

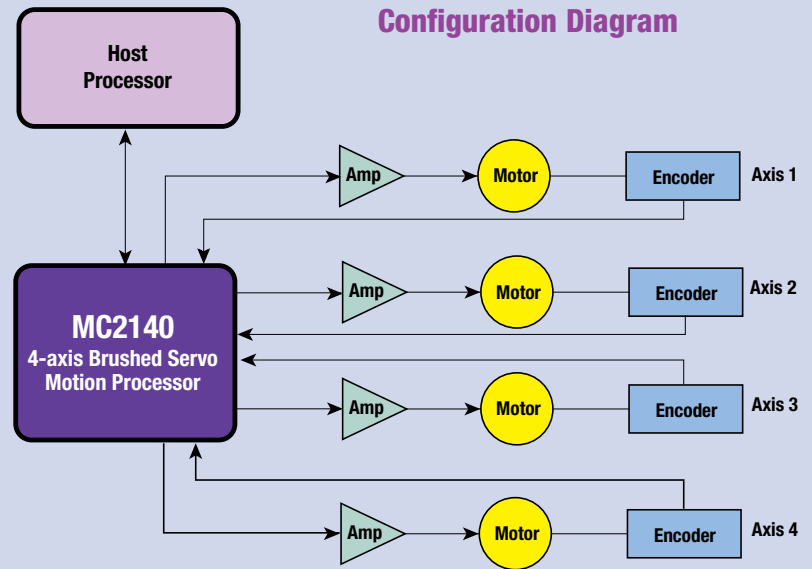


# Navigator™ Motion Processor MC2100 Series For Brushed Servo Motion Control



## Features

- Available in 1, 2 and 4-axis versions.
- Motion profiles include S-curve, trapezoidal, velocity contouring, and electronic gearing.
- Asymmetric acceleration and deceleration to custom program a trapezoidal motion profile.
- Advanced PID filter with velocity and acceleration feedforward, bias offset and 32-bit position error.
- 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.
- Parallel and serial (point-to-point or multi-drop) communications interface.
- Trace capabilities for system performance checks, servo-tuning, maintenance and diagnostics.
- Encoder rate of 5.0 Mcounts/sec allows use of fine resolution feedback devices.
- 10-bit 20 kHz 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 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 (1400, 1200 and 1100 series).



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## Description

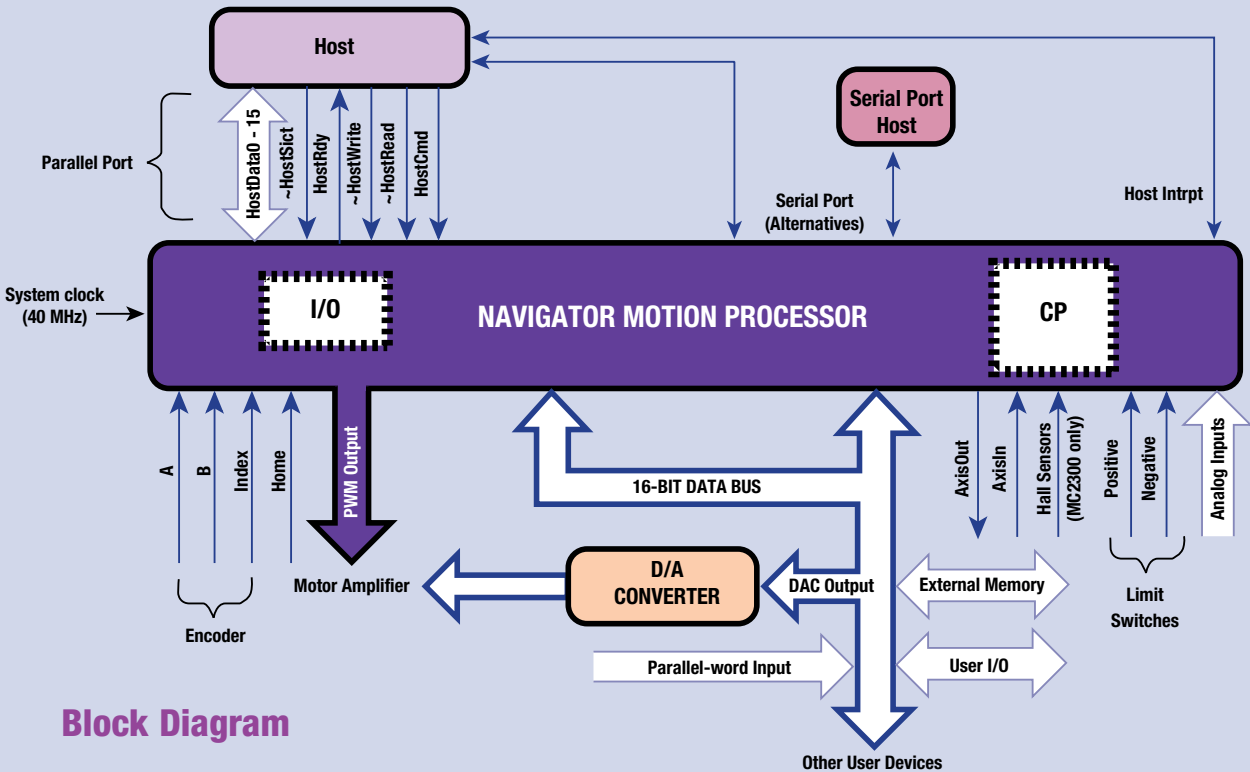
The Navigator™ Brushed Servo Motion Processor (MC2100 Series) is used in embedded control systems for industrial control, automation and robotic applications. Available in one (MC2110), two (MC2120), and four (MC2140) axis configurations, the MC21xx consists of two components, a 132-pin processor and 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.

With over 130 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 MC21xx accepts input parameters such as position, velocity, and acceleration from the host and generates a corresponding trajectory.

The MC21xx has a pre-programmed PID filter with feedforward velocity and acceleration that can be scaled, and a bias offset. The chipset also supports a 32-bit position error. The PID filter operates at 100 usec loop cycle time per enabled axis. Trace capabilities provide on-the-fly data storage to an external RAM for analyzing system performance, tuning servo filters, and performing maintenance and diagnostics.

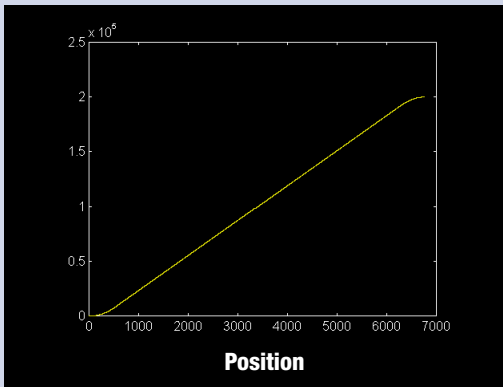
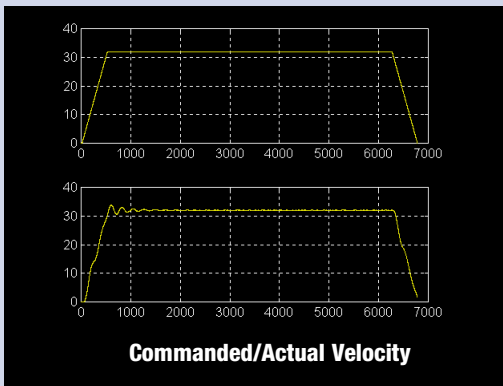
The motion processor accepts feedback from an incremental encoder at 5 megacounts per second or from an absolute encoder or resolver at 160 megacounts per second. Each axis supports 16-bit DAC or 10-bit, 20 kHz PWM compatible output signals. Each axis can also interface to a quadrature encoder with an optional index pulse, or to a parallel-word device, such as an absolute encoder to provide a position feedback signal.

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. 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 tuning the PID filter.

```
// 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, PmdTrace3, PmdAxis1, PmdTraceActualVelocity);
SetTraceVariable(PmdAxis1, PmdTrace4, 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);
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

### Digital Servo Filter

ClearPositionError  
Get/SetAutoStopMode  
GetDerivative  
Get/SetDerivativeTime  
GetIntegral  
Get/SetIntegrationLimit  
Get/SetKaff  
Get/SetKd  
Get/SetKi  
Get/SetKout  
Get/SetKp  
Get/SetKvff  
Get/SetMotorBias  
Get/SetMotorLimit  
GetPositionError  
Get/SetPositionErrorLimit

### Encoder

Get/SetActualPosition  
Get/SetActualVelocity  
Get/SetCaptureSource  
GetCaptureValue  
Get/SetEncoderModulus  
Get/SetEncoderSource

### External RAM

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

### Motor Output

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/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  
Get/SetEventStatus  
GetSignal  
Get/SetSignalSense  
ResetEventStatus

### Traces

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

### Miscellaneous

Get/SetDiagnosticPortMode  
Get/HostIOError  
Get/SetSerialPort  
GetVersion  
NoOperation  
ReadIO  
Reset  
WriteIO

For more information, visit [www.pmdcorp.com](http://www.pmdcorp.com).

## Technical Specifications

<b>Available Configurations</b>	4 axes (MC2140), 2 axes (MC2120), or 1 axis (MC2110)
<b>Operating modes</b>	<i>Closed loop</i> (motor command is driven from output of servo filter) <i>Open loop</i> (motor command is driven from user-programmed register)
<b>Position range</b>	-2,147,483,648 to +2,147,483,647 counts
<b>Velocity range</b>	<i>Velocity-contouring profile mode</i> : -32,768 to +32,767 counts/sample with a resolution of 1/65,536 counts/sample <i>All others</i> : 0 to 32,767 counts/sample with a resolution of 1/65,536 counts/sample
<b>Acceleration and deceleration ranges</b>	-32,768 to +32,767 counts/sample <sup>2</sup> with a resolution of 1/65,536 counts/sample <sup>2</sup>
<b>Jerk range</b>	0 to 1 counts/sample <sup>3</sup> , with a resolution of 1/4,294,967,296 counts/sample <sup>3</sup>
<b>Profile modes</b>	<i>S-curve point-to-point</i> (Velocity, acceleration, jerk, and position parameters) <i>Trapezoidal point-to-point</i> (Velocity, acceleration, deceleration, and position parameters) <i>Velocity-contouring</i> (Velocity, acceleration, and deceleration parameters) <i>Electronic Gearing</i> (Encoder position of one axis used to drive a second axis. Master and slave axes and gear ratio parameters) Electronic gearing not available in MC2110.
<b>Electronic gear ratio range</b>	-32,768 to +32,767 (negative and positive direction)
<b>Filter modes</b>	Scalable PID+Vel feedforward + acceleration feedforward + bias. Also includes integration limit, settable derivative sampling time, and output motor command limiting.
<b>Filter parameter resolution</b>	16 bits
<b>Motor output modes</b>	<i>PWM</i> : 10-bit resolution at 20 kHz <i>DAC</i> : 16 bits
<b>Maximum encoder rate</b>	<i>Incremental</i> : Up to 5 Mcounts/sec <i>Parallel-word</i> : Up to 160.0 Mcounts/sec
<b>Parallel encoder word size</b>	16 bits
<b>Parallel encoder read rate</b>	20 kHz (reads all axes every 50 µsec)
<b>Servo loop timing range</b>	100 µsec to 3355 msec
<b>Minimum servo loop time</b>	100 µsec (nominal; Exact time is 102.4 µsec) per enabled axis.
<b>Limit switches</b>	2 per axis: one for each direction of travel
<b>Position-capture triggers</b>	2 per axis: index and home signals
<b>Analog input</b>	8 10-bit analog inputs
<b>User defined discrete I/O</b>	256 16-bit wide user defined I/O

### Environmental and electrical ratings *(All ratings and ranges are for both the I/O and CP chips.)*

<b>Storage Temperature (T<sub>s</sub>)</b>	-55° C to 150° C
<b>Operating Temperature (T<sub>a</sub>)</b>	0° C to 70° C*
<b>Power Dissipation (P<sub>d</sub>)</b>	650 mW (I/O and CP combined)
<b>Nominal Clock Frequency (F<sub>CLK</sub>)</b>	40.0 MHz
<b>Supply Voltage limits (V<sub>CC</sub>)</b>	-0.3 V to +7.0 V
<b>Supply Voltage operating range (V<sub>CC</sub>)</b>	4.75 V to 5.25 V
<b>Analog Inputs</b>	0 to 5.0 V dc



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