CMO Programmer's Guide

16-01041
Revision 04
December 2021

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1. About This Manual

Related Documentation

- CANopen Programmer's Manual
- CAN Bus Cabling Guide
- CME User Guide

Information about CANopen can be found on the CAN in Automation website at:

http://www.can-cia.de/index.php?id=canopen

Copley Controls software and related information can be found at:
http://www.copleycontrols.com

For more information on Microsoft® .NET please refer to:

http://www.microsoft.com.

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Document Validity

We reserve the right to modify our products. The information in this document is subject to change without notice and does not represent a commitment by Copley Controls. Copley Controls assumes no responsibility for any errors that may appear in this document.

Product Warnings

Observe all relevant state, regional and local safety regulations when installing and using Copley Controls amplifiers. For safety and to assure compliance with documented system data, only Copley Controls should perform repairs to amplifiers.

WARNING

Use caution in designing and programming machines that affect the safety of operators.

The examples in this book are for demonstration purposes only, providing guidelines for programming. The programmer is responsible for creating program code that operates safely for the amplifiers and motors in any given machine.

Failure to adhere to this warning can cause equipment damage, injury, or death.

WARNING

Do not use Copley Motion Objects to implement an Emergency Stop

An Emergency Stop must be hardwired directly to the amplifier. Do not depend on the Copley Motion Objects software to provide for a timely emergency stop. Due to the non-deterministic nature of Microsoft Windows, the software cannot guarantee a timely emergency stop operation.

Failure to adhere to this warning can cause equipment damage, injury, or death.

Revision History

Revision	Date	Applies to	Comments
00	August 2014	CMO Version 4.0 and 5.0	Re-formatted text, added descriptions for new methods and properties.
01	June 2015	CMO V5.1 Release	Added info for multi-axis CAN drives. Added table to the debug levels. Added description of new Linkage settings object.
02	July 2018	CMO V5.2 Release	Added info for LSSObj. Added info for PDO mapping objects. Added drive configuration file methods.
03	November 2018	CMO V6.0	Edited for CMO V6.0
04	December 2021	CMO V6.1.3.0	Added PathPlanningObj and PvtConstAccelTrjObj classes as well as their respective methods in the LinkageObj class.

2. Fundamental Concepts and Procedures

2.1 Introduction

The Copley Motion Objects (CMO) simplifies the creation of Windows-based software for the control of Copley Controls amplifiers over CANopen network. CMO is an API that gives programmers access to an amplifier's CANopen functions without having to learn the complexities of the underlying network protocol. CMO is a managed .NET assembly which means that it can be used with client code that supports .NET assemblies. For control of Copley Controls amplifiers over EtherCAT network, use CMO V5.x.

2.2 System Requirements

Operating System and Hardware

- Operating Systems Supported: Windows 10, 8, and 7.
- CMO supports all the Copley CAN Interface cards

Latest version of firmware is recommended and can be downloaded from Copley's website: www.copleycontrols.com.

2.3 .NET Framework Compatibility

CMO is designed as a .NET Assembly, which means that it can be used in applications that are designed to run under the Microsoft .NET Framework. This includes applications built with Visual Studio. Occasionally, new versions of the .NET Framework released that are not backward compatible with earlier versions. When this occurs, Copley must branch CMO and maintain multiple versions. This recently occurred when V4.0 of the .NET Framework was released. This version is not backward-compatible with any application that targeted version 2.0 through 3.5, and the result was to branch CMO to V4.x and V5.x.

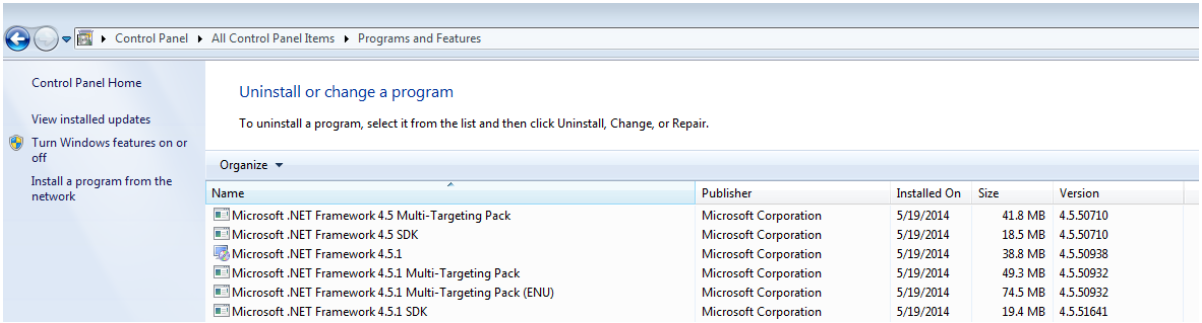
CMO V4.x

The V4.x branch of CMO is compatible with .NET versions 2.0 through 3.5. The examples installed with V4.x were made with Visual Studio 2008 and target the .NET Framework 3.5. This CMO branch is not compatible with applications that target the .NET Framework 4.0 and 4.5.
Note: CMO V4.x is a legacy software.

CMO V5.x / V6.x

The V5.x / V6.x branches of CMO are compatible with .NET versions 4.0 through 4.5. The examples installed with V5.x / V6.x were made with Visual Studio 2010 and Visual Studio 2017 and target the .NET Framework 4.0. These CMO branches are not compatible with applications that target the .NET framework 2.0 through 3.5.
Note: CMO V5.x is a legacy software.

To determine which versions of the .NET Framework are installed on your PC, go to the Control Panel and select Programs and Features (on Win XP, choose Add or Remove Programs).
Scroll through the list of installed programs to the entries for Microsoft .NET Framework as shown below:



2.4 32-bit vs. 64-bit Compatibility

Starting with V5.0, the installer allows the user to choose either the 32-bit or 64-bit version of CMO to be installed. This is done so that the user can target a different architecture when compiling their application with CMO. For instance, an application can be set up to target a 32-bit architecture, even though it is being compiled on a 64-bit machine. In this case, the user must install the 32-bit version of CMO so that it will work with their application on the 32-bit architecture. Please consult the owner's manual for your compiler for information on settings the target architecture.

Important Note
The application that uses CMO must target the same architecture as the version of CMO that is installed. The "any CPU" setting in Microsoft Visual Studio should never be used with CMO.

Using this setting with either the 32-bit or 64-bit version of CMO will cause unpredictable behavior in the application (e.g. exceptions and breakpoints may not work).

2.5 CANopen Network

Addressing and Bit Rate

Use CME software to set up the amplifier's CAN node id and bit rate. CMO supports the following bit rates: 1Mb/s, 800kb/s, 500kb/s, 250kb/s, 125kb/s, 50kb/s, and 20kb/s.
CAN addresses (node id's) have a range of 1 to 127. Setting the node id to 0 disables the CAN operation for that amplifier.

Multi-axis

For multi-axis amplifiers, each axis is treated as a separate node on the CAN network and requires its own AmpObj. Only one node id is configured for a multi-axis drive. That node id is assigned to axis A. The amplifier automatically configures the subsequent axes by increments of one. Therefore, if the amplifier was configured with a node id of 1 on a four-axis drive, then the node ids for that amplifier will be:
Axis A: 1
Axis B: 2
Axis C: 3
Axis D: 4

2.6 Communication Errors

Access Denied

This error indicates that CMO could not find the network hardware (CAN card, or device drivers).

SDO Timeout:

This error indicates that an SDO was sent, but no response was received. Possible causes are:

- The address is incorrect
- The bit rate is incorrect
- The wrong CAN channel is connected on a multiple-channel CAN card
- The CAN bus is improperly terminated
- CAN bus is wired improperly or disconnected
- Firewall is enabled

2.7 Node Guarding

Overview

Node guarding is a CANopen device-monitoring feature. The network manager configures the amplifier to expect node-guarding messages at some interval. The network manager then sends a message to the amplifier at that frequency, and the amplifier responds with a node-guarding message. This allows both the network manager and the amplifier to identify a network failure if the guarding messages stop. CMO can turn node guarding on or off and change the interval. If the amplifier detects that the guarding messages stop, it will abort a move in progress and set the AMPEVENT_NODEGUARD bit active in the AmpEvent status register. If node guarding is turned on, we recommend monitoring amplifier events for the node guard event. This can be done through the EventObj or through a timer, which periodically reads the event mask.

Possibility of False Node Guarding Conditions

In a Windows environment, various factors can delay node-guarding messages, resulting in "false" node guarding conditions. These factors include the non-deterministic nature of Windows operating systems and the performance effects of other processes running on the PC. Thus, by

default, node guarding is disabled in CMO. If node guarding is required, do not enable node guarding without first testing the performance characteristics and usage load of the PC being used, and adjusting the node guarding parameters accordingly using the ampSettingObj properties.

2.8 Exception Handling

If an error occurs, CMO reports the error by throwing an exception. Try/catch blocks should encapsulate all calls to CMO. For better error handling, each program should include error-handling procedures to prevent unexpected motion from occurring.

2.9 Units

Default Amplifier Units

- **Position or Distance**: encoder counts
- **Velocity:** 0.1 encoder counts per second
- **Acceleration:** 10 encoder counts per second^2
- **Deceleration:** 10 encoder counts per second^2
- **Jerk:** 100 encoder counts per second^3

User-Defined Units

The AmpObj property CountsPerUnit is a scaling factor for converting between a drive's default units and user-defined units.

Example

To set user units to millimeters with a 5-micron encoder on a linear motor:

Set CountsPerUnit = 200, since there are 200 encoder counts in one millimeter.

2.10 Stepnet Amplifiers

Stepper and Servo Modes

On power up /reset, Stepnet amplifiers start in stepper mode. If it is necessary to switch from stepper mode to servo mode, change the AmpModeWrite property of the AmpObj to one of the servo modes listed in CML_AMP_MODE. This should be done immediately after amplifier initialization.

In the following example, the amplifier is initialized and then the amplifier's mode of operation is switched to the servo Can profile mode:

```
ampObj.Initialize(canOpen, 1)

ampObj.AmpModeWrite = CML_AMP_MODE.AMPMODE_SERVO_CAN_PROFILE
```

Open Loop Stepper Mode Actual Position and Velocity

When running open loop stepper mode, actual position and actual velocity readings remain at zero. The motor's commanded position can be monitored with AmpObj.PositionCommand (Units: microsteps).
The motor's commanded velocity can be monitored with AmpObj.TrajectoryVel (Units microsteps/second).

When the amplifier is disabled, PositionCommand goes to zero because the amplifier cannot tell if the motor moves while disabled. If the amplifier is enabled, relative and absolute moves can be made based on PositionCommand.

Stepper Mode with Encoder Actual Position and Velocity

When running in stepper mode with an encoder, actual position can be monitored with AmpObj.PositionActual (Units: microsteps). Actual velocity can be monitored with AmpObj.VelocityLoad (Units microsteps/second).

NOTE: Actual velocity can also be monitored with AmpObj.VelocityActual, but the units will be in encoder counts/second. This is not recommended, because user units will also be applied to this value.

3. Using CMO in an application

3.1 Building an Application

Regardless of the programming language or development environment, there are common steps to follow when building an application that uses CMO.

1 Determine the target CPU for the application to run on. This must be either x86 (32-bit) or x64 (64-bit). "Any CPU" cannot be chosen with CMO. See 32-bit vs. 64-bit Compatibility.
2 Determine the target .NET Framework for the application to run on. See .NET Framework Compatibility.
3 Install the version of CMO to match the target CPU in step 1. See Download and Install CMO.
4 Create the project for the application and set the target CPU and .NET Framework.
5 Add a reference to CMO in the project. See
6 Adding a Reference to CMO in Visual Studio.
7 Declare a variable for the network object.
8 Declare one or more variables for the node objects (AmpObj or IOObj) and create instances of those variables.
9 Declare and instantiate settings objects for each node object declared in step 7 (AmpSettingsObj or ioSettingsObj).
10 Set the enableOnInit property of each settings object to False.
11 In the method or procedure that is called when the application, initialize the network and node objects. See Object Initialization Sequence.
12 Enclose all code that accesses CMO methods or properties with exception handling code.

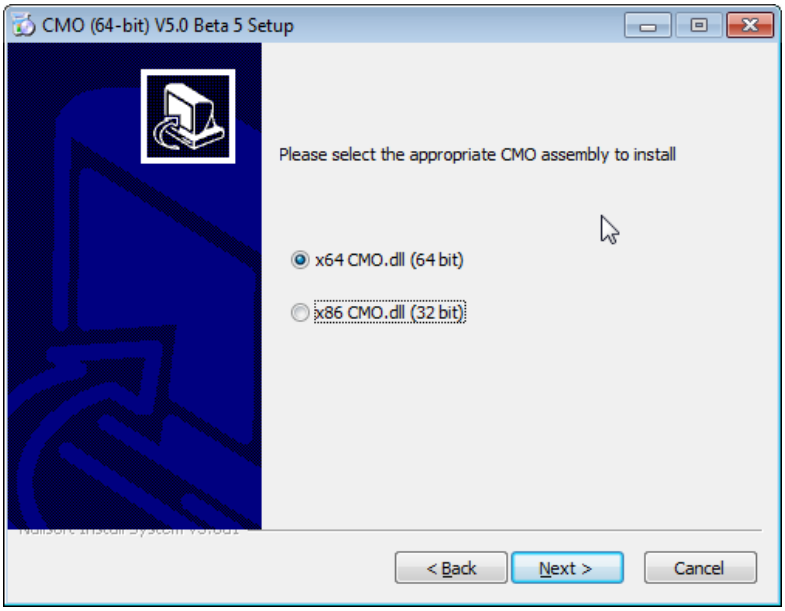
3.2 Before Running a CMO Program

The following general steps must be completed before running any CMO program, including the demonstration programs described in this manual:

1 Review Product Warnings at the beginning of this manual.
2 Set up and tune the motor and amplifier using Copley Controls CME software. Set the CAN node ID and bit rate.
3 Install CMO.
4 Install the CAN interface card and drivers.
5 Connect the amplifier, motor, and network.
6 Read through the steps in
7 Building an Application to make sure that the application is set up properly.

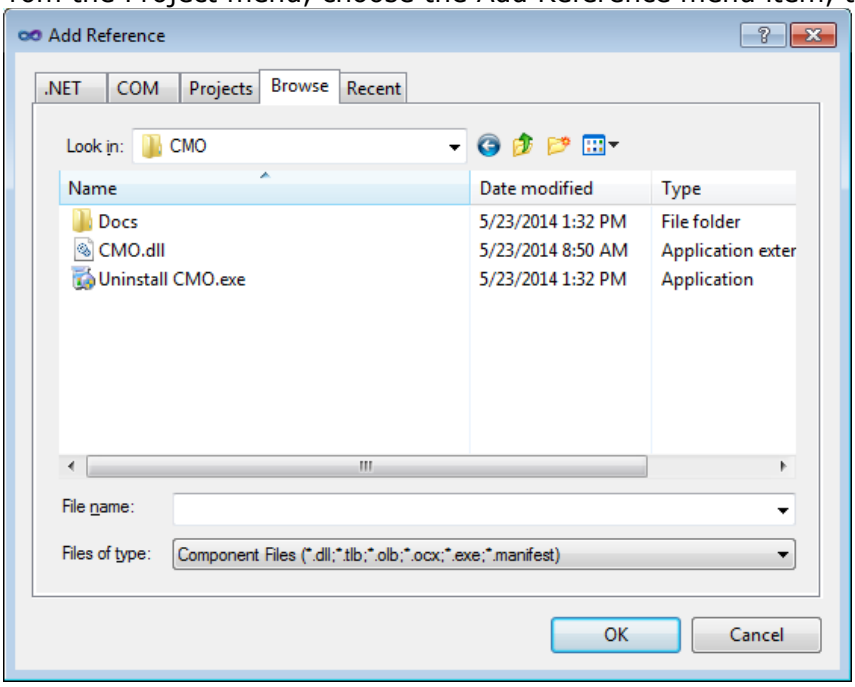
3.3 Download and Install CMO

1 Go to www.copleycontrols.com.
2 Navigate to Software and select CMO.
3 Navigate to the folder where CMO was downloaded to and extract the contents of CMO.zip.
4 Run Setup.exe and follow the instructions on the installer screens. When prompted, choose the version of CMO that your application is targeting (32-bit or 64-bit). It is recommended to install CMO in the default location.



3.4 Adding a Reference to CMO in Visual Studio

From the Project menu, choose the Add Reference menu item, then select the Browse tab.



Browse to the folder where the CMO folder is installed.
Select CMO.dll and click ok.

3.5 Object Initialization Sequence

Every CMO application requires the creation and initialization of a network object, and node objects for each node on the network. These objects should always be initialized in the following order:

1. Network objects (CANOpenObj).
2. Node objects (AmpObj or IOObj).

Initializing the network establishes a connection to the network hardware (but not out on the network). If the call to the network object's initialize () method is successful, then CMO was able to find the network drivers and hardware. Before initializing, the network properties should be set if they are different than the defaults. See the properties of **Error! Reference source not found.** for details. Initializing the nodes establishes communication to that node on the network. If the call to the node's initialize method is successful, then CMO was able to communicate with the node.

CANopen Initialization

```
'Set the bit rate to 1 Mbit per second
canOpen.BitRate = CML_BIT_RATES.BITRATE_1_Mbit_per_sec
'Indicate that channel 0 of a Copley CAN card should be used
canOpen.PortName = "copley0"
canOpen.Initialize()
ampSettings.enableOnInit = False
'Initialize the AmpObj with the settings object
ampObj.InitializeExt(canOpen, 1, ampSettings)
```

Initialization Errors

If the call to the network's initialize method fails, then CMO cannot find and initialize the hardware. This is typically caused by one of the following:

- Network hardware not present
- CAN card drivers not installed
- Incorrect portName specified
- Incorrect channel specified

If the call to the node's initialize method fails, then CMO cannot communicate with the node. Typical causes are:

- Incorrect bit rate
- No termination on the bus
- Network settings of the program do not match the node (bit rate, node id, etc.).
- Node is not connected to the network
- Node is not powered up
- Node has a fault or is not enabled and the ampSettingObj was not used to turn off enableOnInit

4. Network Objects

CANopenObj

Methods

Initialize ()

Description: Initializes the CANopen network.
Parameters: None

ClearErorFrameCounter ()

Description: Clears the CAN error frame counter.
Parameters: None

Properties

ErrorFrameCounter

Type: Integer
Description: Read-only. The number of error frames received over then CAN network since the last time the counter was cleared
Units: None
Default: None

BitRate

Type: CML_BIT_RATES
Description: CANopen Bit Rate.
Units: None
Default: 1 Mb/s

CML_BIT_RATES

BITRATE_1_Mbit_per_sec = 1000000

BITRATE_800_Kbit_per_sec = 800000

BITRATE_500_Kbit_per_sec = 500000

BITRATE_250_Kbit_per_sec = 250000

BITRATE_125_Kbit_per_sec = 125000

BITRATE_50_Kbit_per_sec = 50000

BITRATE_20_Kbit_per_sec = 20000

PortName

Type: String
Description: Port name for the network hardware. The port name is a combination of the CAN card name and the channel number.
- CAN Card: Copley
- Port Name: copley0, copley1

Units: None
Default: The port name defaults to channel 0 of the first supported CAN card found. CMO will search for the CAN cards in numerical order.

5. Amplifier and Related Objects

5.1 ampSettingsObj

Overview

The Amp Settings Object contains information about the amplifier's network settings. All the properties have both read and write access. This object is passed in as a parameter in the InitializeExt method of the Amplifier Object to customize the network settings.

Example:

1 Declare and create an instance of ampSettingsObj.

```
Dim ampSettings As ampSettingsObj
ampSettings = New ampSettingsObj()
```

2 Change one or more properties of the ampSettingsObj.

```
ampSettings.enableOnInit = False
```

3 Call one of the Extended Initialization methods of the ampObj.

```
ampObj.InitializeExt(canOpen, CAN_ADDRESS, ampSettings)
```

Properties

guardTime

Type:	Short
Description:	Node guarding guard time. This property gives the node-guarding period for use with this node. This is the period between node guarding request messages sent by the master controller.
Units:	mS
Default:	200

heartbeatPeriod

Type:	Short
Description:	Configures the heartbeat period used by this amplifier to transmit its heartbeat message. If this property is set to zero, then the heartbeat protocol is disabled on this node.
Units:	mS
Default:	0

heartbeatTimeout

Type:	Short
Description:	Additional time to wait before generating a heartbeat error.
Units:	mS
Default:	0

lifeFactor

Type: Short

Description: Node guarding lifetime factor. The lifetime factor is treated as a multiple of the guard time. If this property and the node guard time are both non-zero, and the heartbeatTimeout is zero, then node guarding will be setup for the amplifier.

Units: mS

Default: 3

resetOnInit

Type: Boolean

Description: If *True*, the amplifier will be reset when it is initialized. This has the advantage of clearing out any fault conditions and putting the amplifier in a known state.

Units: None

Default: False

enableOnInit

Type: Boolean

Description: Enable amplifier at initialization. If true, then the amplifier will be enabled at the end of a successful initialization. If false, the amplifier will be disabled at the end of a successful initialization

Units: None

Default: True

synchID

Type: Integer

Description: Synch object CAN message ID. This is the message ID used for the synch message.

Units: None

Default: 128 (0x00000080)

synchPeriod

Type: Integer

Description: Synch object period. The synch object is a message that is transmitted by one node on a CANopen network at a fixed interval. This message is used to synchronize the devices on the network.

Units: microseconds

Default: 10000

synchProducer

Type: Boolean

Description: If true, this node will produce synch messages. If 'synchUseFirstAmp' property is set to true, this property will not be used and will be overwritten during initialization.

Units: None

Default: False

synchUseFirstAmp

Type: Boolean

Description: Use first initialized amplifier as synch producer. If this setting is true (default), then the first amplifier to be initialized will be set as the synch producer, and all other amplifiers will be setup as synch consumers.

Units: None

Default: True

timeStampID

Type: Integer

Description: High-resolution time stamp CAN ID. The time stamp is a PDO that is generated by the synch producer. It is used to synchronize the clocks of the amplifiers. Setting this to zero will disable the time stamp message.

Units: None

Default: 384 (0x00000180)

5.2 Amplifier Initialization

Methods

Initialize (canOpenObj As CANopenObj, nodeId As Short)

Description: Initializes the amplifier with the CANopen network using default Amplifier Settings.

Parameters:

canOpenObj	An instance of a CanOpenObj that has already been initialized	Units: None
nodeId	The CAN node ID of the amplifier	Units: None

InitializeExt (canOpenObj As CANopenObj, nodeId As Short, ampSettings As AmpSettingsObj)

Description: Initializes amplifier with the CANOpenObj, the specified node ID, and the AmpSettingsObj.

Parameters:

canOpenObj	An instance of a CanOpenObj that has already been initialized	Units: None
nodeId	The node ID of the amplifier	Units: None
ampSettingsObj	An instance of an AmpSettingsObj with customized settings	Units: None

ReInit ()

Description: Re-initializes an amplifier using the same properties that were previously used.
Parameters: None

5.3 Amplifier Enable/Disable

Methods

Enable ()

Description: Software enables the amplifier.

Parameters: None

Disable ()

Description: Software disables the amplifier.

Parameters: None

Properties

IsHardwareEnabled

Type:	Boolean
Description:	Read-only. Returns True if amplifier's Enable input is currently active. Amplifier outputs may still be disabled due to error condition.
Units:	None
Default:	None

IsSoftwareEnabled

Type:	Boolean
Description:	Read-only. Returns True if amplifier is software enabled. Amplifier outputs may still be disabled due to error condition.
Units:	None
Default:	None

IsPWMEnabled

Type:	Boolean
Description:	Read-only. Returns true if the amplifier's PWM outputs are currently enabled.
Units:	None
Default:	None

5.4 Objects Contained by AmpObj

Overview

To reduce the number of methods and properties of the AmpObj, several objects were created and added to the AmpObj as a property. Each sub object contains a set of related method and properties.

Object	Description
AmpInfo	Read-only amplifier characteristics.
MotorInfo	Motor and feedback parameters.
CurrentLoopSettings	Parameters used for tuning the current loop.
VelocityLoopSettings	Parameters used to tune the velocity loop.
PositionLoopSettings	Parameters used to tune the position loop.
HomeSettings	Used to configure homing.
ProfileSettings	Used to configure a point-to-point move.
TrackingWindows	Used to configure the position and velocity error windows.

Example

The following example demonstrates the use of the objects contained by the AmpObj. Please note that the AmpObj must be initialized prior to accessing the sub-objects.

1 Create an instance. There are two ways to do this:

Obtain the instance from the AmpObj. This is the preferred method, because it sets all of the properties of the ProfileSettings object equal to the values set in the AmpObj.

```
Dim profileSettings As ProfileSettingsObj
profileSettings = ampObj.ProfileSettings
```

OR

Create a new instance. This sets default values for all of the properties.

```
Dim profileSettings As ProfileSettingsObj

profileSettings = New ProfileSettingsObj
```

2 Modify one or more properties.

```
profileSettings.ProfileType = CML_PROFILE_TYPE.PROFILE_SCURVE
```

3 Write the new settings to the AmpObj

```
ampObj.ProfileSettings = profileSettings
```

5.5 AmpInfoObj

The properties of the AmpInfoObj provide information about the amplifier. All the properties are Read-Only.

Properties

crntCont

Type: Double
Description: Amplifier continuous current rating.
Units: 0.01 A

crntPeak

Type: Double
Description: Amplifier peak current rating
Units: 0.01 A

crntScale

Type: Short
Description: Current scaling factor
Units: None

crntTime

Type: Double
Description: The maximum time for which the amplifier is rated to output peak current
Units: mS

mfgInfo

Type: String
Description: Amplifier's manufacturing information string
Units: None

mfgName

Type: String
Description: Name of the amplifier manufacturer
Units: None

mfgWeb

Type: String
Description: Web address of the manufacturer
Units: None

model

Type: String
Description: Model number string
Units: None

modes

Type: Integer
Description: Supported modes of operation as described in *CANopen Profile for Drives and Motion Control (DSP 402)*.

Bit	Mode Description
0	Position profile mode (pp).
2	Profile velocity mode (pv).
3	Profile torque mode (tq).
5	Homing mode (hm).
6	Interpolated position mode (ip).
7	Cyclic sync position mode (csp).
8	Cyclic sync velocity mode (csv).
9	Cyclic sync torque mode(cst).

Units: None

pwm_dbcont

Type: Short
Description: PWM dead time used at or above the continuous current limit
Units: servo cycles

pwm_dbzero

Type: Short
Description: PWM deadband at zero current
Units: servo cycles

pwm_off

Type: Short
Description: PWM off time
Units: tens of nanoseconds

pwmPeriod

Type: Double
Description: PWM period
Units: tens of nanoseconds

refScale

Type: Short
Description: Reference scaling factor
Units: None

serial

Type: Integer
Description: Serial number of the amplifier's printed circuit board
Units: None

servoPeriod

Type: Double
Description: Servo loop update period as a multiple of the pwm period
Units: None

swVer

Type: String
Description: The firmware version number
Units: None

tempHyst

Type: Double
Description: Temperature hysteresis for over temperature fault
Units: degrees C

tempMax

Type: Double
Description: Set point for over temperature fault
Units: degrees C

type

Type: Short
Description: Amplifier type
Units: None

voltMax

Type: Double
Description: Set point for an over voltage fault
Units: 0.1V

voltMin

Type: Double
Description: Set point for under voltage fault
Units: 0.1 V

voltScale

Type: Short
Description: Voltage scaling factor
Units: 0.1 V

aencScale

Type: Short
Description: The analog encoder-scaling factor.
Units: None

regenPeak

Type: Short
Description: The internal regen circuit peak current limit
Units: 0.01 A

regenCont

Type: Short
Description: The internal regen circuit continuous current limit
Units: 0.01 A

regenTime

Type: Short
Description: The internal regen circuit time at peak current
Units: mS

voltHyst

Type: Double
Description: Bus voltage hysteresis for over voltage shutdown
Units: 0.1 Volts

5.6 Motor/Feedback Information

Methods

ReadAnalogFeedback (Sin As Short, Cos As Short)

Description: Reads the raw voltage on the two analog feedback inputs.
Parameters:

Sin	This parameter will contain the value read on the analog feedback Sin input upon function return	Units: 0.1 mV
Cos	This parameter will contain the value read on the analog feedback Sin input upon function return	Units: 0.1 mV

Properties

HallState

Type: Short
Description: Read-only. Contains the current digital hall sensor state. The Hall state is the value of the Hall lines AFTER the ordering and inversions specified in the Hall wiring configuration have been applied.
Units: None
Default: None

PhaseAngle

Type: Short
Description: Read-only. Contains the motor phase angle. The phase angle describes the motor's electrical position with respect to its windings
Units: degrees
Default: None

MotorInfoObj

Type: MotorInfoObj
Description: This property contains the MotorInfoObj.
Units: None
Default: None

MotorInfoObj

Properties

backEMF

Type: Double
Description: Back EMF constant
Units: Rotary: V/KRPM, Linear: V/m/S
Default: 0.01

brakeDelay

Type: Short
Description: Delay between applying brake & disabling PWM.

Units: mS
Default: 0

brakeVel
Type: Double
Description: Velocity below which the brake will be applied.
Units: User-defined units/second.
Default: 0.0

ctsPerRev
Type: Integer
Description: Encoder counts/revolution. Rotary motors only
Units:
Default: 4000

eleDist
Type: Integer
Description: Motor electrical distance. Linear motors only.
Units: encoder units/electrical phase
Default: 100000

encRes
Type: Short
Description: Encoder resolution. Linear motors only
Units: encoder units/count
Default: 100

encReverse
Type: Boolean
Description: Reverse encoder direction if True.
Units:
Default: False

encType
Type: Short
Description: Motor Encoder type

Value	Description
0	Incremental quadrature encoder.
1	No encoder.
2	Analog encoder.
3	Secondary quad encoder from input lines.
4	Low frequency analog encoder.
5	Resolver.
6	Use digital hall signals for position & velocity estimates.
7	Analog encoder updated at current loop rate.
8	Reserved for custom encoder.
9	Panasonic
10	SPI command (reserved for custom firmware use).

11	EnDat
12	SSI
13	BiSS
14	Serial encoders from Sanyo Denki, Tamagawa, Panasonic and HD systems.
15	Custom encoders from HD systems.
16	Simple analog potentiometer feedback.
17-19	Reserved for custom encoder.

Units:
Default: 0

encUnits
Type: Short
Description: Encoder units. Linear motor only
Units:
Default: 0

hallOffset
Type: Short
Description: Hall offset
Units: degrees
Default: 0

hallType
Type: Short
Description: Type of hall sensors on the motor.

Value	Description
0	No hall sensors available.
1	Digital hall sensors.
2	Analog hall sensors.

Units: None
Default: 1

hallWiring
Type: Short
Description: Hall wiring code. This bit-mapped value defines the wiring of the hall sensors.

Bit	Description
0-2	The hall wiring code which defines the order of the hall connections Hall Wiring Code / Description: 0 – U V W 1 – U W V 2 – V U W 3 – V W U 4 – W V U 5 – W U V 6,7 – Reserved
3	Reserved.
4	Invert W hall input if set.

5	Invert V hall input if set.
6	Invert U hall input if set.
7	Reserved.
8	Swap analog halls if set.
9-15	Reserved.

Units: None
Default: 0

hallVelocityShift
Type: Short
Description: This value is used to scale up the calculated velocity in Hall velocity mode (Halls used for feedback in velocity mode). It specifies a left shift value for the position and velocity information calculated in that mode
Units: None
Default: 1

hasBrake
Type: Boolean
Description: Motor has a brake if True
Units:
Default: False

inductance
Type: Double
Description: Motor inductance
Units: Henrys
Default: 0.001

inertia
Type: Double
Description: Inertia
Units: Kg-cm^2
Default: 0.00001

mfgName
Type: String
Description: Name of the motor manufacturer
Units: None
Default: None

model
Type: String
Description: Motor model number
Units: None
Default: None

mtrReverse
Type: Boolean
Description: Reverse motor wiring if true
Units: None
Default: False

poles
Type: Short
Description: Number of pole pairs (number of electrical phases) per rotation. Rotary motors only

Units:
Default: 2

resistance
Type: Double
Description: Motor resistance
Units: Ω
Default: 1.0

stopTime
Type: Short
Description: Delay between disabling amplifier and applying brake. During this time, amplifier attempts to stop motor
Units: mS
Default: 0

tempSensor
Type: Boolean
Description: Motor has a temperature sensor
Units: None
Default: False

trqConst
Type: Double
Description: Torque constant (rotary), Force constant (linear). For stepper motors, the value returned is Rated Torque/Rated Current
Units: Rotary: Newton Meters/A; Linear: Newtons/A
Default: 0.001

trqCont
Type: Double
Description: Continuous torque (rotary), Continuous force (linear). This parameter is not used for stepper motors
Units: Rotary: Newton Meters; Linear: Newtons
Default: 0.0001

trqPeak
Type: Double
Description: Peak torque (rotary), Peak force (linear), Rated Torque (stepper motors)
Units: Rotary, Stepper: Newton Meters; Linear: Newtons
Default: 0.0001

type
Type: Short
Description: Bit-mapped value that contains the motor type and family.

Bits	Description
0 - 1	Motor Type: 0 = Rotary, 1 = Linear
5 - 6	Motor Family: 1 = Brush, 2 = Stepper, 3 = Brushless

Units: None
Default: 0

velMax
Type: Double
Description: Maximum motor velocity
Units: User-defined units/second.
Default: 1.0

encShift
Type: Short
Description: Analog feedback interpolation value (used only with Analog feedback)
Units: None
Default: 0

ndxDist
Type: Integer
Description: Index mark distance (reserved for future use)
Units: None
Default: 0

stepsPerRev
Type: Integer
Description: Microsteps/revolution (used for Stepnet amplifiers)
Units: None
Default: 4000

loadEncType
Type: Short
Description: Load Encoder Type. There are two different encodings of this property. The model/firmware version determines which encoding should be used.

For Feature Set E (all versions) and V2.10 or greater for Feature Set C and D, the encoding is as follows:

Bit	Description
0-11	Encoder type
12	Always set to use this new encoding.
13	Linear if set, rotary if clear.
14	If set, do not use this encoder for position feedback (passive mode).
15	Reserved and must be set to zero.

Encoder type

Value	Description
0	No load encoder present.
1	Primary (differential) quadrature encoder.
2	Analog encoder.
3	Secondary quadrature encoder from input lines.
4	Low-frequency analog encoder.
5	Resolver.
6	Use digital hall signals for position & velocity estimates.
7	Analog encoder updated at current loop rate.
8	Reserved for custom encoder.
9	Panasonic
10	SPI command (reserved for custom firmware use).
11	EnDat
12	SSI
13	BiSS
14	Serial encoders from Sanyo Denki, Tamagawa, Panasonic and HD systems.
15	Custom encoders from HD systems.

For Feature Set A and B, the encoding is as follows:

<table>
<tr><td>Bit</td><td>Description</td></tr>
<tr><td>0-3</td><td>Encoder type
<table>
<tr><td>Value</td><td>Description</td></tr>
<tr><td>0</td><td>No load encoder present.</td></tr>
<tr><td>1</td><td>Primary (differential) quadrature encoder.</td></tr>
<tr><td>2</td><td>Analog encoder.</td></tr>
<tr><td>3</td><td>Secondary quadrature encoder from input lines.</td></tr>
<tr><td>4</td><td>Low-frequency analog encoder.</td></tr>
<tr><td>5</td><td>Resolver.</td></tr>
<tr><td>6</td><td>Use digital hall signals for position & velocity estimates.</td></tr>
<tr><td>7</td><td>Analog encoder updated at current loop rate.</td></tr>
<tr><td>8</td><td>Reserved for custom encoder.</td></tr>
<tr><td>9</td><td>Panasonic</td></tr>
<tr><td>10</td><td>SPI command (reserved for custom firmware use).</td></tr>
<tr><td>11</td><td>EnDat</td></tr>
<tr><td>12</td><td>SSI</td></tr>
<tr><td>13</td><td>BiSS</td></tr>
<tr><td>14</td><td>Serial encoders from Sanyo Denki, Tamagawa, Panasonic and HD systems.</td></tr>
<tr><td>15</td><td>Custom encoders from HD systems.</td></tr>
</table></td></tr>
<tr><td>4</td><td>Linear if set, rotary if clear.</td></tr>
<tr><td>5</td><td>If set don't use this encoder for position feedback (passive mode).</td></tr>
<tr><td>6-15</td><td>Reserved and must be set to zero.</td></tr>
</table>

Units: None
Default: 0

loadEncRes

Type: Integer
Description: Load Encoder Resolution: This is encoder counts/rev for rotary encoders and nanometers/count for linear encoders
Units:
Default: 0

loadEncReverse

Type: Boolean
Description: Load Encoder Reverse: Reverse load encoder direction if true
Units:
Default: False

resolverCycles

Type: Short
Description: Number of resolver cycles per motor revolution.
Units:
Default: 1

5.7 Current Loop

Methods

ReadMotorCurrent (Ucurrent As Short, Vcurrent As Short)

Description: The actual current values read directly from the amplifier's current sensors. Note that if the motor wiring is being swapped in software, the U and V reading will be swapped.

Parameters:

Ucurrent	This parameter will contain the value read on the U winding upon function return	Units: 0.01 A
Vcurrent	This parameter will contain the value read on the V winding upon function return	Units: 0.01 A

Properties

CurrentLimited

Type: Short

Description: Read-only. The limited motor current. The commanded current is passed to the current limiter. The output of the current limiter is the limited current, which is passed as an input to the current loop

Units: 0.01 A

Default: None

CurrentCommand

Type: Short

Description: Read-only. This current is the input to the current limiter.

Units: 0.01 A

Default: None

CurrentActual

Type: Short

Description: Read-only. Gets the actual motor current. This current is based on the amplifier's current sensors and indicates the portion of current that is being used to generate torque in the motor.

Units: 0.01 A

Default: None

TorqueTarget

Type: Short

Description: In profile torque mode, this property is an input to the amplifier's internal trajectory generator. Any change to the target torque triggers an immediate update to the trajectory generator

Units: Thousandths of the rated motor torque

Default: 0

TorqueDemand

Type: Short
Description: Read-only. In Profile Torque mode, this is the output value of the torque limiting function
Units: Thousandths of the rated motor torque
Default: None

TorqueActual

Type: Short
Description: Read-only. Instantaneous torque in the motor
Units: Thousandths of the rated motor torque
Default: None

TorqueSlope

Type: Integer
Description: Torque acceleration or deceleration
Units: Thousandths of the rated motor torque per second
Default: 0

CurrentLoopSettings

Type: CurrentLoopSettingsObj
Description: An instance of the CurrentLoopSettingsObj which contains the values set in the amplifier.
Units: None
Default: None

CurrentLoopSettingsObj

Properties

CrntLoopKp
Type: Short
Description: Current loop proportional gain value
Units: None
Default: 0

CrntLoopKi
Type: Short
Description: Current loop integral gain value
Units: None
Default: 0

CrntLoopCrntOffset
Type: Short
Description: Current loop offset value
Units: 0.01 A
Default: 0

CrntLoopPeakCrntLim
Type: Short
Description: Peak current limit. The maximum current that can be applied to the load at any time. In stepper mode, this is the boost current
Units: 0.01 A
Default: 0

CrntLoopContCrntLim
Type: Short
Description: Continuous current limit. Max current that can continuously be applied to load. In stepper mode, this is the run current
Units: 0.01 A
Default: 0

CrntLoopPeakCrntTime
Type: Short
Description: Time at peak current limit. In stepper mode, this is time at boost current
Units: mS
Default: 0

CrntLoopStepHoldCrnt
Type: Short
Description: The Stepper Hold Current. Current used to hold the motor at rest
Units: 0.01A
Default: 0

CrntLoopStepRunToHoldTime
Type: Short
Description: The Stepper Run To Hold Time. The period beginning when a move is complete, to when the output current is switched to the hold current
Units: mS
Default: 0

CrntLoopVolControlDelayTime
Type: Short
Description: The Voltage Control Delay Time. If set to zero, feature is disabled.
Units: mS
Default: 0

5.8 Velocity Loop

Properties

VelocityLimited

Type: Double
Description: Read-only. Gets the limited velocity, which is the result of applying the velocity limiter to the commanded velocity.
Units: User-defined units/second
Default: None

VelocityCommand

Type: Double
Description: Read-only. The commanded velocity is the velocity value passed to the velocity limiter, and, from there, to the velocity control loop
Units: User-defined units/second
Default: None

VelocityActual

Type: Double

Description: Read-only. The motor velocity is calculated by the amplifier based on the change in position. For dual encoder systems, the load velocity can be queried by reading the VelocityLoad property
Units: User-defined units/second
Default: None

VelocityLoad

Type: Double
Description: Read-only. The load velocity is estimated by the amplifier based on the change in position seen at the load encoder. For dual encoder systems, the motor velocity can be queried reading the VelocityActual property
Units: User-defined units/second
Default: None

VelocityLoopSettings

Type: VelocityLoopSettingsObj
Description: This property contains the VelocityLoopSettings
Units: None
Default: None

VelocityLoopSettingsObj

Properties

VelLoopKp
Type: Short
Description: Velocity loop proportional gain value.
Units: None
Default: 0

VelLoopKi
Type: Short
Description: Velocity loop integral gain value.
Units: None
Default: 0

VelLoopKaff
Type: Short
Description: Velocity loop acceleration feed forward value.
Units: None
Default: 0

VelLoopShift
Type: Short
Description: Velocity shift value. After velocity loop is calculated, the result is right-shifted this many times to arrive at the commanded current value. This allows the velocity loop gains to have reasonable values for high-resolution encoders.
Units: None
Default: 0

VelLoopMaxVel
Type: Double
Description: Velocity loop maximum allowed velocity. Limits the velocity command before the velocity loop uses it to calculate output current.
Units: User-defined units/second
Default: 0.0

VelLoopMaxAcc

Type: Double
Description: Velocity loop maximum acceleration limit. Limits the rate of change of the velocity command input to the velocity loop. It is used when the magnitude of the command is increasing.
Units: User-defined units/second^2
Default: 0.0

VelLoopMaxDec

Type: Double
Description: Velocity loop maximum deceleration limit. Limits the rate of change of the velocity command input to the velocity loop. It is used when the magnitude of the command is decreasing.
Units: User-defined units/second^2
Default: 0.0

VelLoopEstopDec

Type: Double
Description: Deceleration used for emergency stop. Setting this value to zero indicates that the deceleration is unlimited.
Units: User-defined units/second^2
Default: 0.0

5.9 Position Loop

Properties

PositionError

Type: Double
Description: The position error (difference between position command and actual position).
Units: User-defined units
Default: None

PositionCommand

Type: Double
Description: The instantaneous position command. This position is the command input to the servo loop. The position command is calculated by the trajectory generator and updated every servo cycle.
Units: User-defined units
Default: None

PositionActual

Type: Double
Description: The actual position used by the servo loop. For dual encoder systems, this property contains the load encoder position and the PositionMotor property should be used to read the motor encoder position.
Units: User-defined units
Default: None

PositionMotor

Type: Double
Description: The actual motor position. For single encoder systems, this value is identical to the PositionActual property. For dual encoder systems, this property contains

the actual motor position and the PositionActual property may be used to get the load encoder position.
Units: User-defined units
Default: None

PositionLoadEncoder

Type: Double
Description: Dual encoder systems only. This value is the load encoder position and is the identical to the PositionActual property. When the load encoder is configured for passive mode, this value is the passive load encoder value. This property is not used in single encoder systems.
Units: User-defined units
Default: None

PositionLoopSettings

Type: PositionLoopSettingsObj
Description: This property contains the PositionLoopSettings.
Units: None
Default: None

PositionLoopSettingsObj

Properties

PosLoopKp
Type: Short
Description: Position loop proportional gain value.
Units: None
Default: 0

PosLoopKvff
Type: Short
Description: Position loop velocity feed forward value.
Units: None
Default: 0

PosLoopKaff
Type: Short
Description: Position loop acceleration feed forward value.
Units: None
Default: 0

PosLoopScale
Type: Short
Description: The output of the position loop is multiplied by this value before being passed to the velocity loop. This scaling factor is calculated such that a value of 100 is a 1.0 scaling factor. This parameter is most useful in dual loop systems.
Units: None
Default: 100

5.10 Tracking Windows

Properties

TrackingWindows

Type: TrackingWindowsObj
Description: This property contains the TrackingWindows object.
Units: None
Default: None

TrackingWindowsObj

Properties

PositionWarnWindow

Type: Double
Description: Position warning window. If the absolute value of the position error exceeds this value, then a tracking warning will result. A tracking warning causes a bit in the amplifier's status to be set.
Units: User-defined units
Default: 0.0

SettlingWindow

Type: Double
Description: Position settling window. An amplifier is settled in position after a move when its absolute position error value has been within the settling window for a time greater than the settling time.
Units: User-defined units
Default: 0.0

SettlingTime

Type: Short
Description: Position settling time value. An amplifier is settled in position after a move when its absolute position error value has been within the settling window for a time greater than the settling time value.
Units: mS
Default: 0

VelocityWarnWindow

Type: Double
Description: Velocity warning window. If the absolute value of the velocity error exceeds this value, then a velocity warning results. A velocity warning causes a bit in the amplifier's status to be set.
Units: User-defined units
Default: 0.0

VelocityWarnTime

Type: Short
Description: Velocity warning window time value. If velocity error exceeds velocity warning window, a bit is set in the amplifier status word. Bit is not cleared until velocity error stays within warning window for at least this long.
Units: mS
Default: 0

5.11 Homing

Methods

GoHome ()

Description: Executes a homing move using the values set in the HomeSettings object.
Parameters: None

Properties

IsReferenced

Type: Boolean
Description: Read-only. Returns True if successfully referenced (homed).
Units: None
Default: False

SoftPositionPosLimit

Type: Double
Description: Positive limit position. Any time the motors actual position is greater than this value, a positive software limit condition will be in effect on the amplifier. Software limits are enabled after the amplifier is referenced and disabled by setting the positive limit equal to the negative limit.
Units: None
Default: 0

SoftPositionNegLimit

Type: Double
Description: Negative limit position. Any time the motors actual position is less then this value, a negative software limit condition will be in effect on the amplifier. Software limits are enabled after the amplifier is referenced and disabled by setting the positive limit equal to the negative limit.
Units: None
Default: 0

HomeSettingsObj

Type: HomeSettingsObj
Description: Contains the HomeSettingsObj.
Units: None
Default: None

HomeSettingsObj

Properties

HomeOffset

Type: Double
Description: The home offset value. After the home position is found as defined by the home method, this offset will be added to it and the resulting position will be considered the zero position.
Units: User-defined units
Default: 0.0

HomeVelFast
Type: Double
Description: Velocity to use for fast moves during the home procedure.
Units: User-defined units/second
Default: 0.0

HomeVelSlow
Type: Double
Description: Velocity to use when seeking a sensor edge.
Units: User-defined units/second
Default: 0.0

HomeAccel
Type: Double
Description: Acceleration/deceleration value used for all homing procedure moves.
Units: User-defined units/second^2
Default: 0.0

HomeCurrentLimit
Type: Short
Description: Home current limit in hard stop mode, in which the amplifier drives the motor to the mechanical end of travel (hard stop). End of travel is recognized when the amplifier outputs the HomeCurrent for the HomeDelay time.
Units: 0.01A
Default: 0

HomeDelay
Type: Short
Description: Delay used for homing to a hard stop in hard stop mode.
Units: mS
Default: 0

HomeMethod
Type: CML_HOME_METHOD
Description: The method used for homing the amplifier.
Units: None
Default: CHOME _NONE

CML_HOME_METHOD
CHOME_NEGATIVE_LIMIT_OUTTO_INDEX = 1
Move into the negative limit switch, then back to the first encoder index pulse beyond it. Index position is home.

CHOME_POSITIVE_LIMIT_OUTTO_INDEX = 2
Move into the positive limit switch, then back to the first encoder index pulse beyond it. Index position is home.

CHOME_POSITIVE_HOME_OUTTO_INDEX = 3
Move to a positive home switch, then back to the first encoder index outside the home region. Index position is home.

CHOME_POSITIVE_HOME_INTO_INDEX = 4
Move to a positive home switch and continue to the first encoder index inside the home region. Index position is home.

CHOME_NEGATIVE _HOME_OUTTO_INDEX = 5
Move to a negative home switch, then back to the first encoder index outside the home region. Index position is home.

CHOME_NEGATIVE _HOME_INTO_INDEX = 6
Move to a negative home switch and continue to the first encoder index inside the home region. Index position is home.

CHOME_LOWER_HOME_OUTSIDE_INDEX_POSITIVE = 7
Move to the lower side of a momentary home switch. Then find the first encoder index pulse outside the home region. If the home switch is not active when the home sequence starts, then the initial move will be positive.

CHOME_LOWER_HOME_INSIDE_INDEX_POSITIVE = 8
Move to the lower side of a momentary home switch. Then find the first encoder index pulse inside the home region. If the home switch is not active when the home sequence starts, then the initial move will be positive.

CHOME_UPPER_HOME_INSIDE_INDEX_POSITIVE = 9
Move to the upper side of a momentary home switch. Then find the first encoder index pulse inside the home region. If the home switch is not active when the home sequence starts, then the initial move will be positive.

CHOME_UPPER_HOME_OUTSIDE_INDEX_POSITIVE = 10
Move to the upper side of a momentary home switch. Then find the first encoder index pulse outside the home region. If the home switch is not active when the home sequence starts, then the initial move will be positive.

CHOME_UPPER_HOME_OUTSIDE_INDEX_NEGATIVE = 11
Move to the upper side of a momentary home switch. Then find the first encoder index pulse outside the home region. If the home switch is not active when the home sequence starts, then the initial move will be negative.

CHOME_UPPER_HOME_INSIDE_INDEX_NEGATIVE = 12
Move to the upper side of a momentary home switch. Then find the first encoder index pulse inside the home region. If the home switch is not active when the home sequence starts, then the initial move will be negative.

CHOME_LOWER_HOME_INSIDE_INDEX_NEGATIVE = 13
Move to the lower side of a momentary home switch. Then find the first encoder index pulse inside the home region. If the home switch is not active when the home sequence starts, then the initial move will be negative.

CHOME_LOWER_HOME_OUTSIDE_INDEX_NEGATIVE = 14
Move to the lower side of a momentary home switch. Then find the first encoder index pulse outside the home region. If the home switch is not active when the home sequence starts, then the initial move will be negative.

CHOME_POSITIVE_LIMIT = 18
Move into the positive limit switch. The edge of the limit is home.

CHOME _ POSITIVE_HOME = 19
Move to a positive home switch. The edge of the home region is home.

CHOME_ NEGATIVE_HOME = 21
Move to a negative home switch. The edge of the home region is home.

CHOME _LOWER_HOME_POSITIVE = 23
Move to the lower side of a momentary home switch. The edge of the home region is home. If the home switch is not active when the home sequence starts, then the initial move will be positive.

CHOME _UPPER_HOME_POSITIVE = 25
Move to the upper side of a momentary home switch. The edge of the home region is home. If the home switch is not active when the home sequence starts, then the initial move will be positive.

CHOME _UPPER_HOME_ NEGATIVE = 27
Move to the upper side of a momentary home switch. The edge of the home region is home. If the home switch is not active when the home sequence starts, then the initial move will be negative.

CHOME _LOWER_HOME_ NEGATIVE = 29
Move to the lower side of a momentary home switch. The edge of the home region is home. If the home switch is not active when the home sequence starts, then the initial move will be negative.

CHOME _INDEX_ NEGATIVE = 33
Move in the negative direction until the first encoder index pulse is found. The index position is home.

CHOME _INDEX_POSITIVE = 34
Move in the positive direction until the first encoder index pulse is found. The index position is home.

CHOME _NONE = 35
Set the current position to home.

CHOME_HARDSTOP_OUTSIDE_INDEX_NEG = 252
Home to a hard stop. Move in the negative direction until the homing current has been reached. This current will be held until the homing delay has expired. Then move away from the hard stop until an index mark is located. The index position is home.

CHOME_HARDSTOP_OUTSIDE_INDEX_POS = 253
Home to a hard stop. Move in the positive direction until the homing current has been reached. This current will be held until the homing delay has expired. Then move away from the hard stop until an index mark is located. The index position is home.

CHOME_HARDSTOP_NEG = 254
Home to a hard stop. The motor will start running in the negative direction until the homing current has been reached. It will hold this current until the homing delay has expired. The actual position after that delay is home.

CHOME_HARDSTOP_POS = 255
Home to a hard stop. The motor will start running in the positive direction until the homing current has been reached. It will hold this current until the homing delay has expired. The actual position after that delay is home.

5.12 Quick Stop

Methods

QuickStop ()

Description: Performs a quick stop on axis using the programmed Quick Stop Mode.
Parameters: None

Properties

QuickStopMode

Type: CML_QUICK_STOP_MODE
Description: Defines how the motor motion is stopped when the QuickStop() command is issued.
Units: None
Default: None

CML_QUICK_STOP_MODE

QSTOP_DISABLE = 0

Disable the amplifier immediately

QSTOP_DECEL = 1

Slow down using the ProfileDecel property of the ProfileSettingsObj, then disable.

QSTOP_QUICKSTOP = 2

Slow down using the QuickStopDec property then disable.

QSTOP_ABRUPT = 3

Slow down with unlimited deceleration then disable

QSTOP_DECEL_HOLD = 5

Slow down using the ProfileDecel property of the ProfileSettingsObj, and then hold. Amplifier must be disabled and re-enabled before motion is allowed again.

QSTOP_QUICKSTOP_HOLD = 6

Slow down using the QuickStopDec property then hold. Amplifier must be disabled and re-enabled before motion is allowed.

QSTOP_ABRUPT_HOLD = 7

Slow down with unlimited deceleration then hold. Amplifier must be disabled and re-enabled before motion is allowed.

5.13 Halt

Methods

HaltMove ()

Description: Halts current move using the halt mode programmed in the amplifier.
Parameters: None

Properties

HaltMode

Type: CML_HALT_MODE
Description: Defines how the motor motion is stopped when the HaltMove() command is issued.
Units: None
Default: None

CML_HALT_MODE

HALT_DISABLE = 0
Disable the amplifier immediately
HALT_DECEL = 1
Slow down using the ProfileDecel property (see ProfileSettingsObj).
HALT_QUICKSTOP = 2
Slow down using the QuickStopDec property.
HALT_ABRUPT = 3
Slow down with unlimited deceleration

5.14 Point-to-Point Moves

Methods

MoveRel (distance As Double)

Description: Performs a relative point-to-point move of the specified distance.
Parameters:

distance	Trajectory distance	Units: User-defined units

MoveAbs (position As Double)

Description: Performs an absolute point-to-point move to the specified position.
Parameters:

position	Trajectory target position	Units: User-defined units

WaitMoveDone (timeout As Long)

Description: Waits for current move to finish. This method is blocking. When called, it will not return until either the event occurs, the timeout expires, a fault occurs, or a move is aborted. If a timeout occurs, CMO will report the timeout by throwing an exception.

Parameters:

timeout	The timeout for the wait. If < 0, then wait indefinitely	Units: mS

Properties

TargetPos

Type: Double
Description: Read-only. Reads the profile target position.
Units: User-defined units
Default:

TrajectoryAcc

Type: Double
Description: Read-only. Gets the instantaneous commanded acceleration passed out of the trajectory generator. This acceleration is used by the position loop to calculate its acceleration feed forward term.
Units: User-defined units/second^2
Default:

TrajectoryVel

Type: Double
Description: Read-only. Gets the instantaneous commanded velocity passed out of the trajectory generator. This velocity is used by the position loop to calculate its velocity feed forward term.
Units: User-defined units/second
Default:

ProfileSettingsObj

Type: ProfileSettingsObj
Description: Contains the ProfileSettings object.
Units: None
Default: None

ProfileSettingsObj

Properties

ProfileType

Type: CML_PROFILE_TYPE
Description: Motion profile type.
Units: None
Default: PROFILE_TRAP

CML_PROFILE_TYPE

PROFILE_VELOCITY = -1

Velocity profile mode. In this profile mode the velocity, acceleration and deceleration values are used. The position value is also used, but it only defines the direction of motion (positive if position is >= 0, negative if position is < 0).

PROFILE_TRAP = 0

Trapezoidal profile mode.

PROFILE_SCURVE = 3

S-curve profile mode (Jerk limited).

ProfileAcc
Type: Double
Description: The profile acceleration value that the motor uses when starting the move.
Units: User-defined units/second^2
Default: 0

ProfileDecel
Type: Double
Description: The profile deceleration value that the motor uses when ending the move. This property is not used for S-curve profiles.
Units: User-defined units/second^2
Default: 0

ProfileJerk
Type: Double
Description: The jerk limit used with S-curve profiles. Jerk is rate of change of acceleration. Only used with S-curve profiles.
Units: User-defined units/second^3
Default: 0

ProfileVel
Type: Double
Description: The profile velocity value that the motor attempts to reach during the move.
Units: User-defined units/second
Default: 0

Profile Abort
Type: Double
Description: Deceleration value to use when aborting a running trajectory.
Units: User-defined units/second^2
Default: 0

5.15 Save/Restore Amplifier Data

Methods

SaveRamToFlash ()

Description: Saves parameters stored in the amplifiers volatile RAM memory to non-volatile flash memory.
Parameters:
None

LoadDriveConfig (name As String, canObj As CANopenObj)

Description: Loads specified drive configuration file. Presently supports loading **.ccd* files created by CME V7.1 and later.
NOTE: This method loads the file into the amplifier's Flash. To move the data to the amplifier's RAM, reset the drive.
Parameters:

name	Name (and optionally path) of the file to load	Units: None
line	An instance of a CANopenObj that has already been initialized	Units: None

5.16 Node Guarding

Methods

StartGuarding (guardTime As Short, lifeFactor As Short)

Description: Starts node guarding with the specified guard time and life factor.
Parameters:

guardTime	Node guarding time	Units: mS
lifeFactor	Life Factor	Units: None

StopGuarding ()

Description: Disables node guarding & heartbeat monitoring.
Parameters: None

ClearNodeGuardEvent ()

Description: Attempts to clear a node guarding event condition.
Parameters: None

5.17 Status, Events, and Faults

Methods

ReadEventStatus (eventStatus As CML_EVENT_STATUS)

Description: Read amplifier's event status register. This is the main internal register, used to describe the amplifier's current state.
Parameters:

eventStatus	The value of the event status is returned here	Units: None

ReadEventSticky (eventSticky As CML_EVENT_STATUS)

Description: Reads the amplifier's 'sticky' event status register, which is a copy of the amplifier's event status register. The bits of this register are set normally, but only cleared when the register is read (i.e., the bits are 'sticky').
Parameters:

eventSticky	The value of the event status is returned here	Units: None

ReadEventLatch (eventLatch As CML_EVENT_STATUS)

Description: Reads the latched version of the amplifier's event status register, which is a copy of the amplifier's event status register. The bits of this register are set normally, but only cleared in response to an amplifier reset or power cycle or by calling ClearFaults (i.e., the bits are latched).
Parameters:

eventLatch	The value of the event status is returned here	Units: None

CML_EVENT_STATUS

Value	Bit	Description
EVENT_STATUS_SHORT_CIRCUIT	0	Amplifier short circuit.
EVENT_STATUS_AMPLIFIER_TEMPERATURE	1	Amplifier over temperature.
EVENT_STATUS_OVER_VOLTAGE	2	Amplifier over voltage.
EVENT_STATUS_UNDER_VOLTAGE	3	Amplifier under voltage.

EVENT_STATUS_MOTOR_TEMPERATURE	4	Motor over temperature.
EVENT_STATUS_ENCODER_ERROR	5	Encoder error.
EVENT_STATUS_PHASE_ERROR	6	Phasing error.
EVENT_STATUS_CURRENT_LIMIT	7	Current limited.
EVENT_STATUS_VOLTAGE_LIMIT	8	Voltage limited.
EVENT_STATUS_POSITIVE_LIMIT	9	Positive limit is active.
EVENT_STATUS_NEGATIVE_LIMIT	10	Negative limit is active.
EVENT_STATUS_DISABLE_INPUT	11	Hardware disabled (enable pin not set).
EVENT_STATUS_SOFTWARE_DISABLE	12	Disabled due to software request.
EVENT_STATUS_STOP	13	Try to stop motor (after disable, before brake).
EVENT_STATUS_BRAKE	14	Brake actuated.
EVENT_STATUS_PWM_DISABLE	15	PWM outputs disabled.
EVENT_STATUS_SOFTWARE_LIMIT_POSITIVE	16	Positive software limit reached.
EVENT_STATUS_SOFTWARE_LIMIT_NEGATIVE	17	Negative software limit reached.
EVENT_STATUS_TRACKING_ERROR	18	Tracking error.
EVENT_STATUS_TRACKING_WARNING	19	Tracking warning.
EVENT_STATUS_RESET	20	Amplifier has been reset.
EVENT_STATUS_POSITON_WRAP	21	Encoder position wrapped (rotary) or hit limit (linear).
EVENT_STATUS_FAULT	22	Latching fault in effect.
EVENT_STATUS_VELOCITY_LIMIT	23	Velocity is at limit.
EVENT_STATUS_ACCELERATION_LIMIT	24	Acceleration is at limit.
EVENT_STATUS_TRACKING_WINDOW	25	Not in tracking window if set.
EVENT_STATUS_HOME	26	Home switch is active.
EVENT_STATUS_MOVING	27	Trajectory generator active OR not yet settled.
EVENT_STATUS_VELOCITY_WIN	28	Velocity error outside of velocity window when set.
EVENT_STATUS_PHASE_INIT	29	Set when using algorithmic phase initialize mode and the phase is not initialized.
EVENT_STATUS_CMD_INPUT_LOST	30	Command input lost
	31	Undefined

ReadEventMask (eventMask As CML_AMP_EVENT)

Description: Reads the current state of the amplifier's event register. The event mask is a bit-mapped variable that describes the state of the amplifier. The contents of this variable are built up from several different amplifier status words.

Parameters:

eventMask The value of the amp event mask is returned here Units: None

CML_AMP_EVENT

Value	Bit	Description
AMPEVENT_MOVE_DONE	0	Set when a move is finished and the amplifier has settled in to position at the end of the move. Cleared when a new move is started.
AMPEVENT_TRAJECTORY_DONE	1	Set when the trajectory generator finishes a move. The motor may not have settled into position at this point. Cleared when a new move is started.
AMPEVENT_NODEGUARD	2	A node guarding (or heartbeat) error has occurred.
AMPEVENT_START_ACKNOWLEDGE	3	The Amplifier Object uses this event bit internally. It is set when the amplifier acknowledges a new move start.
AMPEVENT_FAULT	4	A latching amplifier fault has occurred. The specifics of what caused the fault can be obtained by calling ReadFaults and the fault conditions cleared by calling ClearFaults
AMPEVENT_ERROR	5	A non-latching amplifier error has occurred.
AMPEVENT_POSITION_WARNING	6	The amplifier's absolute position error is greater than the window set with PositionWarnWindow.
AMPEVENT_POSITION_WINDOW	7	The amplifier's absolute position error is greater than the window set with SettlingWindow
AMPEVENT_VELOCITY_WINDOW	8	The amplifier's absolute velocity error is greater than the window set with VelocityWarnWindow
AMPEVENT_DISABLED	9	The amplifier's outputs are disabled. The reason for the disable can be determined by calling ReadEventStatus,
AMPEVENT_POSITIVE_LIMIT	10	The positive limit switch is active.
AMPEVENT_NEGATIVE_LIMIT	11	The negative limit switch is active.
AMPEVENT_SOFTWARE_LIMIT_POSITIVE	12	The positive software limit is active.
AMPEVENT_SOFTWARE_LIMIT_NEGATIVE	13	The negative software limit is active.
AMPEVENT_QUICKSTOP	14	The amplifier is presently performing a quick stop sequence.
AMPEVENT_ABORT	15	The last profile was aborted without finishing
AMPEVENT_SOFTDISABLE	16	The amplifier is software disabled.
AMPEVENT_HOME_CAPTURE	17	A new home position has been captured.
AMPEVENT_PVT_EMPTY	18	The PVT buffer is empty.
AMPEVENT_PHASE_INIT	19	Amplifier is currently performing a phase initialization.
	20-30	Undefined
AMPEVENT_NOT_INITIALIZED	31	This amplifier's event mask has not yet been initialized (internal use only).

ReadFaults (faults As CML_AMP_FAULT)

Description: Reads the current state of the amplifier fault latch register.
Parameters:

faults	The value of the amp fault latch is returned here	Units: None

ClearFaults ()

Description: Clears amplifier faults. This function can be used to clear any latching faults on the amplifier
Parameters: None

Properties

FaultMask

Type: CML_AMP_FAULT
Description: Amplifier's fault mask. Fault mask identifies which conditions will be treated as latching faults by the amplifier
Units: None
Default: None

CML_AMP_FAULT

Value	Bit	Description
FAULT_DATAFLASH = 1	0	Fatal hardware error: the flash data is corrupt.
FAULT_ADCOFFSET = 2	1	Fatal hardware error: an A/D offset error has occurred.
FAULT_SHORT_CIRCUIT = 4	2	The amplifier detected a short circuit condition.
FAULT_AMP_TEMPERATURE = 8	3	The amplifier is over temperature.
FAULT_MOTOR_TEMPERATURE = 16	4	A motor temperature error was detected.
FAULT_OVER_VOLTAGE = 32	5	The amplifier bus voltage is over the acceptable limit.
FAULT_UNDER_VOLTAGE = 64	6	The amplifier bus voltage is below the acceptable limit.
FAULT_ENCODER_ERROR = 128	7	Encoder error.
FAULT_PHASE_ERROR = 256	8	Amplifier phasing error.
FAULT_TRACKING_ERROR = 512	9	Tracking error, the position error is too large.
FAULT_I^2T_LIMIT_ERROR = 1024	10	Current is limited by the I^2T algorithm.

5.18 Digital Inputs/Outputs

Input Methods

ReadInputDebouce (input As Integer, time As Long)

Description: Reads the debounce time for the specified input. This time specifies how long an input must remain stable at a new state before the amplifier recognizes the state.
Parameters:

input	The input to configure. Inputs are numbered starting from 0. Check amplifier data sheet for the number of inputs available	Units: None
time	The debounce time assigned to this input	Units: mS

WriteInputDebounce (input As Integer, time As Long)

Description: Writes the debounce time for the specified input. This time specifies how long an input must remain stable at a new state before the amplifier recognizes the state.

Parameters:

input	The input to configure. Inputs are numbered starting from 0. Check amplifier datasheet for the number of inputs available	Units: None
time	The debounce time assigned to this input.	Units: mS

ReadInputConfig (input As Integer, config As CML_INPUT_PIN_CONFIG)

Description: Gets the input configuration for the specified input. Each of the amplifier's inputs can be configured to perform some function.

Parameters:

input	Input to read. Inputs are numbered starting from 0. Check amplifier datasheet for number of inputs available	Units: None
config	Function assigned to the input	Units: None

ReadInputConfigMultiAxis (input As Integer, config As CML_INPUT_PIN_CONFIG, axis as Short)

Description: Gets the configuration and associated axis number for the specified input.

Parameters:

input	Input to read. Inputs are numbered starting from 0. Check amplifier datasheet for number of inputs available	Units: None
config	Function assigned to the input	Units: None
axis	The axis number this input is associated with (A=0, B=1, etc.)	Units: None

WriteInputConfig (input As Integer, config As CML_INPUT_PIN_CONFIG)

Description: Sets the input configuration for the specified input. Each of the amplifier's inputs can be configured to perform some function. *WriteInputConfig* configures the specified input to perform the specified function.

Parameters:

input	Input to read. Inputs are numbered starting from 0. Check amplifier datasheet for number of inputs available	Units: None
config	Function assigned to the input	Units: None

WriteInputConfigMultiAxis (input As Integer, config As CML_INPUT_PIN_CONFIG, axis as Short)

Description:

Sets the input configuration for the specified input.

Parameters:

input	Input to read. Inputs are numbered starting from 0. Check amplifier datasheet for number of inputs available	Units: None

config	Function assigned to the input	Units: None
axis	The axis number this input is associated with (A=0, B=1, etc.)	Units: None

CML_INPUT_PIN_CONFIG

INPUT_CONFIGURATION_NONE = 0
No function assigned to the input.

INPUT_CONFIGURATION_RESET_RISING = 2
Reset the amplifier on the rising edge of the input.

INPUT_CONFIGURATION_RESET_FALLING = 3
Reset the amplifier on the falling edge of the input.

INPUT_CONFIGURATION_POSITIVE_LIMIT_HIGH = 4
Positive limit switch; active high

INPUT_CONFIGURATION_POSITIVE_LIMIT_LOW = 5
Positive limit switch; active low

INPUT_CONFIGURATION_NEGATIVE_LIMIT_HIGH = 6
Negative limit switch, active high

INPUT_CONFIGURATION_NEGATIVE_LIMIT_LOW = 7
Negative limit switch, active low.

INPUT_CONFIGURATION_MOTOR_TEMPERATURE_HIGH = 8
Motor temperature sensor; active high

INPUT_CONFIGURATION_MOTOR_TEMPERATURE_LOW = 9
Motor temperature sensor, active low

INPUT_CONFIGURATION_CLEAR_FAULTS_HIGH = 10
Clear faults on the rising edge; disable while high

INPUT_CONFIGURATION_CLEAR_FAULTS_LOW = 11
Clear faults on the falling edge, disable while low

INPUT_CONFIGURATION_RESET_DISABLE_RISING = 12
Reset on rising edge; disable while high.

INPUT_CONFIGURATION_RESET_DISABLE_FALLING = 13
Reset on falling edge; disable while low.

INPUT_CONFIGURATION_HOME_HIGH = 14
Home switch; active high.

INPUT_CONFIGURATION_HOME_LOW = 15
Home switch; active low

INPUT_CONFIGURATION_DISABLE_HIGH = 16
Amplifier disable; active high

INPUT_CONFIGURATION_DISABLE_LOW = 17
Amplifier disable; active low.

INPUT_CONFIGURATION_PWM_SYNCH = 19
PWM synchronization. Only for high speed inputs (see data sheet).

INPUT_CONFIGURATION_MOTION_ABORT_HIGH = 20
Abort move in progress; keep the amplifier enabled and servoing; active high

INPUT_CONFIGURATION_MOTION_ABORT_LOW = 21
Abort move in progress; keep the amplifier enabled and servoing; active low

INPUT_CONFIGURATION_HIGH_RES_ANALOG_DIVIDE_HIGH = 22
A high input causes the firmware to divide the level of the analog input signal by 8

INPUT_CONFIGURATION_HIGH_RES_ANALOG_DIVIDE_LOW = 23
A low input causes the firmware to divide the level of the analog input signal by 8

INPUT_CONFIGURATION_HIGHSPEED_CAPTURE_RISING = 24
High speed position capture on rising edge

INPUT_CONFIGURATION_HIGHSPEED_CAPTURE_FALLING = 25
High speed position capture on falling edge

INPUT_CONFIGURATION_COUNT_EDGES_RISING = 26
Count rising edges of input, store the results to an indexer register

INPUT_CONFIGURATION_COUNT_EDGES_FALLING = 27
Count falling edges of input, store the results to an indexer register

INPUT_CONFIGURATION_ABORT_WINDOW_RISING = 36
Abort move on rising edge if not within N counts of destination position

INPUT_CONFIGURATION_ABORT_WINDOW_FALLING = 37
Abort move on falling edge if not within N counts of destination position

INPUT_CONFIGURATION_HV_LOSS_DISABLE_HIGH = 38
Mark HV loss on rising edge, disable while high.

INPUT_CONFIGURATION_HV_LOSS_DISABLE_LOW = 39
Mark HV loss on falling edge, disable while low.

INPUT_CONFIGURATION_TRJ_UPDATE_RISING = 40
Trajectory update on rising edge.

INPUT_CONFIGURATION_TRJ_UPDATE_FALLING = 41
Trajectory update on falling edge.

INPUT_CONFIGURATION_CLR_FAULTS_EVENTS_RISING = 42
Clear faults and event latch on rising edge.

INPUT_CONFIGURATION_CLR_FAULTS_EVENTS_FALLING = 43
Clear faults and event latch on falling edge.

INPUT_CONFIGURATION_DIS_SIM_ENC_L_BURST_RISING = 44
Disable simulated encoder output when low. Burst current position on encoder output on rising edge.

INPUT_CONFIGURATION_DIS_SIM_ENC_H_BURST_FALLING = 45
Disable simulated encoder output when high. Burst current position on encoder output on falling edge.

Input Properties

Inputs

Type: Integer
Description: Read-only. Gets the present hi/low states of the programmable inputs after debounce. The inputs are returned one per bit. The value of IN1 is returned in bit 0 (1 if high, 0 if low), IN2 in bit 1, etc.
Units: None
Default: None

Inputs32

Type: Integer
Description: Read-only. This is the 32-bit version of the Inputs property above.
Units: None
Default: None

IoPullup

Type: Integer
Description: State of the pull up/down resistors. Some Copley Controls amplifiers (see amplifier data sheet) have pull up/down resistors connected to a group of inputs. Each bit in the IoPullup property represents one pull up/down resistor; pull up/down resistor 1 is returned in bit 0, pull up/down resistor 2 is return in bit 2, etc. When the bit is set, the inputs connected to the resistor are pulled up to the high state when they are not connected. When the bit is cleared, the inputs are pulled down to a low state when they are not connected
Units: None
Default: None

IoPullup32

Type: Integer
Description: This is the 32-bit version of the IoPullup property above.
Units: None
Default: None

Output Methods

ReadOutputConfig (output As Short, config As CML_OUTPUT_PIN_CONFIG, mask As Integer)

Description: Reads the configuration for the specified output.
Parameters:

output	Input to read. Inputs are numbered starting from 0. Check amplifier datasheet for number of inputs available	Units: None

config	Function assigned to the input	Units: None
mask	A 32-bit mask used to select which status bits the output should track. If the output is configured for manual mode, then the mask is not used.	Units: None

ReadOutputConfigMultiAxis (output As Short, config As CML_OUTPUT_PIN_CONFIG, mask As Integer, axis As short)

Description: Reads the configuration for the specified output.
Parameters:

output	Input to read. Inputs are numbered starting from 0. Check amplifier datasheet for number of inputs available	Units: None
config	Function assigned to the input	Units: None
mask	A 32-bit mask used to select which status bits the output should track. If the output is configured for manual mode, then the mask is not used.	Units: None
axis	The axis number this output is associated with (A=0, B=1, etc.)	Units: None

ReadOutputConfigExt (output As Short, config As CML_OUTPUT_PIN_CONFIG, param1 As Integer, param2 As Integer)

Description: Reads the configuration for the specified output.
Parameters:

output	Input to read. Inputs are numbered starting from 0. Check amplifier datasheet for number of inputs available	Units: None
config	Function assigned to the input	Units: None
param1	The first 32-bit parameter that defines an output function (used for functions requiring 5 words of data).	Units: None
param2	The second 32-bit parameter that defines an output function (used for functions requiring 5 words of data).	Units: None

ReadOutputConfigExtMultiAxis (output As Short, config As CML_OUTPUT_PIN_CONFIG, param1 As Integer, param2 As Integer, axis As Short)

Description: Reads the configuration for the specified output.
Parameters:

output	Input to read. Inputs are numbered starting from 0. Check amplifier datasheet for number of inputs available	Units: None
config	Function assigned to the input	Units: None
param1	The first 32-bit parameter that defines an output function (used for functions requiring 5 words of data).	Units: None
param2	The second 32-bit parameter that defines an output function (used for functions requiring 5 words of data).	Units: None
axis	The axis number this output is associated with (A=0, B=1, etc.)	Units: None

WriteOutputConfig (output As Short, config As CML_OUTPUT_PIN_CONFIG, mask As Integer)

Description: Sets the configuration for the specified output. Each of the amplifier's outputs can be configured to event status tracking mode or manual mode, as specified by the *config* parameter.

Parameters:

output	The output to configure. Outputs are numbered starting from 0. Check amplifier datasheet for the number of outputs available	Units: None
config	The function to be assigned to this output.	Units: None
mask	A 32-bit mask used to select which status bits the outpu should track. If the output is configured for manual mod then the mask is not used.	Units: None

WriteOutputConfigMultiAxis (output As Short, config As CML_OUTPUT_PIN_CONFIG, mask As Integer, axis As Short)

Description: Sets the configuration for the specified output. Each of the amplifier's outputs can be configured to event status tracking mode or manual mode, as specified by the *config* parameter.

Parameters:

output	The output to configure. Outputs are numbered starting from 0. Check amplifier datasheet for the number of outputs available	Units: None
config	The function to be assigned to this output.	Units: None
mask	A 32-bit mask used to select which status bits the output should track. If the output is configured for manual mode, then the mask is not used.	Units: None
axis	The axis number this output is associated with (A=0, B=1, etc.)	Units: None

WriteOutputConfigExtMultiAxis (output As Short, config As CML_OUTPUT_PIN_CONFIG, param1 As Integer, param2 As Integer, axis As Short)

Description: Sets the configuration for the specified output. Each of the amplifier's outputs can be configured to event status tracking mode, position triggered mode, or manual mode, as specified by the *config* parameter

Parameters:

output	The output to configure. Outputs are numbered starting from 0. Check amplifier datasheet for the number of outputs available	Units: None
config	The function to be assigned to this output	Units: None
param1	The first 32-bit parameter that defines an output function (used for functions requiring 5 words of data).	Units: None
param2	The second 32-bit parameter that defines an output function (used for functions requiring 5 words of data).	Units: None
axis	The axis number this output is associated with (A=0, B=1, etc.)	Units: None

CML_OUTPUT_PIN_CONFIG

OUTPUT_CONFIGURATION_EVENT_STATUS_LOW = 0

The output follows the amplifier's event status register and is active low.

param1 A 32-bit mask used to select which status bits the output should track.

param2 Has no meaning. Set to zero.

OUTPUT_CONFIGURATION_ EVENT_STATUS_HIGH = 256

The output follows the amplifier's event status register and is active high

param1 A 32-bit mask used to select which status bits the output should track.

param2 Has no meaning. Set to zero.

OUTPUT_CONFIGURATION_EVENT_LATCH_LOW = 1

The output follows the latched version of the amplifier's event status register and is active low

param1 A 32-bit mask used to select which status bits the output should track.

param2 Has no meaning. Set to zero.

OUTPUT_CONFIGURATION_EVENT_LATCH_HIGH = 257

The output follows the latched version of the amplifier's event status register and is active high

param1 A 32-bit mask used to select which status bits the output should track.

param2 Has no meaning. Set to zero.

OUTPUT_CONFIGURATION_MANUAL_LOW = 2

The output is manually controlled using Outputs property and is active low. This method does not use parameters; set all parameters to zero.

OUTPUT_CONFIGURATION_MANUAL_HIGH = 258

The output is manually controlled using Outputs property and is active high. This method does not use parameters; set all parameters to zero.

OUTPUT_CONFIGURATION_TRAJECTORY_STATUS_LOW = 3

The output pin follows bits in the amplifier's trajectory status register and is active low.

OUTPUT_CONFIGURATION_ TRAJECTORY_STATUS_HIGH = 259

The output pin follows bits in the amplifier's trajectory status register and is active high.

param1 A 32-bit mask used to select which status bits the output should track.

param2 Has no meaning. Set to zero.

OUTPUT_CONFIGURATION_POSITION_WINDOW_LOW = 4

The output goes active low if the actual motor position is greater than param1 and less than param2

param1 Low edge of position trigger window. Units: Counts.

param2 High edge of position trigger window. Units: Counts.

OUTPUT_CONFIGURATION_POSITION_WINDOW_HIGH = 260

The output goes active high if the actual motor position is greater than param1 and less than param2

param1 Low edge of position trigger window. Units: Counts.

param2 High edge of position trigger window. Units: Counts.

OUTPUT_CONFIGURATION_MOTION_POSITIVE_LOW = 5

The output goes active low when the motor actual position crosses in the low-to-high direction through the point specified in param1. The pin stays active for amount of time specified in param2

param1 Trigger position. Units: Counts.

param2 Output active time. Units: milliseconds.

OUTPUT_CONFIGURATION_MOTION_POSITIVE_HIGH = 261

The output goes active high when the motor actual position crosses in the low-to-high direction through the point specified in param1. The pin stays active for amount of time specified in param2.

param1 Trigger position. Units: Counts.

param2 Output active time. Units: milliseconds.

OUTPUT_CONFIGURATION_MOTION_NEGATIVE_LOW = 6

The output goes active low when the motor actual position crosses in the high-to-low direction through the point specified in param1. The pin stays active for amount of time specified in param2.

param1 Trigger position. Units: Counts.

param2 Output active time. Units: milliseconds.

OUTPUT_CONFIGURATION_MOTION_NEGATIVE_HIGH = 262

The output goes active high when the motor actual position crosses in the high-to-low direction through the point specified in param1. The pin stays active for amount of time specified in param2

param1 Trigger position. Units: Counts.

param2 Output active time. Units: milliseconds.

OUTPUT_CONFIGURATION_TRIG_AT_POSITION_LOW = 7

The output goes active low when the motor actual position crosses in any direction through the point specified in param1. The pin stays active for amount of time specified in param2

param1 Trigger position. Units: Counts.

param2 Output active time. Units: milliseconds.

OUTPUT_CONFIGURATION_TRIG_AT_POSITION_HIGH = 263

The output goes active high when the motor actual position crosses in any direction through the point specified in param1. The pin stays active for amount of time specified in param2

param1 Trigger position. Units: Counts.

param2 Output active time. Units: milliseconds.

OUTPUT_CONFIGURATION_PWM_SYNCH = 512

PWM Synchronization. Note: Valid only on Output 0. This method does not use parameters; set all parameters to zero

Output Properties

Outputs

Type: Integer
Description: Reads or writes the present states (active/inactive) of the programmable outputs. When this property is read, the current active/inactive state of all outputs is returned. Each output is represented by one bit in the returned value; bit 0 for output 1, bit 1 for output 2, etc. When this property is written, it is used to control the active/inactive state of any outputs that are configured to operate in manual mode. Writing a 1 to a bit causes the corresponding output to become active; writing a 0 causes the output to become inactive. Bits corresponding to outputs that are not configured in manual mode are ignored
Units: None
Default: None

5.19 Amplifier Events

Methods

CreateEvent (mask As CML_AMP_EVENT, condition As CML_EVENT_CONDITION) As EventObj

Description: Creates an instance of EventObj, using specified parameters to monitor amplifier events.
Parameters:

mask	The bit-mapped value that indicates which events are to be monitored	Units: None
condition	The trigger condition for the events that will result in the event callback method being called (e.g. all events in the mask)	Units: None

CreateInputEvent (mask As Integer, condition As CML_EVENT_CONDITION) As EventObj

Description: Reads the configuration for the specified output.
Parameters:

mask	A bit-mapped value that indicates which digital input pin is to be monitored. Each corresponds to one input pin; bit 0 for input 0, bit 1 for input 1, etc	Units: None
condition	The trigger condition for the events that will result in the event callback method being called (e.g. all events in the mask)	Units: None

CML_EVENT_CONDITION

CML_EVENT_ANY = 1
Any event occurring
CML_EVENT_ALL = 2
All the events are required
CML_EVENT_NONE = 3
None of the events

5.20 Amplifier Trace

The trace system allows internal amplifier parameters to be sampled and stored at a specified interval. The stored data may later be downloaded for analysis. The typical sequence of steps involved to run the trace is as follows:

1 Set up the trace channels, sample period and trigger.
2 Start the trace.
3 Monitor the status until the trace has triggered and no longer running.
4 Read in the trace data.

The example, EX7_Trace, is provided with the installation of CMO. This example demonstrates the steps necessary to run the trace and save the trace data to a file.

Methods

ReadTraceStatus (status As CML_AMP_TRACE_STATUS, samplesCollected As Short, maxSamples As Short)

Description: Read the status of the amplifier's trace system as a bit mapped value. For most tracing applications, only the first two bits are observed.

Bit	Definition
0	Trace is running
1	Trace has triggered
2	Sampled mode
3	Trace will ignore initial delays

A typical sequence is as follows:

1 The trace is started; bit 0 will be set to indicate that the trace is running.
2 When the trigger condition is met, bit 1 will be set.
3 Once the trigger occurs, the trace will start collecting data.
4 The trace is done collecting data; bit 0 will be cleared and the trace data can be read.

Parameters:

status	Information on whether the trace is currently running is returned in this parameter	Units: None
samplesCollected	The total number of trace samples collected is returned here	
maxSamples	The maximum number of trace samples that will fit in the internal buffer is returned here. This value will change depending on how many trace channels are active and which variables are selected.	

CML_AMP_TRACE_STATUS

TRACE_STATUS_RUNNING = 1
Trace is currently collecting data.

TRACE_STATUS_TRIGGERED = 2
Trace has been triggered

TRACE_STATUS_SAMPLED = 4
Trace is currently in sampled mode

TRACE_STATUS_NODELAY = 8
Trace is configured to ignore initial delays

ReadTraceRefPeriod (ref Period As Integer)

Description: Read-only. Read the fundamental period used with the amplifier's trace. The amplifier internally samples its trace channels at multiples of this time. For example, if the amplifier's reference period is 62500 nanoseconds, then setting the trace period to 10 would indicate that the amplifier should sample its internal variables every 625 μS.

Parameters:

refPeriod	The reference period is returned here.	Units: nS

WriteTracePeriod (tracePeriod As Short)

Description: Set the trace period. The rate at which samples are read by the trace is the product of this value and the TraceRefPeriod.

Parameters:

tracePeriod	The trace period to be set	Units: multiple of TraceRefPeriod

ReadTracePeriod (tracePeriod As Short)

Description: Set the trace period. The rate at which samples are read by the trace is the product of this value and the TraceRefPeriod.

Parameters:

tracePeriod	The trace period is returned here	Units: multiple of TraceRefPeriod

WriteTraceTrigger (type As CML_AMP_TRACE_TRIGGER, channel As Short, level As Integer, delay As Short)

Description: Configure the trace trigger. The trigger resembles the trigger on an oscilloscope. It allows an event to be specified which will cause the trace to start collecting data. Most trigger types watch one of the trace channels and constantly compare its value to a level. The type of comparison made will depend on the type of trigger. For example, the trace can be triggered on the rising edge of a signal, on the falling edge, etc. The trigger also allows a delay value to be specified. The delay specifies the number trace periods to wait after the trigger occurs to start collecting samples. The delay can also be negative, in which case the delay specifies the number of trace periods to collect data before the trigger occurs.

Parameters:

type	The trigger type	Units: None
channel	The trace channel to watch. This parameter defaults to 0 if not specified	Units: None
level	The trigger level. This parameter defaults to 0 if not specified	Units: Varies with trigger type and the trace channel variable
delay	The delay between the occurrence of the trigger and the start of data collection.	Units: trace periods

ReadTraceTrigger (type As CML_AMP_TRACE_TRIGGER, channel As Short, level As Integer, delay As Short)

Description: Get the current configuration of the trace trigger.

Parameters:

type	The type of trigger to be used	Units: None
channel	Which channel to trigger on	Units: None
level	The trigger level	Units: Varies with trigger type and the trace channel variable

delay	The delay between the occurrence of the trigger and the start of data collection. Defaults to 0 if not specified	Units: trace periods

CML_AMP_TRACE_TRIGGER

TRACETRIG_NONE = 0
Trace trigger type none. The trace is triggered immediately on start

TRACETRIG_ABOVE = 256
Trigger as soon as the value on the selected variable is above the trigger level

TRACETRIG_BELOW = 512
Trigger as soon as the value on the selected variable is below the trigger level.

TRACETRIG_RISE = 768
Trigger when the value on the selected variable changes from below the trigger level to above it.

TRACETRIG_FALL = 1024
Trigger when the value on the selected variable changes from above the trigger level to below it

TRACETRIG_BITSET = 1280
Treat the trigger level as a bit mask which selects one or more bits on the selected trace variable. The trigger occurs as soon as any of the selected bits are set.

TRACETRIG_BITCLR = 1536
Treat the trigger level as a bit mask which selects one or more bits on the selected trace variable. The trigger occurs as soon as any of the selected bits are clear.

TRACETRIG_CHANGE = 1792
Trigger any time the selected trace variable value changes

TRACETRIG_EVENTSET = 2048
Treat the trigger level as a bit mask which selects one or more bits on the amplifier's event status register. The trigger occurs as any of the selected bits are set

TRACETRIG_EVENTCLR = 2304
Treat the trigger level as a bit mask which selects one or more bits on the amplifier's event status register. The trigger occurs as any of the selected bits are clear

TRACETRIG_FGEN_CYCLE = 2560
Trigger at the start of the next function generator cycle. This trigger type is only useful when running in function generator mode

TRACETRIG_NODELAY = 16384
If this bit is set, then the trigger can occur even if the trace setup delay has not yet occurred

TRACETRIG_SAMPLE = 32768
Only take a single sample for each trigger. Normally, the occurrence of the trigger causes the trace to begin sampling data and stop when the trace buffer is full.

ReadTraceMaxChannel (maxChannels As Short)

Description: Return the maximum number of trace channels supported by the amplifier.
Parameters:

maxChannels	The number of channels is returned here	Units: None

TraceStart ()

Description: Start collecting trace data on the amplifier. The trace will automatically stop once the amplifier's internal trace buffer fills up.
Parameters: None

TraceStop ()

Description: Stop collecting trace data on the amplifier.
Parameters:
None

ReadTraceData (traceDataArray As Integer, dataCount As Integer)

Description: Upload any trace data captured in the amplifier. Trace data should only be uploaded when the trace has both triggered and stopped. Uploading data during data collection can cause corrupt data to be uploaded. The trace data is returned as an array of 32-bit integer values. The data for all active channels is contained within the trace data array. For example, if there are three active channels, then the trace data array will be formatted as shown below:

Index 0	Index 1	Index 2	Index 3	Index 4	Index 5	Index 6	Index7	Index 8
Chan 1	Chan 2	Chan 3	Chan 1	Chan 2	Chan 3	Chan 1	Chan 2	Chan 3

Parameters:

traceDataArray	An array where the trace data will be returned	Units: None
dataCount	On entry to this call, this parameter must hold the maximum number of samples to upload. Upon successful return, this parameter will contain the total number samples returned.	Units: None

WriteTraceChannel (channel As Short, traceVar CML_AMP_TRACE_VAR)

Description: Set the trace variable associated with the specified channel.
Parameters:

channel	The trace channel that the variable will be assigned to (zero based).	Units: None
traceVar	The trace variable to sample	Units: None

WriteTraceChannel (channel As Short, traceVar CML_AMP_TRACE_VAR, axis As Integer)

Description: Set the trace variable associated with the specified channel.
Parameters:

channel	The trace channel that the variable will be assigned to (zero based).	Units: None
traceVar	The trace variable to sample	Units: None
axis	The axis number this channel is associated with (A=0, B=1, etc.)	Units: None

ReadTraceChannel (channel As Short, traceVar CML_AMP_TRACE_VAR)

Description: Read the trace variable associated with the specified channel.
Parameters:

channel	The trace channel to get (zero based)	Units: None
traceVar	The trace variable assigned to this channel will be returned here	Units: None

ReadTraceChannel (channel As Short, traceVar CML_AMP_TRACE_VAR, axis As Integer)

Description: Read the trace variable associated with the specified channel.
Parameters:

channel	The trace channel to get (zero based)	Units: None
traceVar	The trace variable assigned to this channel will be returned here	Units: None
axis	The axis number this channel is associated with (A=0, B=1, etc.)	Units: None

CML_AMP_TRACE_VAR

TRACEVAR_CRNT_U = 3
Actual current, U winding. Units: 0.01 A.

TRACEVAR_CRNT_V = 4
Actual current, V winding. Units: 0.01 A

TRACEVAR_ANALOG_REF = 5
Analog reference input. Units: mV

TRACEVAR_HIGH_VOLT = 6
High voltage bus. Units: 0.1 V

TRACEVAR_CRNT_CMD = 7
Commanded current (before limiting). Units: 0.01 A

TRACEVAR_CRNT_LIM = 8
Commanded current (after limiting). Units: 0.01 A

TRACEVAR_CRNT_CMD_D = 9
Commanded current, D axis. Units: 0.01 A

TRACEVAR_CRNT_CMD_Q = 10
Commanded current, Q axis. Units: 0.01 A

TRACEVAR_CRNT_ACT_D = 13
Actual current, calculated for D axis. Units: 0.01 A

TRACEVAR_CRNT_ACT_Q = 14
Actual current, calculated for Q axis. Units: 0.01 A.

TRACEVAR_CRNT_ERR_D = 15
Current loop error, D axis. Units: 0.01 A

TRACEVAR_CRNT_ERR_Q = 16
Current loop error, Q axis. Units: 0.01 A

TRACEVAR_VOLT_D = 19
Current loop output voltage, D axis. Units: 0.1 V

TRACEVAR_VOLT_Q = 20
Current loop output voltage, Q axis. Units: 0.1 V

TRACEVAR_VEL_MTR = 23
Motor velocity filtered. Units: 0.1 encoder counts / second

TRACEVAR_VLOOP_CMD = 24
Velocity loop commanded velocity (before limiting). Units: 0.1 encoder counts / second.

TRACEVAR_VLOOP_LIM = 25
Velocity loop commanded velocity (after limiting). Units: 0.1 encoder counts / second

TRACEVAR_VLOOP_ERR = 26
Velocity loop error. Units: 0.1 encoder counts / second

TRACEVAR_LOAD_POS = 28
Load encoder position. Units: encoder counts.

TRACEVAR_CMD_POS = 29
Commanded position from trajectory generator. Units: encoder counts

TRACEVAR_POS_ERR = 30
Position error. Units: encoder counts

TRACEVAR_MTR_POS = 31
Motor encoder position. Units: encoder counts

TRACEVAR_RAW_INPUTS = 33
Digital input pins (before debounce).

TRACEVAR_PHASE = 36
Motor phase angle. Units: 0.1 degree

TRACEVAR_TEMP = 37
Amplifier temperature. Units: degrees C

TRACEVAR_EVENTS = 38
Event status register.

TRACEVAR_EVENTLATCH = 39
Latched version of event status register

TRACEVAR_HALLS = 40
Hall sensor state

TRACEVAR_VEL_LOAD = 43
Load encoder velocity. Units: 0.1 encoder counts / second

TRACEVAR_CMD_VEL = 44

Commanded velocity from trajectory generator.
Units: 0.1 encoder counts / second

TRACEVAR_CMD_ACC = 45
Commanded acceleration from trajectory generator. Units: 10 encoder counts / second / second

TRACEVAR_ENC_SIN = 46
Analog encoder sine. Units: 0.1 mV.

TRACEVAR_ENC_COS = 47
Analog encoder cosine. Units: 0.1 mV

TRACEVAR_INPUTS = 48
Digital input pins (after debounce)

TRACEVAR_DEST_POS = 49
Destination position. Units: encoder counts

TRACEVAR_VEL_RAW = 50
Motor velocity, unfiltered. Units: 0.1 encoder counts / second

TRACEVAR_PASSIVE_ENC_POS = 51,
Passive encoder position

TRACEVAR_GAIN_SCHED_KEY = 52,
Gain scheduling key

TRACEVAR_POS_P_GAIN = 53,
Position loop proportional gain

TRACEVAR_VEL_P_GAIN = 54,
Velocity loop proportional gain

TRACEVAR_VEL_I_GAIN = 55,
Velocity loop integral gain

TRACEVAR_AMP_I2T_SUM = 56,
Amplifier's I2T sum

TRACEVAR_USER_I2T_SUM = 57,
User's I2T sum

TRACEVAR_ANALOG_ENC_INDEX = 59,
Analog encoder index pulse

TRACEVAR_COMMANDED_U = 60,
Commanded current U

TRACEVAR_COMMANDED_V = 61,
Commanded current V

TRACEVAR_CUR_OFFSET_CSP = 62,
Current offset, CSP mode

TRACEVAR_VEL_OFFSET_CSP = 63,
Velocity offset, CSP mode

TRACEVAR_RAW_ENCODER = 66
Raw encoder values

5.21 Other Methods and Properties

Methods

Reset ()

Description: Resets the Amplifier and re-initializes the Amplifier Object.
Parameters: None

SDO_Dnld (index As Short, sub As Short, data As Object)

Description: Downloads data to the amplifier via a CAN SDO transfer.
Parameters:

index	Index of a CANopen dictionary object	Units: None
sub	Sub-index of a CANopen dictionary object	Units: None
data	The data that is to be transferred. This data can be one of four types: 8-bit, 16-bit, 32-bit, or String	Units: None

SDO_Upld (index As Short, sub As Short, data As Object)

Description: Uploads data from the amplifier via a CAN SDO transfer.
Parameters:

index	Index of a CANopen dictionary object	Units: None
sub	Sub-index of a CANopen dictionary object	Units: None
data	The data that is to be transferred. This data can be one of four types: 8-bit, 16-bit, 32-bit, or String	Units: None

SDO_DnldExt (index As Short, sub As Short, data As Byte, size As Integer)

Description: Downloads data to the amplifier via a CAN SDO transfer.
Parameters:

index	The input to configure. Inputs are numbered starting from 0. Check amplifier data sheet for the number of inputs available	Units: None
time	The debounce time assigned to this input	Units: None
data	The data that is to be transferred	Units: None
size	The number of bytes of data to be downloaded	Units: None

SDO_UpldExt (index As Short, sub As Short, data As Byte, size As Integer)

Description: Uploads data from the amplifier via a CAN SDO transfer.
Parameters:

index	The input to configure. Inputs are numbered starting from 0. Check amplifier data sheet for the number of inputs available	Units: None
time	The debounce time assigned to this input	Units: None
data	The data that is to be transferred	Units: None
size	On entry this gives the max number of bytes of data to be uploaded. On successful return this gives the actual number of bytes received	Units: None

SetRPDO (slot As UShort, rpdo As RPDOObj)
SetTPDO (slot as UShort, tpdo As TPDOObj)

Description: Associates the passed RPDO/TPDO with the node.
Parameters:

slot	The PDO slot to assign the PDO to	Units: None
rpdo/tpdo	The rpdo/tpdo object	Units: None

EnableRPDO (slot As UShort, rpdo As RPDOObj)
EnableTPDO (slot As UShort, tpdo As TPDOObj)

Description: Enables the passed RPDO/TPDO in the corresponding slot.
Parameters:

slot	The PDO slot to assign the PDO to	Units: None
rpdo/tpdo	The rpdo/tpdo object	Units: None

DisableRPDO (slot As UShort)
DisableTPDO (slot As UShort)

Description: Disables the RPDO/TPDO in the corresponding slot.
Parameters:

slot	The PDO slot number	Units: None

SavePDOmappingToFlash (saveProfile As Boolean)

Description: Save the current PDO mapping to flash.
Parameters:

saveProfile	If true, the device profile parameters will be saved	Units: None

Properties

CountsPerUnit

Type: Double
Description: Adjustable number of encoder counts/user distance unit. The default value is 1.0 (user distance units are in encoder counts). Also controls velocity, acceleration, and jerk units. These units are always based on a time interval of seconds.
Units: None
Default: None

AmpTemp

Type: Short
Description: Read-only. Get the current amplifier temperature
Units: degrees C
Default: None

HighVoltage

Type: Short
Description: Read-only. Gets the high voltage bus voltage
Units: 0.1 V
Default: None

RefVoltage

Type: Short
Description: Read-only. Gets the analog reference input voltage
Units: mV

Default: None

AmpMode

Type: CML_AMP_MODE
Description: Read-only. The currently active amplifier mode of operation
Units: None
Default: None

AmpModeWrite

Type: CML_AMP_MODE
Description: Change the amplifiers mode of operation
Units: None
Default: None

CML_AMP_MODE

AMPMODE_SERVO_CAN_PROFILE = 7681
A true CANopen position mode. The CANopen network sends move commands to the amplifier, and the amplifier uses its internal trajectory generator to perform the moves. Conforms to the CANopen Device Profile for Motion Control (DSP-402) profile position mode

AMPMODE_SERVO_CAN_VELOCITY = 7683
In this mode the CANopen network commands target velocity values to the amplifier. The amplifier uses its programmed acceleration and deceleration values to ramp the velocity up/down to the target. Note that support for profile velocity mode was added in amplifier firmware version 3.06

AMPMODE_SERVO_CAN_TORQUE = 7684
In this mode, the network controller sends target torque values to the drive. When the drive is enabled, or the torque command is changed, the motor torque ramps to the new value at the rate programmed in the property Torque Slope. When the drive is halted, the torque ramps down at the same rate.
When using Profile Torque mode, the property HaltMode can be set to any mode except HALT_DISABLE, because HALT_DISABLE will disable the amplifier with no torque ramp.
If the torque target value is changed while the amplifier is enabled, the torque will ramp to the new target.
The units for torque target, demand, and actual are per thousand of the motor's rated torque. The units for torque slope are per thousand of the motor's rated torque per second.
The profile torque mode cannot be used with a stepper motor

AMPMODE_SERVO_CAN_HOMING = 7686
A true CANopen position mode. Used to home the motor (find the motor zero position) under CANopen control. Conforms to DSP-402 homing mode

AMPMODE_SERVO_CAN_PVT = 7687
A true CANopen position mode. In this mode the CANopen master calculates the motor trajectory and streams it over the CANopen network as a set of points that the amplifier interpolates between. This mode conforms to the CANopen device profile for motion control (DSP-402) interpolated position mode

AMPMODE_STEPPER_CAN_PROFILE = 10241
Same as AMPMODE_SERVO_CAN_PROFILE, but used with stepper capable amplifiers

AMPMODE_STEPPER_CAN_VELOCITY = 10243
Same as AMPMODE_SERVO_CAN_ VELOCITY, but used with stepper capable amplifiers

AMPMODE_STEPPER_CAN_HOMING = 10246
Same as AMPMODE_SERVO_CAN_ HOMING, but used with stepper capable amplifiers

AMPMODE_STEPPER_CAN_PVT = 10247
Same as AMPMODE_SERVO_CAN_PVT, but used with stepper capable amplifiers

6. Linkage

6.1 LinkageSettingsObj

Overview

The Linkage Settings Object contains the settings for the LinkageObj. All the properties have both read and write access. This object is passed in as a parameter in the InitializeExt method of the LinkageObj to customize the settings.

Example:

1 Declare and create an instance of LinkageSettingsObj.

```
Dim LinkageSettings As LinkageSettingsObj
LinkageSettings = New LinkageSettingsObj()
```

2 Change one or more properties of the LinkageSettingsObj.

```
LinkageSettings.moveAckTimeout = 400
```

3 Call one of the Extended Initialization methods of the ampObj.

```
Linkage.InitializeExt(ampArray, LinkageSettings)
```

Properties

moveAckTimeout

Type: Short
Description: Node guarding guard time. This property gives the node-guarding period for use with this node. This is the period between node guarding request messages sent by the master controller.
Units: mS
Default: 200

haltOnPosWarn

Type: Boolean
Description: When set to true, the linkage move will be halted when a position warning occurs.
Units: none
Default: false

haltOnVelWin

Type: Boolean
Description: When set to true, the linkage move will be halted when the velocity is outside the velocity window.
Units: none
Default: false

6.2 LinkageObj

Overview

The Linkage Object allows the programmer to "link" a group of amplifiers to perform coordinated motion. A move using the Linkage Object will start moving all the linked amplifiers at the same time and end the move at the same time.

Methods

Initialize (ampArray As AmpObj)

Description: Initializes the Linkage object with the array of amp objects passed in as a parameter. These amp objects will be linked together upon successful initialization.

Parameters:

ampArray	Array of one or more AmpObj (which have already been initialized)	Units: None

InitializeExt (ampArray As AmpObj, linakeSettings as LinkageSettingsObj)

Description: Initializes the Linkage object with the array of amp objects and the linkage settings passed in as parameters. The amp objects in the ampArray will be linked together upon successful initialization.

Parameters:

ampArray	Array of one or more AmpObj (which have already been initialized)	Units: None
LinkageSettings	Array of one or more AmpObj (which have already been initialized)	Units: None

MoveTo (positionArray As Double)

Description: Performs a multi-axis move to the positions specified by an array containing one position per axis.

Parameters:

positionArray	Contains the target positions for each axis	Units: Double

ReadMoveLimits (vel As Double, acc As Double, dec As Double, jrk As Double)

Description: Reads the limits for a move.

Parameters:

vel	Velocity limit	Units: User defined units/second
acc	Acceleration limit	Units: User-defined units/second^2
dec	Deceleration limit	Units: User-defined units/second^2
jrk	Jerk limit (maximum rate of change of acceleration)	Units: User-defined units/second^3

SetMoveLimits (vel As Double, acc As Double, dec As Double, jrk As Double)

Description: Sets the limits for the move.

Parameters:

vel	Velocity limit	Units: User defined units/second

acc	Acceleration limit	Units: User-defined units/second^2
dec	Deceleration limit	Units: User-defined units/second^2
jrk	Jerk limit (maximum rate of change of acceleration)	Units: User-defined units/second^3
ampArray	Array of one or more AmpObj (which have already been initialized)	Units: None

TrajectoryInitialize (positions As Double, velocities As Double, times As Integer, lowWater As Integer)

Description: Initializes and starts a PVT (Position-Velocity-Time) trajectory move on a Linkage Object. The linked amplifiers will queue up the PVT segments and find the best-fit curve for each set of three PVT segments.

Parameters:

Positions	A two-dimensional array of positions declared as numOfSegments, numOfAxis	Units: Counts
Velocities	A two-dimensional array of velocities declared as numOfSegments, numOfAxis	Units: User defined units/second
Times	A single dimensional array of delta time values representing times from 1 to 255 milliseconds. A time value of zero indicates to the amplifier that the trajectory is complete. The length of this array, as of the position and velocity arrays, must be equal to the number of segments	Units: mS
lowWater	This is the level of PVT segments left in the Copley Motion Object buffer on the PC at which CMO generates an event requesting more PVT segments. This number must be less than the number of segments	Units: None

SendPath (pathObj As PathPlanningObj, startPath As Boolean)

Description: Initializes a two-dimensional path on a Linkage Object. If the boolean value is true, the path is executed immediately. If it is false, the path is loaded but not executed.

Parameters:

pathObj	A path planning object	Units: None
startPath	A boolean value defining whether to execute the path immediately or not.	Units: None

SendPvtConstAccelTrj (pvtConstAccelTrjObj As PvtConstAccelTrjObj, startPvtTrj As Boolean)

Description: Initializes a PVT trajectory on a Linkage Object. If the boolean value is true, the PVT trajectory is executed immediately. If it is false, the trajectory is loaded but not executed.

Parameters:

pvtConstAccelTrjObj	A PVT constant acceleration trajectory object	Units: None
startPvtTrj	A boolean value defining whether to execute the PVT trajectory immediately or not.	Units: None

TrajectoryAdd (positions As Double, velocities As Double, times As Integer, lowWater As Integer)

Description: This method adds PVT segments to the CMO PVT buffer waiting to be sent to the amplifier. (Note: this buffer is used in addition to the 32-deep PVT buffer on the amplifier.) This method is typically used within the handler for the TrajectoryEventNotify event handler such that new PVT segments can be sent to the amplifier when the CMO PVT trajectory generator reaches the lowWater level.

Parameters:

Positions	A two dimensional array of positions declared as numOfSegments, numOfAxis	Units: Counts
Velocities	A two dimensional array of velocities declared as numOfSegments, numOfAxis	Units: User defined units/second
Times	A single dimensional array of delta time values representing times from 1 to 255 milliseconds. A time value of zero indicates to the amplifier that the trajectory is complete. The length of this array, as of the position and velocity arrays, must be equal to the number of segments	Units: mS
lowWater	This is the level of PVT segments left in the Copley Motion Object buffer on the PC at which CMO generates an event requesting more PVT segments. This number must be less than the number of segments	Units: None

WaitMoveDone (timeout As Long)

Description: Wait until the multi axis move is complete. This method is blocking. When called, it will not return until either the event occurs, the timeout expires, a fault occurs, or a move is aborted. If a timeout occurs, CMO will report the timeout by throwing an exception.

Parameters:

timeout	The timeout for the wait. If < 0, then wait indefinitely	Units: mS

HaltMove ()

Description: Halt the current move. The exact type of halt can be programmed individually for each axis using the AmpObj property HaltMode.

Parameters:

None

CreateEvent (mask As CML_LINK_EVENT, condition As CML_EVENT_CONDITION) As EventObj

Description: Creates an instance of the EventObj that monitors amplifier events and sets them up using the specified parameters.

Parameters:

mask	A bit-mapped value that indicates which events are to be monitored	Units: None
condition	The trigger condition for the events that will result in the event callback method being called (e.g. all events in the mask). See	
eventObject	The EventObj instance created by this method	

CML_LINK_EVENT

Value	Bit	Description
LINKEVENT_MOVEDONE	0	Set when all amplifiers attached to this linkage have finished their moves and have settled in to position at the end of the move. Cleared when a new move is started on any amplifier.
LINKEVENT_TRJDONE	1	Set when all amplifiers attached to the linkage have finished their moves, but have not yet settled into position at the end of the move. Cleared when a new move is started on any amplifier.
LINKEVENT_NODEGUARD	2	A node guarding (or heartbeat) error has occurred. This indicates that one of the amplifiers failed to respond within the expected amount of time for either a heartbeat or node-guarding message.
LINKEVENT_FAULT	4	A latching fault has occurred on one of the amplifiers attached to this linkage.
LINKEVENT_ERROR	5	A non-latching error has occurred on one of the amplifiers.
LINKEVENT_POSWARN	6	One of the amplifiers is reporting a position-warning event.
LINKEVENT_POSWIN	7	One of the amplifiers is reporting a position window event.
LINKEVENT_VELWIN	8	One of the amplifiers is reporting a velocity window event.
LINKEVENT_DISABLED	9	One of the amplifiers is currently disabled.
LINKEVENT_POSLIM	10	The positive limit switch of one or more amplifier is currently active.
LINKEVENT_NEGLIM	11	The negative limit switch of one or more amplifier is currently active.
LINKEVENT_SOFTLIM_POS	12	The positive software limit of one or more amplifier is currently active.
LINKEVENT_SOFTLIM_NEG	13	The negative software limit of one or more amplifier is currently active.
LINKEVENT_QUICKSTOP	14	One of the linkage amplifiers is presently performing a quick stop sequence or is holding in quick stop mode. The amplifier must be disabled to clear this.
LINKEVENT_ABORT	15	One or more amplifier aborted the last profile without finishing.
LINKEVENT_LOWWATER	31	The active PVT profile is at or below the low water mark and needs more data points.

7. The Event Object

Overview

The eventObj allows an application program to be event-driven by having a function called when an event occurs in the amplifier. This eliminates the need for polling for the event. The eventObj is created by calling the CreateEvent method for: AmpObj, LinkageObj, and IOObj. The recommended steps for using the EventObj are as follows:

1 Declare an EventObj variable:

```
// C#
eventObj xAxisEventObj;
```

```
'VB
Friend WithEvents YAxisEventObj As eventObj
```

2 Create the event:

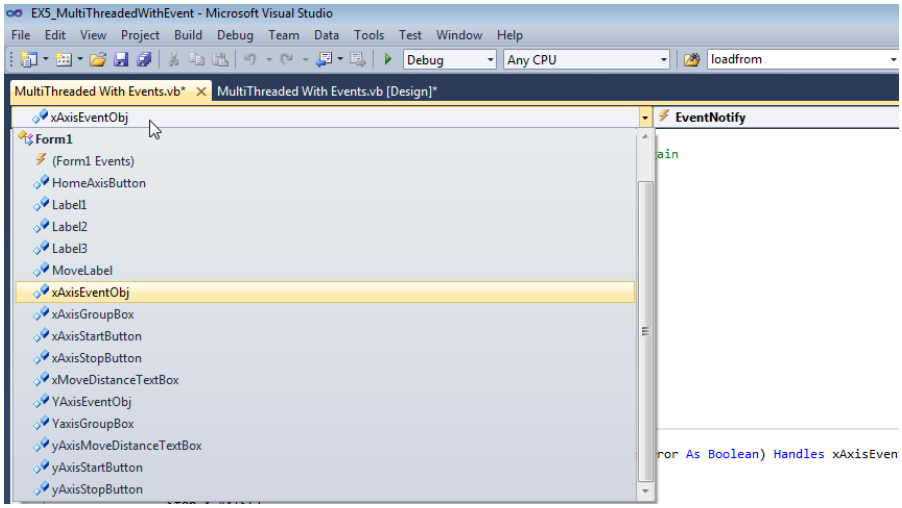
```
// C#
xAxisEventObj = AmpX.CreateEvent(CML_AMP_EVENT.AMPEVENT_MOVE_DONE,
CML_EVENT_CONDITION.CML_EVENT_ANY);
```

```
'VB
xAxisEventObj = AmpX.CreateEvent(CML_AMP_EVENT.AMPEVENT_MOVE_DONE,
CML_EVENT_CONDITION.CML_EVENT_ANY)
```

3 Register the callback method with the eventObj.

```
// C#
xAxisEventObj.EventNotify += new eventObj.EventHandler(xAxisEventObj_EventNotify);
```

```
' VB
' In order to associate the callback method with the eventObj, select the eventObj
' variable from the variable list in Visual Studio as shown below.  Then, select
' EventNotify from the list on the right.  This will create the callback method.
```



4 Start the eventObj:

```
' C# and VB
xAxisEventObj.Start(False, 50000)
```

5 Implement the callback method to handle the event in a manner appropriate with the application.

Methods

Start (repeats As Boolean, timeout As Long)

Description: Starts the event monitor.
Parameters:

repeats	Set to true to set up the event monitor to perform a callback each time the event occurs until the event monitor is stopped. Set to false to set up the event monitor to perform a callback on a one-time basis. When set up for repeating events, the event condition must go away, then come back for the event callback to occur again	Units: None
timeout	The timeout for the wait. If < 0, then wait indefinitely. Units: milliseconds. If the timeout expires before the event occurs, then the callback routine will be called with its second parameter (hasError) set to true	

Stop ()

Description: Stops the event monitor.
Parameters: None

Wait (timeout As Long)

Description: Wait on the event. This method is blocking. When called, it will not return until either the event occurs, or the timeout expires. If a timeout occurs, CMO will report the timeout in the form of a COM compatible error object.
Parameters:

timeout	The timeout for the wait. If < 0, then wait indefinitely	Units: mS

Callback

EventNotify (match As CML_AMP_EVENT, timeout As Boolean)

Description: Returns the contents of the register that was set up to trigger the event. The timeout variable will be true if the timeout period expired.
Parameters:

match	The contents of the register that was set up to trigger the event	Units: None
timeout	*True* if a timeout or error occurred, *False* otherwise. Should be checked for an error condition before processing the event handling code	

8. The I/O Object

Overview

The functions described here support I/O devices that comply to the CiA profile DS-401: CANopen Device Profile for Generic I/O Modules.

Methods

Initialize (canOpenObj As CANopenObj, nodeId As Integer)

Description: Initializes the I/O device with the CANOpenObj and the specified node ID.
Parameters:

canOpenObj	An instance of a CanOpenObj that has already been initialized	Units: None
nodeid	The node ID of the I/O module	Units: None

InitializeExt (canOpenObj As CANopenObj, nodeId As Integer, IOSettingsObj As IOSettings)

Description: Initializes the I/O device with the CANOpenObj and the specified node ID. Also, through the IOsettingsObj parameter, allows the CAN network settings for an I/O module to be set at initialization time. This is necessary if PDO mapping is to be turned off for a particular I/O module.
Parameters:

canOpenObj	An instance of a CanOpenObj that has already been initialized	Units: None
nodeid	The node ID of the I/O module	Units: None
IOsettingsObj	Allows the CAN network settings for an I/O module to be set at initialization time	Units: None

CreateEvent (mask As CML_IOMODULE_EVENTS, condition As CML_EVENT_CONDITION) As EventObj

Description: Creates an instance of the EventObj that monitors I/0 events and sets them up using the specified parameters.
Parameters:

mask	A bit-mapped value that indicates which events are to be monitored	Units: None
condition	Trigger condition for the events that will result in the callback method being called (e.g. all events in the mask)	Units: None

CML_IOMODULE_EVENTS

IOEVENT_AIN_PDO0 = 0x10000
Trigger when any of the first 4 analog inputs generates an event.

IOEVENT_AIN_PDO1 = 0x20000
Trigger when any of the second 4 analog inputs generates an event

IOEVENT_AIN_PDO2 = 0x40000
Trigger when any of the third 4 analog inputs generates an event

IOEVENT_DIN_PDO0 = 0x0001
Trigger when first 64 digital inputs change state.

SDO_Dnld (index As Integer, sub As Integer, data As Object)

Description: Downloads data to the IO module via a CAN SDO transfer.
Parameters:

index	Index of a CANopen dictionary object	Units: None
sub	Sub-index of a CANopen dictionary object	Units: None
data	The data that is to be transferred. This data can be one of four types: 8-bit, 16-bit, 32-bit, or String	Units: None

SDO_Upld (index As Integer, sub As Integer, data As Object)

Description: Uploads data from the IO module via a CAN SDO transfer.
Parameters:

index	Index of a CANopen dictionary object	Units: None
sub	Sub-index of a CANopen dictionary object	Units: None
data	The data that is to be transferred. This data can be one of four types: 8-bit, 16-bit, 32-bit, or String	Units: None

SDO_DnldExt (index As Integer, sub As Integer, data As Byte, size As Integer)

Description: Downloads data to the amplifier via a CAN SDO transfer.
Parameters:

index	Index of a CANopen dictionary object.	Units: None
sub	Sub-index of a CANopen dictionary object	Units: None
data	The data that is to be transferred. This data is an array of bytes	Units: None
size	The number of bytes of data to be downloaded	Units: None

SDO_UpldExt (index As Integer, sub As Integer, data As Byte, size As Integer)

Description: Uploads data from the amplifier via a CAN SDO transfer.
Parameters:

index	Index of a CANopen dictionary object	Units: None
sub	Sub-index of a CANopen dictionary object	Units: None
data	The data that is to be transferred. This data is an array of bytes	Units: None
size	On entry this gives the max number of bytes of data to be uploaded. On successful return this gives the actual number of bytes received	Units: None

ioSettingsObj

Properties

useStandardDinPDO

Type: Boolean
Description: Use the standard digital input PDO object
Units: None
Default: true

UseStandardDoutPDO

Type: Boolean
Description: Use the standard digital output PDO object
Units: None
Default: true

UseStandardAinPDO

Type: Boolean
Description: Use the standard analog input PDO object
Units: None
Default: true

UseStandardAoutPDO

Type: Boolean
Description: Use the standard analog output PDO object
Units: None
Default: true

heartBeatPeriod

Type: Short
Description: Configures the heartbeat period used by this IO module to transmit its heartbeat message. If this property is set to zero, then the heartbeat protocol is disabled on this module
Units: mS
Default: 0

heartbeatTimeout

Type: Short
Description: Additional time to wait before generating a heartbeat error
Units: mS
Default: 0

guardTime

Type: Short
Description: This object gives the time between node-guarding requests that are sent from the network master to this IO module. The IO module will respond to each request with a node-guarding message indicating the internal state of the IO module. If the IO module has not received a node-guarding request within the time period defined by the product of the guard time and the lifeFactor, the IO module will treat this lack of communication as a fault condition
Units: mS
Default: 0

lifeFactor

Type: Short
Description: This property gives a multiple of the guardTime parameter. The IO module expects to receive a node-guarding request within the time period defined by the product of the guard time and the lifetime factor. If the IO module has not received a node-guarding request within this time period, it treats this condition as a fault
Units: None
Default: 3

8.1 Analog Inputs

Methods

Ain16Read (channel As Integer, value As Integer, viaSDO As Boolean)

Description: Reads a 16-bit analog input.
Parameters:

channel	The analog input channel ID	Units: None
value	The analog input value read	Units: None
viaSDO	If True, read inputs using SDO transfer. If False (default), use most recently received PDO data, if this input is mapped to a transmit PDO and the PDO is active	Units: None

AinTrigTypeRead (channel As Integer, trigger As CML_IO_AIN_TRIG_TYPE)

AinTrigTypeWrite (channel As Integer, trigger As CML_IO_AIN_TRIG_TYPE)

Description: Reads/writes the analog input trigger type associated with input channel. Use this command to set/get the type of event associated with an analog input.
Parameters:

channel	The analog input channel ID	Units: None
trigger	The analog input trigger type associated with input channel	Units: None

CML_IO_AIN_TRIG_TYPE

IOAINTRIG_UPPER_LIM = 1

Input above upper limit

IOAINTRIG_LOWER_LIM = 2

Input below lower limit

IOAINTRIG_UDELTA = 4

Input changed by more than the unsigned delta amount

IOAINTRIG_NDELTA = 8

Input reduced by more than the negative delta amount

IOAINTRIG_PDELTA = 16

Input increased by more than the positive delta

Ain16LowerLimitRead (channel As Integer, limit As Integer)
Ain16LowerLimitWrite (channel As Integer, limit As Integer)

Description: Reads/writes the analog input lower limit value as a 16-bit integer. The lower limit defines the value at which an interrupt will be generated if it is enabled.
Parameters:

channel	The analog input channel ID	Units: None
limit	The analog input lower limit value	Units: None

Ain16NegativeDeltaRead (channel As Integer, delta As Integer)
Ain16NegativeDeltaWrite (channel As Integer, delta As Integer)

Description: Reads/writes the analog input negative delta value as a 16-bit integer. The negative delta defines the amount of change at which an interrupt will be generated if it is enabled.

Parameters:

channel	The analog input channel ID	Units: None
delta	The analog input negative delta value	Units: None

Ain16PositiveDeltaRead (channel As Integer, delta As Integer)
Ain16PositiveDeltaWrite (channel As Integer, delta As Integer)

Description: Reads/writes the analog input positive delta value as a 16-bit integer. The positive delta defines the amount of change at which an interrupt will be generated if it is enabled.

Parameters:

channel	The analog input channel ID	Units: None
delta	The analog input positive delta value	Units: None

Ain16UnsignedDeltaRead (channel As Integer, delta As Integer)
Ain16UnsignedDeltaWrite (channel As Integer, delta As Integer)

Description: Reads/writes the analog input unsigned delta value as a 16-bit integer. The unsigned delta defines the amount of change at which an interrupt will be generated if it is enabled.

Parameters:

channel	The analog input channel ID	Units: None
Delta	The analog input unsigned delta value	Units: None

Ain16UpperLimitRead (channel As Integer, limit As Integer)
Ain16UpperLimitWrite (channel As Integer, limit As Integer)

Description: Reads/writes the analog input upper limit value as a 16-bit integer. The upper limit defines the value at which an interrupt will be generated if it is enabled.

Parameters:

channel	The analog input channel ID	Units: None
Limit	The analog input upper limit value	Units: None

Properties

AinIntEnable

Type: Boolean
Description: Current setting of the global interrupt enable for analog inputs
Units: None
Default: False

8.2 Analog Outputs

Methods

Aout16Write (channel As Integer, value As Integer, viaSDO As Boolean)

Description: Writes to a 16-bit analog output.

Parameters:

channel	The analog input channel ID	Units: None
value	The value to write	Units: None
viaSDO	If true, the outputs will be written using SDO messages. If false (default), then a PDO will be used if possible	Units: None

AoutErrModeRead (channel As Integer, mode As Boolean)
AoutErrModeWrite (channel As Integer, mode As Boolean)

Description: Reads/writes the analog output error mode. If the error mode is True, then the analog output will change its value to the programmed error value in the case of a device failure. If False, a device failure will not cause a change in the analog output value.

Parameters:

channel	The analog output channel ID	Units: None
mode	The analog output error mode	Units: None

Aout16ErrorValueRead (channel As Integer, error As Integer)
Aout16ErrorValueWrite (channel As Integer, error As Integer)

Description: Reads/writes the analog out error value.

Parameters:

channel	The analog input channel ID	Units: None
error	The analog output error value	Units: None

8.3 Digital Inputs

Methods

Din8Read (group As Integer, value As Integer, viaSDO As Boolean)

Description: Reads a group of 8 digital inputs.

Parameters:

group	Identifies which group of 8 to read	Units: None
value	The value of the input	Units: None
viaSDO	If true, read inputs using the SDO transfer. If false (default) use the most recently received PDO data if this input group is mapped to a transmit PDO and the PDO is active	Units: None

Din8MaskAnyRead (group As Integer, mask As Integer)
Din8MaskAnyWrite (group As Integer, mask As Integer)

Description: Reads/writes the 'any transition' interrupt mask setting for a group of 8 digital inputs. For each input in the group, a value of 1 enables interrupts on any change, and a value of 0 disables the interrupt.

Parameters:

group	Identifies which group of 8 inputs to read/write	Units: None
mask	The 'any transition' interrupt mask	Units: None

Din8MaskHigh2LowRead (group As Integer, mask As Integer)
Din8MaskHigh2LowWrite (group As Integer, mask As Integer)

Description: Reads/writes the 'high to low' interrupt mask setting for a group of 8 digital inputs. For each input in the group, a value of 1 enables interrupts on a high to low transition, and a value of 0 disables the interrupt.

Parameters:

group	Identifies which group of 8 inputs to read/write	Units: None
mask	The 'high to low' interrupt mask	Units: None

Din8MaskLow2HighRead (group As Integer, mask As Integer)
Din8MaskLow2HighWrite (group As Integer, mask As Integer)

Description: Reads/writes the 'low to high' interrupt mask setting for a group of 8 digital inputs. For each input in the group, a value of 1 enables interrupts on a low to high transition, and a value of 0 disables the interrupt.

Parameters:

group	Identifies which group of 8 inputs to read/write	Units: None
mask	The 'low to high' interrupt mask	Units: None

Properties

DinIntEnable

Type: Boolean
Description: Current setting of the global interrupt enable of digital inputs
Units: None
Default: False

8.4 Digital Outputs

Methods

Dout8Write (group As Integer, value As Integer, viaSDO As Boolean)

Description: Writes a group of 8 digital outputs.

Parameters:

group	Identifies which group of outputs to write	Units: None
value	Value to write to group	Units: None
viaSDO	If true, outputs are written using SDO message. If false (default), a PDO is used if possible	Units: None

Dout8ErrModeRead (group As Integer, mode As Integer)
Dout8ErrModeWrite (group As Integer, mode As Integer)

Description: Reads/writes the current error mode setting of a group of 8 digital outputs. For each output in the group, a value of 1 will cause the output to take its programmed error value on a device failure. Setting the mode to 0 will cause the output to hold its programmed value on failure.

Parameters:

group	Identifies the group of outputs to read/write	Units: None
mode	The current error mode setting of a group of 8 digital outputs	Units: None

Dout8ErrValueRead (group As Integer, error As Integer)
Dout8ErrValueWrite (group As Integer, error As Integer)

Description: Reads/writes the current error value setting for a group of 8 digital outputs. Error values define the state of the output if a device failure occurs. The error value will only be set for those output pins that have an error mode set to 1. Those with error mode set to zero will not be changed by a device failure.

Parameters:

group	Identifies the group of outputs to read/write	Units: None
mode	The current error value setting for a group of 8 digital outputs	Units: None

9. CopleyMotionLibrary Object

Properties

VersionString

Type: String
Description: The version number of Copley Motion Libraries (CML) used by CMO.
Units: None
Default: None

DebugLevel

Type: Integer
Description: Debug message level. Setting this property greater than zero results in debug messages being written to a log file (see table below). The value set for DebugLevel will result in that level, plus all lower levels being logged. Therefore, if DebugLevel is set to 3, then levels 3, 2, and 1 are logged. Setting this property to zero will result in the log file being closed.

Debug Level	Description
0	Debug logging is disabled
1	Log serious errors only
2	Log warning messages and errors
3	Log debugging info
4	Not defined
5	Log most CAN messages (some common messages are filtered out
6	Log all CAN messages
99	Log everything

Units: None
Default: 0 (no messages)

MaxLogSize

Type: Integer
Description: Maximum log file size. Once the log file exceeds MaxLogSize, it is renamed *logfilename*.bak, and a new log file is started. Old backup log files are overwritten.
Units: None
Default: 1,000,000 bytes

LogFileName

Type: String
Description: Name of the debug message log file. This file is used to log debug messages. The file will be created (or truncated if it already exists) when the first message is written to the file. Note that the debug level must be set > 0 for any messages to be written.
Units: None
Default: "cml.log"

10. Layer Setting Service Object

Overview

The LSSObj allows the programmer to access CANopen devices on the network without the node ID. The programmer can use this access to program the CANopen devices with specific node IDs.

Methods

FindAndDisableAmps (serialArray As UInteger)

Description: Searches the CANopen network amplifiers and turns off the CAN LEDs. Returns the number of amplifiers found.

Parameters:

serialArray	An array where the amplifier serial numbers will be returned	Units: None

EnableAmplifier (serial As Uinteger)
DisableAmplifier (serial As UInteger)

Description: Enables/Disables the node causing the CAN LEDS to blink.

Parameters:

serial	The serial number of the amplifier	Units: None

SetAllAmplifierNodeIDs (serialArray As UInteger, idArray as Byte)

Description: Searches the CANopen network amplifiers and turns off the CAN LEDs. Returns the number of amplifiers found.

Parameters:

serialArray	An array where the amplifier serial numbers will be returned	Units: None
idArray	An array of the desired node IDs	Units: None

SetTimeout (timeout As Single)

Description: Sets the timeout value used by the LSS protocol.

Parameters:

timeout	The new timeout	Units: mS

SwitchModeGlobal (config As Boolean)

Description: Set all devices on the network into either LSS configurational mode or operational mode.

Parameters:

timeout	If false, put all devices into operational mode	Units: None

FindAmps (max As Integer, serialArray As UInteger)

Description: Search the CANopen network for Copley amplifiers. Returns the number of amplifiers found.

Parameters:

max	The maximum number of amplifier serial numbers to be returned	Units: None
serialArray	An array where the amplifier serial numbers will be returned	Units: None

StoreConfig (max As Integer, serialArray As UInteger)

Description: Save the current node ID and bit rate information in non-volatile (FLASH) memory on the selected amplifier. When this is called, exactly one drive should be in LSS configuration mode.

SetAmplifierNodeID (serial As UInteger, nodeID As Byte)

Description: Sets the CANopen node ID of the specified amplifier.
Parameters:

serial	The serial number of the amplifier to update	Units: None
nodeID	The CANopen node ID to assign	Units: None

SetNodeID (nodeID As Byte)

Description: Sets the CANopen node ID of the currently selected amplifier.
Parameters:

nodeID	The CANopen node ID to assign	Units: None

SelectAmp (serial As UInteger)

Description: Put the specified amplifier into LSS configure mode. All other amplifiers on the network are switched into LSS operational mode.
Parameters:

serial	The serial number of the amplifier to configure	Units: None

SetBitRate (rate As UInteger)

Description: Send an LSS command to program the selected amplifier's CAN bit rate. Valid bit rates are listed under CML_BIT_RATES.
NOTE: This bit rate will not take effect until the bit rate is activated.
Parameters:

rate	CANopen bit rate	Units: b/s

ActivateBitRate (delay As UInteger)

Description: Activate the new bit rate previously set on all devices.
NOTE: This function does not change the bit rate of the local CAN port, it simply returns after requesting the new rate on the LSS slave devices.
Parameters:

delay	The delay which the LSS devices will use to ensure that they all switch their bit rates at a time when no device is transmitting.	Units: mS

Properties

userBitRate

Type: Integer
Description: The new bit rate value.
Units: bits/sec
Default: 1000000

ampCount

Type: Integer
Description: The number of amplifiers on the network.
Units: None
Default: 0

11. PDO Related Objects

11.1 PDO mapping objects

Overview

The PDO mapping objects contain the data being mapped to the transmit or receive PDO. PDOs can hold up to eight bytes of data and a maximum of four objects. The five types of Pmap objects are Pmap32Obj, Pmap24Obj, Pmap16Obj, Pmap8Obj, and PmapObj. The PmapObj is used as an array to hold the other PDO mapping objects.

Example:

1 Declare an instance of PmapObj as an array.

```
Dim pmapObj(0) As PmapObj
```

2 Create an instance of corresponding size for the object being mapped.

```
pmapObj(0) = New Pmap32Obj()
```

11.2 RPDOObj

Overview

The RPDO Object contains information about the amplifier's receive process data objects (received by the node). This object allows for mapping custom receive PDOs.

Example:

1 Declare and create an instance of RPDOObj.

```
Dim rpdoObj As RPDOObj
rpdoObj = New RPDOObj()
```

2 Initialize the receive PDO.

```
rpdoObj.Init(canID, varArray, objIDArray, type)
```

Methods

Init (canID As Integer, varArray As PmapObj, objIDArray As Integer, type As Integer)

Description: Initializes the RPDO object with the PDO mapping variables and corresponding object IDs and sets the PDO transmission type.

Parameters:

canID	The CAN message ID associated with this RPDO. This value should be unique	Units: None
varArray	Pmap variables to be mapped	Units: None
objIDArray	Pmap variables' object IDs	Units: None
type	PDO transmission type code	Units: None

SendData (dataArray As Integer, index As Integer)

Description: Send the PDO with the new data.

Parameters:

dataArray	An array holding the data to send to the amplifier	Units: None
index	This value represents the indexes of the PDO objects to send. Ex. 1 sends index 0, 2 sends index 1, 3 sends indexes 1 and 2, etc.	Units: None

11.3 TPDOObj

Overview

The TPDO Object contains information about the amplifier's transmit process data objects (transmitted by the node). This object allows for mapping custom transmit PDOs.

Example:

1 Declare and create an instance of TPDOObj.

```
Dim tpdoObj As TPDOObj
tpdoObj = New TPDOObj()
```

2 Initialize the transmit PDO.

```
tpdoObj.Init(canID, varArray, objIDArray, type)
```

Methods

Init (canID As Integer, varArray As PmapObj, objIDArray As Integer, type As Integer)

Description: Initializes the RPDO object with the PDO mapping variables and corresponding object IDs and sets the PDO transmission type.

Parameters:

canID	An array where the amplifier serial numbers will be returned	Units: None
varArray	Pmap variables to be mapped	Units: None
objIDArray	Pmap variables' object IDs	Units: None
type	PDO transmission type code	Units: None

SetRtrOk (ok As Integer)

Description: Enable or disable remote transmission requests (RTR) for this PDO.

Parameters:

ok	Zero for no RTR, non-zero for RTR allowed	Units: None

12. The Path Planning Object

Overview

The PathPlanningObj allows the programmer to plan two-dimensional paths using the methods detailed below. Only two-dimensional paths are supported.

Example:

1 Declare an instance of PathPlanningObj.

```
Dim pathObj As PathPlanningObj
```

2 Create an instance of the object.

```
pathObj = New PathPlanningObj()
```

3 Declare a two-dimensional array of type double to represent a two-dimensional point. The point can be used as an argument for several methods described below.

```
Dim point(1) As Double
```

Methods

SetStartPos (positionArray As Double)

Description: Set the internal position for the path. It is recommended that the starting position be equal to the current position of both axes. If not used, the default starting position will be (0, 0). The starting segment may be set at any time, either before or after adding segments to the path. Internally, the segments are stored as relative positions.

Parameters:

positionArray	A two-dimensional array defining the starting point of the path.	Units: Counts

AddLine (destinationArray As Double)

Description: Add a line segment from the current position to the specified point. The direction of motion required to move from the current position to the given point will be compared to the direction of motion at the end of the last segment. If these directions change then the addition of this new point will require an abrupt change in direction. In this case, the initial velocity will be set to zero.

Parameters:

destinationArray	A two-dimensional array defining the end point (destination) of the line.	Units: Counts

AddLine (length As Double)

Description: Add a line segment of the specified length. The direction of motion will remain the same as it was at the end of the last added segment. If this is the first segment added to the path, then the direction will be positive motion in the first axis.

Parameters:

length	A double value defining the length of the line segment.	Units: Counts

AddArc (centerArray As Double, angle As Double)

Description: Add an arc with the specified center point and angle (radians). The arc will start at the current position and will move in the clockwise (positive angle) or counterclockwise (negative angle) direction.

Parameters:

centerArray	A two-dimensional array defining the center of the arc.	Units:
angle	A double value defining the number of radians through which to rotate.	Counts, Radians

AddArc (radius As Double, angle As Double)

Description: Add an arc with the specified radius and angle (radians). The arc will start at the current position and will move in the clockwise (positive angle) or counterclockwise (negative angle) direction.

Parameters:

radius	A double value defining the radius of the arc.	Units:
angle	A double value defining the number of radians through which to rotate.	Counts, Radians

Pause (time As Double)

Description: Add a time delay to the path.

Parameters:

time	A double value defining the time delay to add to the path in seconds.	Units: Seconds

PlayPath(timeIncrement As Double, positionArray As Double, velocityArray As Double)

Description: Play back path data for display purposes. Before starting a path playback, the path should be reset using the path.reset() method. Each call to this function will return position and velocity information for the current playback position in the path. It will then increment the playback position by the time value passed. When the end of the path is reached, the method will return true. If the end has not been reached, it will return false.

Parameters:

timeIncrement	A double value defining the amount of time to increment the playback position after reading out the position and velocity values.	Units: Seconds
positionArray	A two-dimensional array where position information will be returned.	Counts
velocityArray	A two-dimensional array where velocity information will be returned.	Counts/sec

Reset ()

Description: Reset the path to the first position.

Parameters: None.

Units: None

SetMaxVel (velocity As Double)

Description: Set the velocity limit for the current location. Velocity limits must be greater than zero.

Parameters:

velocity	A double value defining the maximum velocity.	Units: Counts/sec

SetMaxAcc (acceleration As Double)

Description: Set the acceleration limit for the current location. Acceleration limits must be greater than zero.
Parameters:

acceleration	A double value defining the maximum acceleration.	Units: Counts/sec^2

SetMaxDec (deceleration As Double)

Description: Set the deceleration limit for the current location. Deceleration limits must be greater than zero.
Parameters:

deceleration	A double value defining the maximum deceleration.	Units: Counts/sec^2

SetMaxJrk (jerk As Double)

Description: Set the jerk limit for the current location. Jerk limits must be greater than zero.
Parameters:

jerk	A double value defining the maximum jerk.	Units: Counts/sec^3

GetDim ()

Description: Used to return the dimension of the path. Currently, only two-dimensional paths are supported. Therefore, it will always return the integer: 2.
Parameters: None.

Units: None

13. The PvtConstAccelTrj Object

Overview

The PvtConstAccelTrjObj allows the programmer to stream PVT data to a linkage object via the linkage object's SendPvtConstAccelTrj method. The user will enter position and time data into the PvtConstAccelTrj object using the AddPvtPoint method. CMO will calculate the correct velocity data to use in the profile. The velocities calculated will result in a profile that produces constant acceleration (as constant as possible).

The Init method must be called on the PvtConstAccelTrj object and data should be entered before use in a linkage object. During execution of the trajectory, if there is only one PVT point remaining, CMO will set the time value to zero, ending the move correctly. After a PVT point is executed by the trajectory generator, it is permanently deleted from memory. Hence, the PvtConstAccelTrj object will be empty after the PVT profile is executed and should be loaded with more PVT points via the AddPvtPoint method before being sent to the trajectory generator again via the linkage object.

Example:

1 Declare an instance of PathPlanningObj.

```
Dim pvtConstAccelTrjObj As PvtConstAccelTrjObj
```

2 Create an instance of the object.

```
pvtConstAccelTrjObj = New PvtConstAccelTrjObj()
```

3 Initialize the object with the number of dimensions in the linkage.

```
Dim point(2) As Double
```

Methods

Init (dimension As Integer)

Description: Set the dimension (number of axes) in the trajectory.
Parameters:

dimension	An integer setting the number of dimensions of the trajectory	Units: None

AddPvtPoint (positionsArray As Double, timeValue As Integer)

Description: Add a PVT point to the trajectory.
Parameters:

positionsArray	An array with length equal to the number of dimensions in the trajectory. Each index corresponds to an axis in the linkage.	Units: Counts
timeValue	An integer representing the time between this PVT point and the next PVT point.	Units: Milliseconds

GetPvtData (emptyPosArray As Double, emptyVelArray As Double, time As Integer, index As Integer)

Description: Return the PVT data for the PVT point specified by the index. The empty arrays are filled with position and velocity data. The time argument is overwritten with the time value for the PVT point.
Parameters:

emptyPosArray	An array with length equal to the number of dimensions in the trajectory. Each index corresponds to an axis in the linkage.	Units: Counts
emptyVelArray	An array with length equal to the number of dimensions in the trajectory. Each index corresponds to an axis in the linkage.	Units: 0.1 Counts/Sec
time	An integer to be overwritten.	Units: Milliseconds
index	An integer signifying the index of the PVT point to retrieve. The first PVT point will have index 0.	Units: None

CMO Programmer's Guide
16-01041
Revision 04
December 2021