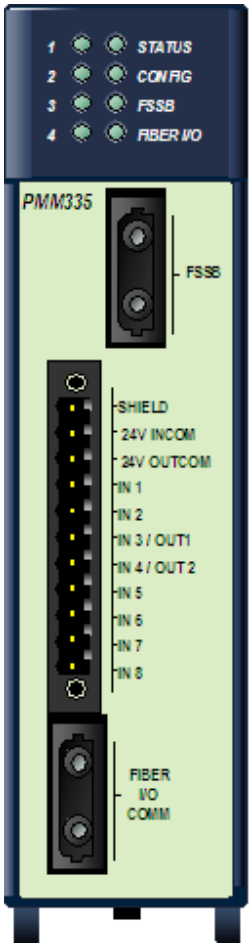
PACMotion™ RX3i

IC695PMM335-AB

Multi-axis Motion Controller

GFK-2449B
December 10, 2008



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), IC695FTB001.

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 (comma separated variable) 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 (3 points minimum per segment) 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
Velocity Loop Update Rate	125µs	All axes in the RX3i rack are updated simultaneously
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 1.01 corrects the issues listed in “Problems Resolved by this Revision” on page 3.

Release History

Catalog Number	Firmware Version	Date
IC695PMM335-AB	1.01	Dec. 2008
IC695PMM335-AA	1.00 (initial release)	Nov. 2008

Upgrades

An IC695PMM335-AA can be field upgraded to an IC695PMM335-AB using firmware upgrade kit 41G1444-MS10-000-A1 and the firmware upgrade utility.

Firmware upgrade kits can be downloaded at no cost from http://support.gefanuc.com/ or purchased.

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 5.90 SIM1or higher is required to use the PMM335. **CAUTION** **SIM1 resolves an issue in version 5.90 that can cause projects to be corrupted when the Data Log Window is used. You should make sure that this patch is installed before using Version 5.90 with the PMM335.** The PMM335 is not compatible with LM90, Control, VersaPro or the DOS-based Motion Programmer (IC641SWP065).

Problems Resolved by this Revision

Subject	Description
MC_GearIn incorrect initial move when following actual position	Executing an MC_GearIn function block configured to follow actual position when the master axis is not moving now functions correctly. Previously, it was possible for the slave axis to experience an Out of Sync error or move a small distance (less than the configured Maximum Position Error).
Validation of Master Actual Velocity Filter (parameter 1321)	An attempt to write an invalid value to the Master Actual Velocity Filter (Parameter 1321) now results in an error. Previously, the function call would succeed and incorrect operation would occur.
MC_SetPosition immediately after drive enabled	If an MC_SetPosition function block is executed on an axis immediately after Drive Enabled goes high, but before the axis transitions from the disabled state to the standstill state, the axis will now operate correctly. Previously, it was possible for the slave axis to experience an Out of Sync error or move a small distance (less than the configured Maximum Position Error).
Actual velocity for virtual axis reported incorrectly	Executing an MC_ReadDwordParameter function call to read the actual velocity (parameters 10 and 1309) of the virtual axis (axis 5) when an external encoder is configured will now return the correct value. Previously, a value of zero was returned.

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.
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.
Detailed description for Motor Encoder error	If an MC_SetPosition function block is executed before the associated encoder has passed through the zero reference, the description of the 0x0053 fault displayed in the I/O fault table indicates a Motor Encoder Error. The corresponding event queue entry is "MC_SetPosition absolute digital encoder has not passed through the zero reference", a more specific description.
Digital Cam Switch misses the Switch Point 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 millisecond of axis movement occurs before the first switch point is reached.
Instability of Beta 1/6000iS motor at speeds greater than 5200 RPM	At speeds close to 6000 RPM, the Beta 1/6000iS motor (motor type 282) exhibits velocity instability. With a constant velocity command, the actual motor velocity varies +/- 80 to 150 RPM. Normal variation should be about 5 to 10 RPM. The PMM can operate the Beta 1/6000iS motor properly if the velocity is limited to 5200 RPM. This limit can be set using the Motor Velocity Limit (RPM) setting of the configuration software.
Some FANUC motors have different Torque Limit, Torque Cmd & Actual Current scaling	Parameters for Torque Limit, Torque Cmd and Actual Current have an error of 11.1% for the Beta 2/4000HViS and Beta 2/4000iS motors. For example a Torque Limit setting of 90% results in an effective limit of 100%. A reported Torque Cmd or Actual Current of 90% represents an actual value of 100%. Parameters for Torque Limit, Torque Cmd and Actual Current have an error of 12.5% for the Beta 0.4/5000iS motor. For example a Torque Limit setting of 80% results in an effective limit of 100%. A reported Torque Cmd or Actual Current of 80% represents an actual value of 100%.
Some cam profile errors not reported by Module Status code	Some cam profile errors (0x800, 0x801, 0x802, 0x803, 0x804, 0x809, 0x80a, 0x80b, 0x80c, 0x80d, 0x80e, 0x810 and 0x811) reported by the MC_CamTableSelect, MC_CamTableDeselect and MC_CamIn function blocks are not subsequently reported on the module status code.
MC_WriteDigitalOutput with invalid Output fault description	Executing a MC_WriteDigitalOutput function with an invalid output (e.g. 3001) will cause an "Invalid function block Output parameter" fault to be generated instead of the more precise "Invalid digital output reference used to write digital output".
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.
Function Block Instance Superceded warnings not cleared by MC_ModuleReset	Warnings 0x034a (MC_Power instance was superseded by another), 0x034b (MC_SetOverride instance was superseded by another) and 0x034c (MC_JogAxis instance was superseded by another) are not cleared by executing an MC_ModuleReset function block. Executing a MC_Reset function block will successfully clear the warnings.

Restriction/Problem	*Description*
High Motor Current alarm with Beta 0.5/6000is and Beta 1/6000is motors	0x60BE error (Abnormally high motor current) may occur when torque limited acceleration is commanded to negative velocities greater than -5000 rpm. To prevent the error from occurring, reduce the acceleration rate so the motor does not operate in torque limit. If the acceleration cannot be reduced, enter Hardware Configuration Advanced Tab parameter 10019 (EMFCMP) with data = 0.
MC_Home While Jogging error not Normal Stop	Attempting to 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.
Normal Stop error 0x5308 reported as 0x0308	If an MC_SetPosition function block with a large absolute position is executed while the axis is moving, and only one direction of movement is allowed, and the new position is past the current move's destination, the set position is not allowed and a normal stop correctly occurs. The set position is not allowed since it would require movement in the direction not allowed. The error code returned on the function block is 0x0308. It should be 0x5308, since a normal stop has occurred.
Extraneous warning while jogging	Aborting an MC_JogAxis function block execution on an axis with another MC_JogAxis function block execution may cause a 0x035c (Move requires a backup to reach commanded position but would cause motion in direction that is not allowed) to be generated. This warning can be ignored.
Commanded position of Synthetic Axis and Virtual Axis differ after initially enabled	A synthetic axis maintains its commanded position if the axis power is disabled then enabled. A virtual axis forces the axis commanded position to zero any time the axis is enabled. The handling of these two similar operations should be consistent. For a virtual axis, if the commanded position has previously been set valid (via MC_Home or MC_SetPosition), it remains valid. If this axis is being used as a master, the slave(s) following will see the master "move" to zero when power is applied and will attempt to follow. This issue can also occur when the virtual master axis is disabled due to an error, and then reset. If the slave's change in position is greater than the configured maximum position error, the slave will immediately go to ErrorStop. When a linear axis is being used as a master, it is recommended that the Software End of Travel limits be set on the slave axes, rather than the master axis.
Digital Cam Switch pre-compensation on rotary axis not supported	Currently, configuring pre-compensation on a DCS 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	Data read from Fiber I/O Terminal Block I/O parameters is not valid unless the FtbOk status bit is set. This includes parameters 3032-3059, 3160-3171, 3256-3257, 3288-3289, 2108, 2110, 2112 and 2113.

Restriction/Problem	Description
Unrecoverable Calculation Error reported due to overconstrained move	A 0x632E error can be generated in instances where an in-process move is interrupted by a new move that has a Jerk input value too small to allow completion without exceeding its maximum velocity. To diagnose this condition, look at the complete fault code, which will contain FF C9 in the location shown in the following example. Example fault code 63 2e 37 21 01 a5 **ff** c9 00 00 00 00 00 00 00 00 00 00 00 00 00 To allow the new move to complete successfully, increase its Jerk command value.
Hardware Configuration error with disabled Axis 5 with external encoder	If a virtual axis with an external encoder is created in the PMM335 hardware configuration and then the virtual axis is disabled, a hardware configuration error may occur on when downloading the hardware configuration. To remove the external encoder on a disabled axis, enable Axis 5 by setting the number of virtual axes to 1 in the Settings tab. On Axis 5 set the external encoder to None. Then disable Axis 5 by setting the number of virtual axes back to 0 in the Settings tab.

Operational Notes

Subject	Description
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.
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. To provide consistent and predictable operation, motion function blocks should be called with positive power flow and their Execute or Enable inputs OFF on the first scan. Once these actions are performed, the outputs of the motion function blocks will be in an initial state. It is strongly recommended that this practice be used with any function blocks for which the states of these outputs are critical to the application.

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 at the GE Fanuc website: http://www.gefanuc.com/.

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.