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cLEAN Drive (MH300)
Configuration with cLEAN Motor

Important User Information

This document is based on the user manual for the MH300 series from Delta. The manufacturer's user manual contains all relevant information on installation, configuration, operation and maintenance of the drive. Read the user manual before working with the device.

You can download the latest document version of the user manual free of charge from the manufacturer's website at the following link:
https://downloadcenter.deltaww.com/en-US/DownloadCenter?v=1&dataType=2&q=MH300%20Series&sort_expr=cdate&sort_dir=DESC.

All Activities are required to be performed by qualified personnel to ensure all safety, codes, laws and standards are met. The activities described in this document are meant as a reference only.

In no event shall STOBER Drives Inc. be liable for any direct, indirect, punitive, incidental, or special consequential damages to property or life whatsoever arising out of or connected with the use or misuse of the product/device.

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cLEAN Drive (MH300) Configuration

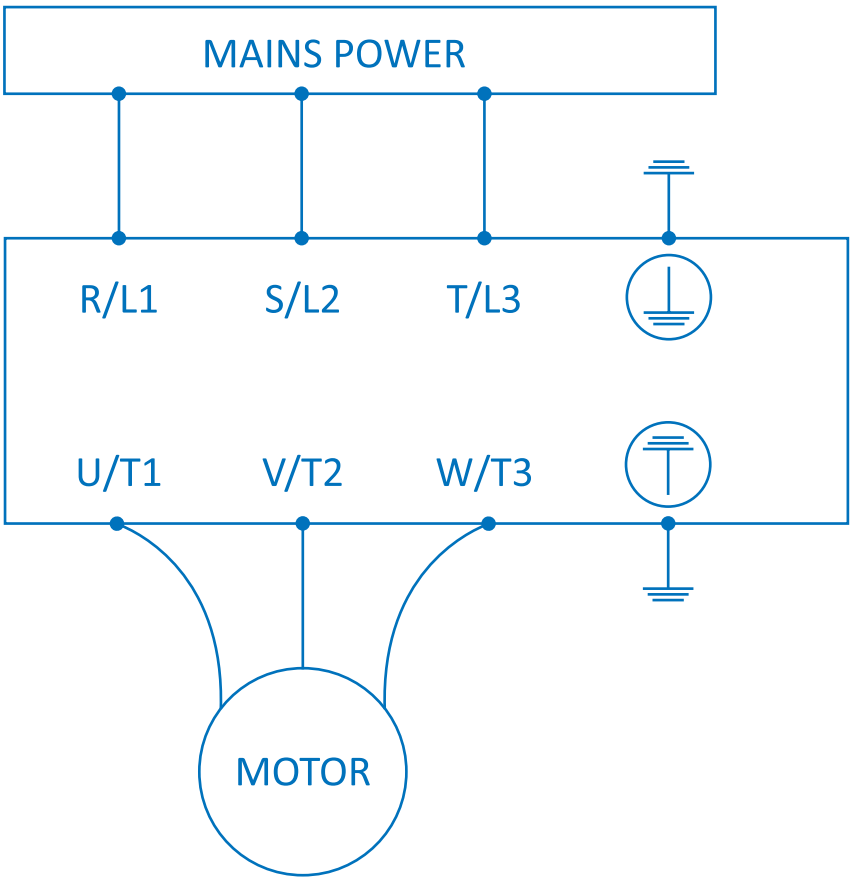
Overview

This document covers the MH300 drive controller (cLEAN Drive) and how it is best used with the STOBER cLEAN Motor. It will cover drive configuration using the interior permanent magnet (IPM) sensorless control scheme. Additional information, such as wiring configuration, application examples, communication options, and additional parameters, will also be discussed.

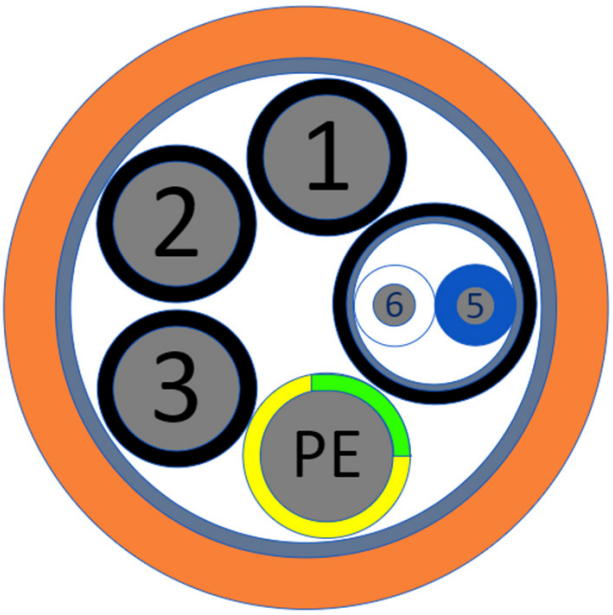
For any questions when installing, configuring, operating, or servicing the STOBER cLEAN System, contact STOBER for assistance.

cLEAN Drive Wiring

Power Wiring



cLEAN Cable



Wire Label	Signal	Color
1	U/L1	BK - 1
2	V/L2	BK - 2
3	W/L3	BK - 3
-	Ground (PE)	Green & Yellow
5	PTC or Disconnect	Blue or Black
6	PTC or Disconnect	White

cLEAN System Wiring with Motor Disconnect

Figure 1 shows the typical motor disconnect application and the best practice for wiring and grounding. Shielding for the power circuits (outer shield) shown in red, should be terminated at the motor side along with the PE of the motor. The outer shield should then be carried separately through the disconnect box back to the PE (⏚) connections on the drive. The inner shield (shown in gray), around the inner twisted pair that is used for feedback/control, should only be grounded back at the source (drive) PE connection.

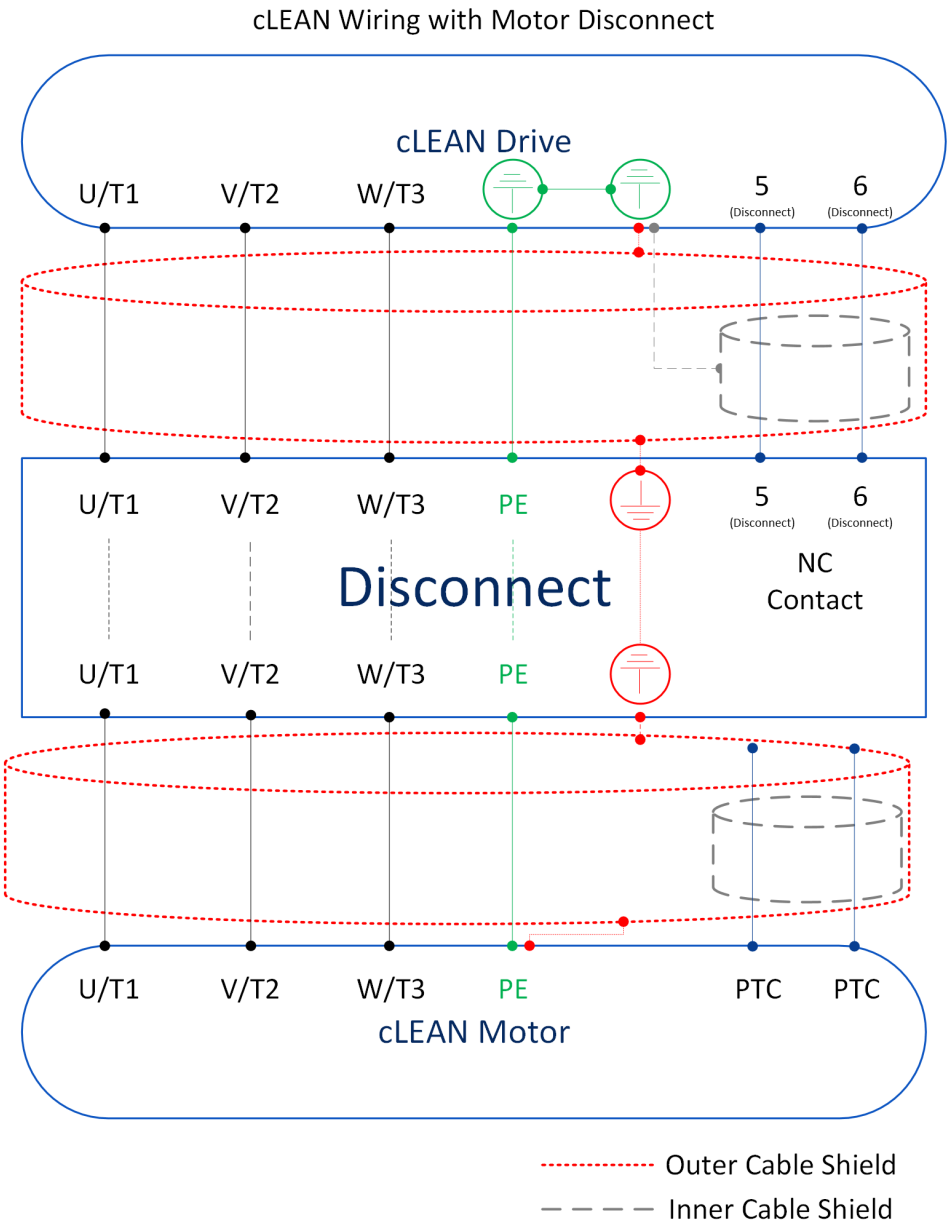


Figure 1: cLEAN Wiring with Motor

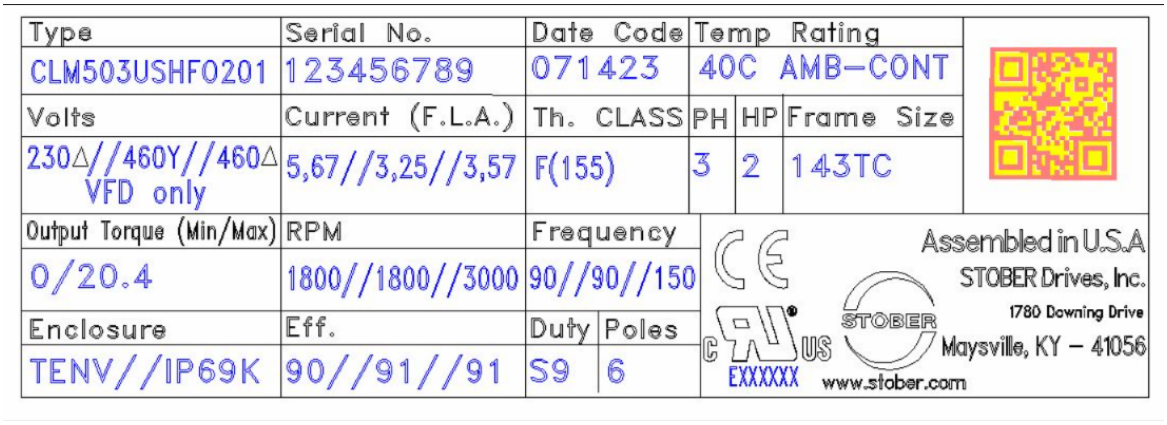
cLEAN Motor Specifications

The technical data specified in the table below shows information for 1 and 2 horsepower cLEAN Motors for operation on three phase 230VAC and 480VAC.
This data only applies to:

- Installation altitudes up to 1000m above sea level
- Surrounding temperatures from 5 °F – 104 °F
- Operation on MH300 drive controller

Technical Data cLEAN 50X													
Typ	**P_N** [Hp]	**U_{AC}** [V]	**n_N** [rpm]	**M_N** [in-lb]	**I_N** [A]	**KM_N** [in-lb/A]	**P_N** [kW]	**η_{mot}** [%]	**M_{max}** [in-lb]	**I_{max}** [A]	**m** [lb]	**KEM** RMS string values 68°F/257°F [V/1000 rpm]	**Temp. Rise** @ Rated Load in the Winding [K]
cLEAN502U	***1***	460Y	1800	35.30	1.60	22.06	0.75	90.77	113.29	4.86	35.00	94/84	115.00
cLEAN502U	***1***	230Δ	1800	35.30	2.73	12.93	0.75	88.18	113.29	8.42	35.00	54/49	134.50
cLEAN502U	***1***	460Δ	3000	21.15	1.74	12.16	0.75	90.62	113.29	8.42	35.00	54/49	107.70
cLEAN503U	***2***	460Y	1800	70.54	3.25	21.70	1.50	91.00	180.56	7.76	44.75	92/82	185.00
cLEAN503U	***2***	230Δ	1800	70.63	5.67	12.46	1.50	88.90	180.56	13.44	44.75	53/48	206.00
cLEAN503U	***2***	460Δ	3000	42.31	3.57	11.85	1.50	90.94	180.56	13.44	44.75	53/48	144.10

The information for the specific motor can also be found on the motor's nameplate. Relevant information can also be found by scanning the QR code or entering the serial number on the STOBER website.



cLEAN Motor Open Loop Control Setup

This section will step through the process for configuring the MH300 for IPM Sensorless control mode for operation with the cLEAN Motor. The drive is preconfigured from STOBER with this already setup, so this only needs to be conducted if the drive is reset. However, it is recommended to start step 5 in this process with the exact motor that will be in operation with the drive for production.

Step 1 Reset Parameters.
Reset Pr.00-02 = 10.
This resets all parameters to default values..
Step 2 Choose Motor Type.
Set Pr. 05-33 = 2 IPM Sensorless Control for the cLEAN Motor.
Step 3 Input Motor Nameplate Parameters.
Enter the motor nameplate parameters.

Parameter	Description	Example (cLEAN503U 460V_{AC})
Pr. 01-00	Max operating frequency (Hz)	150 Hz
Pr. 01-01	Rated frequency (Hz)	90 Hz
Pr. 01-02	Rated voltage (V_{AC})	460 V_{AC}
Pr. 05-33	PM motor type (IPM)	2
Pr. 05-34	Rated current (A)	3.25
Pr. 05-35	Rated power (kW)	1.5
Pr. 05-36	Rated rotor speed (RPM)	1800
Pr. 05-37	Number of poles of the motor (poles)	6

Step 5 Perform Auto-Tune.
Set Pr. 05-00 = 5 (rolling auto-tune for PM, without motor mounted) or 13 (static auto tune for PM, with motor mounted)and press the RUN key, or issue a valid run command, to start motor auto-tuning. If done correctly, the drive will populate the following parameters:

Parameter	Description	Example (cLEAN503U 460V_{AC})
Pr. 05-39	Stator resistance for a permanent magnet motor (Ω)	3.744 Ω
Pr. 05-40	Permanent magnet motor Ld (mH)	17.17 mH
Pr. 05-41	Permanent magnet motor Lg (mH)	38.82 mH
Pr. 05-43	Ke parameter of a permanent magnet motor ($V_{phase,rms}$ / krpm)	96

The auto-tune process will display “Tun” on the drive and should take about 30sec to complete. Stop the drive if it says "in run mode" after the auto-tune. If an auto-tune error (AUE) occurs, refer to “Fault Codes” in the MH300 User Manual for troubleshooting.

Step 6 Set Control Mode.
Control mode for the drive: Pr. 00-10 = 0: Speed mode
Control mode for the motor: Pr. 00-11 = 2: PMSVC Control

Parameter	Description	Example (cLEAN503U 460VAC)
Pr. 00-10	Control method	0: Speed Control
Pr. 00-11	Speed Control Mode	2: PMSVC

Step 7 Power Cycle.
Cycle the power again.
Step 8 Initial Angle Detection.
Set the initial magnetic pole angle detection method to high frequency injection.

Parameter	Description	Set Value
Pr. 10-53	Angle detection method	2: High Frequency Detection

Step 9 Test with no load/light load and with a load.
Test the motor both with no load/light load and with a load. If the motor experiences abnormal behavior such as not running stably or causing over current faults on the drive, refer to “PM SVC adjustment procedure” for troubleshooting.

IPM Sensorless Adjustment Flowchart

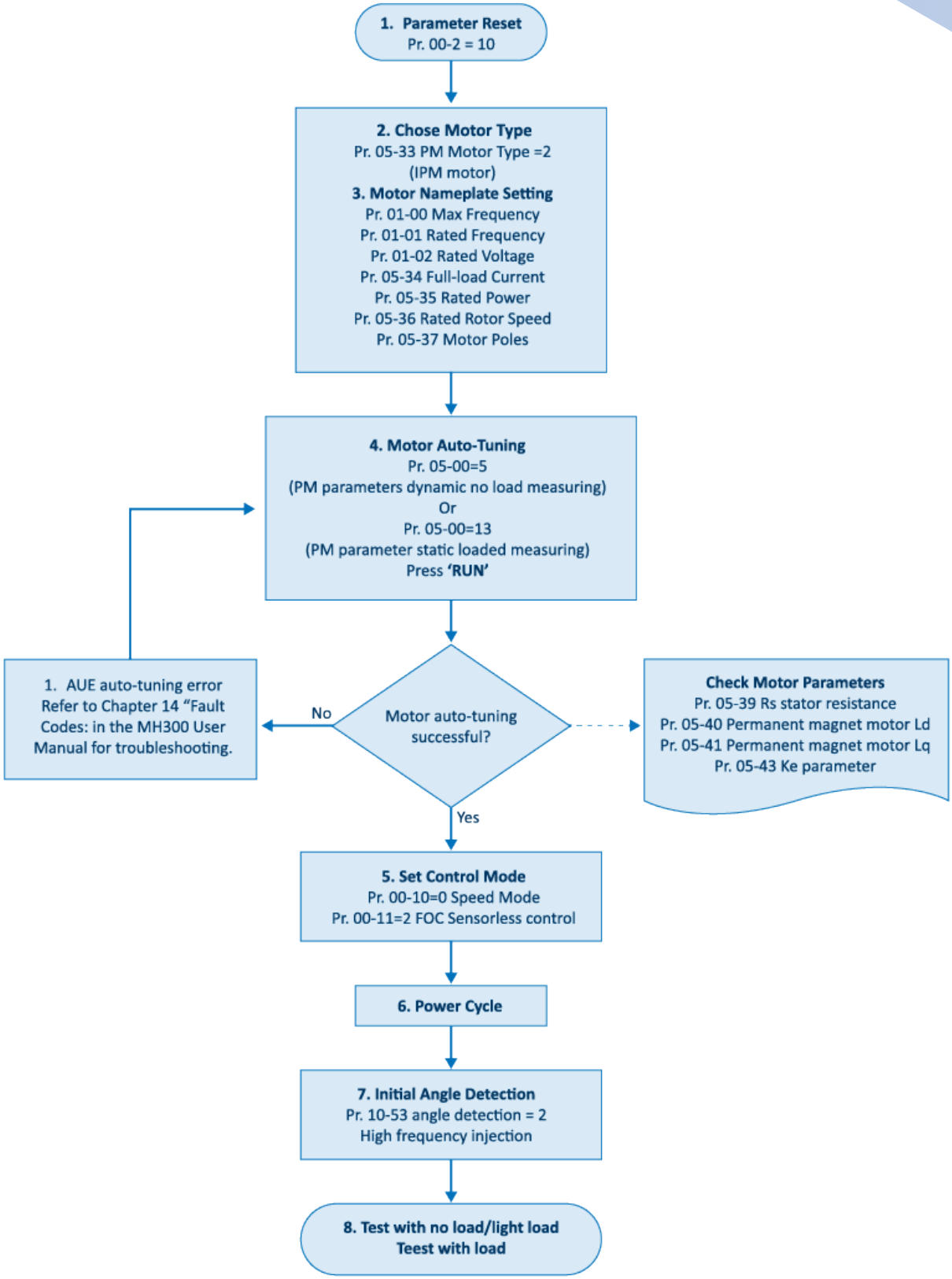


Figure 2: IPM Sensorless Adjustment Flowchart

Removable Keypad Parameter Storage

The MH300's removable keypad has the added functionality to store 4 different parameter sets that can be copied to the drive at any time. The default parameter set from STOBER will be stored in "File1" from the factory. This can be used at any time to revert back to the settings that were delivered from STOBER. Navigate the keypad using the "Menu" button until it says "Read" or "Write" to access this functionality.

Read

The "Read" command will allow the user to save all active parameters on the drive to one of the 4 parameter storage files on the keypad. This will overwrite what is currently stored in the file slot.

Copy from VFD to Keypad.

Write

The "Write" command will allow the user to write all stored parameters from one of the 4 storage files on the keypad to the drive.

It is recommended that an Auto-Tune is preformed after a parameter write, especially if the drive's parameters were reset. Some critical motor information is only written during Auto-Tune, even if it was previously saved in the keypad storage.

Copy from Keypad to VFD.

cLEAN System Application Example

Figure 3 shows the wiring for starting the motor through input as well as properly integrating a motor disconnect. By default, the MH300 is set to sink mode but can also be set to source mode with the slide switch located on the control board. Refer to the control board layout diagram on the back of the front cover for more details.

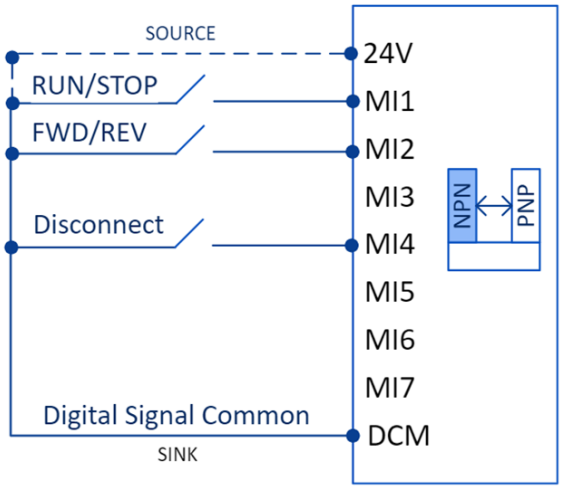


Figure 3: cLEAN Input Wiring Example

Starting Method

The drive controller can be started from the “Run” button on the keypad by default. This section will discuss how to start the drive from an external input, such as a button or relay.

1. Setting Pr. 00-21 = 1 will allow the drive to only be started from an external signal into the input terminals.

Pr. 00-21 Operation Command Source	
Settings:	0: Digital Keypad (default)
	1: External terminals
	2: RS-485 communication
	5: Communication Card

2. Setting Pr. 02-00 = 2 will allow for the two-wire operation shown in the wiring example above

Pr. 02-00 Two-wire/Three-wire Operation Control	
Settings:	0: No function
	1: Two-wire mode 1, power on for operation control (M1: FWD / STOP, M2: REV / STOP5: Two-wire mode 2, Quick Start (M1: RUN / STOP, M2: FWD / REV)
	2: Two-wire mode 2, power on for operation control (M1: RUN / STOP, M2: FWD / REV)
	3: Three-wire, power on for operation control (M1: RUN, M2: REV / FWD, M3: STOP)
	4: Two-wire mode 1, Quick Start (M1: FWD / STOP, M2: REV / STOP)
	5: Two-wire mode 2, Quick Start (M1: RUN / STOP, M2: FWD / REV)
	6: Three-wire, Quick Start (M1: RUN, M2: REV / FWD, M3: STOP)

3. Choosing a NO contact is recommend for ease of integration.
   3.a. If a NC contact is used, Pr. 2-12 will need to be set correctly to allow for proper operation.

Motor/Output Disconnect

Due to the control scheme needed for the cLEAN motor as well as the potential of damage to the drive, it is not recommended to use an inline disconnect to cut power to the motor while the drive is outputting. The drive is meant to be controlled by either an input signal or from the keypad. If a disconnect is needed to disconnect and reapply power to the motor, an early break auxiliary contact is recommended be installed in the disconnect to enable the drive to stop outputting.

The above wiring example shows the disconnect enable being wired into MI4. It is recommended to use this terminal for the disconnect signal due to it being preconfigured from STOBER for this purpose. However, MI5, MI6 and MI7 are also available if desired. Use the same steps below but using Pr. 02-05 – Pr. 02-07 for configuring the other input terminals.

1. Setting Pr. 02-04 = 12 will set the input signal to MI4 for output stop.

Pr. 02-04 Multi-function Input Command	
Settings:	0: Digital Keypad (default)
	12: Output Stops

2. Choosing a NC contact is recommended for ease of integration.
   2.a. If a NO contact is used, Pr. 2-12 will need to be set correctly to allow for proper operation.
3. The STOBER cLEAN Cable has an internal shielded twisted pair, number 5 & 6, that can be used for the connection from the auxiliary contact to the drive input terminal.

Thermal Protection

The cLEAN System has three reliable solutions for providing thermal protection for the motor. Using wire 5 and 6 in the cLEAN cable, the PTC or PT1000, located within the motor's stator, can be used to provide accurate temperature measurement of the stator. If wires 5 and 6 are used for an external disconnect then the drive's I2T model can be used.

PTC

PTC in the cLEAN motor is a triplet that acts like a switch when it reaches a set level (4000Ω). When using PTC with the cLEAN motor, a separate resistor, R1, is needed for getting accurate temperature measurement. The wiring for PTC integration is shown. The correct PTC Level is configured from STOBER when using the resistor included with the cLEAN Drive.

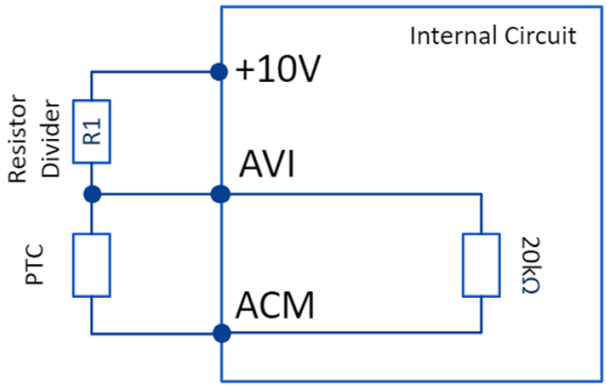


Figure 4: PTC Wiring Example

1. Setting Pr. 03-00 = 6 will configure the input for PTC.
2. Setting Pr. 06-28 will set the operation mode of the drive for PTC trigger level. Recommend value is 1 or 2 to for best motor protection.
3. Setting Pr. 06-30 will set the PTC trigger level.
    a. Use the formula below to determine trigger level from the resistor divider.

$$(Pr.06-30) = \left(10.5 * \frac{3333.33}{(R_1 + 3333.33)}\right) * 10$$

$$R_1 : Resistor\ divider - between\ 1k\ and\ 10k\Omega$$

Pr. 03-00 AVI Analog Input Selection	
Settings:	0: No Function
	6: PTC Value

Pr. 06-29 PTC Detection Selection	
Settings:	0: Warn and continue operation
	1: Fault and ramp to stop
	2: Fault and coast to stop
	3: No warning

Pr. 06-30 PTC Level	
Settings:	**52%**

PT1000

PT1000 is only installed in one phase of the motor so it does not provide as much protection as PTC, but it has a more linear response which lets the drive and other associated devices know an actual value for the motor temperature.

When the motor temperature is higher than the Pr. 06-56 setting, the drive will operate at the frequency set for Pr. 06-58 until the motor temperature is lower than the Pr. 06-56 setting. If the motor temperature is higher than Pr. 06-57 the motor will automatically decelerate to STOP and display a fault.

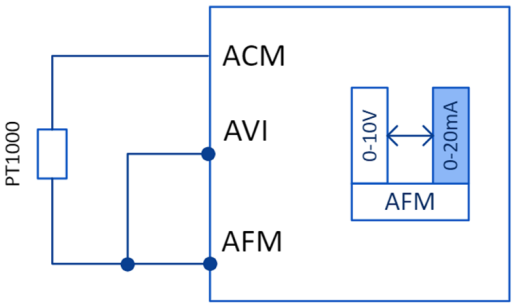


Figure 5: PT1000 Wiring Example

1. Switch the AFM slide switch, that is located on the control board, to 0-20 mA.
    a. The location of the slide switches can be found on the back of the front cover of the drive.
2. Setting Pr. 03-00 = 11 will configure the AVI input to be PT1000.
3. Setting Pr. 03-20 = 23 will configured the AFM terminal for constant current mode.
4. Setting Pr. 03-31 = 1 will configure the AFM terminal to output between 0-20mA.
5. Setting Pr. 03-32 = 25% will configured the AFM terminal to output a constant 5mA.
6. Setting Pr. 06-56 = 7.59V will start the activation level timer at 135°C.
7. Setting Pr. 06-57 = 7.77V will stop the motor at 145°C.
8. Setting Pr. 06-58 = desired level, will cause the motor to operate at the set frequency after the Pr. 06-59 time delay until the motor temp is lower than Pr. 06-56 level.
9. Setting Pr. 06-59 = desired time, starts when motor is at Pr. 06-56 level and will delay the motor before it decelerates to the Pr. 06-58 setting.
10. If the temperature gets higher than Pr. 06-57, the drive automatically decelerates the STOP and displays the warning “OH3”.

Parameter	Description	Set Value
Pr. 03-00	AVI Analog Input Selection	11: PT1000
Pr. 03-20	AFM Multi-function Output	23:Constant current/voltage
Pr. 03-31	AFM Output Selection	1: 0-20mA
Pr. 03-32	AFM DC Output Setting Level	25% (5mA)
Pr. 06-56	PT1000 Voltage Level 1	7.56V
Pr. 06-57	PT1000 Voltage Level 2	7.75V
Pr. 06-58	PT1000 Level 1 Frequency Setting	Desired Level
Pr. 06-59	PT1000 Level 1 Activation Delay Time	Desired Level

I^2T

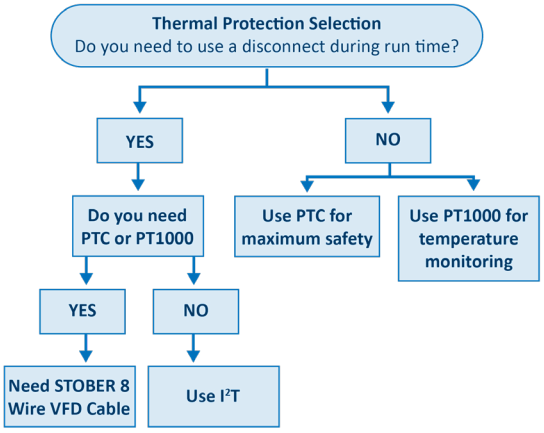
If the 5th and 6th wires are being used for the motor disconnect, the MH300 has a built in I2T model that can provide supplementary protection to the motor based on the amount of current being consumed. The I2T model can be used in conjunction with the thermal feedback from the motor.

1. Setting Pr. 06-13 = 0 will enable the I^2T model of the drive.
2. Leaving Pr. 06-14 = 60 sec. will set the desired model for motor protection.

Parameter	Description	Set Value
Pr. 06-13	Electronic Thermal Relay Selection	11: 0 (motor with external cooling)
Pr. 06-14	Electronic Thermal Relay Action Timer	60.0 secs

Scaling the User Display

The cLEAN Motor has 6 poles. Because of this, the nominal speed of 1800 rpm is at 90 Hz for the cLEAN Motor whereas for many NEMA induction motors nominal (1750 rpm) is at 60 Hz. The user display can be configured to mimic a 4 pole induction motor frequency setting so as not to change processes if desired. The output will automatically scale based on the input, so if the user inputs 60 Hz, the drive will output 90 Hz to maintain the same output rpm. This is preconfigured from STOBER, if the user desires to not have the display scaled set the below parameters to 0.



1. Setting Pr. 00-25 = 2 will make the display show two decimal places.
2. Setting Pr. 00-26 = 60 Hz will scale the display to input a max of 60 Hz.
    a. Note – this setting needs to be 2/3 of the max motor frequency (Pr. 01-00) to have proper scaling to simulate a 4 pole motor frequency setting.

Parameter	Description	Set Value
Pr. 00-25	User-Defined Characteristics	2: Two decimal places
Pr. 00-26	Maximum User-Defined Value (Keypad)	60.00 Hz

Communication Card Option - CMM-EIP03

STOBER is providing the CMM-EIP03 communication extension card capability of EtherNet/IP and Modbus TCP. For installation and wiring, refer to "Option Card Installation" in the MH300 User Manual.

The default static IP address is 192.168.1.5 with a Netmask of 255.255.255.0 and default gateway of 192.168.1.1. An EDS file is available on the manufacturers website for the CMM-EIP03. Loading the EDS file into the respective software will allow the user to configure the IP address to the desired value. Note, a reboot might be needed to save the IP configuration to the drive.

The IP address, netmask and gateway are saved in Pr. 09-75 – Pr. 09-87, in the MH300 user manual for more information.

All of the Modbus ASCII commands for reading and writing to the drive are in the MH300 User Manual under Appendix A. Modbus Protocol.
The following parameter changes are needed to remotely communicate to the drive:

1. Setting Pr. 00-20 = 8 will set the frequency to be controlled by the communication card interface.
2. Setting Pr. 00-21 = 5 will set the operation source to be controlled by the communication card.
3. Setting Pr. 09-30 = 0 will correctly configure the EtherNet/IP communication card decoding method.

Parameter	Description	Set Value
Pr. 00-20	Frequency Command Source	8: Communication Card
Pr. 00-21	Frequency Command Source	5: Communication Card
Pr. 09-30	Decoding Method	0: 2000h-20FFh

Additional Useful Parameters

Pr. 00-22 Stop Method	
Settings:	0: Ramp to stop
	1: Coast to stop

Pr. 00-47 Output Phase Order Selection	
Settings:	0: Standard
	1: Reverse the rotation direction

Pr. 01-12 Acceleration Time 1	
Settings:	0.00 - 600.00 sec.

Pr. 01-13 Deceleration Time 1	
Settings:	0.00 - 600.00 sec.

Error Codes

This document will review error codes that could occur when using the cLEAN System.

Rotor Position Detection Error – RoPd : This error can occur when the drive is outputting while not connected to the cLEAN Motor. This could occur if trying to operate the motor and the disconnect is off without an auxiliary.

Motor Overheating - oH3 : This error occurs when the PTC or PT1000 input is greater than or equal to the set value for the motor overheating trigger level. This can occur if the motor is being consistently

overloaded causing the motor to heat up or if there is a connection issue between the PTC/PT1000 and the drive.

Over-current – oc : Four types, during acceleration, during deceleration, during steady operation, during stop. This trips when the drive output exceeds three times the rated current. There are many factors that can cause this from acceleration time, loading amount, input voltage issues, improper programming.

Ground Fault – GFF : This usually indicates a short in the wiring, but there have been occasions that excess current due to improper programming can cause this. There is also Before Ground Fault (b4GFF) which occurs before running the motor. This is likely a hardware issue with the drive or motor.

Over Voltage – ov : Four types, during acceleration, deceleration, constant speed, at stop. This is when the DC Bus exceeds its maximum allowed trip value. This can be caused by sudden load changes, input voltage too high, need for a brake resistor.

Low Voltage – lv : Four types, during acceleration, deceleration, constant speed, at stop. This is usually caused by input power conditions where a sag on the input power occurs due to various reasons. It could be caused by sudden loads as well.

Electronic thermal relay 1 protection - EoL1 : This occurs when the I2T model of the drive trips due to current monitoring on the output. This is likely caused by either the motor being overloaded for too long, accel/decel duty cycle too short or an improper parameter setting.

Emergency Stop – EF1 : This occurs when the drive input for emergency stop is triggered. This is a deliberately programmed setting by the customer to a drive input. If the drive trips from this, it is likely a programming issue or a hardware issue on the input device.

Safe Torque Off – STo : Like the Emergency Stop fault, this is a deliberately programmed setting by the customer to some drive input. If the drive trips from this, it is likely a programming issue or a hardware issue on the input device.

Auto-Tune Error – AUE : This is a failure that occurs during auto-tuning of the motor. This can occur if the wrong auto-tune method is chosen, if the motor is not wired properly, if the disconnect is off, if nameplate value of the motor is improperly configured or if the motor has a defect.

Internal Communication Error – CEX, SEX, CPX, EoL3/4, ECoX : There are several internal communication errors, and each relate to a specific issue that ranges from reading and writing from Keypad to drive, USB read/write issue, Modbus read/write, EtherNet/IP etc. This is likely caused by a read/write occurring during runtime on a parameter that is not accepted or by a read/write setting for a parameter that is outside the parameter range.

Speed Feedback Error – Svx : This error occurs when the drive loses control of the motor and cannot recover. This can be due to many factors such as improper programming/configuration (wrong motor nameplate information, wrong control scheme, etc.) or extremely high load or speed changes, especially at low speed.