STAGEHAND PRO 3

REFERENCE MANUAL 1.1

GETTING STARTED

The Stagehand Pro 3 is the next-generation, high-performance motor controller from Creative Conners. We designed the Stagehand Pro 3 to make scenic automation safe and easy. It combines sophisticated control with a high-power Variable Frequency Drive (VFD) and redundant safety circuitry in a single, simple device. This combination of features results in an elegant solution that is particularly well-suited to safely hoist or lift scenery on stage with machinery powered by an AC induction motor and equipped with dual failsafe brakes.

This manual will guide you through:

- Unpacking
- Installation
- Powering up
- Operation
- Troubleshooting

If you need help along the way contact us on our website (creativeconners.com), via email (support@creativeconners.com), or by phone (401-289-2942 x2). We want your automation to succeed and we are eager to help you through any head-scratching issues.

What's in the box

Inside the box you should find:

- A welcome card with a quick link to this manual (cci.fyi/pro3)
- Stagehand Pro 3 motion controller
- 10ft power cord
- #10-32 rackmount screws with nylon washers (x8)
- Mitsubishi A800 instructions on CD

If any of these items are missing, please contact us for a replacement. While you're at it, give us a little sass for forgetting to put something in the box. We enjoy an appropriate amount of sass.

If you purchased any power cables, encoders, limits switches, machines, or other accessories, those items are packaged separately. If you didn't purchase any additional items, please visit our online store and order oodles of stuff. It's all pretty neat. http://store.creativeconners.com

Stagehand Pro 3 Features

The Stagehand Pro 3 is an evolution of our Stagehand Pro controller. It shares many of the functional traits with its predecessor while offering a few key improvements. Let's take a look:
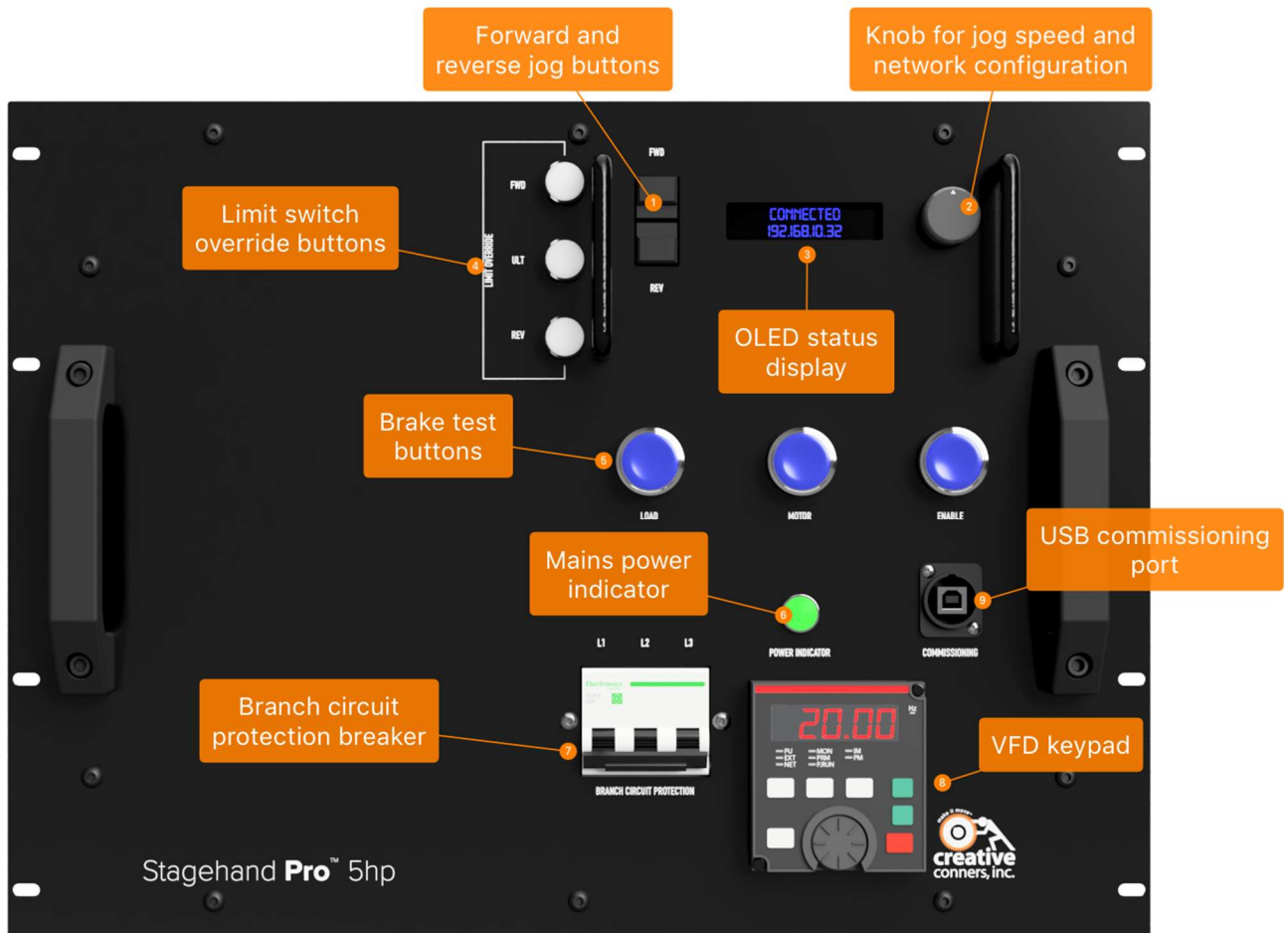
Forward and reverse jog buttons

Press and hold, then turn the speed knob, to manually move the motor

Knob

When used with the jog buttons, the knob will adjust speed from 0%-100%. It doesn't like to be spun super-fast, slow and steady is the best method. The knob is also a button that can be used for network configuration.

OLED status display

A two-line display shows handy, at-a-glance info. It's OLED which makes it easy to see backstage in the dark.

Limit switch override buttons - *New!*

Ever hit a limit switch and grumbled about having to bust out a screwdriver to adjust the switch during initial installation? Grumble no more, you can press the corresponding override button to temporarily disable the limit signal.

Brake test buttons

The Pro 3 has a dedicated logic controller to manage two brakes. The controller uses separate logic conditions and timing for redundancy. The test buttons can be used to verify the brakes are behaving as expected during periodic inspection.

Mains power indicator

The power indicator glows when the circuit feeding the Stagehand Pro 3 is energized.

Pro Tip: this indicator is connected to input phases X & Y only. It's possible that you could be missing the Z input phase. Everything works with only the X & Y input phases, but the horsepower rating is reduced by 50%.

Branch circuit protection breaker - *New!*

A circuit breaker mounted on the front of the controller alleviates worries of a dangerous circuit overload. The breaker also makes it easy to power down the controller without unplugging it from the power distro. (Note: the rendering shows the controller all lit up, but the breaker off. That wouldn't really happen in real life, but it's just computer rendering with some artistic license taken).

VFD Keypad

The keypad has some great display information like output speed, current, and voltage. It also shows an error code when the drive stops with a fault. And, if that wasn't enough, the keypad can be used to adjust one of the nearly thousand parameters in the drive. Don't adjust parameters willy-nilly though, changing a parameter improperly can make the Stagehand stop working completely or worse, work weirdly.

USB commissioning port - *New!*

The USB port on the front can be used to configure the drive with Mitsubishi's FR Configurator software. We don't really recommend that you do this unless you are a VFD maven, but we take advantage of the port for troubleshooting and initial commissioning.

Rack mounting - *New!*

The Stagehand Pro 3 case is now made exclusively for rack mounting. Since 2013, when the Stagehand Pro was introduced, we heard from many customers that wanted an easier rack-mounting solution than was possible with our original case design. The new case is awkwardly large at 8U (we know, we know) but it is much simpler to mount now that it conforms to a typical vertical rack. Before you send the email that you composed asking "why does this thing have to be so tall?!?", let me explain. The reason for the extreme height is that the VFD needs to be mounted vertically for proper ventilation. To adhere to the manufacturer's mounting recommendations, we had to make the case 8U tall. As soon as we figure something better out, we'll do it. I swear.
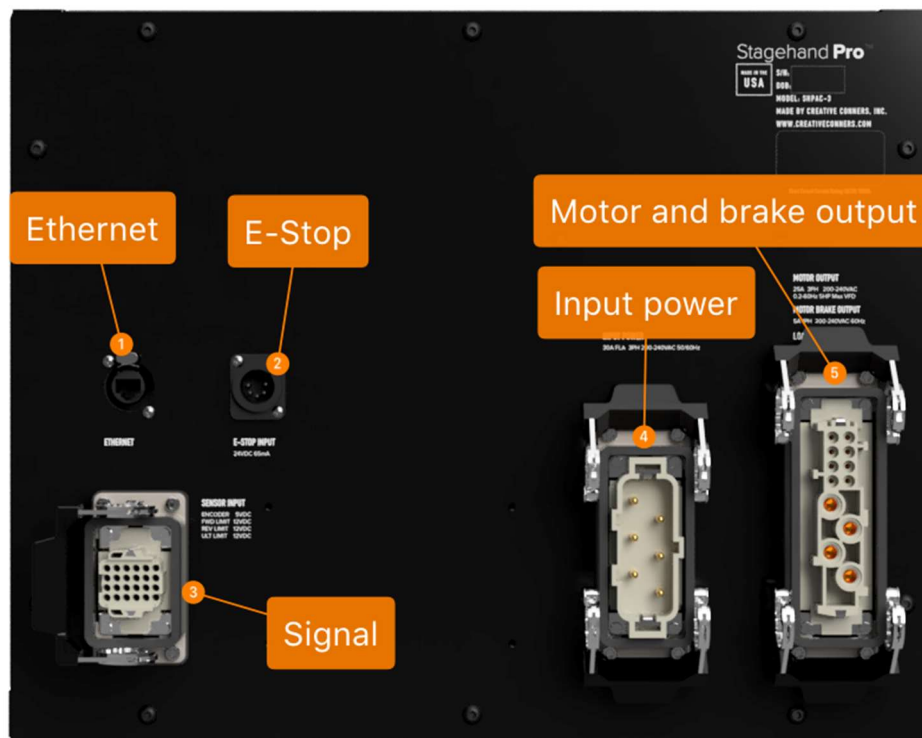
Moving to the back of the Stagehand Pro 3, we find all the cable connections.

Ethernet

All Stagehand motor controllers communicate with our Spikemark software over Ethernet with a standard RJ45 CAT5 cable. The connection can be fortified with a Neutrik EtherCon shell for improved mechanical latching.

E-Stop

The Emergency Stop signal from a Showstopper 3 Base or Hub is sent over a 5-pin XLR connector. Inside, the Stagehand Pro uses a SIL3 safety relay and redundant force-guided contactors to remove power from the motor when the Emergency Stop is activated.

Pro Tip - In the Stagehand Pro 3, the safety relay is powered by the incoming 24VDC e-stop signal but the large power contactors draw their current from the internal power supply. This greatly reduces the electrical load on the Showstopper 3 Base or Hub.

Signal

The 24-pin rectangular signal connector carries limit switch and encoder signals from the machine into the Stagehand Pro 3.

Input Power

All Stagehand Pro's require three-phase input power. Depending on the model, this power is either 200-240VAC (typical) or 380-480VAC (custom).

Motor and brake output

Power for a motor and two brakes is transmitted through a 12-pin rectangular connector.

There are a couple of new features that aren't visible from outside.

Persistent Position - *New!*

The previous Stagehand Pro initially required a battery backup to maintain encoder position data through a power loss. However, we never loved this solution. Wouldn't it be better if the Stagehand could remember the machine's position without a battery? Yes, we thought so too. We developed a nifty feature in the Stagehand firmware that will record the encoder position to flash memory and then read that position if it loses power. This bit of engineering obviated the need for a battery backup, which has been removed from the Stagehand Pro 3.

Pro Tip: Persistent Position writes the encoder position to flash memory after the motor has stopped moving for 30 seconds, or when the e-stop is activated. This prevents spurious, frequent flash writes which can wear the memory prematurely. However, that also means that if you lose power mid-move, or before 30 seconds has elapsed at the end of a move, the recorded position will be wrong and you need to manually reset position within Spikemark.

Pro Tip: All Stagehand controllers can take advantage of Persistent Position. If you have older Stagehands, update their firmware to the latest version to take advantage of this great feature.

USB parameter storage - *New!*

Inside the cavernous case of the Stagehand Pro 3, we've stuck a USB storage device into the Mitsubishi A800 VFD. The VFD has a ton of parameters. There are different sets of parameters required for our different machines. To make it easy to switch parameters, or restore our default parameter sets, we have placed a few parameter sets on that USB key. This should make it easier to

get back and running in a hurry if you suspect that some parameter has gone wonky and you need to wipe the drive's memory to start fresh. More details follow later in this manual to explain the process.

INSTALLATION

The Stagehand Pro 3 is designed to mount in a standard 19" vertical equipment rack. Use the included rackmount screws (qty 8) to fasten the controller into an equipment rack.

POWERING UP

After the Stagehand is installed, it is time to power it up and get your machine spinning. The Stagehand Pro 3 requires a 30-amp, 200VAC-240VAC, 3-phase, 4-wire circuit (3 hot legs and a ground). The Stagehand Pro 3 is equipped with a circuit breaker on the front panel. Flip the breaker **OFF** before applying power.

Input Power

The power inlet on the Stagehand is a 6-pin rectangular plug (*IRC-77mm X 27mm (16B) 6P 35A 400V Male*). There are many manufacturers of these connectors, our favorite is by ILME: CPM-06. No matter the manufacturer, the pin-out is shown below:

200VAC-240VAC 50/60Hz
3-phase input
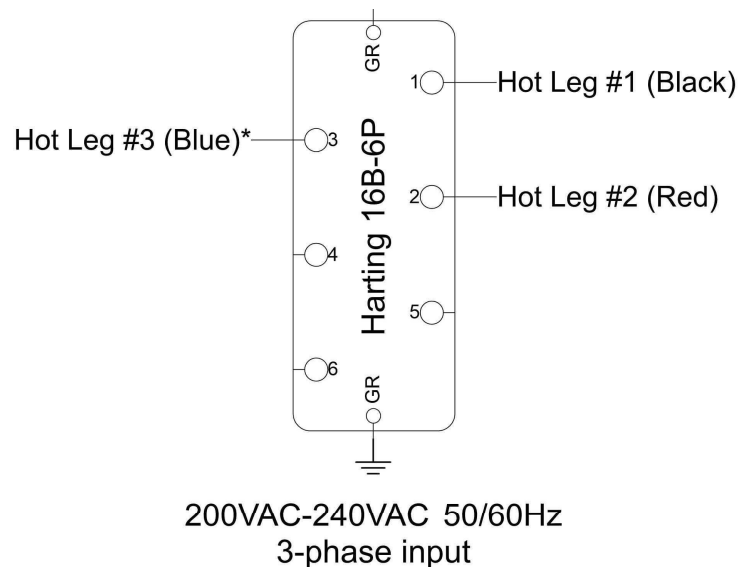
* If wiring for single phase output, do not connect this leg. The Stagehand can operate on single-phase at 50% capacity.

Figure 12

Included with your Stagehand is a 10' power cord that has a rectangular power connector on one end and a more common NEMA L15-30 twist-lock plug on the other end. This adapter cable can make it easier to power the Stagehand from distros or wall receptacles. The pin-out for the NEMA L15-30 twist-lock plug is shown below:

HOT LEG #2 (RED)

HOT LEG #3 (BLUE)

HOT LEG #1 (BLACK)

Y

Z

X

G

GROUND (GREEN)
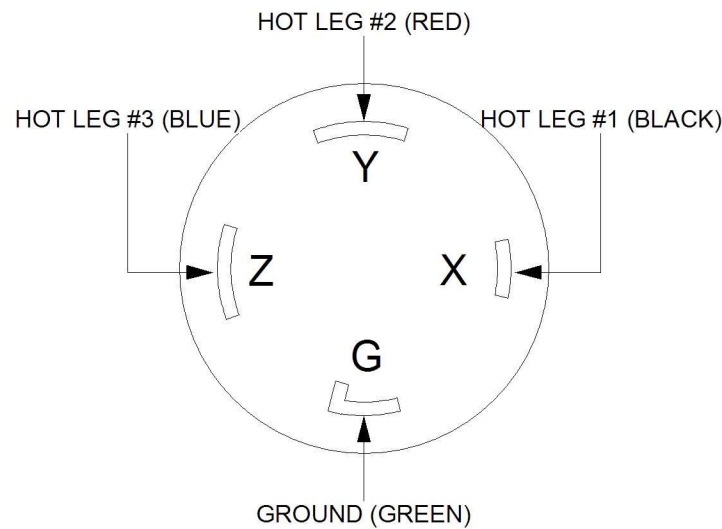
After you plug in the power cord, flip the front-panel circuit breaker **ON**. The green Mains Indicator should glow and the OLED status display will turn on. If that doesn't happen, grab a meter and figure out what's wrong with the power source.

Motor and Brake

Power output connections for a motor and two brakes have been combined into a single, 12-pin rectangular connector (ILME CXF-4/8 or compatible). Before we dive into the details of the pin-out, we should clarify what these three power sources are and why they exist. Below is a picture of Creative Conners' Spotline Hoist which serves as a nice example of a typical machine that needs all three power sources.

Motor Brake

Motor

Load Brake
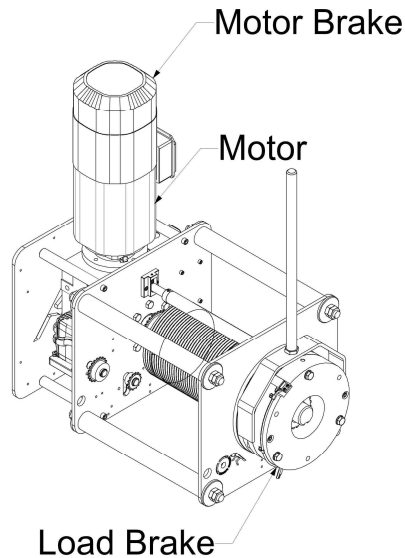
Motor

The motor power source is 230VAC 3P with a variable frequency from 0.5Hz – 60Hz. AC motors vary speed in response to a changing frequency. Every machine will require a motor power connection.

Motor Brake

The motor brake power source is 208/230VAC 1P with a fixed frequency that matches the input power source (typically 60Hz in the United States and 50Hz abroad). The motor brake is a small, fast-acting brake that holds the motor shaft in place when the machine is stopped. The motor brake uses the mechanical advantage of the speed reducer (aka gearbox) to increase its holding ability. The Stagehand Pro 3 expects that the motor brake will be fully released within 60ms of receiving power.

Under normal operation, the motor brake is only engaged once the motor has come to a controlled, complete stop. The motor brake needs power to release. If power is removed, the motor brake will engage by spring force. This is a "fail-safe" brake, it fails to a safe condition by engaging when power is lost. Not all machines explicitly require a motor brake, but we recommend using motor brakes in all applications. All of Creative Conners' machines are built with a motor brake.

Load Brake

The load brake power source is 208/230VAC 1P with a fixed frequency that matches the input power source (typically 60Hz in the United States and 50Hz abroad).   In lifting applications, a second brake is required to provide redundant protection in case of equipment failure. Often, this second brake is placed directly on the output side of the speed reducer. If either the speed reducer or the motor

brake fails, a brake on the load side of the machine will be able to stop a falling load. The Stagehand Pro 3 expects that the load brake will be fully released within 500ms of receiving power.

If a brake is used on the output side (aka load side) of a speed reducer, then it must be much larger than the motor side brake since it isn't able to use the mechanical advantage of the speed reducer to increase its holding power. Load brakes are not required on all machines. The additional expense is often not incurred for machines that are moving scenery laterally. For instance, our Pushstick deck winches do not have a load brake, but our Spotline hoist does use a load brake.

Now that we have an understanding of the terminology the pin-out of the Motor and Brakes connector shown below has more relevance:
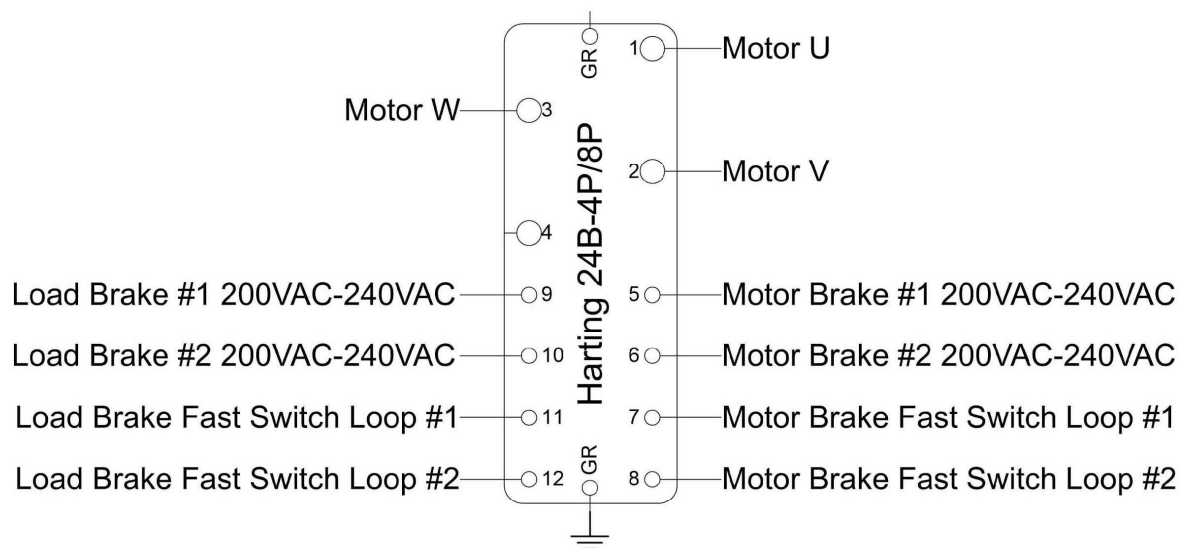
Motor & Brakes Connector

Figure 15

- Motor Power – 230VAC 3P 24A max, variable frequency from 0.5Hz-60Hz

- Motor Brake Power – 208/230VAC 1P 5A max 50/60Hz.

- Motor Brake Fast Switching Circuit – if you are using a DC brake with a rectifier that offers DC switching you can use this circuit to interrupt the DC power to the brake which will greatly reduce the time it takes to engage the brake.

- Load Brake Power – 208/230VAC 1P 5A max 50/60Hz.

- Load Brake Fast Switching Circuit – if you are using a DC brake with a rectifier that offers DC switching you can use this circuit to interrupt the DC power to the brake which will greatly

reduce the time it takes to engage the brake. If you are using a load brake you should use fast-brake switching.

It is important to hook up the correct brake to the designated terminals of the connector. Load brakes are typically much slower to respond than motor brakes because of their necessary size. When moving the motor, the Stagehand will first release the load brake, wait 500ms for the brake to fully release, and then release the motor brake and start spinning the motor. The Stagehand uses this sequencing to make sure that the motion of your machine is smooth and quiet. If the load brake isn't allowed time to fully disengage then the machine will drive through the partially-engaged brake which prematurely wears the brake and makes a distracting noise. If you mistakenly swap the load & motor brake wires, the brake release sequence will be wrong, and the machine will make a loud creak at the beginning of each movement.

Signal

Two sets of encoder signals (one for speed monitoring and one for positioning) and three sets of limit switches (forward, reverse, and ultimate) are combined in one rectangular connector (ILME CDDF-24).

All limit switch signals require Normally Closed (N.C.) switches. The Stagehand sources 12vdc on a pin of each limit circuit and expects to see that 12vdc signal returned on the other pin when the limit is not activated. If the limit is either activated or disconnected or a wiring fault occurs, the 12vdc return signal is lifted and the Stagehand will enter a limit fault condition and disallow motion.

The limit switch inputs are used to protect against the motor traveling too far in a direction and causing damage or injury. When running in a cue, this is one of the safety features that guards against encoder failure. When jogging manually, this keeps you from accidentally traveling too far.

All encoder signals use differential line receivers which use a balanced signal transmitted over twisted-pair wires to drastically reduce electrical interference and thus reduce the opportunity for inaccurate encoder data. Encoders connected to the Stagehand must be equipped with differential line drivers to be compatible. Encoders are powered at 5vdc for broadest compatibility.

Ultimate Limit — Ultimate Limit +12VDC — Forward Limit — Forward Limit +12VDC

Reverse Limit +12VDC — Reverse Limit

Speed Encoder A — Speed Encoder /A — +5VDC — COM — Position Encoder B — Position Encoder /B

Speed Encoder /B — Speed Encoder B — Position Encoder /A — Position Encoder A — COM — +5VDC

Pins: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, GR, 23, 24
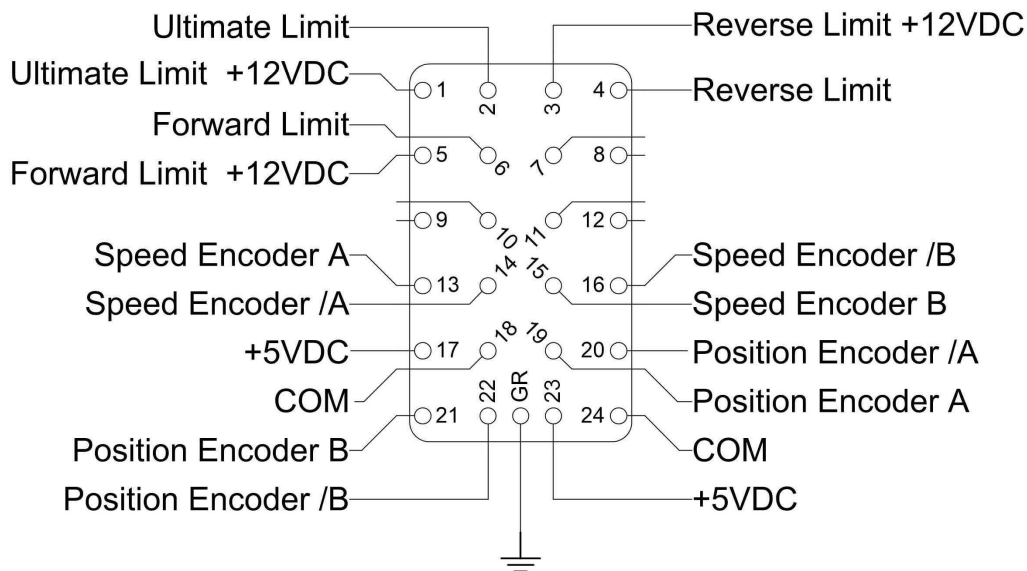
Limit & Encoders Connector

Ultimate Limit

A pair of normally-closed (N.C.) switches can be wired in series to this pair of terminals to provide protection against Forward and Reverse Limit switch failures. Typically, an Ultimate Limit switch is physically positioned just beyond both the Forward and Reverse Limit switch. If an Ultimate Limit is activated, the Stagehand will disallow any further movement until the limit is physically cleared or the limit override button is pressed. In normal operation, there is never a reason to strike an Ultimate Limit. An Ultimate Limit signal indicates an equipment problem with at least one of the primary limit switches. The faulty equipment must be repaired, and the Ultimate Limit must be mechanically reset before the Stagehand will allow motion.

Reverse Limit

A normally-closed (N.C.) switch can be wired to this pair of terminals. If the switch is activated, the Stagehand will not allow further motion in the reverse direction until the limit is cleared either by adjusting the switch mechanically or by moving in the forward direction far enough to clear the limit switch.

Forward Limit

A normally-closed (N.C.) switch can be wired to this pair of terminals. If the switch is activated, the Stagehand will not allow further motion in the forward direction until the limit is cleared either by adjusting the switch mechanically or by moving in the reverse direction far enough to clear the limit switch.

Limit Wiring Strategies

Since the Stagehand provides three (3) separate pins that all source 12vdc, one for each limit signal, you can reduce the wiring in your machine to four (4) wires by using just one of the 12vdc source pins and three (3) wires for the three limit return signals. Sometimes it is more convenient to wire a pair of conductors for each switch, other times it may be better to reduce the number of conductors by sharing a common voltage source. Both options are shown below:
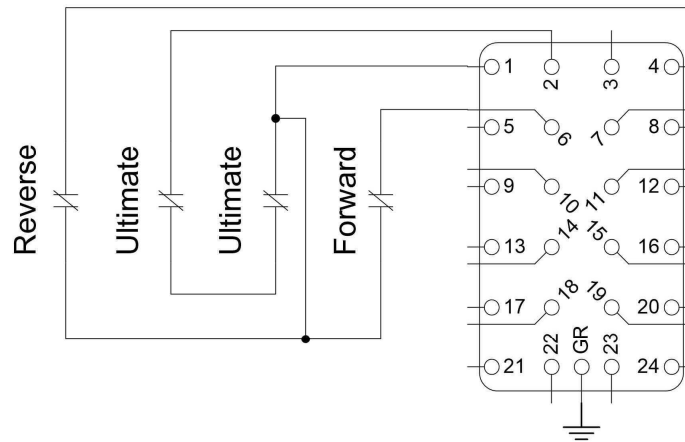
Shared Common Limit Wiring
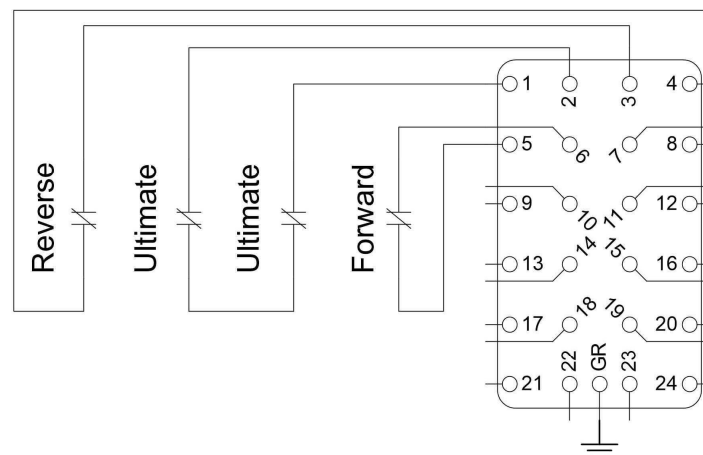
Discrete Limit Wiring

Speed Encoder

A set of quadrature signals used by the Variable Frequency Drive (VFD) to accurately regulate speed. Unlike the Stagehand Classic controller, the Stagehand Pro 3 requires a motor-mounted encoder for speed regulation. This same encoder may be wired for both speed and position data, but only if that encoder is mounted on the motor prior to the speed reducer. If the VFD detects that the Speed

Encoder signal is missing or faulty, the VFD will enter a fault condition and the Stagehand won't allow motion until the encoder is repaired. This feature is vitally important in lifting applications so that the Stagehand can detect a free-falling load and engage the mechanical safety brakes.

Position Encoder

A set of quadrature signals used by the motion controller to drive the motor to correct positions on cue. This encoder may be the same as the Speed Encoder or it may be a separate encoder. For instance, a scissor lift needs a speed encoder on the pump motor, but the positioning encoder should be placed directly on the lift platform since the relationship between the motor rotation and platform position changes depending on the extension height of the lift as it raises and lowers. A deck winch however, can use a single encoder mounted on the motor for both speed and positioning.

Encoder Wiring Strategies

As mentioned above, you can use either a single encoder mounted to the motor for both Speed and Position Encoder signals, or separate encoders mounted in different locations on the machine. Below are two drawings that show how to wire your encoder signals in both scenarios.

Single encoder
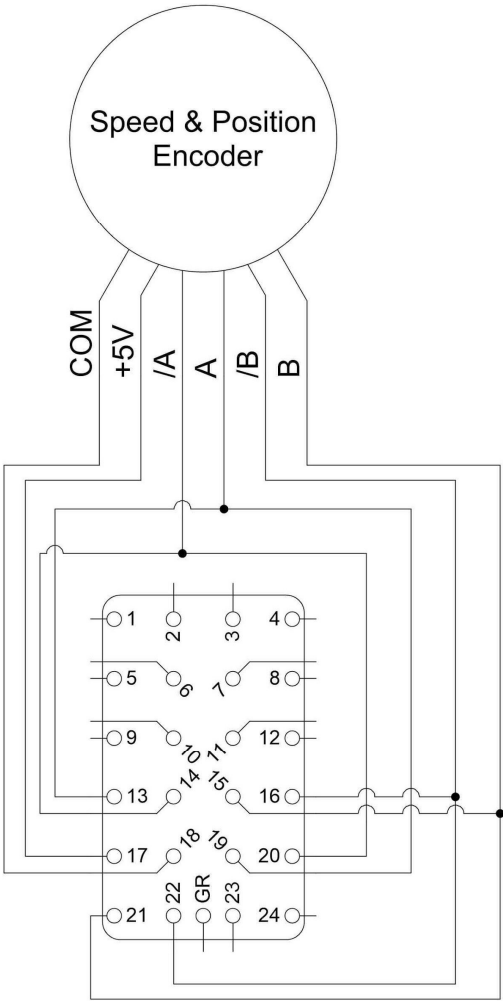
Dual encoders
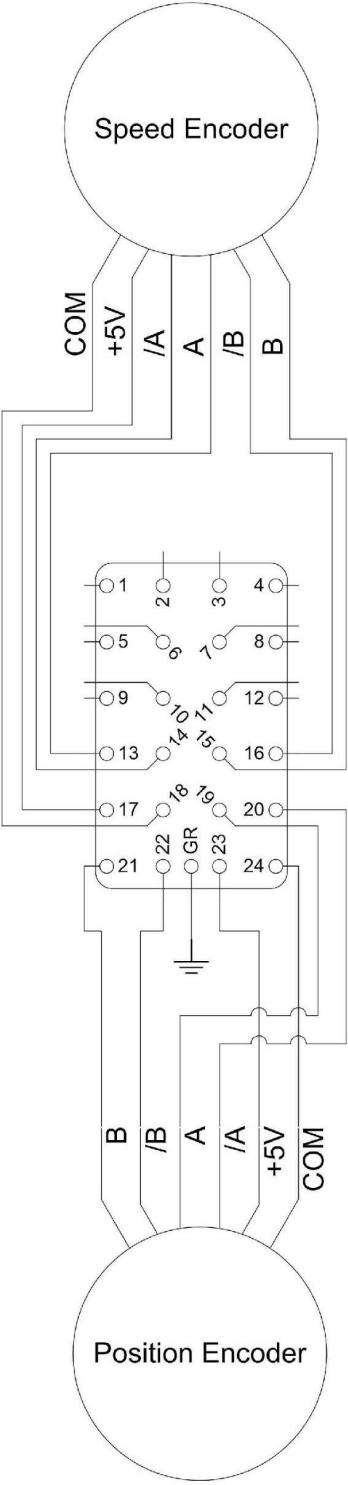
Ethernet

To communicate with Spikemark and run cues in a show, the Stagehand needs to be connected to a network. Located on the back side of the Stagehand, the Ethernet input will accept a CAT5 network cable with either a traditional RJ45 plug or a RJ45 plug with a Neutrik Ethercon shell installed (Mouser Part #568-NE8MC-B). The Ethercon shell is an XLR housing that slips over a network cable to provide additional strain relief and a positive-lock connection that makes it preferred backstage.

Showstopper

The Stagehand requires a 24vdc Emergency Stop signal from a Showstopper in order to allow power to flow to the motor and brakes. Internally, the Stagehand Pro has a redundant, self-monitoring circuit to ensure that power will be removed from the motor and brakes instantly if the 24vdc Emergency Stop signal is interrupted. Before you can move any motor, you must connect the Stagehand to a Showstopper with a 5-pin XLR cable. The 5-pin XLR cable is not a DMX signal, but rather it was chosen as a convenient cable that is prevalent in many venues so you should always be able to find a spare cable when needed.

Below is the pin-out for the Showstopper Emergency Stop input:

COM——1 5——+24VDC
2 3 4
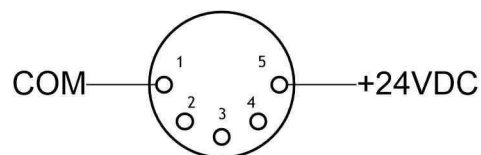
OPERATION

Once all of your connections are made, either by plugging in a pre-wired Creative Conners machine or by wiring up your own machine, the next step is to test the basic machine functions with the Stagehand. The first time you apply power to your machine should be done without a load attached. It can be quite scary if a multi-ton piece of scenery is yanked around by a misbehaving machine, so make sure to do your first test run in the shop or on an empty stage without any scenery connected.

Manual Operation

Before you can write complex cues in Spikemark, let's make sure the machine runs fine with when jogging it manually using the buttons and knobs on the face of the Stagehand.

- Release the Emergency Stop button on your Showstopper

- Press the Forward Button.
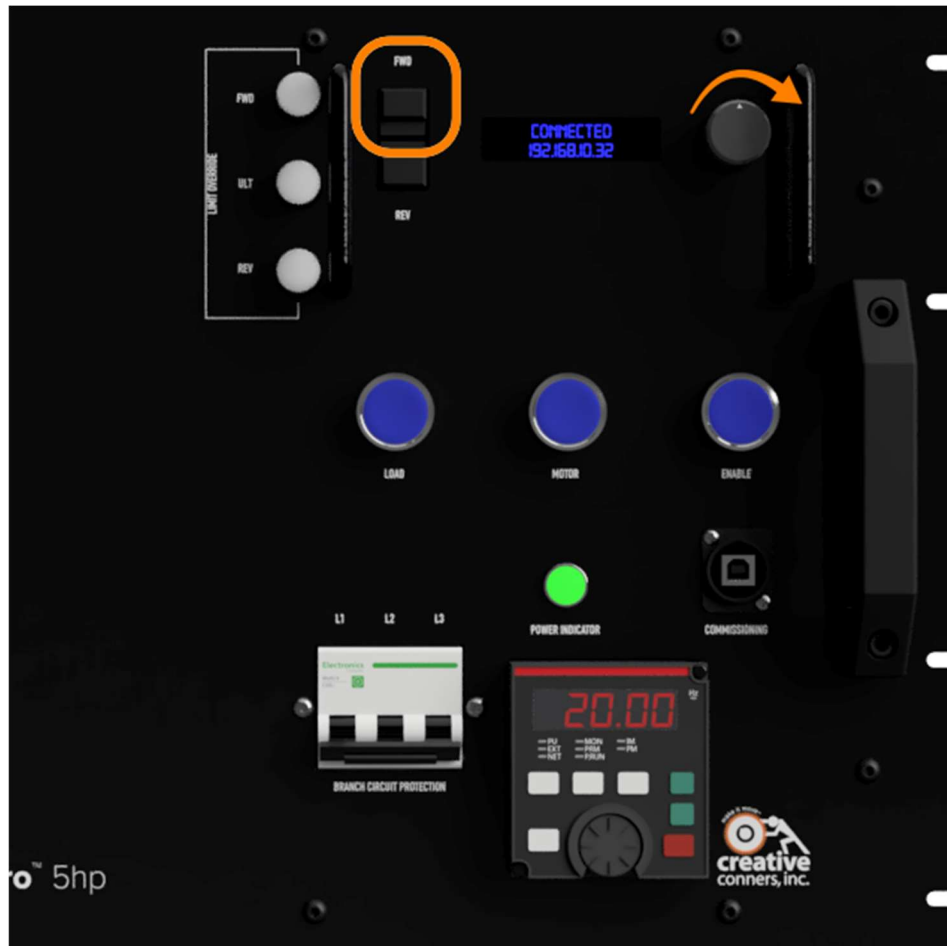
- While holding the Forward Button turn the Knob Clockwise slowly. The brakes should release and the machine should begin to move. The Position Encoder counts are displayed on the Status Display. The counts should be increasing in positive value, if not the motor and encoder are out of phase and you'll need to rewire either the motor or encoder. See the troubleshooting section for more details.

- Gradually rotate the Knob counterclockwise until the machine stops.

- Release the Forward Button.

- Press the Reverse Button.

- While holding the Reverse Button turn the Knob Clockwise slowly. The brakes should release and the machine should begin to move. The Position Encoder counts are displayed on the Status Display. The counts should be decreasing, if not the motor and encoder are out of phase and you'll need to rewire either the motor or encoder. See the troubleshooting section for more details.

If you strike a limit while jogging in the direction of the limit, the Stagehand will immediately stop the motor. If you strike a forward limit while jogging forward you will have to release the forward jog button and then jog in reverse. If you strike a reverse limit while jogging reverse you will have to release the reverse jog button and then jog forward. If you strike an ultimate limit, you will have to physically clear the limit switch before restarting motion in either direction or press the Ultimate Limit override button and move in the opposite direction until you clear the ultimate limit switch.

Understanding the Status Displays

The Stagehand Pro 3 has two status displays: one towards the top for the motion controller, and a second at the bottom for the VFD. Each display has different, but sometimes complementary information to convey.

Motion Controller

The two-line alphanumeric display on the Stagehand Pro motion controller uses OLED technology to make it easy to read backstage without a distracting backlight. It also has excellent viewing angles, making it easier for you and other operators to see status information at a glance. The Stagehand is primarily used through our Spikemark software, but it is handy to have some bits of information displayed on the Stagehand faceplate for those times that you are working onstage near the machinery and not sitting in front of a computer running Spikemark. Also during shop setup, load-in, and strike you may not have Spikemark running and need to manually operate the Stagehand. The following list explains the information that you can glean from the Stagehand display.
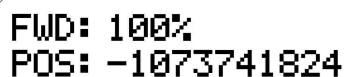
Network Connectivity

```
NOT CONNECTED
192.168.100.100
```

When sitting idle, the Stagehand will display its IP address on the bottom line and whether the Stagehand is actively connected to Spikemark. Connected means that the Stagehand has an active connection with a Spikemark computer, Disconnected means that the Stagehand is not actively communicating with Spikemark.

Encoder Position

```
FWD: 100%
POS: -1073741824
```

If you press either the Forward or Reverse jog button, the Stagehand will display the direction it is traveling and current speed as a percentage of full power on the top line. On the bottom line it will display the Position Encoder counter in raw encoder counts. Inside Spikemark the position data will be shown in scaled units, such as feet or inches, but on the Stagehand the raw encoder counts are displayed since the Stagehand isn't aware of Spikemark's Position Scale. The position information is helpful when testing equipment in the shop prior to load-in. You can use a Stagehand to power up a machine and confirm that the encoder is working properly by watching the counts increase and decrease when running forward and reverse respectively. If counts decrease when running forward you know that the motor and encoder polarity are mismatched and should be rewired before attempting to run cues.

Limits

```
REV LIMIT
192.168.100.100
```

When a Forward, Reverse, or Ultimate Limit is struck the top line of the display will flash an appropriate fault message in rotation with any other fault messages. If you strike a directional limit switch, either forward or reverse, you will have to run the motor in the opposite direction to clear the fault message. If you strike an ultimate limit you will have to physically clear the limit switch before the fault message will clear.

Drive Fault

```
DRIVE FAULT
192.168.100.100
```

The VFD has many fault conditions that can cause it to interrupt power to the motor and cease motion. Mechanical overload, encoder signal loss, over-speed, and under-voltage are just of few of the common faults that will render a Stagehand unresponsive. All of these faults register a common "Drive Fault" message on the status display and in Spikemark. Consult the Mitsubishi A700 manual for the exact fault description (the error code is displayed on VFD keypad). To clear a drive fault, correct the cause of the fault and then either cycle the Emergency Stop or press the STOP|RESET button on the VFD keypad.

Brake Fault

```
BRAKE FAULT
192.168.100.100
```

If you are seeing a Brake Fault message there are two possible causes. If you are seeing this message after auto-tuning the VFD please check that Parameter 414 is set to 1 if you have a Mitsubishi A700 or set to 2 if you have a Mitsubishi A800 (This procedure is detailed in the Autotuning section of this manual on page 28). The second possibility is that the Stagehand monitors the force-guided relay switches which control power to both brake circuits. If the Stagehand detects that a relay has failed to operate properly, it will not allow the remaining, properly-operating brake to release nor will it allow the motor to move. In order to clear this fault, the Stagehand must be returned to Creative Conners for service.

Emergency Stop

```
EMERGENCY STOP
192.168.100.100
```

When the Emergency Stop circuit is activated, or unplugged, the Emergency Stop fault message will be added to the flashing fault messages. Any motion that was occurring when the Emergency Stop was detected will be stopped. To clear the fault, release the Emergency Stop button on the Showstopper. Once the fault is cleared, any motion that you wish to execute will have to be restarted. If you were jogging, you will need to release the jog button and start again. If you were running a cue through Spikemark, that cue will need to be re-loaded and run again. At no time will the Stagehand immediately restart after an Emergency Stop fault is cleared, since such behavior could pose a serious safety risk.

VFD

The VFD keypad will monitor the instantaneous electrical output from the drive when running, display parameters during configuration, and show fault codes when the drive stops moving because of a problem.

Electrical monitor

While the VFD is running it while display the output speed of the motor in Hz by default. Press the **SET** button on the keypad to cycle through the instantaneous current (in Amps), and the voltage. In particular, using the display to check the current draw of the motor is a great way to verify whether the attached machine is over capacity. If the machine has a maximum current draw of 17A, and the current displayed on the VFD is 20A, you know the machine is being asked to move more than it can and you should reduce the load.

Parameter configuration

Pressing the **MODE** button on the VFD keypad will cycle through the various keypad modes (go figure). The default Monitor mode shows the electrical readout described above, but pressing the MODE button will advance into Parameter configuration. You can easily detect that the keypad is in Parameter mode because the readout displays a "**P.**". Refer to parameter configuration later in this manual for tips on what parameters you may want to adjust.

Faults history

Press the **MODE** button until the VFD keypad displays "**E - - -**" and you can view the Faults history of the drive. Spin the wheel on the keypad to scroll through the most recent 8 faults. What are drive faults? Good question. Drive faults are an unexpected condition that prompted the VFD to stop moving the machine. Here's an excerpt from the Mitsubishi A800 VFD manual that shows the various fault displays and an explanation of what each one means.

6.4 Faults history and the list of fault displays

If the displayed message does not correspond to any of the following or if you have any other problem, please contact your sales representative.

(1) Error message

- A message regarding operational fault and setting fault by the operation panel (FR-DU08) and parameter unit (FR-PU07) is displayed. The inverter does not trip.

Operation panel indication	Name	Refer to
E - - - -	Faults history	619
HOLd	Operation panel lock	623
LOCd	Password locked	623
Er 1 to Er4 Er8	Parameter write error	623
rE 1 to rE4 rE6 to rE8	Copy operation error	624
Err.	Error	625

(2) Warning

- The inverter does not trip even when a warning is displayed. However, failure to take appropriate measures will lead to a fault.

Operation panel indication	Name	Refer to page
OL	Stall prevention (overcurrent)	626
oL	Stall prevention (overvoltage)	626
Rb	Regenerative brake pre-alarm	627
rH	Electronic thermal relay function pre-alarm	627
PS	PU stop	627
SL	Speed limit indication	627
CP	Parameter copy	627
SA	Safety stop	628
Mr 1 to Mr 3	Maintenance signal output	628
UF	USB host error	628
HP 1	Home position return setting error	628
HP2	Home position return uncompleted	628
HP3	Home position return parameter setting error	628
EV	24 V external power supply operation	628

(3) Alarm

- The inverter does not trip. An Alarm (LF) signal can also be output with a parameter setting.

Operation panel indication	Name	Refer to page
FN	Fan alarm	629
FN2	Internal-circulation fan alarm	629

(4) Fault

- A protective function trips the inverter and outputs a Fault (ALM) signal.
- The data code is used for checking the fault detail via communication or with **Pr.997 Fault initiation**.

Operation panel indication	Name	Data code	Refer to page
E. OC 1	Overcurrent trip during acceleration	16 (H10)	629
E. OC2	Overcurrent trip during constant speed	17 (H11)	630
E. OC3	Overcurrent trip during deceleration or stop	18 (H12)	630
E. OV 1	Regenerative overvoltage trip during acceleration	32 (H20)	631
E. OV2	Regenerative overvoltage trip during constant speed	33 (H21)	631
E. OV3	Regenerative overvoltage trip during deceleration or stop	34 (H22)	631
E. rHr	Inverter overload trip (electronic thermal relay function)	48 (H30)	632
E. rHM	Motor overload trip (electronic thermal relay function)	49 (H31)	632
E. FIN	Heatsink overheat	64 (H40)	632
E. IPF	Instantaneous power failure	80 (H50)	633
E. UVr	Undervoltage	81 (H51)	633
E. ILF	Input phase loss	82 (H52)	633
E. OLr	Stall prevention stop	96 (H60)	634
E. SOr	Loss of synchronism detection	97 (H61)	634
E. bE	Brake transistor alarm detection	112 (H70)	634
E. GF	Output side earth (ground) fault overcurrent	128 (H80)	635
E. LF	Output phase loss	129 (H81)	635

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Faults history and the list of fault displays

Operation panel indication	Name	Data code	Refer to page		Operation panel indication	Name	Data code	Refer to page
E. OHΓ	External thermal relay operation	144 (H90)	635		E. ECΓ	Signal loss detection	210 (HD2)	640
E. PΓC	PTC thermistor operation	145 (H91)	635		E. Od	Excessive position fault	211 (HD3)	640
E. OPΓ	Option fault	160 (HA0)	636		E. Mb1		213 (HD5)	
E. OP1	Communication option fault	161 (HA1)	636		E. Mb2		214 (HD6)	
E. 16		164 (HA4)			E. Mb3		215 (HD7)	
E. 17		165 (HA5)			E. Mb4	Brake sequence fault	216 (HD8)	641
E. 18	User definition error by the PLC function	166 (HA6)	636		E. Mb5		217 (HD9)	
E. 19		167 (HA7)			E. Mb6		218 (HDA)	
E. 20		168 (HA8)			E. Mb7		219 (HDB)	
E. PE	Parameter storage device fault	176 (HB0)	636		E. EP	Encoder phase fault	220 (HDC)	641
E. PUE	PU disconnection	177 (HB1)	637		E. 1AH	Abnormal internal temperature	225 (HE1)	641
E. REΓ	Retry count excess	178 (HB2)	637		E. LC1	4 mA input fault	228 (HE4)	641
E. PE2	Parameter storage device fault	179 (HB3)	637		E. PCH	Pre-charge fault	229 (HE5)	641
E. CPU		192 (HC0)			E. PId	PID signal fault	230 (HE6)	642
E. 5	CPU fault	245 (HF5)	637		E. 1		241 (HF1)	
E. 6		246 (HF6)			E. 2	Option fault	242 (HF2)	642
E. 7		247 (HF7)			E. 3		243 (HF3)	
E. CΓE	Operation panel power supply short circuit RS-485 terminals power supply short circuit	193 (HC1)	637		E. 11	Opposite rotation deceleration fault	251 (HFB)	642
E. P24	24 VDC power fault	194 (HC2)	638					
E. CdO	Abnormal output current detection	196 (HC4)	638					
E. 1OH	Inrush current limit circuit fault	197 (HC5)	638					
E. SER	Communication fault (inverter)	198 (HC6)	638					
E. AIE	Analog input fault	199 (HC7)	638					
E. USb	USB communication fault	200 (HC8)	639					
E. SAF	Safety circuit fault	201 (HC9)	639					
E. PbΓ	Internal circuit fault	202 (HCA)	639					
E. 13		253 (HFD)	639					
E. OS	Overspeed occurrence	208 (HD0)	639					
E. OSd	Speed deviation excess detection	209 (HD1)	640					

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Override Limits

Engaging a limit switch will prevent the Stagehand from moving the machine. In the case of an initial limit, the machine cannot move further in either the Forward or Reverse direction, but can move away from the engaged limit. In the case of an ultimate limit, the machine cannot move in either direction. Most of the time this is exactly the behavior you want. If you hit a limit switch, the machine has traveled unexpectedly too far. Time to stop, evaluate what happened, and make a correction.

However, sometimes, especially during load-in or shop testing, the limit is merely improperly set and it would be convenient to temporarily override the limit switch. The Limit Override buttons on the face of the Stagehand Pro 3 allow you to do just that. Press and hold the corresponding button and you can drive beyond an engaged limit.

This is a convenience feature that should only be employed temporarily. Don't do anything dangerously negligent like tape the override buttons down, or wedge a paperclip in the buttons, that would permanently disable the limit signals.

Brake Testing

The Stagehand Pro can control two safety brakes for use in hoisting applications. The Stagehand Pro will internally check the electronic systems to insure the brake circuits are working properly before releasing either the motor brake or the load brake to prevent dropping a suspended piece of scenery. However, the Stagehand cannot confirm that the brakes are mechanically operating correctly.

Since the Stagehand cannot confirm that both brakes are functioning mechanically and that neither has jammed in a released state (very rare, but possible), nightly pre-show check should include a brake test. The Stagehand has convenient buttons on the faceplate to assist you with testing the brakes. To test that your brakes are operating correctly in a hoisting application, read through the following steps in their entirety and then perform each action as follows:

- Clear the stage below the suspended scenery

- Press the Brake Test button
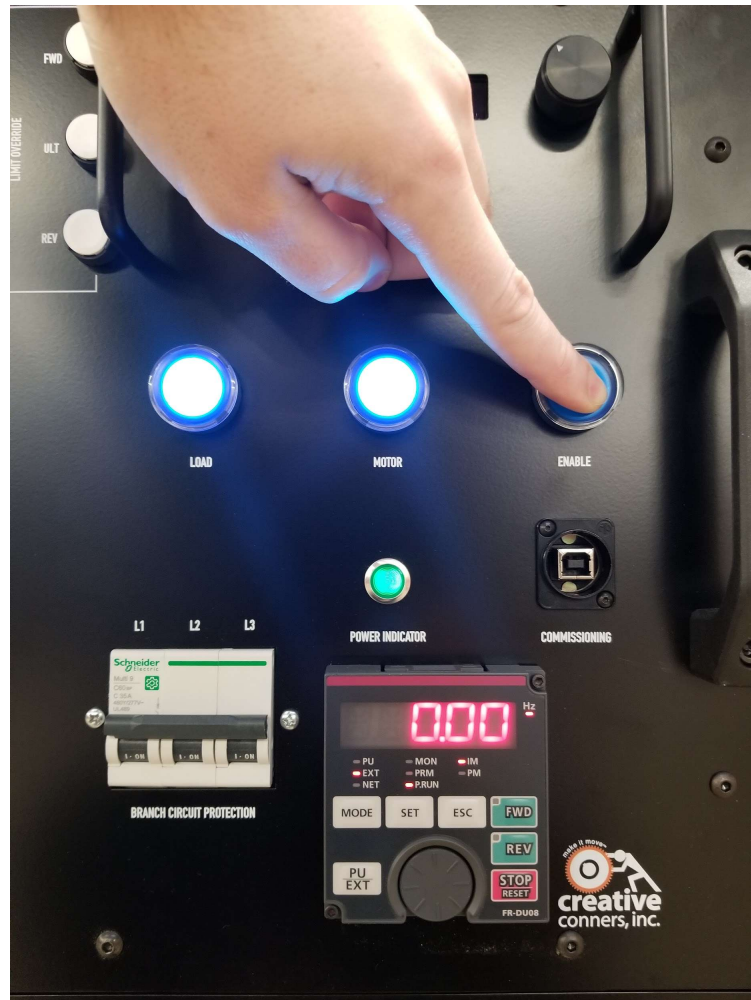
- While holding the Brake Test Button, press the Load Brake button. This will manually release the Load Brake. The Motor Brake should still be engaged and will hold the load. If the suspended scenery slips down, release the Load Brake button immediately. Since the Motor Brake did not hold the load as expected, that brake has failed. DO NOT OPERATE THE MACHINE UNTIL THE MOTOR BRAKE IS REPAIRED OR REPLACED. FAILURE TO REMOVE THE MACHINE FROM SERVICE COULD RESULT IN DAMAGE, INJURY, OR DEATH.
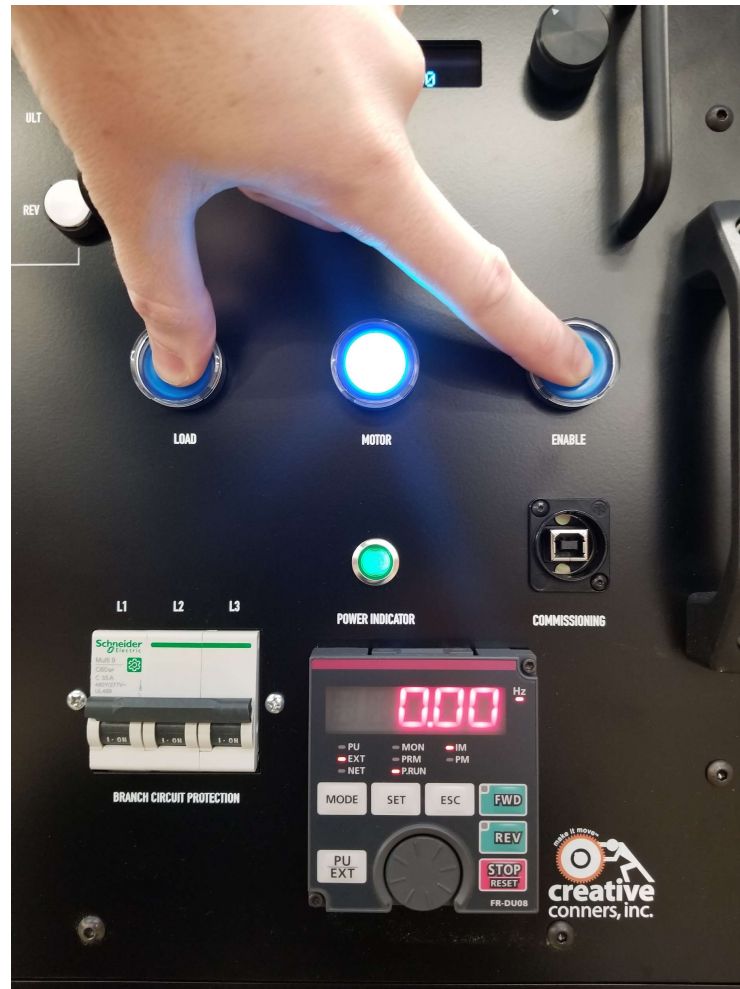
- Provided the Motor Brake passed the functional test, release the Load Brake button.

- While holding the Brake Test Button, press the Motor Brake button. This will manually release the Motor Brake. The Load Brake should still be engaged and will hold the load. If the suspended scenery slips down, release the Motor Brake button immediately. Since the Load Brake did not hold the load as expected, that brake has failed. DO NOT OPERATE THE MACHINE UNTIL THE LOAD BRAKE IS REPAIRED OR REPLACED. FAILURE TO REMOVE THE MACHINE FROM SERVICE COULD RESULT IN DAMAGE, INJURY, OR DEATH.

- Release the Motor Brake button

    Pro Tip: If you press all three buttons at once, all brakes will engage

If you are using the Stagehand to control a hoist, this procedure must be executed every night to ensure that all equipment is operating in a safe, reliable manner. If you are not using the Stagehand to control a hoist, it may be convenient to manually release the safety brakes at times, but it is not required.

Connecting to Spikemark

Setting the IP Address
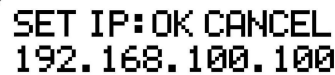
When you are ready to write and run complex cues with Spikemark, you may need to assign a new IP address to the Stagehand Pro. Every device on the automation network must have a unique, but similar, static IP address. The easiest address scheme to adopt is to share the first three segments of the IP address and just alter the last segment. We typically use addresses that start:

192.168.10.xxx

The last number can be any value from 0 – 255, but no devices on the network can share the same value.

To set the IP address of the Stagehand:

- Press the Knob. The Knob serves double-duty as a typical rotary knob and a button (much like a car stereo knob).

- The SET IP address screen will be displayed just like the picture below:

```
SET IP:OK CANCEL
192.168.100.100
```

- There is a blinking cursor on the display, turning the knob will scroll the cursor through the various fields. By turning the Knob, scroll over to the last segment of the IP address which is 32 by default.

- Press the Knob to select the last segment and make it adjustable.

- Turn the Knob to set a new value.

- Once you are happy with the new value, press the Knob to accept the value.

- By turning the Knob, scroll over to the OK and then press the Knob to set the new address and return to the primary display screen. If you want to cancel the changes you made to the IP address, place the cursor over CANCEL and press the Knob.

Setting the Subnet Mask

Stagehand Pro 3 also allows you to set the Subnet Address. To unlock the subnet menu simply press and hold the jog wheel until the display shows the Set Subnet screen. The default subnet of 255.255.255.0 should suffice for almost everyone, though if you are integrating the Stagehand and Spikemark with show control systems you may need to adjust the Subnet.

Auto-Tuning

The Mitsubishi A800 Variable Frequency Drive (VFD) inside the Stagehand Pro 3 is responsible for precisely providing power to the motor to keep it moving at the pace demanded by the motion controller. For instance, if you write a cue to run a Pushstick winch at 24"/sec, the motion controller sends a small signal to the VFD describing the desired speed, and then the VFD is in charge of controlling the motor rotation accurately. In order for the VFD to have the best possible control of motor speed, it needs some knowledge of the motor's electrical character. Depending on the motor and the scenery load, auto-tuning can have a dramatic effect on machine performance. Jerky movements can become silky-smooth and low-speed movements that struggled appear effortless after auto-tuning.

The Mitsubishi A800, like many VFD's, has a built-in "auto-tuning" procedure which electrically probes the motor to give the VFD a better understanding of the motor it is tasked with controlling. This procedure should be run every time you connect the Stagehand to a different motor since different motors have different electrical properties. Not as obvious, you should also run the auto-tuning procedure any time that you change cable lengths between the Stagehand and the machine.

The operation typically takes less than a minute and does not move the motor shaft substantially but will release the motor brake so the drive can sense the motor's reaction to applied power.

There are two methods available to execute the Auto-Tuning procedure: from within Spikemark 4.0 and higher or manually from the VFD keypad. The Stagehand Pro uses the Mitsubishi's internal PLC to insure safe operation of the redundant brake circuits. This PLC feature must be turned off in order run the "auto-tuning" procedure. This procedure is automated from within Spikemark with a click of the mouse. You will need to stop the PLC program manually If running the auto-tune procedure from the VFD keypad.

Within Spikemark

Follow these steps to auto-tune from Spikemark 4.

1. Connect to the Stagehand from Spikemark

2. Select the correct Stagehand in the Cue Grid

3. Scroll down the Stagehand Properties on the right side of Spikemark until the Drive Section

4. Click "Auto-Tune"
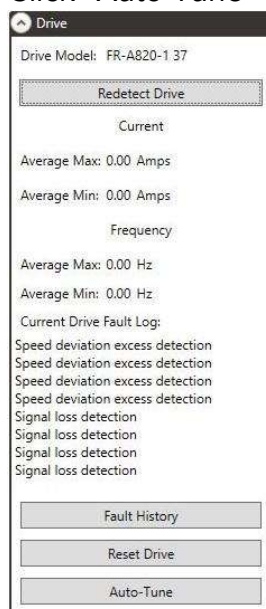
5. The Drive Auto-Tune window will open:

a. The current drive parameters are listed on the left under DRIVE VALUE

b. Make any changes to the parameters in the right-hand column and click WRITE PARAMETERS

6. Click the red Auto-Tune button

    a. The confirmation window opens and if safe to proceed click YES
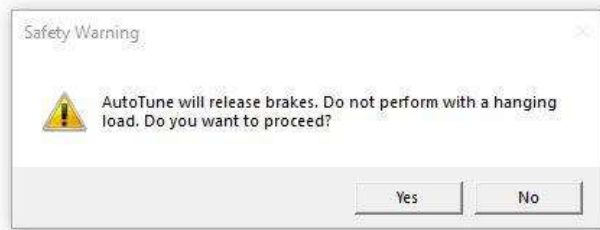
7. During the tuning process the status will change to TUNING DRIVE

8. Once the tuning is complete the status will change to FINISHED TUNING
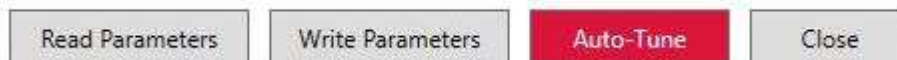
NOTE: In some cases you may need to restart the PLC brake program manually from the VFD keypad after executing the auto-tune procedure from Spikemark. Specifically, if you run the procedure and the Stagehand card is displaying BRAKE FAULT it is time to confirm that P.414 is set to the value 2.

VFD Keypad

If you are not running Spikemark 4 or are unable to execute the Auto-Tune from within Spikemark you will need to execute the auto-tuning from the VFD keypad. Although the procedure has quite a few steps, it is straightforward if you follow this guide.

● Turn off PLC mode governing the Brake Test circuitry using the VFD keypad:

    ○ Enter the Parameter Setting mode by pressing the **MODE** button on the VFD keypad until the display reads **P. 0**
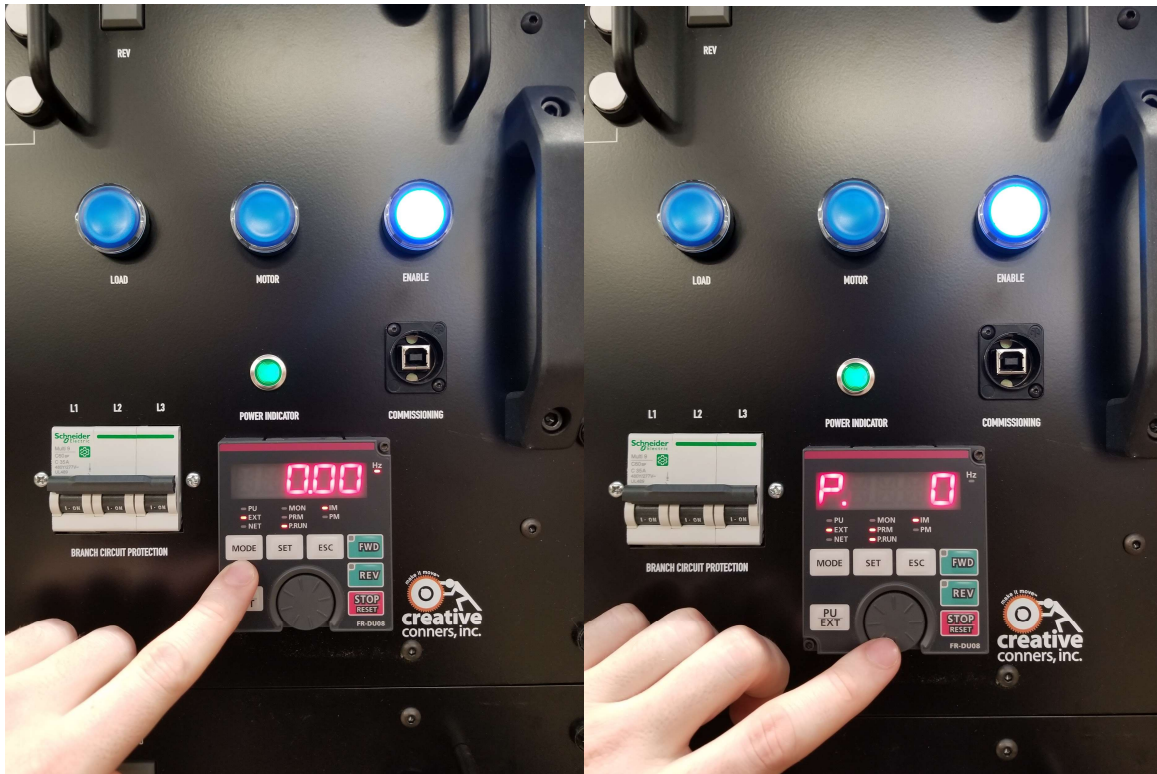
- o Scroll the wheel to find parameter **P 414**.

- o Press the **SET** button to adjust the parameter.

- o Scroll down to the value **0** to turn off the PLC program.

- o   Press the **SET** button to accept the new value.

- Restart the VFD by either cycling power to the Stagehand, or by pressing the Emergency Stop button on the Showstopper and release it. Activating the Emergency Stop circuit will remove power from the VFD.

- Set the following parameters on the VFD keypad using the same process outlined above:

   - o   Set Parameter 9 equal to the rated current of the motor. (14A for 5hp)

   - o   Set Parameter 71 equal to 3. This is the setting for a general purpose motor.

   - o   Set Parameter 81 equal to the number of motor poles appropriate for the base rpm of the motor (2 for 3600 rpm, 4 for 1800 rpm, 6 for 1200 rpm). *(4-pole motors are most common)*

   - o   Set Parameter 83 equal to the rated voltage of the motor. *(230V is standard)*

   - o   Set Parameter 96 equal to 1. This will execute auto-tuning without moving the motor.

- Press the **MODE** button until the keypad displays a 1 without flashing. You will need to press the mode button thrice.

- Press and hold the **Brake Test** button.

- While holding the **Brake Test** button, press and hold the **Forward** button on the Stagehand motion controller (not the VFD keypad).

- You must press both buttons for about a minute while the VFD performs the auto-tuning procedure. The keypad will display 2 while running the tuning procedure. The motor will make some very odd noises during auto-tuning, it sounds like the motor is chirping in various rhythms. This is normal.

- If the auto-tuning completes successfully, the VFD keypad will display **3**. If there was an error another number will be shown. Consult the Mitsubishi A800 manual for more details on the error. The explanation can be found starting on page 433.

- Once auto-tuning is complete, you must restart the PLC program in the VFD:

    o Enter the Parameter Setting mode by pressing the **MODE** button on the VFD keypad until the display reads **P.XXX** (where XXX is any number from 0 – 999).

    o Scroll the wheel to find parameter **P.414**.

    o Press the **SET** button to adjust the parameter.

    o Scroll down to the value **2** to turn on the PLC program.

    o Press the **SET** button to accept the new value.

- Restart the VFD by either cycling power to the Stagehand, or by pressing the Emergency Stop button on the Showstopper and release it. Activating the Emergency Stop circuit will remove power from the VFD.

- After the VFD turns on, confirm the **P.RUN** light on the VFD keypad is illuminated and not flashing. This indicates that the brake logic is functioning correctly.

With the auto-tuning complete, and the PLC program restarted you can return the Stagehand to normal operation.

Parameter Configuration

The Mitsubishi A800 VFD inside the Stagehand Pro 3 has hundreds of parameters that can be configured to alter the behavior of the drive. We preset all the parameters for general purpose use, but you may need to change a parameter for the drive to work properly with a specific machine. Or you may suspect that a parameter is incorrectly set and would like to verify the current value of that parameter. There are two methods for setting parameters: use the keypad, or restore from internal USB storage.

Keypad

Using the keypad to set parameters works well for changing a small number of parameters. It's also a handy way to quickly verify the value of a parameter. To view a parameter:

- Press the MODE button on the keypad until the display reads "**P.   0**" (it may be a different number, the important part is **P.**).
- Now you can scroll through all the parameters with the wheel on the keypad.
- Press the **SET** button when you reach the desired parameter.
- The current value of the parameter is displayed.
- You can:
    - Change the value with the scroll wheel and press **SET** to save
    - Without changing the value, press **SET** to return to the parameter list
    - To return to the parameter list discarding changes press **ESC**

The photos below show the process:
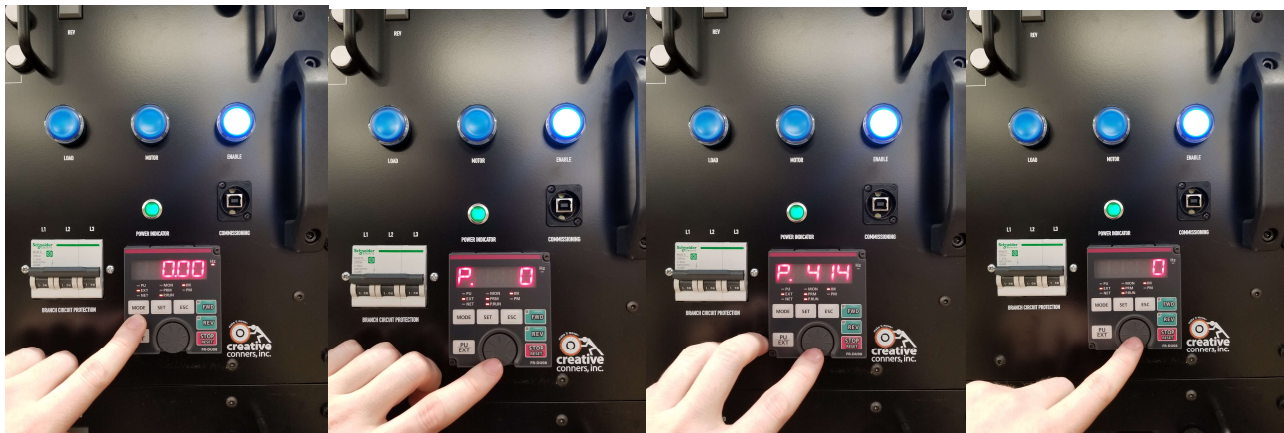
Restore from USB

Inside the Stagehand Pro 3, we have installed a USB flash drive into the VFD. The flash drive contains sets of parameters for our stock machinery that were current at the time the Stagehand Pro 3 in your hands now was made.

There are three standard parameter files stored in the VFD as a backup in case a parameter change renders the drive inoperable. These files are stored as follows:

- CP001 - Standard 5HP Settings (Pushstick, Revolver & Spotline)
- CP002 - Floorpocket Settings
- CP003 - CM Smart Chain Hoist Settings

To restore one of the saved parameter files:

1. Press MODE 4X (Displays USB-A)

2. Press SET 3X (Displays CP---)
3. Scroll to desired program number (ie CP001)
4. Press SET 1X (Displays 0.---)
5. Scroll two clicks right (Displays 2.WR)
6. Press SET 2X (Displays Flashing 2.ALL)
7. The VFD will think for while as it copies all the parameters from the USB drive. When it's finished, it will beep. After the Beep reset the drive by engaging the E-Stop or removing the mains power.

Saving to USB

Pro Tip - *Saving a new parameter set to the internal USB storage is an advanced topic that could overwrite our factory-default parameter sets and cause the Stagehand to stop functioning. You've been warned. Proceed with caution.*

If you have a set of parameters for a machine of your own making, or made tweaks to the stock parameters that you'd like to save, you can save your new parameter set to the USB storage device inside the Stagehand Pro 3. There are 99 available slots that can be saved. We recommend that you start with slot CP004 and work your way up rather than overwrite the standard settings. To save your parameters to a new file on the USB storage:

1. Press MODE 4X (Displays USB-A)
2. Press SET 3X (Displays CP---)
    a. To overwrite an existing file skip to step three
    b. To save a new file location press SET 1X (Displays 0.---)
    c. Scroll one click to the right (Displays 1.RD)
    d. Go to step 6
3. Scroll to desired program number. (ie CP004)
4. Press SET 1X (Displays 0.---)
5. Scroll Right one click (Displays (1.RD)
6. Press SET 1X
7. The VFD will think for a while as it copies all the parameters onto the USB drive. When it's finished, it will beep. After the Beep reset the drive by engaging the E-Stop or removing the mains power.

Factory default parameters

The parameter sets for our stock machines are shown in the table below. Some of the parameters listed are unchanged from the Mitsubishi default, but it's good to verify all of them are correct.

No.	Name	Description	5HP Stock	CM Chain Hoist	Floor Pocket
YOU MUST SET PARAMETER 77 = 2 PRIOR TO BEGINNING THE MANUAL RESTORE PROCESS					
1	Maximum frequency	Set the upper limit of the output frequency.	120	110	80
2	Minimum frequency	Set the lower limit of the output frequency.	0	0	0
3	Base frequency	Set the frequency at the rated motor torque. (50Hz/60Hz)	60	106	60
7	Acceleration time	Standard time to accelerate a movement.	0	0	0
8	Deceleration time	Standard time to decelerate a movement.	0	0	0
9	Electronic thermal O/L relay	Current rating from the motor nameplate.	17.5	13	17.5
10	DC injection brake operation frequency	Set the frequency at which the brakes will release.	3	0.5	3
13	Starting frequency	Motor won't start until the speed signal is at least this value.	0.5	0.5	0.5
18	High speed maximum frequency	Allows for VFD output at 120Hz or higher.	120	110	80
30	Regenerative function selection	External brake resistor, L1/L2/L3 power source.	1	1	1
70	Special regenerative brake duty	Duty cycle of the braking resistor.	10	10	10
71	Applied motor	Other manufacturers' standard motor.	3	3	3
72	PWM frequency selection	Carrier Frequency. Reduces output noise.	15	15	15
73	Analog input selection	0-5vdc	1	1	1

77	Parameter write selection	Allow parameter writes regardless of operation status.	2	2	2
79	Operation mode selection	Keypad disabled, external control.	0	0	0
80	Motor capacity	Kilowatt rating of motor.(1hp=0.75kw, 5hp=3.7kw, 10hp=7kw)	3.7	2.63	4
81	Number of motor poles	governs the base rpm of the motor	4	4	4
83	Rated motor voltage	Set the voltage rating from the motor nameplate.	230	230	230
84	Rated motor frequency	Set the frequency rating from the motor nameplate.	60	106	60
96	Auto tuning setting/status	Offline auto-tuning status. 0 = not set; 1 = auto-tuning initiated, 2 = auto-tuning in progress, 3 = auto-tuning completed. See Stagehand Pro manual for instructions	0	0	0
117	PU communication station number	Specifies the inverter station number.	1	1	1
118	PU communication speed	4800bps	48	48	48
119	PU communication stop bit length / data length	Data length: 8 bits, stop bit: 1 bit	0	0	0
120	PU communication parity check	No parity check.	0	0	0
125	Terminal 2 frequency setting gain frequency	Terminal 2 input gain (maximum) frequency.	60	106	60
180	RL terminal function selection	general input (used to sense load brake relay status)	9999	9999	9999
181	RM terminal function selection	general input (used to sense motor brake relay status)	9999	9999	9999
182	RH terminal function selection	SQ signal, sequence run for PLC mode. Must be shorted to run, open to program	50	50	50
183	RT terminal function selection	general input (used to sense load brake test button)	9999	9999	9999
184	AU terminal function selection	general input (used to sense motor brake test button)	9999	9999	9999
190	RUN terminal function selection	Alarm signal, normally on shuts off if	199	199	199

		there's a fault			
191	SU terminal function selection	general output (used by PLC to indicate a brake relay failure)	9999	9999	9999
192	IPF terminal function selection	general output (used by PLC for motor brake)	9999	9999	9999
193	OL terminal function selection	general output (used by PLC for load brake)	9999	9999	9999
194	FU terminal function selection	General output	9999	9999	9999
252	Override bias	Percentage of analog signal to use for speed signal ***adjust this to overspeed motor	100	100	100
285	Overspeed detection frequency (speed deviation excess detection frequency)	Hz difference between commanded speed and actual that will trip an overspeed fault	20	20	20
331	RS-485 communication station number	RS-485 Communication	1	1	1
332	RS-485 communication speed	RS-485 Communication	48	48	48
333	RS-485 communication stop bit length / data length	RS-485 Communication	0	0	0
334	RS-485 communication parity check selection	RS-485 Communication	0	0	0
338	Communication operation command source	RS-485 Communication	0	0	0
339	Communication speed command source	RS-485 Communication	0	0	0
340	Communication startup mode selection	RS-485 Communication	0	0	0
359	Encoder rotation direction	CCW encoder rotation is forward	1	0	1
368	Feedback gain	Response of the feedback will become slow when the acceleration/deceleration time is long. In such case, increase the setting value	1	1	1
369	Number of encoder pulses	PPR for Vector Control (Floorpocket pre Jan '19 = 2500) All other machines = 1024	1024	1024	1024

374	Overspeed detection level	Inverter shuts down if motor speed is greater than indicated value. (Hz)	9999	9999	9999
376	Encoder signal loss detection enable/disable selection	Inverter shuts down if encoder stops working or encoder signal is lost.	1	1	1
414	PLC function operation selection	enable PLC to run brake switching logic, must be turned off to manually auto-tune motor	2	2	2
549	Protocol selection	MODBUS RTU protocol	1	1	1
550	NET mode operation command source selection	The RS-485 terminals are the command source when in the NET operation mode	1	1	1
551	PU mode operation command source selection	The RS-485 terminals are the command source when in the PU operation mode.	9999	9999	9999
800	Control method selection	0=Vector control, speed control, 10=Sensorless Vector control, 20=Volts/Frequency control	0	0	0
802	Pre-excitation selection	servo lock	1	1	1
818	Easy gain tuning response level setting	1-15 range that governs aggression of easy gain-tuning	2	2	2
819	Easy gain tuning selection	OFF	0	0	0
820	Speed control P gain 1	pgain level, higher for tighter speed control but more oscillation	20	20	20
850	Brake operation selection	zero speed control	1	1	1
853	Speed deviation time	seconds that an overspeed can occur before faulting	1	1	1
903	Terminal 2 frequency setting gain frequency	C4 - Enter the value on the Stagehand cabinet or refer to the manual for details on other methods	TBD	TBD	TBD

Restoring factory VFD settings

There are times when you find yourself in the weeds with a misbehaving Stagehand and nothing you do seems to make a difference. For me these times generally coincide with changing parameters,

running an auto-tune or (of course) 1st tech/1st dress/1st preview. VFDs are complicated devices, one wrong parameter can wreak havoc - tossing out errors, not triggering the brakes or just not working at all. Let's take a look at what to do when it's time to reset the VFD to factory defaults.

In our shop we are able to execute a "mind wipe" from the bench computer. Without this tool in hand, your only sane option is to execute a parameter clear from the keypad. This may sound like a scary prospect, but quite often it is the quickest and simplest approach to get back on track. In order to restore factory defaults we need to execute two different CLEAR functions, an ALL CLEAR and a PARAMETER CLEAR. You may be asking yourself why the all clear doesn't actually clear ALL items… it is because these two functions clear different sections of the memory.

1. Press mode until the display shows P.0
2. Set Pr. 77 to 0
3. Set Pr. 79 to 1
    ○ This locks in PU mode
4. Set Pr. 551 to 9999
5. Cycle power to the drive
6. Press mode until the display shows P.0
7. Scroll to ALL.CL and set to 1 *(the display will flash between ALL.CL and 1 once set)*
8. Scroll to PR.CL and set to 1 *(the display will flash between PRCL and 1 once set)*
9. Power cycle the VFD

Now the VFD is in the default state from the factory. Before you can use it again, you must reload one of our parameter sets onto the VFD. Use either the Keypad or USB Storage techniques outlined above to load a parameter set that matches your machine.

Analog speed signal calibration

Your Stagehand uses an analog input signal to communicate to the VFD how fast and in which direction to turn. In order to ensure your machine moves as fast as physically possible, the VFD should be calibrated to the Stagehand motion controller so that a 100% control signal results in a 60Hz output frequency to the motor. Some models have their factory calibration printed on a label on the back showing the value that should be entered in Parameter C4. If your Stagehand does not have C4 parameter sticker on the back, you can follow this procedure to calibrate the analog speed signal. Note that your stagehand needs to be connected to a motor that can be safely run at full speed (preferably not attached to scenery).

● On the Mitsubishi keypad press **MODE** until the display reads P.0
● Rotate the dial until you get to C…
● Press **SET**
● Rotate the dial to **C4**
● Press **SET**
● Jog forward to 100%
● While jogging press **SET** on the VFD keypad to record the analog input gain. The display on the VFD will flash between your new number and **P C4**

- Stop jogging the motor

TROUBLESHOOTING

If you've reached this section of the manual, things aren't going well. Take a look at some of the common problems and solutions. If none of those help get you up and running, please get in touch with us. Our various methods of communication can be found in the Technical Support section.

Common Problems

Problem	Solution
The motor will not run either from the jog controls or Spikemark	- Confirm that the VFD Keypad is in EXT mode, not PU mode (press the PU/EXT button to change) - Confirm that the Stagehand is connected to a Showstopper 3 Base (or similar) and the E-Stop is released - Confirm that there isn't a drive fault registered on the status displays. If so, press the RESET button on the VFD keypad. - Confirm that there isn't a limit fault on the status display. If so, either move off the limit or use the Limit Override buttons to temporarily defeat it.
When running forward, the encoder position decreases. When running reverse, the encoder position increases	The encoder and motor have electrically inverse polarity. You need to either change the motor wiring or the encoder wiring. Re-wire the motor to match the encoder polarity: - Swap two power legs on the motor by swapping the wires on Pin 1 and Pin 2 inside the motor plug. – OR – Re-wire the encoder to match the motor polarity: - Swap signal A with signal B - Swap signal /A with signal /B You may need to rewire both the Position and Speed encoder signals.
The OLED status display is dark, but the main power indicator is on.	The motion controller may be disconnected internally, to fix it: - Unplug the power cord from the Stagehand. - Remove the side plate of the Stagehand

	● Check that all terminal blocks/RJ45 connectors are securely mated onto the circuit board. Confirm input power has all 3 legs
Motor runs roughly or makes strange noises when jogging manually.	● Run the auto-tuning procedure outlined on page 30. ● Confirm brake(s) are operating
The Stagehand is rolling through FWD/REV/ULTIMATE LIMIT faults and the motor won't move.	● Make sure the Encoder/Limits cable is plugged into the rear of the Stagehand. ● Check the placement of your limit switches, if both are physically activated, adjust the placement to clear one or both switches. ● Check the limit switch wiring, confirm that the switches are wired Normally Closed (N.C.)
I'm trying to jog the motor, but the status display shows "SET IP" or "SET SUBNET".	The motion controller is in IP Address setting mode, which happens when the knob is pressed (either intentionally or just bumped in passing). Turn the knob until the cursor is blinking over the word CANCEL and then press the knob. The motion controller will now be in normal mode and can jog the motor again.
Drive faults whenever the motor tries to move.	There are a few reasons why the drive may be faulting. The first step is to look up the fault code in the Mitsubishi manual that is shown on the VFD keypad. Here are some possible codes and solutions: ● ETHN – overload caused either by too much load, or failure of the brakes to release. Make sure the brake(s) are wired correctly and plugged in. ● ELF – output phase loss caused by the motor being disconnected. Make sure the motor is properly wired and plugged in. ● EOSD – speed deviation error. Caused by a mismatch between encoder feedback and command motor speed. Make sure the Speed Encoder is properly wired and plugged in. ● EECT – encoder signal loss. The Speed Encoder is disconnected, make sure it's wired up and plugged in. ● EOS – over speed. The motor was running faster than the maximum value programmed for the drive. This usually

	means the motor was in free fall. Remove the load from the motor and begin testing in a controlled environment to determine if the machine is healthy.

Technical Support

Despite our best efforts and intentions to provide reliable equipment and clear instructions, there may come a time that you need more direct, personal help. We are happy to do that too. Please get in touch in whatever way is most convenient:

Phone

401-289-2942

We're open weekdays 8:30am – 5:00pm EST. If you call outside of normal business hours (like during tech, or pre-show check, or intermission), please leave a message on the support voicemail. We monitor it off-hours and then draw straws to figure out which support tech calls you back and who gets to eat dinner.

Fax

401-289-0259

Honestly, I don't think anyone uses the fax for tech support, but you are free to be the first.

Email

support@creativeconners.com

Email can be really convenient for tech support if you don't have a time-critical problem. If you are having trouble with a specific cue in a show, please email us your show file and log file from Spikemark with a description of the issue. We respond within 24 hours, but usually it's just a matter of minutes.

SPECIFICATIONS

Physical Specifications
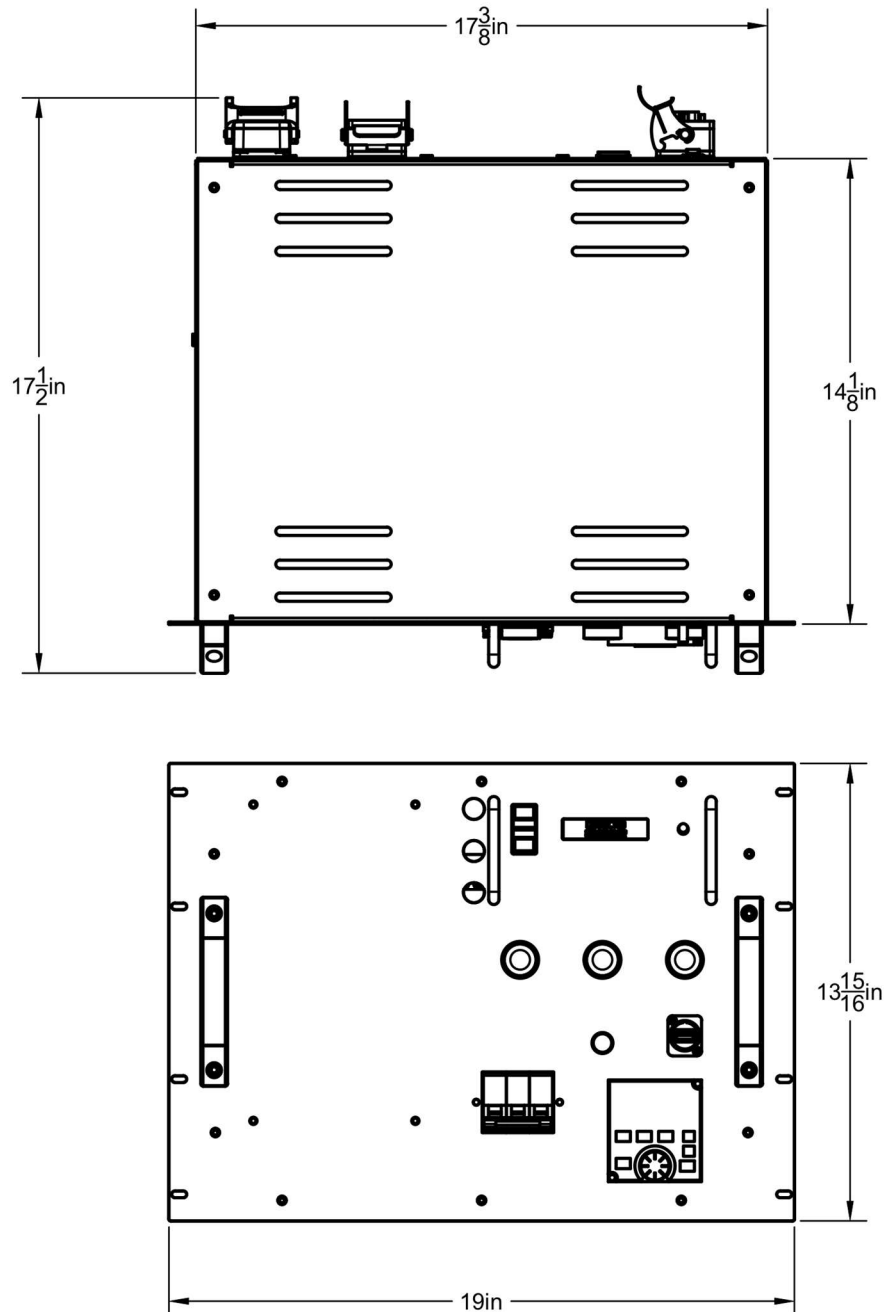
Electrical Specifications

Description	Value
Input Voltage	200VAC-240VAC 50/60Hz 3P or 1P (single-phase input derates output power by 50%)
Max Input Current - 5HP model	30A
Max Input Current - 10HP model	50A
Motor Output Voltage	230VAC 0.2Hz-60Hz
Max Motor Output Power - 5HP model	3HP Heavy Duty 5HP Normal Duty 7.5HP Light Duty *Adjust Mitsubishi VFD parameter 9 to reflect motor current rating.
Max Motor Output Power - 10HP model	7.5HP Heavy Duty 10HP Normal Duty 15HP Light Duty *Adjust Mitsubishi VFD parameter 9 to reflect motor current rating
Min Motor Output Power	2HP (5HP model) or 5HP (10HP model) *Adjust Mitsubishi VFD parameter 9 to reflect motor current rating. **Lower HP possible but auto-tuning is ineffective below 2HP
Minimum Motor Speed	.5Hz
Maximum Motor Speed - Hoisting	60Hz *When hoisting the Stagehand Pro cannot be over-sped because of the overspeed detection safety feature
Maximum Motor Speed – Non-Lifting	120Hz
Motor Brake Output Voltage	200VAC-240VAC 50/60Hz
Motor Brake Output Current	5A max
Load Brake Output Voltage	200VAC-240VAC 50/60Hz
Load Brake Output Current	5A max
Emergency Stop Input Voltage	24VDC
Emergency Stop Input Current	30mA
Forward Limit Switch Voltage	12VDC
Forward Limit Switch Current	10mA
Forward Limit Switch Contact Type	Normally Closed (N.C.) dry contact
Reverse Limit Switch Voltage	12VDC
Reverse Limit Switch Current	10mA
Reverse Limit Switch Contact Type	Normally Closed (N.C.) dry contact
Ultimate Limit Switch Voltage	12VDC
Ultimate Limit Switch Current	10mA
Ultimate Limit Switch Contact Type	Normally Closed (N.C.) dry contact
Speed Encoder Input	5VDC max with differential line driver

Position Encoder Input	5VDC (12VDC tolerant) with differential line driver
Encoder Power Supply Voltage	5.5VDC Increased voltage allows a max of 300' encoder cable
Encoder Power Supply Current Rating	2.4A
Control Input	10Base-T Ethernet

Mitsubishi VFD Parameters

YOU MUST SET PARAMETER 77 = 2 PRIOR TO BEGINNING THE MANUAL RESTORE PROCESS					
No.	**Name**	**Description**	**5HP Stock**	**CM Chain Hoist**	**Floor Pocket**
1	Maximum frequency	Set the upper limit of the output frequency.	120	110	80
2	Minimum frequency	Set the lower limit of the output frequency.	0	0	0
3	Base frequency	Set the frequency at the rated motor torque. (50Hz/60Hz)	60	106	60
7	Acceleration time	Standard time to accelerate a movement.	0	0	0
8	Deceleration time	Standard time to decelerate a movement.	0	0	0
9	Electronic thermal O/L relay	Current rating from the motor nameplate.	17.5	13	17.5
10	DC injection brake operation frequency	Set the frequency at which the brakes will release.	3	0.5	3
13	Starting frequency	Motor won't start until the speed signal is at least this value.	0.5	0.5	0.5
18	High speed maximum frequency	Allows for VFD output at 120Hz or higher.	120	110	80
30	Regenerative function selection	External brake resistor, L1/L2/L3 power source.	1	1	1
70	Special regenerative brake duty	Duty cycle of the braking resistor.	10	10	10
71	Applied motor	Other manufacturers' standard	3	3	3

		motor.			
72	PWM frequency selection	Carrier Frequency. Reduces output noise.	15	15	15
73	Analog input selection	0-5vdc	1	1	1
77	Parameter write selection	Allow parameter writes regardless of operation status.	2	2	2
79	Operation mode selection	Keypad disabled, external control.	0	0	0
80	Motor capacity	Kilowatt rating of motor.(1hp=0.75kw, 5hp=3.7kw, 10hp=7kw)	3.7	2.63	3.7
81	Number of motor poles	governs the base rpm of the motor	4	4	4
83	Rated motor voltage	Set the voltage rating from the motor nameplate.	230	230	230
84	Rated motor frequency	Set the frequency rating from the motor nameplate.	60	106	60
96	Auto tuning setting/status	Offline auto-tuning status. 0 = not set; 1 = auto-tuning initiated, 2 = auto-tuning in progress, 3 = auto-tuning completed. See Stagehand Pro manual for instructions	0	0	0
117	PU communication station number	Specifies the inverter station number.	1	1	1
118	PU communication speed	4800bps	48	48	48
119	PU communication stop bit length / data length	Data length: 8 bits, stop bit: 1 bit	0	0	0
120	PU communication parity check	No parity check.	0	0	0
125	Terminal 2 frequency setting gain frequency	Terminal 2 input gain (maximum) frequency.	60	106	60
180	RL terminal function selection	general input (used to sense load brake relay status)	9999	9999	9999
181	RM terminal function selection	general input (used to sense motor brake relay status)	9999	9999	9999
182	RH terminal function selection	SQ signal, sequence run for PLC mode. Must be shorted to run, open to program	50	50	50

183	RT terminal function selection	general input (used to sense load brake test button)	9999	9999	9999
184	AU terminal function selection	general input (used to sense motor brake test button)	9999	9999	9999
190	RUN terminal function selection	Alarm signal, normally on shuts off if there's a fault	199	199	199
191	SU terminal function selection	general output (used by PLC to indicate a brake relay failure)	9999	9999	9999
192	IPF terminal function selection	general output (used by PLC for motor brake)	9999	9999	9999
193	OL terminal function selection	general output (used by PLC for load brake)	9999	9999	9999
194	FU terminal function selection	General output	9999	9999	9999
252	Override bias	Percentage of analog signal to use for speed signal ***adjust this to overspeed motor	100	100	100
285	Overspeed detection frequency (speed deviation excess detection frequency)	Hz difference between commanded speed and actual that will trip an overspeed fault	20	20	20
331	RS-485 communication station number	RS-485 Communication	1	1	1
332	RS-485 communication speed	RS-485 Communication	48	48	48
333	RS-485 communication stop bit length / data length	RS-485 Communication	0	0	0
334	RS-485 communication parity check selection	RS-485 Communication	0	0	0
338	Communication operation command source	RS-485 Communication	0	0	0
339	Communication speed command source	RS-485 Communication	0	0	0
340	Communication startup mode selection	RS-485 Communication	0	0	0
359	Encoder rotation direction	CCW encoder rotation is forward	1	0	1

368	Feedback gain	Response of the feedback will become slow when the acceleration/deceleration time is long. In such case, increase the setting value	1	1	1
369	Number of encoder pulses	PPR for Vector Control (Floorpocket pre Jan '19 = 2500) All other machines = 1024	1024	1024	1024
374	Overspeed detection level	Inverter shuts down if motor speed is greater than indicated value. (Hz)	9999	9999	9999
376	Encoder signal loss detection enable/disable selection	Inverter shuts down if encoder stops working or encoder signal is lost.	1	1	1
414	PLC function operation selection	enable PLC to run brake switching logic, must be turned off to manually auto-tune motor	2	2	2
549	Protocol selection	MODBUS RTU protocol	1	1	1
550	NET mode operation command source selection	The RS-485 terminals are the command source when in the NET operation mode	1	1	1
551	PU mode operation command source selection	The RS-485 terminals are the command source when in the PU operation mode.	9999	9999	9999
800	Control method selection	0=Vector control, speed control, 10=Sensorless Vector control, 20=Volts/Frequency control	0	0	0
802	Pre-excitation selection	servo lock	1	1	1
818	Easy gain tuning response level setting	1-15 range that governs aggression of easy gain-tuning	2	2	2
819	Easy gain tuning selection	OFF	0	0	0
820	Speed control P gain 1	pgain level, higher for tighter speed control but more oscillation	20	20	20
850	Brake operation selection	zero speed control	1	1	1
853	Speed deviation time	seconds that an overspeed can occur before faulting	1	1	1

903	Terminal 2 frequency setting gain frequency	C4 - Enter the value on the Stagehand cabinet or refer to the manual for details on other methods	TBD	TBD	TBD

PLC Ladder Logic

```
0    Y3        X4                                                      K2        T0
     LOAD_BRA  LOAD_BRK                                            (T0        A/S    14
     KE        _SENSE                                              RLY_DEBO   A/S
                                                                   UNCE

     Y2        X3
     MOTOR_BF  MOTOR_BR
     AKE       K_SENSE


9    Y3        X4        T0                                     [SET   M3     M3
     LOAD_BRA  LOAD_BRK  RLY_DEBO                                      BRAKE_RL  A/S   15
     KE        _SENSE    UNCE                                          Y_FAULT   B/D   30    43    63    89

     Y2        X3
     MOTOR_BF  MOTOR_BR
     AKE       K_SENSE


26   Y3        X4        Y2        X3                            [RST   M3     M3
     LOAD_BRA  LOAD_BRK  MOTOR_BF  MOTOR_BR                             BRAKE_RL  A/S   15
     KE        _SENSE    AKE       K_SENSE                             Y_FAULT   B/D   30    43    63    89


43   M3                                                              (Y1        Y1
     BRAKE_RL                                                        BRAKE_FA
     Y_FAULT                                                         ULT_SIGN
                                                                     AL


45   [>        SD1134    K150      ]                                 (M0        M0
                                                                    MIN_CURR    A/S   49    58    77    79
                                                                    ENT         A/S


49   M0        X0        SM1216              SM1223    M3          (Y2        Y2
     MIN_CURR  STF       RUNNING             ALARM     BRAKE_RL    MOTOR_BR    B/D    2    11    28
     ENT                                               Y_FAULT     AKE         B/D

     X7        X6        SM1216    X1        X0
     MBRAKE_T  LBRAKE_T  RUNNING   STR       STF
     EST_BTN   EST_BTN

     M0        X1        SM1216
     MIN_CURR  STR       RUNNING
     ENT
```

```
      M0       X0                          SM1223    M3                                    ( Y3    )  Y3
77   |  |     |  |                          |/|       |/|                                    LOAD_BRA  B/D|    0|    9|   26|        |
     MIN_CURR STF                          ALARM    BRAKE_RL                                 KE        B/D|
     ENT                                            Y_FAULT


      M0       X1
     |  |     |  |
     MIN_CURR STR
     ENT


      X7       X6      SM1216    X1       X0
     |/|      |  |     |/|       |/|      |/|
     MBRAKE_T LBRAKE_T RUNNING  STR      STF
     EST_BTN  EST_BTN


102  ─────────────────────────────────────────────────────[END  ]
```

Wiring Diagram

The next page has a reduced scale copy of the Stagehand Pro 3 wiring diagram.

creative conners, inc.

Stagehand Pro 3

Schematic
Scale: N/A
Drawn on: 5/21/2018
Drawn By: Steven Ferrier

REVISIONS

Rev.	Drawn	Date	Revisions
A			

tolerances:
.X : ±¹⁄₁₆"
.XX : ±0.010
.XXX : ±0.003

the information contained in the drawing is the property of creative conners inc.

1

USB TYPE B JACK
X5

PRO MOTOR CONNECTOR
MENCOM CXF-4/8
104mm x 27mm (2/8)
4P/8P 50A FEMALE
CXF-4/8

Mitsubishi A8AP
Mitsubishi A800 (200V)

R1

Motor Brake — CR4
Load Brake — CR5

E-Stop 2 — CR3
E-Stop 1 — CR2

Schneider Preventa
XPSAF5130
CR1

PS1
Power Supply
60W

POWER INDICATOR

CB1

CPM-06
MENCOM CPM-06
77mm x 27mm (1x8)
6P 35A MALE

X4 RJ45 Jack
X2 RJ45 Jack
X1 RJ45 Jack

X2 RJ45 Jack
X3 RJ45 Jack
X5 RJ45 Jack

ETHERNET RJ45 Jack
X6 RJ45 Jack

Stagehand Unipolar rev F control card

X4 RJ45 Jack
X2 RJ45 Jack
X3 RJ45 Jack
X1 RJ45 Jack

Pro Signal Adapter PCB
CDDF-24

BRAKE TEST PCB
X2 RJ45 Jack

X2 XLR 5-PIN NC5MD-L-B-1 e-stop plug
X1 XLR 5P Plug

SIGNAL CONNECTOR
MENCOM CDDF-24
44mm x 27mm (I/8)
24P 10A FEMALE
X3

KEY

— CAT5 CABLE
— LOW VOLTAGE
— HIGH VOLTAGE

Models

Horsepower	HV Wire AWG	CB1 Rating	CR2 & CR3 Rating
2HP	12AWG	10 A	32 A
5HP	12AWG	30 A	32 A
10HP	6AWG	50 A	50 A

RJ45 PINOUT

Brown (8)
Brown/White (7)
Blue/White (5)
Blue (4)
Green/White (3)
Orange (2)
Orange/White (1)