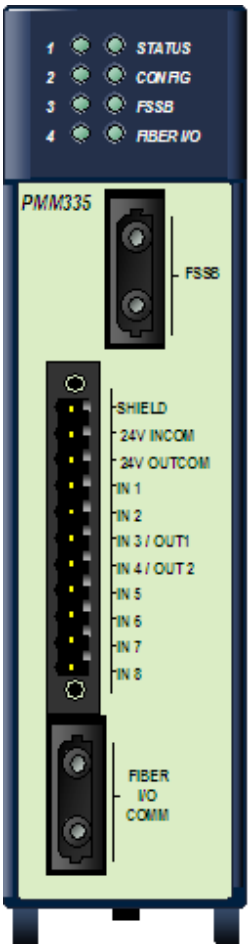
PACMotion* RX3i

IC695PMM335-AF

Multi-axis Motion Controller

GFK-2449G
July 2011

The PACMotion* Multi-axis Motion Controller (PMM335) 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 PMM335 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 PMM335 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 PMM335 supports an optional Fiber I/O Terminal Block (FTB).

Performance - The position loop update rate of the PMM335 is 500µs. The velocity loop update rate is 125µs. Motion path planning is done every 1ms for all five axes.

Synchronization - The PMM335 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 PMM335 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 Proficy* 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 PMM335 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 Proficy 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 PMM335 provides the capability to log data during runtime. Using Proficy Machine Edition, this data can subsequently be uploaded and displayed.

PLCopen Compliance -The PMM335 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
FSSB Velocity Loop Update Rate	125µs	All axes in the RX3i rack are updated simultaneously
FSSB Torque Loop Update Rate	62.5µs	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 FANUC 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	

Important Product Information for this Release

Firmware release 1.60 provides the following new features which are described in greater detail on page 4.

- Support for the Exlar GSM30-605(GSM30-0605-MFB-FA4-238) motor is added to the PMM. To configure the PMM to run the Exlar motor the user selects motor type code 10001. The user will need to pay attention to user units to counts ratio, hardware over travels, and software over travels when setting up this new motor type.

Release History

Catalog Number	*Firmware Version*	*Date*
IC695PMM335-AF	1.60	July 2011
IC695PMM335-AE	1.50	August 2010
IC695PMM335-AD	1.11	March 2010
IC695PMM335-AC	1.10	May 2009
IC695PMM335-AB	1.01	Dec. 2008
IC695PMM335-AA	1.00 (initial release)	Nov. 2008

Upgrades

Previous versions of the PMM335 can be field upgraded to released IC695PMM335-AF using firmware upgrade kit 41G1444-MS10-000-A5 and the firmware upgrade utility.

Firmware upgrade kits can be downloaded at no cost from http://www.ge-ip.com/support .

Functional Compatibility

Subject	*Description*
CPU Version	PACSystems Rx3i firmware release 5.60 or higher is required to use the PMM335.
Programmer Version	Proficy Machine Edition Logic Developer – PLC Version 7.0. or higher is required to use the PMM335 Rev 1.60.

New Feature Descriptions

The Exlar GSM30-605 motor support is added to the PMM 1.6 firmware. To configure the PMM to run the Exlar motor the user must correctly configure the PMM. Items that will require particular attention include motor type code, user units to counts ratio, hardware over travels, and software over travels.

The motor table shown below includes the Exlar GSM30 motor support added for PMM335 Release 1.6.

Motor Type Codes

Either FANUC motor model numbers or motor part numbers can be used to determine the motor type code. FANUC motor part numbers, found on the motor label, are in the form ZA06B-xxxx-yyyy, where xxxx is a four-digit Motor Specification that can be used to look up the Motor Type code configuration value in the following table.

Motor Model	Motor Specification	Motor ID (Type Code)	Rated Speed (rpm)	Maximum Encoder Resolution (cts/rev)
α4/5000HVis	ZA06B-*0216*-B#0#	266	5000	1048576
α8/6000HVis	ZA06B-*0233*-B#0#	292	6000	1048576
α12/4000HVis	ZA06B-*0239*-B#0#	289	4000	1048576
α22/3000i	ZA06B-*0247*-B#0#	297	3000	1048576
α22/3000Hvi	ZA06B-*0249*-B#0#	299	3000	1048576
α22/4000Hvis	ZA06B-*0266*-B#0#	316	4000	1048576
α30/4000Hvis	ZA06B-*0269*-B#0#	319	4000	1048576
α40/4000Hvis	ZA06B-*0273*-B#0#	323	4000	1048576
α50/3000HVis FAN	ZA06B-*0276*-B#1#	326	3000	1048576
β0.2/5000iS	ZA06B-*0111*-B#0#	260	5000	65536
β0.3/5000iS	ZA06B-*0112*-B#0#	261	5000	65536
β0.4/5000iS	ZA06B-*0114*-B#0#	280	5000	65536
β0.5/6000iS	ZA06B-*0115*-B#0#	281	6000	65536
β1/6000iS	ZA06B-*0116*-B#0#	282	6000	65536
β2/4000is	ZA06B-*0061*-B#0#	253	4000	131072
β2/4000HVis	ZA06B-*0062*-B#0#	251	4000	131072
β4/4000is	ZA06B-*0063*-B#0#	256	4000	131072
β4/4000HVis	ZA06B-*0064*-B#0#	264	4000	131072
β8/3000is	ZA06B-*0075*-B#0#	258	3000	131072
β8/3000HVis	ZA06B-*0076*-B#0#	267	3000	131072
β12/3000is	ZA06B-*0078*-B#0#	272	3000	131072
β12/3000HVis	ZA06B-*0079*-B#0#	270	3000	131072
β22/2000is	ZA06B-*0085*-B#0#	274	2000	131072
β22/2000HViS	ZA06B-*0086*-B#0#	278	2000	131072
Exlar GSM30-605	GSM30-0605-MFB-FA4-238	10001	3000	131072
Synthetic Motor	NA	65535	6000	1048576

Problems Resolved by Revision 1.60

None

Restrictions and Open Issues for this Release

Restriction/Problem	*Description*
Hot Swap Only in Stop Mode	Hot Swap of the PMM335 module is only supported when the PLC is in stop mode.
Disconnected Motor Encoder Cable	After the motor encoder feedback cable to the servo has been unplugged, it must be plugged back in before MC_ModuleReset is called to clear the error. If it is still unplugged, the MC_ModuleReset function block will return a 0x0CC2 (Attempt to reset the SCB failed) error. If this occurs, plug the cable back in and then call MC_ModuleReset again.
Store of Hardware Configuration During Drive Disable Delay Causes Loss of Module	If a hardware configuration store is initiated during the drive disable delay period, the PMM does not process the new hardware configuration until the drive disable timeout expires. If the response from the PMM335 to the CPU takes longer than 20 seconds, as can happen with long drive disable timeouts, this delay in response by the PMM335 will cause the CPU to reset the PMM. Loss and addition of module faults will be generated. No further action by the user is required.
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.
MC_Home While Jogging Error Not Normal Stop	Attempting the execute an MC_Home function block while jogging will generate a x0033 (MC_Home while jogging) error on the MC_Home function block. This error should be a normal stop error. Currently, the user is allowed to continue jogging. If desired, the user can implement logic to stop the axis based on the error output of the MC_Home function block.
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.
Fiber I/O Terminal Block I/O Parameters Invalid if FtbOk is Not Set	All data read from Fiber I/O Terminal Block I/O parameters is not valid if FtbOk is not set. This includes parameters 3032-3059, 3160-3171, 3256-3257, 3288-3289, 2108, 2110, 2112 and 2113.
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.

Restriction/Problem	Description
Move that violates MC_Power Direction Constraint Requires two MC_Resets to Clear ErrorIDs	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.
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.
Move Performs a BackUp when No Backup is Required	In rare cases, Moves with very high Jerk/Accel/Decel perform a backup move to the commanded move position when it was not required.
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.
Triggering MC_Power OFF when JOGGING off of HWOT does not stop active jogging command	When an axis exceeds the Overtravel Limit and enters the ErrorStop state, MC_JogAxis can be used to move the axis back inside the Overtravel Limits. In this error condition while the axis is Jogging power can not be turned off using MC_Power. To stop the axis and turn off power disable the MC_JogAxis.
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.”
High-Frequency Motion Command Sequences	Very rarely, executing motion commands at a high rate (i.e. faster than 2ms per axis) can result in errors. When the Jerk is zero, Acceleration and Deceleration are different, and Velocity is very slightly reduced from the preceding command, error 0x5363 “Jerk value too small to complete move without exceeding constraints” may be generated. When the Jerk is zero, Acceleration and Deceleration are the same, and Velocity is very slightly reduced from the preceding command, error 0x632E “An unrecoverable calculation error has occurred” may be generated. Applications that require their own path-planning should consider using the Force Servo Velocity Parameter (1311). Using Force Servo Velocity is discussed in more detail in the Operational Notes section.

Operational Notes

Subject	Description
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 you do not want these blocks to retain the prior state, the application logic must be modified. One method to achieve this result is to re-initialize the instance variables prior to usage in the application logic. A knowledge base article (KB13289 available at http://www.ge-ip.com/support) describes how the user can perform the re-initialization.
Axis parameters should be changed only 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.

Subject	*Description*
Busy and Active outputs not reset after battery-backed power cycle	Instance data for motion function blocks is retentive. 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 you do not want these outputs to retain the prior state, the application logic must be modified. One method to achieve this result is to re-initialize the instance variables prior to usage in the application logic. A knowledge base article (KB13289 available at http://www.ge-ip.com/support) describes how the user can perform the re-initialization.
T2 Execution Time Over Warning Limit Fault	Certain error conditions and heavily loaded systems may see occasional 0x0E00 faults generated (T2 Execution Time Over Warning Limit Fault). T2 is the motion path planning loop.
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.
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.
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 with Position Valid (PN 1201) set True. 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 parameter 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.

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

Proficy 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: http://www.ge-ip.com/support.

Ordering Information

Motion Controller	IC695PMM335	PACMotion Motion Controller for RX3i
Motion I/O Expansion (optional)	IC695FTB001	Fiber I/O Terminal Block
Communication Cable	IC693CBL316	Serial Cable for Programming - 3m (1 per system)
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

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;
- WARNING - EXPLOSION HAZARD - WHEN IN HAZARDOUS LOCATIONS, TURN OFF POWER BEFORE REPLACING OR WIRING MODULES; AND
- WARNING - 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.