

# SOFTWARE FOR MMC AND PIC CONTROLS

This PDF document is a subset of the Sheffield Automation MMC Controls, Block I/O and Cimrex HMI Product Guide, P/N M.1301.6219.

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**MMC CONTROLS, BLOCK I/O AND CIMREX HMI  
MOTION SOLUTIONS PRODUCT GUIDE**

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**Software for MMC and PiC Controls**

Sheffield Automation

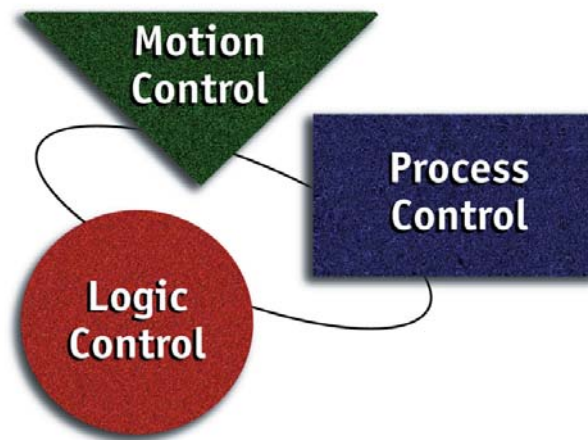


## PiCPro for Windows

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PiCPro for Windows is the universal programming software package for the PiC and MMC family of controls. PiCPro for Windows combines motion, logic and process control all in a single programming environment. Motion and logic are closely coupled to provide high performance total machine control.

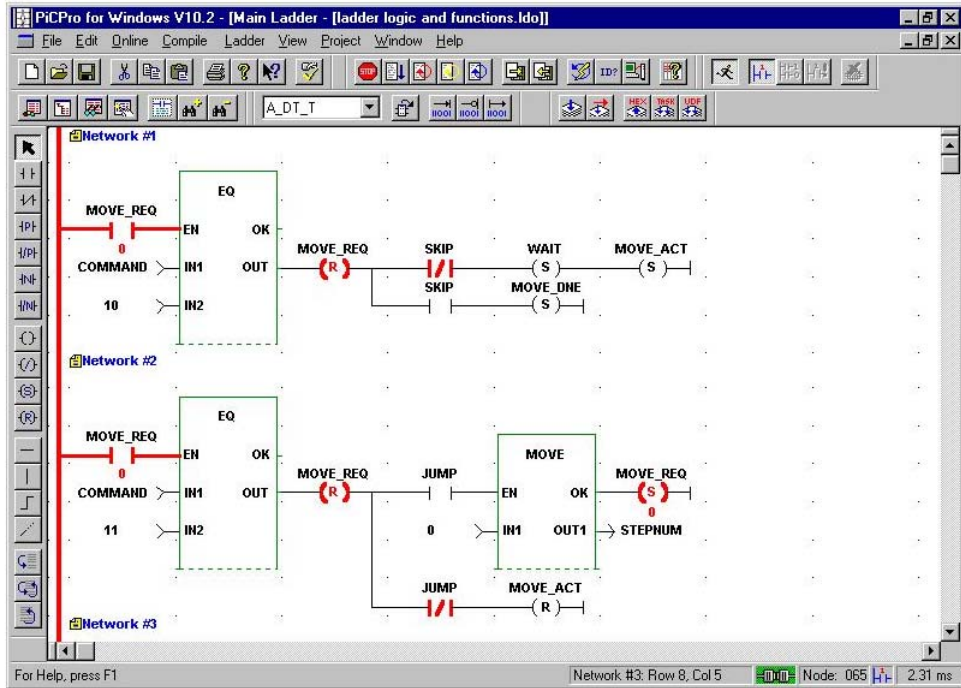


Application programs are created for the PiC and MMC by running PiCPro for Windows on a Windows NT or XP personal computer. An application program consists of ladder logic for machine I/O combined with function blocks and structured text for higher level operations as defined by the IEC61131 standard for programmable controllers.

Each application program is made up of a list of networks. Each network contains up to three items: The logic in the network, a network comment (up to 100 lines), and a network label (8 characters). The network label, in conjunction with the jump-to-label or jump-to-subroutine instructions, allows you to selectively scan portions of the application program.

Each network can contain graphical ladder logic, functions, and function blocks or textual Structured Text program code. The application developer is free to choose on a network-by-network basis the programming language best suited to solving their application.

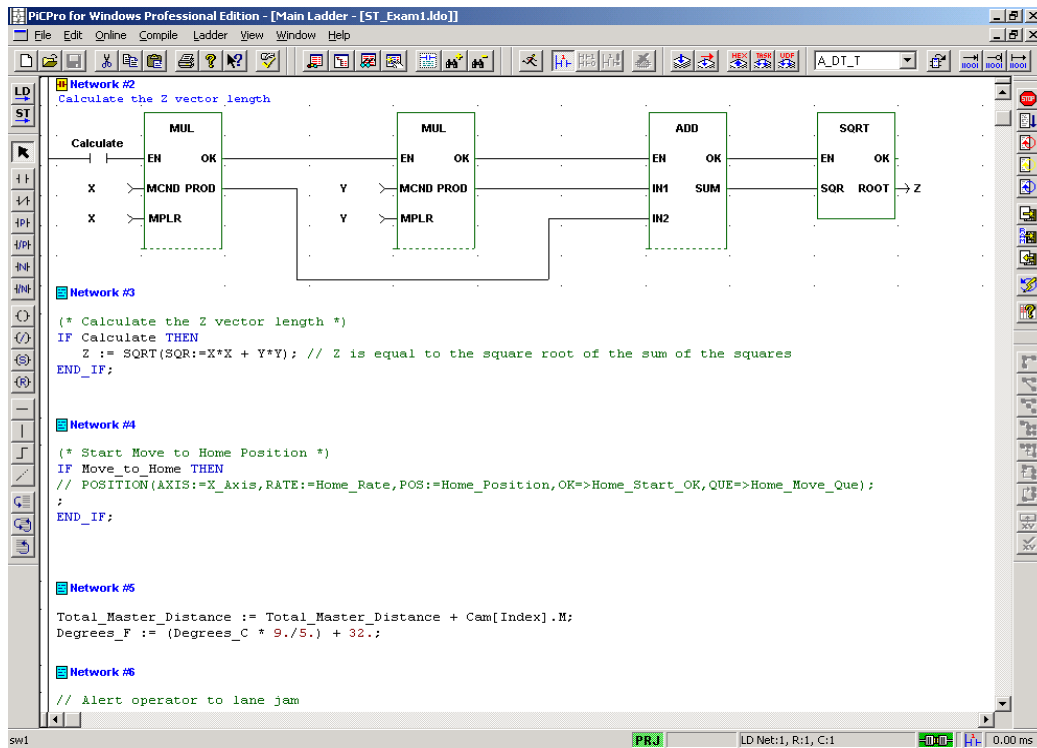
Powerful features, including animation, forcing, and on-line edit of both ladder logic and Structured Text programs, reduce application effort significantly. User-developed function blocks promote re-use of proven code in application after application, improving quality and reducing costs.



Ladder logic is programmed using contacts, coils and wires. Ladder logic is 100% free format, limited to whatever will fit in a 255-cell stretchable matrix. For example, the network could be 255 cells wide and 1 cell high, or 127 cells high and 2 cells wide, as long as there are no more than 255 cells. The configuration of the matrix allows you to group control functions together in a single network, even if the network contains more than one rung.

All contacts and coils are specified using tag names of up to sixty-four alpha-numeric characters. There is no need to program via input or output addresses. The table below contains a list of the contact and coil types available:

Contacts	Coils	Wires
Normally Open -   -	Energize -( )-	Horizontal
Normally Closed - / -	De-energize -( / )-	Vertical
Positive Transition - P -	Set (Latch) -(S)-	Both __
Negative Transition - N -	Reset (Unlatch) -(U)-	
Normally closed positive transition - /P -		
Normally closed negative transition - /N -		



Structured Text provides application programmers with an alternative to graphical ladder logic and function block programming. Certain application programs, such as mathematical equations are much easier to represent in a structured text rather than ladder logic. The complete PiCPro instruction set can be used in Structured Text, including: standard functions and function blocks, application specific function blocks (ASFB's) and user developed function blocks (UDFB's).

A complete set of Structured Text programming constructs provides the tools needed to solve complex problems easily.

Conditional Execution	Iterative Execution
IF-THEN-ELSE	FOR-DO
ELSIF_THEN_ELSE	WHILE-DO
CASE	REPEAT-UNTIL

Higher level operations are performed using functions and function blocks. Over 240 functions are standard in PiCPro for Windows. The functions are divided into categories ranging from arithmetic to motion to string manipulation as described below:

<b>Function Category</b>	<b>Description</b>
Arithmetic	Functions for manipulating numeric type data such as add, subtract, multiply, divide, and trigonometric functions such as sine, tangent, etc.
Binary	Function for manipulating bitwise type data such as AND, OR, SHIFT, etc.
Counters	Function blocks for PLC-type counting
Datatype	Functions to convert numeric and bitwise data from one data type to another
Evaluate	Comparison functions such as LE (less than or equal to), GT (greater than), etc.
Fieldbus	Access DeviceNet or Profibus fieldbus networks
Filter	Data transfer and manipulation functions
I/O	Functions to interface to I/O devices such as the serial port, Ethernet TCP/IP RAMDISK file storage, analog input and output, stepers, thermocouples, etc..
Motion	Functions to initiate motion, retrieve data, and monitor errors on servo axes
String	Functions to manipulate string data types
Timers	PLC timer function blocks
Clock	Functions to set and access the time-of-day clock

Functions can be chained together in a network and data can be passed from the output of one function to the input of the next over a wire. Some functions, such as ADD, are extensible to allow multiple inputs.



Each function has a help screen associated with it that can be accessed by right clicking on the function in PiCPro for Windows. The help screen describes how the function works, what all of the inputs and outputs are, and what data types are required for each input and output.

## RATIOCAM

*Ratio Cam* **Motion/RATIOMOV**

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RATIOCAM

EN	OK
AXIS	QUE
MAST	
CAM	
SSTR	
MSTR	
OPTN	

**Inputs:** EN (BOOL) - enables execution (**One-shot**)  
 AXIS (USINT) - identifies slave axis (servo)  
 MAST (USINT) - identifies master axis  
 CAM (ARRAY OF STRUCTURES) - points to the first element in the array of structures defining the profile to run NOTE: Each segment of the profile is entered in FUs. If you are entering equal master segments, then you enter a STRUCTURE WITH AN ARRAY here.  
 SSTR (DINT) - Slave starting point in LU  
 If SSTR is outside the range of -536,870,912 to 536,870,911 FU, the OK will not be set.  
 MSTR (DINT) - Master starting point in LU  
 If MSTR is outside the range of -536,870,912 to 536,870,911 FU, the OK will not be set  
 OPTN (WORD) - provides five options: repeat, ignore master start, ignore slave start, equal master segments, and use master command position

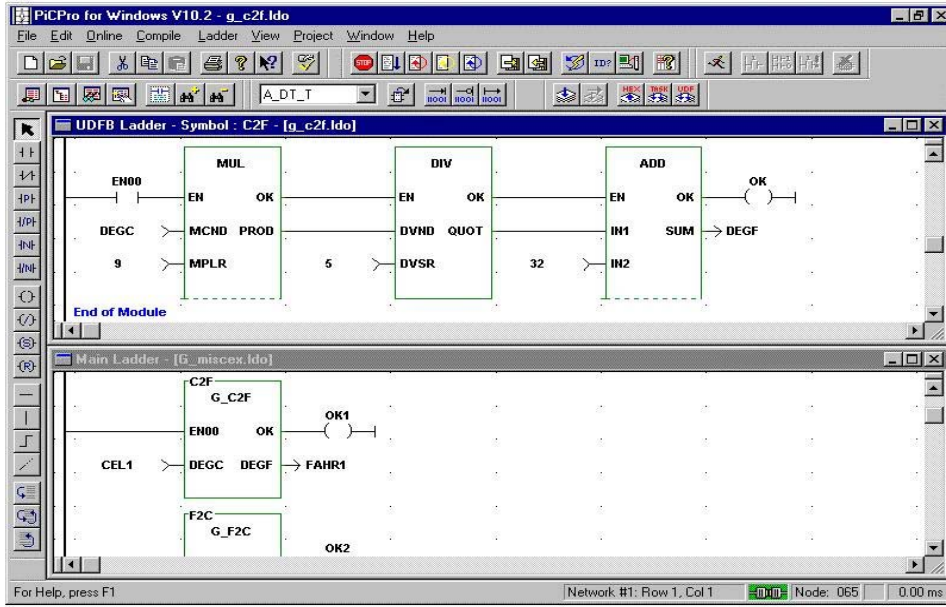
**Outputs:** OK (BOOL) - execution completed without error  
 QUE (USINT) - number of the cam profile move for the queue.

**master axis note**

The master axis for any master/slave move can be one of three types available:

1. **A servo axis**  
 (Range of numbers available to enter at MAST for servo axes is 1 through 16.)

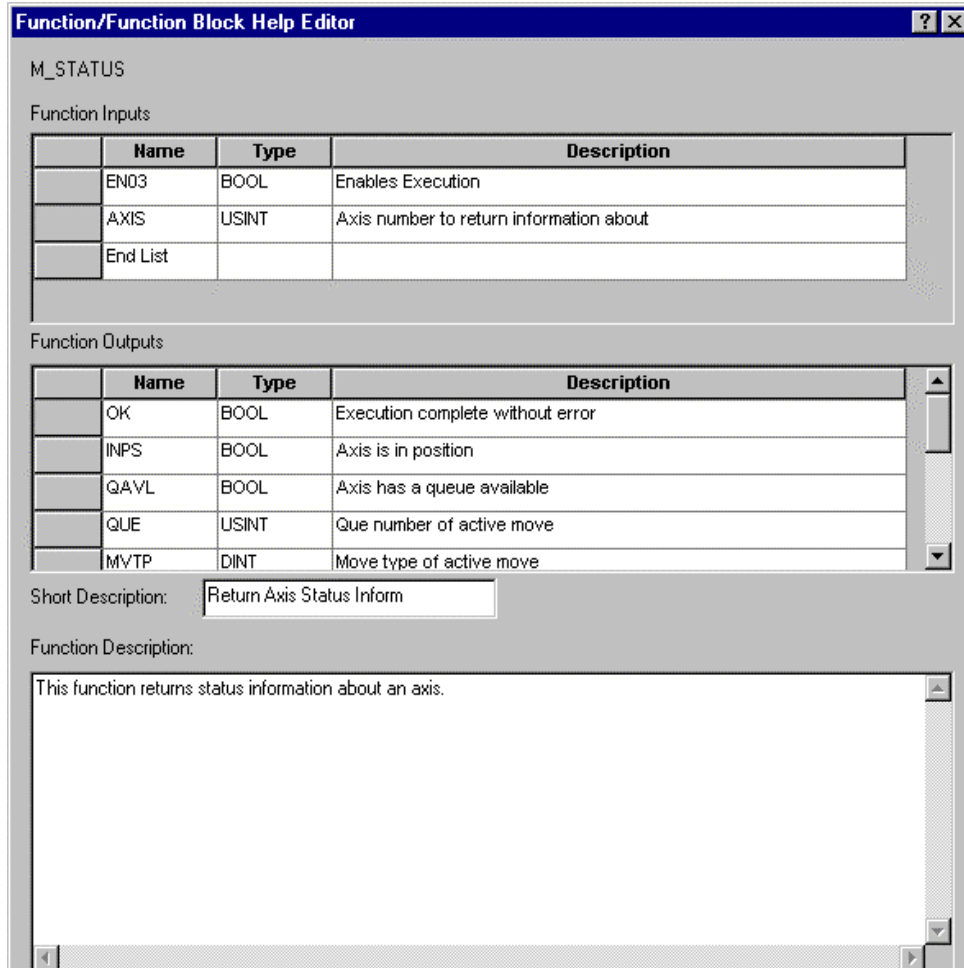
In addition to the standard functions included with PiCPro for Windows, you can create your own function blocks, which are called User Defined Function Blocks or UDFBs. You define the inputs and outputs and write the logic the UDFB is to perform. When you create a UDFB, it is placed in a library on your workstation. The library will then appear under the Functions menu in PiCPro, making your function available to all application programs created afterward.



Using UDFBs results in an application program that is better organized, more readable, and easier to maintain. Some of the ways UDFBs can be used are listed below:

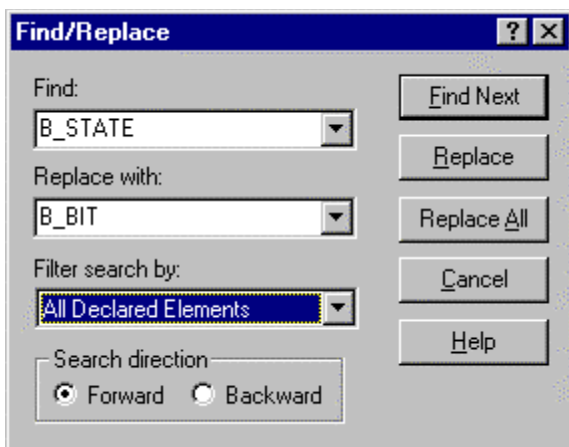
- UDFBs can segregate the logic for a section of an application program (e.g., diagnostics, fault logging, etc.)
- “Custom” functions with a higher level of functionality can be created (e.g., cam profile calculation, proprietary machine algorithm, etc.)
- A single UDFB can replace in-line programming of repetitive machine functions (e.g., axis fault control)

You can create help screens for your UDFBs using the PiCPro for Windows help message editor.

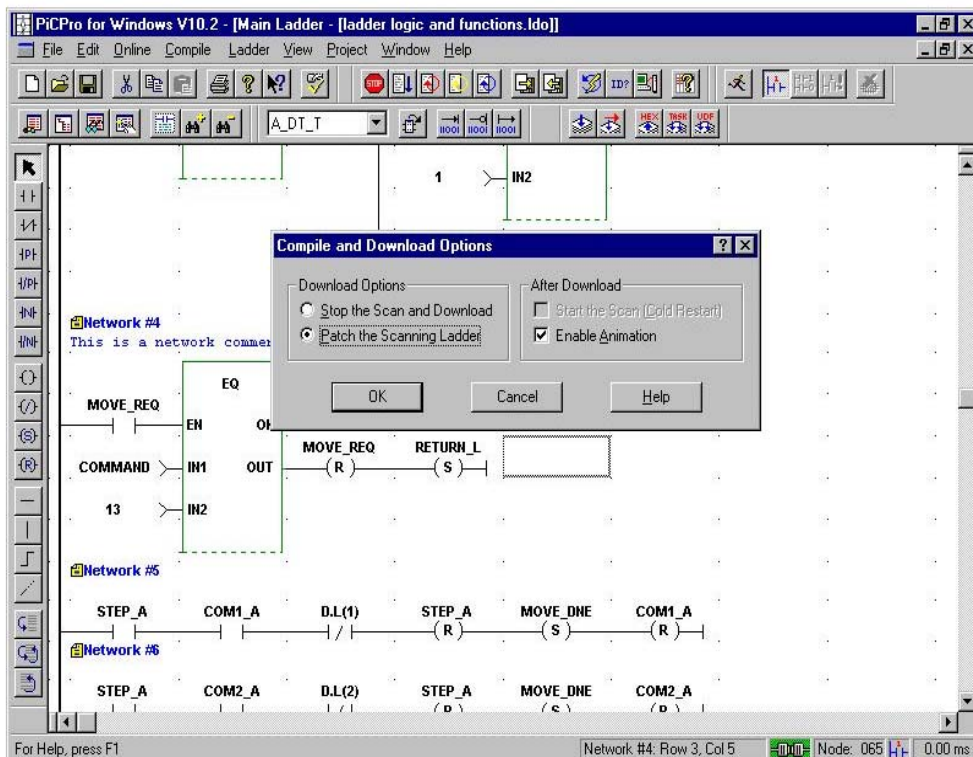


Powerful editing features in PiCPro for Windows allow you to select a block of networks or a piece of an individual network and cut, copy, move, or paste it using the clipboard. You can even paste it into a new application program, and PiCPro will copy the software declarations along with the logic.

The Find/Replace capabilities allow you to search for an element, replace a single occurrence, or all occurrences with a single command.



When you are ready to load the application program into the PiC or MMC, PiCPro for Windows compiles the program and loads it into the control. If you are making a small change to a program that is already running, you can patch your changes in without stopping the application program scan.

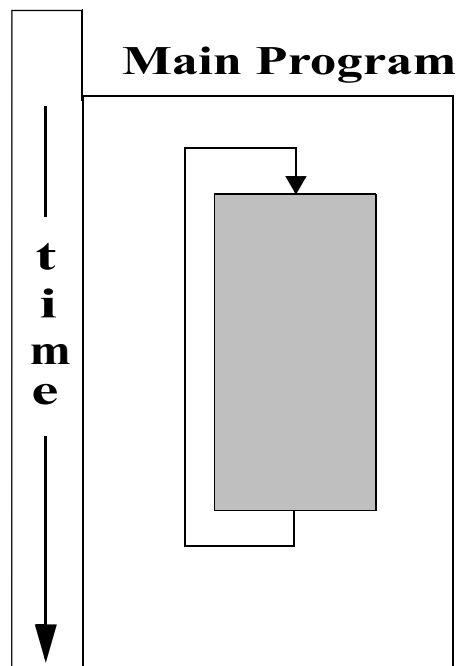


While the application program is running, power flow for contacts, coils, and wires can be highlighted and numeric values for data displayed using animation. You can also create a window of variables, called a view list, to animate at the same time as the program flow. Other on-line tools include variable force and scan control.

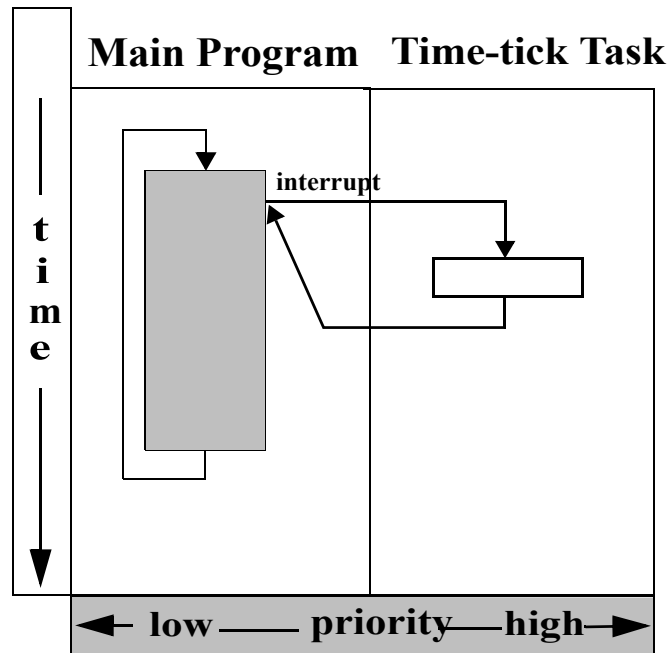
If you have a UDFB in your application program, you can animate the UDFB at the same time as the main application program, too.

In addition to UDFBs, you can create sections of ladders called tasks that will execute at periodic intervals, on the rising or falling edge of a discrete input, or every servo update. This allows you to schedule events in your application program based on machine performance requirements.

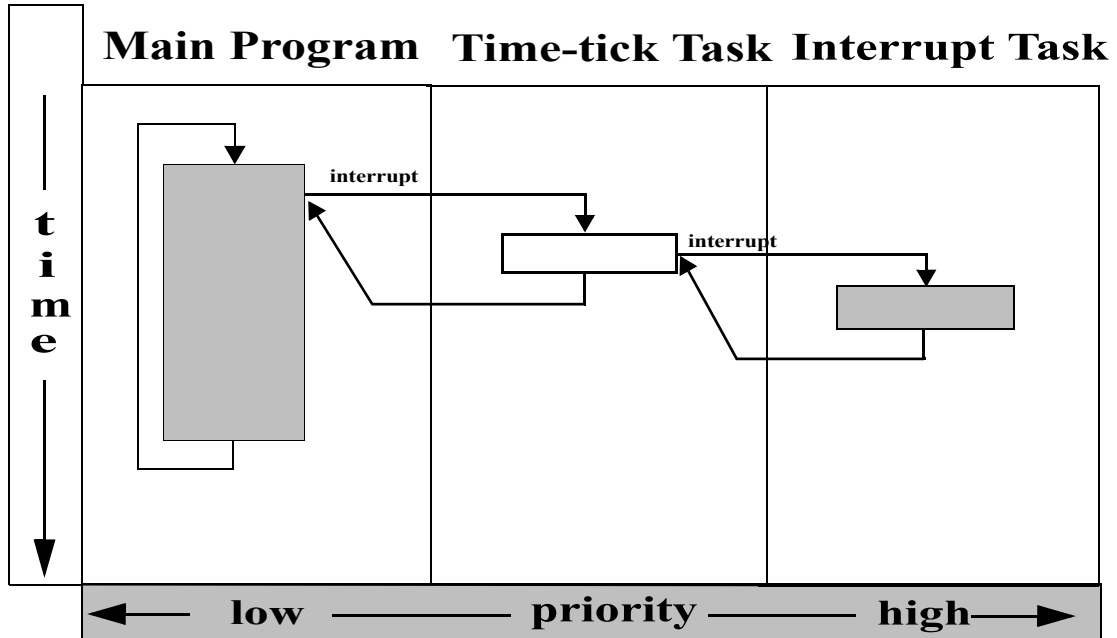
The majority of control functions are solved using standard ladder logic, which is scanned from beginning to end.



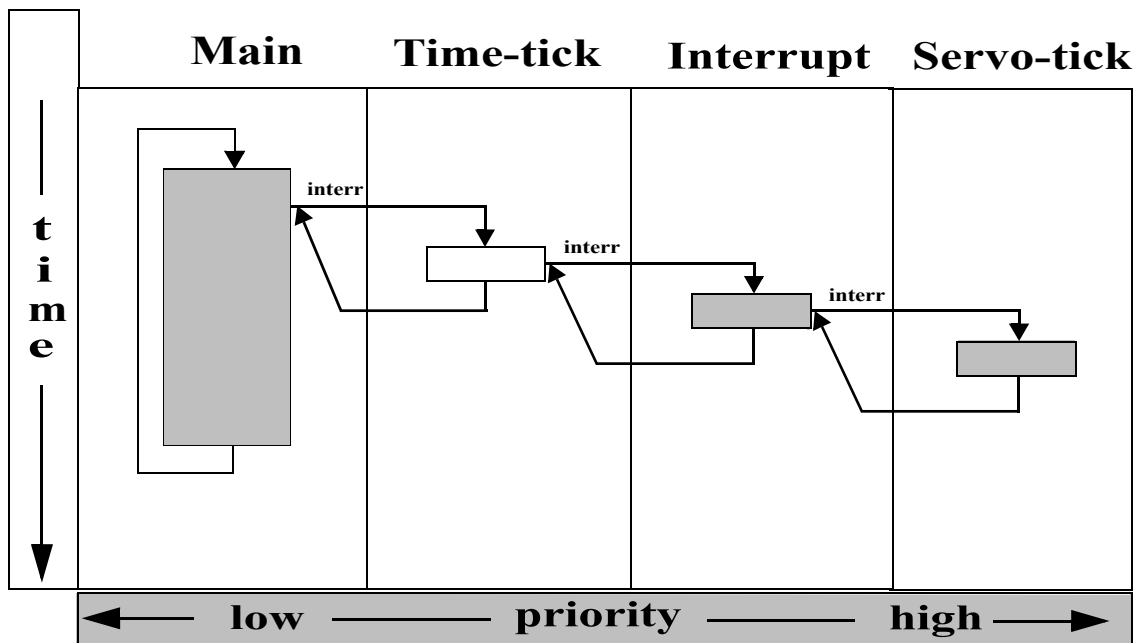
Time-tick Tasks are scheduled at a user-selected rate from 10 milliseconds to 10 minutes. Time-tick Tasks are higher priority than the main program scan. Task I/O is updated at the task rate faster than the main scan



Interrupt Tasks are event-driven and caused by real-world inputs. Interrupt Tasks can be initiated by rising or falling edges of interrupt inputs. Interrupt Tasks are higher priority than both the Time-tick Tasks and the main program and will interrupt them.



Servo-tick Tasks execute synchronously with the servo update loop. Servo-tick Tasks can execute as often as every 1 millisecond. Servo-tick tasks have the highest priority and take precedence over Interrupt Tasks and Time-tick Tasks and the main program.



All variables that are used in the application program must be declared in software declarations. Each variable is assigned a name and a data type. There are five categories of data types: bitwise, numeric, string, time of day, and time duration. The individual data types that are available under each of these categories is listed in the table below

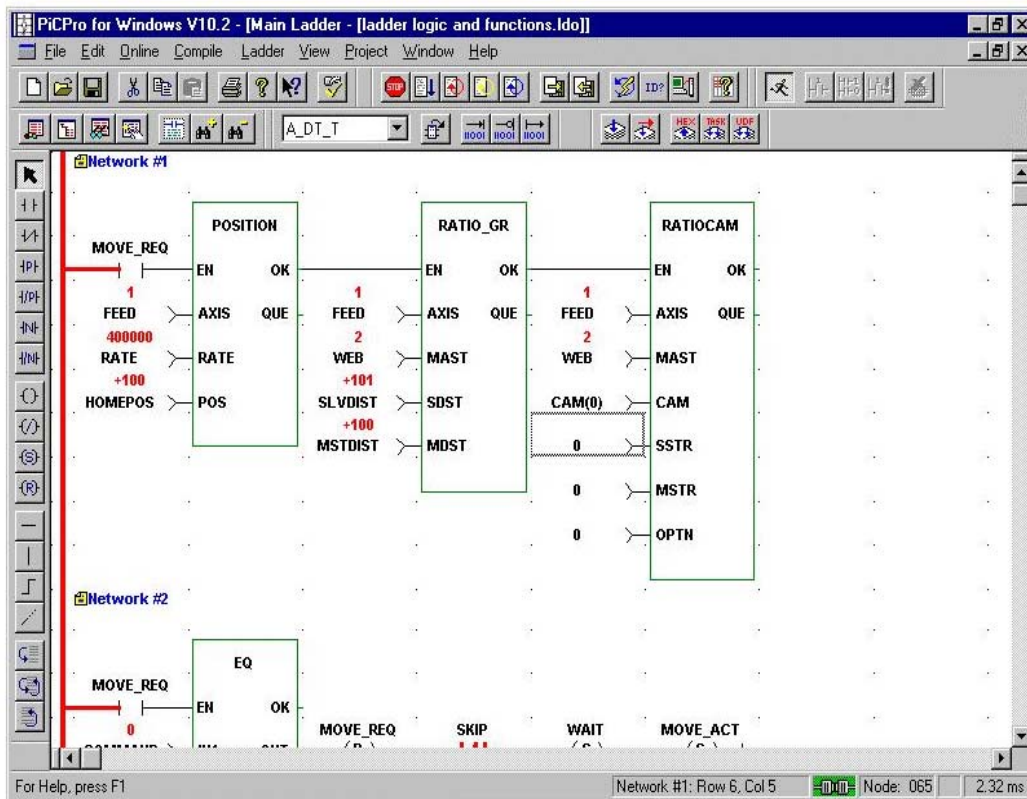
BITWISE	NUMERIC	STRING	TIME OF DAY	TIME DURATION
BOOL	SINT	STRING	DATE	TIME
BYTE	INT		DATE&TIME	
WORD	DINT		TIME OF DAY	
DWORD	LINT			
LWORD	USINT			
	UINT			
	UDINT			
	ULINT			
	REAL			
	LREAL			

Any of the data types listed above can be made into an array. You can also create complex data structures which contain multiple types of variables. Structures are typically used to store recipe information, cam profiles, to transfer information from one control to another, or as inputs to UDFBs.

## Motion Control Using PiCPro for Windows

Using PiCPro for Windows for servo motion control is as easy as programming a PLC timer. All motion functions are enabled by using functions or function blocks in the application program that also controls the machine logic. This close coupling of logic and motion eliminates communication bottlenecks that can occur in systems where a separate PLC and motion controller are used. Close coupling between logic and motion is the difference between success and failure in some high performance applications. There is no need to learn a separate programming language for motion control since it is included in the same programming environment as machine logic. Also, ladder logic is easy to maintain and understand for troubleshooting. Because the motion control is included with the machine logic, you can also on-line edit any motion control function along with machine logic.





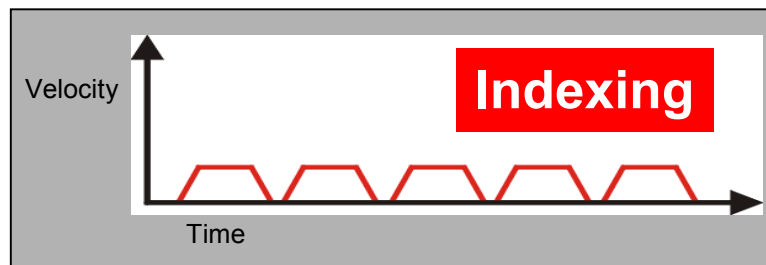
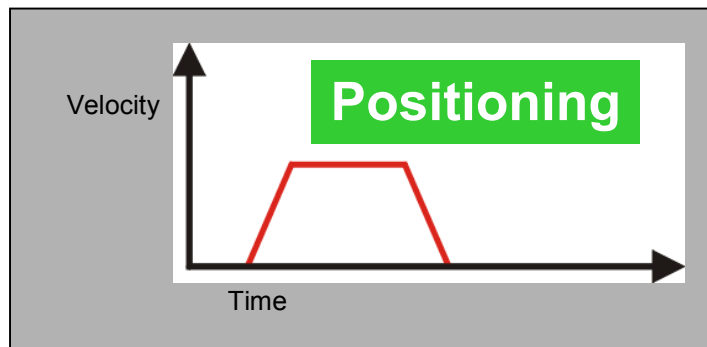
Servo information such as feedback type (encoder, resolver, analog, SERCOS, stepper, TTL, etc.), scaling, position loop gains (P, I, and D), and the number of axes being used in your application are entered in PiCPro for Windows' servo setup. All of this information is then compiled into a function that is called from the application program on start up. Feedback types can be mixed in a PiC system, and up to 32 closed loop axes can be initialized. MMC systems accept encoder or SERCOS feedback.

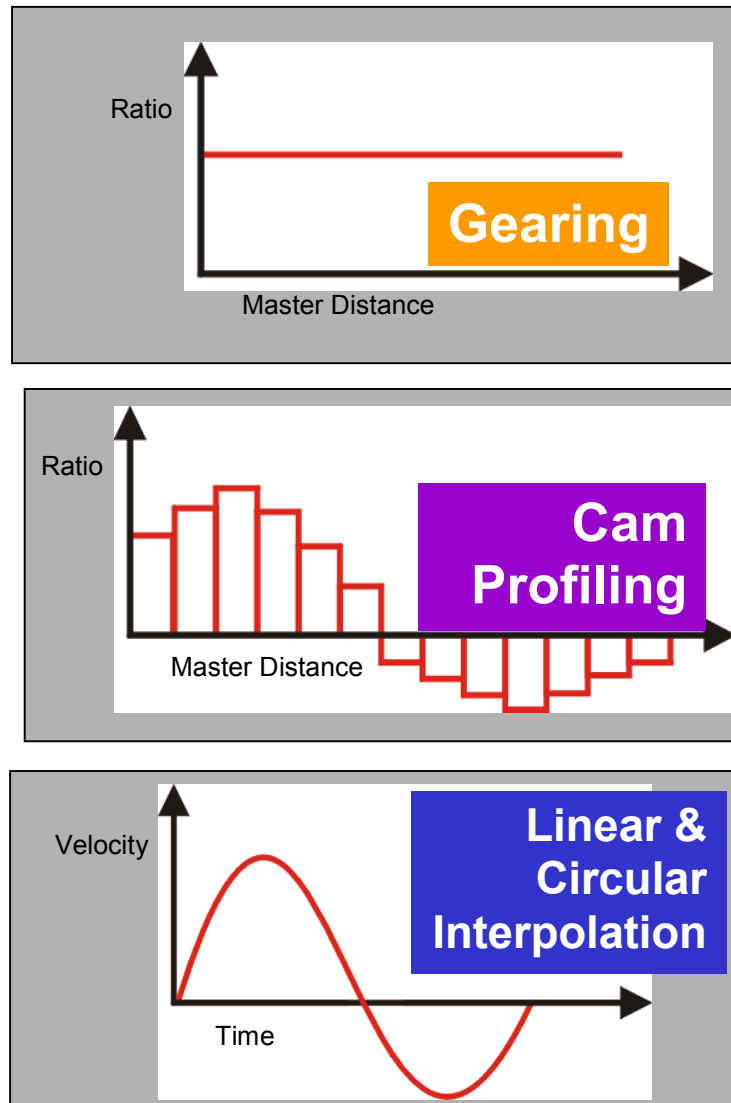
If SERCOS is being used, an additional SERCOS setup function must be created in PiCPro to define the configuration and parameters for each SERCOS ring.

Once an axis has been initialized in the application program, the functions in the Motion library are used to control it and monitor its status. The same functions are used to initiate motion regardless of feedback type. The motion functions are divided into several categories as listed below:

- Initialization -- Functions to initialize servos and close the servo loops
- Move -- Functions to perform simple trapezoidal moves, such as positioning and indexing
- Ratio Moves -- Functions that cause master/slave moves such as gear ratios and cam profiles to start or stop
- Move Support -- Functions that affect how motion occurs such as registration, feedrate override, changing acceleration and deceleration rates
- Reference -- Functions to home an axis
- Queue -- Functions that allow you to manage moves that are stored or waiting for an axis to perform
- Data -- Functions that allow you to read or write axis servo information
- Errors -- Functions that allow you to read and reset axis errors.

Many types of motion are possible using PiCPro for Windows. Some move types are single-axis motions (such as positioning), others are moves that establish a ratio relationship between a master axis and a slave axis (such as gear ratio and cam profile).

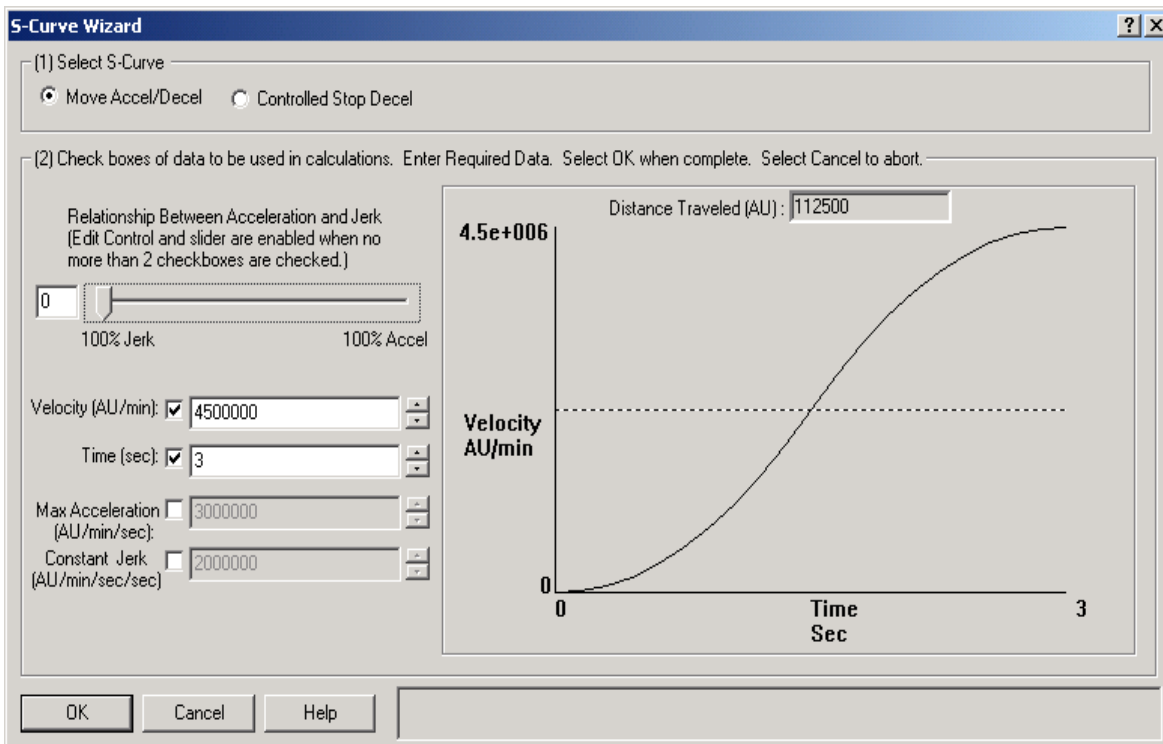




## Registration

If your application requires registration, you may use the standard Registration function that is supplied with PiCPro for Windows. The registration function enables the hardware on the MMC, PiC or SERCOS amplifier to latch the position of the axis when the registration input occurs. The registration algorithm calculates the distance between consecutive registration inputs. Depending on the parameters you enter into the registration function, the software determines whether or not the mark is good. If the mark is good, the registration function automatically calculates the correction required and adjusts the profile of the slave axis accordingly.

## S-Curve Wizard

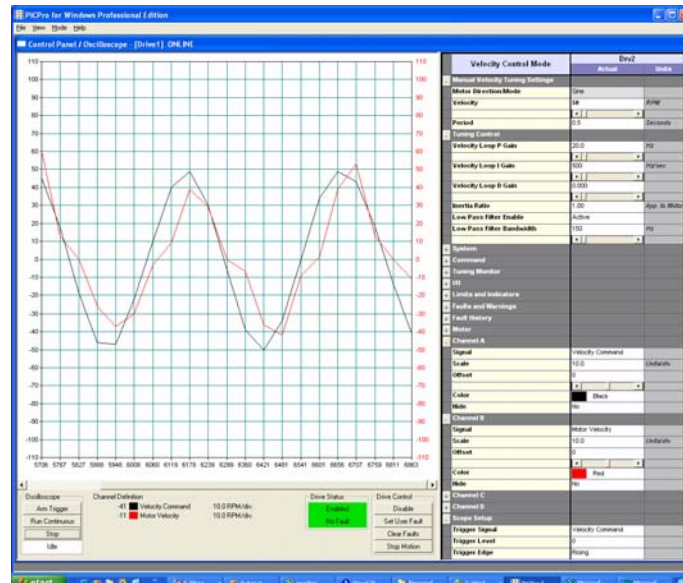


S-Curve acceleration and deceleration can be selected for Position, Distance, Velocity and Time axes motion. The S-Curve Wizard provides a simple tool for calculating the Maximum Acceleration and Constant Jerk parameters that define S-Curve. Using the slider bar on the S-Curve setup wizard provides the programmer with a graphical view of the effect of moving from constant jerk to constant acceleration.

## Resumable E-Stop

Resumable E-Stop provides a means of emergency stopping a machine without terminating cam and motion profiles that are in process. The machine can return to path and continue operation without re-referencing or re-initiating the motion program instructions. This powerful feature improves machine productivity significantly by eliminating the need to clean out and re-start machinery after an E-Stop.

## PiCPro Drive Configuration Software



Configuration software for the MMC Smart Drive servo amplifier family is built in to PiCPro for Windows. Using the same tool you use for motion application programming, you can configure, tune, and maintain MMC Smart Drive amplifiers.

### Summary

PiCPro for Windows provides the tools to solve the toughest applications while keeping simple applications simple. Integrated motion and logic is the key to solving high-performance applications and makes maintaining and troubleshooting your application easy.

## The Computer Workstation

The recommended requirement for a workstation are.

### For a PiC or Standalone MMC Controller;

Computer	486 or Pentium processor with Windows 98, NT4.0, 2000, ME, Home Edition XP, or Professional Edition XP. Windows 2000 and Windows XP require a Pentium processor.
Memory	Consult operating system for additional memory needs.
Video	800 x 600 or higher resolution; 16-bit or greater color.
Disk Drives	Typically, 100 MB of hard disk space is required.
Communication	RS232 Port (COM1 or COM2)

### For an MMC for PC Controller;

Computer	Minimally, a 133 MHz Pentium processor with Windows NT4.0, 2000, or Professional Edition with PCI network card. (ISA network cards are not recommended)
Memory	Consult operating system for additional memory needs.
Monitor	800 x 600 or higher resolution; 16-bit or greater color.
Disk Drives	Typically, 100 MB of hard disk space required.

Note: Power saver option in BIOS should not be set when using an MMC for PC. Setting this option will cause a communications error when the computer is shut down.

## Ordering Information

There are three versions of PiCPro for Windows. The Professional edition can be used to program PiC90, PiC900, MMC and MMC for PC controls. The MMC-Limited edition can only be used to program stand-alone MMC controls without axis I/O expansions. The Monitor edition is used for maintenance of PiC and MMC controls (it does not allow programs to be changed).

All editions of PiCPro for Windows include:

- The PiCPro for Windows CD
- PiCPro programming cable
- PiCPro for Windows Software Manual\*
- PiCPro Function/Function Block Reference Guide\*
- PiC900 Hardware Manual\*
- MMC Hardware Manual\*

The Professional and MMC editions also include an Application Software CD with the following software packages:

- Motion ASFBs (Application Specific Function Blocks) and manual\*
- General ASFBs and manual\*
- Ethernet ASFBs and manual\*
- SERCOS ASFBs and manual\*
- Application software examples\*

Note: Manuals are provided in electronic (pdf) format only. Each manual is available for purchase separately as a printed document with a unit part number for each manual.

Description	Part Number
PiCPro for Windows Professional Edition	M.1300.7213
PicPro for Windows MMC Edition	M.1300.7214
PiCPro for Windows Monitor Edition	M.1300.7215
MMC Hardware Manual	M.1300.7620
PiC900 Hardware Manual	M.1300.7618
PicPro for Windows Software Manual	M.1300.7592
Function/Function Block Reference Guide	M.1300.7591
General ASFB Manual	M.1300.7505
Motion ASFB Manual	M.1300.7573

Note: Software part numbers represent the most current version available. Older versions of PiCPro are available. Please contact factory to order. Please consult manual for PC requirements.

## ASFBS - Application Specific Function Blocks

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Engineers at Giddings & Lewis have designed several libraries of function blocks using the UDFB (user defined function block) feature of PiCPro. The function blocks simplify the application of a PiC900 system and are called application specific function blocks (ASFBS). They are available in the following categories.

<b>Category</b>	<b>Description</b>
<b>General Purpose</b>	Accelerates a wide range of control tasks for the beginning programmer.
<b>Quick Start</b>	Provides turn-key basic motion control.
<b>Motion Control</b>	Aids in setting up any servo motion control application with the PiC or MMC.
<b>Communication</b>	Allows communications in various formats. <ul style="list-style-type: none"><li>• <b>ETHERNET</b> - Data transfer between a PiC or MMC and an Ethernet network using TCP/IP. These ASFBS require an Ethernet TCP/IP module.</li><li>• <b>OPC SERVER</b> - Data transfer between a PiC or MMC and a personal computer over Ethernet. Requires an Ethernet TCP/IP module.</li><li>• <b>DATA HIGHWAY PLUS</b> - Data transfer between a PiC or MMC and the Allen-Bradley Data Highway Plus network.</li><li>• <b>CIP - Ethernet</b> - Data transfer between a PiC or MMC and Allen-Bradley ControlLogix PLC</li><li>• <b>MODBUS</b> - Data transfer between a PiC or MMC and the Modicon Modbus network using serial communications or Ethernet TCP/IP communications</li></ul>

### The General Purpose ASFBS

The general purpose library offers a wide range of ASFBS that will accelerate the efforts of the beginning programmer. Specific areas include using the serial ports, working with the RAM disk, generating a contact histogram and a variety of data type, evaluation, shift register, timer, and miscellaneous function blocks.

<b>Part Number</b>
Included with PiCPro for Windows
Manual - M.1300.7505



## The Quick Start Application Examples

Quick Start ASFBS and example programs provide turn-key basic motion control for 1 to 32 axis applications. Functionality includes: Machine Start, Fault Control, and Drive Control; Manual Servo Operation; and Home Cycle. Used in conjunction with a Cimrex C69 operator interface, the Quick Start examples provide the foundation for many motion applications.

## The Motion Control ASFBS

The Motion Control ASFBS address the majority of PiC and MMC servo motion control applications. They provide for the initialization, jogging, and referencing of the servo axes. Other ASFBS in the motion libraries include SERCOS, linear and circular coordinated motion, press transfer coordinated motion, Centurion DSA drive communications, coarse/fine resolver, and data capture.

<b>Part Number</b>
Included with PiCPro for Windows
Manual - M.1300.7573

## The Communication ASFBS

There are six communication ASFB packages available depending on the format you want to use. These are described below.

### 1. The Ethernet ASFBS

The Ethernet ASFBS provide drop-in functionality for Ethernet support. They are easy-to-use function blocks that enable the PiC or MMC to communicate and share data with other devices over an Ethernet connection using the Ethernet TCP/IP module in the PiC or MMC. They provide support for:

1. PiC to PiC (or MMC) Data Exchange  
There are two Ethernet protocol choices provided: TCP (Transmission Control Protocol) and UDP (User Datagram Protocol). TCP provides much greater confirmation of receipt than does UDP. TCP also allows the streaming of data and larger data packets. UDP can result in less network traffic because each UDP message does not have to be acknowledged (which is the case with TCP).
2. File Transfers  
TFTP (Trivial File Transfer Protocol) is used over UDP to transfer individual RAMDISK files over Ethernet.
3. Internet E-Mail Sending Capability  
The PiC or MMC can send a user programmable text message to a user-specified e-mail address via SMTP (Simple Mail Transfer Protocol). The PiC or MMC does not have the capability to receive or respond to e-mail with this ASFB.

<b>Part Number</b>
Included with PiCPro for Windows
Manual - M.1300.7521

## **2. The OPC Server**

The OPC server (OPC stands for OLE for Process Control) is a program that runs on a PC and allows communication between an Ethernet TCP/IP card in the PC and an MMC for PC or an Ethernet TCP/IP module installed in a PiC or an MMC. The same software is used for PiC as for MMC. The OPC server runs continuously on the PC, and any application on the PC that can act as an OPC client (such as Excel, Wonderware, and Visual Basic) can request information from the server.

On the PiC and MMC side, there is an ASFB called OPC\_ENET that must be inserted into your application program. This ASFB establishes a connection to the OPC server through the Ethernet TCP/IP module in the PiC or MMC or through the MMC for PC. Any variable that you wish to share with the OPC server must have its attribute set to “Global” in the software declarations table of the PiC. When the application program is compiled, PiCPro for Windows creates a tag name database file of all the global variables, and the OPC server uses this tag name file to refer to the PiC variables when communicating with OPC clients. In other words, the same name is used in software declarations, in the OPC server, and in the OPC client. Any variable type can be transferred, including BOOL, REAL, arrays, and structures.

You need to purchase a copy of the OPC server every time you use it. The manuals are included on the CD in PDF format.

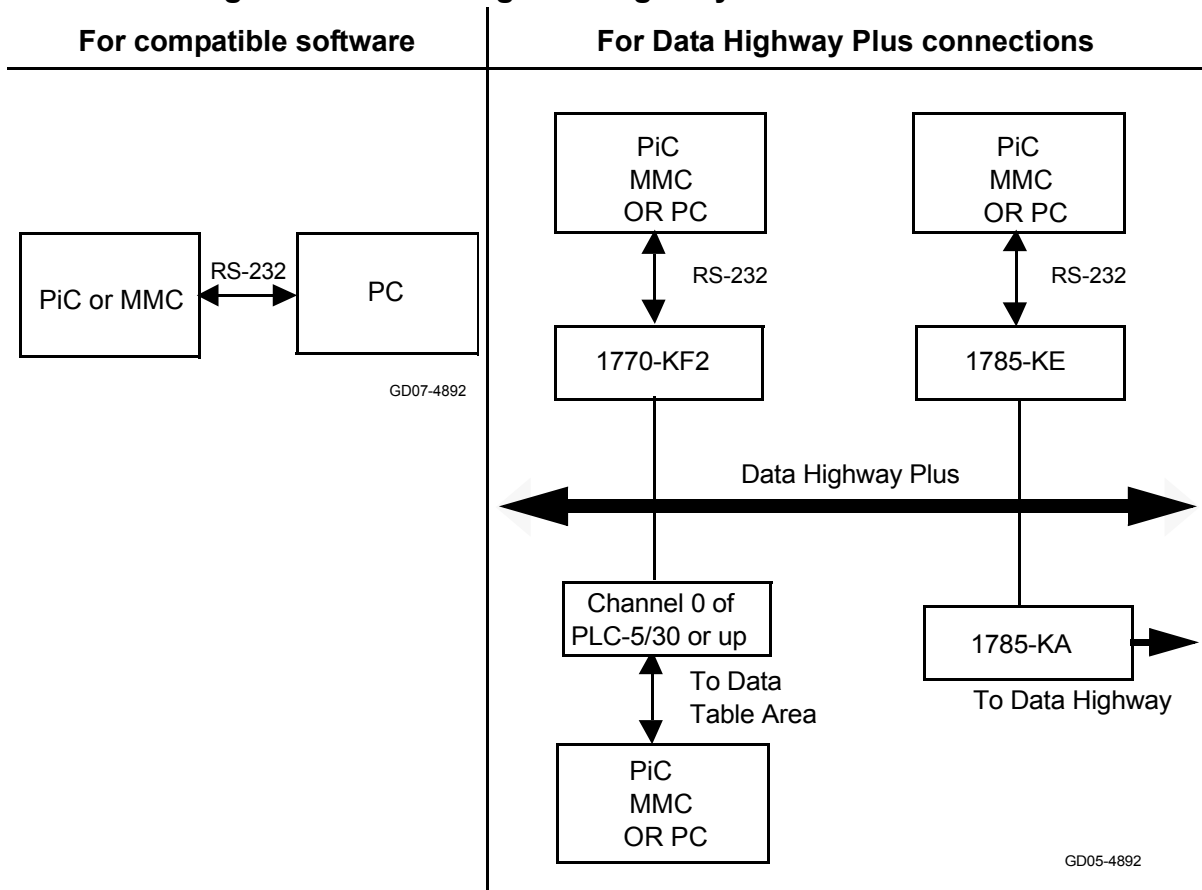
<b>Part Number</b>
M.1300.7216

### 3. The Data Highway Plus ASFBs

The Data Highway Plus ASFB software package allows the PiC or MMC to communicate to another compatible device using the Allen-Bradley DF1 full duplex serial protocol. Communication takes place through the PiC or MMC serial ports. The serial ports include the USER PORT on the PiC CPU or MMC or the ports on a PiC serial communications module (2 or 4 port models available).

Some of the compatible devices include the Allen-Bradley 1770-KF2 or the 1785-KE modules, any PLC-5/30 or higher models with a Channel 0 port, and various compatible software packages running on a PC. See the following block diagram.

#### Configurations for using Data Highway Plus communications



When a PiC or MMC is connected to a 1770-KF2 or 1785-KE module, it can communicate over a Data Highway Plus Network. When the control is connected to the Channel 0 port of a PLC-5/30 or higher, then it can communicate with the data table area of that PLC, but not to any other stations that the PLC may be connected to on the Data Highway Plus network. The Allen Bradley SLC cannot be used as a slave to the PiC or MMC because the SLC can send a PLC5 message but it cannot receive one.

When communicating with the Data Highway Plus protocol, the PiC or MMC can operate in either a slave mode or a master/slave mode. In the slave mode, the control will only receive commands from the other device. It will not initiate any transfers to other devices. In the master/slave mode, the control can initiate transfers to other devices as well as receive commands from them. The ASFB supports the following PLC-5 Data Highway Plus commands:

<b>Command Name</b>	<b>Command</b>	<b>Function</b>
Word Range Read	0F	01
Word Range Write	0F	00
Read-Modify-Write	0F	26
Typed Read (only supported in slave mode)	0F	68
Typed Write (only supported in slave mode)	0F	67

The device the PiC or MMC is communicating with must also support these commands.

<b>Part Number</b>
M.1301.4109
Manual - M.1300.7499

#### **4. The Modbus ASFBS**

The PiC or MMC functions as a slave device when interfaced with a Modbus network. The Modbus function block implements the read coil status, read holding registers, read exception status, force single and multiple coils, and preset single and multiple registers function codes. A Modicon bridge multiplexer is required if the PiC or MMC is going to communicate on a Modbus Plus network.

<b>Part Number</b>
M.1300.7362
Manual - M.1300.7503

## 5. The Open Modbus/TCP ASFBs

The open Modbus/TCP ASFB software package allows the PiC, MMC, or MMC for PC controls to communicate with other Open Modbus/TCP devices over an Ethernet TCP/IP network. The Giddings & Lewis control can be programmed as a Client, a Server, or both.

<b>Part Number</b>
M.1301.4108
Manual - Included on CD

## 6. The CIP - Ethernet ASFBs

The ControlLogix CIP over Ethernet ASFB software package from Giddings & Lewis allows the MMC, MMC for PC, or PiC900 to communicate with an Allen-Bradley ControlLogix 5000 controller using the CIP (Control and Information Protocol) Services over Ethernet. The services used are CIP Read Data Service and CIP Write Data Service. When communicating the CLX, the G&L control can be programmed to be either a Server or a Client.

<b>Part Number</b>
M.1300.7219

