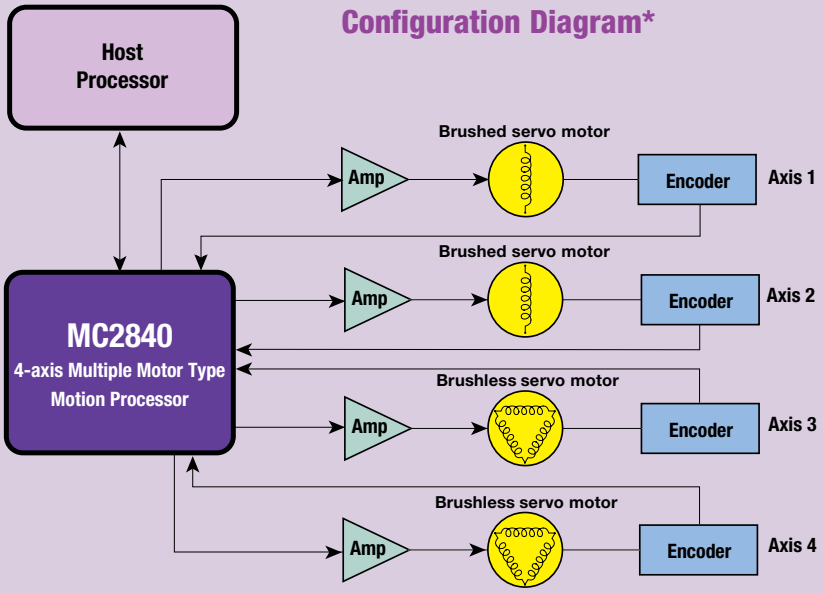
Navigator™ Motion Processor
MC2800 Series
Multiple Motor Type
For Brushed and Brushless Servo Motion Control

Configuration Diagram*

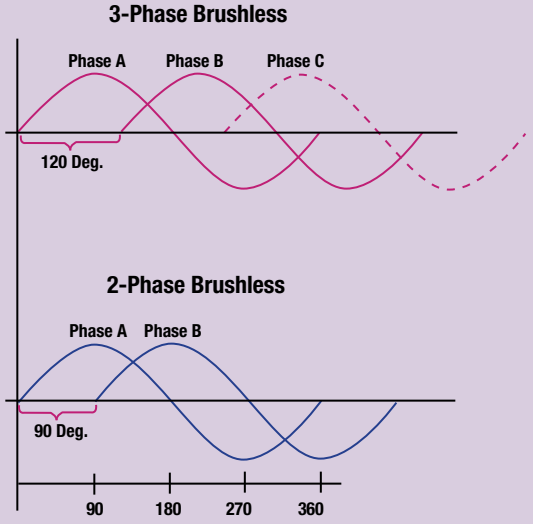


*The diagram shows 2-axis brushed/2-axis brushless. A user can select any axis to be brushed and any axis to be brushless.

Features

- Brushed servo and brushless servo control in one chipset.
- Available in 2- and 4-axis versions.
- 6-step (Hall based) or sinusoidal commutation.
- Supports 2- or 3-phase brushless motors and single phase brushed motors.
- 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.
- 150 µsec brushed and brushless servo loop rate per enabled axis.
- 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.

Sinusoidal Waveform Graph



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Description

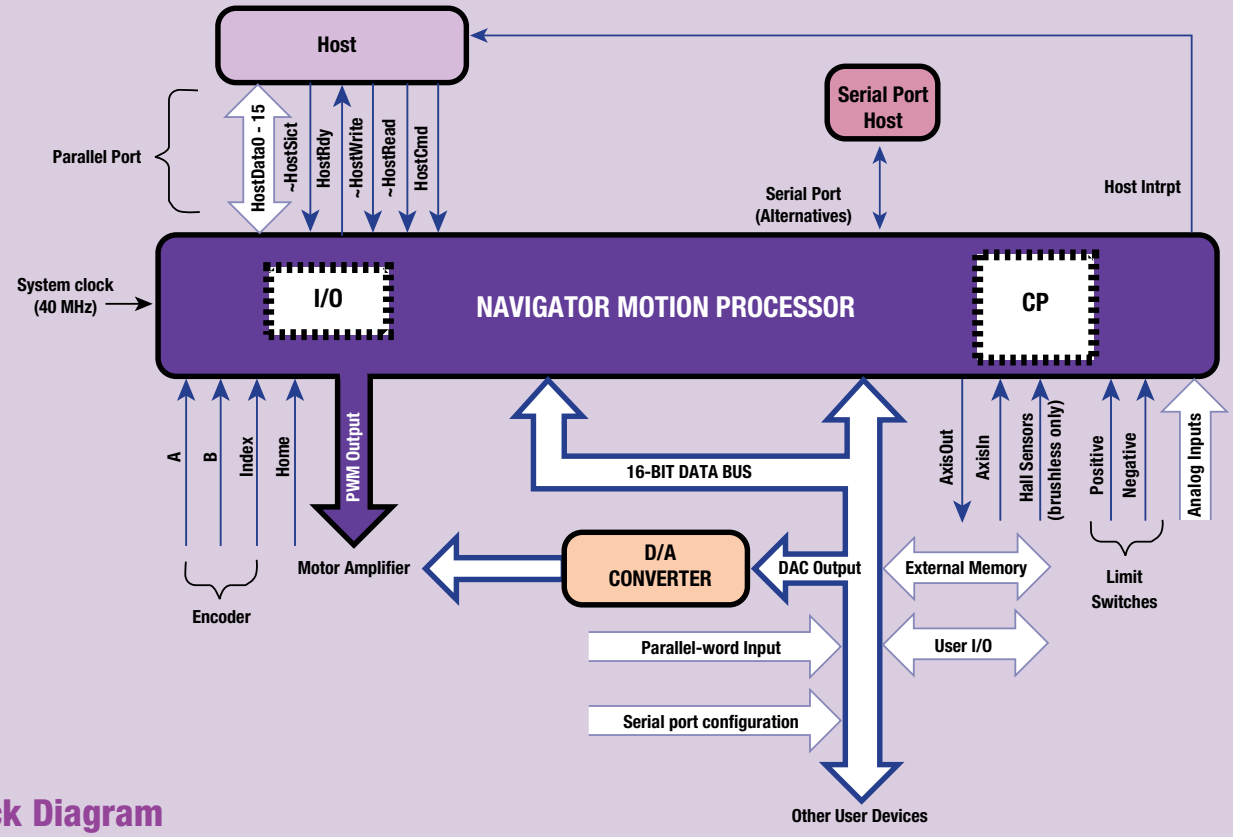
The Navigator™ Multiple Motor Type Motion Processor (MC2800 Series) combines the ability to control both brushed servo and brushless servo motors in one chipset. The user can designate which axes are brushed and which are brushless. Available in two (MC2820) and four (MC2840) axis configurations, the MC28xx 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. For communicating to the host microprocessor, the MC28xx offers the option of a parallel 8-bit or 16-bit interface or an asynchronous bi-directional serial port.

The motion processor offloads resource intensive motion control functions from the application's host. PMD's instruction set, common to all PMD motion processors, offers flexibility and versatility to board designers and software application programmers. User-selectable profiling modes supported by the motion processor include S-curve, trapezoidal, velocity contouring and electronic gearing.

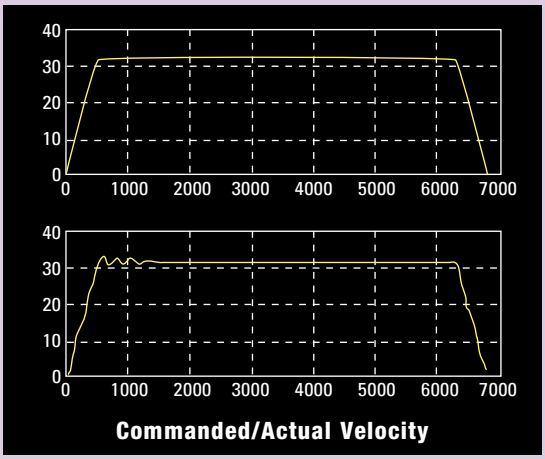
The MC28xx accepts input parameters such as position, velocity and acceleration from the host and generates a corresponding trajectory. The MC28xx has a pre-programmed PID filter with feedforward velocity and acceleration that can be scaled, has a bias offset, and supports a 32-bit position error. The PID filter operates with a 150 µsec servo loop time per enabled axis for both brushed and brushless motors. The MC28xx closes the PID loop with an incremental quadrature encoder at a maximum rate of 5 megacounts per second or with a 16-bit parallel word at a maximum rate of 160 megacounts per second. Each axis supports 16-bit DAC or 10-bit, 20 kHz PWM compatible output signals. For 2- or 3-phase brushless motors, the MC2800 provides sinusoidal commutation; initialization is achieved using Hall-based sensors or with the motion processor's own algorithm.

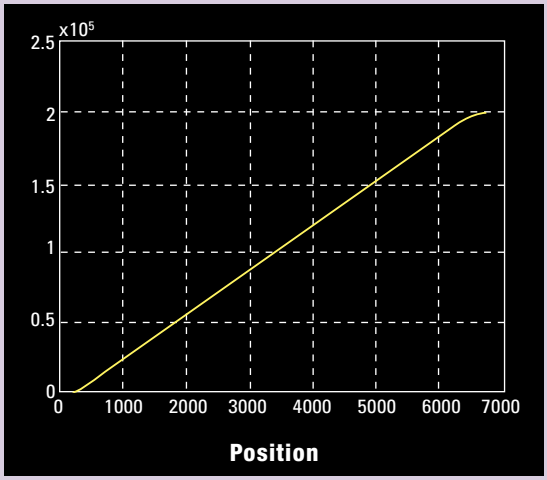
Multiple breakpoints per axis offer precise sequencing and control of events by the application program. PLC-style instructions are provided, which operate on inputs and set outputs. The instructions use Event, Activity and Signal registers. Additional signals include two limit switches (one for each direction of travel), a home indicator, and a general-purpose programmable input/output bit per axis. Eight 10-bit analog (0-5 V) inputs and 256 (16-bit wide) user-defined inputs/outputs are also available. Trace capabilities provide on-the-fly data storage to an external RAM for analyzing system performance, tuning servo filters, and performing maintenance and diagnostics.

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
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 (MC2840) and 2 axes (MC2820)
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*** (Velocity, acceleration, jerk and position parameters) ***Trapezoidal point-to-point*** (Velocity, acceleration, deceleration and position parameters) ***Velocity-contouring*** (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 + velocity feedforward + acceleration feedforward + bias Also includes integration limit, settable derivative sampling time, and output motor command limiting.
Filter parameter resolution	16 bits
Motor output modes	**PWM:** 10-bit resolution at 20 kHz **DAC:** 16 bits 50/50 supports 1-, 2- or 3-phase motors Sign magnitude supports 1- or 2-phase motors
Maximum encoder rate	**Incremental:** 5.0 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) *for brushless only*
Commutation rate	10 kHz (MC2840), or 20 kHz (MC2820) *for brushless only*
Servo loop timing range	150 µsec to 3,355 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

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})	-0.3 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 -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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