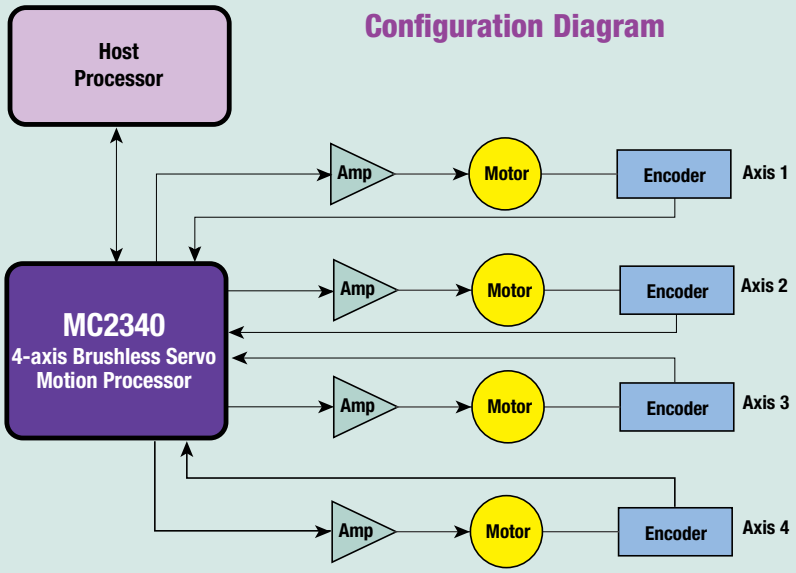
Navigator™ Motion Processor MC2300 Series For Brushless Servo Motion Control

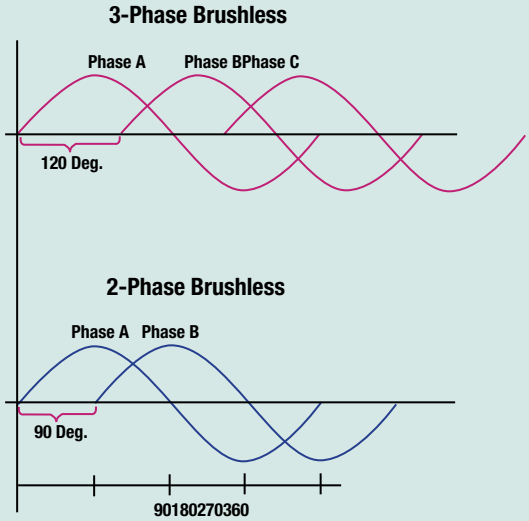
Configuration Diagram



Features

- 6-step (Hall based) or sinusoidal commutation.
- Supports 2 or 3-phase brushless motors.
- 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 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 (1200 and 1100 series).

Sinusoidal Waveform Graph



Navigator™ Motion Processor MC2300 Series For Brushless Servo Motion Control

Description

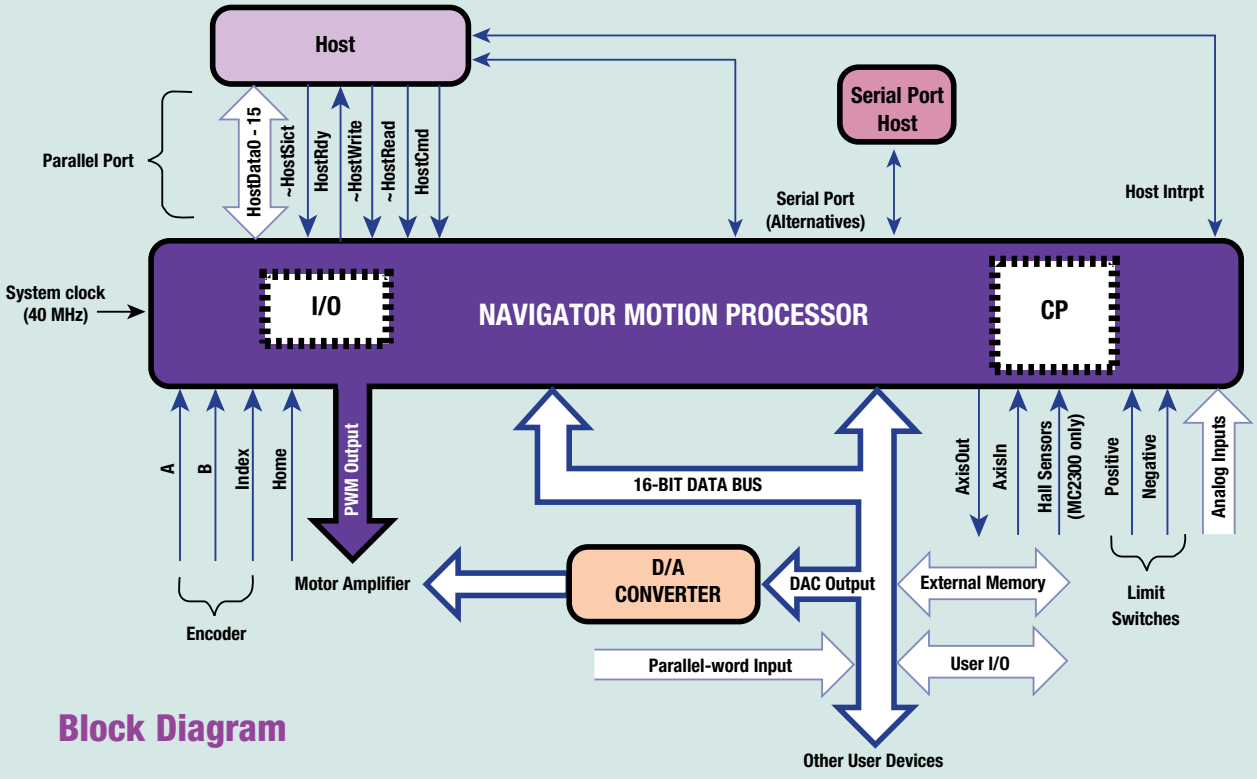
The Navigator™ Brushless Servo Motion Processor (MC2300 Series) is used in embedded control systems for industrial control, automation and robotic applications. Available in one (MC2310), two (MC2320), and four (MC2340) axis configurations, the MC23xx consists of two components, a 132-pin processor and 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 MC2300 Series provides sinusoidal commutation of 2 or 3-phased brushless motors. Initialization is achieved using Hall-based sensors or with the motion processor's own algorithm. The MC23xx accepts incremental quadrature encoder signals for input, and outputs the sinusoidally commutated motor signals. The MC23xx has a pre-programmed PID filter with feedforward velocity and acceleration that can be scaled, has a bias offset, and supports a 32-bit position error. The PID filter operates at 150 µsec 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.

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 MC23xx accepts input parameters such as position, velocity, and acceleration from the host and generates a corresponding trajectory.

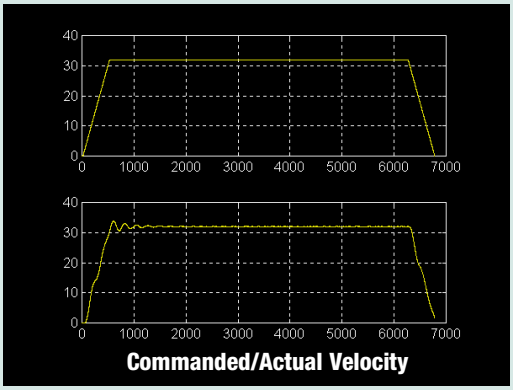
The motion processor accepts feedback from an incremental encoder, up to 5 Mcounts per second, or from an absolute encoder or resolver, up to 160 Mcounts per second. Each axis supports 16-bit DAC or 10-bit, 20 kHz PWM compatible output signals. Each axis can also interface to a quadrature encoder with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

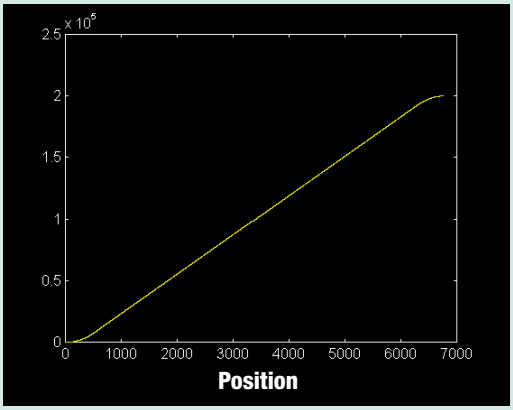
Multiple breakpoints per axis offer precise sequencing and control of events by the application program. PLC-style instructions are provided, which operate on inputs and set outputs. The instructions use Event, Activity and Signal registers. Input signals include two limit switches (one for each direction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

Commutation
Get/SetCommutationMode
Get/SetNumberPhases
Get/SetPhaseAngle
GetPhaseCommand
Get/SetPhaseCorrectionMode
Get/SetPhaseCounts
Get/SetPhaseInitializeMode
Get/SetPhaseInitializeTime
Get/SetPhaseOffset
Get/SetPhasePrescale
InitializePhase

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
GetActualVelocity
Get/SetCaptureSource
GetCaptureValue
Get/SetEncoderModulus
Get/SetEncoderSource
Get/SetEncoderToStepRatio

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

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

Profile generation
Get/SetAcceleration
GetCommandedAcceleration
GetCommandedPosition
GetCommandedVelocity
Get/SetDeceleration
Get/SetGearMaster
Get/SetGearRatio
GetSetJerk
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
GetSignal
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 (MC2340), 2 axes (MC2320), or 1 axis (MC2310)
Operating modes	***Closed loop*** (motor command is driven from output of servo filter) ***Open loop*** (motor command is driven from user-programmed register)
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*** (Position parameters, velocity, acceleration and jerk) ***Trapezoidal point-to-point*** (Position parameters, velocity, acceleration, deceleration, ***Velocity-contouring*** (Velocity, acceleration, and deceleration parameters) ***Electronic Gear*** (Encoder position of one axis used to drive a second axis. Master and slave axes and gear ratio parameters)
Electronic gear ratio range	-32,768 to +32,767 with a resolution of 1/65,536 (negative and positive direction)
Filter modes	Scalable PID+Vel feedforward + acceleration feedforward + bias. Also includes integration limit, settable derivitive sampling time, and output motor command limiting.
Filter parameter resolution	16 bits
Motor output modes	***PWM:*** 10-bit resolution at 20 kHz (for 1 and 2 axis) or 10-bit resolution at 10 kHz (for 4 axis) 50/50 supports 2 or 3 phase motors Sign magnitude supports 2 phase motors only ***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)
Hall sensor inputs	3 Hall effect inputs per axis (TTL level signals)
Commutation rate	10 kHz (MC2340), or 20 kHz (MC2320 and MC2310)
Servo loop timing range	150 µsec to 3355 msec
Minimum servo loop 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
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	152

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

Storage Temperature (T_S)	-55º C to 150º C
Operating Temperature (T_a)	0º C to 70º 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})	-0.3 V to +7.0 V
Supply Voltage operating range (V_{CC})	4.75 V to 5.25 V

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

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