# MAC112 / DPC120
# Profibus DP Actuator Controller
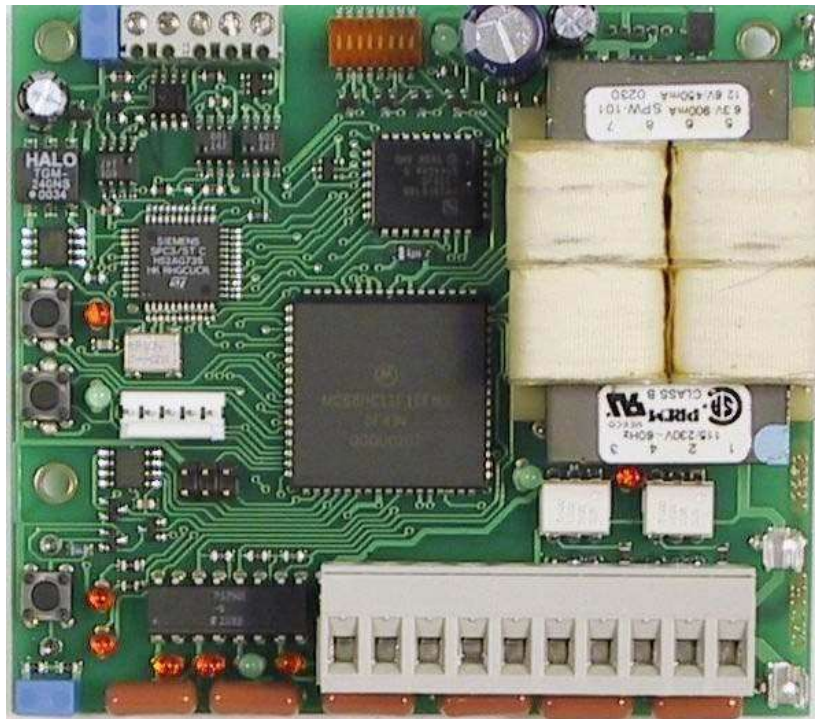
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# 1. Overview

The mAC112 / DPC120 actuator controllers is designed for use with a broad range of actuators. The Controller can position any device with either a rotary or linear movement that can be monitored with a potentiometer or optical encoder and is controlled with a simple open and close mechanism.

Electric, hydraulic and pneumatic actuators are supported. The Controller can directly drive 120VAC devices with current of up to 4 amps. Inputs are provided for full open and full close limits. The position transducer can be a potentiometer or a quadrature optical encoder. The internal Analog to Digital (A-D) converter has 12 bit resolution allowing for position accuracy's of up to 0.1%.

The controller is a fully compliant Profibus DP Slave. It is certified by the PTO under certificate Z00522. The current device GSD file is CMC_088E.GSD, Release date: December 29, 2004. The release information is contained in the file header.

Two models are available. The mAC112 is designed for DIN rail mounting in a control enclosure. The DPC120 is bracket mounted for use inside RCS and Andco electric actuators.

# 2. Description of Terminals, Operators and Indicators

## 2.1 MAC112 / DPC120 Actuator Controller
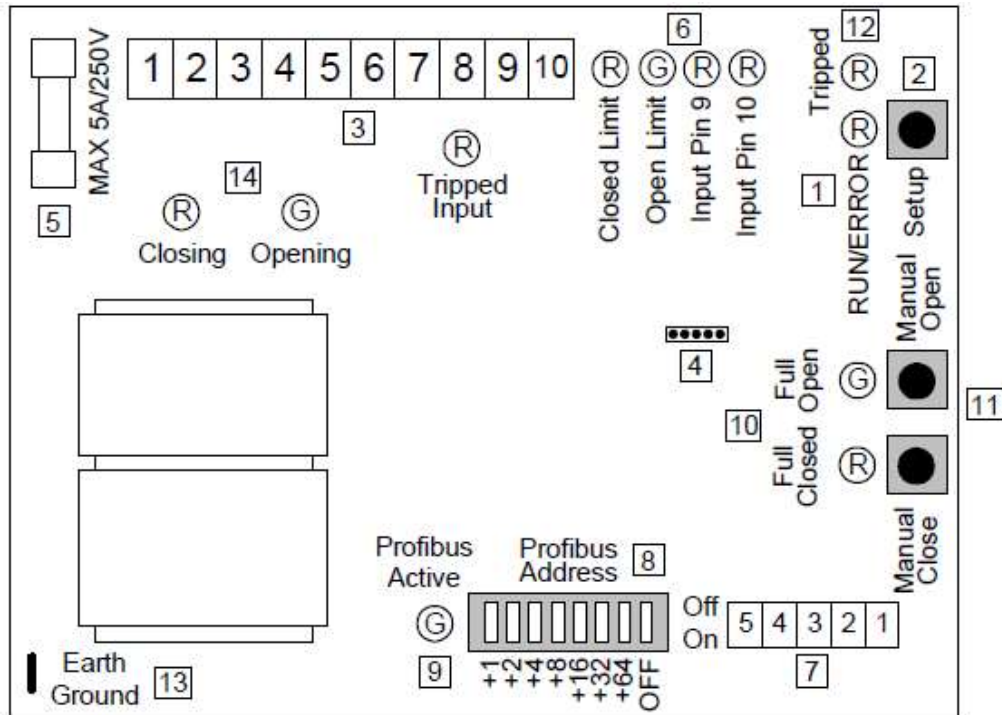


*Figure 1 - Terminals, Operators and Indicators*

| ID | Label | Description |
|----|-------|-------------|
| 1 | RUN/ERROR | 1 / sec - Controller operating normally<br>3 / sec - Calibration in progress<br>10 / sec - Controller in fault |
| 2 | SETUP | Pressing while running starts a self calibration cycle<br>Pressed during power-up reloads factory default values<br>Pressed when in manual operation returns controller to remote operation |
| 3 | AC TERMINALS | AC Field wiring. See "AC Wiring" section. |
| 4 | POT/OPTO | Connect potentiometer or quadrature optical encoder to these terminals. See "Position Translator" section. |
| 5 | FUSE HOLDER | Size fuse to load, maximum fuse 5A / 250VAC |
| 6 | INPUT STATUS LAMPS | Open, close and general purpose input status lamps. Lamp is on when 120VAC input voltage is applied to input terminal |

| 7 | PROFIBUS TERMINALS | Profibus network connections, see "Profibus Communications" section. |
|---|---|---|
| 8 | PROFIBUS ADDRESS | Controller address selector, add values assigned to "on" switches to determine controller address |
| 9 | PROFIBUS ACTIVE | Profibus master is connected and active |
| 10 | INPUT STATUS | Fully open and closed limit switch lamps. In auto operation these lamps indicate when the gate is fully open or fully closed. In manual operation the lamps flash indicating manual operation. |
| 11 | MANUAL OPERATORS | Push button open and closed manual operators. If either button is pressed, the controller will no longer respond to remote commands. The actuator will open while the OPEN pushbutton is pressed and CLOSE while the CLOSED pushbutton is pressed. Limit switches remain active and will stop rotation active. To terminate manual operation, press the setup push button momentarily. |
| 12 | TRIPPED INDICATOR | Indicates that the tripped input has been energized. Actuator movement is stopped. |
| 13 | EARTH GROUND | Earth ground connection using ¼" spade terminal. |
| 14 | OUTPUT INDICATORS | Indicators for the controller outputs. |

# 3. External Connections

## 3.1 AC Wiring
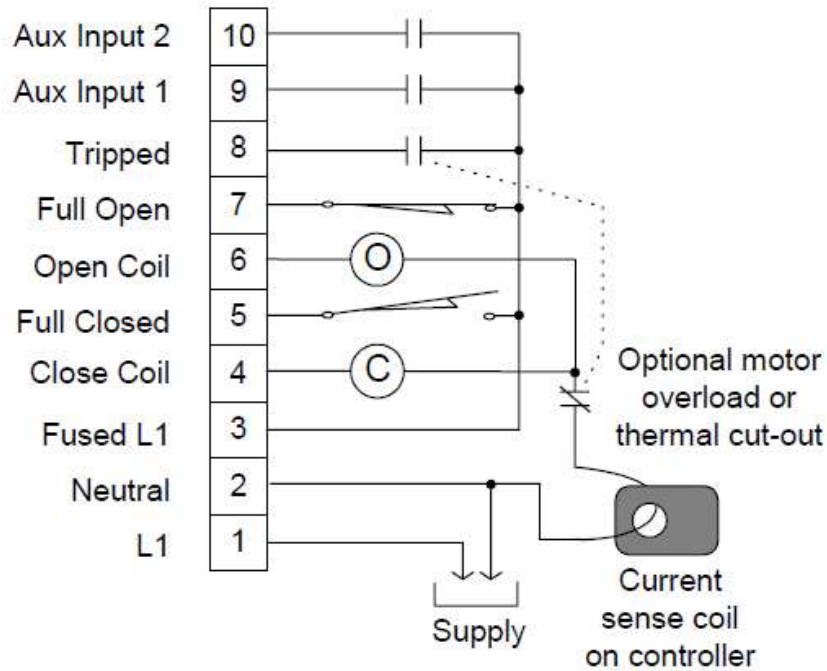


*Figure 2 - AC Wiring*

All AC wiring is connected to the 10 pin terminal strip. All inputs and outputs are 120VAC. The following is a description of each terminal strip connection:

| Terminal | Description |
|---|---|
| 1 | AC supply L1 |
| 2 | AC supply neutral |
| 3 | Fused control power |
| 4 | Close output to motor or contactor |
| 5 | Closed limit switch input, switch opens when actuator is fully closed |
| 6 | Open output to motor or contactor |
| 7 | Open limit switch input, switch opens when actuator is fully open |
| 8 | Tripped input, when energized indicates the motor thermal or contactor overload has tripped and all movement should stop |
| 9 | Auxiliary input 1, general purpose use |
| 10 | Auxiliary input 2, general purpose use |

An earth ground spade terminal is provided. This terminal should be connected to earth ground.

## 3.2 Position Translator

Connect either a potentiometer or an optical encoder as described in Figure 5.  When used with an optical encoder, a fully closed limit switch is required to provide a zero reference point.
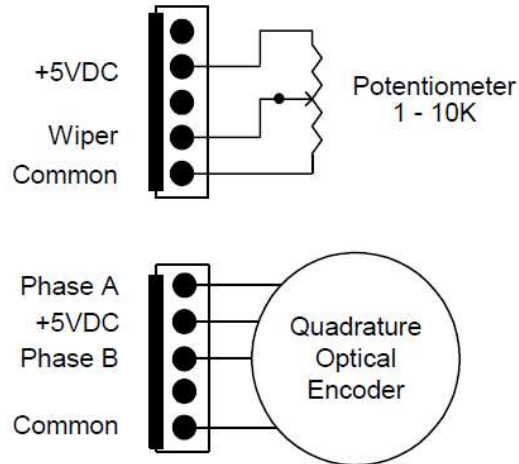


*Figure 3 - Position Translator Connections*

NOTES:

1.  The wiper of the potentiometer should move away from the common terminal as the actuator opens

2.  A-D converter accuracy is 1 in 4096, use 2 A-D divisions for each division of required accuracy

3.  Use shielded cable if distance exceeds 3 feet or if excessive electrical noise is present

4.  A closed limit switch is required with optical encoders

5.  Encoder output frequency must not exceed 1000 Hz

6.  Encoder outputs must be active or have pull-up resistors

7.  Allow twice as many encoder counts as the required position accuracy

## 3.3 Profibus Communications

The controller is a fully compliant Profibus DP slave device. Connection is by the 5 position terminal strip. The optional mTB003 Field Wiring Interconnect allows the separate termination of the in and outbound cables. Switches are provided to allow the disconnection of connected controller as well the ending and termination of the bus at this controller. It is recommended that the mTB003 be used for Profibus termination.
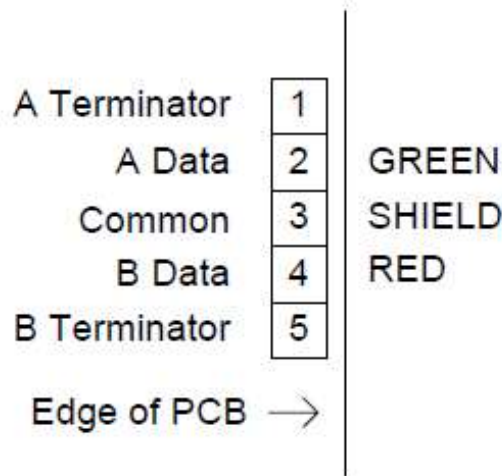


Figure 4 - Profibus Connections

The mTB003 includes a shield grounding kit. The connection of the shields to ground at each controller is optional. All shields should be connected in the same way. If grounding is selected, all shields should be grounded at each controller. If an ungrounded shield system is selected, the shield should only be connected to ground at one end of the cable.
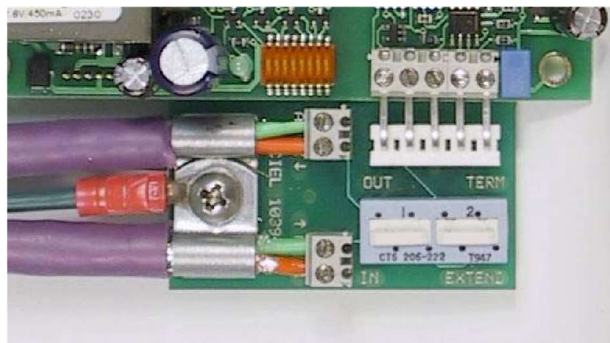


Figure 5 - mTB003 Connections

Set the Profibus address by turning on the switches whose sum equals the required address.
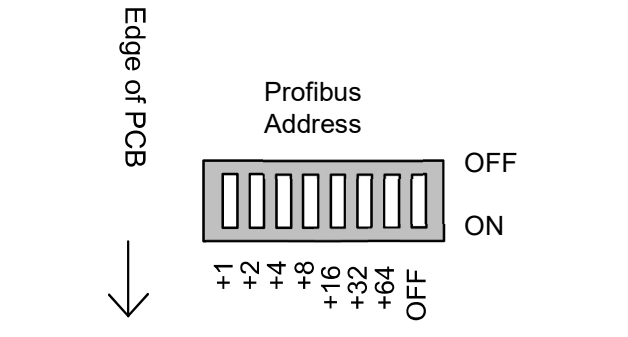
Figure 6 - Profibus Address

Power must be cycled after address selection.

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Engineering\documents\products\IOM\IOM08077.docx

# 4. Controller Parameters

The operation and accuracy of the controller is determined by user configurable parameters. This section describes each of these parameters and the effect they have on the operation of the controller.

Controller parameters on a Profibus system are set during the network configuration procedure. The GSD file provides the configuration software with a description of each of the controller's parameters. Before setting up and configuring your Profibus network determine which of the controller parameters requires setting. Then during network setup, use the network configuration tool to set the required parameters.

The advantage to a Profibus network is that if a controller is replaced on the network, the required operating parameters are automatically transferred to the controller each time the controller goes online.

Some parameters are automatically set during calibration. These parameters have their preset value in the GSD file set to 65535 (0xFFFF) or 255 (0xFF). This value indicates to the controller, that it is to ignore the the parameter value from the Profibus Master and use the value determined during the calibration procedure.

These default calibration values can be changed, however the controller will no longer retain its automatic calibration values. Further discussion of this issue is included in the "Calibration" section of this manual.

Some parameters are arrays of bit flags. The configuration software will automatically select the correct bits based on Yes/No configuration settings.

## *4.1 Reloading Factory Default Values*

There are two methods to restore the controller's parameters to the factory default values.

### 4.1.1 Using the SETUP Push Button

Pressing and holding the SETUP push button during a power-up sequence will restore factory default values. The RUN/ERROR indicator will flash at a 10/sec rate when the parameters have been reloaded. Power should be cycled after a factory reload procedure. Note that these values will be overwritten the next time the controller comes online through the Profibus network.

## 4.1.2 The Default Values

The default values are overwritten whenever the controller is connected to the Profibus Master. Once connected, the master's parameters are saved in non-volatile memory in the controller and become the operating parameters. See Appendix 1 – GSD Files for further details. The default values described in the parameter descriptions are the defaults from the latest GSD file.

The following factory values will be loaded and remain in effect until a Profibus connection is established:

| PARAMETER | VALUE |
|---|---|
| Zero offset | 0 |
| Span factor | 101 |
| Open setback | 0 |
| Close setback | 0 |
| Seek tolerance | 1 |
| Full scale value | 100 |
| Maximum load current | 200 |
| Idle load current | 5 |
| Jog movement tolerance | 1 |
| Load zero offset | 300 |
| Load span factor | 2038 |
| Profibus failed position | 0 |
| Update time | 1 |
| Turn around time | 10 |
| Command failed time | 120 * |
| Jog wait time | 10 |
| Jog on time | 5 |
| Current calc time | 4 |
| Over current delay | 5 |
| Idle current delay | 10 |
| Minimum jog on time | 1 |
| Maximum jog on time | 5 ** |
| Profibus fault time | 10 |
| Seek options | 125 |
| Encoder options | 0 |

* This parameter was 20 for software versions 1.02 and earlier
** This parameter was 50 for software versions 1.02 and earlier

## 4.2 Profibus Parameters

### 4.2.1 Profibus failed position

In the event of a communication interruption, the controller can be programmed to go to a preset position. The value set by this parameter determines the position set. The default value is 0.

### 4.2.2 Profibus fault time

If a communications interruption should occur the controller will wait the time specified in this parameter before setting the position to the Profibus failed position. Setting this value to 0 disables this function. The default value is 10, for 10 seconds.

### 4.2.3 Extended diagnostic on

Profibus has an extended diagnostic system. This system allows the immediate notification of the master station on a slave fault. Each master handles extended diagnostic messages in a unique manner. Contact the master station vendor for information on processing extended diagnostic messages on your master station. This flag allows the disabling of extended diagnostic messages for controllers that cannot manage them. If your master station can use extended diagnostics it is recommended that this feature be enabled. The default is Yes, extended diagnostic on.

## 4.3 Position Translator

### 4.3.1 Input source selection

The position input source can be either a potentiometer or optical encoder.  When using an optical encoder, a fully closed limit switch must be supplied. The controller uses this limit switch to determine the actuator fully closed position.  Each time an operation completes, the closed limit switch is monitored. Upon expiry of the turnaround timer, the position is set to 0 if the closed limit switch is detected. The following options are available:

| Option | Description |
|---|---|
| Optical encoder used? | Set to Yes for encoder, No for potentiometer. If an encoder is used, limit switches are required. (Default is no, potentiometer used) |
| No position input used? | Set to Yes for simple open/close actuators that do not have a position potentiometer or encoder. Limit switches must be provided if no encoder is used. The zero closes to limit and full scale opens to limit options must selected for this option to operate properly. No calibration procedure is required if this option is selected. (Default is no, position input used) |

## *4.4 The Force Close/Open System*

The controller can be set to automatically force the actuator to full open or full closed regardless of the position input from the potentiometer or encoder. The following are the available options:

| Option | Description |
| --- | --- |
| Zero closes to limit? | When the position input from the Master is set to 0, the controller will drive the close output until the fully closed limit switch is reached. (Default is Yes, force closed) |
| Full scale opens to limit? | When the position input from the Master is set to full scale, the controller will drive the open output until the fully open limit switch is reached. (Default is Yes, force open) |
| Force causes fault? | When a force to position operation is in progress and the command does not complete in the "Command failed time" the controller will declare a "Position Fault". (Default is Yes, declare fault) |
| Force fault stops motor? | When a force to position operation is in progress and the command does not complete in the "Command failed time" the controller will stop the motor output. (Default is Yes, stop the motor) |
| Force close on powerup? | During a powerup sequence, run the actuator closed until the fully closed limit switch is reached. This option is required for optical encoder systems to determine the zero starting point. (Default is No, no force close on powerup) |

## *4.5 Positioning Accuracy*

The following parameters determine the accuracy of the final position achieved by the controller.  These parameters should be configured before an automatic calibration sequence is initiated.

The controller uses a two step process to position the actuator.  The first step runs the actuator until the position reaches the requested position less a setback tolerance.  If jogging is disabled, the operation completes at step 1 with the actuator at the current position.  If jogging is enabled, step 2 uses a series of timed pulses to achieve the final position of the actuator.

### 4.5.1 Turn clockwise to open

The controller operating direction can be changed without rewiring the controller. Normally the controller is wired to turn counter-clockwise to open as viewed from above the actuator. By setting this parameter to yes, the direction and all related inputs and outputs will be reversed and the actuator will turn clockwise to open. The default is No, turn counter-clockwise to open.

**NOTE:** Should be set to Yes on actuators mounted to gearboxes if the potentiometer gearing is attached to the indicator shaft that turns opposite the actuator output drive.

### 4.5.2 Full scale value

The full scale value determines the number of divisions displayed for a fully open actuator.  The controller can be setup to use any units for full scale (i.e. inches, millimeters, etc.)  For the purpose of this manual the controller is configured using % of full scale.

The controllers A-D converter delivers up to 4096 counts at full scale.  The number of counts available in any specific application using a potentiometer is [4096 X (% of potentiometer used / 100)].

When using an encoder, the number of input counts available is [encoder pulses per turn X number of turns].  Maximum counts remains 4096 for the encoder.  At least 2 input counts are required for each full scale division.  The default value is 100 for 1% accuracy.

### 4.5.3 Jogging is on

The controller can use jogging to achieve higher accuracy.  Jogging uses precisely timed pulses to move the actuator.  During calibration, the controller determines if jogging is required to achieve the selected accuracy.  If required, jogging is automatically enabled and calibrated.  The default is Yes, jogging enabled.

### 4.5.4 Seek tolerance

This parameter determines the position accuracy when jogging is enabled.  The controller will continue to jog the actuator until the difference between the current position and the requested position is less than or equal to this value.  The default value is 1.

### 4.5.5 Jog on time

This parameter specifies the jog on time to be used after a power-up sequence.  The controller moves the value from this parameter to an internal working variable during the power-up sequence.  The controller automatically modifies the internal working variable after each jog sequence to ensure high accuracy movements. The default value is 255, which retains the controller's calibration value.

### 4.5.6 Jog wait time

After each jog, the controller waits for this time interval before calculating how far the actuator has moved.  This time should be set to a value longer than the settle time of the actuator.  This parameter must be longer than or equal to the Turn around time parameter.  The default value is 10 for 1.0 second.

### 4.5.7 Minimum jog on time

After each jog the controller adjusts the jog on time.  This value is the shortest jog on time the controller will allow.  The actuator should just not move when a pulse of this time is applied.  The default value is 1 for 0.025 seconds.

### 4.5.8 Maximum jog on time

After each jog the controller adjusts the jog on time.  This value is the longest jog on time the controller will allow.  The actuator should move more than one division when a pulse of this time is applied.  The default value is 5 for 0.125 seconds.

### 4.5.9 Continuous seek on

The controller will terminate a seek operation after the requested position is attained.  Some actuators (i.e. Hydraulic) can drift from the selected position over time.  Enabling this option will cause the controller to continuously monitor the position.  If the actuator drifts from the current seek position, a new seek operation is initiated.  The new seek will only utilize the jogging function to position the actuator. The default value is No, continuous seek off.

## *4.6 Calibration Parameters*

The controller can perform an automatic calibration sequence.  This sequence automatically sets the controller's calibration parameters.  See **Calibration** for details on initiating a calibration sequence.

### 4.6.1 Zero offset

During calibration, the actuator is run in the close direction until no further motion is detected.  The raw position value is captured as the zero offset.  This offset is subtracted from the raw position value in the position calculations. The default value is 65535, which retains the controller's calibration value.

### 4.6.2 Span factor

During calibration, the actuator is run in the open direction until no further motion is detected.  The raw position value is captured and used to calculate the span.  The calculations used are detailed in **Appendix 1 - Positioning System Calculations**.  The default value is 65535, which retains the controller's calibration value.

### 4.6.3 Open Setback

During calibration, the actuator is run in the open direction to 75% open.  The amount of over travel is calculated.  This amount is subtracted from the position to be attained on a open operation.  The default value is 65535, which retains the controller's calibration value.

### 4.6.4 Close Setback

During calibration, the actuator is run in the close direction to 25% open.  The amount of over travel is calculated.  This amount is subtracted from the position to be attained on a close operation.  The default value is 65535, which retains the controller's calibration value.

## 4.7 Timing

The controller uses a series of timers during a positioning operation.

### 4.7.1 Turn around time

Most actuators require a delay between open and close operations.  The turnaround timer forces a delay between all operations.  Anytime an output is turned off, both outputs will remain off until this timer has expired.  When jogging is enabled this time must be less than or equal to the Jog wait time or no jogging will occur.  The default value is 10 for 1.0 second.

### 4.7.2 Command failed time

Each time a motion command is executed this timer is reset.  The command will continue until this timer expires, at which point the command will stop and an error will be indicated.   Setting this parameter to 0 disables command faults.  The value should be set to 1.5 times the maximum actuator run time for a 100% move. The default value is 120 for 120 seconds.

### 4.7.3 Update time

The controller will process new A-D or encoder values at intervals set by this timer.  The default value is 1 for 8.33 milliseconds.

## 4.8 The Load Monitoring System

The controller continuously monitors the current flowing through the output terminals.  The load monitor can be used to disable the outputs should the output current exceed a preset value during an actuator movement.  Additionally the current measured while the controller is idle can be used to set an alarm should the current exceed a preset value.  The average load current for the last movement and the idle load current can be read from the controller).

### 4.8.1 Maximum running load

During an actuator movement, the controller calculates the continuous average current for the movement.  If the average running load current exceeds this value, the over current delay timer will be started.  If the load remains over the maximum allowed for the duration of the timer, the actuator is stopped and the overload fault bit is set in the status register.  The default value is 500 for 5.00A.

### 4.8.2 Maximum idle load

While the controller is idle, with no outputs active, the idle load current is measured.  If the idle load current exceeds this value, the idle current delay timer will be started.  If the load remains over the maximum allowed for the duration of the timer, the idle load fault bit is set in the status register.  The default value is 5 for 0.05A.

### 4.8.3 Over current delay

During an actuator movement, the controller calculates the continuous average current for the movement. If the maximum running load current is exceeded, the over current delay timer will be started. If the load remains over the maximum allowed for this time duration, the actuator is stopped and the overload fault bit is set in the status register. A time of 0 disables the over current fault. The default value is 0, for over current monitoring disabled.

### 4.8.4 Idle current delay

While the controller is idle, with no outputs active, the idle load current is measured. If the idle load current exceeds the maximum idle load, the idle current delay timer will be started. If the load remains over the maximum allowed for this time duration, the idle load fault bit is set in the status register. A time of 0 disables maximum idle load fault. The default value is 0, for idle current monitoring disabled.

### 4.8.5 Current calc time

The load current monitoring system reads the load at intervals set by this timer. The load monitor utilizes a peak detector that is reset after each measurement. This timer should be set to record the peak current for at least 4 cycles of the AC line. The default value is 4 for 8.33 millisecond. **4.8.6 Load offset**

During the load calculations this value is used to remove any zero offsets from the detector. This value is automatically determined during a calibration sequence. The default value is 65535, for use controller calibration value.

### 4.8.7 Load span

During the load calculations this value is used to convert the raw peak detector output to load current in amps. See **Appendix 3 - The Load Current Monitoring System Calculations** for details on how the load current is calculated. The default value is 2038.

## *4.9 Unused Parameters*

The GSD file for this controller is shared with the DC version of the controller. There are 2 parameters in the GSD file used only by the DC controller. Adjusting these parameters will not affect the operation of the AC controller. The parameters are "Dynamic brake force" and "Dynamic break time".

# 5. Calibration

## 5.1 Initiating an Automatic Calibration

The mAC185 Actuator Controller has an automatic calibration system.  The calibration sequence can be run with or without a Profibus connection. Calibration is only required for actuators with position feedback. Simple open/close actuators will not complete a calibration cycle and should not be calibrated. To initiate the calibration sequence:

> Press and hold the **Setup** push button.  After 2 seconds, the Run/Error indicator will begin flashing at a 3 per second rate.  Release the push button and the calibration sequence will begin.  To stop the calibration cycle, press the Setup button again for 1 second.

The calibration sequence can also be issued over the Profibus network. To start the calibration issue a command 11 (0BH) with the setpoint set to 11 (0BH). To stop the calibration issue a command 4 with the setpont set to 4. A command 21 (15H), setpoint 0, should be issued immediately after each motion command. Commands are only recognized on change. The controller saves the calculated calibration parameters at the end of the calibration cycle.  Aborting a calibration sequence will return the controller to the previous calibration.  The calibration sequence is as follows:

1. Capture current monitor load offset
2. Open the actuator for 2 seconds
3. Close the actuator and capture zero offset
4. Open the actuator fully and capture span
5. Close the actuator to 25% and calculate close offset
6. Open the actuator to 75% and calculate open offset
7. Jog the actuator if enabled and determine jog on time
8. Save all parameters to EEPROM
9. Close the actuator and exit calibration

The parameters modified by a calibration sequence are detailed in **Controller Parameters - Calibration Parameters**.

# 6. Controller Commands

There are 3 read and 2 write words in the controller. The addresses of these words are determined during the Profibus setup by the master station.  Each of the registers is a single 16bit word. The read/write references refer to operations by the master station. The register layout is as follows:

| Register | Description | Type |
|---|---|---|
| 0 | Command word | Read |
| 1 | Process value | Read |
| 2 | Status word | Read |
| 0 | Command word | Write |
| 1 | Set-point | Write |

********************************************* Caution *****************************************************

PLC's from different manufacturers process the data from Profibus I/O differently. Depending on the PLC, the byte order in the registers can be reversed. The mAC112/DPC120 is big endian and places the high byte of the register in the even I/O byte and the low byte of the register in the odd I/O byte. Most PLC's offer a byte swap instruction that can be used to correct the register byte order.

*************************************************************************************************************

Commands are executed by writing a word to the command word. There are 2 classes of commands; operation commands and value read commands. The following is a table of the operation commands:

| Decimal | Hex | Command | Set-point | Process value | Units | Range |
|---|---|---|---|---|---|---|
| 1 | 1 | Seek to Position | Seek position | Current position | % | 0-FS |
| 2 | 2 | Open Actuator Fully | 2 | Current position | n/a | 2 |
| 3 | 3 | Close Actuator Fully | 3 | Current position | n/a | 3 |
| 4 | 4 | Stop Current Operation | 4 | Current position | n/a | 4 |
| 11 | B | Start a Calibration | 11 (0BH) | Current position | n/a | 11 |

The following is the recommended sequence for issuing a seek to position command:

1. Set the command to 21 (15H), setpoint to 0 (should be the default state);
2. Set the set-point to the required value, command to 1 (01H);
3. Return the command to 21 (15H), setpoint to 0.

The controller will return the current position of the actuator in the process value word. For software revisions 1.02 and earlier, if the command is left set to 1 (01H), any change in the setpoint will immediately cause a move.  The controller will not restart a failed move unless the setpoint is changed.  For software revision 1.03, the controller will start a new move each time a move command is issued without a change in setpoint. However, the command word must be toggled to another command before a command can be repeated.

In the event of a Profibus communications loss, the controller will position the actuator to the setpoint determined by the settings in the master's parameters, after the requested delay. This function can be disabled if the delay is set to 0. When communications resumes, the master will immediately write the contents of its I/O map to the field devices. Should the I/O map contain a seek to position command when communications resumes, the command will be immediately executed.

The following is a table of the value read commands:

| Decimal | Hex | Command | Set-point | Process value | Units | Range |
|---|---|---|---|---|---|---|
| 21 | 15 | Read Current Position | Always 0 | Current Position | % | 0-FS |
| 22 | 16 | Read Average Load | Always 0 | Average load current | 0.00 A | 0-9.99 |
| 23 | 17 | Read Peak Load | Always 0 | Peak load current | 0.00 A | 0-9.99 |
| 24 | 18 | Read Idle Load | Always 0 | Idle load current | 0.00 A | 0-9.99 |
| 25 | 19 | Read Raw Position | Always 0 | The raw position | Counts | 0-4095 |
| 26 | 1A | Read Raw Load | Always 0 | The raw load current | Counts | 0-4095 |
| 27 | 1B | Read Seek Value | Always 0 | Current seek position | % | 0-FS |
| 28 | 1C | Read Jog On Time | Always 0 | Jog on time | 25 ms | 0-255 |
| 29 | 1D | Read Software Revision | Always 0 | Software revision | 0.00 | n/a |

These commands allow the retrieval of the internal operating registers of the controller and are useful for diagnostic functions. Issuing a Read Current Position command 21 (15H) will not reset the bad command diagnostic bit. Any other valid command will reset this bit. This is provided to ensure that the master is informed of the bad command even if Read Current Position is reselected.

The following table describes the bits in the status word:

| Bit | Description |
|---|---|
| 0 | 1 = at closed limit switch (switch not energized) |
| 1 | 1 = at open limit switch (switch not energized) |
| 2 | 1 = auxiliary limit 1 energized |
| 3 | 1 = auxiliary limit 2 energized |
| 4 | 1 = seek in progress |
| 5 | 1 = motor running |
| 6 | 1 = direction is closed |
| 7 | 1 = in manual operation |
| 8 | 1 = failed to reach position |
| 9 | 1 = motor over current |
| 10 | 1 = current to high when idle |
| 11 | 1 = saved parameter table corrupted |
| 12 | 1 = system firmware corrupted |
| 13 | 1 = last command received invalid |
| 14 | 1 = in calibration |
| 15 | 1 = motor too hot |

The following table describes the diagnostic bits returned if extended diagnostics is enabled:

| Bit | Description |
|---|---|
| 0 | Failed to reach position |
| 1 | Motor over current |
| 2 | Idle current too high |
| 3 | Setup parameter fault |
| 4 | Controller firmware bad |
| 5 | Last command invalid |
| 6 | In calibration |
| 7 | Motor too hot or tripped |

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# 7. Specifications

| Description | Characteristic |
|---|---|
| **Actuator** | |
| Voltage | 120VAC 1∅ |
| Current | 5A (2 minute 25% duty-cycle) |
| Fuse | GMA 5 replaceable |
| **Communication** | |
| Standard | Profibus DP |
| **Position** | |
| Resolution | 12 bit (1 part in 4096) |
| Accuracy | 0.1% full scale |
| Potentiometer | 1000Ω typical (500 to 10kΩ) |
| Quadrature Optical Encoder | 1000 to 4000 pulses |
| **Environment** | |
| Temperature | -40 to 70C (-40 to 158°F) |
| Relative Humidity | 0 to 95% non-condensing |

# Appendix 1 – GSD Files

All Profibus slave devices are setup using standard Profibus Configuration Tools that are supplied by the manufacturer of the Profibus master.  These tools utilize a set of files called GSD files to provide the parameter table information for the configuration tool. The GSD file provides a list of parameters, their default settings and ranges. The GSD file is a simple text file that can be edited by the user to make the task of configuring multiple copies of a device easier. Many of the configuration tools allow for the copying of a fully parameterized slave to a second address also reducing the setup time.

The current controller GSD file is:

 CMC_088E.GSD, Release date: December 29, 2004

The file release date is contained in the file header. Confirm the file release date before using the GSD file. The Profibus Trade Organization provided the file designator at the time of certification. The current GSD file can be used with any version of the controller firmware.  A copy of the current file is included in this appendix.

 A second GSD file, cmc0088e.gsd, was produced at the same time. This file is a simplified version of the GSD file for masters that do not support the parameter setup functions. This file is not recommended for new installations.

Certain parameters are set by the controller during calibration and are not normally overwritten by the Profibus Master. These files have the GSD default set to the maximum value of 65535 for word values and 255 for byte values. Changing these defaults will overwrite the calibration values and is not recommended.

The new GSD file, CMC_088E.GSD, was published on December 29, 2004. The new file modifies the default values as shown in the tables below. These changes were made to update the GSD file to the defaults most commonly used in the field.  The units' entries were also corrected as shown, to reflect the correct increments.

| Parameter | GSD Entry | Actual Value | Units |
|---|---|---|---|
| Zero offset | 65535 | No change | a-d counts |
| Span factor | 65535 | No change | n/a |
| Open setback | 65535 | No change | % FS |
| Close setback | 65535 | No change | % FS |
| Seek tolerance * | 1 | 0 % | % FS |
| Full scale value | 100 | 100 % | % FS |
| Maximum load current * | 500 | 5.00 A | 0.00 A |
| Idle load current | 5 | 0.05 A | 0.00 A |
| Jog movement tolerance | 1 | 1 % | % FS |
| Load zero offset | 65535 | No change | a-d counts |
| Load span factor | 2038 | 2038 | n/a |
| Profibus failed position | 0 | 0 % | % FS |
| Update time | 1 | 8.33 msec | 8.33 msec |
| Turn around time | 10 | 1.0 sec | 0.1 sec |
| Command failed time * | 120 | 120 sec | 1 sec |
| Jog wait time | 10 | 1.0 sec | 0.1 sec |
| Jog on time | 255 | No change | 0.025 sec |
| Current calc time | 4 | 8.32 msec | 2.08 msec |
| Over current delay * | 0 | Disabled | 0.1 sec * |
| Idle current delay * | 0 | Disabled | 1 sec |
| Minimum jog on time | 1 | 0.025 sec | 0.025 sec |
| Maximum jog on time * | 5 | 0.125 sec | 0.025 sec |
| Profibus fault time | 10 | 10 sec | 1 sec |
| Dynamic break force | n/a | n/a | n/a |
| Dynamic brake time | n/a | n/a | n/a |
| Turn clockwise to open? | No | No | Yes/No |
| Continuous seek on? * | No | No | Yes/No |
| Jogging is on? | Yes | Yes | Yes/No |
| Zero closes to limit? | Yes | Yes | Yes/No |
| Full scale opens to limit? | Yes | Yes | Yes/No |
| Force causes fault? | Yes | Yes | Yes/No |
| Force fault stops motor? | Yes | Yes | Yes/No |
| Force close on powerup? | No | No | Yes/No |
| Optical encoder used? | No | No | Yes/No |
| No position input used? | No | No | Yes/No |
| Extended diagnostics on? * | Yes | Yes | Yes/No |

* Indicates parameters and units that were changed in this file version

**CMC_088E.GSD, December 29, 2004**

| Parameter | GSD Entry | Actual Value | Units |
|---|---|---|---|
| Zero offset | 65535 | No change | a-d counts |
| Span factor | 65535 | No change | n/a |
| Open setback | 65535 | No change | % FS |
| Close setback | 65535 | No change | % FS |
| Seek tolerance | 0 | 0 % | % FS |
| Full scale value | 100 | 100 % | % FS |
| Maximum load current | 200 | 2.00 A | 0.00 A |
| Idle load current | 5 | 0.05 A | 0.00 A |
| Jog movement tolerance | 1 | 1 % | % FS |
| Load zero offset | 65535 | No change | a-d counts |
| Load span factor | 2038 | 2038 | n/a |
| Profibus failed position | 0 | 0 % | % FS |
| Update time | 1 | 8.33 msec | 8.33 msec |
| Turn around time | 10 | 1.0 sec | 0.0 sec * |
| Command failed time | 20 | 20 sec | 1 sec |
| Jog wait time | 10 | 1.0 sec | 0.0 sec * |
| Jog on time | 255 | No change | 0.025 sec * |
| Current calc time | 4 | 8.32 msec | 2.08 msec |
| Over current delay | 5 | 5 sec | 1 sec |
| Idle current delay | 5 | 5 sec | 1 sec |
| Minimum jog on time | 1 | 0.025 sec | 0.025 sec * |
| Maximum jog on time | 50 | 1.25 sec | 0.025 sec * |
| Profibus fault time | 10 | 10 sec | 1 sec |
| Dynamic break force | n/a | n/a | n/a |
| Dynamic brake time | n/a | n/a | n/a |
| Turn clockwise to open? | No | No | Yes/No |
| Continuous seek on? | Yes | Yes | Yes/No |
| Jogging is on? | Yes | Yes | Yes/No |
| Zero closes to limit? | Yes | Yes | Yes/No |
| Full scale opens to limit? | Yes | Yes | Yes/No |
| Force causes fault? | Yes | Yes | Yes/No |
| Force fault stops motor? | Yes | Yes | Yes/No |
| Force close on powerup? | No | No | Yes/No |
| Optical encoder used? | No | No | Yes/No |
| No position input used? | No | No | Yes/No |
| Extended diagnostics on? | No | No | Yes/No |

* Indicates the correct units for this file version

**CMC_088E.GSD, July 29, 1999**

```
;
;
;=====================================================
; GSD-Data for CMCIEL mAC112 Actuator Controller ; Part No.:
; Release date: December 29, 2004
; CMC_088E.GSD  (PNO/PTO spec. GSD_REV 1 file)
;=====================================================
;
;
#Profibus_DP
;
; PrmText-Block:
PrmText=1
Text(0)="No"
Text(1)="Yes"
EndPrmText
;
; ExtUserPrmData-Block:
ExtUserPrmData=1 "Zero offset (cts)"
Unsigned16 65535 000-65535
EndExtUserPrmData
; ExtUserPrmData-Block:
ExtUserPrmData=2 "Span factor (cts)"
Unsigned16 65535 001-65535
EndExtUserPrmData
; ExtUserPrmData-Block:
ExtUserPrmData=3 "Open setback (%FS)"
Unsigned16 65535 000-65535
EndExtUserPrmData
; ExtUserPrmData-Block:
ExtUserPrmData=4 "Close setback (%FS)"
Unsigned16 65535 000-65535
EndExtUserPrmData
; ExtUserPrmData-Block:
ExtUserPrmData=5 "Seek tolerance (%)"
Unsigned16 1 000-4095
EndExtUserPrmData
; ExtUserPrmData-Block:
ExtUserPrmData=6 "Full scale (%)"
Unsigned16 100 001-4095
EndExtUserPrmData
; ExtUserPrmData-Block:
ExtUserPrmData=7 "Maximum running load (0.00A)"
Unsigned16 500 001-4095
EndExtUserPrmData
; ExtUserPrmData-Block:
ExtUserPrmData=8 "Maximum idle load (0.00A)"
Unsigned16 5 001-4095
EndExtUserPrmData
```

```
ExtUserPrmData=9 "One jog movement (%)"
Unsigned16 1 001-4095
EndExtUserPrmData
; ExtUserPrmData-Block:
ExtUserPrmData=10 "Load offset (cts)"
Unsigned16 65535 000-65535
EndExtUserPrmData
; ExtUserPrmData-Block:
ExtUserPrmData=11 "Load span (cts)"
Unsigned16 2038 001-4095
EndExtUserPrmData
; ExtUserPrmData-Block:
ExtUserPrmData=12 "Proibus failed position (%)"
Unsigned16 0 000-4095
EndExtUserPrmData
; ExtUserPrmData-Block:
ExtUserPrmData=13 "Update time (8.33ms)"
Unsigned8 1 001-255
EndExtUserPrmData
; ExtUserPrmData-Block:
ExtUserPrmData=14 "Turn around time (0.1s)"
Unsigned8 10 001-255
EndExtUserPrmData
; ExtUserPrmData-Block:
ExtUserPrmData=15 "Command failed time (s)"
Unsigned8 120 000-255
EndExtUserPrmData
; ExtUserPrmData-Block:
ExtUserPrmData=16 "Jog wait time (0.1s)"
Unsigned8 10 001-255
EndExtUserPrmData
; ExtUserPrmData-Block:
ExtUserPrmData=17 "Jog on time (0.025s)"
Unsigned8 255 001-255
EndExtUserPrmData
; ExtUserPrmData-Block:
ExtUserPrmData=18 "Current calc time (2.08ms)"
Unsigned8 4 001-255
EndExtUserPrmData
; ExtUserPrmData-Block:
ExtUserPrmData=19 "Over current delay (0.1s)"
Unsigned8 0 000-255
 EndExtUserPrmData
; ExtUserPrmData-Block:
ExtUserPrmData=20 "Idle current delay (s)"
Unsigned8 0 000-255
EndExtUserPrmData
```

; ExtUserPrmData-Block:
ExtUserPrmData=21 "Minimum jog on time (0.025s)"
Unsigned8 1 001-255
EndExtUserPrmData
; ExtUserPrmData-Block:
ExtUserPrmData=22 "Maximum jog on time (0.025s)"
Unsigned8 5 001-255
EndExtUserPrmData
; ExtUserPrmData-Block:
ExtUserPrmData=23 "Dynamic break force (20-80%)"
Unsigned8 40 020-080
EndExtUserPrmData
; ExtUserPrmData-Block:
ExtUserPrmData=24 "Dynamic break time (2.08ms)"
Unsigned8 20 000-255
EndExtUserPrmData
; ExtUserPrmData-Block:
ExtUserPrmData=25 "Profibus fault time (s)"
Unsigned8 10 000-255
EndExtUserPrmData
; ExtUserPrmData-Block:
ExtUserPrmData=26 "Turn clockwise to open?"
Bit(1) 0 0-1
Prm_Text_Ref=1
EndExtUserPrmData
; ExtUserPrmData-Block:
ExtUserPrmData=27 "Continuous seek on?"
Bit(0) 0 0-1
Prm_Text_Ref=1
EndExtUserPrmData
; ExtUserPrmData-Block:
ExtUserPrmData=28 "Jogging is on?"
Bit(3) 1 0-1
Prm_Text_Ref=1
EndExtUserPrmData
; ExtUserPrmData-Block:
ExtUserPrmData=29 "Zero closes to limit?"
Bit(2) 1 0-1
Prm_Text_Ref=1
EndExtUserPrmData
; ExtUserPrmData-Block:
ExtUserPrmData=30 "Full scale opens to limit?"
Bit(6) 1 0-1
Prm_Text_Ref=1
EndExtUserPrmData

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; ExtUserPrmData-Block:
ExtUserPrmData=31 "Force causes fault?"
Bit(4) 1 0-1
Prm_Text_Ref=1
EndExtUserPrmData
; ExtUserPrmData-Block:
ExtUserPrmData=32 "Force fault stops motor?"
Bit(5) 1 0-1
Prm_Text_Ref=1
EndExtUserPrmData
; ExtUserPrmData-Block:
ExtUserPrmData=33 "Force close on powerup?"
Bit(1) 0 0-1
Prm_Text_Ref=1
EndExtUserPrmData
; ExtUserPrmData-Block:
ExtUserPrmData=34 "Optical encoder used?"
Bit(0) 0 0-1
Prm_Text_Ref=1
EndExtUserPrmData
; ExtUserPrmData-Block:
ExtUserPrmData=35 "No position input used?"
Bit(2) 0 0-1
Prm_Text_Ref=1
EndExtUserPrmData
; ExtUserPrmData-Block:
ExtUserPrmData=36 "Extended Diagnostic on?"
Bit(3) 1 0-1
Prm_Text_Ref=1
EndExtUserPrmData

```
GSD_Revision = 1
;
Vendor_Name = "CMCIEL"
Model_Name = "mAC112"
Revision = "Rev_1.03"
Ident_Number = 0x088E
Protocol_Ident = 0
Station_Type = 0
FMS_supp = 0
Hardware_Release = "1.00"
Software_Release = "1.03"
9.6_supp = 1
19.2_supp = 1
45.45_supp = 1
93.75_supp = 1
187.5_supp = 1
500_supp = 1
1.5M_supp = 1
3M_supp = 1
6M_supp = 1
12M_supp = 0
MaxTsdr_9.6 = 60
MaxTsdr_19.2 = 60
MaxTsdr_45.45 = 60
MaxTsdr_93.75 = 60
MaxTsdr_187.5 = 60
MaxTsdr_500 = 100
MaxTsdr_1.5M = 150
MaxTsdr_3M = 250
MaxTsdr_6M = 450
MaxTsdr_12M = 800
Repeater_Ctrl_Sig = 0
24V_Pins = 0
Implementation_Type = "SPC3"
```

```
;
;--Slave Parameters--
;
Freeze_Mode_supp = 1
Sync_Mode_supp = 1
Auto_Baud_supp = 1
Set_Slave_Add_supp = 0
Min_Slave_Intervall = 5
;
Max_Diag_Data_Len = 8
;
Max_User_Prm_Data_Len = 40
Ext_User_Prm_Data_Const(0)=0x00,0xFF,0xFF,0xFF,0xFF,0xFF,0xFF,0xFF,0xFF,0x00,\
0x00,0x00,0x64,0x00,0xC8,0x00,0x05,0x00,0x01,0xFF,0xFF,0x07,0xF6,0x00,0x00,\
0x01,0x0A,0x14,0x0A,0xFF,0x04,0x05,0x0A,0x01,0x05,0x28,0x20,0x0A,0x3D,0x00
Ext_User_Prm_Data_Ref(1)=1
Ext_User_Prm_Data_Ref(3)=2
Ext_User_Prm_Data_Ref(5)=3
Ext_User_Prm_Data_Ref(7)=4
Ext_User_Prm_Data_Ref(9)=5
Ext_User_Prm_Data_Ref(11)=6
Ext_User_Prm_Data_Ref(13)=7
Ext_User_Prm_Data_Ref(15)=8
Ext_User_Prm_Data_Ref(17)=9
Ext_User_Prm_Data_Ref(19)=10
Ext_User_Prm_Data_Ref(21)=11
Ext_User_Prm_Data_Ref(23)=12
Ext_User_Prm_Data_Ref(25)=13
Ext_User_Prm_Data_Ref(26)=14
Ext_User_Prm_Data_Ref(27)=15
Ext_User_Prm_Data_Ref(28)=16
Ext_User_Prm_Data_Ref(29)=17
Ext_User_Prm_Data_Ref(30)=18
Ext_User_Prm_Data_Ref(31)=19
Ext_User_Prm_Data_Ref(32)=20
Ext_User_Prm_Data_Ref(33)=21
Ext_User_Prm_Data_Ref(34)=22
Ext_User_Prm_Data_Ref(35)=23
Ext_User_Prm_Data_Ref(36)=24
Ext_User_Prm_Data_Ref(37)=25
Ext_User_Prm_Data_Ref(38)=26
Ext_User_Prm_Data_Ref(38)=27
Ext_User_Prm_Data_Ref(38)=28
Ext_User_Prm_Data_Ref(38)=29
Ext_User_Prm_Data_Ref(38)=30
Ext_User_Prm_Data_Ref(38)=31
Ext_User_Prm_Data_Ref(38)=32
```

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```
Ext_User_Prm_Data_Ref(39)=33
Ext_User_Prm_Data_Ref(39)=34
Ext_User_Prm_Data_Ref(39)=35
Ext_User_Prm_Data_Ref(39)=36
;
Modular_Station = 0
;
Fail_Safe= 1
Slave_Family = 4
;
Unit_Diag_Bit(0) = "Failed to reach position"
Unit_Diag_Bit(1) = "Motor overcurrent"
Unit_Diag_Bit(2) = "Idle current too high"
Unit_Diag_Bit(3) = "Setup parameter fault"
Unit_Diag_Bit(4) = "Controller firmware bad"
Unit_Diag_Bit(5) = "Last command invalid"
Unit_Diag_Bit(6) = "In calibrate mode"
Unit_Diag_Bit(7) = "Motor too hot or tripped"
;
; Module I/O Configuration
;
Module = "2 Words Out, 3 Words In" 0xE1,0xD2
EndModule
```

# Appendix 2 - Positioning System Calculations

The actual position value read from the controller is generated by the following formula:

$$\frac{(\text{Raw counts from the A-D or encoder - position zero offset value) * position span value}}{4096}$$

# Appendix 3 - Seek Operation Sequence

When a seek to position, full open or full close command is issued the controller executes a seek operation. The seek operation uses the following logic:

| | |
|---|---|
| Step 1 | Determine direction |
| Step 2 | Run output until position, less setback offset is reached |
| Step 3 | If jogging is enabled check current position, otherwise operation is complete |
| Step 4 | If not within seek tolerance jog output for jog on time |
| Step 5 | Wait jog wait time and recheck output, if not within seek tolerance return to step 4 |
| Step 6 | If continuous seek is enabled check position after each jog wait time; restart seek process in jog mode only if position falls outside of seek tolerance. |

# Appendix 4 - Load Current Monitoring System Calculations

The load measuring system uses a peak load type detector.  A simple current transformer is tied to a half wave peak load detector.  The value of the peak load detector is read by the 12 bit a-d converter at an interval set by the Current Calculation Timer.  The resolution is in 2.08ms increments.  It is recommended that this timer be set to 16 for 60hz systems and 20 for 50hz systems.  This ensures at least one full cycle of current flow will have occurred prior to each reading.  The following formula is used to calculate the output load current:

$$\frac{(\text{Raw load counts from A-D - load current zero offset value}) * \text{load current span factor}}{4096}$$

The resulting number scales the output load to x.xx amps.  The decimal places are implied, and a value read from the controller of 100 would be 1.00 amps.

The load current accuracy improves with applied current.  For current under 5 amps the accuracy is less than ± 25%.  Between .5 and 1 amp the accuracy is ±10% and above 1 amp the accuracy is ± 5%.  For any specific application, the accuracy can be improved by measuring the load current and adjusting the "load current span factor".

# Appendix 5 - Drawings

| Drawing Number | Title |
| --- | --- |
| 10280 | AC Profibus Actuator Controller Connection Details |
| 10537 | mTB004 Profibus Termination |

**Notes:**

1. 120VAC inputs draw is nominally 10mA at 120VAC, guaranteed minimum on current is 8mA and maximum off current is 4mA.
2. I/O terminal spacing is 0.2" and will accept a single #14 wire.
3. Profibus connector is 0.15" spacing.
4. Current sensor opening will accept 1 - #16/600VAC insulated conductor.
6. Controller current consumption is 6VA at 120VAC.
7. Position limit switches shown in fully closed position.
8. Trip contact shown in not tripped position.

CMC Industrial Electronics Ltd.
Burnaby, BC Canada
AC Profibus Actuator Controller
Connection Details
REF. mAC112
DRAWING NO. 10280  REV A
PAGE: 1 OF 1
DRAWN BY: D. FORST
DATE: March 12, 2009
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**120VAC I/O**
- 10 Input 1
- 9 Input 2
- 8 Tripped
- 7 Full Open
- 6 Open Coil
- 5 Full Closed
- 4 Close Coil
- 3 Fused L1
- 2 Neutral
- 1 L1

**Potentiometer/Encoder**
- Phase A
- +5VDC
- Phase B
- Wiper
- Common

**Current Sense**

**Profibus**
- 1 A Terminator
- 2 A Data  GREEN
- 3 Common  SHIELD
- 3 B Data  RED
- 5 B Terminator

**Profibus Cable**

**Cable Stripping Guide**

**Switch Functions**

Switch 1   IN = this controller is connected to the bus
OUT = this controller is disconnected from the bus

Switch 2   EXTEND = the bus continues to the next segment of cable
TERM = the bus ends at this controller and is terminated

Ground Cable

CMC Industrial Electronics Ltd.
Burnaby, BC Canada

PROFIBUS TERMINAL BOARD
WIRING DIAGRAM

REF: mTB003 / mAC112 / DPC120
DRAWING NO. 10537   REV. A
PAGE: 1 OF 1

Notes:

1) Strip cable as shown by "Cable Stripping Guide"
2) Spread the cable clamp and slide over braided cable shield
3) Terminals marked "A" are for the green Profibus wires
4) Terminals marked "B" are for the red Profibus wires
5) Connect terminals A1 and B1 to the cable from the Profibus Master
6) Connect terminals A2 and B2 to the cable continuing the bus
7) Connect the lug on the ground cable to a PCB mounting screw

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