IMPORTANT PRODUCT INFORMATION

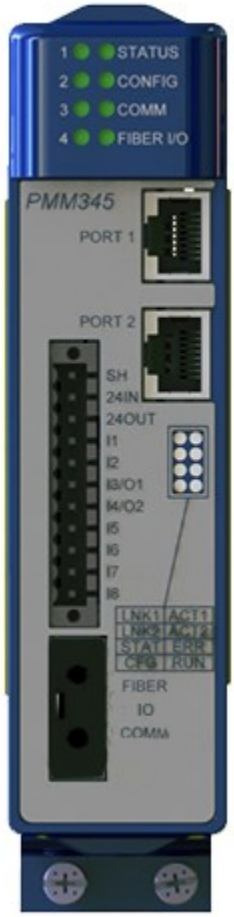
GFK-3164A

Sep 2020

PACMotion™ Multi-Axis Motion Controller

(IC695PMM345)

Release 1.0



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Warning notices are used in this publication to emphasize that hazardous voltages, currents, temperatures, or other conditions that could cause personal injury exist in this equipment or may be associated with its use.

In situations where inattention could cause either personal injury or damage to equipment, a Warning notice is used.

⚠ CAUTION

Caution notices are used where equipment might be damaged if care is not taken.

Note: Notes merely call attention to information that is especially significant to understanding and operating the equipment.

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Introduction

The PACMotion™ Multi-axis Motion Controller (PMM345) is a high performance, easy-to-use servo motion control module that is closely integrated with the PACSystems RX3i CPU's logic solving and communications functions. This versatile motion controller combines highly integrated motion and machine logic with the performance, flexibility and scalability required for advanced machine automation.

Features

Four Servo Axes Plus Additional Virtual Axis - Each PMM345 module can control up to four servo axes. An additional virtual (time-based) axis and an additional external encoder can be configured. Eight modules can be included in a single rack for a total of 40 axes.

Faceplate I/O - The built-in faceplate I/O on the PMM345 has four general-purpose 24 volt digital inputs, two high-speed 24 volt digital inputs with open wire fault detection, and two general-purpose 24 volt configurable inputs/outputs. In addition to simple I/O, Faceplate I/O is configurable for motion-specific functionality such as Touch Probe inputs, Overtravel Limit switches, Home switches, and A Quad B Encoder and Marker inputs (Axis 5 only).

Fiber I/O Terminal Block - The PMM345 supports an optional Fiber I/O Terminal Block (FTB).

Performance - The position loop update rate of the PMM345 is 500µs. The The EtherCAT communication rate is 250us. Motion path planning is done every 1ms for all five axes.

Synchronization - The PMM345 provides synchronized or delayed start of up to eight axes. For electronic cam or gear applications, any number of real (motor) or virtual (time-based) axes in a rack can be used as masters for one or more slave axes on any module in a rack. For electronic cams, master and slave axes can be rescaled dynamically. A cam slave axis can be phase shifted dynamically. Two electronic gearing modes are provided, a simple velocity synchronization, and a velocity/position synchronization. Velocity-synchronized gear slaves can have moves superimposed dynamically allowing jerk-limited position adjustments. For both gearing and camming, the PMM345 uses a ramping function to synchronize a slave to a moving master.

Cam Profiles - Electronic cams can be created using the built-in cam editor in the PACSystems software or imported via CSV file. The cam editor allows master/slave points to be added in either a table or through graphical manipulation. Point data can be fitted using 1st, 2nd, 3rd, or 5th degree spline curve fitting. A cam profile can be subdivided into segments with a different curve fit degree for each segment. Up to 2048 cam profiles can be downloaded and stored on the RX3i CPU at one time. Up to 256 profiles can be selected and stored on each module. Cam profiles can be replaced dynamically as required.

Interrupts - Up to three interrupts are provided for each PACMotion module. One interrupt can be configured as time based with configurable update time down to 2ms. Any of the three interrupts can be configured as I/O input event driven interrupts.

Digital Cam Switch - The digital cam switch (programmable limit switch) capability of the PMM345 provides up to four outputs (tracks) using either regular or high-speed outputs on the faceplate or the FTB. Each track can have up to eight switches.

Diagnostic Logic Block - To assist with commissioning and debug, the PAC Machine Edition software provides the capability to program one diagnostic logic block that can be downloaded to the RX3i CPU and executed without altering the main program logic.

Data Logging -The PMM345 provides the capability to log data during runtime. Using PAC Machine Edition, this data can subsequently be uploaded and displayed.

PLCopen Compliance -The PMM345 module is designed to be compliant with the PLCopen specification for motion. All motion functionality is controlled by specialized functions and function blocks integrated into the CPU logic. Capabilities of motion function blocks include blending and buffering of blocks, and velocity, acceleration and jerk limited motion.

Specifications

For RX3i environmental specifications, refer to the PACSystems Rx3i System Manual, GFK-2314.

Specification Details		Comments
Motion Path Planning	1ms	Consistent update regardless of the number of axes in the system
Position Loop Update Rate	500µs	All axes in the RX3i rack are updated simultaneously
EtherCAT Communication Rate	250µs	All axes in the RX3i rack are updated simultaneously
Controlled Axes/Module	4	βi, βHVi or αHVi series servos are supported via a fiber optic interface
Master Axes/Module	1	Can be a virtual time-based or incremental encoder master
Servo Command Interface	Fiber Optic	50Mb/s Emerson Serial Servo Bus (FSSB)
FSSB Cable Length	Max. 100 meters between nodes	400 meters maximum for a 4 axis system
Maximum Axes per RX3i:		
DC Power Supplies	40 + 10 master axes	Requires 16 slot backplane, CPU and 2 DC power supplies
AC Power Supplies	40 + 10 master axes	Requires 16 slot backplane, CPU and 2 AC power supplies
Position Resolution:		
αHVi Series	1,048,576 counts/rev	—
βi and βHVi Series	65,536 or 131,072 counts/rev	β2i and larger motors support the higher resolution
Feedback Type	Incremental/Absolute Serial Encoder	Battery backup required for absolute feedback mode
Faceplate I/O:		
24V General Purpose Inputs	4 optically isolated; source/sink	—
24V High-Speed Inputs	2 optically isolated; source/sink	Open circuit detection; can be used to connect a quadrature master encoder (500 kHz max)
24V General Purpose Inputs/Outputs	2 optically isolated; source/sink	125mA maximum output current each
Connector	Plug-on Screw Terminal	—
Floating Point Support	Yes	Double precision IEEE 754
Cam Profiles per Module	256 at one time	Up to 2048 profiles can be stored in the RX3i file system for use by any module
Synch/Delayed Start	Up to 8 axes	Axes can be on any module and are synchronized over the backplane
High Speed Position Capture	2 Inputs per axis	—

Installation in Hazardous Locations

The following information is for products bearing the UL marking for Hazardous Locations:

⚠ WARNING

- EXPLOSION HAZARD - SUBSTITUTION OF COMPONENTS MAY IMPAIR SUITABILITY FOR CLASS I, DIVISION 2;
- EXPLOSION HAZARD - WHEN IN HAZARDOUS LOCATIONS, TURN OFF POWER BEFORE REPLACING OR WIRING MODULES; AND
- EXPLOSION HAZARD - DO NOT CONNECT OR DISCONNECT EQUIPMENT UNLESS POWER HAS BEEN SWITCHED OFF OR THE AREA IS KNOWN TO BE NONHAZARDOUS.
- EQUIPMENT LABELED WITH REFERENCE TO CLASS I, GROUPS A, B, C & D, DIV. 2 HAZARDOUS LOCATIONS IS SUITABLE FOR USE IN CLASS I, DIVISION 2, GROUPS A, B, C, D OR NON-HAZARDOUS LOCATIONS ONLY.

Related Information

PACSystems CPU Reference Manual	GFK-2222
TCP/IP Ethernet Communications for PACSystems	GFK-2224
Station Manager for PACSystems	GFK-2225
PACMotion Multi-Axis Motion Controller User's Manual	GFK-2448
PAC Machine Edition Logic Developer-PLC Getting Started	GFK-1918
PACSystems RX3i Hardware and Installation Manual	GFK-2314
Servo Products Specifications Guide	GFH-001
AC Servo Motor βis Series - Descriptions Manual	B-65302EN
PLCopen, www.plcopen.org	

In addition to these manuals, product update documents describe individual product revisions. The most recent PACSystems documentation is available on the Support website: https://www.emerson.com/Industrial-Automation-Controls/support.

Ordering Information

Product	CATALOGUE NUMBER	DESCRIPTION
Motion Controller	IC695PMM345	PACMotion Motion Controller for RX3i
Motion I/O Expansion (optional)	IC695FTB001	Fiber I/O Terminal Block
Fiber Optic Cables	ZA66L-6001-0023#L150R0	FSSB and FTB I/O Cable 0.15 Meter
	ZA66L-6001-0023#L300R0	FSSB and FTB I/O Cable 0.3 Meter
	ZA66L-6001-0023#L1R003	FSSB and FTB I/O Cable 1 Meter
	ZA66L-6001-0023#L3R003	FSSB and FTB I/O Cable 3 Meter
	ZA66L-6001-0026#L1R003	FSSB and FTB I/O Cable Sheathed, 1 Meter
	ZA66L-6001-0026#L3R003	FSSB and FTB I/O Cable Sheathed, 3 Meter
	ZA66L-6001-0026#L5R003	FSSB and FTB I/O Cable Sheathed, 5 Meter
	ZA66L-6001-0026#L10R03	FSSB and FTB I/O Cable Sheathed, 10 Meter
	ZA66L-6001-0026#L20R03	FSSB and FTB I/O Cable Sheathed, 20 Meter
	ZA66L-6001-0026#L30R03	FSSB and FTB I/O Cable Sheathed, 30 Meter
	ZA66L-6001-0026#L50R03	FSSB and FTB I/O Cable Sheathed, 50 Meter
	ZA66L-6001-0026#L100R3	FSSB and FTB I/O Cable Sheathed, 100 Meter

Important Product Information for this Release

No new features are introduced in this release.

Release History

Catalog Number	Firmware Version	Date	Description
IC695PMM345-AA	1.0	Sep 2020	Initial Release

Functional Compatibility

Subject	Description
CPU Version	PACSystems Rx3i firmware release 10.05 or higher is required to use the PMM345.
Programmer Version	PAC Machine Edition Logic Developer – PLC Version 9.8 SIM 4 or higher is required to use the PMM345 Rev 1.00.

Restrictions and Open Issues for Release 1.0

Restriction/Issue	Description
Disconnect of EtherCAT connection between drives.	In an EtherCAT system with two or more drives connected that is configured and in an operational state, breaking the EtherCAT connection to the second, third, or fourth EtherCAT drive may result in an error which the MC_RESET or MC_MODULERESET commands will not clear. The affected drives' axis status %I bits will remain off, the drive display will indicate error F706, and MC_RESET or MC_MODULERESET commands will fail with a 0xCC2 error ID. To recover, disconnect and reconnect the EtherCAT connection between the PMM345 and the first drive then execute MC_MODULERESET.
Hot Swap Only in Stop Mode	Hot Swap of the PMM345 module is only supported when the PLC is in stop mode.
MC_CamIn Error Reported Incorrectly in Fault Table	When the MC_CamIn function block returns a 0x581E error "Cam profile slave start and end positions are not equal", the error is incorrectly reported in the fault table as 0x081E.
Incorrect Error Returned by MC_CamFileRead	In a heavily loaded system, executing an MC_CamFileRead function block while another MC_CamFileRead is in progress will usually correctly produce a 0x0F83 error. However, occasionally it may erroneously return 0x000E or 0x7F08 error codes.
MC_CamTableSelect Incorrect Error Code	Executing an MC_CamTableSelect function block specifying a Cam Profile that currently is not present on the PLC will cause a 0x0FA2 error (Uninitialized Axis, Module, or Cam Table variable) to be generated instead of the correct error 0x0F9D (MC_CamTableSelect - Cam file not found). The user should store the required cam profile to the PLC to avoid this problem.
Digital Cam Switch Pre-compensation on Rotary Axis Not Supported	Currently, configuring pre-compensation on a digital cam switch switch point on a rotary axis will cause a 0x287 error.
Incorrect event queue entry reporting backup required	A jog past the minimum jog distance generates a warning in the event queue that incorrectly says a backup is required. The text for this message is incorrect no backup is required for this movement and no backup is performed.
Using MC_DigitalCamSwitch while changing Low Position Limit and Position Range on Axis 5.	If a MC_DigitalCamSwitch is active on Axis 5 and has Position Source = Actual Position. When Parameter numbers 1006 or 1007 (External Encoder Low Position Limit and Range) are changed with a MC_WriteParameter the MC_DigitalCamSwitch will error with ErrorID = 0x520f, rather than the expected ErrorID = 0x0286. When Parameter numbers 1022 or 1023 (Commanded Low Position Limit and Range) are changed with a MC_WriteParameter the MC_DigitalCamSwitch will error with ErrorID = 0x520f, when the MC_DigitalCamSwitch should continue to operate normally.
Axis 5 Feedback Moving Deadband Validated Incorrectly	On Axis 5 allowable maximum Feedback Moving Deadband may be limited to a value less than expected. The maximum value is calculated as 200000 * Command Position Resolution. The correct calculation should be 200000 * External Device User Units / External Device Counts.

Restriction/Issue	Description
Clearing Errors resulting from a Buffered move unable to execute due to direction constraint causes axis to generate a fast stop error and remain in Error Stop State	When a buffered MFB is unable to execute due to a direction constraint on MC_Power and consequently sends the axis to Error Stop State, executing MC_Reset causes a 0x6308 Invalid Direction error and the axis remains in Error Stop State. Executing MC_Reset a second time will clear this error.
MC_CamIn: Rotary Master axes, selected as Absolute and non-periodic	When MC_CamIn is executed with a Master axis that is Rotary, and it is Absolute (StartMode bit-1 equals 1), and the periodic input was low (False) on the MC_CamTableSelect, and the Master Axis range does not match the Master Profile range, then non-zero MasterOffsets should not be used. The MC_CamIn may fail in this situation with the 0x5321 error "The end of the ramp (master position + ramp distance) was found to be off the cam profile." To use non-zero MasterOffsets consider restructuring the application to use Masters selected as Relative.
High-Frequency Motion Command Sequences	Very rarely, multiple rapid power cycles of the Fiber I/O Terminal Block or the PMM345 module can result in the FTB powering up in a state that appears to be correct. However, subsequent executions of MC_ReadDigitalInput, MC_WriteDigitalOutput, MC_ReadAnalogInput or MC_WriteAnalogOutput function blocks fail with an error of 0x0F81 "Invalid parameter data in PMM". Alternatively, the FTB may fail to configure successfully. If this occurs, a 0x0229 (Configure FTB unable to communicate), 0x0CC3 (Attempt to reset the FTB failed) and 0x00C8 (System Manager entered error state) faults will be logged in the event queue. The user can power cycle again, or execute an MC_ModuleReset to correct either of these problems.

Operational Notes

Subject	Description
MC_DigitalCamSwitch is not supported on Axis 5, Virtual Axis	MC_DigitalCamSwitch should not be used on Axis 5, Virtual Axis. When enabling MC_DigitalCamSwitch on Axis 5, the selected outputs may not switch at the positions selected with First On Position and Last On Position. Instead configure Axis 1-4 as a Synthetic Axis to use as the virtual axis for use with MC_DigitalCamSwitch.
Motion Function Block Instance Data is Stored in RX3i CPU Retentive Memory	The PACMotion Motion Function Block instance data (internal inputs and outputs) is stored in CPU retentive memory. CPUs with battery-backed memory will retain this data across a power cycle event. The retentive functionality means at power up the function block outputs will reflect the state of the block prior to the power cycle event. If it is undesirable for these blocks to retain the prior state information, the application logic must be modified. One method to achieve this result is to reinitialize the instance variables prior to usage in the application logic.
Axis Parameters Should Only be Changed in Disabled State	Some axis parameters have been specified as writable only if the axis is in the Disabled states. Changing these parameters in the Standstill or Errorstop states may result in axis warnings or events that are difficult to diagnose. Therefore it is strongly recommended that these parameters only be changed in the Disabled state.
Busy and Active Outputs Not Reset after Battery-backed Power Cycle	Instance data for motion function blocks is non-volatile. Consequently, when the RX3i experiences a power cycle and then transitions to Run mode, the Busy or Active outputs for these function blocks may be ON, even though the function blocks are not being executed. If it is undesirable for these outputs to retain the prior state information, the application logic must be modified. One method to achieve this result is to reinitialize the instance variables prior to usage in the application logic.
PMM FTB unable to communicate after double power cycle	Very rarely, after experiencing multiple rapid power cycles, the PMM345 may fail to reestablish communication with an FTB. The user can power cycle again to recover from this issue.

Subject	Description
Digital Cam Switch Switch Point Missed During First Sample	A digital cam switch requires one sample of axis movement to determine direction and position. If the first switch point is passed during that first sample, it will not be recognized by the digital cam switch. Users should ensure that at least one ms of axis movement occurs before the first switch point is reached.
Control Loop Execution Time Over Warning Limit Event	Occasionally 0x0E00 (“Control loop execution time exceeded warning limit”) events may be seen in the I/O Fault table. Since this is only a warning the application will continue to work as normal. If you would like to help the ongoing effort to improve the product, please send the Event Log and/or Fault Table and description of the application’s function blocks in progress to Technical Support when the event occurs.
Using Force Servo Velocity	Force Servo Velocity (FSV) sends a velocity command directly to the velocity control loop, bypassing the path generation and position loops. The Axis State when FSV is active is called the Setup State and can be checked using MC_ReadStatus. To use FSV, the axis must be in the Standstill State. The FSV can then be commanded by first writing a timeout of how long the move should last followed by writing the velocity of the move. The ForceServoVelocityTimeout (PN 1320) is a DWORD parameter that is used to specify how long in milliseconds the FSV should last. The valid range is 0ms to 10000ms. While in the Setup State it is allowed to re-write the velocity to either extend the length of the FSV or with a value of zero to immediately stop motion. The ForceServoVelocity (PN 1311) is an LREAL that sets the desired servo velocity in RPM. The forced velocity cannot exceed the MaxVelocityAppl (PN 9). The axis will enter the Setup State and the timeout counter will start when ForceServoVelocity is written. The axis will return to the Standstill state when the timeout expires or a value of zero is written to the ForceServoVelocityTimeout. FSV cannot be aborted by other moves. CAUTION: While in the Setup State the servo does not check for Software End of Travel limits. Hardware Over Travel Limit Switches are still enforced.

General Contact Information

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Any escalation request should be sent to: mas.sfdcescalation@emerson.com

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