

## Introduction

The motion engine is used to distribute motion and/or sequencing to the drive, offloading the HMI, PC or PLC from calculating motion trajectories. The Motion Engine is an internal motion generator. It provides selection, execution, status and supervision of motion and control tasks. When the Motion Engine is enabled it takes control of the command generation and depending on the mode of the Motion Engine it may take control of the sequence of execution of tasks. The Motion Engine supports Indexing and Sequencing commands. When the Motion Engine is enabled, it will be considered the Active Mode of the drive as seen in the Figure below.

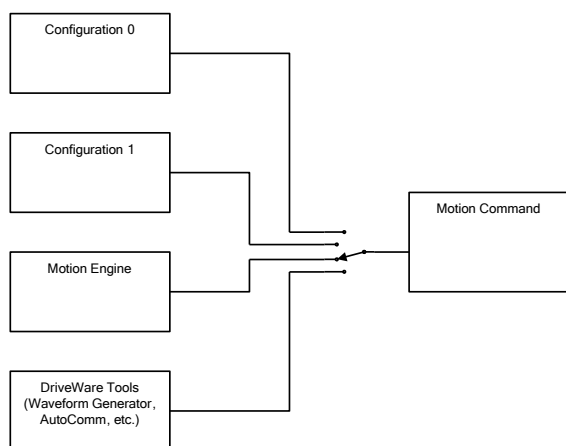


Figure 1 – Active Mode Commands

## Motion Engine Interfaces

The Motion Engine can be controlled by one of two interfaces, a Network or Discrete interface. The interface is used to control the selection, starting and stopping of the Motion Tasks and configuration of Motion parameters.

### Discrete Interface

A Discrete Interface is typically used when the host/machine controller is a PLC or another drive. The host/machine controller will use the Digital I/O for controlling the Motion Engine.

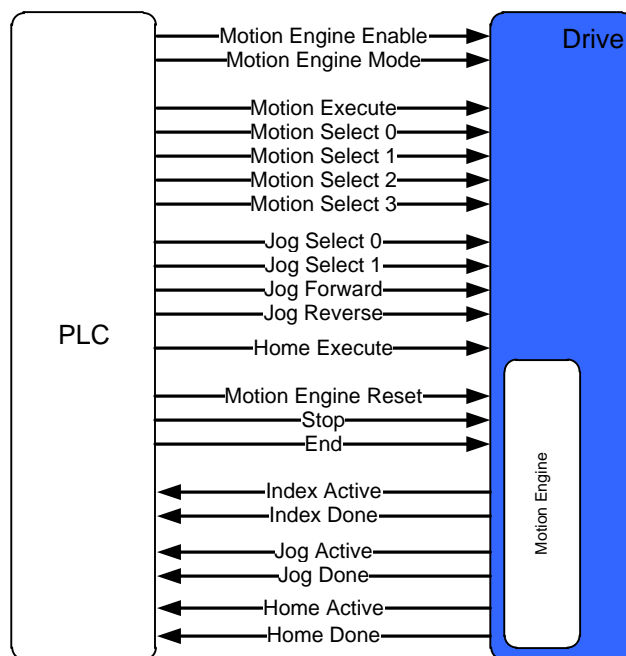


Figure 2 – Typical Discrete Interface Signal and Sources

### Network Interface

A Network Interface is typically used when the host/machine controller is a HMI or PC. The host/machine controller will use one of the communication protocols supported by the drive; either the primary or auxiliary port can be used.

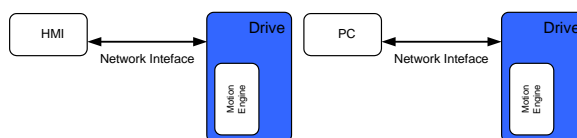


Figure 3 – Typical Network Interfaces

### Configuration

Indexes must be initially configured using the DriveWare® setup and configuration software. For more details, reference the DriveWare Software Manual, available for download at [www.a-m-c.com](http://www.a-m-c.com).

### Start-Up Motion

A pre-defined index can be selected and run automatically, immediately after the drive is powered up. Configuration settings for this option can be selected in the DriveWare software or over the network. The table below lists the available options for configuration over the network. For additional details, reference the

appropriate *ADVANCED* Motion Controls communication manual.

Start-Up Motion	CANopen Object	Modbus Register	Description
Start-Up Sequence Control	2008.01h	Configure in DriveWare	Bit 4 will configure the drive to enable the Motion Engine on power-up.
Start-Up Motion Type	20C8.01h	40016	Bits 0:2 0: Indexer Mode 1-7: Reserved
Motion / Program Selection Source	20C8.01h	40016	Bits 3:4 0: Discrete 1: Network 2-7: Reserved
Startup Index	20C8.01h	40016	Bits 5:8 Specifies the index number to run on power-up.
Auto Initiate on Startup	20C8.01h	40016	Bits 9-15 0: Motion will not immediately start 1: Motion will automatically start if the Motion Engine is configured to be enabled on power up. 2-7: Reserved

**Table 1 – Start-Up Motion**

## Enabling and Disabling the Motion Engine

The motion engine can be enabled by any of the following methods:

- A digital input mapped to the Motion Engine Enable going active.
- The Motion Engine is configured to enable upon power-up.
- The Motion Engine enable bit of the Drive Control Word is asserted via a network command.

While enabled, the Motion Engine will prevent certain external commands from execution to avoid conflicts. Therefore, it may be necessary to disable the motion engine before performing other operations. Upon enabling the Motion Engine, the drive will be re-configured with the following settings.

- Active Loops: Position around Velocity around Current.
- Command Limiter: Accel/Decel.
- Command Source: Communication Channel
- Torque Offset: Same as drive configuration 0

- Velocity Offset: Same as drive configuration 0
- Position Offset: The Profiled Ramp (for jogging)
- Loop Feedbacks: Same as drive configuration 0
- Filter configuration: Same as drive configuration 0
- Active Gain Set: Same as drive configuration 0

The Motion Engine will be disabled when a falling edge of the digital input is detected, or when the Motion Enable bit of the Drive Control Word is set to zero. Upon disabling the motion engine, the following will occur:

- If the Motion Engine is presently executing a motion command, an internal “halt” will be generated, and the motion brought to an immediate stop.
- Once the drive is not moving, the previous loop configuration will be restored.
- The drive will be restored to its previous mode. The previous gains, profiles and source modifier values will be restored.
- Motion Engine command processor will release Write Access to all commands.

Command	CANopen Object	Modbus Register	Description
Enable Motion Engine Mode	6060h	5	A value of EC written to object 6060h will enable Motion Engine Mode. For more information about the modes of operation, reference the appropriate communication manual. The motion engine must be disabled before certain drive control events can be used.

**Table 2 – Motion Engine Mode Enable**

## Motion Engine Network Commands

The motion engine can be controlled over the network using the appropriate Motion Engine Control command enum. The drive will only allow motion to be initiated if the following is true:

- The motion engine is enabled
- The bridge is be enabled
- The Motion Select Source must be the communication channel
- A valid index must be pre-defined and stored in the drive
- Absolute Position Valid must be active

Tables 3 and 4 below lists the index definitions for interacting with the motion engine command object. Bits 0 through 15 of the index data are used to select the command, while Bits 16 through 31 of the index data will determine the data associated with the command. Bits 16 through 31 will have a different function depending on what is written to Bits 0-15. In some cases there is no data associated with the command, and the values are ignored.

Commands	CANopen Object	Modbus Register	Description
Motion Engine Control Command	20C9.01h	4001	Bits 0:15 Enumerated values 0: Select Motion (This enum is only used when motion is initiated via a digital input) 1: Initiate Selected Motion (Run the index specified in the Motion Engine Control Data) 2: Abort Active Motion, (No fault, Motion Engine will return to ready for motion start) 3: Reset Motion Engine Fault and return to the ready for motion state. 4: Initiate Dynamic Index 5: Set Motion Select Source: This controls where the motion and program page select is read from. The Motion Select Source must be set to Communication Channel before an index can be initiated over the network. 6: Indexer / Sequencer Select: This controls the motion type that is selected. The Motion Select Source must be set to Communication Channel for motion type selection. 7-15: Reserved

**Table 3 – Motion Engine Control Command**

Motion Engine Control Command (Bits 0-15)	Motion Engine Control Data (Bits 16-31)
0: Select Motion	Contains the index to be initiated
1: Initiate Selected Motion	Contains the index to be initiated, and executes it immediately
2: Abort Active Motion	Ignored
3: Reset Motion Engine Fault	Ignored
4: Initiate Dynamic Index	Ignored
5: Set Motion Select Source	0: Digital Inputs 1: Over the Network
6: Indexer / Sequencer Select	0: Indexer 1: Sequencer

**Table 4 – Motion Engine Control Data**

## Motion Engine Status

Real time status of the motion engine can be monitored using the motion engine status commands. The definitions are listed in Table 5.

Commands	CANopen Object	Modbus Register	Description
Index Executing	2029.01h	30003	Bits 0:7 0-15 for index 0-15 FE: Dynamic Index FF: No/Invalid Index  Bits 8:15 Reserved
Motion Engine Status	2029.04h	30005	This represents the status of the Motion Engine State Machine. The possible values are: Enum Values 0: Inactive 1: Waiting for Motion Start (motion engine is enabled and ready for an index) 2: Executing Motion (Index is currently running) 3: Program Load in Progress (Motion engine is not ready for commanded index) 4: Program Load Failure-CRC Error (Problem loading index. Must reset motion engine to continue) 5: Invalid Parameter (Problem loading index. Must reset motion engine to continue) 6: Invalid Op-Code (Problem loading index. Must reset motion engine to continue) 7: Halt Asserted (Motion has been interrupted) 8: Invalid Reference Frame (Problem with index parameters.) 9: Invalid Bridge State (Bridge must be enabled to begin indexed motion) 10: Invalid Op-code for Dynamic Motion (Problem with index parameters) 11: User defined Fault 12: Single Step Complete 13: Break Point Active

**Table 5 – Motion Engine Status**

## Example Predefined Index and Sequence Initiation

Tables 6 and 7 provide examples of how to initiate predefined Indexes and Sequences. Prior to sending these commands, the following configuration steps within DriveWare are recommended:

- Configuring and tuning the drive. The Motion Engine can only be operated over CANopen while the *Loop Configuration* is set to **Position around Velocity**.
- In the *Drive Settings* window, set *Drive Operation* to **Network Mode**.
- Configure and define any Sequences or Indexes, and make note of their associated identification numbers. These will be ran through CAN communication.
- In the *Motion Engine Settings* window, set *Motion Select Source* to **Network Interface**.
- In the *Configuration* window, set the *Command Source* to **Communication Channel**.
- Confirm that the network settings are appropriate for your system in the *Network*

*Settings* window. This includes the **Address** and **Baud Rate**. The **Initial Mode of Operation** will be set through CAN communication.

- Absolute Position Valid must be active. This can be achieved through Homing or a Set Position command.

CANopen Object	Message/Data	Description
6040.00	22 40 60 00 07 00 00 00	Write "Switch On" to ControlWord
6040.00	22 40 60 00 0F 00 00 00	Write "Enable Operation" to ControlWord
6060.00	22 60 60 00 EC 00 00 00	Switch Mode of Operation to Motion Engine
20C9.01	22 C9 20 01 06 00 00 00	Specify Indexer Mode
20C9.01	22 C9 20 01 01 00 01 00	Initiate Index 01
20C9.01	22 C9 20 01 02 00 00 00	Abort Motion
20C9.01	22 C9 20 01 01 00 00 00	Initiate Index 00

**Table 6 – Motion Engine Index Operation**

CANopen Object	Message/Data	Description
6040.00	22 40 60 00 07 00 00 00	Write "Switch On" to ControlWord
6040.00	22 40 60 00 0F 00 00 00	Write "Enable Operation" to ControlWord
6060.00	22 60 60 00 EC 00 00 00	Switch Mode of Operation to Motion Engine
20C9.01	22 C9 20 01 06 00 01 00	Specify Sequencer Mode
20C9.01	22 C9 20 01 01 00 02 00	Initiate Sequence 02
20C9.01	22 C9 20 01 02 00 00 00	Abort Motion
20C9.01	22 C9 20 01 01 00 03 00	Initiate Sequence 03

**Table 7 – Motion Engine Sequence Operation**