Kyntronics
Innovation in Motion

TECHNICAL REPORT

TR-358

INTERFACE FOR ETHERNET/IP EXAMPLE PRESS

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1 PURPOSE

To provide guidelines for interfacing a Kyntronics Smart Hydraulic Actuator (SHA) custom system over Ethernet/IP.

2 USER INTERFACE OVERVIEW

The system consists of an SHA (Smart Hydraulic Actuators) and control panel with Nidec Control Techniques Drives and associated hardware and cabling for the actuator.

The system presents a user interface consisting of two STO signals for the M750 drives, or one STO signal for the M700 drives, and Ethernet/IP ports.

An optional keypad/display may also be added to the M750 drives to inspect and modify settings, and jog the unit. The M700 drives include the keypad/display.

Each drive has two RJ45 Ethernet sockets, labeled 1 and 2; right below the keypad. Socket 1 should be used for Ethernet/IP communication with the customer's host device. Socket 2 may be used simultaneously for Ethernet communication with a laptop for programming or monitoring the drive.

Drive communication can utilize both protocols of the Ethernet/IP suite: Implicit and Explicit Messaging.

Ethernet/IP Implicit Messaging is the faster of the two, but with fixed content. The host PLC continuously writes to the Command register and a few target values. The SHA continuously returns Status, Position, and Fault Code.

Ethernet/IP Explicit Messaging can access all of the drive's registers. Explicit Messages are typically used to modify motion parameters which change less frequently. But it is possible to do the whole interface with just Explicit Messages.

3 STO (SAFE TORQUE OFF)

STO (Safe Torque Off) is a method of reliably disabling a motor for safety purposes, without shutting off the drive's electrical power. The M750 drives are equipped with two electrically isolated 24VDC STO discrete inputs, and the M700 drives each have one STO input. Typically, they are tied to a safety relay, as part of an E-stop circuit. Turning off STO does not interfere with any logic or communications functions of the drive. The installation print shows the STO terminals on the drives.

If the M750 drive's STO inputs are not satisfied, the M750 display will show "n" (for no torque). If the STO inputs have 24 Vdc applied and the DC bus has full power, the display will show "A" to show torque

is being applied to the motor. (A display of “U” means the DC bus is undervoltage, so no torque control is possible.)
If the M700 drive’s STO input is not satisfied, the M700 display will show “Inhibit” (for no torque). If the STO input has 24 Vdc applied and the DC bus has full power, the display will show “Stop 0 rpm” to show torque is being applied to the motor, or it will show “Run xxxx rpm” when STO is satisfied and motion is being commanded.

4 TRANSDUCERS AND SCALING

4.1 M750 Units

The position of the cylinder rod is measured by a non-contact linear transducer. It senses the absolute position of the rod as soon as powered, without a homing procedure or external reference or battery. The transducer output is digital (SSI), with a resolution of 50 steps per millimeter, and reports position to the nearest hundredths of millimeters. A feedback position of 1250 represents the rod extended by 12.50 mm from the 0 mm position. The quoted rod stroke is 279.4 mm (11.0”). Driving the rod into the hard end stops in either direction should be avoided; stay a couple of mm short of those end positions.

If an analog position sensor is used, then the drive parameter 18.052 will specify the maximum position in whatever units are desired (mm or inches), and longer sensors will have lower positional resolution.

This example will use position with mm*100 scaling, which is the most common SSI unit and scaling. Some actuators are setup with inch*1000 scaling, if inch units are requested.

The position value increases as the rod extends. The transducer has no internal adjustments.
The transducers actual zero position is always inboard of the rod’s fully retracted position.
The system subtracts a constant called ZeroOffset to define a reachable position as “zero”.
This constant is set at the factory extremely close to the fully retracted position.
ZeroOffset is readable and adjustable via the optional keyboard/display or Connect software at drive menu 18.051.

Should you adjust the ZeroOffset parameter with Connect, be sure to click the “Save parameters in drive” icon. If using the optional keypad, execute the “Make Changes Permanent” procedure below.

A pressure sensor provides the force feedback via analog input 1 on the drive. This value is scaled per the swept area of the piston, to produce force in pounds. Full scale on this device is 14,726 pounds; however, the quoted working force is 10,000 pounds with 50% duty cycle.

The retract force can only be measured if there is a retract pressure sensor (or a loadcell). The unit is capable of 10,272 pounds force in the retract direction.

NOTE: If a loadcell will be used, then it is good practice to use a signal conditioner between the load cell output and the drive’s analog input.

The raw ADC pressure sensor value is viewable with the optional keypad, or through Connect software.
Extend Force ADC: Menu 0.07.001, raw analog input #1. It is scaled -100% to +100%.

4.2 M700 Units

The position of the cylinder rod is measured by a non-contact linear transducer. It senses the absolute position of the rod as soon as powered, without a homing procedure or external reference or battery.

The position value increases as the rod extends. The transducer has no internal adjustments.
The transducers actual zero position is always inboard of the rod's fully retracted position.
The system subtracts a constant called ZeroOffset to define a reachable position as "zero".
This constant is set at the factory extremely close to the fully retracted position.
The ZeroOffset is readable and adjustable via the optional keyboard/display or Connect software at drive menu 18.051.

Should you adjust the ZeroOffset parameter with Connect, and then be sure to click the "Save parameters in drive" icon. If using the optional keypad, execute the "Make Changes Permanent" procedure explained in a later section.

A pressure sensor provides the force feedback via analog input 1 on the drive. This value is scaled per the swept area of the piston, to produce force in pounds. Full scale extend force on this device is 84823 pounds; however, the quoted working force is 70000 pounds with 50% duty cycle.

The retract force can only be measured if there is a retract pressure sensor (or a loadcell). The unit is capable of 55960 pounds force in the retract direction.

NOTE: If a loadcell will be used, then it is good practice to use a signal conditioner between the load cell output and the drive's analog input.

The raw ADC pressure sensor value is viewable with the optional keypad, or through Connect software.
Extend Force ADC: Menu 0.07.001, raw analog input #1. It is scaled -100% to +100%.

5 CONTROL MODES

The interface supports closed-loop control of position mode, closed-loop force limited position mode, and closed-loop pure Force mode.

By closed-loop we mean that the pump is controlled to achieve a target position using feedback. Jogging, which spins the pump at a constant speed, is not a closed-loop mode. See also the Manual Control section.

When a command is issued, it is up to the host controller to determine when the command has been completed. Typically, the host sets up an "in position" or an "in force" tolerance range, along with a time

window. It is also a defensive best practice to run a timeout against each step, in case an error or something unexpected happens, which might prevent the command from completing normally.

Position is measured with an absolute encoder, hence there is no requirement to “home” the system at startup or ever. Extending the rod is considered more positive.

Closed loop position control is activated by setting COMMAND bit zero (Enable Closed Loop Control) along with the Position Select mode (bit 1), so COMMAND = 3 is closed loop position control. The COMMAND word is parameter 1.71.001 on M750 Units, and 3.71.001 on M700 Units.

NOTES:

1. In closed-loop position control mode, the actuator will use up to its maximum capable Force to try and reach the specified extend target position, subject to the maximum motor torque and the relief valve pressure trip point.
2. In closed-loop position control mode, when the actuator reaches the target position, it will stop there and actively hold that position.

Closed loop force limited position mode is activated by setting COMMAND bit zero (Enable Closed Loop Control) along with the Force Limited Position Select mode (bit 2), so COMMAND = 5 is closed-loop Force Limited Position mode.

NOTE: In closed-loop Force Limited Position mode, the actuator will use up to the Force Limit Max target (specified in parameter 1.71.003 on M750 Units, and 3.71.003 on M700 Units) to try and reach the Target Position. If the actuator reaches the maximum Force limit first, then it will stop at that position because of the limiting Force. If later the Force drops, then the actuator will start moving again to try to reach the Target Position. If the Force increases above the Maximum Force Target, then the actuator will move back to try and maintain the Maximum Force Target limit. Although a retract pressure sensor is not present, the Force Limit Min target should be set to a negative value, such as -1000 and left at that value, to insure proper motion planning.

Pure Force mode is activated by setting COMMAND bit zero (enable closed loop control) along with the Force mode (bit 3), so COMMAND = 9 is closed loop Force mode. In this mode, the Force Reference acts as the target force. Specifying a positive value will cause the actuator to extend until it encounters a force of the specified value. Providing a negative Reference force will cause the actuator to retract; however, as there is not a retract pressure sensor, the Command should be stopped prior to reaching the fully retracted position.

NOTE: It is possible to mix modes based on use. For example, if pure Force control is desired in the work zone, the Position mode commands can be used to move toward (or back from) the work zone, if desired.

In POSITION MODE and FORCE LIMITED POSITION MODE
The Position Target (specified in parameter 1.71.002 for M750; or 3.71.002 for M700 Units) determines the final position value.
Position Jerk, Position Accel, and Position Velocity govern the motion profile.

These are the most frequently adjusted/monitored parameters.

The Ethernet/IP interface covers them with Implicit Messaging.
They can also be accessed by Explicit Messaging or “Connect” software or the optional keypad/display.

Name	Units	Address (M750 or M700)
COMMAND	Bitmap	(1 or 3).71.001
Position Target	mm * 100	(1 or 3).71.002
Force Limit Max (in Position with Force Limit mode)	Lbf	(1 or 3).71.003
Force Limit Min (in Position with Force Limit mode)	Lbf	(1 or 3).71.004
Force Reference (used in pure Force mode)	Lbf	(1 or 3).71.005
Speed Reference (used in Speed mode)	RPM	(1 or 3).71.006
STATUS	Bitmap	0.20.035
Measured Position	mm * 100	0.20.036
Fault Code	See Faults	0.20.037
Measured Force	Lbf * 100	0.20.038
Force Profile (used in pure Force mode)	Lbf * 100	0.20.039
PumpSpeed	RPM	0.20.040

These are the less frequently adjusted motion parameters:

These addresses are used for Explicit Messages, or “Connect” software or the optional keypad/display.

M750 Units: (position resolution is hundredths of millimeters!)

Name	Units	Address (M750)
Position Jerk (factory: 200,000)	mm/sec^3 * 100	(1 or 3).70.001
Position Accel (factory: 19,050)	mm/sec^2 * 100	(1 or 3).70.002
Position Velocity (factory: 1900)	mm/sec * 100	(1 or 3).70.003
Force Jerk, pure force mode (400,000)	Lbf/sec^3	(1 or 3).70.091
Force Accel (factory: 40,000)	Lbf/sec^2	(1 or 3).70.092
Force Velocity (factory: 20,000)	Lbf/sec	(1 or 3).70.093
Jog Speed (factory: 500.0)	RPM*10	0.01.005

M700 Units:

Name	Units	Address (M700)
Position Jerk (factory: 7,000)	mm/sec^3	3.70.001
Position Accel (factory: 70)	mm/sec^2	3.70.002
Position Velocity (factory: 14)	mm/sec	3.70.003
Force Jerk, pure force mode (1,000,000)	Lbf/sec^3	3.70.091
Force Accel (factory: 100,000)	Lbf/sec^2	3.70.092
Force Velocity (factory: 50,000)	Lbf/sec	3.70.093
Jog Speed (factory: 750.0)	RPM*10	0.01.005

Jogging rotates the pump at a constant speed.

The pump is essentially positive displacement, so this can be converted to linear travel.

Since the piston rod is not zero diameter, it takes less fluid to move the piston in the retract direction, so for the same RPM, retracting moves faster than extending.

Example Speed:
2718 RPM should produce 19 mm/sec (0.75 in/sec) in the extend direction, and 27.4 mm/sec (1.08 in/sec) in retract. By default, the unit ships with the (slower) extend max speed in the Position Velocity.

These are the rated example speeds of the systems.

6 ETHERNET/IP IMPLICIT MESSAGING INTERFACE

Implicit Messaging is a technology used to make registers in a remote device act like scanned I/O. The host PLC sets up an arrangement with the remote device, detailing how many registers of what length are going to be read and written. Then when the PLC scans the device, it only has to send the outputs and read the inputs. The addresses are *implicit*.

A "DINT" is a Double precision INTeger. In most computers and PLCs this is a 32-bit (4 byte) variable. All data exchanged over the SHA's Ethernet/IP interface is in the form of DINTs.

6.1 COMMAND OUTPUTS – Data from Host to SHA

The Implicit Messaging interface includes six "output" registers (data from the PLC to the SHA).
The first three are COMMAND, TARGET POSITION and FORCE LIMIT MAX.
The Ethernet/IP host ***must*** be configured with an output table size of 24 bytes. (6 times 4).

COMMAND: (bitmap), Parameter 1.71.001 on M750; 3.71.001 on M700.

Bit 0 – Enable closed loop control
Bit 1 – Select Position mode
Bit 2 – Select Force Limited Position mode
Bit 3 – Select Force mode <Do not use>
Bit 4 – Jog Extend (See Manual Control Section)
Bit 5 – Jog Retract "
Bit 6 – Enable Jog mode "
Bit 13 – Enable Force Hold with lock valve.

Bit 15 – Reset fault (See Faults section)

Position control is active when bit 0 and 1 are true, the drive is not faulted, and the STO inputs are satisfied. (COMMAND = 3)

Force Limited Position control is active when bit 0 and 2 are true, the drive is not faulted, and the STO inputs are satisfied. (COMMAND = 5; or, with Force Hold via Lock Valve, COMMAND = 5 + 8192 = 8197)

(Pure) Force control is active when bit 0 and 3 are true, the drive is not faulted, and the STO inputs are satisfied. (COMMAND = 9; or, with Force Hold via Lock Valve, COMMAND = 9 + 8192 = 8201)

Jog Extend, COMMAND = 80 (decimal)
Jog Retract, COMMAND = 96 (decimal)

NOTES about commands:

1. Command = 0 means stop/idle. No motion is active.
2. Commands continue to run so long as a valid non-zero command value is present. If the Command value is set to 80 (decimal, for Jog Extend), the jog will continue as long as the Command is maintained at 80. If the actuator is jogged into either endstop, the motor will continue to have torque and build pressure, subject to tripping the relief valve. A Command value of 96 decimal will run a retract jog.
3. For Position and Force Limited Position modes, it is up to the external control to decide if/when the actuator is "in position" at the target position. When a position mode is commanded, the actuator attempts to move to the specified Target Position, and it will stop and hold there. It is permissible to leave the position command active, and change the target position, as needed.
4. With Force Limited Position mode, the Force Limit Max value can be changed "on the fly", if needed. The Position and Force feedback each have PID control loops running on their feedbacks.

TARGET POSITION: Parameter 1.71.002 on M750; 3.71.002 on M700.
Target position, in Position and Force Limited Position modes.
Position is in hundredths of miillimeters measured from "zero" as covered in section 4 above, so a target position of 5800 will be extended to 58.00 mm.

FORCE LIMIT MAX: Parameter 1.71.003 on M750; 3.71.003 on M700.
This is the target maximum (extend) Force to use when Force Limited Position mode is used.
Unit are in LBF so 2,000 represents a 2,000 LBF (the quoted working force for this unit)

FORCE LIMIT MIN: Parameter 1.71.004 on M750; 3.71.004 on M700.
This is the target minimum (retract) Force to use when Force Limited Position mode is active and it should be a negative value. When running extend force commands, this Force Limit Min should be set to -1000. If this value is set very low (less than -500), then that could slow down positional moves.
Unit are in LBF, so -1,000 represents a -1,000 LBF.

FORCE REFERENCE: Parameter 1.71.005 on M750; 3.71.001 on M700.
Used with Force mode. When the Force command is issued, the actuator will extend (if the force reference is positive), looking to sense a force of that value. The max speed used (in RPM) during extend moves is set in parameter 1(or 3).70.082, which is set at the factory to 2500 rpm. For negative force reference values, the retract speed is taken from parameter 1(or 3).70.083 which is -2500 rpm at the factory.
Units are in LBF.

6.2 STATUS INPUTS – Data from SHA to Host

The Implicit Messaging interface includes six “input” registers (data from the SHA to the PLC).

The Ethernet/IP host ***must*** be configured with an input table size of 24 bytes. (6 times 4).
This is true even if your PLC does not care about Fault Codes.

STATUS: (bitmap) (parameter 0.20.035)
- Bit 0 - Ready (No faults, and the STO is satisfied. Stays on while moving.)
- Bit 1 - In Position mode
- Bit 2 - In Force Limited Position mode
- Bit 3 - In Force mode
- Bit 5 - Faulted
- Bit 11 - STO is satisfied (corresponds to parameter 6.029 Hardware Enable).
- Bit 12 - Jogging

The other bits do not apply to this application, but should not be assumed to be zeros.

MEASURED POSITION: (parameter 0.20.036)
Positions are in hundredths of mm, measured from “zero” as covered in section 3 above. A value of 3250 represents the rod extended by 32.50 mm from the zero position.
Its validity is not influenced by SafeTorqueOff or Command or Faults.
Increasing value corresponds to extending the rod.

FAULT CODE: (parameter 0.20.037)
Retains the current or last fault. Does not clear when fault goes away.
But the Faulted bit in Status word does. See Faults section below.

MEASURED FORCE: (parameter 0.20.038)
Actual force, based on feedback from the extend pressure sensor.
Units are in LBF.

FORCE PROFILE: (parameter 0.20.039)
The reference/target force in Force Mode. A positive value will cause the actuator to extend, looking to press with the specified force value. A negative value will cause the actuator to retract, looking to pull with the specified force value.
Units are in LBF.

MEASURED SPEED: (parameter 0.20.040)
The motor/pump speed.
Units are in RPM.

6.3 Using the Lock Valves to Optionally Hold Force

The logic to use the Lock Valves to hold a Force setpoint can be enabled by setting Bit 13 to a “1” in the Command word (= 8192 decimal), along with the normal Force Mode of Bit 3 (=8 decimal) and the closed loop mode in Bit 1. So a Command word of 8192 + 8 + 1 = 8201 decimal will run Force mode and use the Lock Valve to hold the Force when the Force Setpoint is reached.

Alternately, this same Force Hold mechanism may also be enabled when using the Position with Force Limit mode (Command = 5); so 5 + 8192 = 8197.

With this “Use Lock Valves to hold force” enabled, the following parameters are then active to determine when and how to apply the lock valves for the force hold:

ForceLock_Deadband_Percent : DINT (32-bit). Parameter (1 or 3).75.051

Value: Percent * 10. Therefore, a value of 35 means +- 3.5% of the force setpoint/reference.
Once the target force is locked, it must stay within this deadband range, to remain locked.
If it goes outside, then the motor is activated and the lock valve is opened and the Force is re-stabilized.
The Nidec CTScope software (free download) is recommended, to monitor and capture the force values on the running system, to help in setting up these force lock variables.

ForceLock_StabilizeTime : DINT (32-bit). Parameter (1 or 3).75.052

Value: Force stabilizing time, in milliseconds.
Once the force is greater than the (TargetForce * ForceLock_StabilizePercent) threshold, the Force must remain greater for the ForceLock_StabilizeTime in order for the LockValve to be engaged (locked).
If the force drops below the threshold value, the timer is reset and starts over when the Force is back above.
If the force has a high amount of variance, then this number should be kept smaller.

ForceLock_StabilizePercent : DINT (32-bit). Parameter (1 or 3).75.053

Value: ForceLock_StabilizePercent * 10.
The ForceLock_StabilizePercent sets the +/- percent window around the target force that must be reached in order to start tracking for the ForceLock_StabilizeTime. Once the Force has stayed within this threshold rangefor the ForceLock_StabilizeTime, then the Lock is engaged.
This percent needs to coordinate with the ForceLock_DeadbandPercent in as much as the actual Force needs to be within the Deadband when the Force Lock engages, as otherwise it will immediately disengage because of the Deadband test. For example, a value of 25 means the Force feedback must remain within +- 2.5% of the Force Reference/Target in order to start checking for the Stabilize Time value.

Also note that because this ForceLock_StabilizePercent means the lock can engage at less than the Force Setpoint, then it is acceptable to use a slightly higher Force Setpoint to help ensure the Lock Valve is engaged at the desired value. For example, if the usual Force Setpoint is 10,000 Pounds, then if the StabilizePercent is set to 25 (= 2.5%), then the Force lock could engage at 10000 * 97.5% = 9750 pounds. If the Force is desired to lock at 10000, then use a Force setpoint of 10000 * 1.025 = 10,250 so then the Lock will wait for a Force above 10,250 * 0.975 = 9994.

ForceLock_TorqueSettleTime : DINT (32-bit). Parameter (1 or 3).75.054

Value is the Delay in milliseconds.

If the Force falls outside the deadband, then the motor needs to be started prior to releasing the lock valve/clamp, to help prevent a drop in Force when the lock valve is opened. This setting is that delay time. In testing, a value of 290 is a good starting point. CTScope can be used to monitor the force when a reclamp occurs, to verify whether the force drops momentarily (in which case raise this delay value) or spikes up momentarily (in which case reduce this value).

ForceLock_ReclampTorque : DINT (32-bit). Parameter (1 or 3).75.055

Value is read-only (do NOT write to or set this value).
Whenever the "Hold Force with Lock Valve" is engaged, the motor torque value is captured and saved here. Then, when the force changes enough to require the lock valve to be opened to adjust the force, the motor is brought back up to 90% of this value, and then the TorqueSettleTime is run, and after that, the lock valve is opened and the force is adjusted.

Option_PositionRateEnable: DINT (32-bit). Parameter (1 or 3).75.056

Value: 0=disable this option; 1=enable this option.

If this option is disabled, then the Force Lock enable is determined by the target force Percents and timings explained above.

When enabled, then the "hold force with lock valve" logic is not checked until the positional rate of change of the actuator falls below the threshold rate set in parameters 75.057:

PositionRate_ForceLock: DINT (32-bit). Parameter (1 or 3).75.057

Value: Units per second. This is in (MM*100)/second.

PositionLock_StabilizeTime: DINT (32-bit). Parameter (1 or 3).75.058

Value: Time in milliseconds.
This is the amount of time the positional rate of change must stay below the PositionRate_ForceLock value in order to engage the lock valve to hold the force. Once the lock valve is engaged and holding the force, then the ForceLock_DeadbandPercent is used to determine when to turn on the motor, open the lock valve and re-adjust the Force.

7 ETHERNET/IP EXPLICIT MESSAGING INTERFACE

Ethernet/IP Implicit Messaging is used for data such as Command and Status. They are rapidly and constantly scanned in a background task, which makes programming easy. But there are other motion parameters which are changed infrequently or never. Having the PLC read the current values and transmit new values would require exchanging many more bytes. This would slow scanning down for no good reason.

Explicit Messaging is the alternate method of data exchange in the Ethernet/IP protocol.
It allows the PLC to read or write one register only when desired.
For example, the host could read all of the default values at startup and adjust any as desired.

Explicit messaging can address any parameter in the drive, *bar none*. Therefore, one should be cautious when first testing a new bit of software. Consider for example reading a particular parameter first as a test. Use the keypad to modify the value and read again. The idea is to verify that you really are addressing the parameter you think you are, before you write to the drive.

All data exchanged over the SHA's Ethernet/IP interface is in the form of a 32-bit (4 byte) variable.
In most computers and PLCs this is referred to as a Double precision INTeger or "DINT".

Drive parameters are structured in the form: **Device.Menu.Element**
In this system, devices are numbered 1,2, 3, and blank.

An Ethernet/IP explicit data transfer has the following settings: Class, Instance, Attribute, Service.

For Device "blank" (or 0), set Class = 100 (0x64)

Otherwise, the Device is x65 + Device #:
For Device 1, set Class = 102 (0x66)
For Device 2, set Class = 103 (0x67)
For Device 3, set Class = 104 (0x68)
The (0x…) is the value in hexadecimal form, which is what most PLCs use for this parameter.

For example, to access CT parameter 1.70.003:
Set the Class = x66 for Device=1; 0x65 + 1 = x66 (decimal 102).
For the M750 Units, Device 1 is the MCi200 module, so use Class = 102 (0x66), for 1.70.003.
For the M700 Units, Device 3 is the MCi200 module, so use Class = 104 (0x68), for 3.70.003.

Set the Instance equal to the Menu. For example, to set parameter 1.70.003, Instance = 70.

Set the Attribute equal to the Element. For example, to set parameter 1.70.003, Attribute = 3, and convert the Attribute to hexadecimal. Decimal 3 = 0x3.

Set Service = Get_Attribute_Single to read from the drive.
Set Service = Set_Attribute_Single to write to the drive.
For Rockwell PLCs, the Message Type is CIP Generic.
At this point the drive does not support reading/writing multiple parameters with a single transaction.

To test the Explicit message, keep STO off, and use Connect software to verify the expected parameter value is accessed.

8 FAULTS

The built-in (single digit) display will signal trip codes by scrolling in the form “E###-###”.
The first number is the trip code, and the second is the subtrip code.
Hardware faults are signaled in the form “HF-###”.

The optional display/keypad decodes most faults to a description in English.

The red Reset button on the keypad will clear a fault unless its cause persists, such as undervoltage.

Bit 15 in the COMMAND register performs the same function as the red Reset button on the keypad.

The FAULTCODE input register in the interface holds the current or last fault code reported by the drive.
It does not go to zero when the fault is cleared. (But the Faulted bit in STATUS does.)
Its value is a composite of two fault registers within the drive.

The MSW (top 16 bits) are the Trip Value, from drive menu 10.020.
The LSW (bottom 16 bits) are the Sub-Trip Value from menu 10.070.

The Nidec/CT M750 User Guide section 13.4 has 35 pages of trip codes. Here are the common ones:

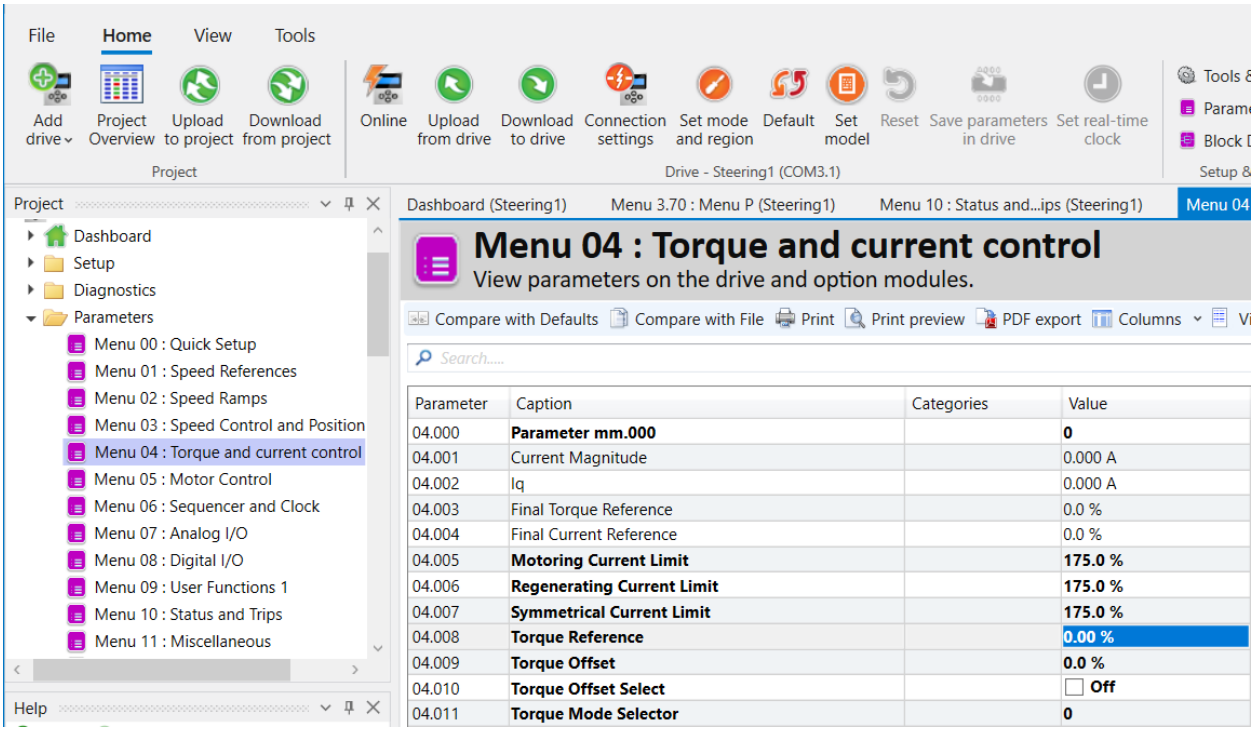
2 : OverVolts – Energy from an overhauling load or fast decel has raised the DC bus too high.
3 : Instantaneous Overcurrent – Cannot be reset for ten seconds.
6 : External Trip.3- Brake resistor thermal switch tripped, if equipped. See below.
19 : Brake R Too Hot – Energy dumped into the braking resistor during fast decels has overheated it.
20 : Motor Too Hot – This is estimated by a mathematical model; not a sensor.

On the M700 Units (only), the pump is supervised by a thermal switch, which is closed when the temperature is below the trip point.
The thermostat is monitored by drive input 6, readable at menu 08.005. It should be high (on) when OK.
If the thermostat trips, the keypad will announce this fault as User Trip 001 in the Drive Trip Log.
If you see this error during startup, verify the wiring of the PUMP THERMAL cable.
If you see this error on every powerup, and the reset button clears it, see section 16.4 of this manual.

9 DRIVE TORQUE AND CURRENT

During startup or for troubleshooting, it may be necessary to view or monitor the drive torque and current values. These items are available through the Connect software in Menu 04: Torque and current control, in parameters 0.04.003 Final Torque Reference and 0.04.004 Final Current Reference.

During operation, the motion logic will set 0.04.007 Symmetrical Current Limit using the value in (1 or 3).070.084 Pump Torque Max. The factory default value is 150, which is 150%.



10 ETHERNET ADDRESSING

10.1 M750 Panels and Drive IP Addresses

M750 drives. The factory IP addresses for the drives in these panels are set as follows:

Panel #1: Drive 1 is 192.168.1.11; Drive 2 is 192.168.1.12 and so on, with Drive 11 at 192.168.1.21

The M750 Drive's IP address can be inspected and changed with Connect software or with the optional keypad/display at menu element 3.02.006.

The M750 drives shipped with the compact display, which includes two 16-position selector switches. Changing these to anything but 00 overrides the rightmost byte of the IP address with their hex combo.

10.2 M700 Panels and Drive IP Addresses

Each M700 Panel contains eleven M700 drives. The factory IP address for the drives in these panels are set as follows:

Panel #1: Drive 1 is 192.168.1.51; Drive 2 is 192.168.1.52 and so on, with Drive 11 at 192.168.1.61

The M700 Drive's IP address can be inspected and changed with Connect software or with the keypad/display at menu element 4.02.006.

Note: After changing the IP address, you must cycle the power in order for the change to take effect.

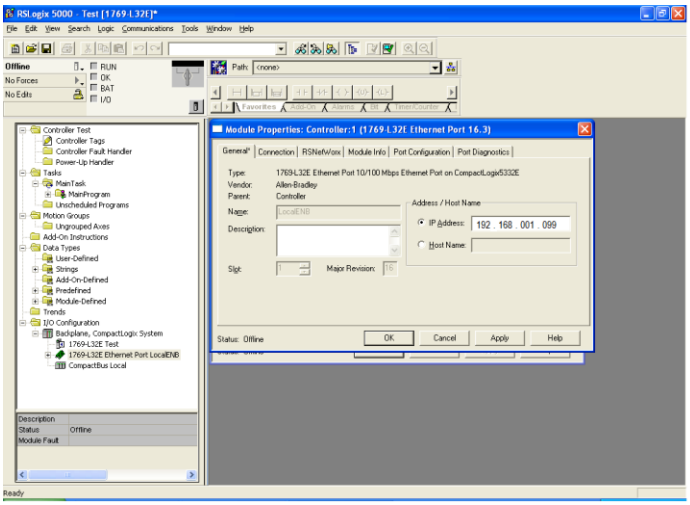
As shipped, the drives subnet mask was set to 255.255.0.0. It is adjustable at menu element 4.02.007.

After changing either parameter, do the Making Changes Permanent procedure in section 16.4 later in the manual.

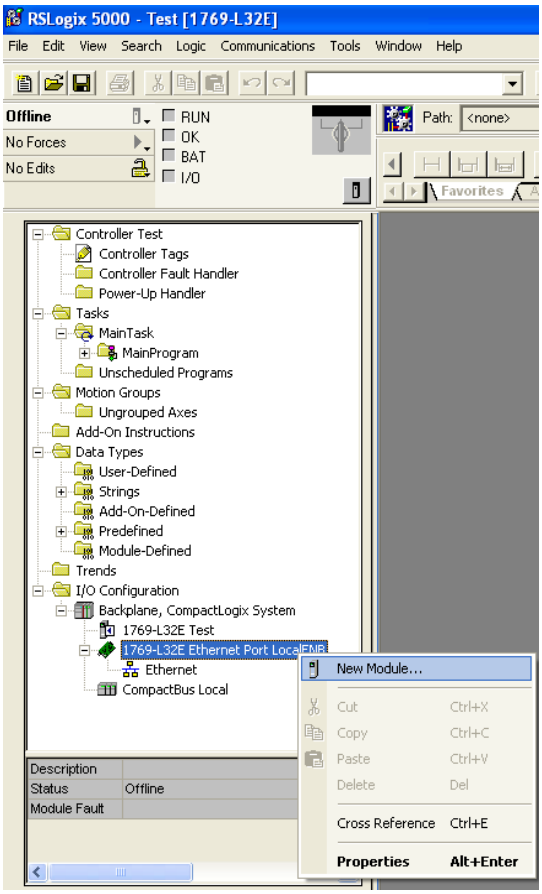
11 SETTING UP ETHERNET/IP IMPLICIT MESSAGING IN RSLOGIX

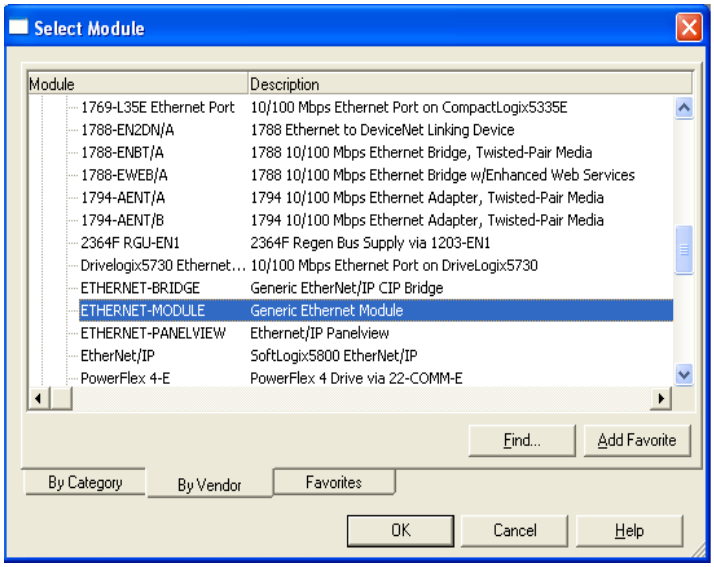
1. Assign the PLC an IP address which is in the same subnet as the drives.

This is covered in the Ethernet Addressing section above. For example:

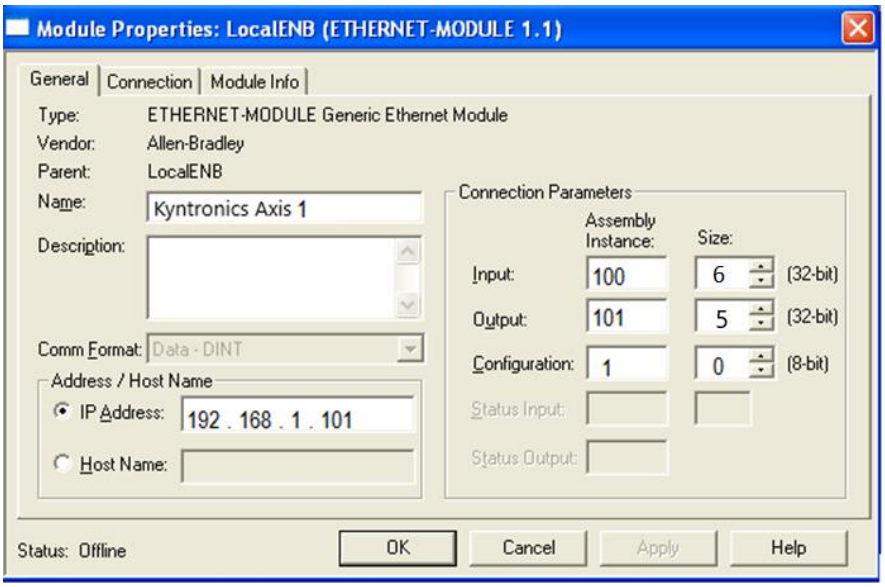

RSLogix 5000 - Test [1769-L32E]*
File Edit View Search Logic Communications Tools Window Help
Offline
No Forces
No Edits
RUN
OK
BAT
I/O
Path: <none>
Controller Test
Controller Tags
Controller Fault Handler
Power-Up Handler
Tasks
MainTask
MainProgram
Unscheduled Programs
Motion Groups
Ungrouped Axes
Add-On Instructions
Data Types
User-Defined
Strings
Add-On-Defined
Predefined
Module-Defined
Trends
I/O Configuration
Backplane, CompactLogix System
1769-L32E Test
1769-L32E Ethernet Port LocalENB
CompactBus Local
Module Properties: Controller:1 (1769-L32E Ethernet Port 16.3)
General* Connection RSNetWorx Module Info Port Configuration Port Diagnostics
Type: 1769-L32E Ethernet Port 10/100 Mbps Ethernet Port on CompactLogix5332E
Vendor: Allen-Bradley
Parent: Controller
Name: LocalENB
Description:
Slot:
Major Revision:
Address / Host Name
IP Address: 192 . 168 . 001 . 099
Host Name:
Status: Offline
OK
Cancel
Apply
Help
Description
Status Offline
Module Fault
Ready

2. Add a Generic Ethernet Module as shown.

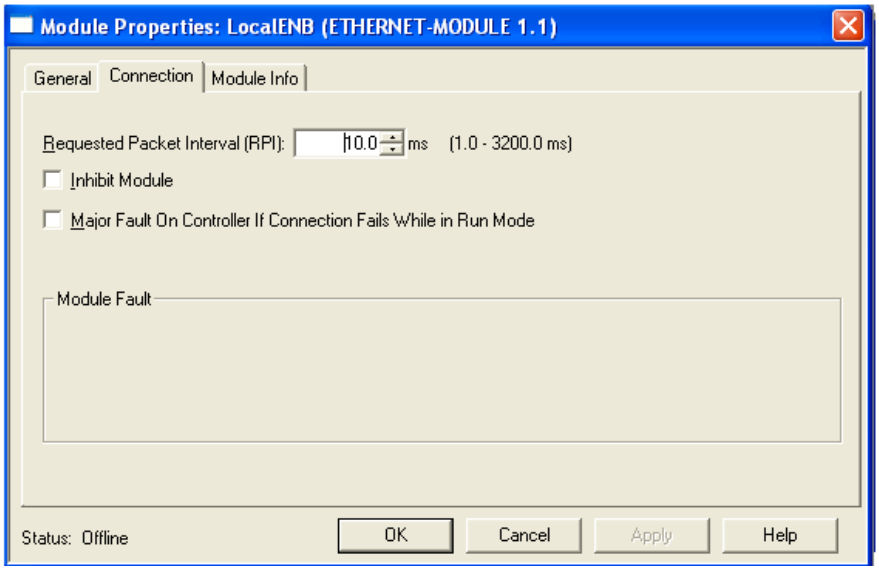




3. Configure the module as shown.

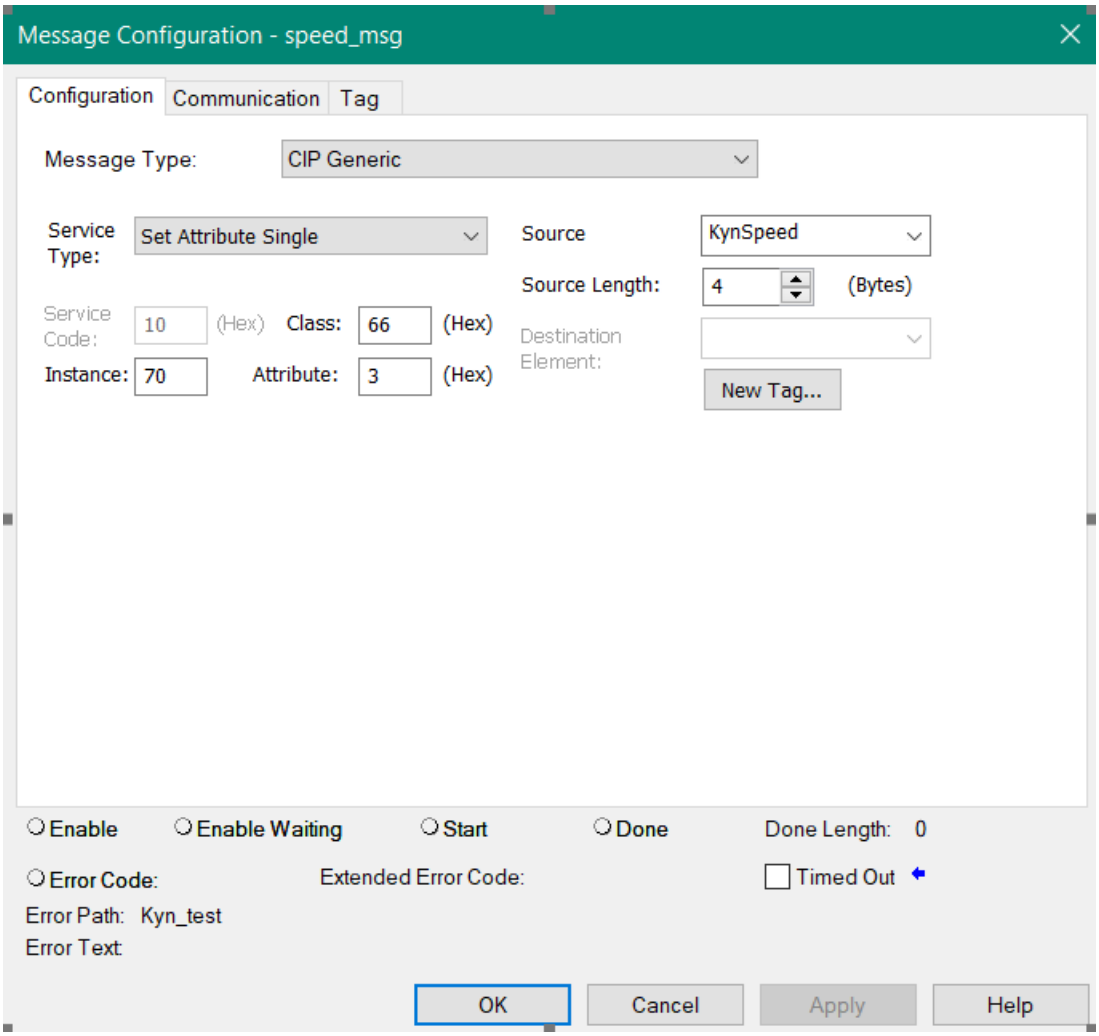


4. Configure the Requested Packet Interval (RPI) to taste.



12 SETTING UP ETHERNET/IP EXPLICIT MESSAGING ON RSLOGIX

In the Allen-Bradley RsLogix platform, a single command called MSG handles a complete exchange.
It can serve to read or write one parameter each time the instruction is triggered.
Review the ETHERNET/IP EXPLICIT MESSAGING INTERFACE for background.



1. Add a MSG instruction to the ladder program.
2. Give the MSG a unique name, such as ReadAxis2_ParamBlock1.
3. RsLogix will pop up a New Tag window. Assign the data type as “MESSAGE”.
4. Assign the scope as “controller”.
5. Click Configure next to the data type, which will pop up another window.
6. On the Communication tab, click Browse and pick the name of the GENERIC-ETHERNET module associated with the actuator. Or, alternately, use the local ethernet port; such as “LocalENB”;

then add a comma and the port number, which is usually 2. Now we have “LocalENB, 2”.
Then add another comma and the IP address of the drive. Such as “LocalENB, 2, 192.168.1.101”

7. On the Configuration tab, select Message Type: CIP Generic.

8. Select Service_Type. “Get Attribute Single” reads from SHA. “Set Attribute Single” writes to it.

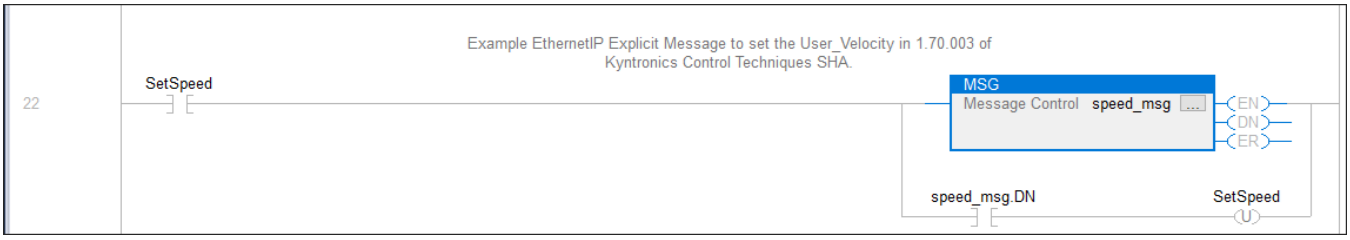
9. Set Instance to the Menu being addressed. I.E. for 1.70.003, Instance = 70 (value is decimal).

10. Set Class = x64 if Device is “blank”. Otherwise set Class = x65 + Device (value is hexadecimal). For 1.70.003, the Device is 1, so the Class = x65 + 1 = x66.

11. Set Attribute to the Element being addressed. I.E. for 1.70.003, Attribute is 3 (value is in hexadecimal, so convert as needed. Decimal 3 is hexadecimal 3.).

12. Set Destination or Source Element to a tag in your PLC. It must be of type DINT (32-bit integer), so the Source/Destination Length is 4 bytes.

13. Back at your ladder rung, add a contact or two to trigger the MSG only when needed.



13 MANUAL CONTROL

Occasionally you might need to move the SHA without an Ethernet/IP host; for example, during installation. This can be done IF you have installed the optional remote keypad/display. Alternately, if the optional remote display is not present, then the Connect software can be used to manually control the actuator if the Ethernet/IP control is temporarily disabled. On M750 Units, set parameter 3.20.001 to OFF to disable Ethernet/IP; or on M700 Units set 4.20.001 to OFF. Then the Control parameters can be directly manipulated through Connect (parameters 1.71.001 through 1.71.005 on M750 Units; parameters 3.71.001 through 3.71.005 on M700 Units) to move the actuator. For example, set the Command Word (1 or 3).71.001 to 80 to extend jog the actuator; or set it to 96 to retract jog the actuator. But be ready to change the Command Word back to 0 to stop the Command!

Jogging is done by running the pump at a constant speed. No position loop control is involved.
Manual jog speed is set at menu 1:005. It is scaled in RPM.
500 RPM is a nice starting point.

On the M700 drive Units, front keypad Jogging is armed by setting Drive menu 18.047 = “on”. At power-up it *should* default to off. See below.
When Menu 18.047 is on, the system will ignore most of the COMMAND word. Instead, the green and blue keypad keys will jog at the speed specified in 1.005, as mentioned above.

Green → key = Jog Extend
Blue ← key = Jog Retract

However, keypad jogging requires that the appropriate Control Panel be opened to allow access to the keypad, which may not be allowed, for reasons of safety.

Bits 4 and 5 of the Command register can function the same as the green/blue keys:

Command.bit 4 = Jog Extend
Command.bit 5 = Jog Retract

Setting Command bit 6 performs the same function as setting menu 18.047.

Don’t forget to set 18.047 OFF or cycle power to give control back to Ethernet/IP.

IF you find that the system is powering up with Jogging enabled, someone left 18.047 on and executed the “Making Changes Permanent” procedure. Turn it off, then do the procedure again.

14 TUNING

The position and force controllers are classical Proportional/Integral (PI) feedback loops.
Its tuning parameters are adjustable by the usual methods, or even over Ethernet/IP although that would be a rare application. The unit ships tuned for good performance; however, it can be optimized for the specific load and fixture characteristics.

The tuning parameters are stored in non-volatile registers, which will retain their values while power is removed. It is not necessary to execute the Making Changes Permanent procedure after changing.

14.1 M750 Unit Tuning Values

Name	As Shipped	Address
Position Proportional Gain	24,000,000	1.70.050
Position Integral Gain	240,000	1.70.051
Force Proportional Gain (for Position with Force Limit)	2,400,000	1.70.070
Force Integral Gain (for Position with Force Limit)	2,800,000	1.70.071
Force Jerk (used on pure Force mode, lbs/sec^3)	400,000	1.70.091
Force Acceleration (used in pure Force mode, lbs/sec^2)	40,000	1.70.092
Force Velocity (used in pure Force mode, lbs/sec)	20,000	1.70.093

14.2 M700 Unit Tuning Values

Name	As Shipped	Address
Position Proportional Gain	60,000,000	3.70.050
Position Integral Gain	6,000,000	3.70.051
Force Proportional Gain (for Position with Force Limit)	500,000	3.70.070
Force Integral Gain (for Position with Force Limit)	600,000	3.70.071
Force Jerk (used on pure Force mode, lbs/sec^3)	1,000,000	3.70.091
Force Acceleration (used in pure Force mode, lbs/sec^2)	100,000	3.70.092
Force Velocity (used in pure Force mode, lbs/sec)	50,000	3.70.093

15 ETHERNET DIAGNOSTICS

A green LED is located directly (within a quarter inch) below each of the drive's Ethernet sockets. If this is not flashing, check the network connections and power to the device on the other end of the cable. There is almost no software misconfiguration which will prevent this LED from flashing. One exception may be the presence of another device with the same IP address.

The drive requires about 20 seconds after power-up before becoming active on the Ethernet.

If the host device is unable to establish a connection with the SHA, consider connecting it to a laptop and pinging it. From the Windows or Linux command line, type PING 192.168.1.101 or whatever address you have set if you changed from the factory default.

The host computer or PLC and the SHA will only be able to communicate if they are on the same *subnet*. In most networks, the Ethernet subnet mask is set to 255.255.255.0. In this case, the first three numbers of devices address must match to be on the same subnet.

If still no response, verify the drive's IP address using the procedure in ETHERNET ADDRESSING above.

Each drive has two Ethernet ports, marked 1 and 2.
The ports are daisy-chained so that the external Ethernet port allows all drives to be accessed. If a computer is connected to this ethernet link, then Connect software can be used with any of those drives.

The registers being exchanged using Ethernet can be inspected and modified with the keypad & display. This can be useful when debugging the PLC interface.
The menu elements for the other parameters are itemized in MOTION PARAMETERS above.

Sometimes you suspect that the Ethernet/IP interface is constantly writing *something* to a given register, but can't be sure because it never changes. Try using the keypad to temporarily write a different value. See if the Ethernet/IP interface stomps on your change, reverting to the previous value.

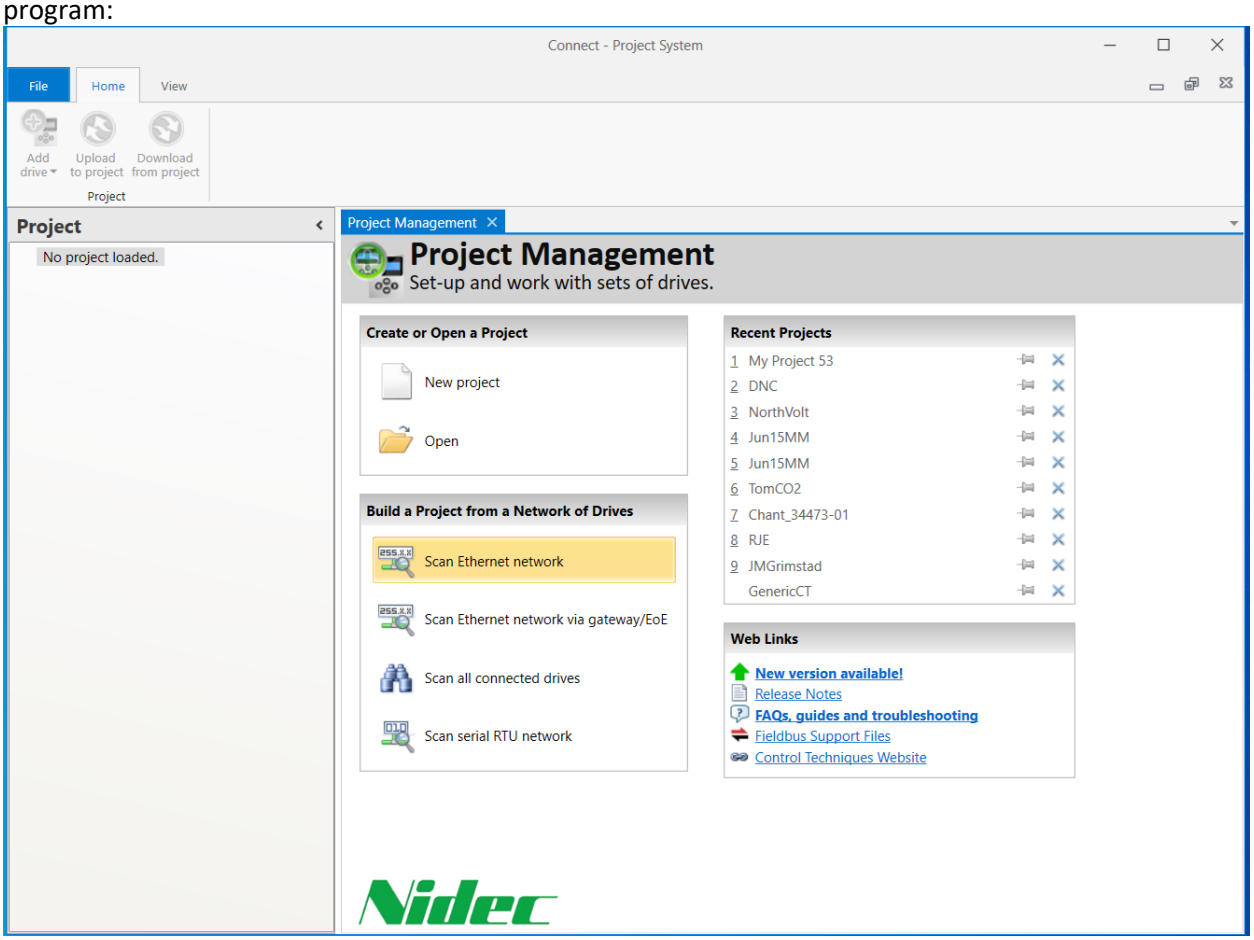
Windows 10 Firewall has been known to block Connect in rare instances.

16 CHANGING DRIVE SETTINGS

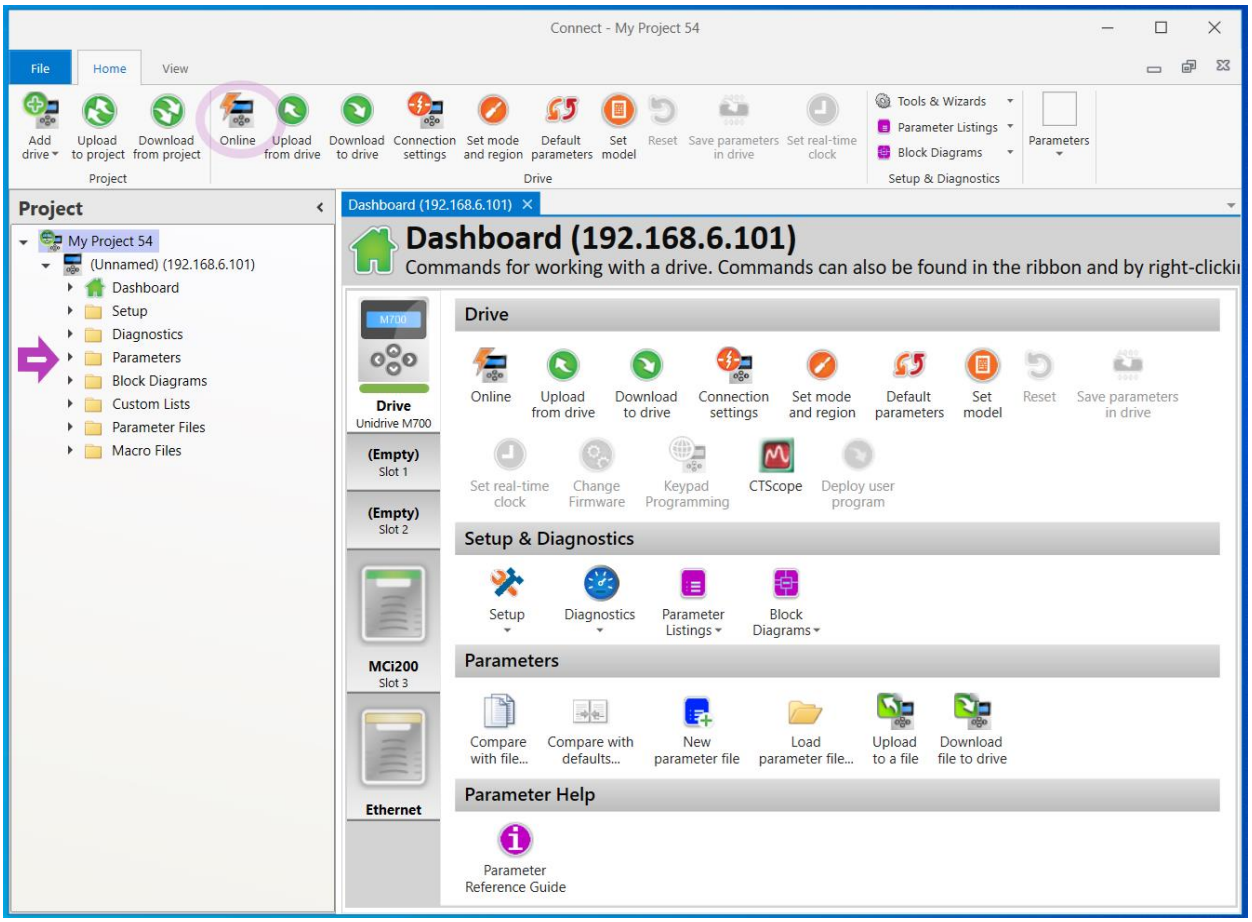
16.1 Control-Techniques “Connect” Software

The servo drive manufacturer, Nidec/Control Techniques, named its configuration software Connect. It is a free download from the web, and requires no job-specific files or password to access the drives. On the download site, look for the Connect Software bundle, Issue: v02.19.01, zip file (as of December, 2023). You will need to setup a login/email but the download is free.

Connect your laptop to the drive via Ethernet, or via an unused Ethernet port, and start the Connect program:



Click “Scan Ethernet Network” and the software will find the drive.
If there is more than one drive on the net, it will find them all.
Caution: While it is more work, it is usually best to have just one drive in each Connect Project. Putting multiple drives into a single Connect Project file is allowed, but can be VERY confusing to determine which drive is actually Online, as Connect only allows 1 drive to be Online at a time.
If more than one is found, you can click “wink” and the corresponding drive will flash its red LED at you.
Also note that each Connect project MUST be in a unique directory/folder! Perhaps setup a folder hierarchy:
Panel_1/Unit1
Panel_1/Unit2, etc.

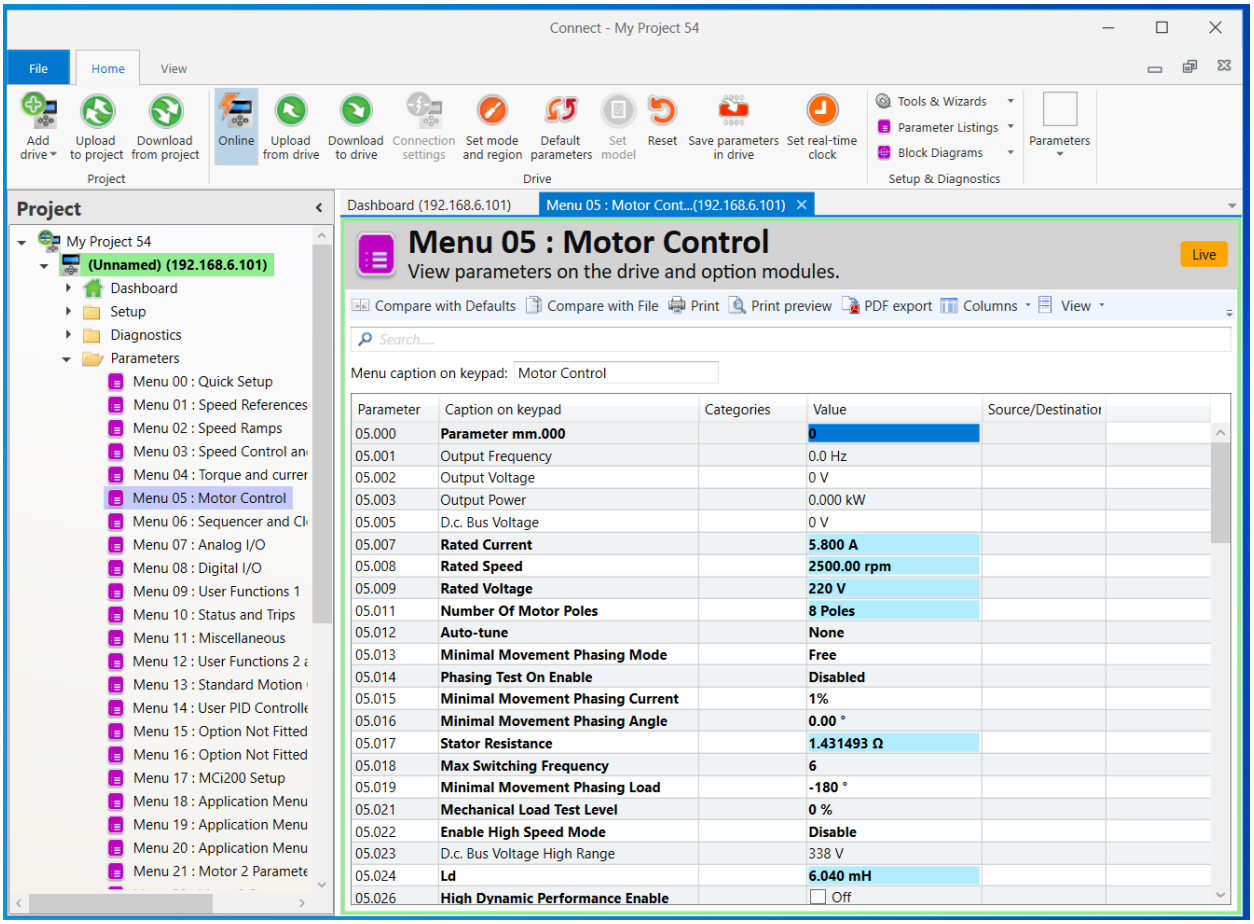


Connect has created a new file called “My Project ##”. On my machine there were already 53 others.

If you expand the tree structure at left by clicking on “Parameters” (magenta arrow) you could inspect any menu item, thinking these are the drive settings. And you would be wrong. This is one of the two gotchas in Connect. The software has fetched the drive type and filled in the option slots. (My drive happens to have an Mci200 in slot three.) But all of the menu items are populated with default values, not the ones on the drive. If you were to close Connect now, the file it saves on your laptop will NOT have the values from the drive.

Clicking “Upload from drive” will copy the drive value to your laptop. Now when you close Connect, the saved file will contain the drive settings.

Notice the Online icon at top, circled in magenta. It is not highlighted. This signifies that we are not live with the drive. Click it, and expand the Parameter tree at left.



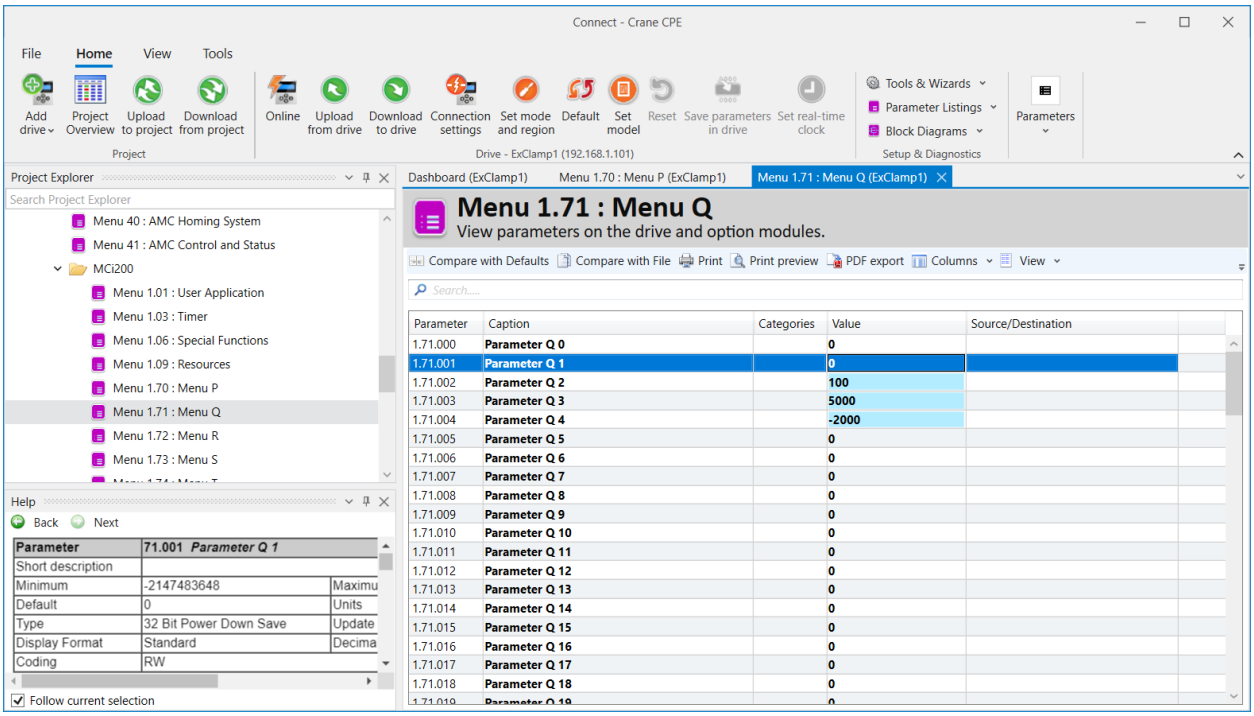
Notice how the Online icon is now highlighted; bluelighted on my machine.
This tells you that you are looking at live values on the drive. This brings me to the other gotcha: Forgetting that you are offline and making changes and wondering why they don't do anything.
It happens.

Notice that only some of the names and values are in bold. The ones not in bold are read only.
You can edit the ones in bold by clicking on the value itself. Be careful. It's live.

Notice that some values are backlighted in pale blue. These deviate from the default values.

Once you have made a flock of changes, you may want to save them on the laptop, so you click the File tab and look for "save as" and its greyed out. Don't panic. This is because you are online. Click the Online icon to unhighlight it and then "save as" will become available. BUT WAIT! If you click it now, the settings you save will not reflect those changes you just made online. Click "Upload from drive" before saving.

All of the parameters shown in this snip are for the drive itself (device zero).
On the left hand window pane, slide the vertical scroll bar down a bit…



Here is where the non-drive menu items are hiding. All menu items have three fields, such as 1.71.003. The first field specifies the device, the second field is the menu, and the third is the specific parameter. The drive itself is device zero, and the option modules use their slot number.

All drives have an Ethernet interface built into the drive, but it acts like an option module.
M750 drives have it at slot 3. M700 drives have it at slot 4.

All Kyntronics SHA drives are equipped with either an MCi200 or MCi210 module to do the heavy computation. M750 drives have it in slot 1. M700 drives have it in slot 3.

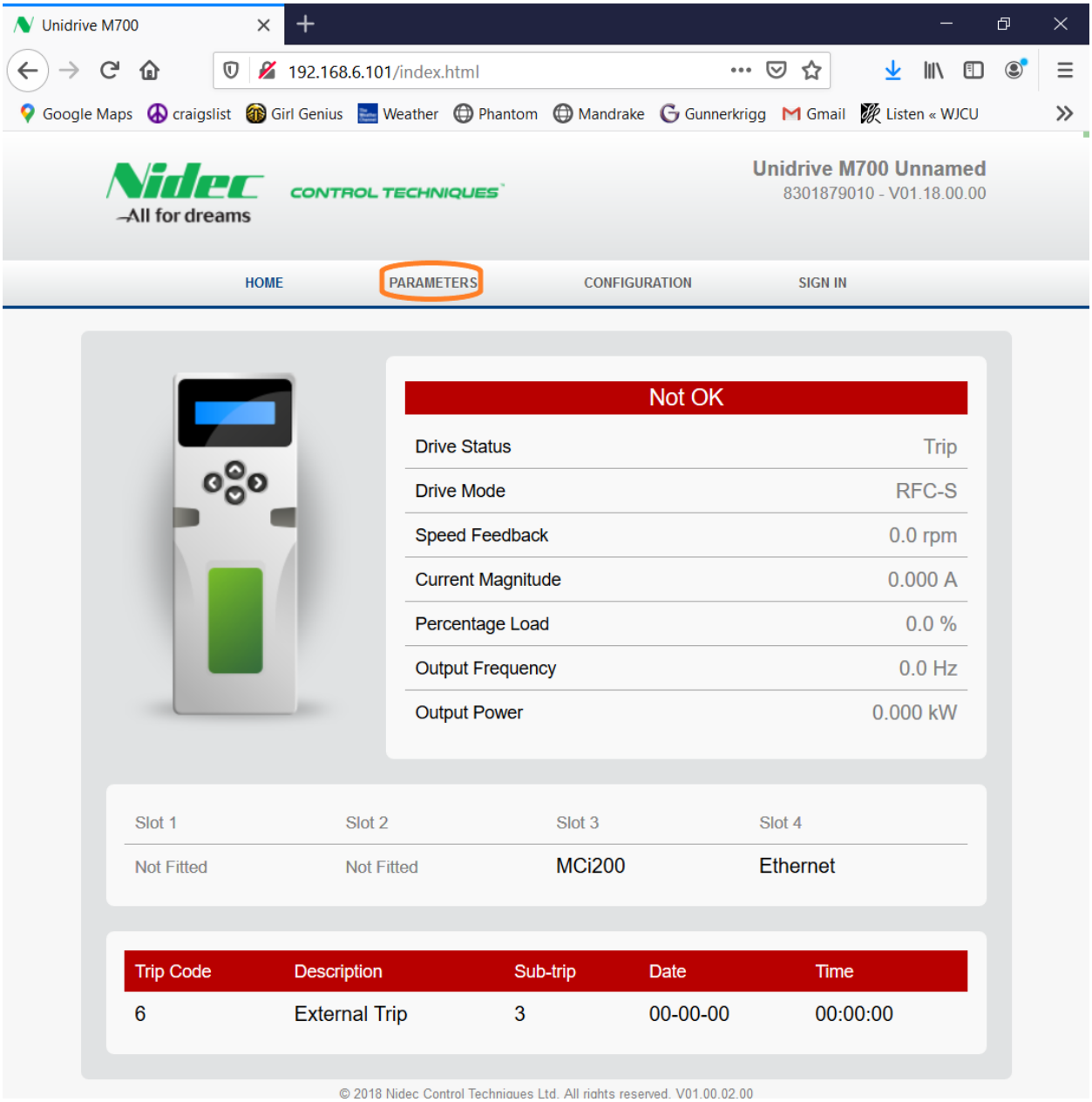
An MCi210 module also has its own Ethernet ports, that stick out the top of the drive.
When a drive is equipped with an MCi210, such as the master on a master/follower system, the ports on the MCi210 should be used instead of the drives native Ethernet ports.

Should you happen to be changing an Ethernet address, be sure you are changing the ports on the device you think you are.

The MCi210 Ethernet settings on an M750 drive are at Menu 1.02.0xx.

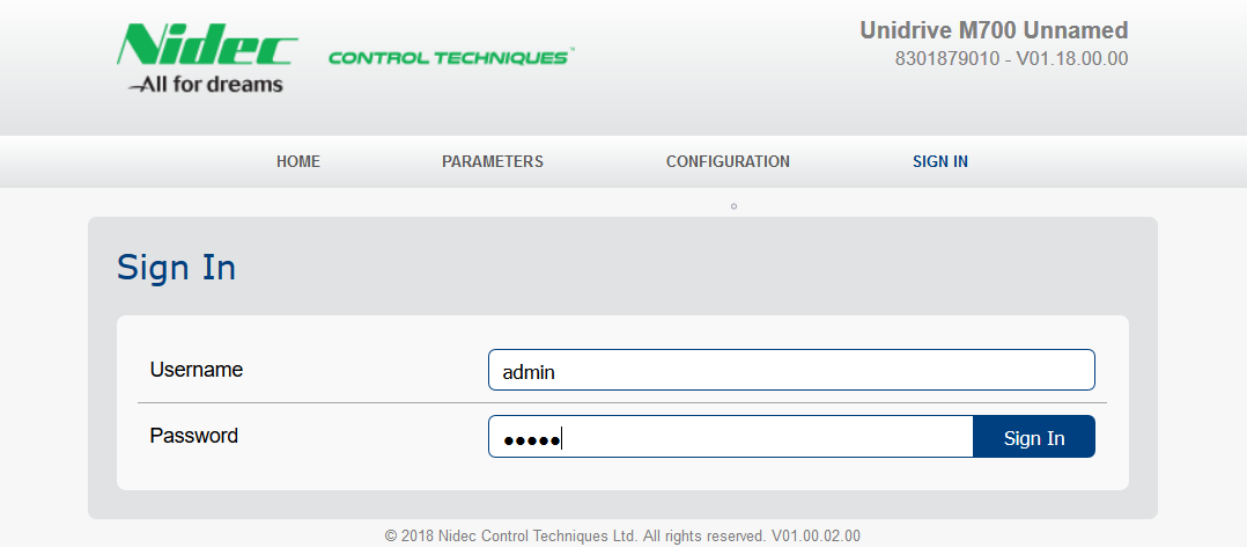
16.2 Web Browser

A laptop connected to the drive via Ethernet can view and modify any parameter, using its web server. Open your preferred web browser and enter the IP address of the drive, like so:

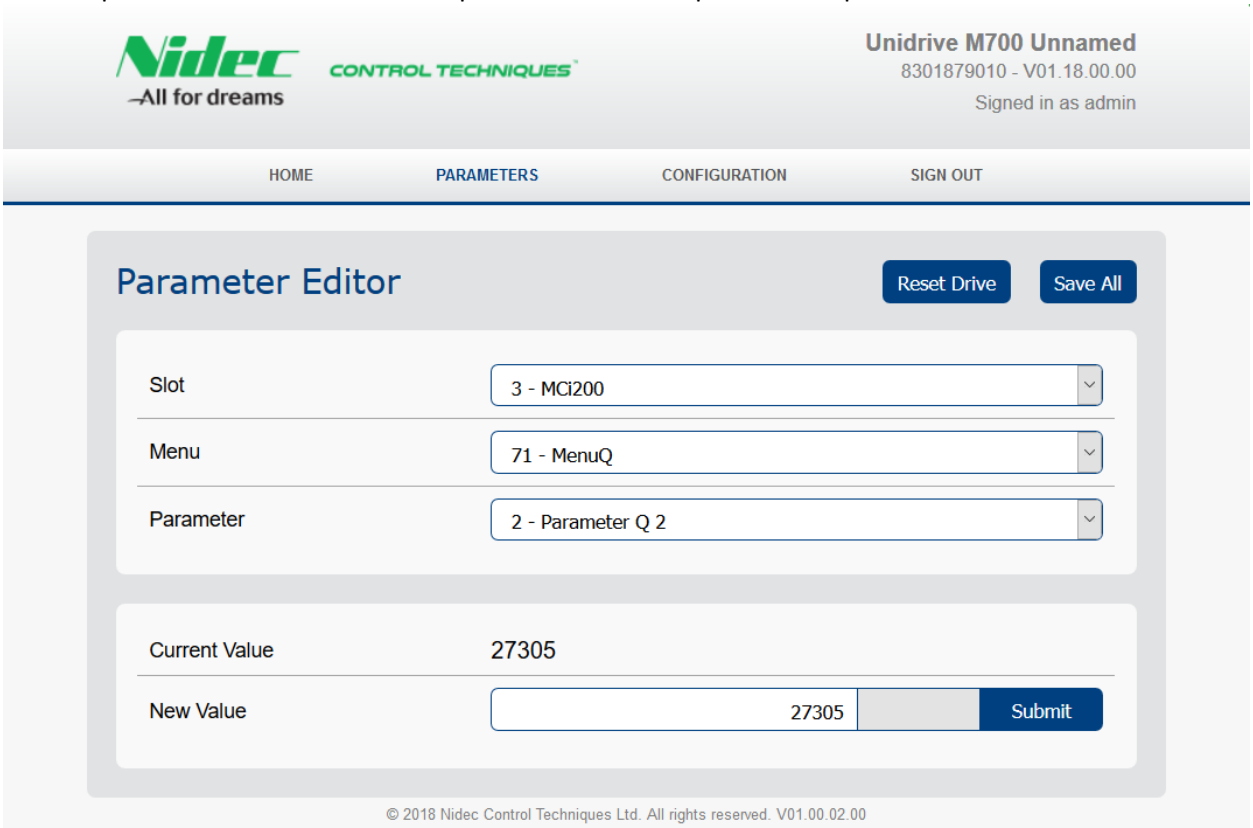


Click the PARAMETERS tab circled at top center.

Enter Username “admin” and Password “admin”. Yes really.



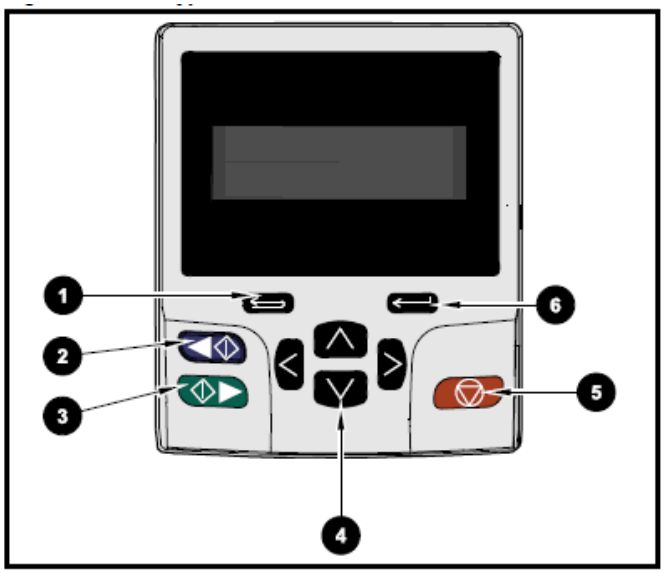
Use the pull-down boxes to select the parameter. This snapshot corresponds to menu 3.71.002.



To change a value, enter “New Value” and click “Submit”.

16.3 Optional Keypad/Display

Any of the servo drive can be equipped with a keypad and display. This shows status and fault conditions and allows various motion parameters to be modified. It requires the KI-Compact RS485 adapter as well. It also allows Jogging of the actuator without the fieldbus host connection, which is useful for setup.



1 = Escape. Backs out. Always safe.
2 = (blue) Jog Retract.
3 = (green) Jog Extend.
4 = Arrow keys. See text.
5 = (red) Reset. See FAULTS section.
6 = Enter. Use caution. See text.

16.3.1 Inspecting Parameters

Parameters are structured in the form: **Device.Menu.Element**
The left and right arrows scroll through the **Device.Menu** combinations.
In this system, devices are numbered 0, 1, 2, and 3.
Some devices will not be visible until the drive has been powered for at least 20 seconds.

The keypad/display does not show the “0.” on the front of the addresses for Device zero.
For example, the address 0.18.047 is shown as 18.047.

The left and right arrows never modify anything unless you have first pressed the Enter key.

The up and down arrows scroll through the elements of a given menu.
They stay within the menu, and do not jump to the next one when you scroll past the last element.
As soon as you select an element, its value and terse description are displayed.
Looking at a parameter will never interfere with the operation of the system.

16.3.2 Modifying Parameters

To modify a value, inspect it as detailed above, then press the Enter key.
A digit of the value will begin flashing.
While flashing, the left and right arrows select digits, and up and down arrows change them.
Pressing Enter again will accept the changed value. Think “Key on the RIGHT does a WRITE”.
Pressing Escape instead will back out, with the old value intact. Think “Key on the LEFT, LEFT it alone.”

Some parameters are Boolean instead of numeric. These only accept values ON or OFF.
In these cases, the up arrow always selects ON, and the down arrow selects OFF.

Note that changes take effect instantly, even before you press Enter. Yes, really.
For example, setting menu 18.047 = ON will arm the jog keys immediately.
Using arrow keys to step through values on the Command word can pass thru unintended commands.

16.4 Making Changes Permanent

In some cases, changes must be saved to nonvolatile memory, or they will be lost when power is removed. This is not true of any of the parameters in device 01.xx.xxx.

First, put the system in the state you want it to power-up in.
For example, turn JogEnable off if you have left it on.

Next set menu 0.10.034 to a value of 1. This prevents a spurious pump thermostat fault at powerup.

If using Connect, click the Save Parameters in Drive icon.
If using the browser interface, click the SaveAll icon.
If using the optional keypad/display:

1. Select element zero of *any* drive.menu; for example 0.07.000 or 0.18.000.
2. Press the Enter key (upper right). At this point, “no change” should start flashing.
3. Press the Up arrow, and the display should change to “save parameters”.
4. Hit Enter and then the red reset button. The display will change back to “no change”.

17 GLOSSARY

H	Hexadecimal (suffix). The attached value is expressed in base 16.
IP Address	Four-byte address used by Ethernet. Expressed in the form 192.168.001.002
MSW	Most Significant Word. The upper 16 bits of a 32-bit value.
LSW	Least Significant Word. The lower 16 bits of a 32-bit value.