



8 Troubleshooting

8.1 Common Issues

Failure	Possible Solution
Controller screen shows "EXCESSIVE PAUSE"	• Briefly press one of the MANUAL CALIBRATE buttons until the Controller moves
Primary arm rotation lock will not disengage	• Ensure MULE is plugged in • Ensure the red light on the bottom of the Powerpack is lit • Verify lock pin is in correct position and operates manually (see Section G7) • Check for a major air leak • Contact Dealer
Controller Screen is Dark	• Ensure that MULE is plugged in and red light is on • Check that the black data cord is plugged into the top of the Controller • See if the Primary Arm rotation lock is disengaged • Check all data connectors in Powerpack and Arm (see Section G6.2)
Controller Screen shows ############	• Cycle power • Check that the black data connector is fully connected to the Controller • Check all data connectors in Powerpack and Arm (see Section G6.2 on page 47)
Controller/Gripper drifts up or down when loaded	• Briefly press one of the MANUAL CALIBRATE buttons until the Controller moves, wait until the Blue light below the screen returns to touch the Controller or Load
Controller/Gripper drifts up or down when unloaded	• Controller & Gripper weight in software does not match physical weight, Teach new Anti-Drop tool weight (Section G4.4 on page 41)
Controller not entering Float Mode	• Check that the FLOAT button is pressed in • Power Cycle MULE • Teach a new Anti-Drop Tool Weight (Section G4.4 on page 41) • Check the I/O block is seeing input (Section G4) • Contact Dealer
Controller doesn't retract after place	• Check that the AUTO-RETRACT button is pressed in • Teach a new Retract Height by pressing the RETRACT HEIGHT button at the desired height • Power Cycle MULE • Check the I/O block is seeing input (Section G4 on page 41) • Teach a new Anti-Drop Tool Weight (Section G4.4 on page 41) • Contact Dealer
Controller moves unusually fast/slow in manual mode	• Check if the SPEED button is pressed in (out is fast) • Adjust speeds in the Controller menu (Section G4.2 on page 41)
The *SPEED* button does not change anything	• Check that the software speeds are set to different values • Check the I/O block is seeing input (Section G4 on page 41)
Fuse repeatedly blows in Actuator	• Check all wiring for damage and tight connections • Contact Dealer
Grip button doesn't work	• Power Cycle MULE • Check that air is connected to the Controller • Check that the rotation lock is released • Make sure external buttons are plugged into the bottom of the Controller • Check the I/O block is seeing input (Section G4 on page 41) • Teach a new Anti-Drop Tool Weight (Section G4.4 on page 41) • Contact Dealer
Set button doesn't work	• Ensure the screen says "RUN MODE FLOAT" • Make sure external buttons are plugged into the bottom of the Controller • Check that "Negative Tare" value in menu is set high enough to be noticed

	• Check the I/O block is seeing input (Section G4 on page 41)
Only 1 cam moves	• Unplug air from Controller, check for mechanical binding • Listen for air leaks
Air is leaking from the Controller/the buttons are whistling	• Unplug air from Controller • Send Controller to CR for servicing
Error appears on screen	• See section G8.2 (Page 51)
Wire Rope continues to pay out after load has been placed	• Test slack detection system (Section H2.4 on page 54)

Wire Rope will not move down when gripper is unloaded without excessive force	• Test slack detection system (Section H2.4 on page 54)
Air compressor runs continually	• Ensure that tank drain is closed • Listen for where the leak is coming from and tighten loose connection • If air is leaking through the dryer drain line, tighten the fitting on the bottom of the dryer.
Primary Arm moves too slow/fast	• Adjust friction brake (Section G2.1 on page 39)
Secondary Arm moves too slow/fast	• Adjust friction brake (Section G2.2 on page 40)
Primary/Secondary Arms drift away	• Check that both inclinometers are within 1/2° of 0 • Tighten friction brakes (Section G2 on page 39)
Cams move unusually slow	• If it is below 40°outside cycle the Cams several times with the *FLOAT* button out. The cams will warm up and move much faster. • Check that there is sufficient air pressure • Check air hoses for kinks
Load places too hard in RUN MODE FLOAT	• Speed button • Adjust speeds in menu

8.2 Error Codes

In case of certain actuator and other electrical errors, a message will be displayed on the Controller Screen.

There are 3 different types of messages that will display based on the error; Drive Fault, Command Fault and Command Warning

Drive Fault: Faults detected in the motor controller that result in an Actuator Shutdown. The Controller Screen will display "DRIVE FAULT" with the appropriate error code.

Command Fault: Faults detected by the electronics while executing a command that results in a system shutdown. The Controller Screen will display "COMMAND FAULT" with the appropriate error code.

Command Warning: A condition sensed by the electronics that will allow the system to continue to operate. These warnings are cleared through the Controller Menu Structure. The Controller Screen will display "COMMAND WARNING" with the appropriate error code.

Common Error Codes

- Drive Fault
  - 4005 – Drive in Error State
    - Look to other messages for more information
  - 7211-7219 – Supply voltage not in range
    - Ensure that any extension cord used is within requirements (See Section C2.3 on Page 12)
    - Adjust Transformer Switch (See Section G6.1 on page 45)
- Command Fault
  - 501 – 2 travel or slack switches engaged during power-up
    - Check that there is tension on the Wire Rope, cycle power
  - 502 – Unexpected downward motion
  - 503 – Wire rope slack in Float Mode
  - 11000 – 2 travel or slack switches engaged after power-up
    - Check that there is tension on the Wire Rope, cycle *RUN STOP*
- Command Warning
  - 10500 – PLC Battery Error
    - The battery in the PLC needs to be replaced, contact your Dealer. If this warning is ignored for too long, MULE will lose all functionality

Contact your dealer for troubleshooting assistance or CR Customer Support at (844) 476-2684

9 Shut Down

To shut down MULE, no special procedure is required. Rotate the Primary Arm to the desired position and tie off the controller as desired. Unplug MULE.

If a generator is being used to power MULE, CR suggests that MULE be unplugged prior to turning off the generator to avoid potential issues.

H PREVENTATIVE MAINTENANCE AND BASIC SERVICE

1 Maintenance Summary

1.1 Daily

- Pre-shift inspection on Wire Rope
- Pre-shift inspection on MULE Power Cord
- Drain Air Compressor Tanks
- Inspect for structural damage and loose parts

1.2 Weekly

- Clean the fan filter on the bottom of the Powerpack, replace as needed
- Inspect Coil Cords for wear or damage
- Inspect MULE structure for damage

1.3 Monthly

- Documented Wire Rope inspection
- Documented Power Cord inspection
- Wire Rope lubrication
- Test Wire Rope slack detection system
- Inspect rollers on the base of the hoist arm and the joint between the Primary and Secondary Arms
- Check Inclinometer calibration
- Clean Air Compressor Air Filter

2 Wire Rope

2.1 Inspection

OSHA requires that machines using Wire Rope must be frequently inspected.

2.1(a) *Each Shift*

At the beginning of each shift, a trained employee must visually inspect the Wire Rope prior to the machine being used. This visual inspection is designed to identify gross damage such as:

- Kinking
- Crushing
- Unstranding
- Birdcaging
- Large contaminates or broken wires
- Significant Corrosion
- Electrical Arc Damage
- Heat Damage

2.1(b) *Monthly*

Each month a documented inspection must be performed that covers the same items as the Pre-Shift inspection but is more thorough. The conclusion of this inspection is an ideal time to re-lubricate the Wire Rope as explained in Section H2.2.

This inspection should cover the entire length of the Wire Rope which will require the Arm Access Panel to be removed and MULE to be located such that the Wire Rope can travel the full 11'.

If any broken wires in the Wire Rope are found during the inspection, CR suggests that the MULE should be scheduled for Wire Rope replacement.

2.2 Lubrication

MULE's Wire Rope comes pre-lubricated from the Factory. As MULE is used and the Wire Rope flexes the lubricant will need to be replenished.

CR recommends that the Wire Rope is lubricated with Prelube 6 which is available through CR. OSHA prohibits the use of any Wire Rope lubricants that hinder inspection.

To lubricate the Wire Rope, the following items are needed:

- 2 people
- 1 can of Prelube 6
- A clean rag
- 4mm Allen key
- MULE positioned so that the Wire Rope can travel the full 11' feet
- Personnel access to the top of the mast and the ability to reach the controller along the full 11' of range

Clear any Virtual Limits that have been set (see Section G3)

Remove the Arm Access Panel

Move the controller up until it stops on its own

While moving the controller down at a smooth and steady speed, spray the Wire Rope with Prelube 6 as it travels through the Arm Access Panel opening. Use a rag to catch any overspray.

Once the controller is all the way down, move to the end of Secondary Arm where the Wire Rope turns down to the Controller. Repeat the lubrication as the Controller travels up.

2.3 Required Replacement Criteria

CR recommends that Wire Ropes be scheduled for replacement as soon as any broken strands are found.

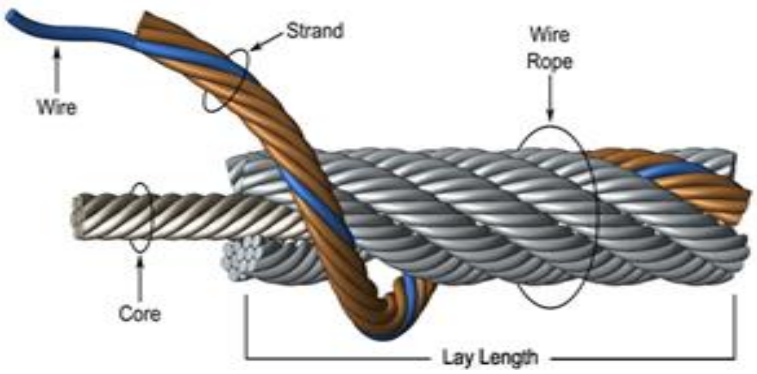


Figure H-1 - Wire Rope Terminology

Removal criteria for the rope replacement shall be as follows, see Figure H-1 for Wire Rope terminology:

- 6 randomly distributed broken wires in one lay or 3 broken wires in one strand in one lay (1-3/4" of Wire Rope), (OSHA 1926.1413)
- one outer wire broken at the contact point with the core of the rope, which has worked its way out of the rope structure and protrudes or loops out from the rope structure
- wear of one-third the original diameter of outside individual wires
- kinking, crushing, birdcaging, or any other damage resulting in distortion of the rope structure
- evidence of heat damage from any cause
- reductions from nominal diameter greater than 1/64" (.4 mm) for 3/16" (4.76 mm) diameter rope.

2.4 Slack Detection

The slack detection system prevents damage to the Wire Rope and actuator when the load is placed.

2.4(a) *Quick Check*

A quick test suitable for monthly preventative maintenance is accomplished by taking the empty controller out of float mode (release the *FLOAT* button), and then manually running it onto the ground using the *MANUAL/CALIBRATE DN* button. The gripper should stop without generating significant slack in the wire rope. If this is not the case, conduct the formal testing described below in order to make the required adjustments.

2.4(b) *Formal Testing*

Ensure MULE is powered on

Ensure MULE is not in *FLOAT Mode* (button on the Controller is released and the screen shows “Gripper Ready” or “Hook Ready")

Depress the *MANUAL/CALIBRATE DN* button on the Controller to lower it onto a table so that it is fully supported. Detach the Wire Rope and feed it through the coils so that it has a direct path toward the ground. Attach a 10 lb load and attempt to lower it using the *MANUAL/CALIBRATE DN* button. If the load **does not** move, the slack spring is too tight and must be adjusted. Refer to Figure H-4 and Figure H-3.

Switch to a 5 lb load and attempt to lower it using the *MANUAL/CALIBRATE DN* button. If this load **does** move, the slack spring is too loose and must be adjusted (more common situation). Refer to Figure H-4.

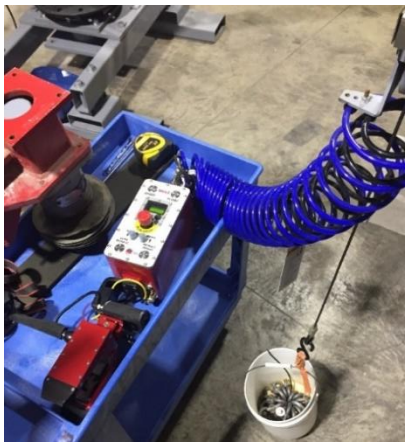


Figure H-4

Place Controller on a table keeping electrical and air connected. Attach weight directly to wire rope

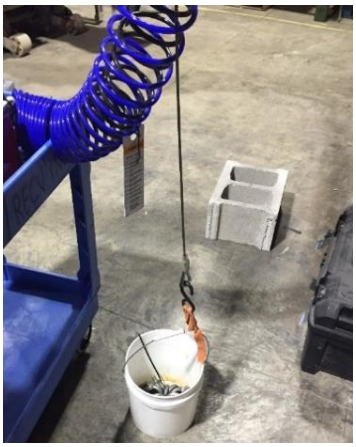


Figure H-3

10 pounds should be able to lower using manual button

Figure H-2

5 pounds should not be able to lower using manual button

2.4(c) *Adjustment*

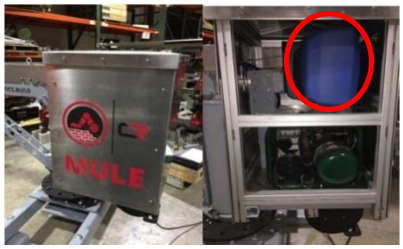


Figure H-5

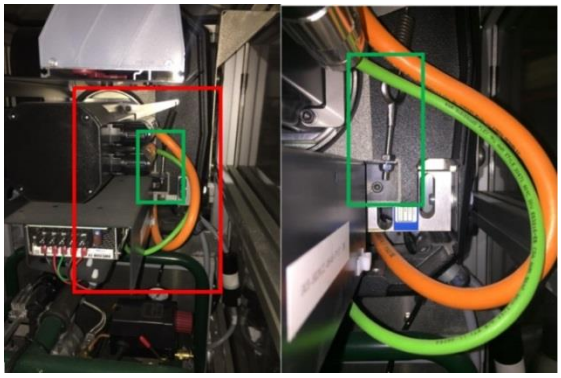
Unplug MULE

Remove the air compressor side panel

Remove the actuator cover above the air compressor Figure H-5

If 5 pound weight was able to drive down (most common)

Loosen the eye bolt nut on the top side of the bracket. Holding the eye bolt from turning, tighten the nut on the bottom of the bracket ½ turn.



Power MULE on and redo the slack test

Repeat tightening until the slack test is performed and the 5 pound weight cannot be driven down. When complete, tighten the top eye bolt nut down onto the bracket and reassemble

If 10 pound weight was unable to drive down

Loosen the eye bolt nut on the bottom side of the bracket. Holding the eye bolt from turning, tighten the nut on the top of the bracket ½ turn.

Power MULE on and redo the slack test

Repeat loosening until the 10 pound weight is able to be driven down

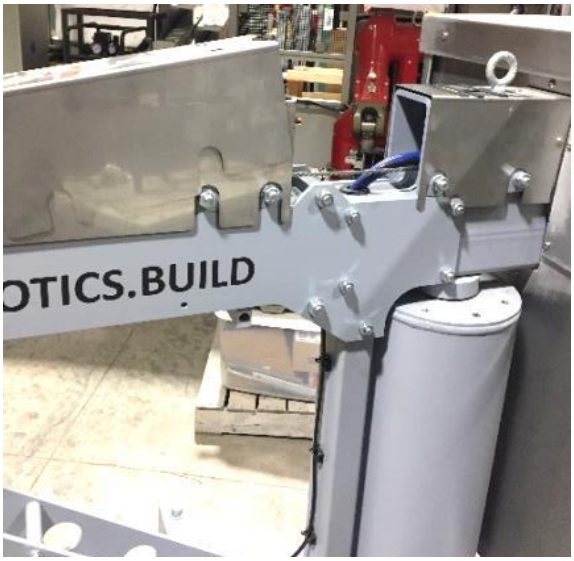
When complete, tighten the bottom eye bolt nut down onto the bracket and reassemble

2.5 Replacement

Warning: Wire Rope replacement is to be performed by qualified maintenance personnel only.

Tools:

- Table or similar flat surface
- 3mm Allen key
- 4mm Allen key
- 5mm Allen key
- 6mm Allen key
- 7mm wrench
- 8mm wrench
- 17mm wrench
- Long screwdriver or Allen key



Removing Existing Wire Rope

Ensure MULE is powered on

Ensure the *FLOAT* button on the Controller is released and the screen shows "LIFT READY"

Using the manual buttons on the Controller, lower the Controller on to the table so that it is fully supported

Reset any virtual limits; see section G4

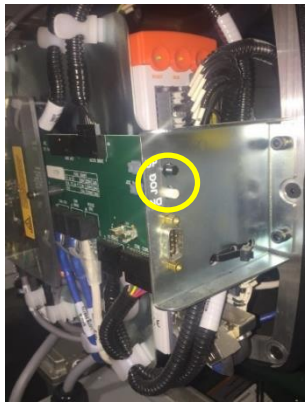
Disconnect the Wire Rope from the Controller (Leave the air and data coil cords attached)

Remove the Arm Access Panel

Remove the Powerpack Service Panel (has latches not screws)

Remove the blue cover from the Actuator; there are 4 bolts, 2 on top and 2 on bottom. **Take extreme care to avoid the circuit board during the remainder of the replacement process.**

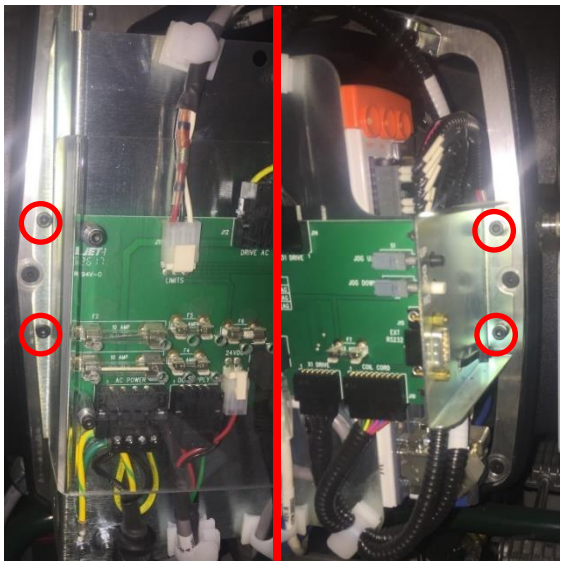
With your right hand keep tension on the Wire Rope through the Arm Access Panel (use a rag to avoid injuring your hand) while pressing the down jog button (beside programing port) with your left hand. Continue until Wire Rope will not go down any more.



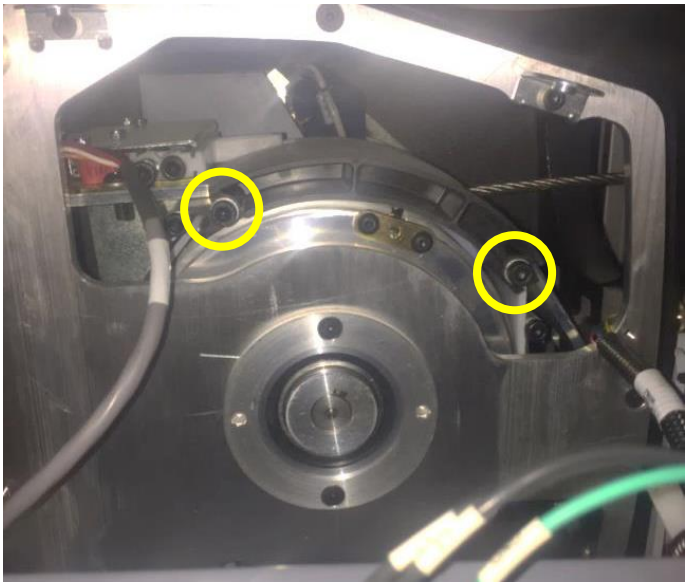
Fully press in the spring loaded screw, hold in position. Apply tension to the Wire Rope with your right hand and jog down until rotation stops.

Unplug the limit switch assembly from the circuit board

Using the 4mm Allen key, remove the 4 bolts fastening the circuit board bracket to the actuator, carefully tilt the bracket down once loose.



Using the 5mm Allen key, remove 2 bolts from plastic drum cover, slide cover out.



Using the 3mm Allen key, remove 2 bolts from the rope retainer. Slide retainer off the Wire Rope.

Push rope with Right Hand into the drum to unseat the stop sleeve. The rope should now be free of the actuator.

Remove the Secondary Arm cover (including attached joint cover), removing the 2-19mm bolts will allow this assembly to slide out.

Using the 6mm Allen key, remove the bolts holding the pulleys at the arm joint, these bolts need to be removed evenly. Slide the one of the pulleys over so that the stop sleeve of the Wire Rope will pass through the gap.

Using the 3mm Allen key, 6mm Allen key, 8mm wrench and 17mm wrench remove the 2 bolts holding the pulley block at the end of the arm.

Using the 3mm Allen key and 7mm wrench, remove the 3 bolts holding the plastic pulley block together. The Wire Rope should now be completely free.

Installing New Wire Rope

Take care to keep new rope clean and orderly during installation. Avoid twisting or kinking Wire Rope.

Slide the stop sleeve end of the Wire Rope through the arm to the actuator.

Bend the Wire Rope approximately 3" from the stop sleeve end; try to kink rope to make a bend radius.

Insert the stop sleeve into the slot in the drum; pull on the rope to seat fully.

Using the 3mm Allen key, reinstall the rope retainer, tightening until the lock washers are fully compressed.

Ensure that the rope is seated in the drum slot and bolt the plastic retainer back in place, tightening until the lock washers are fully compressed.

Reattach the circuit board bracket, tightening the bolts until the lock washers are fully compressed.

Reattach the limit switch connector.

Reassemble both pulleys and make sure Wire Rope is going through the center of the coil cords; the Wire Rope should be fully routed at this point.

Using a clean rag, pull on the Wire Rope through the Arm Access Panel and use the jog buttons to move up.

Reattach the controller and check that it moves as expected to upper limit.

Reinstall the actuator cover, Arm Access Panel and Powerpack Service Panel.

3 Pneumatic System

Any service to the air system should be performed with the compressor drained and the valve locked in the open position to prevent accidental pressurization.

3.1 Air Compressor

To drain the air compressor, unplug MULE and open the ball valve at the bottom of the Powerpack.

3.1(a) *Filter*

The compress filter should be cleaned monthly to increase longevity and performance.

To access the filter, remove the Air Compressor side panel (same access area as slack spring adjustment).

At the top left of the air compressor there is a black canister that houses the filter, rotate counter-clockwise to open.

The filter should be shaken out and blown out with compressed air from the air compressor side. If any holes are found the filter should be replaced.

3.2 Water Separator

The water separator installed within the Powerpack automatically drains. If the drain needs to be manually activated for any reason fully open the fitting at the bottom of the unit. When draining is complete, tighten the fitting fully and loosen 1 full turn. If the drain is left open air will continually bleed from the water separator.

Every 2 years the separator element should be replaced.

4 Structural Inspection

As part of each weekly inspection, the entire structure must be inspected for damage. If any damage is found, the damaged piece must be removed from operation immediately.

Consult with CR Engineering on all damaged components and repairs prior to returning the component to operation.

5 Power Cord

5.1 Daily Inspection

During the daily inspection the power cord must be check for the following issues (OSHA 1926.404):

- Deformed or missing pins on plug.
- Insulation Damage.

- Indications of possible internal damage.

5.2 Monthly Inspection

During the monthly inspection the power cord must be check for the following issues (OSHA 1926.404):

- Deformed or missing pins on plug.
- Insulation Damage.
- Indications of possible internal damage.
- Ground conductor is tested for continuity between both ends.

This inspection must be documented.

6 Rollers on Arm

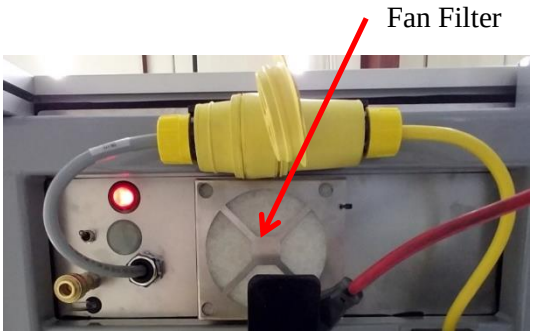
2 sets of rollers should be inspected to ensure that they are still functional. If any structural damage or flat spotting is observed the rollers should be replaced.

6.1 Primary Arm Rollers

The primary arm has 2 rollers near the rotation lock. Ensure that these rollers are both present and not flat. Also ensure that the spring loaded band connecting the 2 rollers on the back side of the rotation mast is intact.

6.2 Secondary Arm Roller

The Secondary Arm has 1 roller (also used as the Friction Brake) at the joint with the Primary Arm. Ensure that this roller is present and not flat.



7 Fan Filter

To access the fan filter, unplug MULE and slide the filter out of the housing (towards the arrow). Keep track of which side of the filter is facing the fan.

Once the filter is free use compressed air (from the fan side of the filter) to blow the contaminates out.

If the filter has become plugged with contaminates or physically damaged the filter should be replaced.

Reinstall the filter in the same orientation as it was removed.

8 Inclinometers

Inclinometers have been installed to provide a visual indicator of how plumb MULE is. Calibration should be checked as part of the monthly inspection.

To check calibration, plumb the rotation mast in both directions using a 2' level (it is important not to do this on the mast stack itself)

When the rotation mast is plumb, check each inclinometer for accuracy. CR does not suggest making an adjustment unless the measurement is more than ½° off of 0.

To adjust loosen both mounting bolts slightly and slide into position. Once in position tighten both mounting bolts

1. Gripper
2. Handle
3. Controller
4. Wire Rope (Cable), Data and Air Cords
5. Secondary Arm
6. Primary Arm
7. Power Pack
8. Fork Base
9. Mast
10. Outrigger
11. Ground Base

Technical Specs	ML150
Arm Weight	870 lbs
Fork Pockets Weight	290 lbs
Core Weight (Arm + Forks)	1,160 lbs
5' Mast Weight	200 lbs
2.5' Mast Weight	145 lbs
Ground Base Weight	950 lbs
Max Lifting Capacity	150 lbs
Power	20A @ 120V AC, 60HZ
Max Free Standing	20'
Reach Radius	12'
Head Height Clearance	4'-4"
Width	2'-8"
Height	4'-2"
Length	14'-7"
Stowed Width	3'-1"
Stowed Length	8'-10"
Cable Reach (with out extension)	11'

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