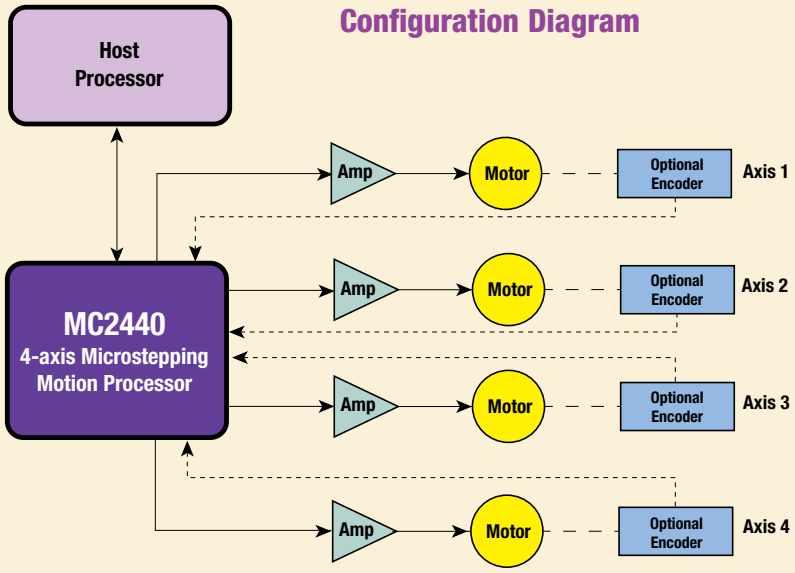
Navigator™ Motion Processor
MC2400 Series
For Microstepping Motion Control

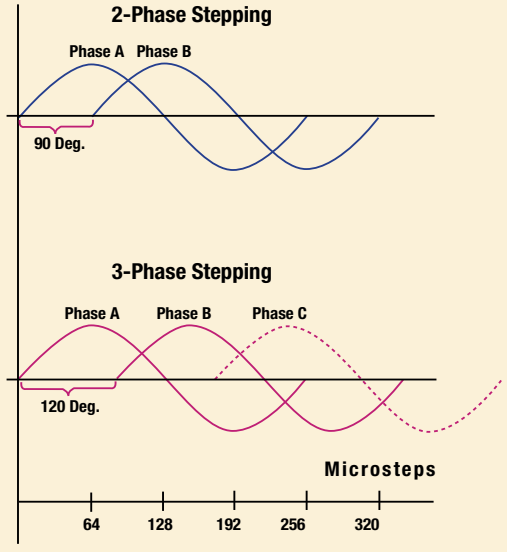
Configuration Diagram



Features

- Available in 1, 2 and 4-axis versions.
- Supports 2 and 3-phase stepping motors.
- Programmable microstepping rate from 1 to 256 microsteps per full step.
- Motion profiles include S-curve, trapezoidal, velocity contouring, and electronic gearing.
- Asymmetric acceleration and deceleration to custom program a trapezoidal motion profile.
- Velocity and acceleration changes on-the-fly for trapezoidal and velocity-contouring profiles.
- Incremental encoder quadrature input and parallel input for absolute encoder or resolver for on-the-fly motor stall detection.
- Parallel and serial (point-to-point or multi-drop) communications interface.
- Trace capabilities for system performance checks, maintenance and diagnostics.
- Encoder rate of 5.0 Mcounts/sec allows use of fine resolution feedback devices for reading motor position.
- 10-bit 20kHz PWM or 16-bit DAC motor control output to amplifier.
- Advanced breakpoint capability allows precise sequencing of events.
- PLC-style programmable inputs and outputs, including a per-axis programmable input and output.
- 256 16-bit word I/O locations for user-defined peripherals.
- 8 general-purpose 10-bit analog inputs.
- Two-directional limit switches, index input, and home indicator per axis.
- Axis settled indicator and tracking window in addition to automatic motion error detection.
- Packaged in a 132-pin processor and a 100-pin logic device (surface mount CMOS technology).
- Available in commercial and industrial temperature versions.
- Software backward compatible with PMD's MC1xxx family (1241 and 1141 series).

Microstepping Waveform Graph



Navigator™ Motion Processor
MC2400 Series
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Description

The Navigator™ Microstepping Motion Processor (MC2400 Series) is used in embedded control systems for industrial motion control, automation and robotic applications. Available in one (MC2410), two (MC2420), and four (MC2440) axis configurations, the MC24xx consists of two components, a 132-pin processor and a 100-pin logic device. Both components are surface mount CMOS technology and powered by 5 volts. The motion processor is driven by a host microprocessor via an 8-bit or 16-bit bus interface or through an asynchronous bi-directional serial port, giving users the ability to offload resource intensive motion control functions from the application's host.

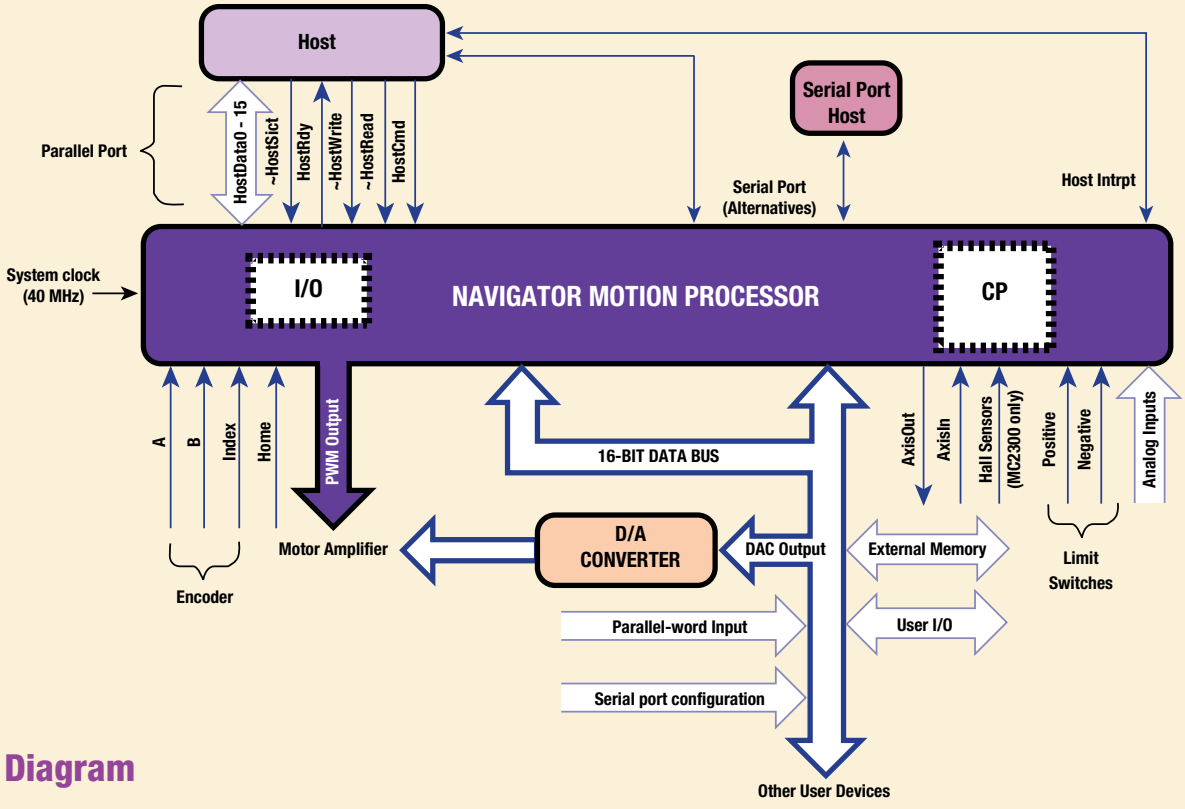
The MC2400 Series outputs a PWM or DAC-compatible motor command signal needed to directly drive the windings of a stepping motor. A programmable microstepping rate can be specified to designate the desired number of microsteps per full step, from 1 to 256. The MC24xx operates in an open loop mode where the motor command is driven from output of the trajectory generator. Optional encoder feedback provides on-the-fly motor stall detection and allows the chipset to detect when the stepping motor has lost steps during a motion. Trace capabilities provide on-the-fly data storage for analyzing system performance, and performing maintenance and diagnostics.

With over 115 commands, PMD's instruction set offers flexibility and versatility to board designers and software application programmers. Instructions are used to initialize and control the motion processor. User selectable profiling modes supported by the motion processor include S-curve, trapezoidal, velocity contouring and electronic gearing. The MC24xx accepts input parameters such as position, velocity, and acceleration from the host and generates a corresponding trajectory.

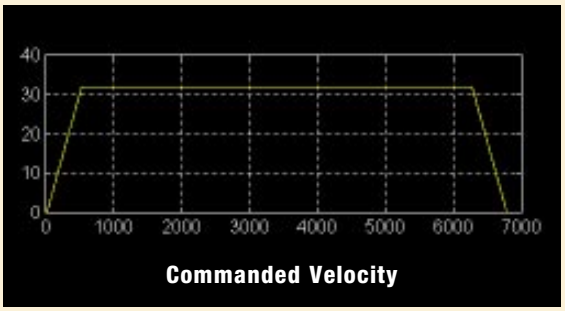
The motion processor accepts feedback from an incremental encoder, up to 5 megacounts per second, or from an absolute encoder or resolver, up to 160 megacounts per second, to read the current axis position. Each axis supports 16-bit DAC or 10-bit, 20kHz (1 or 2 axis versions) or 10-bit, 10kHz (2 axis versions) PWM-compatible output signals.

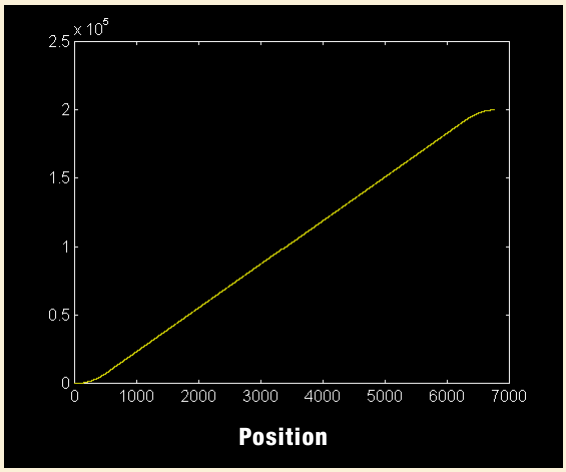
Multiple breakpoints per axis offer precise sequencing and control of events by the application program. PLC-style instructions are provided, which operate on inputs and set outputs. The instructions use Event, Activity and Signal registers. Input signals include two limit switches (one for each direction of travel), home indicator, and a general-purpose programmable input per axis. One general-purpose programmable output signal is also provided per axis. Eight general-purpose analog (0-5 V) and 256 (16-bit wide) general-purpose discrete inputs/outputs are available.

Block Diagram



Sample Application





Example C-Motion™ code for executing a profile and tracing some processor variables
The information captured in this example could be used for observing system performance.

```
// set the trace buffer wrap mode to a one time trace
SetTraceMode(PmdAxis1, PmdTraceOneTime);

// set the processor variables that we want to capture
SetTraceVariable(PmdAxis1, PmdTrace1, PmdAxis1, PmdTraceActualPosition);
SetTraceVariable(PmdAxis1, PmdTrace2, PmdAxis1, PmdTraceCommandedVelocity);

// set the trace to begin when we issue the next update command
SetTraceStart(PmdAxis1, PmdTraceConditionUpdate);

// set the trace to stop when the MotionComplete event occurs
SetTraceStop(PmdAxis1, PmdTraceConditionEventStatus,
PmdEventMotionCompleteBit, PmdTraceStateHigh);

// set the magnitude of the output waveform to 50%
SetMotorCommand(PmdAxis1, 0x3fff);

// set the processor to output 1/256 microsteps
SetPhaseCounts(PmdAxis1, 1);
SetProfileMode(PmdAxis1, PmdTrap);

// set the profile parameters
SetPosition(PmdAxis1, 200000);
SetVelocity(PmdAxis1, 0x200000);
SetAcceleration(PmdAxis1, 0x1000);
SetDeceleration(PmdAxis1, 0x1000);

// start the motion
Update(PmdAxis1);
```

Command Summary

Breakpoints and Interrupts
ClearInterrupt
Get/SetBreakpoint
Get/SetBreakpointValue
GetInterruptAxis
Get/SetInterruptMask

Encoder
Get/SetActualPosition
Get/SetActualPositionUnits
GetActualVelocity
ClearPositionError
Get/SetAutoStopMode
Get/SetCaptureSource
GetCaptureValue
Get/SetEncoderModulus
Get/SetEncoderSource
GetPositionError
Get/SetPositionErrorLimit
Get/SetEncoderToStepRatio

External RAM
Get/SetBufferLength
Get/SetBufferReadIndex
Get/SetBufferStart
Get/SetBufferWriteIndex
ReadBuffer
WriteBuffer

Motor Output
Get/SetNumberPhases
GetPhaseCommand
GetCurrentMotorCommand
Get/SetMotorCommand
Get/SetMotorMode
Get/SetOutputMode

Profile Generation
Get/SetAcceleration
GetCommandedAcceleration
GetCommandedPosition
GetCommandedVelocity
Get/SetDeceleration
Get/SetGearMaster
Get/SetGearRatio
Get/SetJerk
Get/SetPosition
Get/SetProfileMode
Get/SetStartVelocity
Get/SetStop
Get/SetVelocity
MultiUpdate
Update

Servo Loop Control
Get/SetAxisMode
Get/SetLimitMode
Get/SetMotionCompleteMode
Get/SetSampleTime
Get/SetSettleTime
Get/SetSettleWindow
GetTime
Get/SetTrackingWindow

Status Registers and AxisOut Indicator
GetActivityStatus
Get/SetAxisOutSource
GetEventStatus
GetSignalStatus
Get/SetSignalSense
ResetEventStatus

Traces
GetTraceCount
Get/SetTraceMode
Get/SetTracePeriod
Get/SetTraceStart
GetTraceStatus
Get/SetTraceStop
Get/SetTraceVariable

Miscellaneous
Get/SetDiagnosticPortMode
GetHostIOError
Get/SetSerialPort
GetVersion
NoOperation
Read/WriteIO
Reset

For more information, visit www.pmdcorp.com.

Technical Specifications

Available configurations	4 axes (MC2440), 2 axes (MC2420), or 1 axis (MC2410)
Operating modes	***Open loop*** (motor command is driven from output of trajectory generator)
Position range	-2,147,483,648 to +2,147,483,647 counts
Velocity range	-32,768 to +32,767 counts/sample with a resolution of 1/65,536 counts/sample
Acceleration and deceleration ranges	-32,768 to +32,767 counts/sample^2 with a resolution of 1/65,536 counts/sample^2
Jerk range	0 to 1 counts/sample^3, with a resolution of 1/4,294,967,296 counts/sample^3
Profile modes	***S-curve point-to-point*** (Velocity, acceleration, jerk, and position parameters) ***Trapezoidal point-to-point*** (Velocity, acceleration, deceleration, and position parameters) ***Velocity-contouring*** (Velocity, acceleration, and deceleration parameters) ***Electronic Gear*** (Master axis, slave axis and gear ratio parameters. Encoder position of one axis used to drive a second axis.) Not available in MC2410.
Electronic gear ratio range	-32,768 to +32,767 with a resolution of 1/65,536 (negative and positive direction)
Motor output modes	**PWM:** 10-bit resolution at 20 kHz **DAC:** 16 bits
Maximum encoder rate	**Incremental:** 5 Mcounts/sec **Parallel-word:** 160.0 Mcounts/sec
Parallel encoder word size	16 bits
Parallel encoder read rate	20 kHz (reads all axes every 50 µsec)
Profile calculation timing range	150 µsec to 3,355 msec
Minimum profile calculation time	150 µsec nominal (Exact time is 153.6 µsec) per enabled axis.
Limit switches	2 per axis: one for each direction of travel
Position-capture triggers	2 per axis: index and home signals
Capture trigger latency	50 nsec
Analog input	8 10-bit analog inputs
User defined discrete I/O	256 16-bit wide user defined discrete I/O
Number of host instructions	116

Environmental and Electrical Ratings

All ratings and ranges are for both the I/O and CP chips.

Storage Temperature (T_s)	-55 °C to 150 °C
Operating Temperature (T_a)	0 °C to 70 °C*
Power Dissipation (P_d)	650 mW (I/O and CP combined)
Nominal Clock Frequency (F_{clk})	40.0 MHz
Supply Voltage limits (V_{cc})	-0.3V to +7.0V
Supply Voltage operating range (V_{cc})	4.75V to 5.25V

* An industrial version with an operating range of -40°C to 85°C is also available. Please contact PMD for more information.

Performance Motion Devices, Inc.
12 Waltham Street
Lexington, MA 02421

tel: 781.674.9860
fax: 781.674.9861

e-mail: info@pmdcorp.com
www.pmdcorp.com

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