

Innovation in soft start technology



agility

USER MANUAL

agility user manual

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Safety

Important information

Installers should read and understand the instructions in this guide prior to installing, operating and maintaining the soft start. The following symbols may appear in this guide or on the soft start to warn of potential hazards or to draw attention to certain information.



Dangerous Voltage

Indicates the presence of a hazardous voltage which could result in personal injury or death.



Warning/Caution

Indicates a potential hazard. Any instructions that follow this symbol should be obeyed to avoid possible damage to the equipment, and personal injury or death.




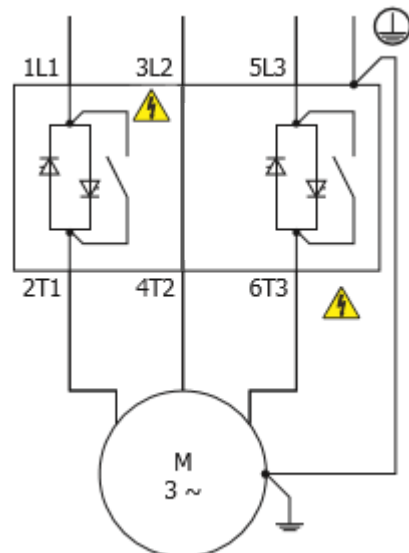
Protective Earth (Ground)

Indicates a terminal which is intended for connection to an external conductor for protection against electric shock in case of a fault.

Caution Statements

The examples and diagrams in this manual are included solely for illustrative purposes. The information contained in this manual is subject to change at any time and without prior notice. In no event will responsibility or liability be accepted for direct, indirect or consequential damages resulting from the use or application of this equipment.

|  |
|--|
| <ul style="list-style-type: none"> • agility soft starts contain dangerous voltages when connected to the mains supply. Only qualified personnel that have been completely trained and authorised, should carry out installation, operation and maintenance of this equipment. |
| <ul style="list-style-type: none"> • Installation of the soft start must be made in accordance with existing local and national electrical codes and regulations and have a minimum protection rating. |
| <ul style="list-style-type: none"> • It is the responsibility of the installer to provide suitable grounding and branch circuit protection in accordance with local electrical safety codes. |
| <ul style="list-style-type: none"> • This soft start contains no serviceable or re-usable parts. |
| <ul style="list-style-type: none"> • The STOP function of the soft start does not isolate dangerous voltages from the output of the soft start. An approved electrical isolation device must be used to disconnect the soft start from the incoming supply before accessing electrical connections. |



Mechanical Installation

Mounting

Fix the unit to a flat, vertical surface using the mounting holes (or slots) on its base-plate. The mechanical outline diagrams, shown on Page 8, give the dimensions and mounting hole positions for each model. Ensure that:

- The orientation of the unit has the 'TOP' uppermost.
- The location allows adequate front access.
- You can view the touchscreen.

Do not install other equipment that generates significant heat close to the soft starter.

Requirements for an Enclosure

For a typical industrial environment, an enclosure would provide the following:

- A single location for the unit and its protection/isolation switch-gear.
- The safe termination of cabling and/or bus-bars.
- Means to effect proper air flow through the enclosure.



Enclosure Ventilation

When fitting agility into a cabinet, ventilation must be provided. The heat dissipated can be approximated with the formula:-

Starting

Watts (agility) = start current(A) x start time(s) x number of starts per hour / 1800

Running

Watts(agility) = 0.4 x running amps

Use the following formula to determine the fan requirement. An allowance has been incorporated into the formula so that the figure for Q is the air delivery in the fan suppliers data.

$$Q = (4 \times W_t / (T_{max} - T_{amb}))$$

Q = volume of air (cubic metres per hour-m³/h)

W_t = Heat produced by the unit and all other heat sources within the enclosure (Watts) T_{max} = Maximum permissible temperature within the enclosure (40°C for a fully rated agility™)

T_{amb} = Temperature of the air entering the enclosure (°C) [to work in CFM, substitute °F for °C. Q is now in CFM]

Altitude Derate

Altitude above sea level 1000m (3281ft). Above 1000m de rate by 1% of agility™ Ie per 100m (328ft) to a maximum altitude of 2000m (6562ft)

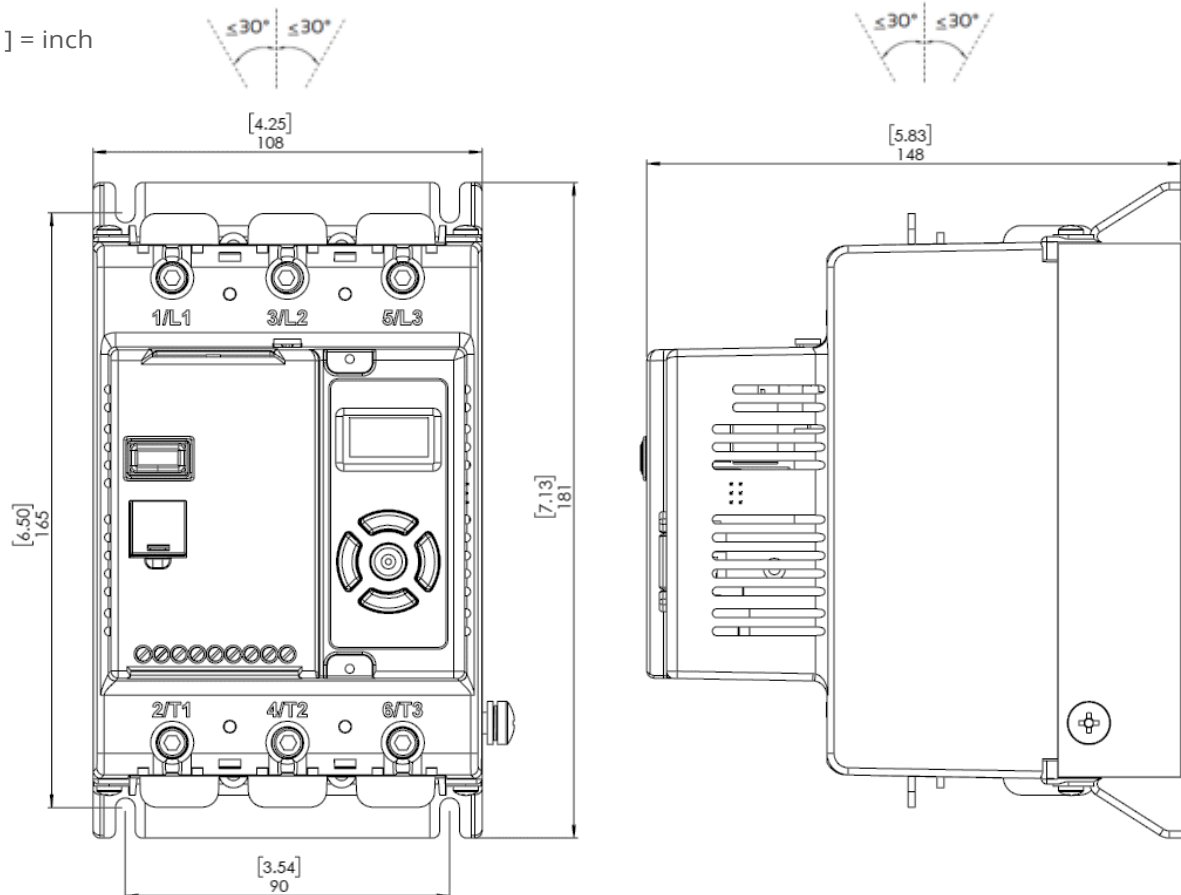
Ambient Temperature Derate

-20°C (-4°F) to 40°C (122°F). Above 40°C de-rate linearly by 2% of agility™ Ie per °C to a maximum of 60°C (140°F).

Mechanical Installation (continued)

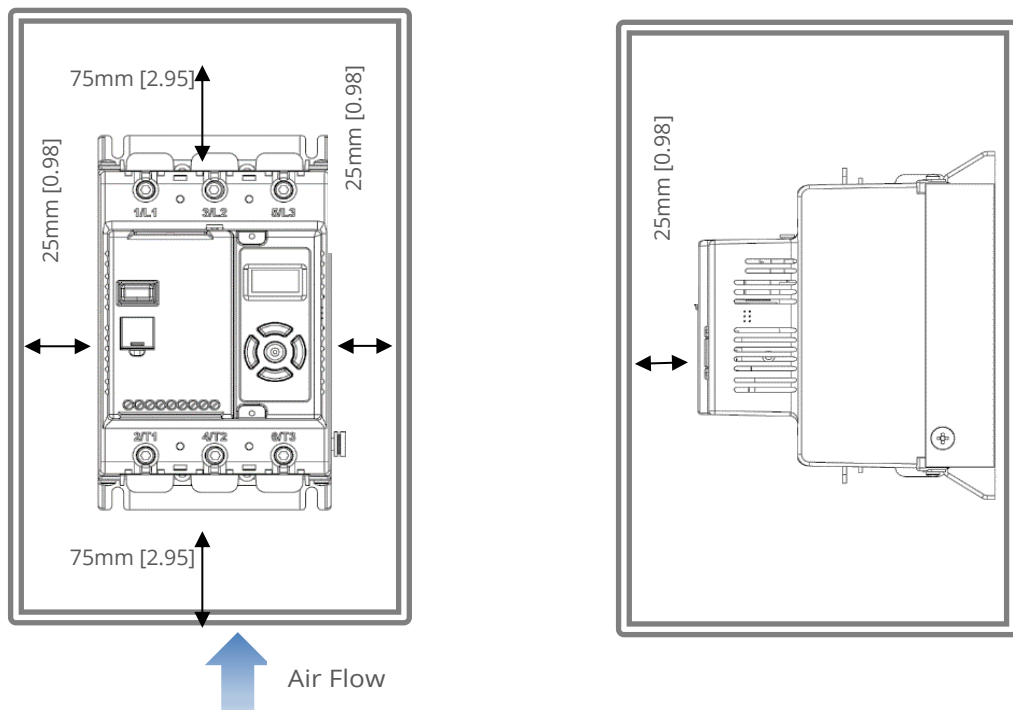
Dimensions AGY-101 to AGY-113

[] = inch



Weight 1.97kg (3.75lb)

Fitting



Mechanical Installation (continued)

Mechanical Specification

| Mechanical Specifications | | | | | | | |
|--|--|-----|-----|-----|-----|-----|-----|
| Model (AGY-) | 101 | 103 | 105 | 107 | 109 | 111 | 113 |
| Frame Size | 1 | | | | | | |
| Heat output (W) | 9 | 12 | 14 | 16 | 20 | 25 | 30 |
| Weight kg [lb] | 1.97 [4.20] | | | | | | |
| Ambient Operating Temp. | -20°C [-4°F] to 40°C [104°F] ; above 40°C derate linearly by 2% of agility I _e per °C to a maximum of 60°C (140°F) | | | | | | |
| Transportation and Storage Temperature | -20°C to 60°C [-4°F to 140°F] continuous | | | | | | |
| Humidity | max 85% non-condensing, not exceeding 50% @ 40°C [104°F] | | | | | | |
| Maximum Altitude | 1,000m [3281ft] ; above 1000m derate by 1% of agility I _e per 100m (328ft) to a maximum altitude of 2,000m (6562ft) | | | | | | |
| Environmental Rating | Main Circuit: IP00 (IP20 with optional finger guards); Control Circuit: IP20; No corrosive gases permitted | | | | | | |

Electrical Installation

Warnings

Isolation



Caution: agility uses semiconductor devices in the main circuit and is not designed to provide isolation. For this reason isolation means must be installed in the supply circuit in accordance with the appropriate wiring and safety regulations

Electrical Control Supply Requirements



All electrical connections are made to power input and output terminals, control terminals and an earth stud .

Fuse Protection



The Mains Supply and the Control Supply each require protection. Although all units have electronic overload protection for the Soft Start, the installer should always fit fuses, for motor protection, between the unit and the Mains Supply, not between the unit and the motor. Semiconductor fuses can be supplied as an option for short-circuit protection of the semiconductors. These fuses must be fitted externally to the agility chassis to comply with certain standards. It is the responsibility of the installer and system designer/specifier to ensure that the required standards or regulations are not affected by so doing.

Safety



agility soft starters contain hazardous voltages when connected to the electrical power supply. Only qualified personnel who are trained and authorized should carry out installation, operation and maintenance of this equipment. Refer to and carefully follow all of the 'Warnings' section at the beginning of this user manual, as well as other warnings and notes throughout the manual.

Electrical Supplies

The unit requires a 3-phase balanced Mains Supply to provide the power for the controlled motor, and a 24Vdc for the internal control circuitry. The unit will not operate unless the control supply voltage is within the specified limits.

Electrical Installation (continued)

| General Specification | | | |
|---|------------------------|--|-------------------------|
| Product Standard | | EN 60947-4-2: 2012 | |
| Rated operational voltages | U_e | 200Vac to 600Vac (See Key to part numbers) | |
| Rated operational current | I_e | See Rating Table | |
| Rating index | | See Rating Table | |
| Rated frequency/frequencies | | 50 - 60Hz ± 5Hz | |
| Rated duty | | Uninterrupted. | |
| Form designation | | Form 1, Internally Bypassed | |
| Method of operation | | Symmetrically controlled starter | |
| Method of control | | Semi-automatic | |
| Method of connecting | | Thyristors connected between windings and supply | |
| Number of poles | | 3 main poles, 2 main poles controlled by semiconductor switching element | |
| Rated insulation voltage | U_i | Main circuit | See Key to part numbers |
| | | Control supply circuit | 230V a.c. r.m.s |
| Rated impulse withstand voltage | U_{imp} | Main circuit | 6 kV |
| | | Control supply circuit | 4 kV |
| IP code | | Main circuit | IP00 (IP20 optional) |
| | | Supply and Control circuit | IP20 |
| Overvoltage Category / Pollution degree | | III / 3 | |
| Rated conditional short-circuit current and type of co-ordination with associated short circuit protective device (SCPD) | | Type 1 co-ordination See Short Circuit Protection Tables for rated conditional short-circuit current and required current rating and characteristics of the associated SCPD | |

Electrical Installation (continued)

| General Specification (continued) | | | | |
|--|--|---|---------------------------|-----------------------------------|
| As Standard | Control supply | Supply input | 0, 24V | Protect with 4A UL listed fuse |
| | | Kind of current, rated frequency | d.c. | |
| | | Rated voltage U_s | 24Vd.c. | |
| | | Maximum power consumption | 12VA | |
| | Control circuit | Programmable opto-isolated inputs | D1, D2 | |
| | | Common input, marking | COM | |
| | | Kind of current, rated frequency | d.c. | |
| | | Rated voltage U_c | 24Vd.c. | |
| With extra module | Control Supply | Supply input | L, N | |
| | | Kind of current, rated frequency | a.c., 50 - 60Hz \pm 5Hz | |
| | | Rated voltage U_s | 110V to 230V a.c. | |
| | | Rated input current | 1A | |
| | Control circuit | Programmable opto-isolated inputs | D1, D2 | |
| | | Common input | COM | |
| | | Kind of current, rated frequency | a.c., 50 - 60Hz \pm 5Hz | |
| | | Rated voltage U_c | 110V to 230V a.c. | |
| Auxiliary circuit ¹⁾ | Form A - Single gap make -contact (normally open) | 13, 14 | | |
| | Form B - Single gap break-contact (normally closed) | 21, 22 | | |
| | Utilization category, voltage rating, current rating | Resistive load, 250Vac, 2A. Cos ϕ =0.5, 250Vac, 2A. | | |
| Electronic overload relay with manual reset and thermal memory | Trip Class | 10 (factory default), 20 or 30 (selectable) | | |
| | Current setting | 7A to I_e | | |
| | Rated frequency | 50 to 60Hz \pm 5Hz | | |
| | Time-current characteristics | See 'Motor Overload 'cold' trip curves' | | |
| 1) Compliant with Annex S of IEC 60947-1:2007 at 24Vd.c. | | | | |

Electrical Installation (continued)

| Rating Table | | | | | | | | | | | | |
|-----------------------------------|------------------|------|--------------------|------------------------|------------------|------|--------------|--------------|----------------------------|--|--|--|
| I _e A ³⁾ | kW ¹⁾ | | | FLA A ³⁾ | Hp ²⁾ | | | | | Trip Class 10 I _e : AC- 53a: 3.5-17: 90-5 ⁵⁾ | Trip Class 20 I _e : AC- 53a: 4-19: 90-5 ⁵⁾ | Trip Class 30 I _e : AC- 53a: 4-29: 90-5 ⁵⁾ |
| | 230V | 400V | 500V ⁴⁾ | | 200V | 208V | 220- 240V | 440- 480V | 550- 600V ⁴⁾ | | | |
| 17 | 4 | 7.5 | 7.5 | 17 | 3 | 5 | 5 | 10 | 15 | AGY- 101 | AGY- 103 | AGY- 105 |
| 22 | 5.5 | 11 | 11 | 22 | 5 | 5 | 7.5 | 15 | 20 | AGY- 103 | AGY- 105 | AGY- 107 |
| 29 | 7.5 | 15 | 15 | 27 | 7.5 | 7.5 | 7.5 | 20 | 25 | AGY- 105 | AGY- 107 | AGY- 109 |
| 35 | 7.5 | 18.5 | 22 | 34 | 10 | 10 | 10 | 25 | 30 | AGY- 107 | AGY- 109 | AGY- 111 |
| 41 | 11 | 22 | 22 | 41 | 10 | 10 | 10 | 30 | 40 | AGY- 109 | AGY- 111 | AGY- 113 |
| 55 | 15 | 30 | 37 | 52 | 15 | 15 | 15 | 40 | 50 | AGY- 111 | AGY- 113 | - |
| 66 | 18.5 | 37 | 45 | 65 | 20 | 20 | 20 | 50 | 60 | AGY- 113 | - | - |

Minimum current ratings based on typical rated operation currents of motors for the corresponding rated operational powers.

Current rating optimised for kW@400V & hp@440-480V - Ref IEC 60947-4-1:2009 Table G.1 where applicable.

- 1) Rated operational powers in kW as per IEC 60072-1 (primary series) corresponding to IEC current rating.
- 2) Rated operational powers in hp as per UL508 corresponding to FLA current rating.
- 3) The I_e and FLA rating applies for a maximum surrounding air temperature of 40°C. Above 40°C de-rate linearly by 2% of I_e or FLA per °C to a maximum of 60°C.
- 4) kW and Hp ratings applicable for AGY-101-6 to AGY-113-6 models only.
- 5) A duty cycle F-S of up to 90-40 (up to 40 starts per hour) is possible with optional fan fitted.


Electrical Installation (continued)

| Short Circuit Protection | | | | | | | | | | |
|--|----------------------|----|--|-------|-------|-------|--|-------|-------|------|
| Type designation (AGY-) | | | 101-6 | 103-6 | 105-6 | 107-6 | 109-6 | 111-6 | 113-6 | |
| Rated operational current | I_e | A | 17 | 22 | 29 | 35 | 41 | 55 | 66 | |
| Rated conditional short circuit current | I_q | kA | 5 | 5 | 5 | 5 | 5 | 5 | 10 | |
| Class J time-delay fuse #1 | Maximum rating Z_1 | A | 30 | 40 | 50 | 60 | 70 | 100 | 125 | |
| UL Listed inverse-time delay circuit breaker #1 | Maximum rating Z_2 | A | 60 | 60 | 60 | 60 | 60 | 150 | 150 | |
| Semiconductor fuse (class aR) #2, duty ≤ 5 starts per hour. | Type | | Mersen 6,9 URD 30 _ Bussmann 170M30 __ Bussmann 170M31 __ Bussmann 170M32 __ SIBA 20 61 ____ | | | | | | | |
| | Fuse rating | A | 100A | 100A | 160A | 160A | 160A | 200A | 200A | 200A |
| Semiconductor fuse(class aR), #2 duty > 5 starts per hour #3. | Type | | Mersen 6,9 URD 30 _ Bussmann 170M30 __ Bussmann 170M31 __ Bussmann 170M32 __ SIBA 20 61 ____ | | | | Mersen 6,9 URD 31 _ Bussmann 170M40 __ Bussmann 170M41 __ Bussmann 170M42 __ SIBA 20 61 ____ | | | |
| | Fuse rating | A | 160A | 160A | 200A | 200A | 250A | 250A | 250A | 250A |

- # 1. Suitable For Use On A Circuit Capable Of Delivering Not More Than I_q rms Symmetrical Amperes, 600Volts Maximum, When Protected by Class J time delay Fuses with a Maximum Rating of Z_1 or by a Circuit Breaker with a Maximum Rating of Z_2 .
- # 2. Correctly selected semiconductor fuses can provide additional protection against damage to the agility unit (This is sometimes referred to as type 2 co-ordination). These semiconductor fuses are recommended to provide this increased protection.
- # 3. Only when optional fan is fitted, see Rating table (Note 5).

Electrical Installation (continued)

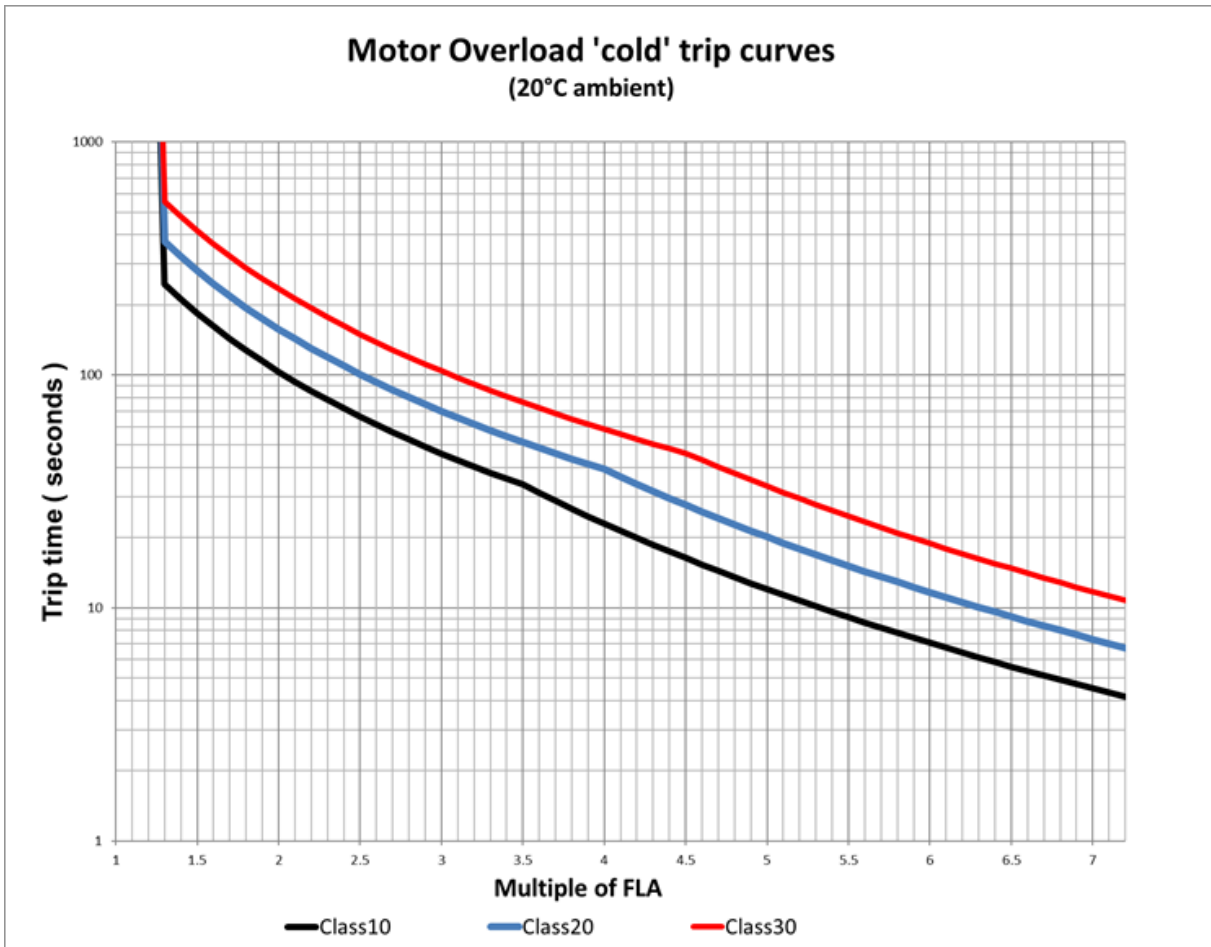
| Electromagnetic Compatibility | | |
|---|---------------|--|
| EMC Emission levels | EN 55011 | Class A \square |
| EMC Immunity levels | IEC 61000-4-2 | 8kV/air discharge or 4kV/contact discharge |
| | IEC 61000-4-3 | 10 V/m |
| | IEC 61000-4-4 | 2kV/5kHz (main and power ports) |
| | | 1kV/5kHz (signal ports) |
| | IEC 61000-4-5 | 2kV line-to-ground |
| 1kV line-to-line | | |
| IEC 61000-4-6 | 10V | |
| <p>\square NOTICE: This product has been designed for environment A. Use of this product in environment B may cause unwanted electromagnetic disturbances, in which case the user may be required to take adequate mitigation measures</p> | | |

| Wire Sizes and Torques | | | | |
|--|-----------------|---------|--------|-------|
| Terminal | Wire Size | | Torque | |
| | mm ² | AWG | Nm | lb-in |
| Main terminals Cu STR 75°C only | 2.5 - 70 | 12- 2/0 | 9 | 80 |
| Control terminals | 0.5-1.5 | 20-16 | 0.8 | 7.0 |
| M6 screw Protective Earth ¹⁾ Cu only  | ≥ 10 | ≥ 8 | 8 | 70 |
| <p>¹⁾ Protective Earth wire size based on bonding conductor requirements of UL508 Table 6.4 and UL508A Table 15.1.</p> | | | | |

Electrical Installation (continued)

Motor Overload Protection

agility provides full motor overload protection, configurable through the user interface. Overload trip settings are determined by the Motor Current setting and the Trip Class setting. Trip class choices are Class 10, Class 20, and Class 30. The agility soft starters are protected using full I²T motor overload with memory. See Appendix 1 for sizing guide.

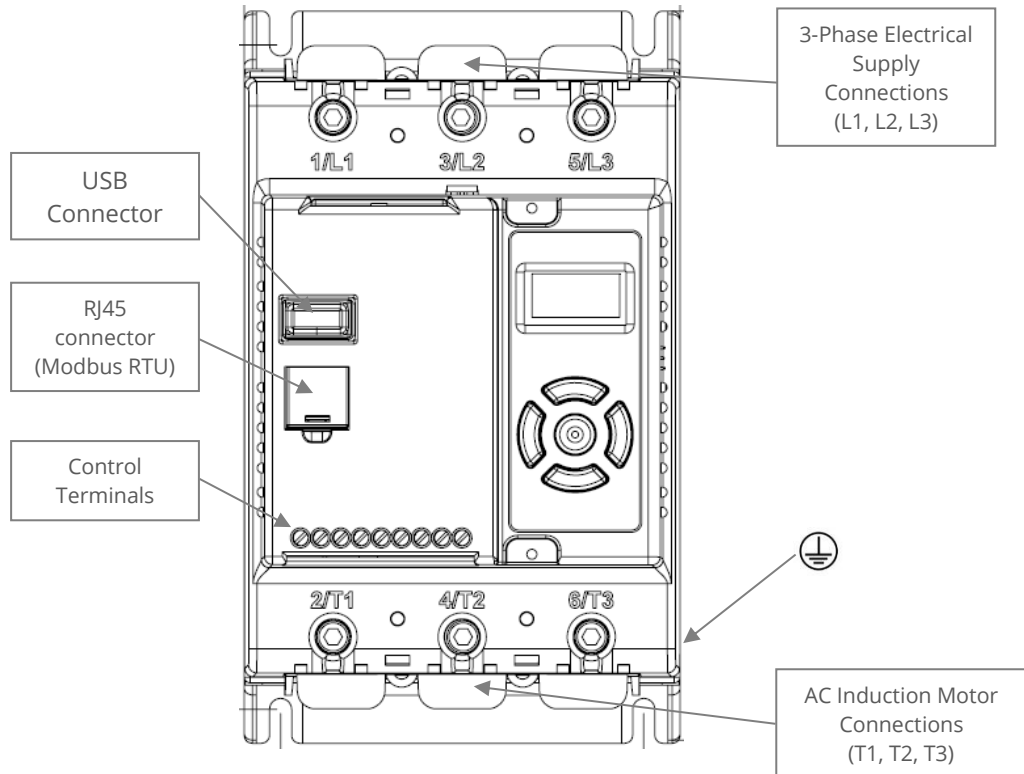


Please note: When the overload has tripped, there is a forced cooling time to allow the overload to recover before the next start.

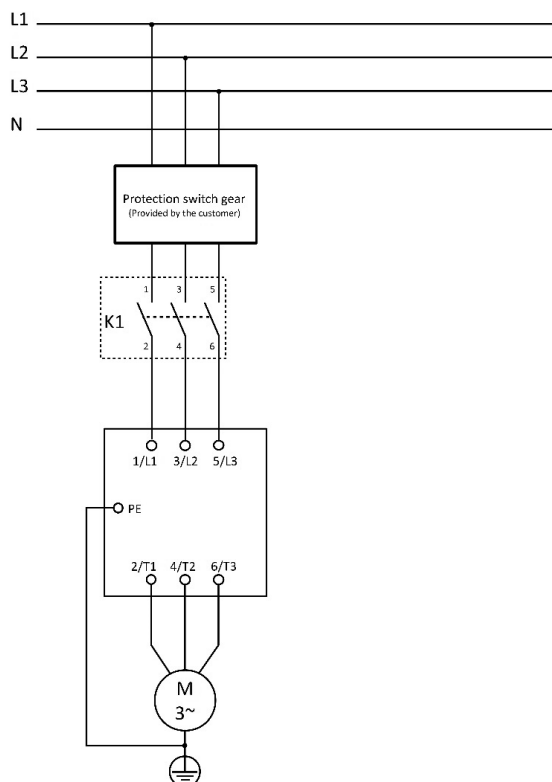
The 'warm' trip times are 50% of the 'cold' trip time

Electrical Installation (continued)

Electrical Connections

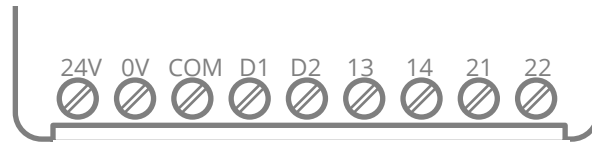


Main Circuit Wiring Diagram



Electrical Installation (continued)

Control Terminal Connection



Control Terminal Functions

| Terminal | Description | Function Selectable | Note |
|----------|------------------------------------|---------------------|------|
| 24Vdc | Control Supply +Us | No | #1 |
| 0V | Control Supply -Us | No | |
| COM | Digital Inputs Common | No | |
| D1 | Digital Input 1 | No | #2 |
| D2 | Digital Input 2 | Yes | #2 |
| 13/14 | Main Contactor Control (Run Relay) | No | #3 |
| 21/22 | Top of Ramp Relay | Yes | #3 |

#1 24V dc Specification: 24V 10VA, residual ripple < 100Mv, spikes/switching peaks < 240mv,

#2 The voltage applied to the digital inputs D1 and D2 must not exceed 24V dc

#3 230Vac, 1A, AC15. 30Vdc, 0.5A resistive

Digital Input 2 (D2) Selectable Functions

Different functions may be assigned to Digital Input 2 in the I/O menu. Available assignments are:

- Reset
- Hold Start Ramp
- Enable
- Fire Mode



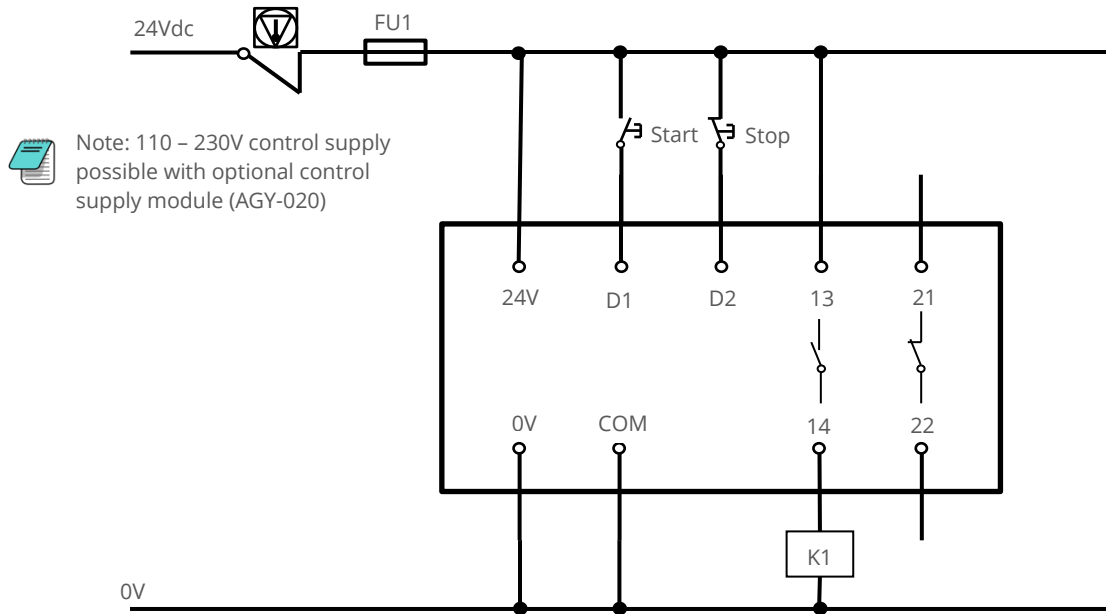
In Fire Mode all trips are disabled.

Digital Output 21/22 Selectable Functions

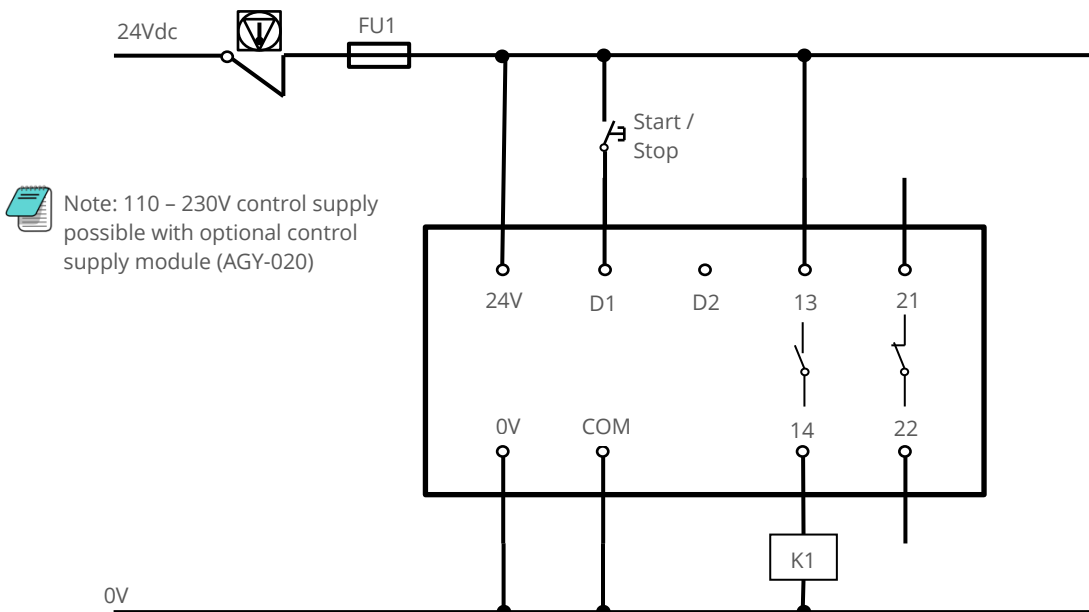
The output may be mapped to Fault or Top-of-Ramp indication

Electrical Installation (continued)

3-Wire Control Circuit Wiring Diagram



2-Wire Control Wiring Diagram



Configuration and Parameters

Display and Controls



Key

- ① Status messages
- ② Instantaneous motor current
- ③ Control scheme: Local, Control terminal, Modbus RTU
- ④ Keypad guidance wizard: Displays which keys are valid for specific menu items
- ⑤ Motor overload level; 0 to 100%
- ⑥ Control keypad
- ⑦ Status LED (incorporated into centre button) –

Keypad Guidance Examples



All keys active



Left & Right keys active



Right, Down & Centre keys active

Note: A flashing centre button indicates that a menu item may be selected or saved.

Configuration and Parameters (continued)

Auto Setup Procedure (Auto App)

Allows the user to change all of the parameters at once to settings that are typical for general applications. One or more parameters as can be adjusted to fine tune the settings for your specific application.

Setup by Individual Parameter Settings (Advanced)

Allows the user to change the parameter settings one at a time.

Auto Application Setup Parameter Settings

| | Initial Volts | Start Time | Stop Time | Trip Class | Current Limit | Current Limit Time |
|-------------------|---------------|------------|-----------|------------|---------------|--------------------|
| Unit | % | s | s | - | *FLC | s |
| Default | 20% | 10 | 0 | 10 | 3.5 | 30 |
| Heavy | 40% | 10 | 0 | 20 | 4 | 40 |
| Agitator | 30% | 10 | 0 | 10 | 3.5 | 25 |
| Compressor 1 | 40% | 15 | 0 | 20 | 3.5 | 25 |
| Compressor 2 | 35% | 7 | 0 | 10 | 3.5 | 25 |
| Conveyor Loaded | 10% | 10 | 7 | 20 | 5.5 | 30 |
| Conveyor Unloaded | 10% | 10 | 7 | 10 | 3.5 | 30 |
| Crusher | 40% | 10 | 0 | 30 | 3.5 | 60 |
| Fan High Inertia | 40% | 10 | 0 | 30 | 3.5 | 60 |
| Fan Low Inertia | 30% | 15 | 0 | 10 | 3.5 | 30 |
| Grinder | 40% | 10 | 0 | 20 | 3.5 | 40 |
| Mill | 40% | 10 | 0 | 20 | 3.5 | 40 |
| Mixer | 10% | 10 | 0 | 20 | 4 | 25 |
| Moulding M/C | 10% | 10 | 0 | 10 | 4.5 | 25 |
| Press Flywheel | 40% | 10 | 0 | 20 | 3.5 | 40 |
| Pump 1 | 10% | 10 | 60 | 10 | 3.5 | 25 |
| Pump 2 | 10% | 10 | 60 | 20 | 3.5 | 25 |
| PumpJack | 40% | 10 | 0 | 20 | 3.5 | 40 |
| SawBand | 10% | 10 | 0 | 10 | 3.5 | 25 |
| SawCircular | 40% | 10 | 0 | 20 | 3.5 | 40 |
| Screen Vibrating | 40% | 10 | 0 | 20 | 4.5 | 40 |
| Shredder | 40% | 10 | 0 | 30 | 3.5 | 60 |
| Wood Chipper | 40% | 10 | 0 | 30 | 3.5 | 60 |

Compressor 1 = Centrifugal, Reciprocating, Rotary Screw

Compressor 2 = Rotary Vane, Scroll

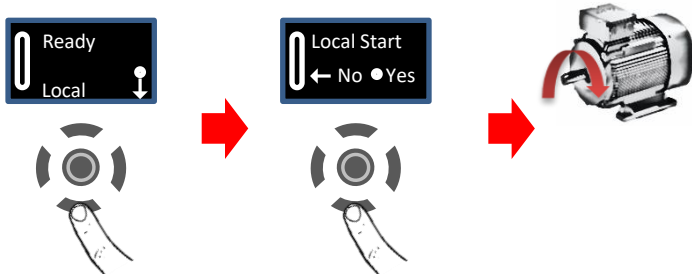
Pump 1 = Submersible: Centrifugal, Rotodynamic

Pump 2 = Positive Displacement: Reciprocating , Rotary

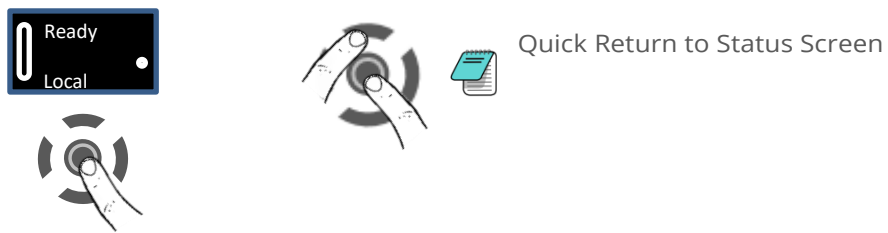
Configuration and Parameters (continued)

Operation

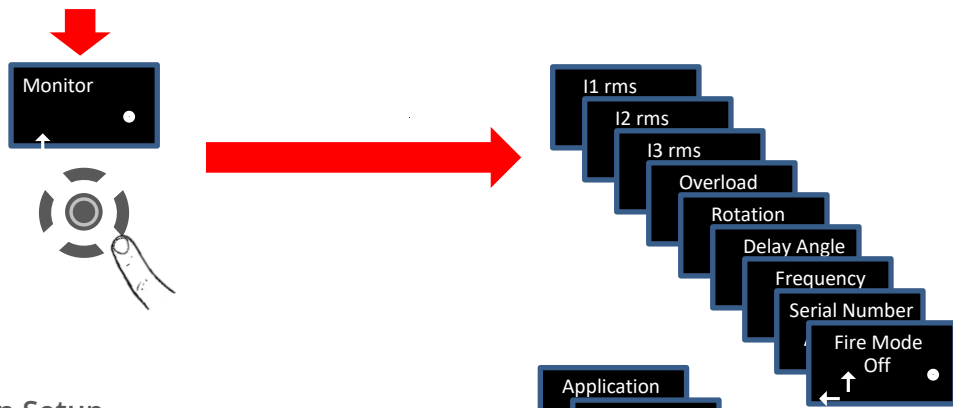
Local Motor Start



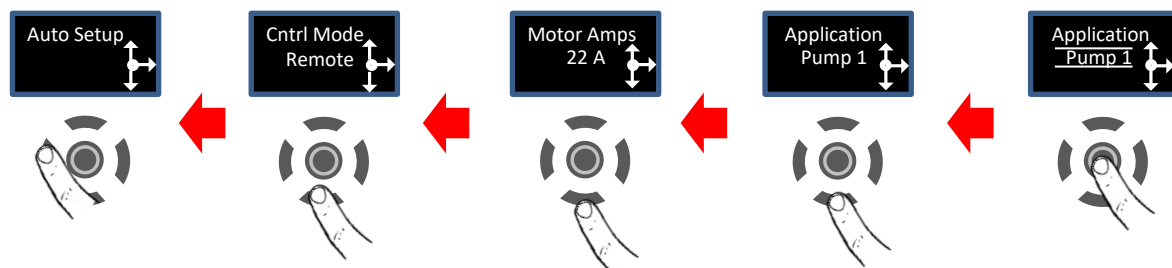
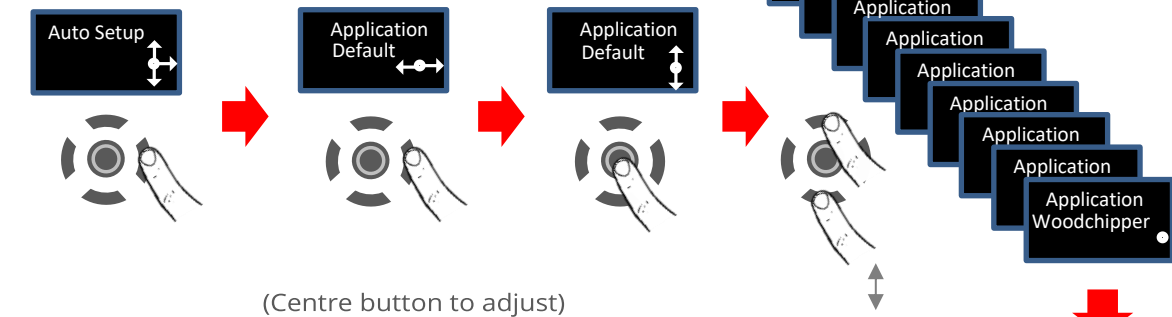
Example Navigation Method



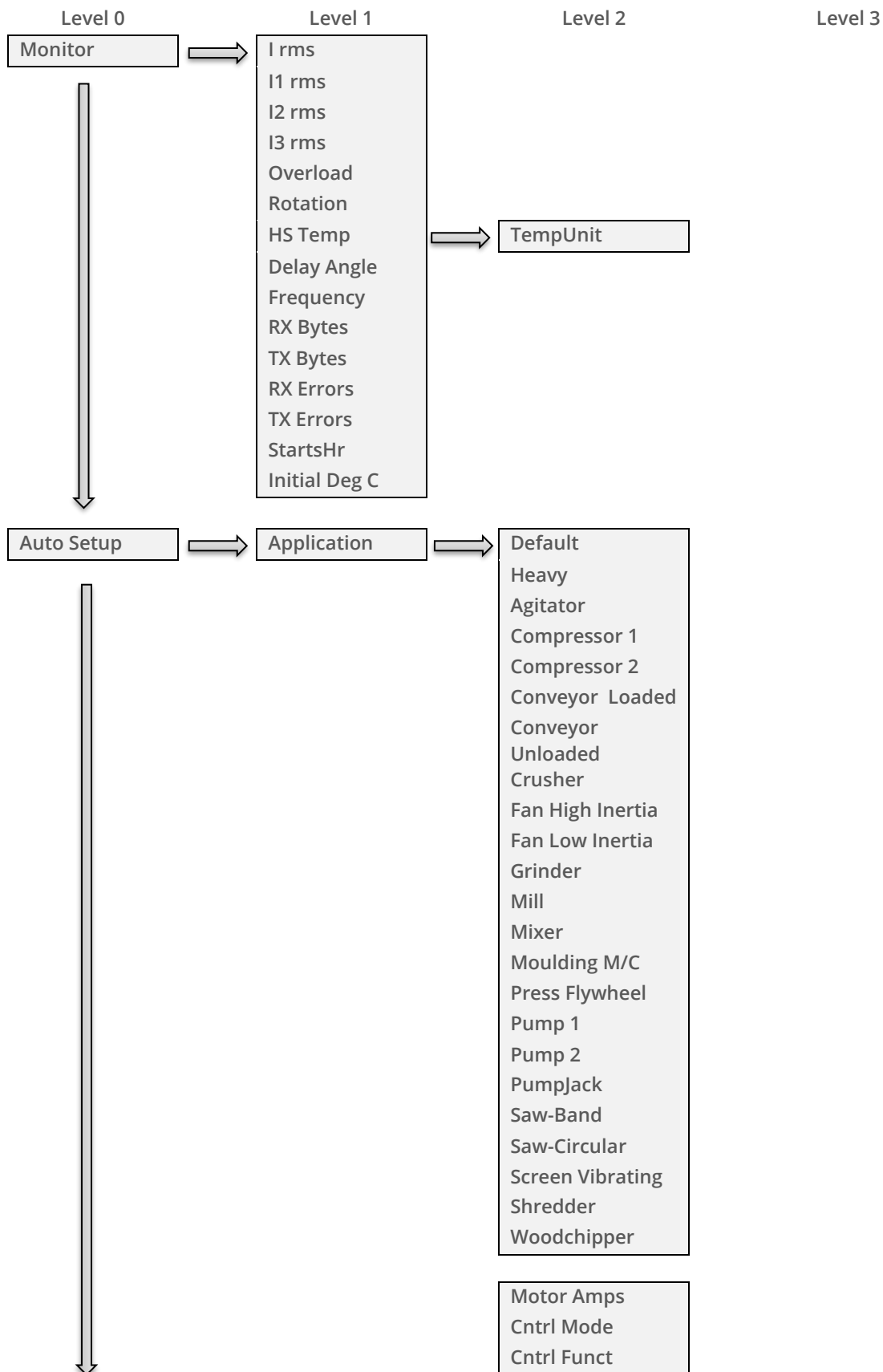
Quick Return to Status Screen



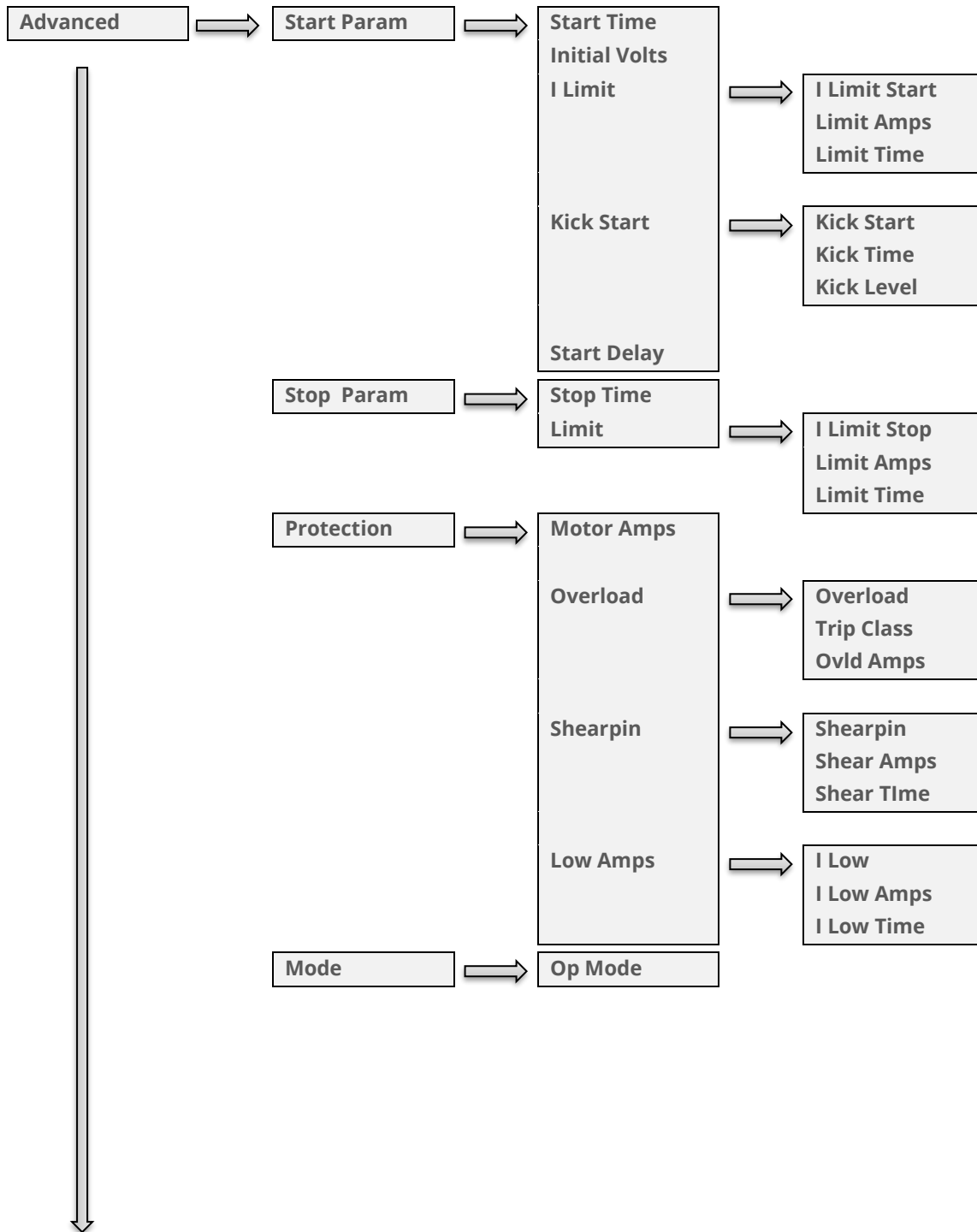
Auto Application Setup



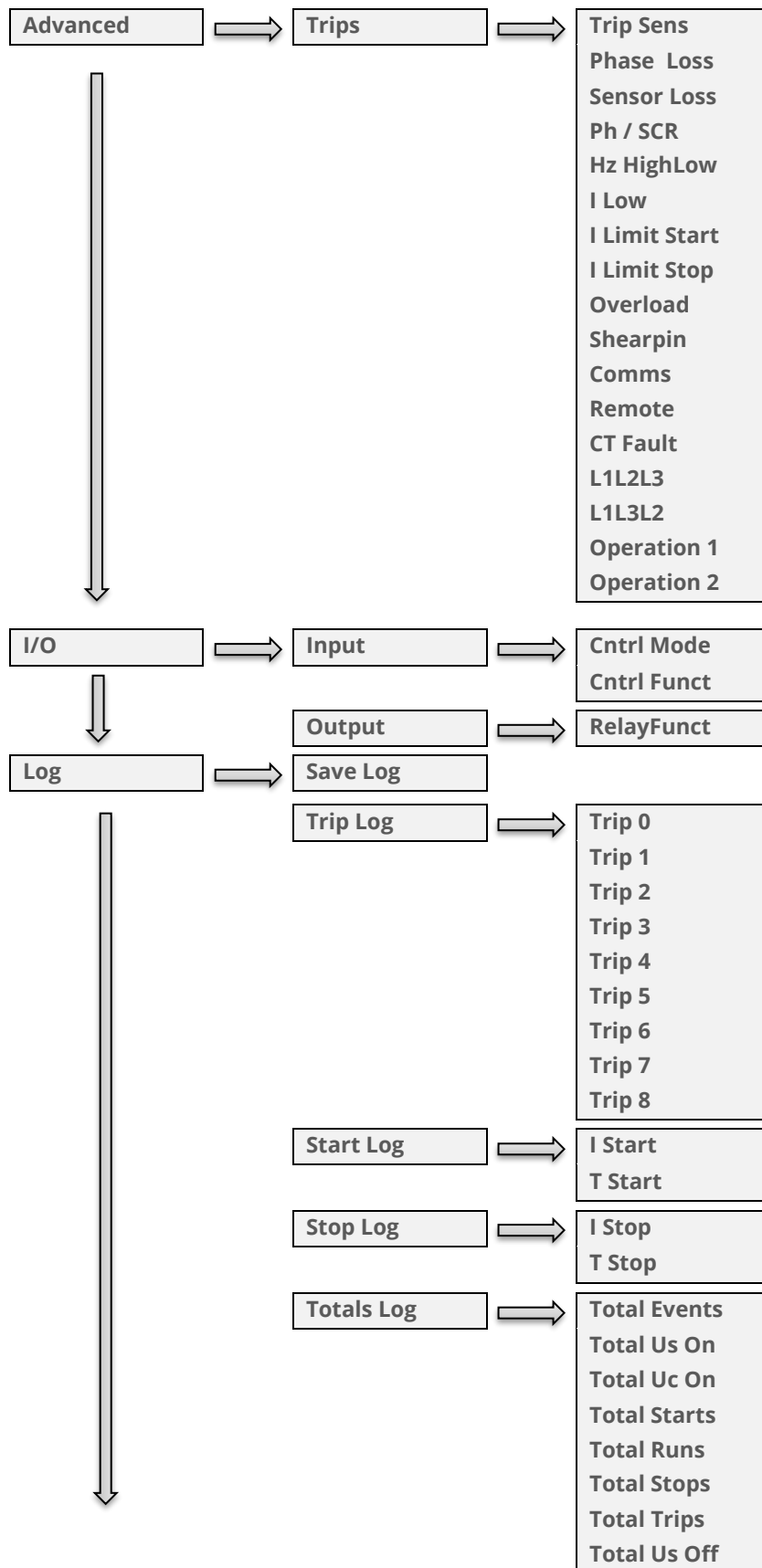
Menu Structure



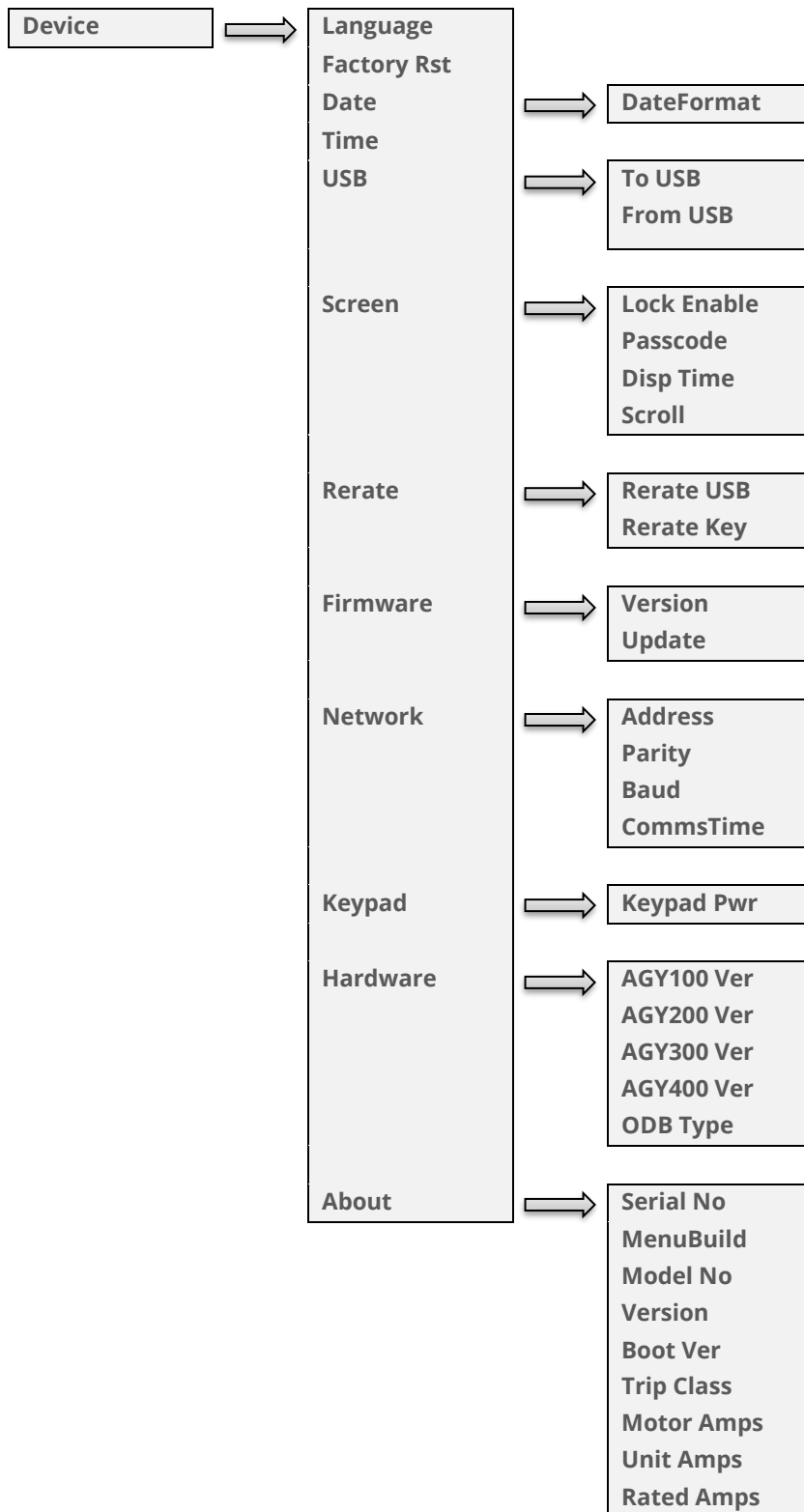
Menu Structure (continued)



Menu Structure (continued)



Menu Structure (continued)



Function Descriptions

| | |
|-------------|---|
| Address | Sets the Modbus address number |
| Application | The unit has numerous pre-set applications built in as standard. Select the application best suited to the load. The selected application will automatically change several parameters and functions. Depending on the application loaded the "Trip Class" may also change |
| Baud | Sets the serial communications baud rate The available baud rates are 9600 19200 38400 57600 or 115200 |
| Boot Ver | Software Version for the Bootloader |
| Cntrl Funct | Allows the Digital inputs to be mapped to different functions Cntrl Mode must be set to "Remote" Two Wire: D1 = Start (Reset) / Stop Three Wire: D1 = Start (Reset) D2 = Stop D2 Reset, D2 HoldStart , D2 Enable , D2 FireMode : Programs D2 as shown |
| Cntrl Mode | Selects the method for starting and controlling the motor Local: Control using the button on the keypad Remote: Control using the terminals. Modbus: Control via Modbus network |
| Comms | Detects if the communications bus has failed or become inactive. To keep the bus active there must be at least one Modbus read or write (any PNU) during the "Comms Time" period (ModbusPNU 147) Trip On: Communication trip enabled. Trip Off: External Trip is disabled |
| CommsTime | Communications trip Timeout period To prevent a 'Communications Trip' (if enabled) the bus must be kept active. To keep the bus active there must be at least one Modbus read or write (any PNU) during the "Timeout ms" period |
| Cont Delay | Time allowed for external contactors to close. Increase if contactors are driven by buffer relays or motor trips on phase loss when start signal applied. Decrease if response to start signal needs to be improved |

Function Descriptions (continued)

| | |
|-------------|---|
| CT Fault | <p>Detects if the internal current sensors have failed or reading a very low level.</p> <p>Trip On: The unit will trip if the internal current sensors fail or the current measured falls to a very low level</p> <p>Trip Off: Will continue to operate even if the sensor has failed. Measurements and overload protection may be effected</p> |
| Date | <p>Enter current date</p> <p>Date format can be set to either dd/mm/yyyy or mm/dd/yyyy. Refer to "Date format" parameter.</p> |
| DateFormat | <p>Allows the date format to be changed</p> <p>dd/mm/yy or mm/dd/yy or yy/mm/dd</p> |
| Delay Angle | <p>Internal firing delay angle in Degrees</p> <p>Displayed for diagnostic purposes</p> |
| Disp Time | <p>Time for backlight on display</p> <p>After the period set the back light on the screen will turn off</p> <p>To reactivate touch screen anywhere. To disable set to 0</p> |
| Factory Rst | <p>Restores the unit to the factory defaults</p> |
| Fan Fault | <p>Detects if the cooling fans have failed.</p> <p>Trip On: The unit trips if the cooling fans fitted to the unit fail.</p> <p>Trip Off: Will continue to operate and is likely to trip on a thermal trip as the heatsink will not be sufficiently cooled</p> |
| Fire Mode | <p>A special feature that allows the unit to operate with ALL of the trips OFF. Set " Cntrl Funct" to "D2 FireMode" , Enabled when D2 is high</p> <p>Although the unit will keep running in this mode it may become damaged. In some instances, the damage may inhibit a subsequent starts</p> <p>This is only to be used in an emergency</p> |
| Frequency | <p>The frequency of the 3-phase supply</p> |
| From USB | <p>Allows the user to load parameters stored on a USB flash drive</p> <p>Uploads the parameters from the USB drive to the unit</p> <p>Data is stored in CSV format.</p> |
| HS Temp C | <p>The temperature of the internal unit heatsink.</p> <p>The unit will trip when the heatsink temperature exceeds 80°C.</p> |
| HS Temp F | <p>The temperature of the internal unit heatsink.</p> <p>The unit will trip when the heatsink temperature exceeds 176°F</p> <p>The optional cooling fans will turn on if this temperature exceeds 104°F</p> |
| I Limit | <p>Selects trip or continue if the current limit has been active for too long</p> <p>Trip On: The unit will trip</p> <p>Trip Off: The start will continue regardless of the motor current level</p> |
| I Low | <p>This can be used to detect if the motor is running lightly loaded.</p> <p>Trip On: The unit will trip. This feature is not active during soft start and soft stop.</p> <p>Trip Off: The unit will continue to operate regardless of motor current</p> |

Function Descriptions (continued)

| | |
|---------------|---|
| I rms | The RMS motor current Indicates average current of the 3 phases. |
| I Start | Displays the peak current during the last start. |
| I Stop | Displays the peak current during the last stop. |
| I1 rms | The RMS current on phase L1 |
| I2 rms | The RMS current on phase L2 |
| I3 rms | The RMS current on phase L3 |
| Initial Volts | Percentage of the supply voltage applied to motor at the beginning of the soft start. Increase to provide more torque If the load fails to break away. Decrease if the motor accelerates too quickly. |
| Kick Level | Percentage of the supply voltage applied to the motor during the 'kick' period Increase to provide more torque If the load fails to break away. Decrease if the motor accelerates too quickly. |
| Kick Start | Applies a short duration torque pulse to dislodge 'sticky' loads On: The torque pulse is applied at start-up when complete the torque drops to the "Initial Volts" Off: The initial starting torque is defined by the "Initial Volts" |
| Kick Time | Time that the torque pulse is applied to load Increase to provide more torque If the load fails to break away. Decrease if the motor accelerates too quickly. |
| Last Trip | |
| Limit Amps | The current in Amps at which the soft Start ramp is held. Normally set to 350% of motor FLC. Increase if motor fails to accelerate at required rate The "Limit Amps" will affect actual time to start. If set too low the motor may not accelerate to full speed. |
| Limit Time | The maximum time allowed for the current limit. If the current limit is still active at the end of this period, the unit will either 'Trip' or 'continue' |
| MenuBuild | Menu Version |

Function Descriptions (continued)

| | |
|---------------|---|
| Modbus Enable | Enable using Modbus On: The unit is enabled Off: The unit is disabled |
| Modbus Reset | Reset using Modbus On: The initial state required for a reset. Off: The final state required for a reset. To reset pulse high and then low |
| Modbus Start | Start / Stop using Modbus On: Starts the unit Off: Stops or Soft stops the unit |
| Model No | The device Model number stored at the point of manufacture |
| Motor Amps | This should be set to the Full Load Current shown on the motor plate The overload works with multiples of the set "Motor Amps" Also referred to as Motor FLA |
| MotorState | Indicates the unit operating State |
| Op Mode | |
| Overheat | Detects if the internal temperature sensor has malfunctioned Trip On: The unit will trip if the internal temperature sensor malfunctions Trip Off: The unit will continue to operate even if the temperature sensor has malfunctioned. Operating with the Trip Off for prolonged periods may result in SCR failure |
| Overload | The unit has an "Overload" function that is an electronic equivalent to a thermal overload. Overload displays the overload capacity which is a measure of how close the unit to tripping on "Overload Trip" When "Irms" is greater than the "Overload Amps" the "Overload" increases in accordance with the "Trip Class". When "Current Irms" is less than "Overload Level" the "Overload" decreases exponentially (if greater than 50%) When the "Overload" reaches 100% the unit will trip. During situations when "Motor Amps" is equal to "unit Amps" the overload will indicate 50% |

Function Descriptions (continued)

| | |
|-------------------------|--|
| Overload Trip | The unit has an "Overload" function that is an electronic equivalent to a thermal overload. Trip On: The unit will trip when the "Overload" capacity (Modbus PNU 27) exceeds 100% Trip Off: The unit will continue to operate regardless of motor current level |
| Ovld Amps | Determines the level in Amps at which the overload will start. Normally set to 115% of the set "Motor Amps" Reduce to speed up trip response |
| Parity | Sets the serial communications parity bit The available parity options are None Even Odd Also, sets the stop bits. No parity uses 2 stop bits. Odd or even parity uses 1 stop bit |
| Patch Addr 1 through 16 | Used to arrange the Modbus Parameters into Groups Refer to MAN-AGY-002-V01 for more details |
| Ph / SCR | Detects for various issues when "Starting" or " Stopping" Detects for input phase loss / Output phase loss / SCR misfire Trip On: Trips if there is an input phase loss / motor side phase loss / SCR misfire Trip Off: The unit will attempt to run although the operation may be erratic. Operating in this mode for prolonged periods may result in SCR failure |
| Phase Loss | Detects for various issues when the start signal is applied Detects for input phase loss / input phase relationship Trip On: Trips if there is an input phase loss / supply out of balance Trip Off: The unit will attempt to run although the operation may be erratic. Operating in this mode for prolonged periods may result in SCR failure |
| Rated Amps | Unit Class20 / Class30 Current Rating |
| RelayFunct | Allows the n/c relay (21 -22) to be reconfigured Available options are 22 = TOR or 22 = ERR |

Function Descriptions (continued)

| | |
|------------|--|
| Remote | <p>For safety reasons the unit will trip during some operations if the remote start signal is active</p> <p>Trip On: Trips if the remote start signal is active when the unit is powered up or a reset is applied.</p> <p>Trip Off: The unit will not trip and may start unexpectedly if the start signal is accidentally left active.</p> |
| Rotation | <p>Indicates the phase sequence of the incoming supply.</p> <p>RYB = ABC = L1-L2-L3</p> <p>RBY = ACB = L1-L3-L2</p> |
| Save Log | <p>Download the full log file on to the USB stick</p> <p>The unit logs several parameters during normal and fault conditions</p> <p>Data is stored in CSV format. Please send all downloaded files to Fairford on request</p> |
| Serial No | The device serial number stored at the point of manufacture |
| Shear Amps | <p>The current in Amps that will cause a "Shear Trip"</p> <p>A trip will occur if the motor current is greater than the "Shear Amps" for the "Shear Time"</p> |
| Shear Time | <p>The trip time for the Shearpin trip</p> <p>A trip will occur if the motor current is greater than the "Shear Amps" for the "Shear Time"</p> |
| Shearpin | <p>The Shearpin is an electronic equivalent of a mechanical Shearpin</p> <p>Trip On: The unit will trip. This feature is not active during soft start and soft stop.</p> <p>Trip Off: The unit will continue to operate regardless of motor current level</p> |
| Start Time | <p>Time taken to soft start from the "Initial Volts" to the end of the start</p> <p>Normally set between 5 and 30 seconds.</p> <p>Actual time to get to full voltage depends on the "Limit Amps".</p> <p>If set too long the motor can be at speed before the end of the time set.</p> |
| Stop Time | <p>The time taken to soft stop from full voltage to the end of the stop</p> <p>Normally set between 15 and 30 seconds.</p> <p>Actual time to get to the final voltage depends on the "Limit Amps".</p> <p>If set too long the motor may reach zero speed before the end of the time set.</p> |

Function Descriptions (continued)

| | |
|--------------|---|
| Store Param | Saves all Read /Write parameters to non-volatile memory Yes: Parameters are permanently written No: Parameters remain changed until next power cycle |
| System | Detects if the Control Board has failed to operate normally Trip On: System Trip enabled. Trip Off: System Trip disabled. |
| T Start | Displays the time of the last start |
| T Stop | Displays the time of the last stop |
| Tempunit | Selects °C or °F for displayed temperatures °C: All displayed temperatures are °C °F: All displayed temperatures are °F |
| Time | Allows the time to be changed to 'local' time By default, the time is set to GMT |
| To USB | Allows the user to save parameters Downloads the parameters from the unit to the USB drive Data is stored in CSV format. |
| Total Events | The total number of events that have been recorded in the log file |
| Total Run | The total number of times the unit as successfully got to the "Running" State The Running state is active when the unit is operating at full voltage. When operating at full voltage the internal bypass relays are closed. |
| Total Starts | The total number of successful starts |
| Total Uc On | The total number of times the unit has been powered up. Te unit is powered up by applying a voltage to Uc Uc will be 24V or 110V / 230V depending on model |
| Total Uc Off | The total number of times the unit has been powered down. Te unit is powered down by removing the voltage at Uc Uc will be 24V or 110V / 230V depending on model |

Function Descriptions (continued)

| | |
|------------------------|--|
| Trip 0 | Displays the last Fault trip |
| Trip 1 | Displays the last Fault trip -1 |
| Trip 2 | Displays the last Fault trip -2 |
| Trip 3 | Displays the last Fault trip -3 |
| Trip 4 | Displays the last Fault trip -4 |
| Trip 5 | Displays the last Fault trip -5 |
| Trip 6 | Displays the last Fault trip -6 |
| Trip 7 | Displays the last Fault trip -7 |
| Trip 8 | Displays the last Fault trip -8 |
| Unit Amps | unit Class10 Current Rating |
| Version | Software Version for the Main control PCB Software version recorded in log file |
| Window 1 through 24 | Used to arrange the Modbus Parameters into Groups |
| Window Code | Used to arrange the Modbus Parameters into Groups |
| Window View | Used to arrange the Modbus Parameters into Groups |

Trip and Fault Codes

| Trip Code | Trip Name | Description |
|-----------|-----------|--|
| 101-199 | Ph Loss | Input phase voltage missing or motor discontinuity at the instant of startup. Check all incoming and outgoing connections. If a main contactor is being controlled by a digital output check contactor delay is sufficient |
| 201-299 | Thermal | Internal heatsink temperature has exceeded 90°C It is possible the Unit is operating outside specified limits. Check enclosure ventilation and airflow around the Unit. If the unit trips immediately the internal temperature sensor could be faulty. |
| 301-399 | Ph / SCR | Input phase voltage missing or motor discontinuity or SCR failure Check all incoming and outgoing connections. ISOLATE SUPPLY. Check by measuring the resistance between L1-T1 L3-T3 (Anything < 10R is assumed short circuit) |
| 601-699 | Uc Low | The internal control supply of the Unit level has fallen to a low level Can be caused by a weak 24VDC control supply. Ensure 24VDC supply meets the requirements specified in the Quick Start Guide. |
| 1101-1199 | Low Amp | The motor current has been lower than the low trip level for the low trip time This trip is not active during soft start and soft stop and is "off" by default. If the low current trip is not required turn "off" in "Trip Settings". |
| 1201-1299 | Limit | The motor has been held in current limit longer than the "Current limit Time" It is likely that the current limit level has been set too low for the application. Increase the current limit level or timeout period. |
| 1301-1399 | Overload | The "Overload" has exceeded 100% The Unit is attempting to start an application that is outside its capacity or it is starting too often. Refer to the overload trip curves to determine whether the Unit has been sized correctly. |
| 1401-1499 | Shear | The motor current has been higher than the "Shearpin Trip Level" for the trip time. This trip is not active during soft start and soft stop and is "off" by default. If Shearpin trip is not required turn "off" in "Trip Settings". |

Trip and Fault Codes (continued)

| Trip Code | Trip Name | Description |
|-------------|-----------|---|
| 1701-1799 | Comms | Communications failure The command or status PNU has not been polled in the time set in the "Timeout" period If the communication trip is disabled the Unit cannot be stopped in the communications fail |
| 1801-1899 | Bypass | One or more of the internal bypass relays has failed to close or open The internal bypass relay has failed or the control supply is too weak. Ensure 24VDC supply meets the requirements specified in the Quick Start Guide. |
| 2001-2099 | Remote | The remote start signal is active. The remote start signal was active during power up or Reset or Parameter Load. Turn off remote or if Remote On trip is not required turn "off" in "Trip Settings" |
| 2101-2199 | Rotation | Checks the input phase rotation The phase rotation is opposite to that required. Change phase rotation or if the trip is not required turn "off" in trip settings. |
| 2201-2299 | Op1 | Fail Safe operation A process associated with the Control Board has been affected and is unable to recover automatically |
| 2301-2399 | CT Fault | Current sensor failure One or more of the internal sensors used to measure current has failed or is reading a low value. Check the connections to the supply and motor as disconnection will result in a zero current reading. Check the plate FLA of the motor being controlled is at least 25% of the "i-motor" rating |
| 11001-11099 | Op2 Pnu | Fail Safe operation A process associated with the Control Board has been affected and is unable to recover automatically |
| 12001-12099 | Op2 Mod | Fail Safe operation A process associated with the Control Board has been affected and is unable to recover automatically |

Trip and Fault Codes (continued)

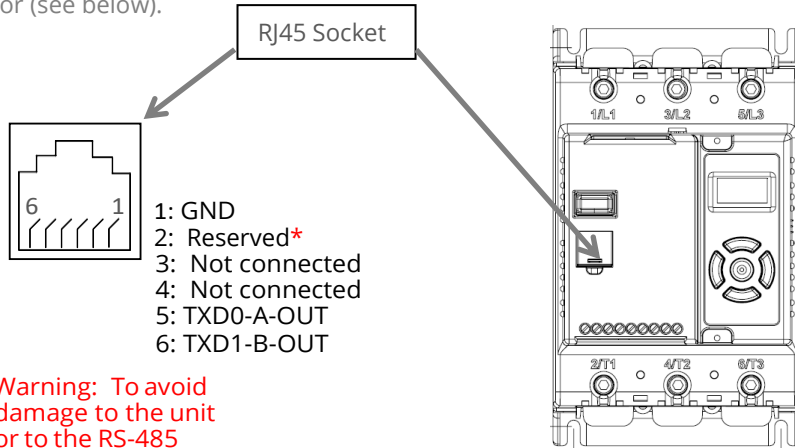
| Trip Code | Trip Name | Description |
|-------------|-----------|---|
| 13001-13099 | Op2 Mon | Fail Safe operation A process associated with the Control Board has been affected and is unable to recover automatically |
| 14001-14099 | Op2 Men | Fail Safe operation A process associated with the Control Board has been affected and is unable to recover automatically |
| 15001-15099 | Op2 Keys | Fail Safe operation A process associated with the Control Board has been affected and is unable to recover automatically |
| 16001-16099 | Op2 Motr | Fail Safe operation A process associated with the Control Board has been affected and is unable to recover automatically |
| 17001-17099 | Op2 Log | Fail Safe operation A process associated with the Control Board has been affected and is unable to recover automatically |
| 18001-18099 | Op2 Disk | Fail Safe operation A process associated with the Control Board has been affected and is unable to recover automatically |

Communication

Modbus RTU Serial Communications

Modbus RTU Communications Interface

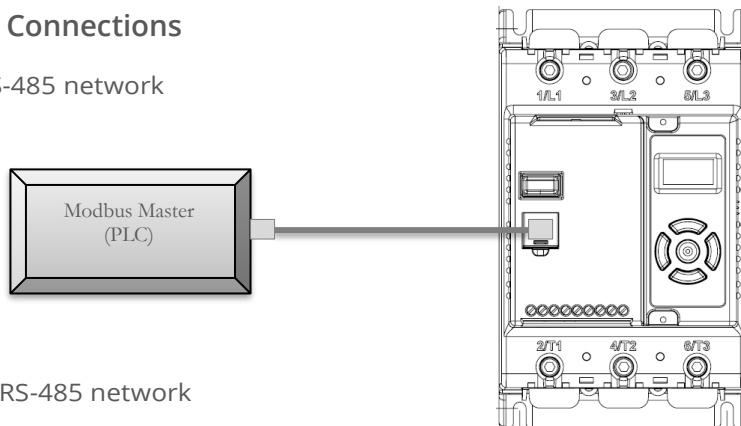
All agility soft starts support Modbus RTU as standard. The RS-485 communications are accessible from the RJ45 connector (see below).



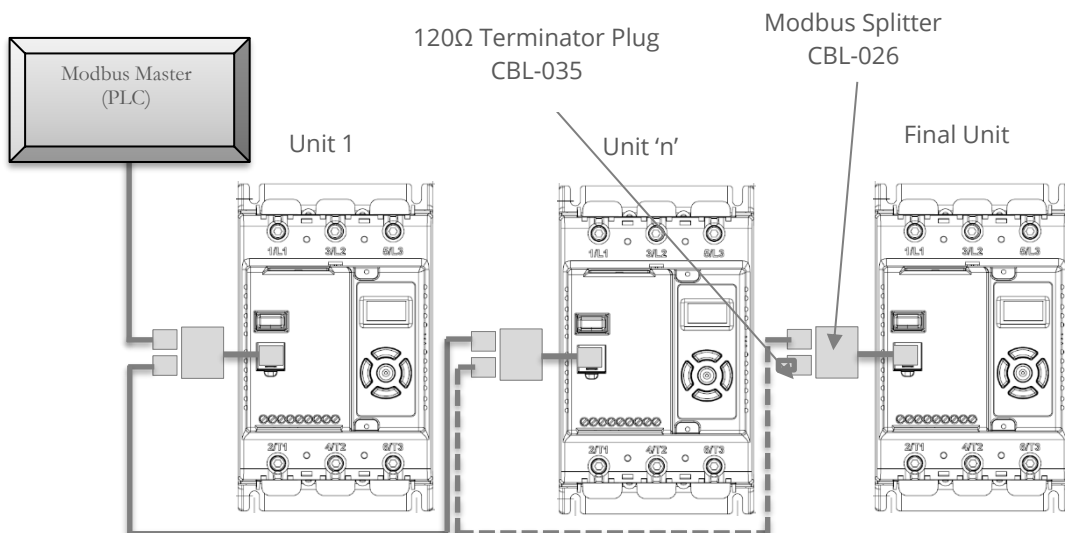
*** Warning: To avoid damage to the unit or to the RS-485 master, do NOT connect to this pin!**

Modbus RTU Connections

Single agility RS-485 network



Multiple agility RS-485 network



Communication (continued)

Modbus Communications Configuration

The Modbus communication settings may be configured from the Device menu:

- Device >> Networks >> Modbus Network Settings >> Address (1 – 32)
- Device >> Networks >> Modbus Network Settings >> Baud (9600 – 115200)
- Device >> Networks >> Modbus Network Settings >> Parity (Odd / Even)
- (Data bits = 8, Stop bits = 1)

The communication parameters should be set before connecting the Modbus master.

Transmission Modes

ASCII and RTU transmission modes are defined in the Modbus protocol specification. agility uses *only the RTU mode* for the message transmission.

Message Structure For RTU Mode

The Modbus RTU structure uses a master-slave system for message exchange. In the case of the agility system, it allows up to 32 slaves, and one master. Every message begins with the master making a request to a slave, which responds to the master in a defined structure. In both messages (request and answer), the used structure is the same:

- Address, Function Code, Data and CRC.

Master (request message):

| | | | |
|---------------------|----------------------|---------------------------|------------------|
| Address (1 byte) | Function (1 byte) | Request Data (n bytes) | CRC (2 bytes) |
|---------------------|----------------------|---------------------------|------------------|

Slave (response message):

| | | | |
|---------------------|----------------------|----------------------------|------------------|
| Address (1 byte) | Function (1 byte) | Response Data (n bytes) | CRC (2 bytes) |
|---------------------|----------------------|----------------------------|------------------|

Address

The master initiates the communication by sending a byte with the address of the destination slave. When responding, the slave also initiates the message with its own address. Broadcast to address 0 (zero) is not supported.

Function Code

This field contains a single byte, where the master specifies the type of service or function requested to the slave (reading, writing, etc.). According to the protocol, each function is used to access a specific type of data.

Data Field

The format and contents of this field depend on the function used and the transmitted value.

Communication (continued)

CRC

The used method is the CRC-16 (Cyclic Redundancy Check). This field is formed by two bytes; where first the least significant byte is transmitted (CRC-), and then the most significant (CRC+). The CRC calculation form is described in the Modbus RTU protocol specification.

Supported Functions

Modbus RTU specification defines the functions used to access different types of data.

- agility parameters are defined as *holding type registers*.
- For Modbus RTU/TCP Client devices that use Modicon style addressing, place a 4 as the high digit followed by the Modbus address defined in the parameter mapping table. Note that agility Modbus addressing starts at zero; not 1 as some devices do.
- agility 32-bit parameters are High Word / Low Word in Modbus format.

The following services are available:

Read Holding Registers

Description: reading register blocks of holding register type (block R/W limited to 8 registers).

- Function code: 03

| Modbus Function 03 Transaction Table | | | |
|--------------------------------------|----------|---------------|----------|
| Quer | | Respons | |
| Field | Hex Byte | Field | Hex Byte |
| Slave address | 01 | Slave address | 01 |
| Function | 03 | Function | 03 |
| Start address Hi | 00 | Byte count | 02 |
| Start address Lo | 01 | Data Hi | 01 |
| No of registers | 00 | Data Lo | 2C |
| No of registers | 01 | CRC Lo | B8 |
| CRC Lo | D5 | CRC Hi | 09 |
| CRC Hi | CA | | |

Write Single Register

Description: writing in a single register of the holding type.

- Function code: 06

| Modbus Function 06 Transaction Table | | | |
|--------------------------------------|----------|---------------|----------|
| Quer | | Respons | |
| Fiel | Hex Byte | Fiel | Hex Byte |
| Slave address | 01 | Slave address | 01 |
| Function | 06 | Function | 06 |
| Address Hi | 00 | Address Hi | 02 |
| Address Lo | 0C | Address Lo | 0C |
| Force data Hi | 00 | Force data Hi | 00 |
| Force data Lo | 09 | Force data Lo | 09 |
| CRC Lo | 48 | CRC Lo | 88 |
| CRC Hi | 0C | CRC Hi | 77 |

Communication (continued)

Write Multiple Registers

Description: writing register blocks of holding register type (block R/W limited to 8 registers).

- Function code: 16

| Modbus Function 16 Transaction Table | | | |
|--------------------------------------|----------|---------------|----------|
| Query | | Response | |
| Field | Hex Byte | Field | Hex Byte |
| Slave address | 01 | Slave address | 01 |
| Function | 16 | Function | 16 |
| Address Hi | 00 | Address Hi | 02 |
| Address Lo | 0C | Address Lo | 0C |
| Force data Hi | 00 | Force data Hi | 00 |
| Force data Lo | 09 | Force data Lo | 09 |
| CRC Lo | 48 | CRC Lo | 49 |
| CRC Hi | 0C | CRC Hi | B4 |

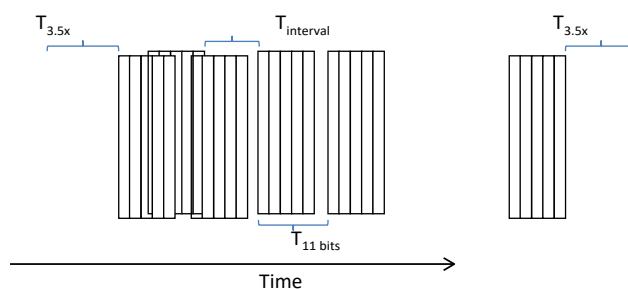
Memory Map

agility™ Modbus communication is based on reading or writing equipment parameters from or to the holding registers. The data addressing is zero offset, such that the parameter Modbus address corresponds to the register number.

| Parameter Modbus Address | Modbus Data Address | |
|-----------------------------|---------------------|-------------|
| | Decimal | Hexadecimal |
| 0000 | 0 | 0000h |
| 0001 | 1 | 0001h |
| • | • | • |
| • | • | • |
| • | • | • |
| 0128 | 128 | 0080h |
| • | • | • |
| • | • | • |
| • | • | • |

Message Timing

In the RTU mode there is no specific start or stop byte that marks the beginning or the end of a message. Indication of when a new message begins or when it ends is achieved by the absence of data transmission for a minimum period of 3.5 times the transmission time of a data byte. Thus, in case a message is transmitted after this minimum time has elapsed; the network elements will assume that the first received character represents the beginning of a new message.



Modbus RTU Parameters

| PNU | Name | Description | Options | Words | Type | Units | Detail |
|-----|---------------|---|------------------------------------|-------|------|-------|---|
| 1 | Cntrl Mode | Selects the method for starting and controlling the motor Local : Control using the button on the keypad Remote : Control using the terminals. Modbus : Control via Modbus network | 0=Local, 1=Remote, 2=Modbus. | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 2 Default: 0 |
| 2 | Initial Volts | Percentage of the supply voltage applied to motor at the beginning of the soft start. Increase to provide more torque if the load fails to break away. Decrease if the motor accelerates too quickly. | | 1 | R/W | % | Multiplier: 100 Divisor:16384 Offset: 0 Min: 1638 Max: 13107 Default: 3277 |
| 4 | Start Time | Time taken to soft start from the "Initial Volts" to the end of the start Normally set between 5 and 30 seconds. Actual time to get to full voltage depends on the "Limit Amps". If set too long the motor can be at speed before the end of the time set. | | 1 | R/W | s | Multiplier: 1 Divisor:1 Offset: 0 Min: 1 Max: 30 Default: 10 |
| 5 | Stop Time | The time taken to soft stop from full voltage to the end of the stop Normally set between 15 and 30 seconds. Actual time to get to the final voltage depends on the "Limit Amps". If set too long the motor may reach zero speed before the end of the time set. | | 1 | R/W | s | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 30 Default: 0 |

Modbus RTU Parameters (continued)

| PNU | Name | Description | Options | Words | Type | Units | Detail |
|-----|-------------|--|---------|-------|------|-------|---|
| 6 | Start Delay | Time allowed for external contactors to close. Increase if contactors are driven by buffer relays or motor trips on phase loss when start signal applied Decrease if response to start signal needs to be improved | | 1 | R/W | ms | Multiplier: 1 Divisor:1 Offset: 0 Min: 100 Max: 30000 Default: 160 |
| 7 | Serial No | The device serial number stored at the point of manufacture | | 4 | R | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 255 Default: 0 |
| 11 | Model No | The device Model number stored at the point of manufacture | | 1 | R | | Multiplier: 1 Divisor:1 Offset: 0 Min: 101 Max: 113 Default: 101 |
| 14 | Version | Software Version for the Main control PCB Software version recorded in log file | | 2 | R | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 0 |

Modbus RTU Parameters (continued)

| PNU | Name | Description | Options | Words | Type | Units | Detail |
|-----|-------------|---|---|-------|------|-------|--|
| 16 | Application | <p>The Unit has numerous pre-set applications built in as standard. Select the application best suited to the load.</p> <p>The selected application will automatically change several parameters and functions. Depending on the application loaded the "Trip Class" may also change Refer to the separate 'applications document' for more details</p> | See Table 1 | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 23 Default: 0 |
| 17 | Trip Class | <p>The trip class is a numeric value that correlates the trip time with overload level.</p> <p>Select Trip class according to application requirements</p> <p>The trip time depends on the selected "Trip Class" the duration of the overload and the level of the over current.</p> <p>Refer to the Motor Overload 'cold' trip curves given in the Guide.</p> <p>When "Class 20" or "Class30" are selected the Unit current rating (Unit Amps) will be reduced to a lower value (Rated Amps).</p> | 10=Class10, 20=Class20, 30=Class30. | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 10 Max: 30 Default: 10 |
| 18 | Motor Amps | <p>This should be set to the Full Load Current shown on the motor plate</p> <p>The overload works with multiples of the set "Motor Amps"</p> <p>Also referred to as Motor FLA</p> | | 2 | R/W | A | Multiplier: 1 Divisor:1000 Offset: 0 Min: 0.1 x PNU18 Max: 1 x PNU20 Default: 1 x PNU20 |
| 19 | Reserved | -- | | | | | Multiplier: Divisor: Offset: Min: Max: Default: |

Modbus RTU Parameters (continued)

| PNU | Name | Description | Options | Words | Type | Units | Detail |
|-----|------------|---|-------------|-------|------|-------|--|
| 20 | Rated Amps | Unit Class20 / Class30 Current Rating | | 2 | R | A | Multiplier: 1 Divisor:1000 Offset: 0 Min: 17000 Max: 66000 Default: 17000 |
| 22 | Unit Amps | Unit Class10 Current Rating | | 2 | R | A | Multiplier: 1 Divisor:1000 Offset: 0 Min: 17000 Max: 66000 Default: 17000 |
| 24 | MotorState | Indicates the Unit operating State | See Table 2 | 1 | R | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 0 |
| 25 | I rms | The RMS motor current This is the average of the 3 phases. This value is used for the current Limit and overload features | | 2 | R | A | Multiplier: 1 Divisor:1000 Offset: 0 Min: 0 Max: 24 Default: 0 |

Modbus RTU Parameters (continued)

| PNU | Name | Description | Options | Words | Type | Units | Detail |
|-----|-------------|---|----------------------|-------|------|-------|---|
| 27 | Overload | <p>The Unit has an "Overload" function that is an electronic equivalent to a thermal overload.</p> <p>Overload displays the overload capacity which is a measure of how close the Unit to tripping on "Overload Trip" When "Irms" is greater than the "Overload Amps" the "Overload" increases in accordance with the "Trip Class".</p> <p>When "Current Irms" is less than "Overload Level" the "Overload" decreases exponentially (if greater than 50%)</p> <p>When the "Overload" reaches 100% the Unit will trip.</p> <p>During situations when "Motor Amps" is equal to "Unit Amps" the overload will indicate 50%</p> | | 1 | R | % | Multiplier: 100 Divisor:16384 Offset: 0 Min: 0 Max: 16384 Default: 0 During situations when "Motor Amps" is equal to "Unit Amps" the overload will indicate 50% |
| 30 | Frequency | The frequency of the 3-phase supply | | 1 | R | Hz | Multiplier: 1 Divisor:1000 Offset: 0 Min: 45000 Max: 65000 Default: 0 |
| 31 | Factory Rst | Restores the Unit to the factory defaults | 0=Idle, 1=Active. | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 1 Default: 0 |

Modbus RTU Parameters (continued)

| PNU | Name | Description | Options | Words | Type | Units | Detail |
|-----|-------------|--|----------------------|-------|------|-------|---|
| 32 | Store Param | Saves all Read /Write parameters to non volatile memory Yes : Parameters are permanently written No : Parameters remain changed until next power cycle | 0=Idle, 1=Active. | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 1 Default: 0 |
| 33 | Save Log | Download the full log file on to the USB stick The Unit logs several parameters during normal and fault conditions Data is stored in CSV format. Please send all downloaded files to Fairford on request | 0=Idle, 1=Active. | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 1 Default: 0 |
| 34 | Date | Enter current date Date format can be set to either dd/mm/yyyy or mm/dd/yyyy. Refer to "Date format" parameter. | | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 0 |
| 35 | Time | Allows the time to be changed to 'local' time By default the time is set to GMT | | 2 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 0 |

Modbus RTU Parameters (continued)

| PNU | Name | Description | Options | Words | Type | Units | Detail |
|-----|-----------|--|------------------------------------|-------|------|-------|---|
| 37 | Rotation | Indicates the phase sequence of the incoming supply. RYB = ABC = L1-L2-L3 RBY = ACB = L1-L3-L2 | 0=-----, 1=L1L2L3, 2=L1L3L2. | 1 | R | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 2 Default: 0 |
| 39 | HS Temp C | The temperature of the internal Unit heatsink. The Unit will trip when the heatsink temperature exceeds 80°C. The internal cooling fans will turn on if this temperature exceeds 40°C | | 1 | R | C | Multiplier: 1 Divisor:16 Offset: 0 Min: 0 Max: 65535 Default: 0 |
| 40 | HS Temp F | The temperature of the internal Unit heatsink. The Unit will trip when the heatsink temperature exceeds 176°C The internal cooling fans will turn on if this temperature exceeds 104°F | | 1 | R | F | Multiplier: 9 Divisor:80 Offset: 32 Min: 0 Max: 65535 Default: 0 |
| 41 | I1 rms | The RMS current on phase L1 | | 2 | R | A | Multiplier: 1 Divisor:1000 Offset: 0 Min: 0 Max: 24 Default: 0 |

Modbus RTU Parameters (continued)

| PNU | Name | Description | Options | Words | Type | Units | Detail |
|-----|-------------|---|---------|-------|------|-------|---|
| 43 | I2 rms | The RMS current on phase L2 | | 2 | R | A | Multiplier: 1 Divisor:1000 Offset: 0 Min: 0 Max: 24 Default: 0 |
| 45 | I3 rms | The RMS current on phase L3 | | 2 | R | A | Multiplier: 1 Divisor:1000 Offset: 0 Min: 0 Max: 24 Default: 0 |
| 47 | Delay Angle | Internal firing delay angle in Degrees Displayed for diagnostic purposes | | 1 | R | ° | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 180 Default: 0 |
| 48 | AGY100 Ver | The hardware version for display PCB | | 1 | R | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 1 |

Modbus RTU Parameters (continued)

| PNU | Name | Description | Options | Words | Type | Units | Detail |
|-----|------------|--|---------------------------|-------|------|-------|---|
| 49 | Phase Loss | <p>Detects for various issues when the start signal is applied</p> <p>Detects for input phase loss / input phase relationship / motor side loss</p> <p>Trip On : Trips if there is an input phase loss / supply out of balance / motor side loss</p> <p>Trip Off : The Unit will attempt to run although the operation may be erratic. Operating with the Trip Off for prolonged periods may result in SCR failure</p> | 0=Trip Off, 1=Trip On. | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 1 Default: 1 |
| 50 | Overheat | <p>Detects if the internal temperature sensor has malfunctioned</p> <p>Trip On : The Unit will trip if the internal temperature sensor malfunctions</p> <p>Trip Off : The Unit will continue to operate even if the temperature sensor has malfunctioned.</p> <p>Operating with the Trip Off for prolonged periods may result in SCR failure</p> | 0=Trip Off, 1=Trip On. | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 1 Default: 1 |
| 51 | Ph / SCR | <p>Detects for various issues when "Starting" or " Stopping"</p> <p>Detects for input phase loss / Output phase loss / SCR misfire</p> <p>Trip On : Trips if there is an input phase loss / motor side phase loss / SCR misfire</p> <p>Trip Off : The Unit will attempt to run although the operation may be erratic. Operating with the Trip Off for prolonged periods may result in SCR failure</p> | 0=Trip Off, 1=Trip On. | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 1 Default: 1 |

Modbus RTU Parameters (continued)

| PNU | Name | Description | Options | Words | Type | Units | Detail |
|-----|-------------|---|---------------------------|-------|------|-------|---|
| 58 | Low | <p>This can be used to detect if the motor is running lightly loaded.</p> <p>Trip On : The Unit will trip. This feature is not active during soft start and soft stop. Trip Off: The Unit will continue to operate regardless of motor current</p> | 0=Trip Off, 1=Trip On. | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 1 Default: 0 |
| 59 | Limit Start | <p>Selects trip or continue if the current limit has been active for too long</p> <p>Trip On : The Unit will trip Trip Off: The start will continue regardless of the motor current level</p> | 0=Trip Off, 1=Trip On. | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 1 Default: 1 |
| 60 | Overload | <p>The Unit has an "Overload" function that is an electronic equivalent to a thermal overload.</p> <p>Trip On : The Unit will trip when the "Overload" capacity (Modbus PNU 27) exceeds 100% Trip Off: The Unit will continue to operate regardless of motor current level</p> | 0=Trip Off, 1=Trip On. | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 1 Default: 1 |
| 61 | Shearpin | <p>The Shearpin is an electronic equivalent of a mechanical Shearpin</p> <p>Trip On : The Unit will trip. This feature is not active during soft start and soft stop. Trip Off: The Unit will continue to operate regardless of motor current level</p> | 0=Trip Off, 1=Trip On. | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 1 Default: 1 |

Modbus RTU Parameters (continued)

| PNU | Name | Description | Options | Words | Type | Units | Detail |
|-----|-------------|---|---------------------------|-------|------|-------|---|
| 64 | Comms | <p>Detects if the communications bus has failed or become inactive.</p> <p>To keep the bus active there must be at least one Modbus read or write (any PNU) during the "Comms Time" period (ModbusPNU 147)</p> <p>Trip On :Communication trip enabled. Trip Off : External Trip is disabled</p> | 0=Trip Off, 1=Trip On. | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 1 Default: 1 |
| 66 | Remote | <p>For safety reasons the Unit will trip during some operations if the remote start signal is active</p> <p>Trip On : Trips if the remote start signal is active when the Unit is powered up or a reset is applied. Trip Off : The Unit will not trip and may start unexpectedly if the start signal is accidentally left active.</p> | 0=Trip Off, 1=Trip On. | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 1 Default: 1 |
| 67 | CT Fault | <p>Detects if the internal current sensors have failed or reading a very low level.</p> <p>Trip On : The Unit will trip if the internal current sensors fail or the current measured falls to a very low level Trip Off : Will continue to operate even if the sensor has failed. Measurements and overload protection may be effected</p> | 0=Trip Off, 1=Trip On. | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 1 Default: 1 |
| 68 | Operation 1 | <p>Detects if the Control Board has failed to operate normally</p> <p>Trip On : System Trip enabled. Trip Off : System Trip disabled.</p> | 0=Trip Off, 1=Trip On. | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 1 Default: 1 |

Modbus RTU Parameters (continued)

| PNU | Name | Description | Options | Words | Type | Units | Detail |
|-----|-------------|---|---|-------|------|-------|--|
| 69 | Limit Amps | The current in Amps at which the soft Start ramp is held. Normally set to 350% of motor FLC. Increase if motor fails to accelerate at required rate The "Limit Amps" will effect actual time to start. If set too low the motor may not accelerate to full speed. | | 2 | R/W | A | Multiplier: 1 Divisor:1000 Offset: 0 Min: 0.5 x PNU18 Max: 5 x PNU20 Default: 3.5 x PNU20 |
| 71 | Limit Time | The maximum time allowed for the current limit. If the current limit is still active at the end of this period the Unit will either 'Trip' or 'continue' | | 1 | R/W | s | Multiplier: 1 Divisor:1 Offset: 0 Min: 1 Max: 60 Default: 30 |
| 72 | Boot Ver | Software Version for the Bootloader | | 2 | R | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 0 |
| 74 | Cntrl Funct | Allows the Digital inputs to be mapped to different functions Cntrl Mode must be set to "Remote" Two Wire : D1 = Start (Reset) / Stop Three Wire : D1 = Start (Reset) D2 = Stop D2 Reset , D2 Hold , D2 Enable , D2 Fire : D1= Start /Stop, D2 programmed as shown | 0=Three Wire, 1=Two Wire, 2=D2 Reset, 3=D2 Hold, 4=D2 Enable, 5=D2 Fire. | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 5 Default: 0 |

Modbus RTU Parameters (continued)

| PNU | Name | Description | Options | Words | Type | Units | Detail |
|-----|---------|--|---------------------------|-------|------|-------|---|
| 75 | Op Mode | Allows the unit to operate with a single phase motor 3 phase : Set to control a three phase motor 1 Phase: Set to control a single phase motor | 0=3 phase , 1=1 Phase. | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 1 Default: 0 |
| 77 | Trip 0 | Displays the last Fault trip | See Table 3 | 1 | R | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 0 |
| 78 | Trip 1 | Displays the last Fault trip -1 | See Table 3 | 1 | R | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 0 |
| 79 | Trip 2 | Displays the last Fault trip -2 | See Table 3 | 1 | R | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 0 |

Modbus RTU Parameters (continued)

| PNU | Name | Description | Options | Words | Type | Units | Detail |
|-----|--------|---------------------------------|-------------|-------|------|-------|---|
| 80 | Trip 3 | Displays the last Fault trip -3 | See Table 3 | 1 | R | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 0 |
| 81 | Trip 4 | Displays the last Fault trip -4 | See Table 3 | 1 | R | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 0 |
| 82 | Trip 5 | Displays the last Fault trip -5 | See Table 3 | 1 | R | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 0 |
| 83 | Trip 6 | Displays the last Fault trip -6 | See Table 3 | 1 | R | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 0 |

Modbus RTU Parameters (continued)

| PNU | Name | Description | Options | Words | Type | Units | Detail |
|-----|------------|--|-------------|-------|------|-------|---|
| 84 | Trip 7 | Displays the last Fault trip -7 | See Table 3 | 1 | R | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 0 |
| 85 | Trip 8 | Displays the last Fault trip -8 | See Table 3 | 1 | R | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 0 |
| 86 | MenuBuild | Menu Version | | 1 | R | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 0 |
| 87 | Kick Level | Percentage of the supply voltage applied to the motor during the 'kick' period Increase to provide more torque If the load fails to break away. Decrease if the motor accelerates too quickly. | | 1 | R/W | % | Multiplier: 100 Divisor:16384 Offset: 0 Min: 3277 Max: 13107 Default: 9830 |

Modbus RTU Parameters (continued)

| PNU | Name | Description | Options | Words | Type | Units | Detail |
|-----|------------|--|----------------------|-------|------|-------|--|
| 88 | Kick Time | Time that the torque pulse is applied to load Increase to provide more torque If the load fails to break away. Decrease if the motor accelerates too quickly. | | 1 | R/W | ms | Multiplier: 1 Divisor:1 Offset: 0 Min: 100 Max: 2000 Default: 100 |
| 89 | Kick Start | Applies a short duration torque pulse to dislodge 'sticky' loads On : The torque pulse is applied at start-up when complete the torque drops to the "Initial Volts" Off: The initial starting torque is defined by the "Initial Volts" | 0=Off, 1=On. | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 1 Default: 0 |
| 90 | To USB | Allows the user to save parameters Downloads the parameters from the Unit to the USB drive Data is stored in CSV format. | 0=Idle, 1=Active. | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 1 Default: 0 |
| 91 | From USB | Allows the user to load parameters stored on a USB flash drive Uploads the parameters from the USB drive to the Unit Data is stored in CSV format. | 0=Idle, 1=Active. | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 1 Default: 0 |

Modbus RTU Parameters (continued)

| PNU | Name | Description | Options | Words | Type | Units | Detail |
|-----|---------|--|---------|-------|------|-------|---|
| 94 | I Start | Displays the peak current during the last start. | | 1 | R | A | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 528 Default: 0 |
| 95 | T Start | Displays the time of the last start | | 1 | R | s | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 90 Default: 0 |
| 96 | I Stop | Displays the peak current during the last stop. | | 1 | R | A | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 528 Default: 0 |
| 97 | T Stop | Displays the time of the last stop | | 1 | R | s | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 90 Default: 0 |

Modbus RTU Parameters (continued)

| PNU | Name | Description | Options | Words | Type | Units | Detail |
|-----|--------------|--|---------|-------|------|-------|---|
| 98 | Total Events | The total number of events that have been recorded in the log file | | 2 | R | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 0 |
| 103 | AGY200 Ver | The hardware version for Main PCB | | 1 | R | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 1 |
| 104 | AGY300 Ver | The hardware version for Power PCB | | 1 | R | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 1 |
| 106 | Total Uc On | The total number times the start command has been applied | | 2 | R | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 0 |

Modbus RTU Parameters (continued)

| PNU | Name | Description | Options | Words | Type | Units | Detail |
|-----|-------------|---|---------------------------|-------|------|-------|--|
| 109 | Operation 2 | <p>Detects if the Control Board has failed to operate normally</p> <p>Trip On : System Trip enabled. Trip Off : System Trip disabled.</p> | 0=Trip Off, 1=Trip On. | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 1 Default: 1 |
| 110 | Rerate Key | <p>The Key issued by Fairford to re rate the unit to a different current rating</p> <p>Use this parameter to enter the key manually.</p> | | 4 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 255 Default: 0 |
| 114 | Shear Amps | <p>The current in Amps that will cause a "Shear Trip"</p> <p>A trip will occur if the motor current is greater than the "Shear Amps" for the "Shear Time"</p> | | 2 | R/W | A | Multiplier: 1 Divisor:1000 Offset: 0 Min: 1 x PNU18 Max: 5 x PNU22 Default: 3.5 x PNU18 |
| 116 | Shear Time | <p>The trip time for the Shear pin trip</p> <p>A trip will occur if the motor current is greater than the "Shear Amps" for the "Shear Time"</p> | | 1 | R/W | s | Multiplier: 1 Divisor:1 Offset: 0 Min: 1 Max: 10 Default: 1 |

Modbus RTU Parameters (continued)

| PNU | Name | Description | Options | Words | Type | Units | Detail |
|-----|---------------|---|--------------|-------|------|-------|---|
| 119 | Modbus Enable | Enable using Modbus On : The unit is enabled Off : The unit is disabled | 0=Off, 1=On. | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 1 Default: 0 |
| 120 | Modbus Start | Start / Stop using Modbus On : Starts the Unit Off : Stops or Soft stops the Unit | 0=Off, 1=On. | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 1 Default: 0 |
| 121 | Modbus Reset | Reset using Modbus On : The initial state required for a reset. Off : The final state required for a reset. To reset pulse high and then low | 0=Off, 1=On. | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 1 Default: 0 |
| 143 | Fire Mode | A special feature that allows the Unit to operate with ALL of the trips OFF. Set " Cntrl Funct" to "D2 Fire Mode" , Enabled when D2 is high Although the unit will keep running in this mode it may become damaged. In some instances the damage may inhibit a subsequent starts This is only to be used in an emergency | 0=Off, 1=On. | 1 | R | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 1 Default: 0 |

Modbus RTU Parameters (continued)

| PNU | Name | Description | Options | Words | Type | Units | Detail |
|-----|-----------|---|-------------|-------|------|-------|--|
| 145 | TempUnit | Selects °C or °F for displayed temperatures °C : All displayed temperatures are °C °F : All displayed temperatures are °F | 0=°C, 1=°F. | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 1 Default: 0 |
| 146 | Disp Time | Time for backlight on display After the period set the back light on the screen will turn off To reactivate touch screen anywhere. To disable set to 0 | | 1 | R/W | s | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 7200 Default: 60 |
| 147 | CommsTime | Communications trip Timeout period To prevent a 'Communications Trip' (If enabled) the bus must be kept active. To keep the bus active there must be at least one Modbus read or write (any PNU) during the "Timeout ms" period | | 1 | R/W | ms | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 60000 Default: 5000 |
| 148 | Address | Sets the Modbus station number | | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 1 Max: 32 Default: 1 |

Modbus RTU Parameters (continued)

| PNU | Name | Description | Options | Words | Type | Units | Detail |
|-----|------------|--|--|-------|------|-------|---|
| 149 | Parity | Sets the serial communications parity bit The available parity options are None Even Odd Also sets the stop bits. No parity uses 2 stop bits. Odd or even parity uses 1 stop bit | 0=Odd, 1=Even. | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 1 Default: 1 |
| 150 | Baud | Sets the serial communications baud rate The available baud rates are 9600 19200 38400 57600 or 115200 | 0=9600 baud, 1=19200 baud, 2=38400 baud, 3=57600 baud, 4=115200 baud. | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 2 Default: 1 |
| 151 | DateFormat | Allows the date format to be changed dd/mm/yy or mm/dd/yy or yy/mm/dd | 0=dd/mm/yy, 1=mm/dd/yy, 2=yy/mm/dd. | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 2 Default: 1 |
| 153 | AGY400 Ver | Displays the hardware version for the temperature sense PCB | | 1 | R | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 1 |

Modbus RTU Parameters (continued)

| PNU | Name | Description | Options | Words | Type | Units | Detail |
|-----|-------------|--|----------------------------|-------|------|-------|---|
| 154 | RelayFunct | Allows the n/c relay (21 -22) to be reconfigured Available options are 22 = TOR or 22 = ERR | 0=22 = TOR, 1=22 = ERR. | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 1 Default: 1 |
| 155 | Rerate USB | The Key issued by Fairford to re rate the unit to a different current rating Use this parameter to enter the key that has been pre-stored on a USB stick. | 0=Idle, 1=Active. | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 0 |
| 157 | Window View | Used to arrange the Modbus Parameters into Groups Refer to 'Special Modbus parameters' document for more details | | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 0 |
| 158 | Window Code | Used to arrange the Modbus Parameters into Groups Refer to 'Special Modbus parameters' document for more details | | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 0 |

Modbus RTU Parameters (continued)

| PNU | Name | Description | Options | Words | Type | Units | Detail |
|-----|--------------|---|---------|-------|------|-------|---|
| 159 | ODB Type | Reserved for future use | | 1 | R | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 1 |
| 160 | Patch Addr 1 | Used to arrange the Modbus Parameters into Groups Refer to 'Special Modbus parameters' document for more details | | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 0 |
| 161 | Patch Addr 2 | Used to arrange the Modbus Parameters into Groups Refer to 'Special Modbus parameters' document for more details | | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 0 |
| 162 | Patch Addr 3 | Used to arrange the Modbus Parameters into Groups Refer to 'Special Modbus parameters' document for more details | | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 0 |

Modbus RTU Parameters (continued)

| PNU | Name | Description | Options | Words | Type | Units | Detail |
|-----|--------------|---|---------|-------|------|-------|---|
| 163 | Patch Addr 4 | Used to arrange the Modbus Parameters into Groups Refer to 'Special Modbus parameters' document for more details | | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 0 |
| 164 | Patch Addr 5 | Used to arrange the Modbus Parameters into Groups Refer to 'Special Modbus parameters' document for more details | | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 0 |
| 165 | Patch Addr 6 | Used to arrange the Modbus Parameters into Groups Refer to 'Special Modbus parameters' document for more details | | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 0 |
| 166 | Patch Addr 7 | Used to arrange the Modbus Parameters into Groups Refer to 'Special Modbus parameters' document for more details | | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 0 |

Modbus RTU Parameters (continued)

| PNU | Name | Description | Options | Words | Type | Units | Detail |
|-----|---------------|---|---------|-------|------|-------|---|
| 167 | Patch Addr 8 | Used to arrange the Modbus Parameters into Groups Refer to 'Special Modbus parameters' document for more details | | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 0 |
| 168 | Patch Addr 9 | Used to arrange the Modbus Parameters into Groups Refer to 'Special Modbus parameters' document for more details | | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 0 |
| 169 | Patch Addr 10 | Used to arrange the Modbus Parameters into Groups Refer to 'Special Modbus parameters' document for more details | | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 0 |
| 170 | Patch Addr 11 | Used to arrange the Modbus Parameters into Groups Refer to 'Special Modbus parameters' document for more details | | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 0 |

Modbus RTU Parameters (continued)

| PNU | Name | Description | Options | Words | Type | Units | Detail |
|-----|------------------|---|---------|-------|------|-------|---|
| 171 | Patch Addr 12 | Used to arrange the Modbus Parameters into Groups Refer to 'Special Modbus parameters' document for more details | | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 0 |
| 172 | Patch Addr 13 | Used to arrange the Modbus Parameters into Groups Refer to 'Special Modbus parameters' document for more details | | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 0 |
| 173 | Patch Addr 14 | Used to arrange the Modbus Parameters into Groups Refer to 'Special Modbus parameters' document for more details | | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 0 |
| 174 | Patch Addr 15 | Used to arrange the Modbus Parameters into Groups Refer to 'Special Modbus parameters' document for more details | | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 0 |

Modbus RTU Parameters (continued)

| PNU | Name | Description | Options | Words | Type | Units | Detail |
|-----|------------------|---|---------|-------|------|-------|---|
| 175 | Patch Addr 16 | Used to arrange the Modbus Parameters into Groups Refer to 'Special Modbus parameters' document for more details | | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 0 |
| 176 | Window 1 | Used to arrange the Modbus Parameters into Groups Refer to 'Special Modbus parameters' document for more details | | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 0 |
| 177 | Window 2 | Used to arrange the Modbus Parameters into Groups Refer to 'Special Modbus parameters' document for more details | | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 0 |
| 178 | Window 3 | Used to arrange the Modbus Parameters into Groups Refer to 'Special Modbus parameters' document for more details | | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 0 |

Modbus RTU Parameters (continued)

| PNU | Name | Description | Options | Words | Type | Units | Detail |
|-----|----------|---|---------|-------|------|-------|---|
| 179 | Window 4 | Used to arrange the Modbus Parameters into Groups Refer to 'Special Modbus parameters' document for more details | | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 0 |
| 180 | Window 5 | Used to arrange the Modbus Parameters into Groups Refer to 'Special Modbus parameters' document for more details | | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 0 |
| 181 | Window 6 | Used to arrange the Modbus Parameters into Groups Refer to 'Special Modbus parameters' document for more details | | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 0 |
| 182 | Window 7 | Used to arrange the Modbus Parameters into Groups Refer to 'Special Modbus parameters' document for more details | | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 0 |

Modbus RTU Parameters (continued)

| PNU | Name | Description | Options | Words | Type | Units | Detail |
|-----|-----------|---|---------|-------|------|-------|---|
| 183 | Window 8 | Used to arrange the Modbus Parameters into Groups Refer to 'Special Modbus parameters' document for more details | | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 0 |
| 184 | Window 9 | Used to arrange the Modbus Parameters into Groups Refer to 'Special Modbus parameters' document for more details | | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 0 |
| 185 | Window 10 | Used to arrange the Modbus Parameters into Groups Refer to 'Special Modbus parameters' document for more details | | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 0 |
| 186 | Window 11 | Used to arrange the Modbus Parameters into Groups Refer to 'Special Modbus parameters' document for more details | | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 0 |

Modbus RTU Parameters (continued)

| PNU | Name | Description | Options | Words | Type | Units | Detail |
|-----|-----------|---|---------|-------|------|-------|---|
| 187 | Window 12 | Used to arrange the Modbus Parameters into Groups Refer to 'Special Modbus parameters' document for more details | | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 0 |
| 188 | Window 13 | Used to arrange the Modbus Parameters into Groups Refer to 'Special Modbus parameters' document for more details | | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 0 |
| 189 | Window 14 | Used to arrange the Modbus Parameters into Groups Refer to 'Special Modbus parameters' document for more details | | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 0 |
| 190 | Window 15 | Used to arrange the Modbus Parameters into Groups Refer to 'Special Modbus parameters' document for more details | | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 0 |

Modbus RTU Parameters (continued)

| PNU | Name | Description | Options | Words | Type | Units | Detail |
|-----|-----------|---|---------|-------|------|-------|---|
| 191 | Window 16 | Used to arrange the Modbus Parameters into Groups Refer to 'Special Modbus parameters' document for more details | | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 0 |
| 192 | Window 17 | Used to arrange the Modbus Parameters into Groups Refer to 'Special Modbus parameters' document for more details | | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 0 |
| 193 | Window 18 | Used to arrange the Modbus Parameters into Groups Refer to 'Special Modbus parameters' document for more details | | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 0 |
| 194 | Window 19 | Used to arrange the Modbus Parameters into Groups Refer to 'Special Modbus parameters' document for more details | | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 0 |

Modbus RTU Parameters (continued)

| PNU | Name | Description | Options | Words | Type | Units | Detail |
|-----|-----------|---|---------|-------|------|-------|---|
| 195 | Window 20 | Used to arrange the Modbus Parameters into Groups Refer to 'Special Modbus parameters' document for more details | | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 0 |
| 196 | Window 21 | Used to arrange the Modbus Parameters into Groups Refer to 'Special Modbus parameters' document for more details | | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 0 |
| 197 | Window 22 | Used to arrange the Modbus Parameters into Groups Refer to 'Special Modbus parameters' document for more details | | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 0 |
| 198 | Window 23 | Used to arrange the Modbus Parameters into Groups Refer to 'Special Modbus parameters' document for more details | | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 0 |

Modbus RTU Parameters (continued)

| PNU | Name | Description | Options | Words | Type | Units | Detail |
|-----|--------------|---|---------|-------|------|-------|---|
| 199 | Window 24 | Used to arrange the Modbus Parameters into Groups Refer to 'Special Modbus parameters' document for more details | | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 0 |
| 200 | Total Us On | The total number of times the unit has been powered up. The unit is powered up by applying a voltage to Uc Uc will be 24V or 110V / 230V depending on configuration | | 2 | R | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 0 |
| 202 | Total Us Off | The total number of times the unit has been powered down. The unit is powered down by removing the voltage at Uc Uc will be 24V or 110V / 230V depending on configuration | | 2 | R | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 0 |
| 204 | Total Runs | The total number of times the unit as successfully got to the "Running" State The Running state is active when the unit is operating at full voltage. When operating at full voltage the internal bypass relays are closed. | | 2 | R | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 0 |

Modbus RTU Parameters (continued)

| PNU | Name | Description | Options | Words | Type | Units | Detail |
|-----|--------------|---|---------|-------|------|-------|---|
| 206 | Total Stops | The total number of successful stops / soft stops | | 2 | R | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 0 |
| 210 | Total Trips | The total number of trips | | 2 | R | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 0 |
| | | | | | | | Multiplier: Divisor: Offset: Min: Max: Default: |
| 212 | Diagnostic 1 | Used for diagnostic purposes only | | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 65535 |

Modbus RTU Parameters (continued)

| PNU | Name | Description | Options | Words | Type | Units | Detail |
|-----|--------------|-----------------------------------|---------|-------|------|-------|---|
| 213 | Diagnostic 2 | Used for diagnostic purposes only | | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 65535 |
| 214 | Diagnostic 3 | Used for diagnostic purposes only | | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 65535 |
| 215 | Diagnostic 4 | Used for diagnostic purposes only | | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 65535 |
| 216 | Diagnostic 5 | Used for diagnostic purposes only | | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 65535 |

Modbus RTU Parameters (continued)

| PNU | Name | Description | Options | Words | Type | Units | Detail |
|-----|--------------|--|--|-------|------|-------|--|
| 217 | Diagnostic 6 | Used for diagnostic purposes only | | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 65535 |
| 218 | Ovld Amps | Determines the level in Amps at which the overload will start. Normally set to 115% of the set "Motor Amps" Reduce to speed up trip response | | 2 | R/W | A | Multiplier: 1 Divisor:1000 Offset: 0 Min: 1 x PNU18 Max: 1.25 x PNU18 Default: 1.15 x PNU18 |
| 220 | Language | Selects the display language for the keypad Enter the required language from the displayed list | 1=English, 2=Deutsch, 3=Francais, 4=Italiano, 5=Portugues, 6=Espanol. | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 1 Max: 10 Default: 1 |
| 221 | Total Starts | The total number of successful starts | | 2 | R | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 0 |

Modbus RTU Parameters (continued)

| PNU | Name | Description | Options | Words | Type | Units | Detail |
|-----|-----------|--|---------------------------|-------|------|-------|---|
| 223 | L1L2L3 | Determines if supply phase sequence is incorrect for motor rotation On : Trips if the phase sequence is L1-L2-L3. Off : The Unit will continue to operate normally | 0=Trip Off, 1=Trip On. | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 1 Default: 0 |
| 224 | L1L3L2 | Determines if supply phase sequence is incorrect for motor rotation On : Trips if the phase sequence is L1-L3-L2. Off : The Unit will continue to operate normally | 0=Trip Off, 1=Trip On. | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 1 Default: 0 |
| 225 | RX Bytes | Diagnostic parameter for Modbus communications Indicates transmission bytes are being received | | 1 | R | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 0 |
| 226 | RX Frames | Diagnostic parameter for Modbus communications Indicates transmission frames are being received | | 1 | R | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 0 |

Modbus RTU Parameters (continued)

| PNU | Name | Description | Options | Words | Type | Units | Detail |
|-----|-----------|--|---------|-------|------|-------|---|
| 227 | RX Errors | Diagnostic parameter for Modbus communications Indicates whether the data has errors | | 1 | R | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 0 |
| 228 | RX TMO Er | Diagnostic parameter for Modbus communications Indicates a timing error | | 1 | R | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 0 |
| 229 | TX Bytes | Diagnostic parameter for Modbus communications Indicates transmission bytes are being sent | | 1 | R | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 0 |
| 230 | TX Frames | Diagnostic parameter for Modbus communications Indicates transmission frames are being sent | | 1 | R | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 0 |

Modbus RTU Parameters (continued)

| PNU | Name | Description | Options | Words | Type | Units | Detail |
|-----|--------------------|---|---------|-------|------|-------|---|
| 231 | TX Errors | Diagnostic parameter for Modbus communications Indicates whether the data has errors | | 1 | R | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 0 |
| 232 | StopCodeFile | Diagnostic parameter For Fairford use only | | 1 | R | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 65535 |
| 233 | StopCodeFile _1 | Diagnostic parameter For Fairford use only | | 1 | R | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 65535 |
| 234 | StopCodePos | Diagnostic parameter For Fairford use only | | 1 | R | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 65535 |

Modbus RTU Parameters (continued)

| PNU | Name | Description | Options | Words | Type | Units | Detail |
|-----|-------------------|---|---------|-------|------|-------|--|
| 235 | StopCodePos _1 | Diagnostic parameter For Fairford use only | | 1 | R | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 65535 |
| 236 | Limit Amps | The current in Amps at which the soft stop ramp is not allowed to go above. Normally set to 350% motor FLC. Increase if motor decelerates too rapidly. The current limit level will effect actual time to stop the motor. | | 2 | R/W | A | Multiplier: 1 Divisor:1000 Offset: 0 Min: 0.5 x PNU18 Max: 5 x PNU20 Default: 5 x PNU20 |
| 238 | Limit Time | The maximum time allowed for the current limit. If the current limit is still active at the end of this period the Unit will either trip or continue | | 1 | R/W | s | Multiplier: 1 Divisor:1 Offset: 0 Min: 1 Max: 60 Default: 2 |
| 239 | I Low Amps | The current in Amps that will cause a trip A trip will occur if the motor current is less than the "I Low Amps" level for the "I Low Time" | | 2 | R/W | A | Multiplier: 1 Divisor:1000 Offset: 0 Min: 0.25 x PNU18 Max: 1 x PNU18 Default: 0.25 x PNU18 |

Modbus RTU Parameters (continued)

| PNU | Name | Description | Options | Words | Type | Units | Detail |
|-----|--------------|--|---------------------------|-------|------|-------|---|
| 241 | I Low Time | The trip time for the Low current trip A trip will occur if the motor current is less than the "I Low Amps" level for the "I Low Time" | | 1 | R/W | s | Multiplier: 1 Divisor:1 Offset: 0 Min: 1 Max: 60 Default: 30 |
| 242 | I Limit Stop | Selects trip or continue if the current limit has been active for too long Trip On : The Unit will trip Trip Off: The stop will continue regardless of the motor current level | 0=Trip Off, 1=Trip On. | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 1 Default: 0 |
| 243 | Keypad Pwr | Connects the 24V dc supply a pin on the RJ45 connector. Must be turned "On" if the remote keypad is connected | 0=Off, 1=On. | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 1 Default: 0 |
| 244 | Service No | Diagnostic parameter For Fairford use only | | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 0 |

Modbus RTU Parameters (continued)

| PNU | Name | Description | Options | Words | Type | Units | Detail |
|-----|---------------|---|--------------|-------|------|-------|---|
| 245 | Scroll | Used to allow the text to scroll on the keypad On : If the text is too long for the display it will scroll Off : If the text is too long for the display the message will be truncated | 0=Off, 1=On. | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 1 Default: 1 |
| 246 | Reset Ovld | Factory parameter Fairford use only | 0=Off, 1=On. | 1 | R/W | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 1 Default: 0 |
| 247 | StartsHr | When the fan is connected the number of fully rated starts can be increased Without the fan connected the number of fully rated starts is 5 With the fan connected the number of fully rated starts is 40 | | 1 | R | | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 0 |
| 248 | Initial Deg C | Displays the temperature of the heatsink at the beginning of the start | | 1 | R | C | Multiplier: 1 Divisor:1 Offset: 0 Min: 0 Max: 65535 Default: 0 |

Modbus RTU Parameters (continued)

| Table 1 | |
|---------------------|-------------------------|
| <i>PNU 16 Value</i> | <i>Auto Application</i> |
| 0 | Default |
| 1 | Heavy |
| 2 | Agitator |
| 3 | Compressor 1 |
| 4 | Compressor 2 |
| 5 | Conveyor Loaded |
| 6 | Conveyor Unloaded |
| 7 | Crusher |
| 8 | Fan High Inertia |
| 9 | Fan Low Inertia |
| 10 | Grinder |
| 11 | Mill |
| 12 | Mixer |
| 13 | Moulding M/C |
| 14 | Press Flywheel |
| 15 | Pump 1 |
| 16 | Pump 2 |
| 17 | PumpJack |
| 18 | Saw-Band |
| 19 | Saw-Circular |
| 20 | Screen Vibrating |
| 21 | Shredder |
| 22 | Woodchipper. |

| Table 2 | |
|---------------------|----------------|
| <i>PNU 24 Value</i> | <i>Status</i> |
| 20 | Starting |
| 22 | Fire Mode |
| 25 | Limit Start |
| 35 | Limit Stop |
| 40 | Stopping |
| 60 | Running |
| 128 | Ready |
| 140 | Tripped |
| 200 | Disabled |
| 250 | Initialisation |

Modbus RTU Parameters (continued)

| Table 3 | |
|----------------|-------------|
| PNU 78 thru 85 | Trip Status |
| 100 | Ph Loss |
| 200 | Thermal |
| 300 | Ph / SCR |
| 400 | Mot Side |
| 500 | Freq |
| 600 | Uc Low |
| 700 | SCR Sen |
| 800 | Fan |
| 1000 | SCR S/C |
| 1100 | Low Amp |
| 1200 | Limit |
| 1300 | Overload |
| 1400 | Shear |
| 1500 | PTC |
| 1600 | External |
| 1700 | Comms |
| 1800 | Bypass |
| 1900 | FireMode |
| 2000 | Remote |
| 2100 | Rotation |
| 2200 | Op1 |
| 2300 | CT Fault |
| 1100 | Op2 Pnu |
| 1200 | Op2 Mod |
| 13000 | Op2 Mon |
| 14000 | Op2 Men |
| 15000 | Op2 Keys |
| 16000 | Op2 Motr |
| 17000 | Op2 Log |
| 18000 | Op2 Disk. |

Modbus RTU Parameters (continued)

Special Modbus Registers

List of **special** Modbus registers, descriptions, and usage.

Window registers section

There is a section of Modbus registers that can be used for special (user programable) purposes.

| Register Name | Reg ID | Description |
|-----------------------|------------|--|
| Window View | 157 | Selects what is viewed through the Window 0 – Patched Registers 1 – Log Records |
| Window Code | 158 | Log Record function 0 – None 1 – Report 2 – Rewind 3 – Unwind 4 – Seek Absolute 5 – Seek Relative 6 – Next Record 16 – Auto Increment |
| Reserved | 159 | For future functionality. |
| Patch Address 1 to 16 | 160 to 175 | 16 place holders for the registers that need to be patched |
| Window 1 to 24 | 176 to 199 | Either: - If Window View set to 0 16 data holders related to the selected addresses in the Patch Address section (in Window 1 to 16 only). Or For Window View set to 1 All 24 words to hold the currently select log record |

Currently there are two uses for this group of Modbus registers.

- 1) Register patching.

Register patching is enabled when the Window View register (157) is set a to Patched Registers (0).

It allows the user to patch (re-map) a selection of disparate registers into a contiguous register section or window, so that retrieval of the most requested data can be handled in more efficient single block reads by a host controller (PLC). When the address of a register is placed in the Patch Address section (160 to 175) then the corresponding

Modbus RTU Parameters (continued)

WORD(s) in the Window section (176 to 192) will mirror the data and function of that register.

For example, if register 24 (Motor State) is set into register 160 (Patch Address 1) then the value report in 176 (Window 1) from then on.

| Register Name | Register Number | Register Value | ⇒ | Patch Register | Patch Value | Window Register | Window Value |
|---------------|-----------------|----------------|---|----------------|-------------|-----------------|--------------|
| Motor State | 24 | 128 | | 160 | 24 | 176 | 128 |

Consideration needs to be given to registers that produce multiple WORD data. For example, 22 (Unit Amps) produces a 32 bit or 2 WORD datum. To mirror both of those WORDs into the Window both registers 22 and 23 will need to be assigned (side by side) in to the corresponding Patch Address section.

| Register Name | Register Number | Register Value | ⇒ | Patch Register | Patch Value | Window Register | Window Value |
|---------------|-----------------|----------------|---|----------------|-------------|-----------------|--------------|
| Unit Amps | 22 | 0 | | 160 | 22 | 176 | 0 |
| | | 5500 | | 161 | 23 or 0 | 177 | 5500 |

It follows that the entire 16 Aliases can be populated with a mixture of the required data, that can then be queried from (or set to, with writable registers) with a 16 word Modbus transaction frame.

| Register Name | Register Number | Register Value | ⇒ | Patch Register | Patch Value | Window Register | Window Value |
|---------------|-----------------|----------------|---|----------------|-------------|-----------------|--------------|
| Serial Number | 7 | 0x0041 | | 160 | 7 | 176 | 0x0041 |
| | | 0x3132 | | 161 | 8 or 0 | 177 | 0x3132 |
| | | 0x3334 | | 162 | 9 or 0 | 178 | 0x3334 |
| | | 0x3536 | | 163 | 10 or 0 | 179 | 0x3536 |
| Motor State | 24 | 128 | ⇒ | 164 | 24 | 180 | 128 |
| Unit Amps | 22 | 0 | ⇒ | 165 | 22 | 181 | 0 |
| | | 5500 | | 167 | 23 or 0 | 182 | 5500 |

Modbus RTU Parameters (continued)

2) Log record access.

Log record access is enabled when the Window View register (157) is set a to Log Records (1).

The event log is a list of event records stored within a non-volatile store in the system. Register 158 (Window Code) can be set to one of the following values.

a) Report (1)

If Window Code is set to When 1 the Window registers are filled with information about the first and last record in the event log, in the following arrangement.

| Window Register numbers | Description of data copied |
|-------------------------|--|
| 176,177 | Index number of first record. |
| 178,179,180 | Date and Time when the event was recorded of first record. See date Time format in Appendix. |
| 181,182 | Index number of last record. |
| 183,184,185 | Date and Time when the last event was recorded. See date Time format. TBD |

b) Rewind (2)

Setting Window Code to 2 will rewind the log record pointer to the first record. Subsequently when the Next Record is requested the data from the first record will be placed into the Window registers.

c) Unwind (3)

Setting Window Code to 3 will set the log record pointer to the last created record. Subsequently when the Next Record is requested the data from the last record will be placed into the Window registers.

d) Seek Absolute (4)

Setting Window Code to 4 along with setting Window 1 and 2 to the required record pointer will prepare the Next Record request to return the record with that record number.

e) Seek Relative (5)

When setting Window Code to 5, the **signed** number set into Window 1 and 2 will added to the current pointer so the Next Record request will return the record whose position is offset by that number.

f) Next Record (6)

Setting Window Code to 6 will cause the log record with the position of the current record pointer to be copied into the Window registers (registers 176 to 199). These will then contain the following information.

Modbus RTU Parameters (continued)

| Generic Word PNU Register number | Data Description |
|----------------------------------|--|
| 176,177 | Record Index number |
| 178,179,180 | Date and Time when the event was recorded. See date Time format. See appendix. |
| 181 | Event type. See event type codes. See appendix. |
| 181 to 199 | Event data. See event data. See appendix. |

g) Auto Increment (16)

If this value can be added (ORed) in with Next record (6 + 16 = 22) then each Modbus read of the Window 1 register, with or without a block read of the following 23 registers, will automatically increment the record pointer so that the next read will return information from the next record. This avoids the need to do a Next Record request before each record read. Note that if register Window 1 is read on its own, as one Modbus transaction, the subsequent reads the other higher Window registers will be from the next record. Block reads of all 24 registers is required for this function to successfully.

Memory Probes

Each register WORD is used as two BYTES. Each byte showing the current amount of available memory for each designation. These are used within the firmware to record and respond to low memory situations in the device operating system. Note that these have a maximum value of 0xff or 255. 0xff could mean a value greater than 0xff, so it works as a soft limit. In normal and stressed operation, it is desirable that these values never reach zero.

| Register Name | Reg ID | Size | Description |
|----------------------|--------|----------|--|
| | | | Free Memory |
| Main Memory Free | 212 | 2 x BYTE | MSByte – Main Stack LSByte – Main Heap |
| Task 1&2 Free Stack | 213 | 2 x BYTE | MSByte – Task 1 Stack (Monitor) LSByte – Task 2 Stack (IDLE) |
| Task 3&4 Free Stack | 214 | 2 x BYTE | MSByte – Task 3 Stack (Keys) LSByte – Task 4 Stack (Menu) |
| Task 5&6 Free Stack | 215 | 2 x BYTE | MSByte – Task 5 Stack (PNU) LSByte – Task 6 Stack (Modbus) |
| Task 7&8 Free Stack | 216 | 2 x BYTE | MSByte – Task 7 Stack (Disk) LSByte – Task 8 Stack (Log) |
| Task 9&10 Free Stack | 217 | 2 x BYTE | MSByte – Task 9 Stack (Reserved) LSByte – Task 10 Stack (Motor) |

Modbus RTU Parameters (continued)

Notes:

Date/Time format.

The Date and Time is recorded in three consecutive registers. This is true for Modbus registers Date, Time, Saved Date, Saved Time and the Time stamps shown in the

| Register Ordinal | Description | Detail Bit Layout of each 16 bit words | |
|------------------|-------------------------|--|----------------------------------|
| 1 | Date | Bits 0 - 4 | Day (1 - 31) |
| | | Bits 5 - 8 | Month (1 - 12) |
| | | Bits 9 - 15 | Year (00 - 127) -> (2000 - 2127) |
| 2 | Time 1 (Hours, Minutes) | Bits 0 - 5 | Minute (0 - 59) |
| | | Bits 6 - 10 | Hour (0 - 23) |
| | | Bits 11 - 15 | Unused |
| 3 | Time 2 (Milliseconds) | Bits 0 - 9 | Milliseconds (0 - 999) |
| | | Bits 10 - 15 | Seconds (0 - 59) |

Event Type Codes.

| Code | Meaning |
|------|----------------------|
| 1 | Initialise (boot up) |
| 10 | Power Off |
| 100 | Motor Start |
| 300 | Motor Dwell |
| 600 | Motor Stop |
| 900 | Motor Tripped |

Modbus RTU Parameters (continued)

Event Data.

| | Initialise | Power Off | Start | Dwell | Stop | Tripped |
|----|------------------|------------------|------------------|-----------------------|-----------------------|-----------------------|
| 1 | Software Version | Software Version | Software Version | | | |
| 2 | Model Number | Overload | Model Number | | | |
| 3 | Rated Amps | Motor State | Rated Amps | | | |
| 4 | Motor Amps | | Motor Amps | | | |
| 5 | Unit Amps | | Rated Amps | | | |
| 6 | Trip Class | | Frequency | | | |
| 7 | | | Rotation | | | Mean RMS Normalised |
| 8 | | | Temp | | | Mean RMS Amps |
| 9 | | | | IStart | | IStart |
| 10 | | | | TStart | | TStart |
| 11 | | | | | IStop | IStop |
| 12 | | | | | TStop | TStop |
| 13 | | | | Irms | Irms | Irms |
| 14 | | | | Temperature degrees C | Temperature degrees C | Temperature degrees C |
| 15 | | | | Overload | Overload | Overload |
| 16 | | | | | | Trip Code |
| 17 | | | | | | |
| 18 | | | | | | |

Modbus RTU Parameters (continued)

Modbus PNU Alphabetical Cross Reference


| PNU | Name | PNU | Name | PNU | Name | PNU | Name |
|-----|---------------|-----|---------------|-----|----------------|-----|-------------|
| 148 | Address | 87 | Kick Level | 167 | Patch Addr 8 | 77 | Trip 0 |
| 48 | AGY100 Ver | 89 | Kick Start | 168 | Patch Addr 9 | 78 | Trip 1 |
| 103 | AGY200 Ver | 88 | Kick Time | 51 | Ph / SCR | 79 | Trip 2 |
| 104 | AGY300 Ver | 223 | L1L2L3 | 49 | Phase Loss | 80 | Trip 3 |
| 153 | AGY400 Ver | 224 | L1L3L2 | 20 | Rated Amps | 81 | Trip 4 |
| 16 | Application | 220 | Language | 154 | RelayFunct | 82 | Trip 5 |
| 150 | Baud | 69 | Limit Amps | 66 | Remote | 83 | Trip 6 |
| 72 | Boot Ver | 236 | Limit Amps | 110 | Rerate Key | 84 | Trip 7 |
| 74 | Cntrl Funct | 71 | Limit Time | 155 | Rerate USB | 85 | Trip 8 |
| 1 | Cntrl Mode | 238 | Limit Time | 37 | Rotation | 17 | Trip Class |
| 64 | Comms | 86 | MenuBuild | 225 | RX Bytes | 229 | TX Bytes |
| 147 | CommsTime | 119 | Modbus Enable | 227 | RX Errors | 231 | TX Errors |
| 67 | CT Fault | 121 | Modbus Reset | 226 | RX Frames | 230 | TX Frames |
| 34 | Date | 120 | Modbus Start | 228 | RX TMO Er | 22 | Unit Amps |
| 151 | DateFormat | 11 | Model No | 33 | Save Log | 14 | Version |
| 47 | Delay Angle | 18 | Motor Amps | 7 | Serial No | 176 | Window 1 |
| 212 | Diagnostic 1 | 24 | MotorState | 114 | Shear Amps | 185 | Window 10 |
| 213 | Diagnostic 2 | 159 | ODB Type | 116 | Shear Tlme | 186 | Window 11 |
| 214 | Diagnostic 3 | 75 | Op Mode | 61 | Shearpin | 187 | Window 12 |
| 215 | Diagnostic 4 | 68 | Operation 1 | 6 | Start Delay | 188 | Window 13 |
| 216 | Diagnostic 5 | 109 | Operation 2 | 4 | Start Time | 189 | Window 14 |
| 217 | Diagnostic 6 | 50 | Overheat | 5 | Stop Time | 190 | Window 15 |
| 146 | Disp Time | 27 | Overload | 232 | StopCodeFile | 191 | Window 16 |
| 31 | Factory Rst | 60 | Overload | 233 | StopCodeFile_1 | 192 | Window 17 |
| 143 | Fire Mode | 218 | Ovld Amps | 234 | StopCodePos | 193 | Window 18 |
| 30 | Frequency | 149 | Parity | 235 | StopCodePos_1 | 194 | Window 19 |
| 91 | From USB | 160 | Patch Addr 1 | 32 | Store Param | 177 | Window 2 |
| 39 | HS Temp C | 169 | Patch Addr 10 | 95 | T Start | 195 | Window 20 |
| 40 | HS Temp F | 170 | Patch Addr 11 | 97 | T Stop | 196 | Window 21 |
| 59 | I Limit Start | 171 | Patch Addr 12 | 145 | TempUnit | 197 | Window 22 |
| 58 | I Low | 172 | Patch Addr 13 | 35 | Time | 198 | Window 23 |
| 25 | I rms | 173 | Patch Addr 14 | 90 | To USB | 199 | Window 24 |
| 94 | I Start | 174 | Patch Addr 15 | 98 | Total Events | 178 | Window 3 |
| 96 | I Stop | 175 | Patch Addr 16 | 204 | Total Runs | 179 | Window 4 |
| 41 | I1 rms | 161 | Patch Addr 2 | 221 | Total Starts | 180 | Window 5 |
| 43 | I2 rms | 162 | Patch Addr 3 | 206 | Total Stops | 181 | Window 6 |
| 45 | I3 rms | 163 | Patch Addr 4 | 210 | Total Trips | 182 | Window 7 |
| 2 | Initial Volts | 164 | Patch Addr 5 | 106 | Total Uc On | 183 | Window 8 |
| 87 | Kick Level | 165 | Patch Addr 6 | 202 | Total Us Off | 184 | Window 9 |
| 89 | Kick Start | 166 | Patch Addr 7 | 200 | Total Us On | 158 | Window Code |
| | | | | | | 157 | Window View |

Upgrading Firmware

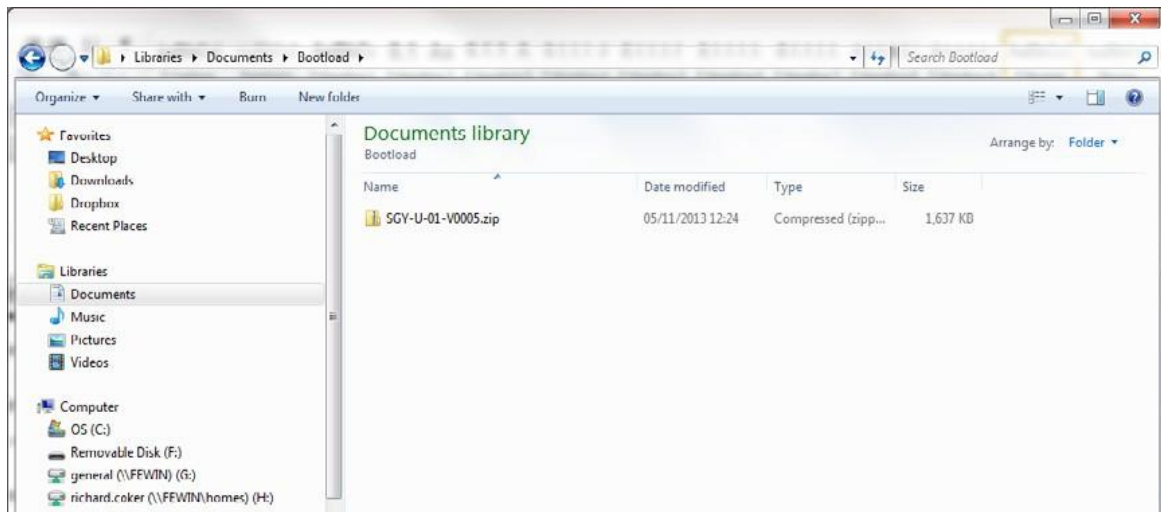
Update Procedure

In the event that the agility unit requires a firmware update, this can be achieved on an installed unit without the need for any additional equipment other than a USB memory stick.

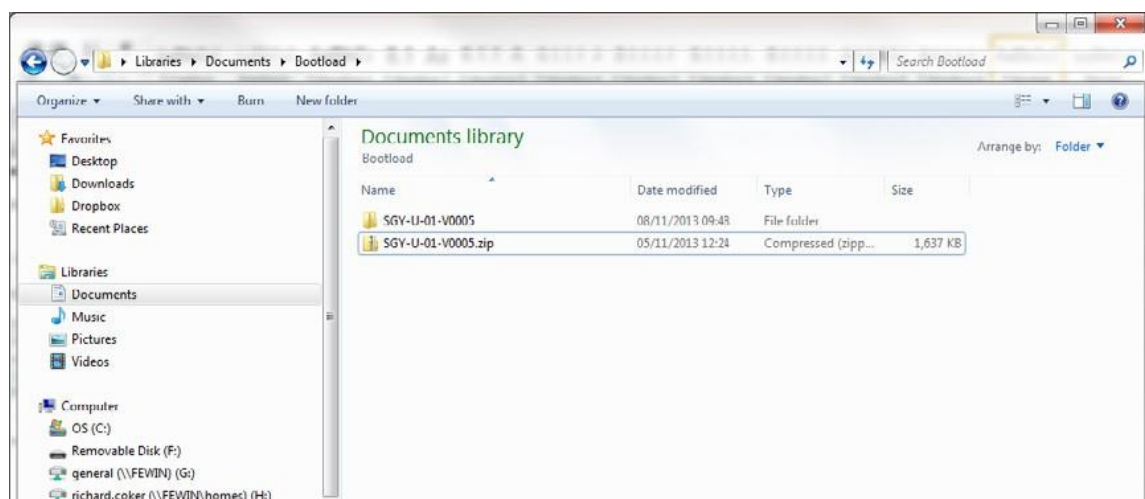
Instruction for Updating

- Obtain a USB flash drive, and ensure that it has been formatted to FAT32.
 Part number USB-KEY is a USB flash drive that has been verified to work with agility. Other flash drives may not physically fit, or may not perform correctly. Available to purchase from Fairford Electronics Ltd.

- Download a new firmware zip file from: <http://www.fairford.com/download/agility-firmware/>
- Copy the zip file into a suitable location on your PC that you can extract all of the firmware files

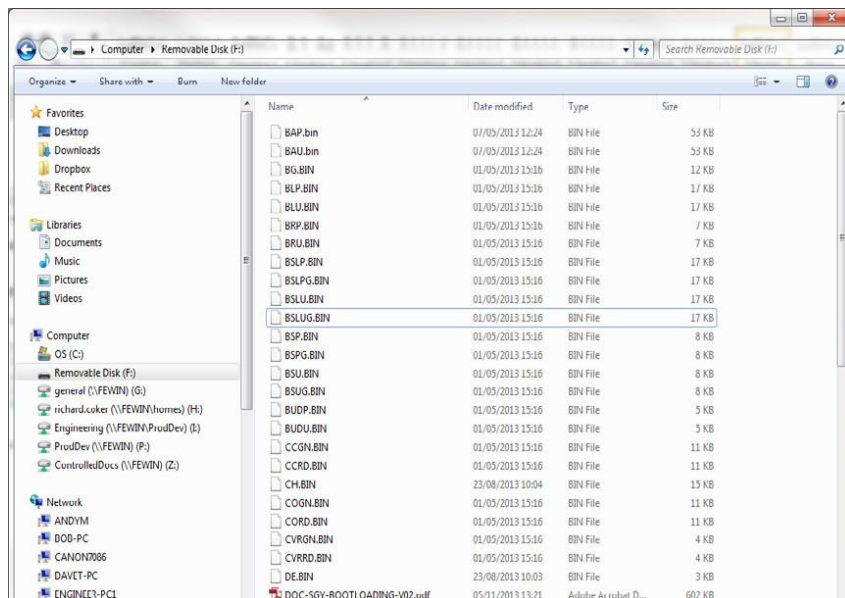
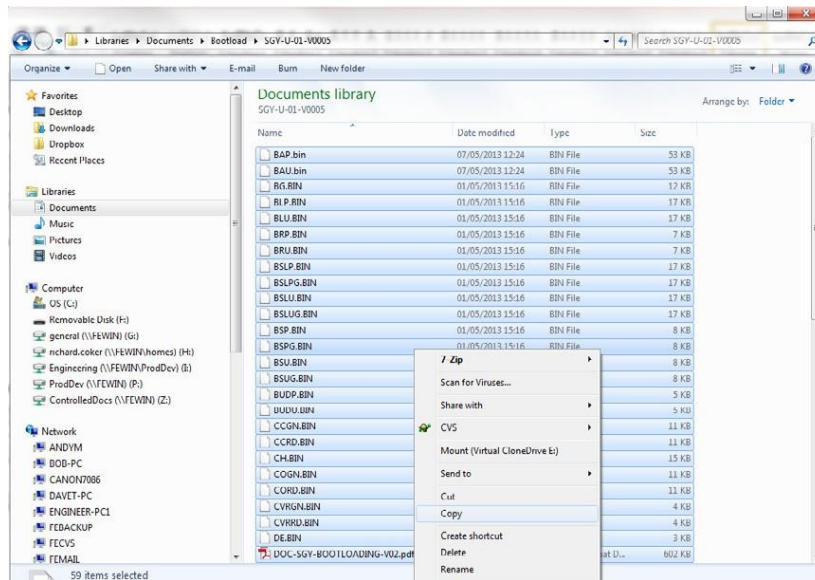


- Right click on the zip file and select extract all. This will create an unzipped directory in the same location with the same name.



Upgrading Firmware

Double click on the new directory and inside to display of the unit update files. Select all files and copy them to the root directory of the USB flash drive.



Power down the agility unit and insert the USB stick with the upgrade files into the corresponding socket on the front panel.

Power up the agility unit and the upgrade process will start automatically. The update progress will be shown on the display. During this time, do not remove the USB stick and ensure power is not disconnected.

When the upgrade process is completed agility will reboot. The USB stick may now be removed.

Applications

Motor Suitability and Associated Considerations

The agility soft-starter is based on the “Fairford System” of microprocessor-based optimising soft-starters which have been used world-wide in critical and non-critical systems. Since 1983, Fairford System soft-starters have successfully operated with almost every type of load and environment from the Antarctic to the jungle. The design has proven to be both reliable and adaptable, and provides a powerful mechanism with which to control fixed-speed induction motors. However, due to the intrinsic differences between electronic and electro-mechanical starting systems, there are a number of simple rules and observations to follow when using the agility soft-starter. This section introduces guidelines for the user and those incorporating the unit as part of their system design.

Suitability

In principle, any induction motor can be started by a soft-starter. Normally, the breakaway torque of the load should be less than the full-load torque of the motor, unless a motor with a high locked rotor torque characteristic is employed. As a quick assessment, any load which has a low or no-load start with a moderate starting time, or which can be started with a star-delta starter, auto transformer or other forms of reduced-voltage starting, can be considered to be a potential application for a soft-starter

Induction Motor Characteristics

Induction motors are required to provide sufficient torque to accelerate the motor and its load from standstill to full speed and to maintain full speed efficiently at all torque levels up to the design full load torque. Most modern induction motors have characteristics that are wholly suitable for use with soft starters, however, the characteristics vary considerably between different manufacturers and design types. It is important that the motor is capable of providing sufficient torque to drive the load at all speeds between standstill and rated speed, to enable the agility to function properly. It is particularly important that the motor to be soft started does not have a low pull-up or saddle torque otherwise the load may not be accelerated correctly.

The primary function of the soft-starter is to act as a torque-regulating device. It cannot apply a torque greater than that which the motor generates. For this reason, problematic applications for which many different starting methods have been tried but failed, may need analysis of the motor or load performance before a soft-start can be successfully applied.

Rating

For most applications, except high inertia loads, the starting demands and the inertia of the rotating masses are small enough to be insignificant. This means that no special consideration needs to be given to the rating of the soft-starter, other than to ensure that it is equal or marginally greater than the rated voltage and current of the controlled motor.

Alternatively, if the number of poles of the motor and the moments of inertia of the load (J_{load}) and motor rotor (J_{motor}) are known, a soft-starter will be suitable if the figures comply with the criteria given in the bottom row of following table

| | | | | |
|------------------------------------|------|------|------|-----|
| Number of Poles | 2 | 4 | 6 | 8 |
| Synchronous Speed (rpm) | 3000 | 1500 | 1000 | 750 |
| $(J_{load})/(J_{motor})$ less than | 5 | 15 | 20 | 25 |

Applications (continued)

Maximum Motor Cable Length

The length of the cable between the output terminals of the starter and the motor should not normally be greater than 100 metres.

Power Factor Correction Capacitors

Power factor correction capacitors applied to a single motor MUST always be connected by a separate contactor placed on the SUPPLY side of the agility soft-start. Capacitors should be switched in after top-of-ramp (full line voltage) is reached and switched out of circuit before a stop is initiated.

It is important that any total system PFC scheme that automatically corrects for a range of inductive loads is not operated in such a way as to leave it heavily over compensated since this might introduce oscillations leading to damaging over-voltages.

Lightly Loaded, Small Motors

Lightly loaded, small-sized (less than 2kW), star connected motors can produce high voltages at the motor terminals when shut down by simply opening the line contactor. As these voltages can damage the soft-starter, it is safer to control the opening of the line contactor with the soft start run relay contacts.

Motors Fitted with Integral Brakes

Motors that include an integral, electrically operated brake, internally connected to the motor input terminals, can only be soft-started when the brake is re-connected to the supply through its own contactor.

Older Motors

The action of the fully-controlled soft-starter introduces harmonic currents and voltages to the motor. It is therefore, important to ensure that the motor employs techniques such as rotor skewing in its construction to suppress the effects of harmonic fluxes and avoid rough starting. This is rarely a problem with modern motors because nearly all motors designed in the last 20 years employ these techniques.

Wound-rotor or Slip-ring Motors

Slip-ring induction motors ALWAYS need some resistance in the rotor circuit to ensure that sufficient rotational torque is generated to overcome any alignment torque, which is present at start-up. The resistance can be safely shorted out in the normal fashion with a contactor controlled by the programmable relay set as 'top-of-ramp' contacts.

Enclosures

Thyristors are not perfect conductors, and the passage of current through them causes heat dissipation in the body of the device, which in turn causes the heatsink temperature to increase. As a rough guide, the heat generated is 1 watt/amp/phase when energy saving, which equates to a dissipation of 30 watts from the heatsink for a line current of 10 amps. Therefore, all cabinets or enclosures that house soft-starters should have adequate ventilation. (Refer to the Mechanical installation procedures, section 1.0 for more detailed information.)

High-Efficiency Motors

Due to an inherently steep front to the speed/torque curve, high efficiency motors can exhibit instability when lightly loaded and the iERS parameter group may need adjusting to compensate.

Applications (continued)

EU Compliance with the EMC Directive

When considering the use or fitting of any Soft Starter, users and installers in European countries must comply with the EMC Directive 89/336/EEC. The manufacturer of the soft starter has a statutory obligation to provide a guide for compliance with this directive. For agility, this guidance is given in the EMC guide which is A3 of this manual. It is essential that users and installers understand and comply with the requirements described in these sections.

Fuses

Circuit protection fuses should be rated at twice the motor rated current for normal low inertia applications. See also section 8.2.2 relating to high inertia loads. Semiconductor fuses are available for the short circuit protection of the thyristors in agility. See Electrical Installation section for fuse recommendations.

Rules for Specific Applications

High Inertia Loads

High inertia loads such as centrifugal and axial fans, grinders, flywheel presses, etc., may require a larger size of soft-start than the motor. For example, a 75kW starter may be needed for a 55kW motor. This is necessary due to the extra heat produced by the thyristors due to the extended start times and/or higher over-currents. If very high inertia loads are involved, then an analysis of the starting characteristics should be made. This will require accurate data about the motor speed-torque and speed-current characteristics as well as the load characteristics. For further information, consult your supplier. Consideration must also be given to thermal overload and fuse protection systems when extended start times are involved. This must be as for heavy duty starting, as a standard thermal overload will trip under these conditions. A heavy-duty start thermal overload or an electronic overload with dual settings for start and run is recommended. Modern HRC motor fuses will allow for some overload during the start, but the fuse curve, giving time/current data, will give an indication of suitability for the particular application.

Frequent Starting

High starting frequencies require careful consideration of the soft-start thermal capabilities. In many cases a standard sized agility may be suitable as start times are generally shorter for this type of application. If this is not the case then a larger soft-start may be required. (Please refer to Fairford for further information.)

Soft-Stopping

Soft-stopping can reduce positive surge pressures in pipelines on shutdown. It is necessary to make sure that the ramp-down time is long enough to remove the energy from the fluid before the firing of the thyristors is stopped, otherwise the surge pressure may still be present. Soft-stopping can also be successfully applied to loads such as conveyer belt systems where sensitive items such as bottles are being transported.

Reversing Configuration

agility soft-starters used in conjunction with contactor controlled reversing and plug-braked motors show considerable benefits to the user by reducing mechanical and electrical stresses, particularly when utilising the current limited start feature. It is required, with this type of application, to insert a 150 to 350 millisecond delay between the opening of one contactor and the closing of the other, to allow any residual flux in the rotor to die away. See section 2.9.3 for details.

Applications (continued)

Replacement of Fluid Couplings

Soft-starters can replace fluid couplings yielding benefits of higher efficiency running and lower costs to the user. If the coupling is used to magnify the available breakaway torque, it may be necessary to replace the fitted motor with another of a larger size or one with a high starting torque characteristic before a soft-start can be employed.

Two-speed Motor Applications

Two speed motors, whether Dahlander connected or with dual windings, can be soft started at each speed, provided that the start is initiated when the actual motor speed is less than the synchronous speed for the winding selected. This is particularly important when changing from high to low speeds.

Overhauling Loads

Certain applications can over-speed the motor as part of normal operation. Power flow is then from the motor to the supply. It is important that the optimising is disabled during the over-speed condition and reinserted during normal conditions.

Application Table

The table on the following page shows many common motor applications that suit the agility soft-starter. It lists typical breakaway torque requirements as a percentage of motor full-load torque (FLT). For the most satisfactory soft-start in a given application, the motor should have a full-voltage locked-rotor-torque (LRT) that is at least twice the breakaway torque. (E.g. For a reciprocating compressor the FLT is normally in the region of 50% motor LRT.) As a general rule, the higher the motor LRT is above the load breakaway torque, the greater the control over the starting process.

Applications (continued)

| Applications | | |
|--------------------------------------|-------------------------|--|
| Application | Breakaway Torque (%FLT) | Remarks |
| Agitator | 35 | – |
| Air compressor- rotary, unloaded | 25–35 | – |
| Air compressor- reciprocating, | 50–100 | – |
| Air compressor- screw type, | 30 | Usually two-pole motor |
| Ball mill | 30–50 | Eccentric load, needs high starting torque motor |
| Carding machine | 100 | Often high inertia |
| Centrifuge | 50–90 | Usually high inertia |
| Centrifugal fan- dampers closed | 10–25 | Usually high inertia |
| Centrifugal fan- dampers open | 10–25 | Usually high inertia, very long ramp times |
| Centrifugal blower- valve closed | 25–35 | – |
| Centrifugal blower- valve open | 30–40 | Can have long ramp time |
| Conveyor- horizontal, unloaded | 10–50 | – |
| Conveyor- horizontal, loaded | 100–150 | – |
| Conveyor- vertical lifting, unloaded | 50–85 | – |
| Conveyor- vertical lifting, loaded | 100–175 | – |
| Conveyor- vertical lowering, | 10–40 | – |
| Conveyor- vertical lowering, loaded | 10–25 | – |
| Crusher (not rock)- unloaded | 25–75 | Can be high inertia |
| Drilling machine- unloaded | 10 | – |
| Fan, axial-flow propeller | 20–40 | – |
| Feeder- screw | 100–175 | Needs high starting torque motor |
| Feeder- vibrating, motor driven | 100–150 | Needs high starting torque motor |
| Grinder- unloaded | 10–25 | Usually high inertia |
| Hammer mill | 20–125 | Eccentric load, needs high starting torque motor |
| Mills- flour etc. | 30–50 | – |
| Mixer- dry contents | 35–75 | – |
| Mixer- fluid contents | 10–40 | – |
| Mixer- plastic contents | 75–125 | High torque motor offers advantage |
| Mixer- powder contents | 75–125 | High torque motor offers advantage |
| Pelletizers | 50–100 | – |
| Press, flywheel | 50–150 | Needs high starting torque motor |
| Pump- centrifugal | 10–25 | Soft stopping useful |
| Pump- positive displacement, | 100–175 | Needs high starting torque motor |
| Pump- vane type, positive | 100–150 | Needs high starting torque motor |
| Rolling mill | 30–50 | – |
| Saw, band | 10–35 | – |
| Saw, circular | 25–50 | May be high inertia; Plug brake may be useful |
| Screen, vibrating | 30–60 | – |
| Transformers, voltage regulators | Nil | Change firing mode |
| Tumblers | 30–100 | Can be eccentric load, may need high torque |

Applications (continued)

| Applications (continued) | | |
|----------------------------------|-------------------------|--|
| Application | Breakaway Torque (%FLT) | Remarks |
| Rolling mill | 30–50 | – |
| Saw, band | 10–35 | – |
| Saw, circular | 25–50 | May be high inertia; Plug brake may be |
| Screen, vibrating | 30–60 | – |
| Transformers, voltage regulators | Nil | Change firing mode |
| Tumblers | 30–100 | Can be eccentric load, may need high |

Concepts and principles of fixed-speed induction motor starting and control.

Since its invention one hundred years ago, the standard 3-phase induction motor has become one of the most familiar items of industrial equipment ever known. Due to its simplicity of construction, low cost, reliability and relatively high efficiency, it is likely to remain the prime source of mechanical energy for the foreseeable future.

Introduction

Energy conversion, from the electrical supply to rotating mechanical energy, is a characteristic of all motors. To regulate energy flow, most motor circuits require a mechanism to connect and disconnect them from their electrical power source; electro-mechanical switches, known as 'Contactors', are the standard means of achieving this control. Even today, more than one hundred years after their introduction, contactor-based systems remain the most widely used method of motor control. Nevertheless, there is a definite trend towards more sophisticated electronic systems of control being applied to fixed-speed motor drives. This section will discuss these newest forms of control - namely, electronic, microprocessor-controlled, optimising soft-starters such as agility.



Note: Since there is a wealth of detailed literature available in the technical press, it is not proposed to dwell too heavily on the specifics of realising the electronic control system, but rather, to offer an outline of its various capabilities.

The Induction Motor

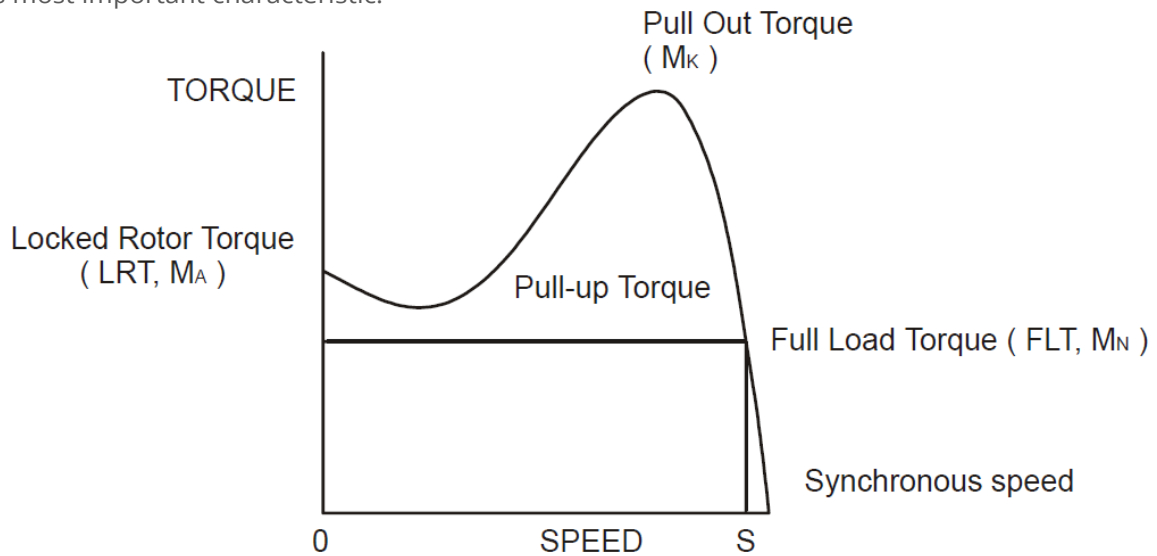
In order to appreciate the benefits of using an electronic controller, it is important to have some understanding of the characteristics and limitations of the induction motor and the electro-mechanical systems currently used to control them. The standard, fixed-speed induction motor fulfils two basic requirements:

- To accelerate itself and its load to full speed (or speeds with multi-speed motors)
- To maintain the load at full speed efficiently and effectively over the full range of loadings.

Due to the constraints of materials and design, it can be difficult to achieve both objectives effectively and economically in one machine. So, how does a motor start in the first place? As mentioned earlier, motors convert electrical energy drawn from the power supply into a

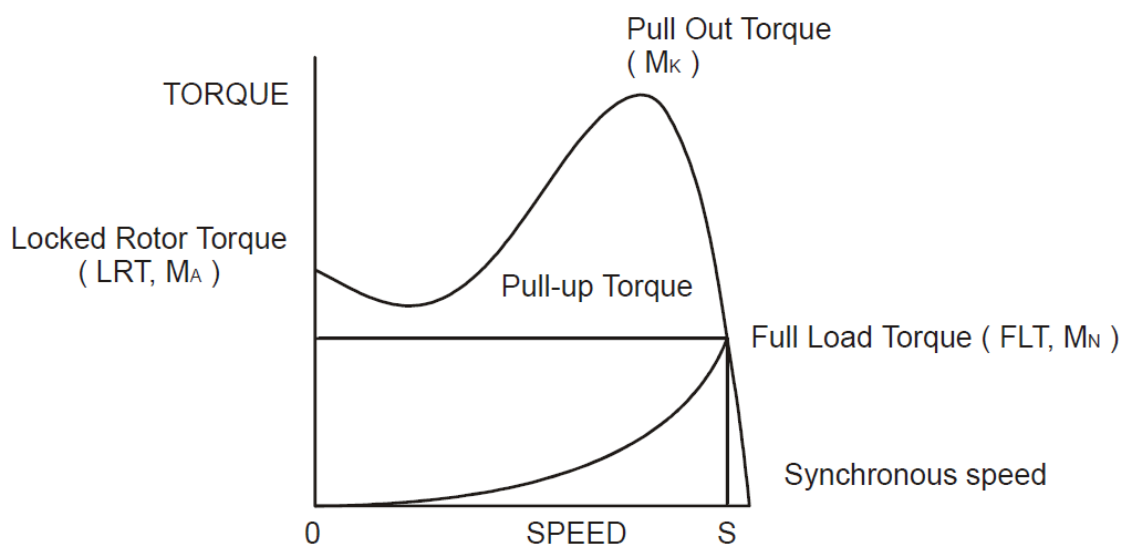
Applications (continued)

mechanical form, usually as a shaft rotating at a speed fixed by the frequency of the supply. The power available from the shaft is equal to the torque (moment) multiplied by the shaft speed (rpm). From an initial value at standstill, the torque alters, up or down, as the machine accelerates, reaching a peak at about two thirds full speed, finally to become zero at synchronous speed. This characteristic means that induction motors always run at slightly less than synchronous speed in order to develop power - the 'slip speed' and, hence the term asynchronous. The following graph is of an induction motor torque/speed curve and illustrates this most important characteristic.



Torque/Speed Curve – Induction Motor

As for each type of motor, so each load coupled to an induction motor has its own speed/torque curve:

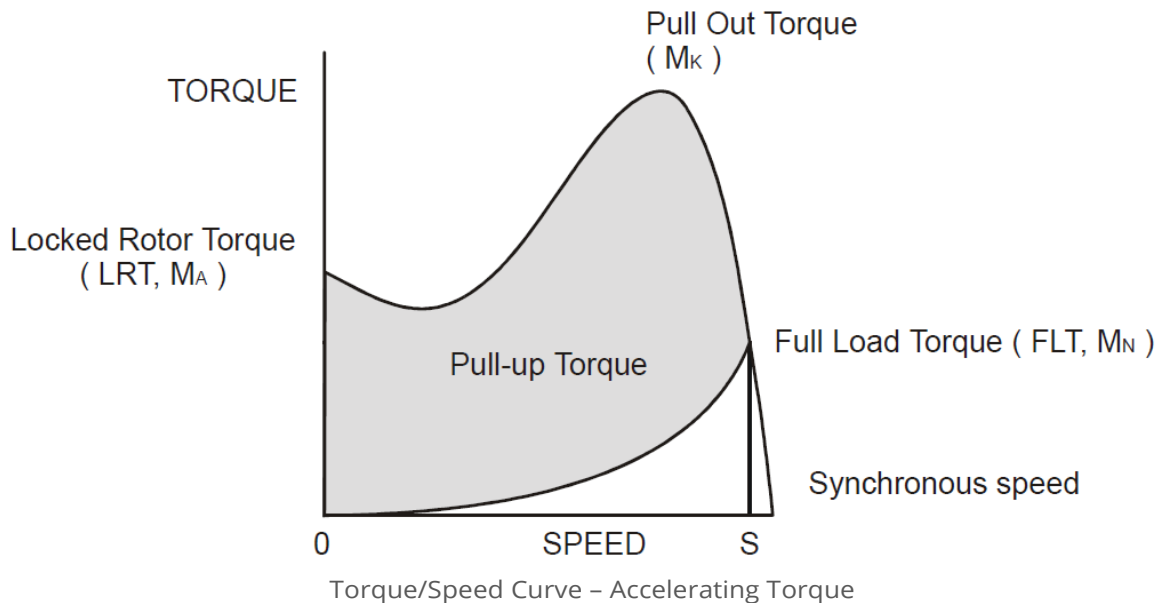


Torque/Speed Curve – Coupled Load

Applications (continued)

The Induction Motor (continued)

The acceleration of a motor-load system is caused by the difference between the developed torque (motor) and the absorbed torque (load), and is shown by the shaded area in the next figure:

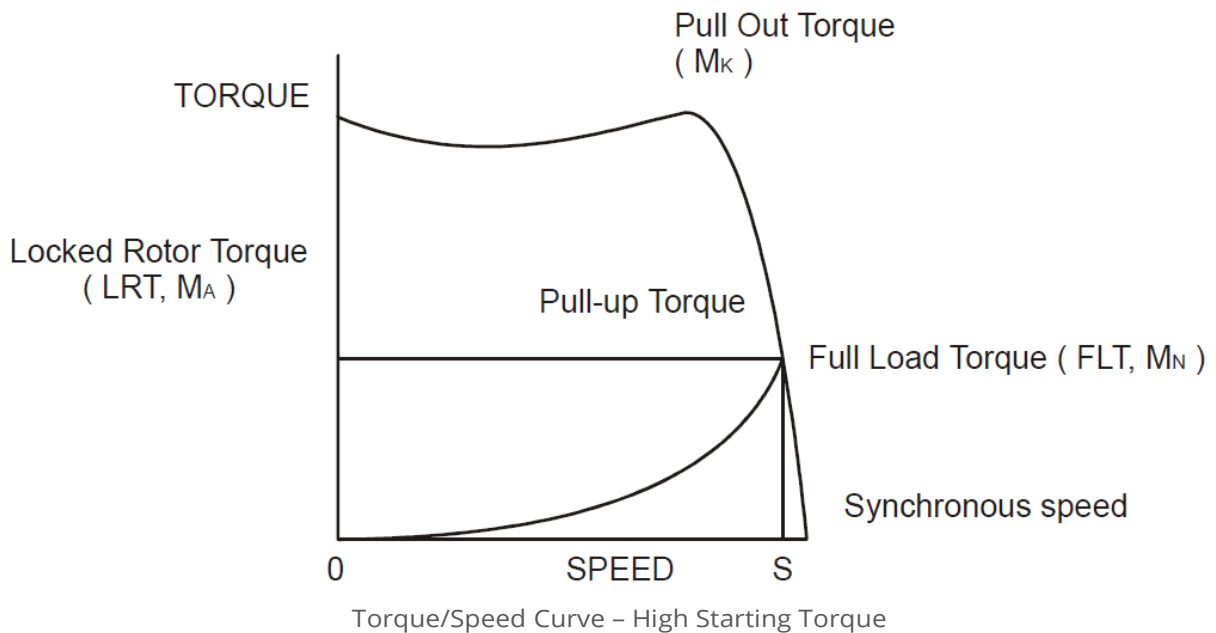


Obviously, the larger the difference, the faster the acceleration and the quicker full speed is reached - and, coincidentally, the greater the stresses experienced by the supply and drive systems during the acceleration process. An “ideal” start would accelerate the load with just sufficient force to reach full speed smoothly in a reasonable time, and with minimum stress to the supply and drive mechanisms.

Broadly speaking, the motor speed/torque characteristic is controlled by the rotor resistance - a motor with high rotor resistance can generate its peak torque (pull-out torque) at standstill giving the high break-away torque characteristic, which reduces steadily as the speed increases and becoming zero at synchronous speed. At the other end of the scale, a motor with a very low rotor resistance will produce a low starting torque but will generate its peak torque closer to the synchronous speed. Consequently this type of motor runs at full power with higher operating efficiency and low slip speed. It is possible to combine the twin requirements of high starting torque and efficient full-speed operation within a single motor by techniques such as double-cage or deep bar design, and this, usually, is the motor characteristic chosen for lifting and hoisting applications:

However, most induction motors are designed to have a “standard” characteristic that provides a compromise between starting torque and operating efficiency. To summarise, an induction motor will only start and accelerate when it produces more torque than the connected load absorbs. This is true for all speeds - including standstill and full speed.

Applications (continued)



Starting Induction Motors

Starting a de-magnetised induction motor from standstill is a demanding and complex process. At the instant of switching all the energy necessary to magnetise the motor, to provide the acceleration force, and to supply the kinetic energy of the rotor and load, must be present together with the energy to overcome the mechanical and electrical losses. To do so at full supply voltage places considerable stresses on the supply, the motor windings, and the iron cores of the stator and rotor. Excessive acceleration of a rotor when the mechanical load is small can produce torque oscillations in the shaft causing severe wear to transmissions, gears and drives. Excessive acceleration when the load inertia is high such as in centrifugal fans, causes belts to slip in the pulleys, producing rapid wear and early failure.

Electro-Mechanical Methods Of Starting

Method A: Direct-on-Line

The most simple means of controlling energy flow to an induction motor is to interrupt the power supply by a single, solenoid operated, 3-phase switch, known as a contactor. Very widely applied, the method is known variously as "direct-on-line", "across-the-line", "direct" etc., and is the usual form of control where low cost is the first, and most important consideration. As a result, it is most often used on small motor sizes (up to approx. - 22kW), or where the supply is strong enough to withstand the inrush and starting current surges without causing unacceptable voltage drops.

The harsh, damaging effects described earlier are all imposed by direct-on-line starting and, as a control method, it is the most destructive of equipment. Its simplicity and apparent low cost, although attractive at first sight, hide large cost penalties in the shape of increased maintenance,

Applications (continued)

reduced transmission equipment life and higher risk of motor failure, particularly when frequent starting and stopping is needed.

In larger sized motors special strengthening is necessary, at higher cost, before they can be safely used with direct-on-line starting. However, the shortcomings of the direct-on-line starter have been recognised ever since motors have been used and alternative systems have been developed over the years to reduce the damaging effects of this form of control.

Method B: Star-Delta and other Reduced Voltage Starting Systems

Reduced voltage starting makes use of the fact that motor torque is proportional to the square of the terminal voltage; the most familiar type of reduced-voltage starter is the star-delta starter. Consisting of three contactors and a time switch (which can be mechanical, pneumatic, electrical or electronic), the star-delta starter changes the motor winding configuration from an initial star connection to a delta as the motor accelerates. The change-over or transition point is controlled by the time switch and is usually arranged to be approximately at 80% of full speed. The effect of starting in star is to alter the voltage across each stator winding to 58% of normal. This reduces the starting torque to a third of locked rotor torque (LRT) with a consequent reduction in starting currents and acceleration forces.

Although an apparent improvement over the direct system, significant disadvantages still remain. The transfer from star to delta momentarily removes the motor from the supply. During this time the motor is under the mechanical influence of the rotating load and, at the instant of disconnection, current will still flow in the rotor bars due to the time delay necessary for the magnetic flux to die away. Therefore, there is a residual flux “frozen” on the surface of the rotating rotor, which cuts the stator windings, generating a voltage whose frequency depends on the rotor speed. If the load inertia is small, such as in a pump, or if the friction is high, there could be a significant loss of speed during the time the supply is disconnected.

In this case, when the reconnection to delta is made, a large phase differential can exist between the supply and the rotor fluxes. This can give rise to very large current surges (as much or more than full-voltage locked rotor current), together with massive transient torque oscillations, which can peak at levels in the region of fifteen-times full-load torque. Although the effects described are only present for a very short period of time (about one fifth of a second), they are sources of great stress and damage to the whole drive system, and where frequent starting is necessary, invoke high maintenance costs. The current surges, in the form of a very high level short duration “spikes”, are an increasing problem in these days of computer control systems and other “sensitive” electronic equipment. The voltage disturbance on the supply is very difficult to filter out and can cause severe problems, especially when larger motors are involved.

There are methods of control, for example, the Wauchope starter, which eliminate or reduce the reconnection transients. However, such starters are expensive and have reliability implications; for these reasons they are not widely applied.

The star-delta starter also has disadvantages due to the restricted starting torque available (if you need 40% LRT to break-away, you can only increase the motor size, or revert to direct-on-

Applications (continued)

line). Combined with the severe effects of the re-switching surges, and the additional costs of bringing six conductors from the motor to the starter instead of only three, star-delta only offers an imperfect solution to the problem of starting the induction motor.

Method C: Primary Resistance Starter

It has long been recognised that the transition step in the star-delta system was a source of problems such as welded contactors, sheared drive shafts etc., and for many years a method of stepless control has been available in the form of the primary resistance starter. This type of controller inserts a resistance in one, or more often in each, of the phase connections to the stator at start-up, after which it is progressively reduced and shorted out at the end of the acceleration process. Frequently, the resistances are movable blades that are gradually inserted into an electrolyte liquid. The mechanism is usually large and expensive, both to purchase and to maintain, and considerable heat is created by the passage of current through the electrolyte resistor. This limits the starting frequency (because the electrolyte has to condense back to liquid before a new start can proceed), and these restrictions prevent this starter from being a popular option when selecting a control system. However, it has the distinction of being the smoothest and least stressful method of accelerating an induction motor and its load.

Method D: Other Electro-Mechanical Systems

Other control methods such as auto-transformer starting (popular in North America), primary reactance starting etc., are employed to a greater or lesser extent, to compensate for some of the disadvantages of each type of starter discussed. Nevertheless, the fundamental problems of electro-mechanical starters remain, and it is only in the last decade or two that their dominance has been challenged by the introduction of power semiconductors controlled by electronics.

The Semiconductor Motor Controller

During the 1950's, much effort was put into the development of a four-layer transistor device which had the power to switch large currents at high voltages when triggered by a very small pulse of current. This device became known as the silicon controlled rectifier (SCR), or in Europe, the 'Thyristor'; it is the basis on which all soft starting systems are built. The characteristic of most interest is the ability of the thyristor to switch rapidly (in about 5 millionths of a second) from "OFF" to "ON" when pulsed, and to remain "ON" until the current through the device falls to zero, - which conveniently, happens at the end of each half-cycle in alternating current supplies.

By controlling the switch-on point of a thyristor relative to the voltage zero crossing in each half wave of an alternating current, it is possible to regulate the energy passing through the device. The closer the turn-on point is to the voltage zero crossing point, the longer the energy is allowed to flow during the half-cycle. Conversely, delaying the turn-on point reduces the time for the energy to flow. Putting two thyristors back-to-back (or anti-parallel) in each of the phase connections to a motor, and by precisely controlling their turn-on points, an electronic soft starter continuously adjusts the passage of energy from the supply so that it is just sufficient for the motor to perform satisfactorily.

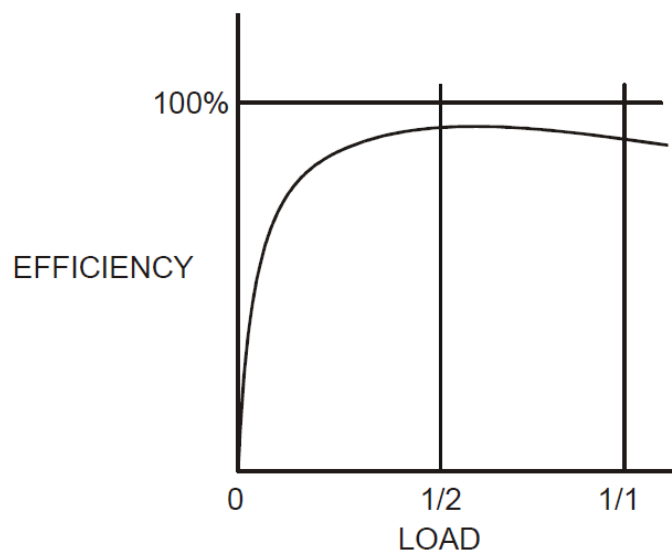
So, for instance, by starting with a large delay to the turn on point in each half cycle, and progressively reducing it over a selected time period, the voltage applied to the motor starts from a relatively low value and increases to full voltage. Due to the motor torque being

Applications (continued)

proportional to the square of the applied voltage, the starting torque follows the same pattern giving the characteristic smooth, stepless start of the soft-starter.

Running Induction Motors

Once a start has been completed the motor operating efficiency becomes of interest. When working at or near full load, the typical 3-phase induction motor is relatively efficient, readily achieving efficiencies of 85% to 95%. However, as shown below, motor efficiency falls dramatically when the load falls to less than 50% of rated output.



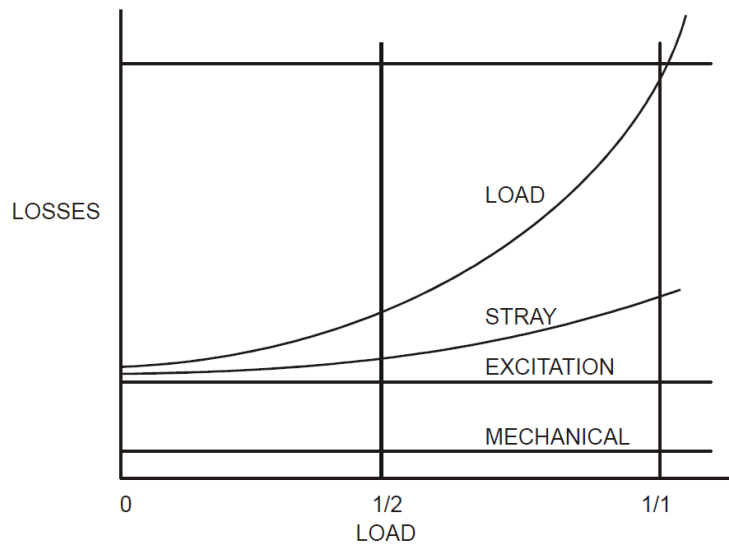
Motor Efficiency/Load Characteristic

In fact, very few motors actually experience consistent fully rated operation, the vast majority operate at much lower loads due to either over-sizing (a very frequent situation), or natural load variations. For Fan and Pumping applications, the affinity laws will allow the inverter drive to show very considerable energy savings over virtually all other methods of control through varying the speed of the motor in response to changes in load. Where motor speeds cannot be varied, an optimising version of semiconductor motor controller, such as agility will also produce energy savings in lightly loaded motors. Less sophisticated systems of soft-starter remain at full conduction and the motor then behaves as if it were connected directly to the mains supply. However, at light loads and mains voltages, induction motors always have excess magnetic flux, and efficiency loss and power factor degradation result. By detecting the load at any instant, and adjusting the motor terminal voltage accordingly, it is possible to save some of the excitation energy and load loss, and improve motor power factor when the motor is running inefficiently at light loads.

All agility soft-starters are microprocessor controlled, and this gives them a number of advantages. Firstly, there are no adjustments to be made for the energy saving function: all calculations necessary to find the best degree of phase-back of the thyristors for any load condition is made by the microprocessor. Secondly, the start always synchronises with the supply voltage and a special structure of turn-on pulses virtually eliminates the inrush currents

Applications (continued)

normally associated with motor start-up; this happens every time. Lastly, there is the absolutely stepless starting process, found only with the primary resistance or reactance electromechanical starters - but without the wasted energy, and with the opportunity to control the maximum current allowed to flow during the starting process. Other features such as soft stopping are included to give considerable control over all modes of induction motor operation.



Motor Efficiency/Loss Characteristic

Reliability Considerations

An aspect of electronic controllers for induction motors which is of increasing concern is that of reliability. There is little point in installing an expensive item of electronic equipment to save potentially considerable amounts of money if the device is unreliable to the point that vital processes are constantly interrupted.

There are electronic products in the market place which appear to offer soft starting cheaply. They almost always rely on less advantageous technologies such as analogue control, or half-control, where one of the two thyristors in each phase is replaced with a diode. There are systems which only control the energy flow in one phase while the other two are directly connected. Owing to the variable quality and performance of many so-called inverters and soft-starters available to the unsuspecting purchaser, international standards for these products have been developed.

So far, IEC 60947-4-2 - 'AC Semiconductor Motor Controllers and Starters' defines the soft starter in every important respect, including thermal and overload performance as well as electromagnetic compatibility. By ensuring that any motor controller equipment purchased conforms to IEC 60947-4-2, a user should be reasonably safeguarded from shoddy or inadequate

Applications (continued)

products when specifying equipment for future installations. A particular advantage of the use of the optimising soft starter is its impact on the maintenance requirements of associated electro-mechanical equipment. Optimising lowers the surface temperature of the motor by reducing the losses within the motor. This prolongs the motor life - and reduces heating of the surrounding atmosphere in the process. If the atmosphere is subject to air conditioning, reducing the heat input will reduce the air conditioning costs. Reduced starting and running currents reduces cable losses and, contactor switching operations are carried out under the most advantageous conditions. No current flows on switch-on since all switching is carried out by the thyristors - virtually eliminating the need for contact replacement.

Indeed, there are a growing number of installations where contactors are no longer employed, being replaced by controllable circuit breakers or isolators instead.

In summary, electronic controllers for most fixed-speed applications are opening new ways of increasing the efficient operation of induction motors, as well as offering significant benefits in control. Intending users need to ensure themselves of the quality and performance of any products they expect to fit and this can be reasonably expected if compliance with the appropriate IEC standards is demanded.

EMC

Electromagnetic Compatibility (EMC)

As supplied, all agility Soft Starters meet the standards of emission and immunity levels defined in the IEC 60947-4-2 and EN 60947-4-2 product standards for AC Semiconductor Motor Controllers and Starters. However, the EMC performance of the controller can be significantly affected by the manner in which it is incorporated into the system in which it is intended to operate. To prevent inadvertent degradation of EMC performance, attention must be given to motor cable lengths, wiring configurations, the nature of the power supply, etc., at the design, construction and implementation stages of a project.

Introduction

It is widely accepted that electromagnetic compatibility between electronic and electrical products is a desirable objective. Technical standards are increasingly stipulating levels of EMC performance which compliant products are required to meet. The decision by the European Union (EU) to implement a community-wide directive covering EMC caused considerable activity among electrical and electronic equipment manufacturers and suppliers to identify, understand, and mitigate the sources of electromagnetic interference within their products and systems.

Applicable Standard Within the EU

The product standard which defines EMC performance for soft starters is IEC 60947-4-2 'AC Semiconductor Motor Controllers and Starters.' (The Official Journal of the EC will list this standard as EN 60947-4-2.). agility has been type tested in accordance with the test procedures and levels laid down in the product standard.

Mandatory Requirements Within the EU

(Applicable to any person involved in the installation and operation of the equipment.)

The EU Directive 2004/108/EC, describes the required EMC performance of all electrical equipment which is to be connected to a low voltage supply network. It imposes an obligation on the manufacturer of the soft starter to provide sufficient information for installers, system integrators, users, and anyone else connected with the installation and operation of the equipment. This section provides the technical information to support the obligation of the manufacturer.

The provision and maintenance of compatibility extends from the manufacturer to the panel builder, assembler, systems integrator, and ultimately to the installer and user. Anyone involved in the installation and operation of the equipment, through a lack of knowledge, misdirection, or for other reasons, can completely negate the initial EMC performance of the equipment.

Guidance for Installation Personnel and System Designers

For safety reasons, all agility products are intended to be installed and set to work by skilled personnel who are capable of interpreting and following EMC guidelines correctly. Any person not fully trained in the appropriate technology should not attempt the installation.

If you do not understand, or if you are unclear about any part of these guidelines, then please consult your supplier. Often, consultation with the supplier can avoid unnecessary problems in specifying and installing the correct combination of equipment.

EMC (continued)

EMC Basic Criteria

The electromagnetic compatibility of a product is defined by two criteria:

1. Immunity to electromagnetic disturbances generated externally to the product.
2. The type and amount of conducted and radiated electromagnetic emissions emanating from the product.

Ascertaining the nature of the power supply is of primary consideration when deciding on appropriate EMC requirements. The requirements for equipment installed in heavy industrial environments (fed from their own isolated low voltage power supply) differ from those installed in residential, commercial, light industrial, and health-care applications (directly connected to a public low-voltage network).

Generally, industrial installations require higher immunity levels and permit higher levels of conducted and radiated emissions than those for non-industrial installations. On the other hand, lower levels of emissions output, and lower immunity levels, are specified for installations connected directly to the public low-voltage network.

Purchasing Implications of Meeting an EMC Standard

Before purchasing components for the installation, the specifier must evaluate the expected source of power for the Soft Starter and understand exactly the implications for meeting EMC requirements. It is likely that failure to do so will result in the purchase and installation of inappropriate equipment.



IMPORTANT: The information and guidance given in section C.7 forms part of the statutory requirements of the European Union Directive 2004/108/EC on EMC

Basic EMC Considerations

Immunity

The product standard for immunity requirements is EN 60947-4-2:2012. All agility Soft Starter products meet, or exceed the industrial level immunity requirements laid down in this standard.

Emissions

Emissions are classified as low frequency (below 9kHz), known as harmonics, and high or radio frequency (above 9kHz). Both radio-frequency emissions and low-frequency harmonics are generated by the action of the agility Soft-Starter.



NOTICE: This product has been designed for environment A. Use of this product in environment B may cause unwanted electromagnetic disturbances in which case the user may be required to take adequate mitigating measures.

Emissions - Harmonics

During normal operation, soft starters turn their semiconductor switches on and off in order to vary the voltage at the motor terminals, and this introduces supply discontinuities and generates harmonics. However, the mode of pulsing used by agility Soft Starters minimizes these harmonic effects, since agility power circuits are configured as a fully-controlled regulators (W3C).

EMC (continued)

Only non-triplen (integer multiples of the third harmonic), odd harmonic frequencies are created, starting with and diminishing rapidly from the fifth harmonic, and virtually disappearing by the nineteenth harmonic.

Emissions - Radio Frequency (RF)

Radio frequency emissions are propagated in two ways:

- a) Conduction along the leads supplying the soft starter.
- b) Radiation from the operating equipment.

They also have two sources:

- 1) The high-frequency currents associated with the control electronics (this includes the microprocessor).
- 2) The action of the semiconductor devices forming the power switching elements located in the controller main circuits.

The radiation measurements made from operating versions of agility Soft Starters show levels lower than the allowed limits. Further, enclosures of metallic construction provide additional shielding for agility Soft Starters mounted within them. The only radiated interference effect that might arise from a soft starter would be if mobile telephones, walkie-talkies, etc. were to be used in very close proximity to a unit which was operating with the enclosure door open. For this reason, any enclosure must display a label that brings the possibility of electromagnetic interference to the attention of the operator under these circumstances.

Emissions - Conducted

Conducted emissions are able to travel great distances and may cause interference to any neighboring consumers connected to the common low-voltage supply network.

Allowable levels for conducted emissions generated by semiconductor motor controllers and starters are influenced by the nature of the low-voltage power distribution network. The determining factor is whether the source of power is, either:

- a) a private supply with a single consumer whose Point of Common Coupling (PCC) is at a high or medium voltage transformer, or
- b) a public low-voltage network with more than one consumer, where the individual PCC is made directly to the network itself.

The first type of supply (a) is identified as "Industrial", and requires the use of soft starters compliant with EN 60947-4-2 Table 19 Environment A Emission Levels.

The second type of supply (b) is identified as "Residential" and requires the use of Class B equipment. Class B equipment is equipment suitable for use in domestic establishments and in establishments directly connected to a low-voltage power supply network which supplies buildings for domestic purposes.

Important Systems Information

The specification limits for both equipment classes assume systems are grounded at the star (wye) point of the supply transformer through low impedance connections.

Certain industries, particularly continuous process industries, employ distribution systems that operate either with a ground connection through a high impedance or without a ground at all. These systems may cause severe problems of operator safety when installed with capacitive high frequency filters. Such systems are not considered in this document.

EMC (continued)

In the case of an isolated or high impedance grounded system, seek advice from your supplier before fitting a capacitive high frequency filter to a agility Soft Starter. It is essential that the specifying authority, user, or installer has a clear knowledge of the type of network to which the product is to be installed before making decisions as to which EMC strategy to adopt. As supplied, all agility products comply with the conducted emissions requirements for environment class A as defined by EN 60947-4-2:2012 Table 19. However, the length and type of cable connecting the motor to the starter module materially affects the level of emissions generated, and can amplify them greatly. The standard also allows different levels of emissions depending on rated input power, which also affects the need to fit filters. The EN 60947-4-2:2012 standard only requires consideration of steady-state conditions for EMC emission purposes, and expressly excludes varying conditions such as those during ramp-up and ramp-down. Finally, statistics show that the number of disturbances arising from soft starters, operating in a very wide variety of applications and networks throughout the world, is insignificant. Where EMC disturbances occur, it is very unlikely that they can be genuinely attributed to a soft starter.

Strategies for Attaining and Maintaining EMC Compliance

Where possible, minimize the effect of electrical interference by using the strategies listed below.

- Locate the agility Soft Starter unit as close as reasonably possible to the motor terminal box in order to minimize cable length.
- Ensure that, within any enclosure, the control wiring does not run parallel to the power wiring. Where this is unavoidable, maintain a 100 mm [3.9 in] separation between control cables and power cables.
- Where possible, ensure that the control wiring crosses at right angles to the power wiring. This practice reduces the cross-coupling between cables.
- Shield any cables carrying sensitive signals. The digital control inputs to a agility are opto-isolated, and do not normally require buffering (e.g. through a small relay) or shielding.

Where a special purpose system filter has been applied at the point of common coupling, additional filtering of individual drives is not necessary and may introduce undesirable effects due to resonance.

For the purposes of EMC, the connections between the agility controller and motor are considered to be an extension of the enclosure, and preferably should be contained within grounded metallic trunking or conduit. Armoured cable may be used providing it is correctly terminated, although the EMC performance will be slightly inferior. Shielded cable is not necessary.

All associated electrical and electronic equipment near to the controller complies with the emission and immunity requirements of the EMC Directive.

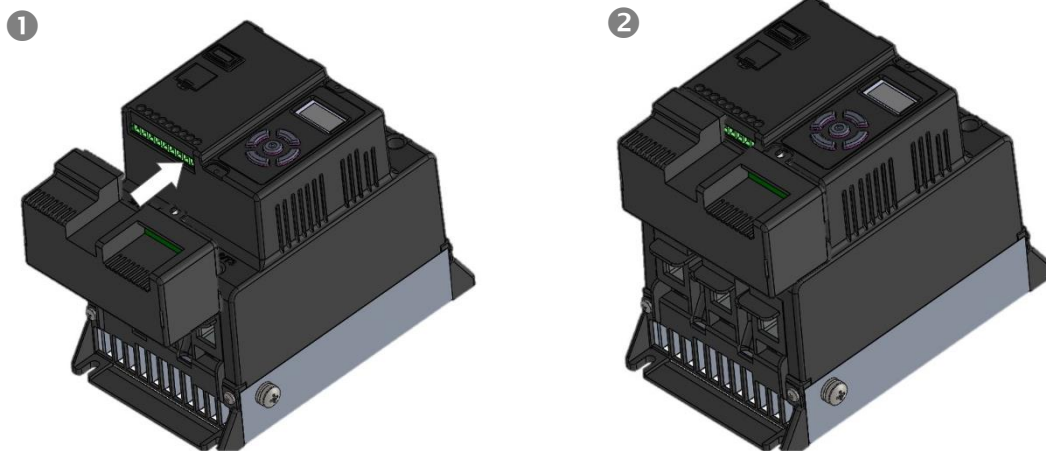
Accessories

Power Supply (AGY-020)

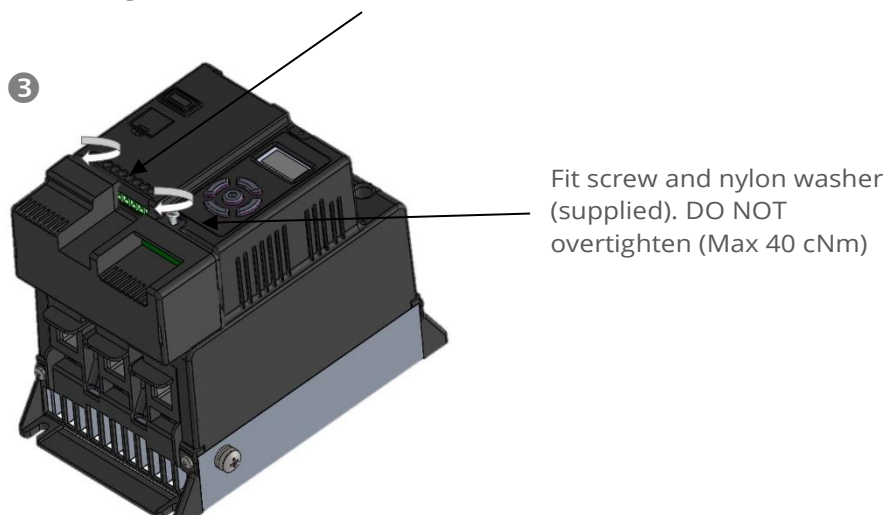
AGY-020 is a dedicated mains power supply for the agility soft start. In addition to allowing for mains control voltage operation, the power supply also allows for mains voltage digital control (D1/D2).

Fitting

Ensure terminals 24V, 0V, COM, D1 and D2 are fully open before installing power supply as shown below:



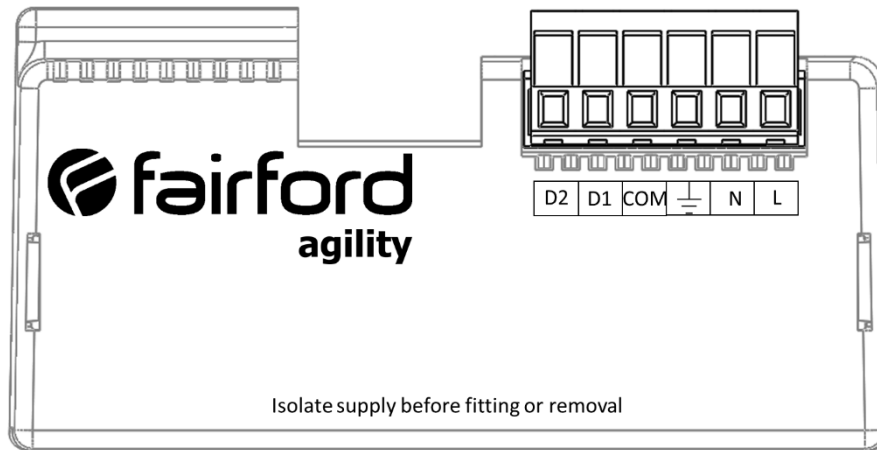
Tighten terminals 24V, 0V, COM, D1 and D2




When the AGY-020 installation is complete, control supply, D1 and D2 are provided on the power supply rather than the agility main unit

Accessories (continued)

Connections



Control Terminal Functions

| Terminal | Description | Default | Function Selectable | Note |
|---|------------------------------------|---------|---------------------|------|
| L | Control Supply Live (+Us) | - | No | #1 |
| N | Control Supply Neutral -(Us) | - | No | |
|  | Mains supply Earth | - | No | |
| COM | Digital Inputs Common | - | No | |
| D1 | Digital Input 1 | - | Yes | #2 |
| D2 | Digital Input 2 | - | Yes | #2 |
| 13/14 | Main Contactor Control (Run Relay) | - | No | #3 |
| 23/24 | Top of Ramp Relay | - | No | #3 |

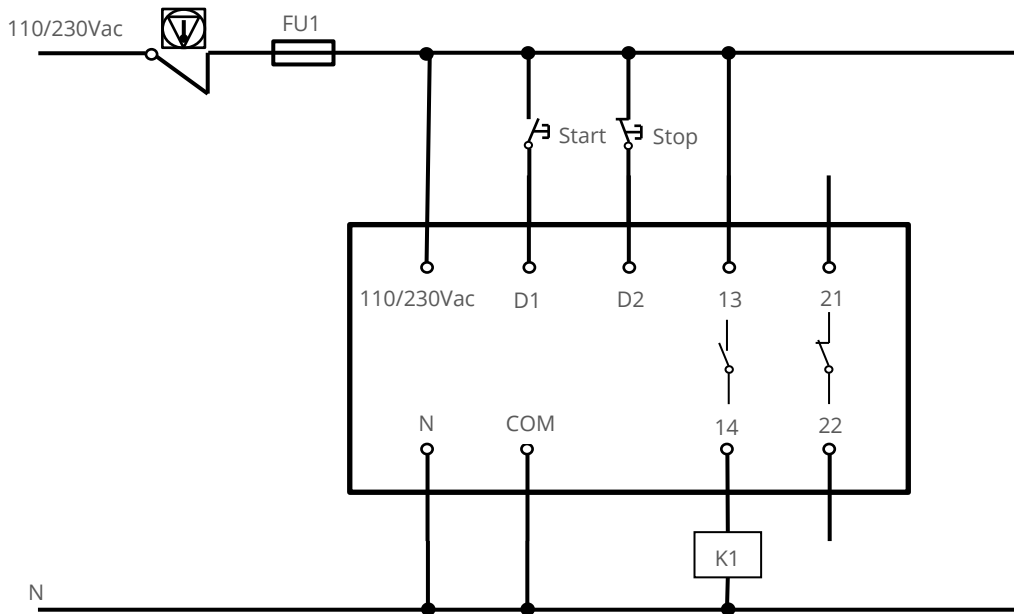
#1 110Vac or 230Vac, 47 – 63Hz

#2 The voltage applied to the digital inputs D1 and D2 must be the same as the supply voltage.

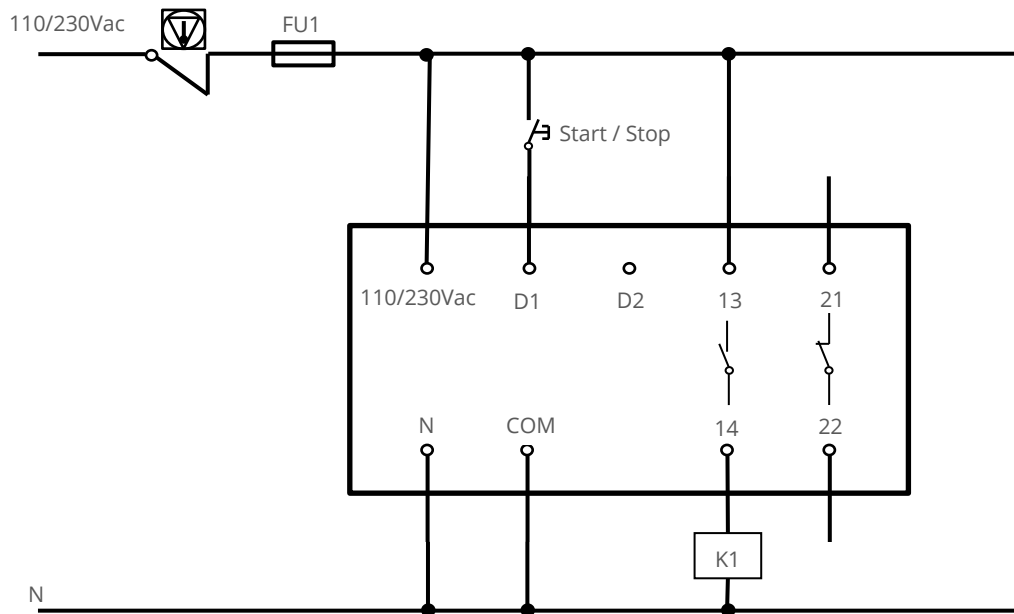
#3 230Vac, 1A, AC15. 30Vdc, 0.5A resistive

Accessories (continued)

3-Wire Control Using AGY-020



2-Wire Control Using AGY-020



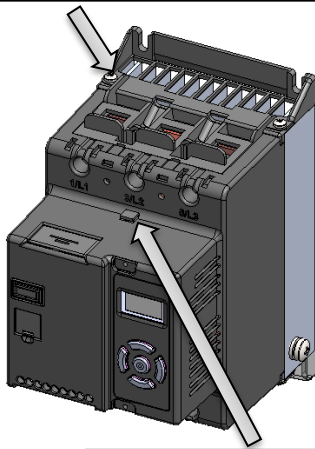
Accessories (continued)

Fan (AGY-030)

AGY-030 increases the number of starts to 40/hour. The fan operates automatically during a soft start or soft stop and will continue to run if the heatsink temperature is $> 45^{\circ}\text{C}$. The fan stops when the heatsink temperature has fallen below 40°C .

Fitting

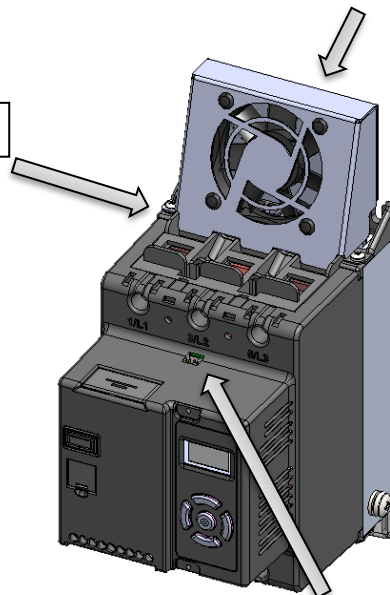
Step 1. Remove screw (x1) and retain



Step 2. Remove blanking plug (x1)

Step 3. Fit fan as shown

Step 4. Replace screw (x1)



Step 5. Fit flying lead from fan into socket.

Sizing Guide

| agility | | | | |
|--|---|--|--|---|
| | Typical Applications | Standard Duty | Medium Duty | Heavy Duty |
| | | <p>Step 1 - Select the application from the list and follow that column down.</p> | <p>Agitator</p> <p>Compressor - Rotary Vane</p> <p>Compressor - Unloaded</p> <p>Conveyor - Unloaded</p> <p>Bow Thruster - Zero Pitch</p> <p>Fan - Low Inertia or <85A</p> <p>Feeder - Screw</p> <p>Lathe Machines</p> <p>Mixer - Unloaded</p> <p>Moulding Machine</p> <p>Plastic and Textile Machines</p> <p>Pump - Submersible</p> <p style="padding-left: 40px;">- Centrifugal</p> <p>Pump - Submersible</p> <p style="padding-left: 40px;">- Rotodynamic</p> <p>Saw - Band</p> <p>Transformers</p> <p>Voltage Regulators</p> | <p>Compressor - Centrifugal</p> <p>Compressor - Reciprocating</p> <p>Compressor - Rotary Screw</p> <p>Ball Mill</p> <p>Bow Thruster - Loaded</p> <p>Conveyor - Loaded</p> <p>Grinder</p> <p>Hammer Mill</p> <p>Mills - flour etc.</p> <p>Mixer - Loaded</p> <p>Pelletizers</p> <p>Press, Flywheel</p> <p>Positive Displacement Pump</p> <p style="padding-left: 40px;">- Reciprocating</p> <p>Positive Displacement Pump</p> <p style="padding-left: 40px;">- Rotary</p> <p>Pump Jack</p> <p>Rolling Mill</p> <p>Roots Blower</p> <p>Saw - Circular</p> <p>Screen - Vibrating</p> <p>Tumblers</p> |
| <p>Step 2 - Confirm the rated starting capability of the soft start against the application.</p> | <p>Trip Class</p> <p>Rated Starting Capability</p> <p>Max Starts per Hour with Optional Cooling Fan</p> | <p>Trip Class 10</p> <p>3x Motor Current - 23secs</p> <p>3.5x Motor Current - 17secs</p> <p>5 starts/hour</p> <p>40 starts/hour</p> | <p>Trip Class 20</p> <p>4x Motor Current - 19secs</p> <p>5 starts/hour</p> <p>40 starts/hour</p> | <p>Trip Class 30</p> <p>4x Motor Current - 29secs</p> <p>5 starts/hour</p> <p>40 starts/hour</p> |
| <p>Step 3 - Consider the operating environment and make the model selection on a higher amp rating.</p> | <p>Height Above Sea Level</p> <p>Operating Temperature</p> <p>Increased Starts per Hour</p> | <p>Standard operating height is 1000m, for every 100m increase motor Amps/kW by 1%, up to 2000m. Example: For a 20A motor at 1500m make model selection based on 21A (5% higher)</p> <p>Standard operating temperature is 40degC, for every 1degC above, increase motor Amps/kW by 2%, up to 60degC. Example: For a 20A motor at 50degC make model selection based on 24A (20% higher)</p> <p>Fit optional fan to increase maximum up to 40 starts per hour.</p> | | |

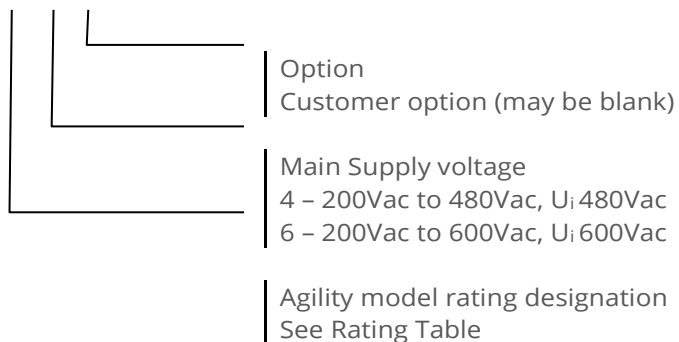
Sizing Guide (continued)



| Step 4 - Select your motor Voltage and Horsepower/kW and select model. | Motor Rating | | | | | | | | | | Select Model 5 starts/hour @ 40°C | Select Model 5 starts/hour @ 40°C | Select Model 5 starts/hour @ 40°C |
|--|---------------------|------|------|------|----------|------|------|----------|----------|----------|--------------------------------------|--------------------------------------|--------------------------------------|
| | I _e A | kW | | | FLA A | Hp | | | | | | | |
| | | 230V | 400V | 500V | | 200V | 208V | 220-240V | 440-480V | 550-600V | | | |
| 17 | 4 | 7.5 | 7.5 | 17 | 3 | 5 | 5 | 10 | 15 | | AGY-101 | AGY-103 | AGY-105 |
| 22 | 5.5 | 11 | 11 | 22 | 5 | 5 | 7.5 | 15 | 20 | | AGY-103 | AGY-105 | AGY-107 |
| 29 | 7.5 | 15 | 15 | 27 | 7.5 | 7.5 | 7.5 | 20 | 25 | | AGY-105 | AGY-107 | AGY-109 |
| 35 | 7.5 | 18.5 | 22 | 34 | 10 | 10 | 10 | 25 | 30 | | AGY-107 | AGY-109 | AGY-111 |
| 41 | 11 | 22 | 22 | 41 | 10 | 10 | 10 | 30 | 40 | | AGY-109 | AGY-111 | AGY-113 |
| 55 | 15 | 30 | 37 | 52 | 15 | 15 | 15 | 40 | 50 | | AGY-111 | AGY-113 | - |
| 66 | 18.5 | 37 | 45 | 65 | 20 | 20 | 20 | 50 | 60 | | AGY-113 | - | - |

Key to Part Numbers

AGY-101-6-XX



Electric current, Danger to life!

Only skilled or instructed persons may carry out the operations.

Lebensgefahr durch Strom!

Nur Elektrofachkräfte und elektrotechnisch unterwiesene Personen dürfen die im Folgenden beschriebenen Arbeiten ausführen.

Tension électrique dangereuse!

Seules les personnes qualifiées et averties doivent exécuter les travaux ci-après.

¡Corriente eléctrica! ¡Peligro de muerte!

El trabajo a continuación descrito debe ser realizado por personas cualificadas y advertidas.

Tensione elettrica: Pericolo di morte!

Solo persone abilitate e qualificate possono eseguire le operazioni di seguito riportate.

触电危险!

只允许专业人员和受过专业训练的人员进行下列工作。

Электрический ток! Опасно для жизни!

Только специалисты или проинструктированные лица могут выполнять следующие операции.

Levensgevaar door elektrische stroom!

Uitsluitend deskundigen in elektriciteit en elektrotechnisch geïnstrueerde personen is het toegestaan, de navolgend beschreven werkzaamheden uit te voeren.

Livsfare på grund af elektrisk strøm!

Kun uddannede el-installatører og personer der er instruerede i elektrotekniske arbejdsopgaver, må udføre de nedenfor anførte arbejder.

Προσοχή, κίνδυνος ηλεκτροπληξίας!

Οι εργασίες που αναφέρονται στη συνέχεια θα πρέπει να εκτελούνται μόνο από ηλεκτρολόγους και ηλεκτροτεχνίτες.

Perigo de vida devido a corrente eléctrica!

Apenas electricistas e pessoas com formação electrotécnica podem executar os trabalhos que a seguir se descrevem.

Livsfara genom elektrisk ström!

Endast utbildade elektriker och personer som undervisats i elektroteknik får utföra de arbeten som beskrivs nedan.

Hengenvaarallinen jännite!

Vain pätevät sähköasentajat ja opastusta saaneet henkilöt saavat suorittaa seuraavat työt.

Nebezpečí úrazu elektrickým proudem!

Niže uvedené práce směji provádět pouze osoby s elektrotechnickým vzděláním.

Eluhtlik! Elektrilöögiolt!

Järgnevalt kirjeldatud töid tohib teostada ainult elektriala spetsialist või elektrotehnilise instrueerimise läbinud personal.

Életveszély az elektromos áram révén!

Csak elektromos szakemberek és elektrotechnikában képzett személyek végezhetik el a következőkben leírt munkákat.

Elektriskā strāva apdraud dzīvību!

Tālāk aprakstītos darbus drīkst veikt tikai elektrospeciālisti un darbam ar elektrotehnikām iekārtām instruētās personas!

Porażenie prądem elektrycznym stanowi zagrożenie dla życia!

Opisane poniżej prace mogą przeprowadzać tylko wykwalifikowani elektrycy oraz osoby odpowiednio poinstruowane w zakresie elektrotechniki.

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Pavojus gvybei dėl elektros srovės!

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Življenjska nevarnost zaradi električnega toka!

Spodaj opisana dela smejo izvajati samo elektrostrokovnjaki in elektrotehnično poučene osebe.

Nebezpečnost ohrozenia života elektrickým prúdom!

Práce, ktoré sú nižšie opísané, smú vykonávať iba elektroodborníci a osoby s elektrotechnickým vzdelaním.

Опасност за живота от электрически ток!

Операциите, описани в следващите раздели, могат да се извършват само от специалисти-електротехници и инструктиран електротехнически персонал.

Atenție! Pericol electric!

Toate lucrările descrise trebuie efectuate numai de personal de specialitate calificat și de persoane cu cunoștințe profunde în electrotehnică.

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