PositionServo

```
;*************************** I/O List  *********************************
;       Input A1    -   not used
;       Input B1    -   not used
;       Input C1    -   not used
;       Output 1    -   Pick Arm
;       Output 2    -   Gripper
;********************** Initialize and Set Variables **********
UNITS = 1
ACCEL = 75
DECEL =75
MAXV = 10
;********************** Events ********************************
;Set Events handling here
;********************** Main Program  *************************
PROGRAM_START:
ENABLE
EVENT  SPRAY_GUNS_ON ON    ;Enable the Event
EVENT  SPRAY_GUNS_OFF ON   ;Enable the Event
WAIT UNTIL IN_A4==0        ;Make sure Arm is retracted before st
MOVEP 0                    ;Move to position 0 to pick part
OUT1 = Output_On           ;Turn on output 1 to extend Pick a
WAIT UNTIL IN_A4 == 1      ;Check input to make sure Arm is e
OUT2 = Output_On           ;Turn on output 2 to Engage grippe
WAIT TIME 1000             ;Delay 1 sec to Pick part
OUT1 = Output_Off          ;Turn off output 1 to Retract Pick
WAIT UNTIL IN_A4==0        ;Check input to make sure Arm is r
MOVED 100                  ;Move to Place position
OUT1 = Output_On           ;Turn on output 1 to extend Pick a
WAIT UNTIL IN_A4 == 1      ;Check input to make sure Arm is e
OUT2 = Output_Off          ;Turn off output 1 to Disengage gr
WAIT TIME 1000             ;Delay 1 sec to Place part
OUT1 = Output_Off          ;Retract Pick arm
WAIT UNTIL IN_A4 == 0      ;Check input to make sure Arm is retra
GOTO PROGRAM_START
END
```

S950

PROGRAMMING MANUAL

PM94P01B

This document printed in the United States of America

Table of Contents

Safety Information

All safety information contained in these Operating Instructions is formatted with this layout including an icon, signal word and description:

Signal Word! (Characterizes the severity of the danger)

Note (describes the danger and informs on how to proceed)

Icon		Signal Words	
	Warning of hazardous electrical voltage	**DANGER!**	Warns of **impending danger**. Consequences if disregarded: Death or severe injuries.
	Warning of a general danger	**WARNING!**	Warns of **potential, very hazardous situations**. Consequences if disregarded: Death or severe injuries.
	Warning of damage to equipment	**STOP!**	Warns of **potential damage to material and equipment**. Consequences if disregarded: Damage to the controller/drive or its environment.
	Information	**Note**	Designates a general, useful note. If you observe it, handling the controller/drive system is made easier.

1. Getting Started

1.1 Introduction

Definitions

PositionServo: The PositionServo is a Programmable Digital Drive/Motion Controller, which can be configured as a stand alone Programmable Motion Controller, or as a high performance Torque and Velocity Drive for Centralized Control Systems. The PositionServo family of drives includes the 940 Encoder-based drive and the 941 Resolver-based drive.

MotionView: MotionView is a universal communication and configuration software package that is utilized by the PositionServo drive family. It has an automatic self-configuration mechanism that recognizes what drive it is connected to and configures the tool set accordingly. The MotionView platform is divided up into three sections or windows, the “Parameter Tree Window”, the “Parameter View Window” and the “Message Window”. Refer to Section 1.3 for more detail.

SimpleMotion Programming Language (SML): SML is the programming software utilized by MotionView. The SML software provides a very flexible development environment for creating solutions to motion applications. The software allows you to create complex and intelligent motion moves, process I/O, perform complex logic decision making, do program branching, utilize timed event processes, as well as a number of other functions found in PLC’s and high end motion controllers.

User Program (or Indexer Program): This is the SML program, developed by the user to describe the programmatic behavior of the PositionServo drive. The User Program can be stored in a text file on your PC or in the PositionServo’s EPM memory. The User Program needs to be compiled (translated) into binary form with the aid of the MotionView Studio tools before the PositionServo can execute it.

MotionView Studio: MotionView Studio is a part of the MotionView software platform. It is a tool suite containing all the software tools needed to program and debug a PositionServo. These tools include a full-screen text editor, a program compiler, status and monitor utilities, an online oscilloscope and a debugger function that allows the user to step through the program during program development.

WARNING!

- Hazard of unexpected motor starting! When using the MotionView software, or otherwise operating the PositionServo drive over RS-232/485 or Ethernet, the motor may start unexpectedly, which may result in damage to equipment and/or injury to personnel. Make sure the equipment is free to operate in this manner, and that all guards and covers are in place to protect personnel.
- Hazard of electrical shock! Circuit potentials are at 115 VAC or 230 VAC above earth ground. Avoid direct contact with the printed circuit board or with circuit elements to prevent the risk of serious injury or fatality. Disconnect incoming power and wait 60 seconds before servicing drive. Capacitors retain charge after power is removed.

1.2 Getting Started with the PositionServo

Before the PositionServo can execute a motion program the drive has to be properly installed and configured. First time users are encouraged to read through the appropriate sections in this manual for the best configuration of the PositionServo's programmable features and parameters. They are also encouraged to reference the PositionServo User's Manual for the proper hardware installation.

The PositionServo drive has a number of features and parameters that can be programmed via the MotionView Software. Below is a list of programmable features and parameters specific for operation under program control. The features are listed in the order they appear in the 'Parameter Tree Window" in MotionView. Please refer to the PositionServo User's Manual for details on parameters not covered herein.

Parameters

- **Autoboot - Enable / Disable**

  If this option is Enabled, the drive will start executing the user program stored in the drive's flash memory (i.e EPM) at Power Up. If there is not a valid program existing in the flash memory, then the program must be started manually via MotionView or a Host Interface.

DANGER!

Hazard of unexpected motor starting! When using the MotionView software, or otherwise operating the PositionServo drive over RS-232/485 or Ethernet, the motor may start unexpectedly, which may result in damage to equipment and/or injury to personnel. Make sure the equipment is free to operate in this manner, and that all guards and covers are in place to protect personnel.

- **Group ID**

  The Group ID feature allows the user to group PositionServo drives together via an Ethernet network. When used with the SEND and SENDTO command, drives in the same group can share and update variables. Group ID Numbers can be set between 0 and 32767. See statements SEND and SENDTO for further explanations.

Communication

- IP Setup - Displays properties and settings for Ethernet communication port (IP Address).

Digital I/O

- **Inputs**
  - The PositionServo has 12 digital inputs. These inputs are grouped into three sets of four inputs, [A1 - A4], [B1 - B4], and [C1 - C4]. Each group shares its own common, [Acom, Bcom, and Ccom].
  - IN_A3 is dedicated as the ENABLE/DISABLE input for the drive.
  - Inputs can be assigned individual debounce times via MotionView. Debounce times can be set between 0 and 1000ms. (1ms = 0.001 sec)
  - Inputs can be monitored via the user program or via a host interface. Inputs can also be assigned Special Purpose Functions. Refer to Section 1.6 for more detail.
- **Outputs**
  - The PositionServo has 5 digital outputs. The first output is refered to as the ready output, RDY. This output is a dedicated output and only comes on when the drive is enabled and in RUN mode. The remaining 4 outputs Out1, Out2, Out3 and Out4. can be activated via the user program or via a host interface. The se outputs can also be assigned a Special Purpose Function. Refer to Section 1.6 for more detail.

Indexer Program

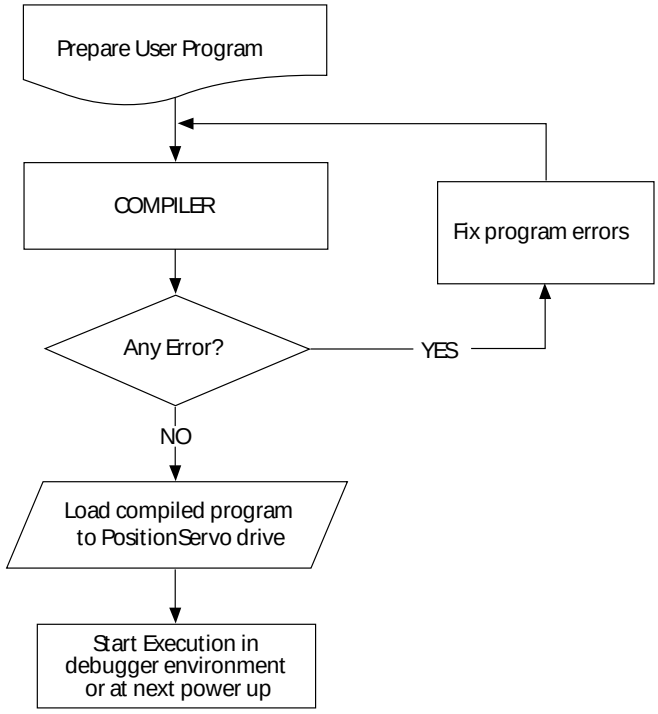
When the Indexer Program file is selected from the node tree, the Parameter View Window displays the drive's user program. This area can now be used to enter, edit and debug the user program. Also additional programming features will be displayed in the menu and toolbar. Refer to Section 1.3 for more detail.

1.3 Programming Flowchart Overview

MotionView utilizes a BASIC-like programming structure referred to as SimpleMotion Programming Language (SML). SML is a quick and easy way to create powerful motion applications.

With SML the programmer describes his system's logistics, motion, I/O processing and user interaction using the SML structured code. The program structure includes a full set of arithmetic and logical operator programming statements, that allow the user to command motion, process I/O and control program flow.

Before the PositionServo drive can execute the user's program, the program must first be compiled (translated) into binary machine code, and downloaded to the drive. Compiling the program is done by selecting the [Compile] button from the toolbar. The user can also compile and download the program at the same time by selecting the [Compile and Load] button from the toolbar. Once downloaded, the compiled program is stored in both the PositionServo's EPM memory and the internal flash memory. Figure S801 illustrates the flow of the program preparation process.



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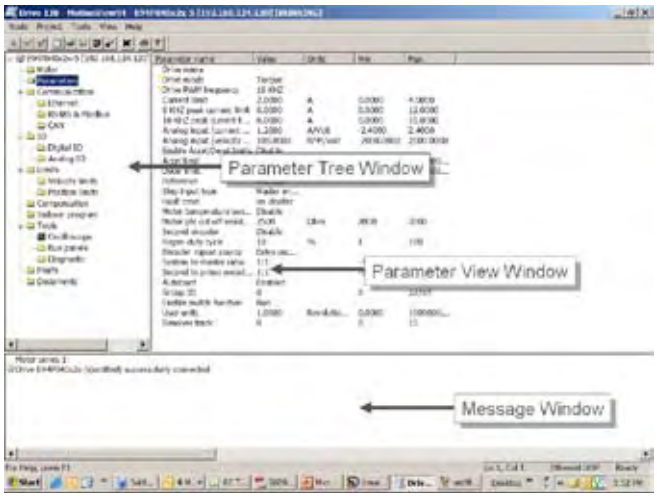
1.4 MotionView / MotionView Studio



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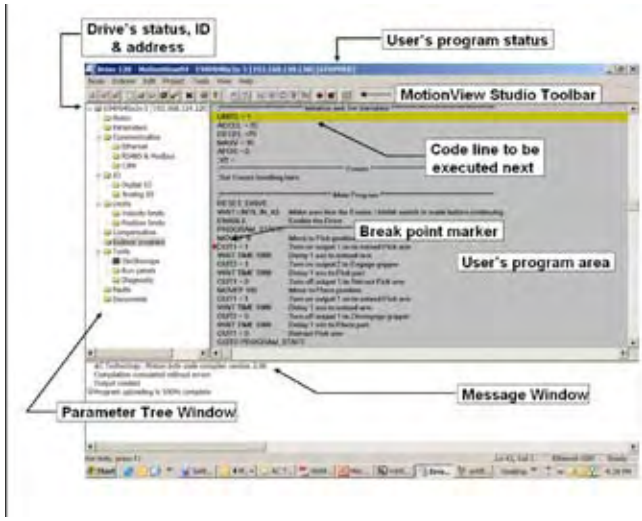
MotionView is the universal programming software used to communicate with and configure the SimpleServo and PositionServo drives. The MotionView platform is segmented into three windows. The first window is the **"Parameter Tree Window"**. This window is used much like Windows Explorer. The various parameters for the drive are represented here as folders or files. Once the desired parameter file is selected, all of the corresponding information for that parameter will appear in the second window, the **"Parameter View Window"**. The user can then enable, disable or edit drive features or parameters. The third window is the **"Message Window"**. This window is located at the bottom of the screen and will display all communication status and errors.

MotionView Studio



mb803

MotionView Studio Screen Layout

The MotionView Studio provides a tool suite used by MotionView to enter, compile, load and debug the user program. To view and develop the user program, the "Indexer Program" file must be selected from the Parameter Tree Window. Once selected the toolbar is expanded and two additional drop down menus are added to the Menu Bar: "Indexer" and "Edit". The program displayed in the View window is uploaded from the drive when the connection is made between MotionView and the drive. This upload is always performed regardless of program running state.

Studio Tool Suite Menu & Toolbar Options

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Studio Tool Suite Menu

When developing or editing a program, the additional Menu option tabs [Indexer] and [Edit] become available. These tabs are only available when the user is in the programming area (Parameter View Window). These options are used to load, compile, save and debug the program. The following examples illustrate how to utilize the Indexer and Edit option tabs.

Please note that to utilize these features the “Indexer program” must be selected from the node tree. This will expand the menu options. Click the mouse anywhere in the Parameter View Window to activate Menu Tabs.

Load User program from the PC to MotionView

- Select **“Indexer”** from the pull down menu.
- Select **“Import program from file”** from the drop down menu and select a program from the folder where it locates.

This procedure loads the program from the file to the editor window. It doesn’t load the program to the drive’s memory.

Compile program and load to the drive

- Select **“Indexer”** from the pull down menu.
- Select **“Compile and send to drive”** from the drop down menu. If the program is successfully compiled then the source code and the compiled bitstream will be loaded to the PositionServo drive.
- or Select **“Compile and load without source”** from the drop down menu. If the program is successfully compiled only the compiled bitstream will be loaded to the PositionServo drive. This feature is used to prevent others from obtaining your source code.

To check syntax errors without loading the program to drive select **“Compile”** from the **“Indexer”** menu. If the compiler finds any syntax error, compilation stops and program will not be loaded to the drive’s memory. Errors are reported in bottom portion of the screen in Message Window.

Save User program from MotionView to PC .

- Select **“Indexer”** from the pull down menu.
- Select **“Export program to file”** from the drop down menu.

The program will be saved to the MotoinView **“User Data**” folder by default.

Run User program in drive.

- Select **“Indexer”** from the pull down menu.
- Select **“Run”** from the drop down menu.

If the program is already running, then you may need to **Restart** or **Stop** the program first.

Execute Program Step through the User program.

- Select **“Indexer”** from the pull down menu.
- Select **“Step in / Step over”** from the drop down menu.

The drive will execute the program one step at a time. The program statement under execution will be highlighted. If the program is running, it will have to be either stopped or restarted.

Set **Breakpoint(s) in the program**

- Select the point in the program where you would like the program to stop.
- Select **“Indexer”** from the pull down menu.
- Select **“Toggle breakpoint”** from the drop down menu.

A convenient way to debug a user program is to insert breakpoints at critical junctions throughout the program. These breakpoints are marked by red dots and stop the drive from executing the program, but do not disable the drive and the position variables. Once the program has stopped, the user can continue to run the program, step through the program or restart the program.

Stop program execution

- Select **"Indexer"** from the pull down menu.
- Select **"Stop"** from the drop down menu.

The program will stop after completing the current statement. Select **Run** to resume the program.

IMPORTANT!

The [STOP] button only stops the execution of the program code. It does not stop or disable the motion.

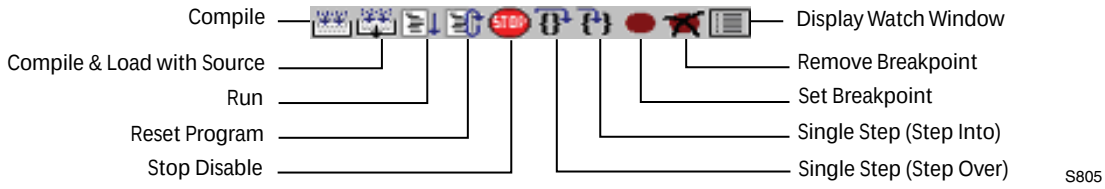
Restart Program execution

- Select **"Indexer"** from the pull down menu.
- Select **"Restart"** from the drop down menu.

The program will be reset and the drive will be disabled. All the position variables will no longer be valid.

Studio Tool Suite Toolbar Options

When developing a User program, the MotionView Studio Toolbar becomes available. The toolbar provides shortcuts to most of the options found in the **Indexer** Menu Option Tab. The toolbar is only available when you are in the programming area (Parameter View Window). These options are used to load, compile, save and debug the program.



MotionView Studio Toolbar Icons

1.5 Programming Basics

The user program consists of commands which when executed will not only initiate motion moves but also process the drives I/O and make decisions based on drive parameters. Before motion can be initiated, certain drive and I/O parameters must be configured. To configure these parameters perform the following procedure.

Parameter setup - Select **"Parameter"** from Parameter Tree Window and set the following parameters.

Set the "Drive" to "Position".

- Select **"Drive mode"** from the Parameter View Window.
- Select **"Position"** from the pull down menu.

Set the "Reference" to "Internal".

- Select **"Reference"** from the Parameter View Window.
- Select **"Internal"** from the pull down menu.

Set the "Enable switch function" to "Inhibit".

- Select **"Enable switch function"** from the Parameter View Window.
- Select **"Inhibit"** from the menu.

I/O Configuration

Input A3 is the Inhibit/Enable special purpose input. Refer to section 4.1.7 for more information. Before executing a program input A3 must be activated to enable the drive and take it out of Inhibit mode. Note: If the drive starts to execute the user program and comes to an "Enable" command and input A3 is not made then the following fault will occur "F_36"("Drive Disable").

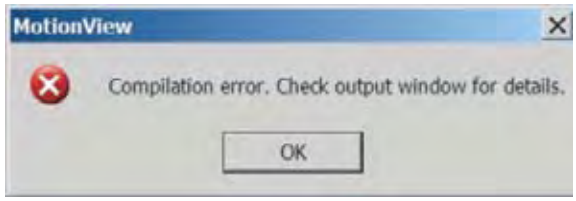
Basic Motion Program

Select **"Indexer program"** from the Parameter Tree. The Parameter View Window will display the current User Program stored in the drive. Note that if there is no valid program in the drive's memory the program area will be empty.

In the program area, clear any existing program and replace it with the following program:

```
UNITS=1
ACCEL = 5
DECEL = 5
MAXV = 10
ENABLE
MOVED 10
MOVEDISTANCE  -10
END
```

After the text has been entered into the program area, select the [Compile and load] icon from the toolbar. After compilation is done, the following message should appear:



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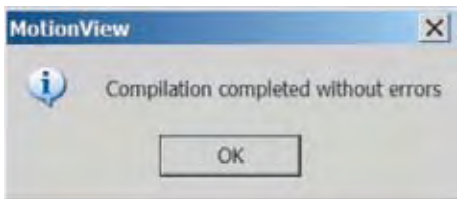
Click [OK] to dismiss the “Compliation error” dialog box. The cause of the compilation error will be displayed in the Message Window, located at the bottom of the MotionView window. MotionView will also highlight the program line where the error occurred.

```
UNITS=1
ACCEL = 5
DECEL = 5
MAXV = 10 ;
ENABLE
MOVED 10    ;
MOVEDISTANCE  -10
END
```

The problem in this example is that “**MOVEDISTANCE**” is not a valid command. Change the text “**MOVEDISTANCE**” to “**MOVED**”.

```
UNITS=1
ACCEL = 5
DECEL = 5
ENABLE
MOVED 10
MOVED -10
END
```

After editing the program, select the [Compile and load] icon from the toolbar. After compilation is done, the following message box should appear.



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The program has now been compiled and loaded to the drive’s memory and is ready to run. Click [OK] to dismiss the dialog box.

Supose that the drive has been set up according to the PositionServo User Manual.

To **Run** the program, select the [**Go**] icon on the toolbar. The drive will start to execute the User Program. The motor will spin 10 revolutions in the CCW direction and then 10 revolutions in the CW direction. After all the code has been executed, the program will stop and the drive will stay enabled.

To **Restart** the program, select the [**Restart**] icon on the toolbar. This will disable the drive and reset the program to execute from the start. The program does not run itself automatically. To run the program again, either select the [**Go**] icon on the toolbar or select [**Run**] from the "**Indexer**" pull down menu.

Program Layout

When developing a program, structure is very important. It is recommended that the program be divided up into the following 7 segments:

Header:	The header defines the title of the program, who wrote the program and description of what the program does. It may also include a date and revision number.
I/O List:	The I/O list defines what the inputs and outputs of the drive are used for. For example input A1 might be used as a Start Switch.
Init & Set Var:	Initialize and Set Variables defines the drives settings and system variables. For example here is where acceleration, deceleration and max speed are set.
Events:	An Event is a small program that runs independently of the main program. This section is used to define the Event.
Main Program:	The Main Program is the area where the process of the drive is defined.
Sub-Routines:	This is the area where any and all sub-routines should reside. These routines will be called out from the Main Program with a GO SUB command.
Fault Handler:	This is the area where the Fault Handler code resides. If a Fault handler is utilized this code will be executed when the drive generates a fault.

The following is an example of a Pick and Place program divided up into the above segments.

```
***************************** HEADER  ************************************
;Title:          Pick and Place example program
;Author:         Lenze / AC Technology
;Description:    This is a sample program showing a simple sequence that
;                picks up a part moves to a set position and drops the part
;***************************** I/O List  **********************************
;      Input A1    -   not used
;      Input A2    -   not used
;      Input A3    -   Enable Input
;      Input A4    -   not used
;      Input B1    -   not used
;      Input B2    -   not used
;      Input B3    -   not used
;      Input B4    -   not used
;      Input C1    -   not used
;      Input C2    -   not used
;      Input C3    -   not used
;      Input C4    -   not used
;      Output 1    -   Pick Arm
;      Output 2    -   Gripper
;      Output 3    -   not used
;      Output 4    -   not used
;********************** Initialize and Set Variables **********************
UNITS = 1
ACCEL = 75
DECEL =75
MAXV = 10
;V1 =
;V2 =
```

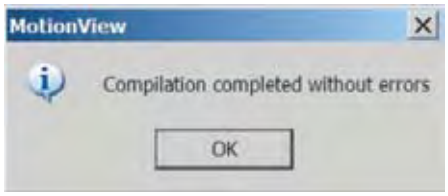
```
;********************** Events ****************************************
;Set Events handling here
;********************** Main Program  *********************************
RESET_DRIVE:         ;Place holder for Fault Handler Routine
WAIT UNTIL IN_3A:    ;Make sure that the Enable input is made before continuing
ENABLE
PROGRAM_START:
MOVEP  0             ;Move to Pick position
OUT1 = 1             ;Turn on output 1 on to extend Pick arm
WAIT TIME 1000       ;Delay 1 sec to extend arm
OUT2 = 1             ;Turn on output 2 to Engage gripper
WAIT TIME 1000       ;Delay 1 sec to Pick part
OUT1 = 0             ;Turn off output 1 to Retract Pick arm
MOVED -10            ;Move 10 REVs to Place position
OUT1 = 1             ;Turn on output 1 on to extend Pick arm
WAIT TIME 1000       ;Delay 1 sec to extend arm
OUT2 = 0             ;Turn off output 2 to Disengage gripper
WAIT TIME 1000       ;Delay 1 sec to Place part
OUT1 = 0             ;Retract Pick arm
GOTO PROGRAM_START
END
;********************** Sub-Routines **********************************
Enter Sub-Routine code here
;********************** Fault Handler Routine *******************
;     Enter Fault Handler code here
ON FAULT
ENDFAULT
```

Saving Configuration File to PC

The “Configuration File” consists of all the parameter settings for the drive, as well as the User Program. Once you are done setting up the drive’s parameters and have written your User Program, you can save these setting to your computer. To save the settings, select **[Save configuration As]** from the **Node** pull down menu. Then simply assign your program a name, (e.g. Basic Motion), and click Save. The configuration file has a “dcf” extension and by default will be saved to the “User Data” subfolder in the MotionView installation folder.

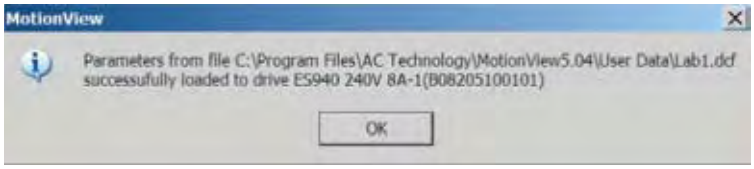
Loading Configuration File to the Drive -

There are times when it is desired to import (or export) the program to another drive. Other times the program was prepared off-line. In both scenarios, the program or configuration file needs to be loaded from the PC to the drive. To load the configuration file to the drive, select **[Load configuration file to drive]** from the **Node** pull down menu. Then simply select the program you want to load and click Open. MotionView will first compile the selected program. Once compiled, the following message box should appear.



S807

Click [OK] to dismiss this dialog box. MotionView will then load the selected file to the drive and display the following message box when done.



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Click [OK] to dismiss the dialog box.

Create a new Configuration File

There are times when you are not connected to the drive and would like to develop a new application. This may be accomplished by loading a virtual drive. To create a new configuration file, select [**New configuration file**] from the **Node** pull down menu. The following message box should appear.

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Select the desired drive and click [OK]. This will load a virtual drive onto the Parameter Tree. From here you can set all your parameters as well as create your User Program. When done you can use the above "**Saving Configuration File to PC**" procedure to save your work. Later you can continue to work on your program offline by selecting [**Open configuration file**] from the **Node** pull down menu.

Motion source (Reference)

The PositionServo can be set up to operate in one of three modes: Torque, Velocity, or Position. The drive must be given a command before it can initiate any motion. The source for commanding this motion is referred to as the "Reference". With the PositionServo you have two ways of commanding motion, or two types of References. When the drive's command signal is from an external source, for example a PLC or Motion Controller, it is referred to as an External Reference. When the drive is being given its command from the User program or through one of the system variables it is referred to as an Internal Reference.

	"Reference" Parameter Setting	
Mode	**External**	**Internal**
Torque	Analog input AIN1	System variable "IREF"
Velocity	Analog input AIN1	System variable "IREF"
Position	Step/Direction Inputs Master Encoder Pulse Train Inputs User Program (Trajectory generator output)	User Program/Interface (Trajectory generator)

Units

All motion statements in the drive work with User units. The statement on the first line of the test program, UNITS=1, sets the relationship between User units and motor revolutions. For example, if UNITS=0.5 the motor will turn 1/2 of a revolution when commanded to move 1 Unit. By default the "User Units" value under the parameter folder in MotionView is used, not set in the User's Program. When the UNITS variable is set to zero, the motor will operate with encoder counts as User units.

Time base

Time base is always in seconds i.e. all time-related values are set in USER UNITS/SEC.

Enable/Disable/Inhibit drive

Set "Enable switch function" to "Run".

When the "Enable switch function" parameter is set to Run, and the Input A3 is made, the drive will be enabled. Likewise, toggling input A3 to the off state will disable the drive.

- Select **"Parameter"** from the Parameter Tree Window.
- Select **"Enable switch function"** from the Parameter View Window.
- Select **"Run"** from the popup menu.

Set "Enable switch function" to "Inhibit".

In the above example the decision on when to enable and disable the drive is determined by an external device, PLC or Motion controller. The PositionServo's User Program allows the programmer to take that decision and incorporate it into the drive's program. By default the drive will execute the User Program whether the drive is enabled or disabled, however if a motion statement is executed while the drive is disabled, the F36 fault will occur. When the "**Enable switch function**" parameter is set to **Inhibit**, and Input A3 is on, the drive will be disabled and remain disabled until the ENABLE statement is executed by the User Program.

- Select "**Parameter**" from the Parameter Tree Window.
- Select "**Enable switch function**" from the Parameter View Window.
- Select "**Inhibit**" from the popup menu.

Faults

When a fault condition has been detected by the drive, the following events occur:

- If the PositionServo drive is running the user program, the program execution will be stopped immediately. If a fault handler routine was defined, its code starts executing. Refer to Fault Handler section. If there is no fault handler, the user program will be terminated
- A fault code will be written in the DFAULTS register and will be available to user's program. Refer to section 2.15 for a list of fault codes.
- Dedicated "Ready" output will turn OFF.
- Any output with assigned special function "fault" will turn ON.
- Any output with assigned special function "ready/enabled" will turn OFF.
- Enable LED located on drive's front panel will turn OFF:
- The fault code will be displayed on the front LED.

Clearing a fault condition can be done in one of the following ways:

- Select the [**Restart**] icon from the toolbar.
- Execute the **RESUME** statement at the end of the Fault Handler routine (see Fault Handler Example).
- Send "Reset" command over the Host Interface.
- Cycle power (hard reset).

Fault Handler

The Fault Handler is a code segment that will be executed when the drive is experiencing a fault. This allows the program to recover from a fault rather than just disabling the drive. While the drive is executing the Fault Handler Routine the drive is disabled and therefore will not be able to detect any additional faults that might occur. Because of this and due to the limited number of executable commands which can be used within the Fault Handler Routine, it is highly recommended that the user exits the Fault Handler Routine by executing a "**RESUME**" statement and jumps to a code segment designated to recover the drive from the fault.

Without Fault Handler

To simulate a fault, restart the Pick and Place example program. While the program is running, switch the ENABLE input IN_A3 to the off state. This will cause the drive to generate an F_36 fault (Drive Disabled) and put the drive into Fault Mode. While the drive is in Fault Mode, any output on will remain on and any off output will remain off. The program execution will stop and any motion moves will be terminated. In this example the Pick and Place arm may not be in a desired location when the program goes into the fault mode.

With Fault Handler

Add the following code to your sample program. While the program is running, switch the ENABLE input IN_A3, to the off state. This will cause the drive to generate an F_36 fault (Drive Disabled) and put the drive into a Fault Mode. From this point the Fault Handler Routine will take over.

```
F_PROCESS:
WAIT UNTIL IN_A4==1   ;Wait until reset switch is made
WAIT UNTIL IN_A4==0   ;and then released before
GOTO RESET_DRIVE      ;returning to the beginning of the program
END
;********************** Sub-Routines ****************************
Enter Sub-Routines here;
;********************** Fault Handler Routine ****************************
ON FAULT              ;Statement starts fault handler routine
                      ;Motion stopped, drive disabled, and events no longer
                      ;scanned while executing the fault handler routine.
OUT2 = 0              ;Output 1 off to Disengage gripper.
                      ;This will drop the part in the gripper
OUT1 = 0              ;Retract Pick arm to make sure it is up and out of the way
RESUME F_PROCESS      ;program restarts from label F_PROCESS
ENDFAULT              ;fault handler MUST end with this statement
```

Note

The following statements can not be used inside the Fault Handler Routine:

- ENABLE
- WAIT UNTIL
- MOVE
- MOVED
- MOVEP
- MOVEDR
- MOVEPR
- MDV
- MOTION SUSPEND
- MOTION RESUME
- GOTO, GOSUB
- JUMP
- ENABLE
- VELOCITY ON/OFF

See section 2.1 for additional details and the Language Reference section for the statement “ON FAULT/ENDFAULT”.

1.6 Using Advanced Debugging Features

The [**Restart**] icon is used to restart the program from the beginning, acting as a reset.

The [**Step into]** icon allows the user to execute the program one line at a time, including Sub-Routines

The [**Step over]** icon allows the user to execute the program one line at a time, **ex**cluding Sub-Routines.

By selecting the [**Insert/Remove breakpoints**] icon on the toolbar the user can insert breakpoints throughout the program. The drive will execute the program line by line until it comes to one of the breakpoints. At this point the program will stop, allowing the user to evaluate program variables, check program branching or just check code execution.

To continue code processing, you can either Step through the program using the above procedure or you can select the [**Go**] icon from the toolbar.

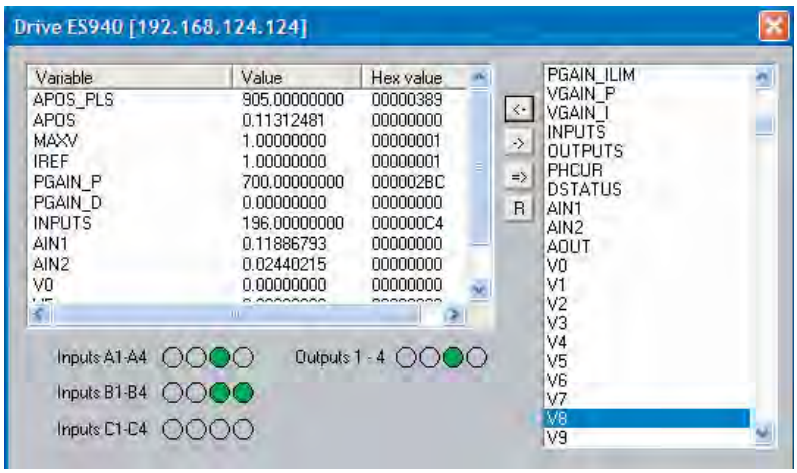
To open the **Variable Debug Window**, select the [**Debug View**] icon from the toolbar. The Debug Window allows you to view the drive's system and user variable as well as I/O status.

Use the left arrow key to add variables after selecting a variable.

Use the right arrow key to remove variables after selecting a variable.

Use the [**Refresh**] key to refresh variable values.

Note that variable values are refreshed manually when you click on the [**Refresh**] button or automatically when the program stops, when a single step is completed or when a breakpoint is encountered.



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1.7 Inputs and Outputs

Analog Input and Output

- The PositionServo has two analog inputs. These analog inputs are utilized by the drive as System Variables and are labeled "**AIN1**" and "**AIN2**". Their values can be directly read by the User Program or via a Host Interface. This value can range from -10 to +10 and correlates to ± 10 volts analog input.
- The PositionServo has one analog output. This analog output is utilized by the drive as a System Variable and is labeled "**AOUT**". It can be directly written by the User Program or via a Host Interface. Its value can range from -10 to +10 which correlates to ± 10 volts analog input.

Note

If an analog output is assigned to any special function from MotionView, writing to AOUT from the User Program will not change its value. If an analog output is set to "Not assigned" then it can be controlled by writing to the AOUT variable.

Digital Inputs

- The PositionServo has twelve digital inputs. These digital inputs are utilized by the drive for decision making in the User Program. Some examples would be travel limit switches, proximity sensors, push buttons and hand shaking with other devices.
- Each input can be assigned an individual debounce time via MotionView. From the **Parameter Tree**, select [**IO**]. Then select the [**Digital Input**] folder. The debounce times will be displayed in the **Parameter View Window**. Debounce times can be set between 0 and 1000 ms (1ms = 0.001 sec).
- The twelve inputs are separated into three groups: A, B and C. Each group has four inputs and share one common: Acom, Bcom and Ccom respectfully. The inputs are labeled individually as **IN_A1 - IN_A4, IN_B1 - IN_B4** and **IN_C1 - IN_C4**.
- In addition to monitoring each input individually, the status of all twelve inputs can be represented as one binary number. Each input corresponds to 1 bit in the INPUTS system variable. It is suggested that the following format be used:

- Some inputs can have additional special functionality such as Travel Limit switch, Enable input, and Registration input. Configuration of these inputs is done from MotionView. Input functionality is summarized in the table below and in the following sections. The status of the current state of the drive's inputs is available to the programmer through dedicated System Flags or as bits of the System Variable INPUTS. The table below summarizes the serial functions for the inputs:

Function	Special function
Input A1	negative limit switch(1)
Input A2	positive limit switch(1)
Input A3	Inhibit/Enable input
Input A4	N/A
Input B1	N/A
Input B2	N/A
Input B3	N/A
Input B4	N/A
Input C1	N/A
Input C2	N/A
Input C3	Registration sensor input
Input C4	N/A

(1) Assume A1 is connected to the negative limit switch and A2 is connected tio the positive limit switch

Read Digital Inputs

The Pick and Place example program has been modified below to utilize the “WAIT UNTIL” inputs statements in place of the “WAIT TIME” statements. **IN_A1** and **IN_A4** will be used as proximity sensors to detect when the pick and place arm is extended and when it is retracted. When the arm is extended, **IN_A1** will be in an ON state and will equal “1”. When the arm is retracted, **IN_A4** will be in an ON state and will equal “1”.

```
;********************* Main Program ************************************
RESET_DRIBVE:           ;Place holder for Fault Handler Routine
WAIT UNTIL IN_3A        ;Make sure that the Enable input is made before continuing
ENABLE
PROGRAM_START:
WAIT UNTIL IN_A4==1     ;Make sure Arm is retracted
MOVEP  0                ;Move to Pick position
OUT1 = 1                ;Turn on output 1 to extend Pick arm
WAIT UNTIL IN_A1==1     ; Arm extend
OUT2 = 1                ;Turn on output 2 to Engage gripper
WAIT TIME 1000          ;Delay 1 sec to Pick part
OUT1 = 0                ;Turn off output 1 to Retract Pick arm
WAIT UNTIL IN_A4==1     ;Make sure Arm is retracted
MOVED -10               ;Move 10 REVs to Place position
OUT1 = 1                ;Turn on output 1 on to extend Pick arm
WAIT UNTIL IN_A1==1     ; Arm is extended
OUT2 = 0                ;Turn off output 2 to Disengage gripper
WAIT TIME 1000          ;Delay 1 sec to Place part
OUT1 = 0                ;Retract Pick arm
WAIT UNTIL IN_A4==1     ;Arm is retracted
GOTO PROGRAM_START
END
```

Once the above modifications have been made, export the program to file and save it as “Pick and Place with I/O”, then compile, download and test the program.

ASSIGN & INDEX - Using inputs to generate predefined indexes

“INDEX” is a variable on the drive that can be configured to represent a certain group of inputs as a binary number. “ASSIGN” is the command that designates which inputs are utilized and how they are configured.

Below the Pick and Place program has been modified to utilize this “INDEX” function. The previous example program simply picked up a part and moved it to a place location. For demonstration purposes we will add seven different place locations. These locations will be referred to as Bins. What Bin the part is placed in will be determined by the state of three inputs, B1, B2 and B3.

Bin 1 - Input B1 is made
Bin 2 - Input B2 is made
Bin 3 - Inputs B1 and B2 are made
Bin 4 - Input B3 is made
Bin 5 - Inputs B1 and B3 are made
Bin 6 - Inputs B2 and B3 are made
Bin 7 - Inputs B1, B2 and B3 are made

The “ASSIGN” command is used to assign the individual input to a bit in the “INDEX” variable. ASSIGN INPUT <input name> AS BIT <bit #>

```
;********************** Initialize and Set Variables ******************
ASSIGN INPUT IN_B1 AS BIT 0     ;Assign the Variable INDEX to equal 1 when IN_B1 is made
ASSIGN INPUT IN_B2 AS BIT 1     ;Assign the Variable INDEX to equal 2 when IN_B2 is made
ASSIGN INPUT IN_B3 AS BIT 2     ;Assign the Variable INDEX to equal 4 when IN_B4 is made
```

Bin Location	Input state	INDEX Value
Bin 1	Input B1 is made	1
Bin 2	Input B2 is made	2
Bin 3	Inputs B1 and B2 are made	3
Bin 4	Input B3 is made	4
Bin 5	Inputs B1 and B3 are made	5
Bin 6	Inputs B2 and B3 are made	6
Bin 7	Inputs B1, B2 and B3 are made	7

The Main program has been modified to change the end place position based on the value of the “**INDEX**” variable.

```
;************************* Main Program *********************************
ENABLE
PROGRAM_START:
WAIT UNTIL IN_A4==1     ;Make sure Arm is retracted
MOVEP  0                ;Move to (ABS) to Pick position
OUT1 = 1                ;Turn on output 1 to extend Pick arm
WAIT UNTIL IN_A1==1     ;Arm extends
OUT2 = 1                ;Turn on output 2 to Engage gripper
WAIT TIME 1000          ;Delay 1 sec to Pick part
OUT1 = 0                ;Turn off output 1 to Retract Pick arm
WAIT UNTIL IN_A4==0     ;Make sure Arm is retracted

IF INDEX==1             ;In this area we use the If statement to
GOTO BIN_1              ;check and see what state inputs B1, B2 & B3
ENDIF                   ;are in.
IF INDEX==2             ;    INDEX = 1 when input B1 is made
GOTO BIN_2              ;    INDEX = 2 when input B2 is made
ENDIF                   ;    INDEX = 3 when input B1 & B2 are made.
.                       ;    INDEX = 4 when input B3 is made
.                       ;    INDEX = 5 when input B1 & B3 are made.
.                       ;    INDEX = 6 when input B2 & B3 are made.
IF INDEX==7             ;    INDEX = 7 when input B1, B2 & B3 are made
GOTO BIN_7              ;We can now direct the program to one of seven
ENDIF                   ;locations based on three inputs.

BIN_1:                  ;Set up for Bin 1
MOVEP 10                ;Move to Bin 1 location
GOTO PLACE_PART         ;Jump to place part routine
BIN_2:                  ;Set up for Bin 2
MOVEP 20                ;Move to Bin 2 location
GOTO PLACE_PART         ;Jump to place part routine
BIN_7:                  ;Set up for Bin 7
MOVEP 70                ;Move to Bin 7 location
GOTO PLACE_PART         ;Jump to place part routine
PLACE_PART:
OUT1 = 1                ;Turn on output 1 to extend Pick arm
WAIT UNTIL IN_A4 == 1   ;Arm extends
OUT2 = 0                ;Turn off output 2 to Disengage gripper
WAIT TIME 1000          ;Delay 1 sec to Place part
OUT1 = 0                ;Retract Pick arm
WAIT UNTIL IN_A4 == 0   ;Arm is retracted
GOTO PROGRAM_START
END
```

Note

Note: Any one of the 12 inputs can be assigned as a bit position within the INDEX variable. Only bits 0 through 7 can be used with the INDEX variable. Bits 8-31 are not used and are always set to 0. Unassigned bits in the INDEX variable are set to 0.

BITS 8-31 (not used)	A1	0	A2	A4	0	0	0	0

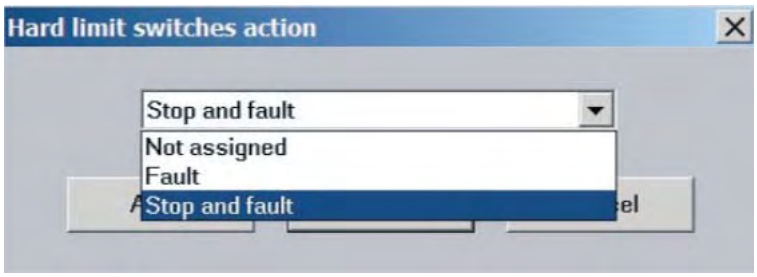
Limit switch input functions

Inputs A1 and A2 can be configured as special purpose inputs from the **Digital I/O** folder in MotionView. They can be set to one of three settings:

- The "**Not assigned**" setting designates the inputs as general purpose inputs which can be utilized by the User Program.
- The "**Fault**" setting will configure A1 and A2 as Hard Limit Switches. When either input is made the drive will be disabled, the motor will hard stop, and the drive will generate a fault. If the negative limit switch is activated, the drive will display an F-33 fault. If the positive limit switch is activated the drive will display an F32 fault.
- The "**Stop and fault**" setting will configure A1 and A2 as End of Travel limit switches. When either input is made the drive will initiate a rapid stop before disabling the drive and generating an F34 or F35 fault (refer to section 2.15 for details). The speed of the deceleration will be set by the value stored in the "**QDECEL**" System Variable.

Note

The "Stop and Fault" function is available in position mode only, i.e. when the parameter "Drive mode" is set to "Position". In all other cases, the Stop and Fault function will act the same as the Fault function.



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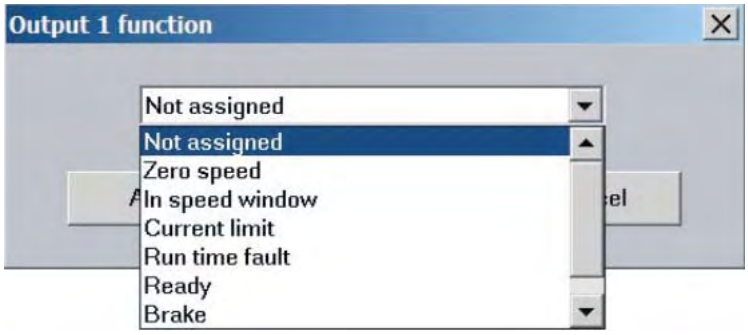
To set this parameter, select the "**IO**" folder from the Parameter Tree. Then select the "**Digital IO**" folder. From the Parameter View Window, select "**Hard limit switches action**".

Digital Outputs Control

- The PositionServo has 5 digital outputs. The "**RDY**" or READY output is dedicated and will only come on when the drive is enabled, i.e. in **RUN** mode. The other outputs are labeled **OUT1 - OUT4**.
- Outputs can be configured as Special Purpose Outputs. If an output is configured as a **Special Purpose Output** it will activate when the state assigned to it becomes true. For example, if an output is assigned the function "**Zero speed**", the assigned output will come on when the motor is not in motion. To configure an output as a Special Purpose Output, select the "**IO**" folder from the Parameter Tree. Then select the "**Digital IO**" folder. From the Parameter View Window, select the "**Output function**" parameter you wish to set:



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- Outputs which are configured as "Not assigned" can be activated either via the User Program or from a host interface. If an output is assigned as a Special Purpose Output, neither the user program nor the host interface can overwrite its status.
- The Systems Variable "**OUTPUTS**" is a read/write variable which allows the User Program, or host interface, to monitor and set the status of all four outputs. Each output allocates 1 bit in the OUTPUTS variable. For example, if you set this variable equal to 15 in the User Program,i.e. 1111 in binary format, then all 4 outputs will be turned on.
- The example below summarizes the output functions and corresponding System Flags. To set the output, write any non-0 value (TRUE) to its flag. To clear the output, write a 0 value (FALSE) to its flag. You can also use flags in an expression. If an expression is evaluated as TRUE then the output will be turned ON. Otherwise, it will be turned OFF.

```
OUT1 = 1                    ;turn OUT1 ON
OUT2 = 10                   ;any value but 0 turns output ON
OUT3 = 0                    ;turn OUT3 OFF
OUT2 = APOS>3 && APOS<10    ;ON when position within window, otherwise OFF
```

1.8 Events

Scanned Events

A Scanned Event is a small program that runs independently of the main program. Scanned Events are very useful when it is necessary to trigger an action, e.g. handle I/O, while the motor is in motion. In the following example the Event "**SPRAY_GUNS_ON**" will be setup to turn Output 3 on when the drive's position becomes greater than 25. Note: the event will be triggered only at the instant when the drive position becomes greater than 25. It will not continue to execute while the position is greater than 25.

```
;********************** EVENT SETUP ************************************
EVENT SPRAY_GUNS_ON       APOS>25
OUT3=1
ENDEVENT
;***************************************************************************
```

The Event code should be entered in the EVENT SETUP section of the program. To Setup an Event, the **"EVENT"** command must be entered. This is followed by the Event Name **"SPRAY_GUNS_ON"** and the triggering mechanism, **"APOS>25"**. After that you can addd a sequence of programming events you wish to occur once the event is triggered. In our case, we will turn on output 3. To end the Event, the **"ENDEVENT"** command ust be used.

Events can be activated, i.e. turned on, and deactivated, i.e. turned off, throughout the program. To turn on an Event, the "**EVENT**" command is entered, followed by the Event Name "**SPRAY_GUNS_ON**". This is trailed by the desired state of the Event, "**ON**" or "**OFF**".

```
;*************************************************************************
EVENT SPRAY_GUNS_ON      ON
;*************************************************************************
```

To learn more about Scanned Events refer to Section 2.12.

Two Scanned Events have been added to the Pick and Place program below to trigger a spray gun on and off. The Event will be triggered after the part has been picked up and is passing in front of the spray guns (POS 25). Once the part is in position, output 3 is turned on to activate the spray guns. When the part has passed by the spray guns, (POS 75), output 3 is turned off, deactivating the spray guns.

```
;********************** Events ****************************************
EVENT  SPRAY_GUNS_ON    APOS>25
OUT3=1
ENDEVENT

EVENT  SPRAY_GUNS_OFF   APOS>75
OUT3=0
ENDEVENT
;********************** Main Program **********************************
PROGRAM_START:
ENABLE
EVENT  SPRAY_GUNS_ON   ON
EVENT  SPRAY_GUNS_OFF  ON
WAIT UNTIL IN_A4==1             ;Make sure Arm is retracted
MOVEP 0                         ;Move to Pick position
OUT1 = 1                           ;Turn on output 1 to extend Pick arm
WAIT UNTIL IN_A1==1             ;Arm extends
OUT2 = 1                           ;Turn on output 2 to Engage gripper
WAIT TIME 1000                  ;Delay 1 sec to Pick part
OUT1 = 0                           ;Turn off output 1 to Retract Pick arm
WAIT UNTIL IN_A4==1             ;Make sure Arm is retracted
MOVEP 100                       ;Move to Place position
OUT1 = 1                           ;Turn on output 1 to extend Pick arm
WAIT UNTIL IN_A1==1             ;Arm extends
OUT2 = 0                           ;Turn off output 2 to Disengage gripper
WAIT TIME 1000                  ;Delay 1 sec to Place part
OUT1 = 0                           ;Retract Pick arm
WAIT UNTIL IN_A4==1             ;Arm is retracted
GOTO PROGRAM_START
END
```

1.9 Variables and Define Statement

Variables are resources in the drive. Some of these variables can be read / write and some can be read only. Certain variables are used to set the operating parameters of the drive, e.g. ACCEL, DECEL, or MAXV. Other variables can be used to determine the status of the drive, e.g. AIN, INPUTS, or APOS. Variables can also be used as system registers. These system registers can be local to the drive, (V01- V31), or network variables (NV0 - NV31). In the example below we set the trigger position for the EVENT "**SPRAY_GUNS_ON**" to be equal to "V1", and the trigger position for EVENT "SPRAY_GUNS_OFF" to be equal to "V2".

The DEFINE command is used to assign a name to the state of a drive variable, e.g. Output_ON = 1, Output_OFF = 0. You can also assign a meaningful name to a set number, e.g. MIN = 25, MAX = 75. In the example below we assign the name "Output_On" to equal the value "1", and "Output_Off" to equal the value "0".

Defining and setting variables should be done in the "**Initialize and set Variables**" segment of the program.

```
;********************** Initialize and Set Variables **********************
UNITS = 1
ACCEL = 5
DECEL = 5
MAXV = 10
V1 = 25                          ;Set Variable V1 equal to 25
V2 = 75                          ;Set Variable V2 euqal to 75
DEFINE      Output_On     1      ;Define Name for output On
DEFINE      Output_Off    0      ;Define Name for output Off
;********************** EVENTS  ***************************************
EVENT SPRAY_GUNS_ON   APOS > V1  ;Event will trigger as position passes 25 in pos dir.
OUT3= Output_On                  ;Turn on the spray guns (out 3 on)
ENDEVENT                         ;End event

EVENT SPRAY_GUNS_OFF  APOS > V2  ;Event will trigger as position passes 75 in neg dir.
OUT3= Output_Off                 ;Turn off the spray guns (out 3 off)
ENDEVENT                         ;End even
;********************** Main Program **********************************
PROGRAM_START:
ENABLE
EVENT       SPRAY_GUNS_ON ON     ;Enable the Event
EVENT       SPRAY_GUNS_OFF ON    ;Enable the Event
WAIT UNTIL IN_A4==1              ;Ensure Arm is retracted before running the program
MOVEP 0                          ;Move to position 0 to pick part
OUT1 = Output_On                 ;Turn on output 1 to extend Pick arm
WAIT UNTIL IN_A1==1              ;Check input to make sure Arm is extended
OUT2 = Output_On                 ;Turn on output 2 to Engage gripper
WAIT TIME 1000                   ;Delay 1 sec to Pick part
OUT1 = Output_Off                ;Turn off output 1 to Retract Pick arm
WAIT UNTIL IN_A4==1              ;Check input to make sure Arm is retracted
MOVED 100                        ;Move to Place position
OUT1 = Output_On                 ;Turn on output 1 to extend Pick arm
WAIT UNTIL IN_A1==1              ;Check input to make sure Arm is extended
OUT2 = Output_Off                ;Turn off output 2 to Disengage gripper
WAIT TIME 1000                   ;Delay 1 sec to Place part
OUT1 = Output_Off                ;Retract Pick arm
WAIT UNTIL IN_A4==1              ;Check input to make sure Arm is retracted
GOTO PROGRAM_START
END
```

1.10 IF/ELSE Statements

An IF/ELSE statement allows the user to execute one or more statements conditionally. The programmer can use an IF or IF/ELSE construct:

Single IF example:

This example increments a counter, Variable “V1”, until the Variable, “V1”, is greater than 10.

```
Again:
      V1=V1+1
      IF   V1>10
      V1=0
      ENDIF
      GOTO Again
END
```

IF/ELSE example:

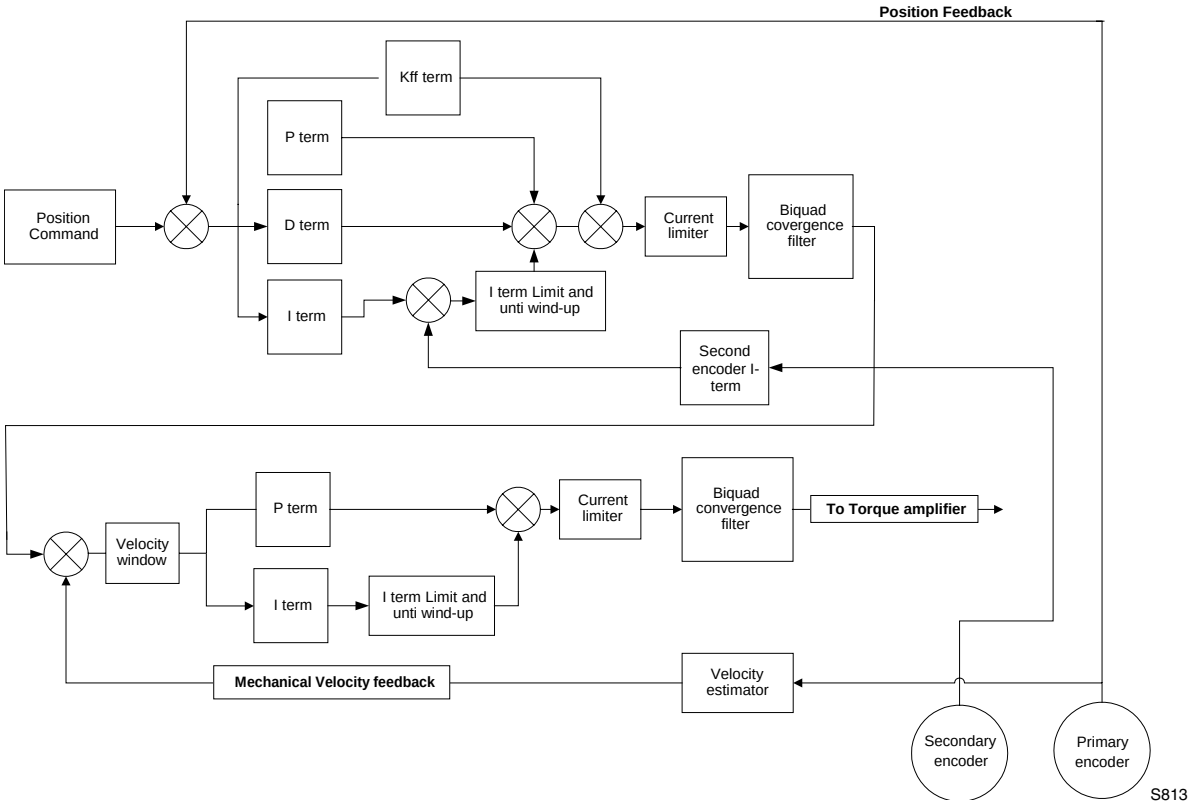
This example checks the value of Variable V1. If V1 is greater than 3, then V2 is set to 1. If V1 is not greater than 3, then V2 is set to 0.

```
      IF V1>3
      V2=1
      ELSE
      V2=0
      ENDIF
```

Whether you are using an IF or IF/ELSE statement the construct must end with ENDIF keyword.

1.11 Motion

Figure S813 ilustrates the Position and Velocity regulator of the PositionServo drive.



PositionServo Position and Velocity Regulator’s Diagram

The “**Position Command**”, as shown in the regulator’s diagram (S813), is produced by a **Trajectory Generator**. The Trajectory Generator processes the motion commands produced by the User’s program to calculate the position increment or decrement, also referred to as the “index” value, for every servo loop. This calculated target (or theoretical) position is then supplied to the **Regulator** input.

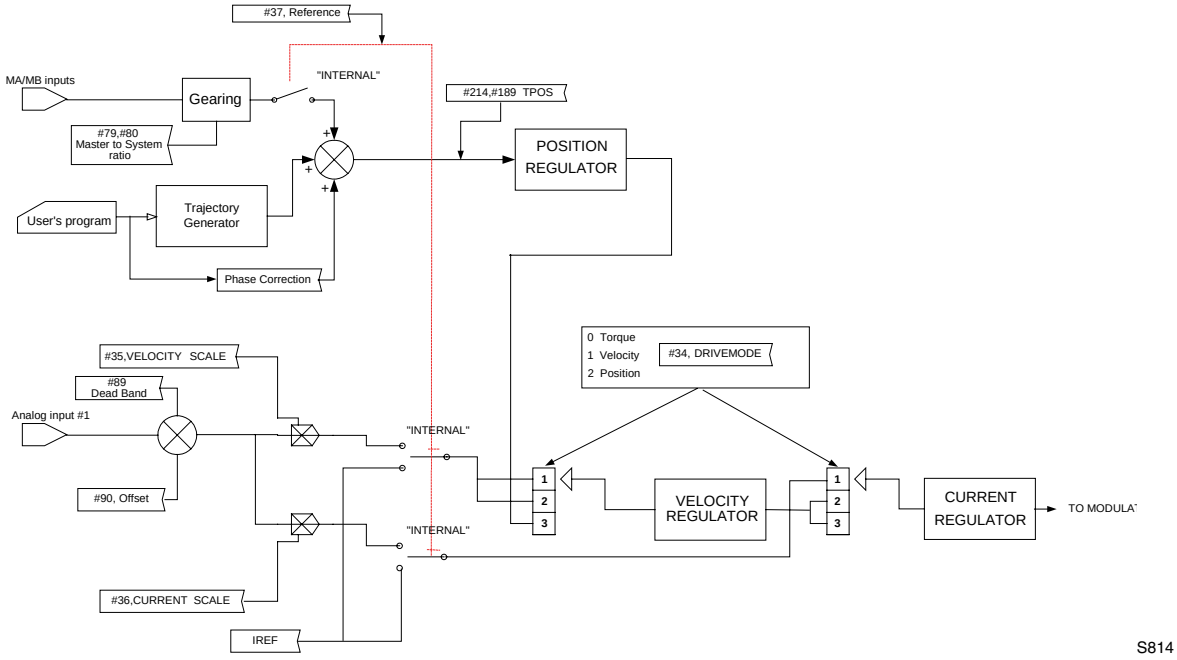
The main purpose of the **Regulator** is to set the motors position to match the target position created by the Trajectory Generator. This is done by comparing the input from the Trajectory Generator with the position feedback from the encoder or resolver, to control the torque and velocity of the motor. Of course there will always be some error in the position following. Such error is referred to as “Position Error” and is expressed as follows:

Position Error = Target Position - Actual Position

When the actual Position Error exceeds a certain threshold value a “Position Error limit”, fault (F_PE) will be generated. The Position Error limit and Position Error time can be set under the Node Tree “Limits”/ “Position Limits” in MotionView. The Position Error time specifies how long the actual position error can exceed the Position Error limit before the fault is generated.

Drive Operating Modes

There are three modes of operation for the PositionServo, Torque, Velocity and Position. Torque and Velocity modes are generally used when the command reference is from an external device, (Ain). Position mode is used when the command comes from the drives User Program, or from an external device, encoder or a step and direction pulse. Setting the drive’s mode is done from the “**Parameter**” folder in MotionView. To command motion from the User Program the drive must be configured to Position Mode. Even though the drive is setup in position mode, velocity mode can be turned on and off from the User Program. Executing the VELOCITY ON statement is used to activate this mode while VELOCITY OFF will deactivate this mode. This mode is used for special case indexing moves. Velocity mode is the mode when the target position is constantly advanced with a rate set in the VEL system variable. Gear mode is the mode when the target position reference is fed from MA/MB inputs scaled by the Gear Ratio (gear ratio set by statement Gear Ratio). The Reference arrangements for the different modes of operation are illustrated in Figure S814.

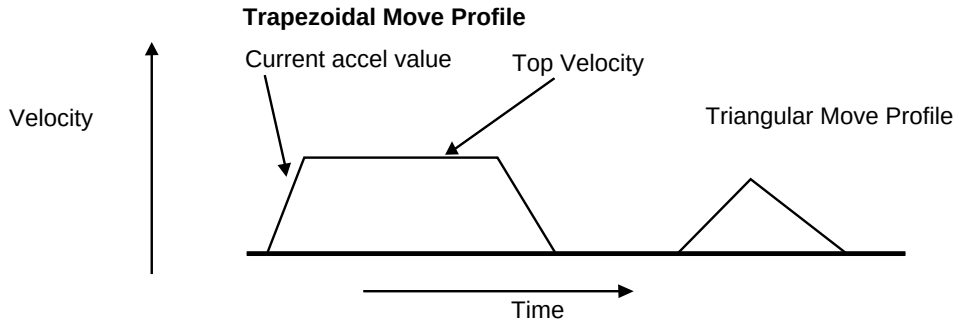


Reference Arrangement Diagram

Point To Point Moves

The PositionServo supports two types of moves, absolute and incremental. The statement MOVEP (Move to Position) is used to make an absolute move. When executing an absolute move, the motor is instructed to move to a known position. The move to this known position is always referenced from the motors “home” or “zero” location. For example, the statement (MOVEP 0) will cause the motor to move to its zero or home position, regardless of where the motor is located at the beginning of the move. The statement MOVED (Move Distance) makes incremental, (or relative), moves from its current position. For example, MOVED 10, will cause the motor to move forward 10 user units from it current location.

MOVEP and MOVED statements generate what is called a trapezoidal point to point motion profile. A trapezoidal move is when the motor accelerates, using the current acceleration setting, (ACCEL), to a default top speed, (MAXV), it then maintains that speed for a period of time before decelerating to the end position using the deceleration setting, (DECEL). If the distance to be moved is fairly small, a triangular move profile will be used. A triangular move is a move that starts to accelerate toward the Max Velocity setting but has to decelerate before ever achieving the max velocity in order to reach the desired end point.



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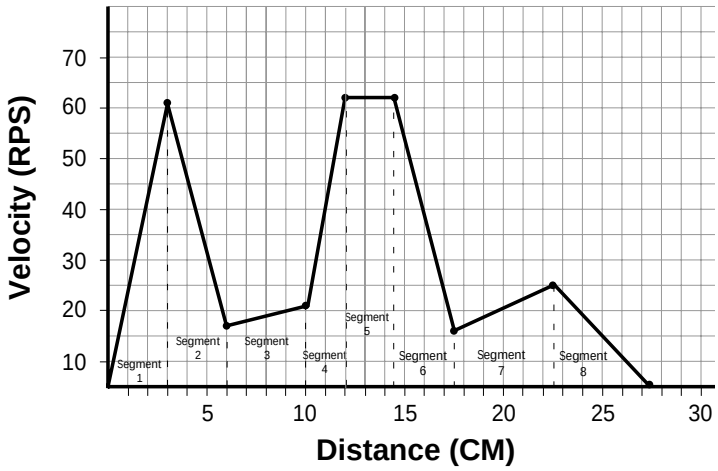
Segment moves

MOVED and MOVEP commands are simple and useful, but if the required move profile is more complex than a simple trapezoidal move, then the segment move MDV can be used.

The profile shown below is divided up into 8 segments or 8 MDV moves. An MDV move (Move Distance Velocity) has two arguments. The first argument is the distance moved in that segment. This distance is referenced from the motors current position and is in User Units. The second argument is the desired target velocity for the end of the segment move. That is the velocity at which the motor will run at the moment when the specified distance in this segment is moved.



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Segment Number	Distance moved during segment	Velocity at the end of segment
1	3	56
2	3	12
3	4	16
4	2	57
5	2.5	57
6	3	11
7	5	20
8	5	0
-	-	-

Here is the user program for the segment move example. The last segment move must have a “0” for the end velocity, (MDV 5 , 0). Otherwise, fault F_24 (Motion Queue Underflow), will occur.

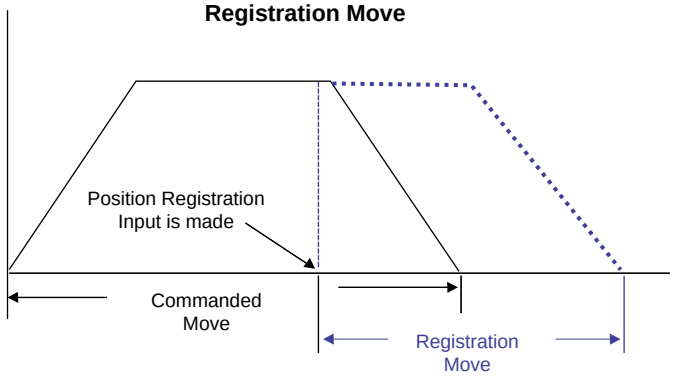
```
;Segment moves
LOOP:
WAIT UNTIL IN_A4==0  ;Wait until input A4 is off before starting the move
MDV 3 , 56           ;Move 3 units accelerating to 56 User Units per sec
MDV 3 , 12           ;Move 3 units decelerating to 12 User Units per sec
MDV 4 , 16           ;Move 4 units accelerating to 16 User Units per sec
MDV 2 , 57           ;Move 2 units accelerating to 57 User Units per sec
MDV 2.5 , 57         ;Move 2.5 units maintaining 57 User Units per sec
MDV 3 , 11           ;Move 3 units decelerating to 11 User Units per sec
MDV 5 , 20           ;Move 5 units accelerating to 20 User Units per sec
MDV 5 , 0            ;Move 5 units decelerating to 0 User Units per sec
WAIT UNTIL IN_A4==1  ;Wait until input A4 is on before looping
GOTO LOOP
END
```

Note

- When an MDV move is executed, the segment moves are stored to a Motion Queue. If the program loops on itself, then the queue will become full and an F_23 Fault Motion Queue Overflow will occur.
- Since the MDV moves utilize a Motion Queue, the **“Step into”** or **“Step over”** debugging features can not be used.

Registration

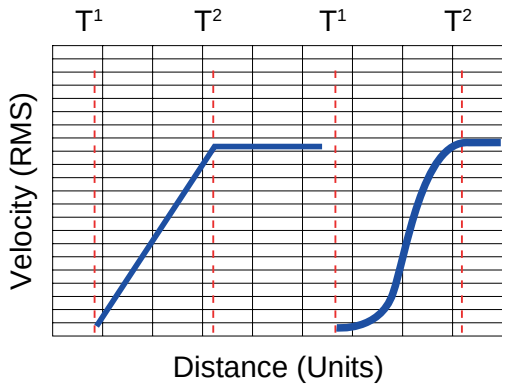
Both absolute and incremental moves can be used for registration moves. The statements associated with these moves are MOVEPR and MOVEDR. These statements have two arguments. The first argument specifies the commanded move distance or position. The second argument specifies the move made after the registration input is seen. If the registration move is an absolute move, (MOVEPR 10,30), then the second argument, “30”, will simply define the position to move to after the registration input is made. If the registration move is an incremental move, (MOVEDR 10,30), then the second argument will be the distance to move from the point where the registration input is seen.



S-Curve Acceleration

Very often it is important for a move profile to be as smooth as possible. For example, using a smooth move profile could minimize the wear and tear on a machine tool, proving critical to the successful completion of an operation. To perform smooth motion profiles, the PositionServo supports S-curve acceleration.

With normal straight line acceleration, the axis is accelerated to the target velocity in a linear fashion. With S-curve acceleration, the motor accelerates slowly at the first, then twice as fast as the middle straight line area, and then slowly stops accelerating as it reaches the target velocity. With straight line acceleration, the acceleration changes are abrupt at the beginning of the acceleration and again once the motor reaches the target velocity. With S-curve acceleration, the acceleration gradually builds to the peak value then gradually decreases to no acceleration. The disadvantage with S-curve acceleration is that for the same acceleration distance the peak acceleration is twice that of straight line acceleration, which often requires twice the peak torque. Note that the axis will arrive at the target position at the same time regardless of which acceleration method is used.



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To use S-curve acceleration in a MOVED, MOVEP or MDV statement requires only the additional ",S" at the end of the statement.

Examples:

```
MOVED   10 , S
MOVEP   10 , S
MDV     10,20,S
MDV     10,0,S
```

Motion Queue

The PositionServo drive executes the User Program one statement at a time. When a move statement (MOVED or MOVEP) is executed, the move profile is stored to the Motion Queue. The program will, by default, wait or hang on that statement until the Motion Queue has executed the move. Once the move is completed, the next statement in the program will be executed. This will effectively suspend the program until the motion is complete.

A standard move (MOVED or MOVEP) is only followed by one argument. This argument references the distance or position to move the motor to. By adding the second argument "C", (MOVEP 0,C) or (MOVED 100,C), the drive is allowed to continue executing the user program during the move. At this point, multiple move profiles can be stored to the queue. The Motion Queue can hold up to 32 profiles. Like the EVENT command, the Continue "C" argument is very useful when it is necessary to trigger an action, e.g. handle I/O, while the motor is in motion. Below the Pick and Place Example Program has been modified to utilize the Continue, "C", argument.

```
;*************************** Main Program ********************************
PROGRAM_START:
ENABLE
WAIT UNTIL IN_A4==1          ;Make sure Arm is retracted before starting the program
MOVEP 0                      ;Move to position 0 to pick part
OUT1 = 1                     ;Turn on output 1 to extend Pick arm
WAIT UNTIL IN_A1==1          ;Check input to make sure Arm is extended
OUT2 = 1                     ;Turn on output 2 to Engage gripper
WAIT TIME 1000               ;Delay 1 sec to Pick part
OUT1 = 0                     ;Turn off output 1 to Retract Pick arm
WAIT UNTIL IN_A4==1          ;Check input to make sure Arm is retracted
MOVED 100,C                  ;Move to Place position and continue code execution
WAIT UNTIL APOS >25          ;Wait until pos is greater than 25
OUT3 = 1                     ;Turn on output 3 to spray part
WAIT UNTIL APOS >=75         ;Wait until pos is greater than or equal to 75
OUT3 = 0                     ;Turn off output 3 to shut off spray guns
WAIT UNTIL APOS >=95         ;Wait until move is almost done before extending arm
OUT1 = 1                     ;Turn on output 1 to extend Pick arm
WAIT UNTIL IN_A1==1          ;Check input to make sure Arm is extended
OUT2 =0                      ;Turn off output 2 to Disengage gripper
WAIT TIME 1000               ;Delay 1 sec to Place part
OUT1 = 0                     ;Retract Pick arm
WAIT UNTIL IN_A4==1          ;Check input to make sure Arm is retracted
GOTO PROGRAM_START
END
```

When the “C” argument is added to the standard MOVED and MOVEP statements, the generated motion profile is treated like an MDV move. With an MDV move the execution of the program is never suspended.

The generated motion profiles are stored directly to the Motion Queue and are then executed one by one. If the MOVED and MOVEP statements don’t have the “C” modifier, then the motion profiles generated by these statements go to the motion stack and the program is suspended until each profile has been executed.

1.12 Subroutines and Loops

Subroutines

Often it is necessary to repeat a series of steps in several places in a program. Subroutines can be useful in such situations. The syntax of a subroutine is simple. Subroutines must be placed after the main program, i.e. after the END statement, and must start with the subname: label (where subname is the name of subroutine), and must end with a statement RETURN.

Note that there can be more than one RETURN statement in a subroutine. Subroutines are called using the GOSUB statement.

Loops

SML language supports WHILE/ENDWHILE block statement which can be used to create repetition loops. Note that IF-GOTO statements can also be used to create loops.

The following example illustrates calling subroutines as well as how to implement looping by utilizing WHILE / ENDWHILE statements.

```
;************************** Initialize and Set Variables *****************
UNITS = 1
ACCEL = 15
DECEL = 15
MAXV = 100
APOS = 0
DEFINE   LOOPCOUNT      V1
DEFINE   LOOPS          10
DEFINE   DIST           V2
DEFINE   REPETITIONS    V3
REPETITIONS = 0
;****************************** Main Program *******************************
PROGRAM_START:
ENABLE
MAINLOOP:
        LOOPCOUNT=LOOPS          ;Set up the loopcount to loop 10 times
        DIST=10                  ;Set distance to 10
        WHILE   LOOPCOUNT        ;Loop while loopcount is greater than zero
                DIST=DIST/2      ;decrease dist by 1/2
                GOSUB   MDS      ;Call to subroutine
                WAIT TIME  100   ;Delay executes after returned from the subroutine
        LOOPCOUNT=LOOPCOUNT-1    ;decrement loop counter
        ENDWHILE
        REPETITIONS=REPETITIONS+1  ;outer loop
        IF      REPETITIONS < 5
GOTO MAINLOOP
        ENDIF
END

;***************************** Sub-Routines ******************************
MDS:
      V4=dist/3
      MDV      V4,10
      MDV      V4,10
      MDV      V4,0
RETURN
```

2. Programming

2.1 Introduction

One of the most important aspects of programming is developing a structure for the program. Before you begin to write a program, you should develop a plan for that program. What tasks must be performed? In what order do they need to be performed? What things can be done to make the program easy to understand and to be maintained by others? Are there any procedures that are repetitive?

Most programs are not a simple linear list of instructions where every instruction is executed in exactly the same order each time the program runs. Programs need to do different things in response to external events and operator input. SML contains program control structure instructions and scanned event functions that may be used to control the flow of execution in an application program.

Control structure instructions are the instructions that cause the program to change the path of execution. Scanned events are instructions that execute at the same time as the main body of the application program.

Program Structure

Header - *Enter in program description and title information*

```
;********************************* HEADER *********************************
;Title:           Pick and Place example program
;Author:          Lenze / AC Technology
;Description:     This is a sample program showing a simple sequence that
;           picks up a part, moves to a set position and drops the part
```

I/O List - *Define what I/O will be used*

```
;******************************** I/O List  ******************************
;     Input A1    -     not used
;     Input A2    -     not used
;     Input A3    -     Enable Input
;     Input A4    -     not used
;     Input B1    -     not used
;     Input B2    -     not used
;     Input B3    -     not used
;     Input B4    -     not used
;     Input C1    -     not used
;     Input C2    -     not used
;     Input C3    -     not used
;     Input C4    -     not used
;
;     Output 1    -     Pick Arm
;     Output 2    -     Gripper
;     Output 3    -     not used
;     Output 4    -     not used
```

Initialize and Set Variables - *Define and assign Variables values*

```
;***************************** Initialize and Set Variables ****************
UNITS = 1
ACCEL = 75
DECEL =75
MAXV = 10
;V1 =
;V2 =
DEFINE Output_on 1
DEFINE Output_off 0
```

Events - *Define Event name, Trigger and pgm*

```
;***************************** Events ************************************
EVENT SPRAY_GUNS_ON   APOS > V1 ;Event will trigger as position passes 25 in pos dir.
OUT3= Output_On                 ;Turn on the spray guns (out 3 on)
ENDEVENT                        ;End event
EVENT SPRAY_GUNS_OFF  APOS > V2 ;Event will trigger as position passes 75 in neg dir.
OUT3= Output_Off                ;Turn off the spray guns (out 3 off)
ENDEVENT                        ;End even
```

Main Program *- Define the motion and I/O handling of the machine*

```
;***************************** Main Program ******************************
RESET_DRIVE:                  ;Palce holder for Fault Handler Routine
WAIT UNTIL IN_3A              ;Make sure that the ENABLE input is made before
                               continuing
ENABLE
PROGRAM_START:
EVENT    SPRAY_GUNS_ON  ON    ;Enable the Event
EVENT    SPRAY_GUNS_OFF ON    ;Enable the Event
WAIT UNTIL IN_A4==1           ;Make sure Arm is retracted before starting the program
MOVEP 0                       ;Move to position 0 to pick part
OUT1 = Output_On              ;Turn on output 1 to extend Pick arm
WAIT UNTIL IN_A1==1           ;Check input to make sure Arm is extended
OUT2 = Output_On              ;Turn on output 2 to Engage gripper
WAIT TIME 1000                ;Delay 1 sec to Pick part
OUT1 = Output_Off             ;Turn off output 1 to Retract Pick arm
WAIT UNTIL IN_A4==1           ;Check input to make sure Arm is retracted
MOVED 100                     ;Move to Place position
OUT1 = Output_On              ;Turn on output 1 to extend Pick arm
WAIT UNTIL IN_A1==1           ;Check input to make sure Arm is extended
OUT2 = Output_Off             ;Turn off output 2 to Disengage gripper
WAIT TIME 1000                ;Delay 1 sec to Place part
OUT1 = Output_Off             ;Retract Pick arm
WAIT UNTIL IN_A4==1           ;Check input to make sure Arm is retracted
GOTO PROGRAM_START
END
```

Sub-Routine - *Any and all Sub-Routine code should reside here*

```
;************************* Sub-Routines ********************************
;     Enter Sub-Routine code here
```

Fault Handler - *Define what the program should do when a fault is detected*

```
;************************* Fault Handler Routine ***************************
;     Enter Fault Handler code here
ON FAULT
ENDFAULT
```

The **header section** of the program contains description information, program name, version number, description of process and programmers name. The **I/O List section** of the program contains a listing of all the I/O on the drive. The **Initialize and Set Variables section** of the program defines the names for the user variables and constants used in the program.

The **Events section** contains all scanned events. Remember to execute the **EVENT <eventname> ON** statement in the main program to enable the events. Please note that not all of the SML statements are executable from within the EVENT body. For more detail, reference “EVENT” and “ENDEVENT” in Section 3 of the manual. The GOTO statement can not be executed from within the Event body. However, the JUMP statement can be used to jump to code in the main program body. This technique allows the program flow to change based on the execution of an event. For more detail, reference “JUMP”, in Section 3 (Language Reference) of this manual.

The **main program** body of the program contains the main part of the program, which can include all motion and math statements, labels, I/O commands and subroutine calls. The main body has to be finished with an END statement.

Subroutines are routines that are called from the main body of the program. When a subroutine is called, (GOSUB), the program's execution is transferred from the main program to the called subroutine. It will then process the subroutine until a RETURN statement occurs. Once a RETURN statement is executed, the program's execution will return back to the main program to the line of code immediately following the GOSUB statement.

Fault handler is a section of code that is executed when the drive detects a fault. This section of code begins with the "ON FAULT" statement and ends with an "ENDFAULT" statement. When a fault occurs, the normal program flow is interrupted, motion is stopped, the drive is disabled, Event scanning is stopped and the statements in the Fault Handler are executed, until the program exits the fault handler. The Fault handler can be exited in three ways:

- The "RESUME" statement will cause the program to end the Fault Handler routine and resume the execution of the main program. The location called out in the "RESUME" command will determine where the program will commence.
- The "RESET" statement will cause the program to end the Fault Handler routine and reset the main program to its first statement.
- The "ENDFAULT" statement will cause the user program to be terminated.

While the Fault Handler is being executed, Events are not being processed and detection of additional faults is not possible. Because of this, the Fault Handler code should be kept as short as possible. If extensive code must be written to process the fault, then this code should be placed in the main program and the "RESUME" statement should be utilized. Not all of SML statements can be utilized by the Fault Handler. For more details reference "ON FAULT/ENDFAULT", in Section 3 (Language Reference) of this manual.

Comments are allowed in any section of the program and are preceded by a semicolon. They may occur on the same line as an instruction or on a line by themselves. Any text following a semicolon in a line will be ignored by the compiler.

2.2 Variables

All variables are ordinal numbers. Any variable can be accessed by that number from the User's program or from a Host Interface. In addition to numbers some of the variables have predefined names and can be accessed by that name from the User's program.

The following syntax is used when accessing variables by their ordinal number:

```
@102 = 20   ; set variable #102 to 20
@23=@100    ; copy value of variable #100 to variable #23
```

There are two types of variables in the PositionServo drive - **User Variables** and **System Variables**.

User Variables are a fixed set of variables that the programmer can use to store data and perform arithmetic manipulations. All variables are of a single type. Single type variables, i.e. typeless variables, relieve the programmer of the task of remembering to apply conversion rules between types, thus greatly simplifying programming.

User Variables

V0-V31	User defined variables. Variables can hold any numeric value including logic (Boolean 0 - FALSE and non 0 - TRUE) values. They can be used in any valid arithmetic or logical expressions.
NV0-NV31	User defined network variables. Variables can hold any numeric value including logic (Boolean 0 - FALSE and non 0 - TRUE) values. They can be used in any valid arithmetic or logical expressions. Variables can be shared across Ethernet network with use of statements SEND and SENDTO.

Since SML is a typeless language, there is no special type for Boolean type variables (variables that can be only 0 or 1). Regular variables are used to facilitate Boolean variables. Assigning a variable a "FALSE" state is done by setting it equal to "0". Assigning a variable a "TRUE" state is done by assigning it any value other than "0".

In addition to the user variables, system variables are also supported. System variables are dedicated variables that contain particular values. For example, **APOS** variable holds actual position of the motor shaft. For more details refer to Section 2.9.

Scope
SML variables are available system wide. Each of the variables can be read and set from any user program, subroutine or Host Language Command at any time. There is no provision to protect a variable from change. This is referred to as global scope.

Volatility
All variables are volatile i.e. they don't maintain their values after the drive is powered down. After power up the values of all of the variables are set to 0. Loading or resetting the program doesn't change variables values.

Flags, Resolution and Accuracy
As mentioned before you can use any variable as a flag in a logical expression and as a condition in a conditional expression. Flags are often used to indicate that some event has occurred, logic state of an input has changed or that the program has executed to a particular point. Variables with non '0' values are evaluated as "TRUE" and variables with a "0" values are evaluated as "FALSE".

Variables are stored internally as 4 bytes (double word) for integer portion and 4 bytes (double word) for fractional portion. This way every variable in the system is stored as 64 bit in 32.32 fixed point format. Maximum number can be represented by this format is +/- 2,147,483,648. Variable resolution in this format is 2.3E-10.

2.3 Arithmetic Expressions

Four arithmetic functions are supported. Constants as well as User and System variables can be part of the arithmetic expressions.

Examples.

```
V1 = V1+V2              ;Add two user variables
V1 = V1-1               ;Subtract constant from variable
V2 = V1+APOS            ;Add User and System (actual position) variables
APOS = 20               ;Set System variable
V5 = V1*(V2+V3*5/2+1)   ;Complicated expression
```

Operator	Symbol
Addition	+
Subtraction	-
Multiplication	*
Division	/

Result overflow for "*" and "/" operations will cause arithmetic overflow fault F_19. Result overflow/underflow for "+" and "-" operations does not cause an arithmetic fault.

2.4 Logical Expressions and Operators

Bitwise, Boolean, and comparison operators are considered as Logical Operators. Simply put, they are the operators which operate on logical values of the operands. There are two possible values for logical operand: TRUE and FALSE. Any value contained in a User variable, System variable or flag is treated as TRUE or FALSE with these types of the operators. If a variable value equals "0", it is considered FALSE. All other values (non-0) including negative numbers are considered TRUE.

2.5 Bitwise Operators

The following bitwise operators are supported

Operator	Symbol
AND	&
OR	|
XOR	^
NOT	!

Both User or System variables can be used with these operators.

Examples:

```
V1 = V2 & 0xF        ;clear all bits but lowest 4
IF  (INPUTS & 0x3)   ;check inputs 0 and 1
V1 = V1 | 0xff       ;set lowest 8 bits
V1 = INPUTS ^ 0xF    ;invert inputs 0-3
V1 = !IN_A1          ;invert input 0
```

2.6 Boolean Operators

These operators are used in logical expressions.

Operator	Symbol
AND	&&
OR	||
NOT	!

Examples:

```
IF APOS >2 && APOS <6 || APOS >10 && APOS <20
            {statements if true}
      ENDIF
```

The above example checks if APOS (actual position) is within one of two windows; 2 to 6 units or 10 to 20 units. In other words:

If (APOS is more than 2 AND less than 6)
OR
If (APOS is more than 10 AND less then 20)
THEN the logical expression is evaluated to TRUE. Otherwise it is FALSE

2.7 Comparison Operators

Following operators are supported:

Operator	Symbol
More	>
Less	<
Equal or more	>=
Equal or less	=<
Not Equal	<>
Equal	==

Examples:

```
      IF APOS <=10
      IF APOS > 20
      IF APOS ==5
      IF  V1<2  && V2 <>4
```

2.8 System Variables and Flags

System variables are variables that have a predefined meaning. They give the programmer / user access to certain drive parameters. Most of these variables can be set in MotionView. In most cases the value of these variables can be read and set in your program or via a Host Interface. Variables are either read only, write only or read and write. Read only variables can only be read and can't be set. For example, INPUT = 5, is an illegal action because you can not set an input.

System Flags are System Variables that can only have values of 0 or 1. For example, IN_A1 is the system flag that reflects the state of digital input1. Since inputs can only be ON or OFF, then the value of IN_A1 can only be 0 or 1.

2.9 System Variables Storage Organization

All system variables are located in drive's RAM memory and therefore are volatile. However, values for some of these system variables are also stored in EPM. When a system variable is changed in MotionView, its value changes in both RAM and EPM. When a system variable is changed from the user's program, its value is changed in RAM only.

Host interfaces have the capability to change the variable value in both the EPM and in memory so the user has a choice to change a variable in RAM and EPM or in RAM only.

2.10 System Variables and Flags Summary

A full list of system variables is available in Appendix "A". Every aspect of the PositionServo can be controlled by the manipulation of the values stored in the System Variables. All System Variables start with a "VAR_" followed by the variable name. Alternatively, System Variables can be addressed as an @NUMBER where the number is the variable Index. The most frequently used variables also have alternative names as listed below. Variables can be Read-Only (R) or Read/Write (R/W) types. System Flags are always Read Only (R).

Flags don't have an Index number assigned to them. They are the product of a BIT mask applied to a particular system variable by the drive and are available to the user only from the User's program.

Index	Variable	Access	Variable Description	Units
186	UNITS	R/W	User Units scale.(1)	UserUnits/Rev
215	APOS	R/W	Actual motor position	User Units
214	TPOS	R/W	Theoretical/commanded position	User Units
217	TV	R	Commanded velocity in	User Units/Sec
213	RPOS	R	Registration position. Valid when system flag F_REGISTRATION set	User Units
218	TA	R	Commanded acceleration	User units/Sec^2
184	INPOSLIM	R/W	Maximum deviation of position for INPOSITION Flag to remain set	User Units
180	MAXV	R/W	Maximum velocity for motion commands	User Units/Sec
181	ACCEL	R/W	Acceleration for motion commands	User Units/Sec^2
182	DECEL	R/W	Deceleration for motion commands	User Units/Sec^2
183	QDECEL		Quick Deceleration for STOP MOTION QUICK statement	User Units/Sec^2
185	VEL	R/W	Set Velocity when in velocity mode	User Units/Sec
46	PGAIN_P	R/W	Position loop P-gain	-
47	PGAIN_I	R/W	Position loop I-gain	-
48	PGAIN_D	R/W	Position loop D-gain	-
49	PGAIN_ILIM	R/W	Position loop I gain limit	-
44	VGAIN_P	R/W	Velocity loop P-gain	-
45	VGAIN_I	R/W	Velocity loop I-gain	-
65	INPUTS	R	Digital Inputs states. The first 12 bits correspond to the 12 drive inputs	-
66	OUTPUTS	R/W	Digital outputs. Bits #0 to #4 represent outputs 1 through 5	-
	INDEX	R/W	Lower 8 bits are used. See ASSIGN statement for details.	-
188	PHCUR	R	Motor phase current	A(mpere)
54	DSTATUS	R	Status flags register	-
	DFAULTS	R	Fault code register	-
71	AIN	R	Analog input. Scaled in volts. Range from -10 to +10 volts	V(olt)
72	AIN2	R	Analog input 2. Scaled in Volts. Range from -10 to +10 volts	
88	AOUT	R/W	Analog output. Value in Volts. Valid range from -10 to +10 (V)(2)	V(olt)

(1) When a "0", (Zero), value is assigned to the variable "UNITS", then "USER UNITS" is set to QUAD ENCODER COUNTS. This is the default setting at the start of the program before UNITS=<value> is executed.

(2) Any value outside +/- 10 range assigned to AOUT will be automatically trimmed to that range

Any value outside +/- 10 range assigned to AOUT will automatically be trimmed to that range.

Example:

```
AOUT=100 , AOUT will be assigned value of 10.
V0=236
VOUT=V0, VOUT will be assigned 10 and V0 will be unchanged.
```

System Flags

Name	Access	Description
IN_A1-4, IN_B1-4, IN_C1-4	R	Digital inputs . TRUE if input active, FALSE otherwise
OUT1, OUT2, OUT3, OUT4, OUT5	W	Digital outputs OUTPUT1- OUTPUT5
F_ICONTROL OFF	R	Interface Control Status (ON/OFF) #27 in DSTATUS register
F_IN_POSITION	R	TRUE when Actual Position (APOS) is within limits set by INPOSLIM variable and motion completed
F_ENABLED	R	Set when drive is enabled
F_EVENTS OFF	R	Events Disabled Status (ON/OFF) #30 in DSTATUS register
F_MCOMPLETE	R	Set when motion is completed and there is no motion commands waiting in the Motion Queue
F_MQUEUE_FULL	R	Motion Queue full
F_MQUEUE_EMPTY	R	Motion Queue empty
F_FAULT	R	Set if any fault detected
F_ARITHMETIC_FLT	R	Arithmetic fault
F_REGISTRATION	R	Set when registration mark was detected. Content RPOS variable is valid when this flag is active. Flag resets by any registration moves MOVEPR,MOVEDR or by command REGISTRATION ON
F_MSUSPENDED	R	Set if motion suspended by statement MOTION SUSPEND

Flag logic is shown below:

```
IF
      TPOS-INPOSLIM  < APOS <  TPOS+INPOSLIM  && F_MCOMPLETE && F_MQUEUE_EMPTY
      F_IN_POSITION = TRUE
ELSE
      F_IN_POSITION = FALSE
ENDIF
```

For VELOCITY and GEAR mode F_MCOMPLETE and F_MQUEUE_EMPTY flags are ignored and assumed TRUE.

2.11 Control Structures

Control structures allow the user to control the flow of the program's execution. Most of the power and utility of any programming language comes from its ability to change statement order with structure and loops.

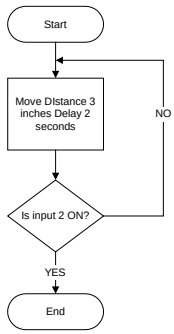
DO/UNTIL structures

This statement is used to execute a block of code one time and then continue executing that block until a condition becomes true (satisfied). The difference between DO/UNTIL and WHILE statements is that the DO/UNTIL instruction tests the condition after the block is executed so the conditional statements are always executed at least one time. The syntax for DO/UNTIL statement is:

```
DO
      …statements
UNTIL  <condition>
```

The flowchart and code segment in Figure S819 illustrate the use of the DO/UNTIL statement.

```
… statements

DO
        MOVED 3
        WAIT TIME 2000
UNTIL   IN_A3
…statements
```



S819

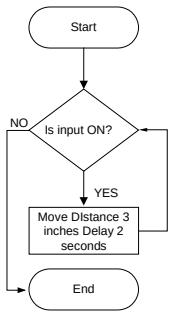
WHILE Structure

This statement is used if you want a block of code to execute while a condition is true.

The syntax for the WHILE instruction is:

```
WHILE  <condition>

      …statements

ENDWHILE
```

```
…statements

WHILE    IN_A3
      MOVED 3
      WAIT TIME   2000
ENDWHILE

…statements
```



S820

Subroutines

A subroutine is a group of SML statements that is located at the end of the main body of the program. It starts with a label which is used by the GOSUB statement to call the subroutine and ends with a RETURN statement. The subroutine is executed by using the GOSUB statement in the main body of the program. Subroutines can not be called from an EVENT or from the FAULT handlers.

When a GOSUB statement is executed, execution is transferred to the first line of the subroutine. The subroutine is then executed until a RETURN statement is met. When the RETURN statement is executed, the program's execution returns to the program line, in the main program, following the GOSUB statement. Subroutines may have more than one RETURN statement in its body.

Subroutines may be nested up to 16 times. Only the remaining body of the program may contain a GOSUB statement. Refer to Section 3 (Language Reference) for more detailed information on the GOSUB and RETURN statements. The following flowchart and code segment illustrate the use of subroutines.

```
…statements
GOSUB CalcMotionParam
MOVED V1
OUT2=1
…statements
END
;Subs usually located after END
;statement of main program
;
CalcMotionParam:
V1 = (V3*2)/V4
RETURN
```

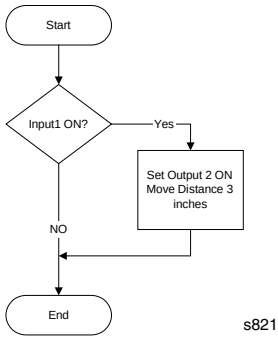
IF Structure

The “IF” statement is used to execute an instruction or block of instructions one time if a condition is true. The simplified syntax for IF is:

```
IF condition
      …statement(s)
ENDIF
```

The following flowchart and code segment illustrate the use of the IF statement.

```
…statements

IF IN_A2
      OUT2 = 1
      MOVED 3
ENDIF

..statements
```



s821

IF/ELSE Structure

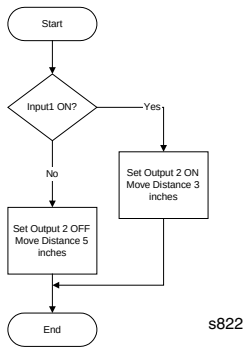
The IF/ELSE statement is used to execute a statement or a block of statements one time if a condition is true and a different statement or block of statements if condition is false.

The simplified syntax for the IF/ELSE statement is:

```
IF <condition>
      …statement(s)
ELSE
      …statement(s)
ENDIF
```

The following flowchart and code segment illustrate the use of the IF/ELSE instruction.

```
…statements

IF IN_A2
      OUT2=1
      MOVED 3
ELSE
      OUT2=0
      MOVED 5
ENDIF

..statements
```



s822

WAIT Statement

The WAIT statement is used to suspend program execution until or while a condition is true. The simplified syntax for this statement is:

```
WAIT  UNTIL  <condition>
WAIT  WHILE <condition>
WAIT  TIME  <time>
WAIT  MOTION COMPLETE
```

GOTO/Label

The GOTO statement can be used to transfer program execution to a new point marked by a label. This statement is often used as the action of an IF statement. The destination label may be above or below the GOTO statement in the application program.

Labels may be any alphanumeric string 64 characters in length beginning with a letter and ending with a colon ":".

```
GOTO TestInputs
      …statements
TestInputs:
      …statements
IF (IN_A1) GOTO TestInputs
```

Program Structure Instruction Summary

The following table contains a summary of instructions that relate to program branching.

Name	Description
GOTO	Transfer code execution to a new line marked by a label
DO/UNTIL	Do once and keep doing until conditions becomes true
IF and IF/ELSE	Execute if condition is true
RETURN	Return from subroutine
WAIT	Wait fixed time or until condition is true
WHILE	Execute while a condition is true

2.12 Scanned Event Statements

A Scanned Event is a small program that runs independently of the main program. SCANNED EVENTS are very useful when it is necessary to trigger an action , i.e. handle I/O, while the motor is in motion. When setting up Events, the first step is to define both the action that will trigger the event as well as the sequence of statements to be executed once the event has been triggered. Events are scanned every 256µs. Before an Event can be scanned however it must first be enabled. Events can be enabled or disabled from the user program, from another event or from itself (see explanations below). Once the Event is defined and enabled, the Event will be constantly scanned until the trigger condition is met, this scan rate is independent of the main program's timing. Once the trigger condition is met, the Event statements will be executed simultaneously with the user program.

Scanned events are used to record events and perform actions independent of the main body of the program. For example, if you want output 3 to come ON when the position is greater then 4 inches, or if you need to turn output 4 ON whenever input 2 and 3 are ON, you may use the following scanned event statements.

```
EVENT       PositionIndicator APOS > 4
            OUT3=1
ENDEVENT

EVENT       Inputs3and4       IN_A4 & IN_B1
            OUT4=1
ENDEVENT
…statements
```

Scanned events may also be used with a timer to perform an action on the periodic time basis.

The program statements contained in the action portion of the scanned event can be any legal program statement except the following statements: Subroutine calls (GOSUB), DO/WHILE, WHILE, WAIT, GOTO and also motion commands: MOVED,MOVEP, MDV, STOP, MOTION SUSPEND/RESUME.

EVENT <name> INPUT <inputname>

This scanned event statement is used to execute a block of code each time a specified input <inputname> changes its state from low to high. To trigger when the state changes from high to low, place an exclamation point symbol (!) in front of the <inputname>, (!IN_A4).

EVENT <name> TIME <timeout>

This scanned event statement is used to execute a block of code with a repetition rate specified by the <timeout> argument. The range for “timeout” is 1 - 50,000ms (milliseconds).

EVENT <name> expression

This scanned event statement is used to execute a block of code when the expression evaluates as true.

EVENT <name> ON/OFF

This statement is used to enable/disable a scanned event. Statement can be used within event’s block of code.

Scanned Event Statements Summary

The following table contains a summary of instructions that relate to scanned events. Refer to Section 3 “Language Reference” for more detailed information.

Name	Description
EVENT <name> ON/OFF	enable / disable event
EVENT <name> INPUT <inputname>	Scanned event on input <#>
EVENT <name> TIME <value>	Periodic event with <value> repetition rate.
EVENT <name> expression	Scanned event on expression = true

2.13 Motion

Moves Overview

The position command that causes motion to be generated comes from the profile generator or profiler for short. The profile generator is used by the MOVE, MOVED, MOVEP, MOVEPR, MOVEDR and MDV statements. MOVE commands generate motion in a positive or negative direction, while or until certain conditions are met. For example you can specify a motion while a specific input remains ON (or OFF). MOVEP generates a move to specific absolute position. MOVED generates incremental distance moves, i.e. move some distance from its current position. MOVEPR and MOVEDR are registration moves. MDV commands are used to generate complicated profiles. Profiles generated by these commands are put into the motion stack which is 32 levels deep. By default when one of these statements except for MDV is executed, the execution of the main User Program is suspended until the generated motion is completed. Motion requests generated by an MDV statement or MOVE statement with the “C” modifier do not suspend the program. They are merely put into the motion stack and executed by the profiler in the order in which they where loaded. The Motion Stack can hold up to 32 moves. The SML language allows the programmer to load moves into the stack and continue on with the program. It is the responsibility of the programmer to check the motion stack to make sure there is room available before loading new moves. This is done by checking the appropriate flag in the System status register.

Incremental (MOVED) and Absolute (MOVEP) Motion

MOVED and MOVEP statements are used to create incremental and absolute moves respectively. The motion that results from these commands is by default a trapezoidal velocity move or an S-curved velocity move if the “,S” modifier is used with the statement,

For example:

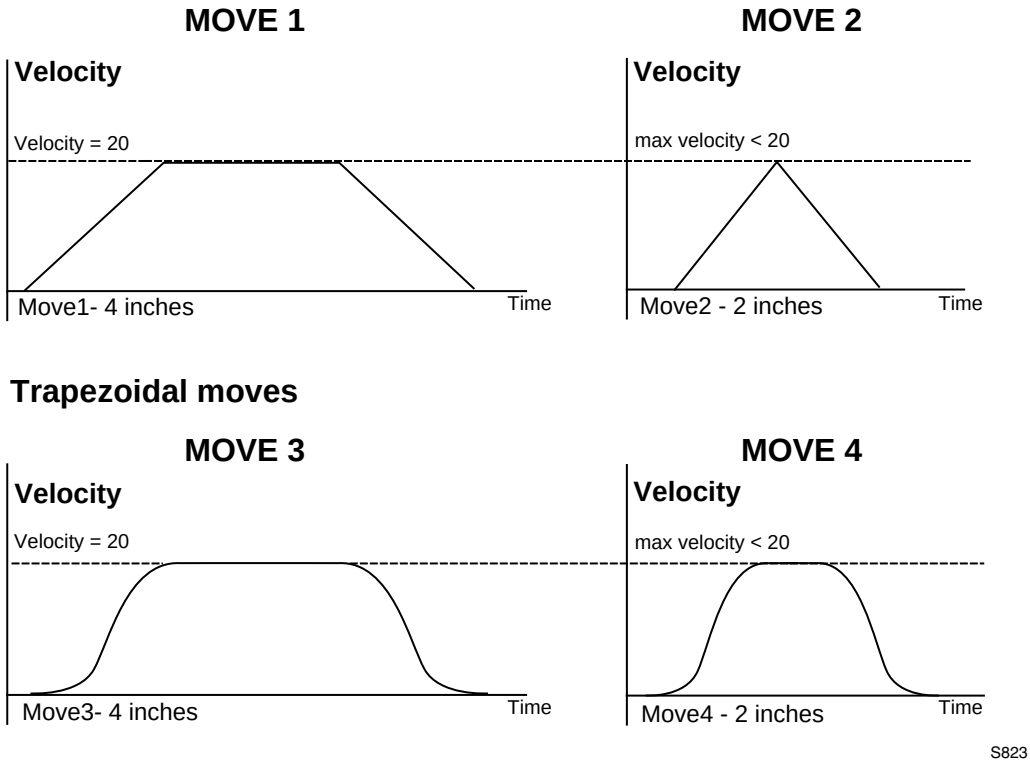
```
MOVEP 10      ;will result in a trapezoidal move
```

But

```
MOVEP 10,S   ;will result in an S-curved move
```

In the above example, (MOVEP 10), the length of the move is determined by the argument following the MOVEP command, (10). This argument can be a number, a variable or any valid arithmetic expression. The top velocity of the move is determined by setting the system variable MAXV. The acceleration and deceleration are determined by setting the system variables ACCEL and DECEL respectively.

If values for velocity, acceleration and deceleration, for a specified distance, are such that there is not enough time to accelerate to the specified velocity, the motion profile will result in triangular or double S profile as illustrated in Figure S823.




```
ACCEL =  200
DECEL =  200
MAXV  =  20
MOVED 4           ;Move 1
MOVED 2           ;Move 2
MOVED 4 , S       ;Move 3
MOVED 2 , S       ;Move 4
```

All four of the moves shown in Figure S823 have the same Acceleration, Deceleration and Max Velocity values. Moves 1 and 3 have a larger value for the move distance than Moves 2 and 4. In Moves 1 and 3 the distance is long enough to allow the motor to accelerate to the profiled max velocity and maintain that velocity before decelerating down to a stop. In Moves 2 and 4 the distance is so small that while the motor is accelerating towards the profiled Max Velocity it has to decelerate to a stop before it can ever obtain the profiled Max Velocity.

Incremental (MOVED) motion

Incremental motion is defined as a move of some distance from the current position. ‘Move four revolutions from the current position’ is an example of an incremental move.

MOVED is the statement used to create incremental moves. The simplified syntax is:

MOVED <+/-distance>

+/- sign will tell the motor shaft what direction to move.

Absolute (MOVEP) move

Absolute motion is defined as a motion to some fixed position from the current position. The fixed position is defined as a position relative to a fixed zero point. The zero point for a system is established during the homing cycle, typically performed immediately after power-up.

During a homing cycle, the motor will make incremental moves while checking for a physical input, index mark, or both.

Registration (MOVEDR MOVEPR) moves

MOVEPR and MOVEDR are used to move to position or distance respectively just like MOVEP and MOVED. The difference is that while the statements are being executed they are looking for a registration signal or registration input. If during the motion a registration signal is detected, then a new end position is generated. If the move is a MOVEDR, then the drive will increment the distance called out in the registration statement. This increment will be referenced from the position where the registration input has seen. If the move is a MOVEPR, then the new position will be the absolute position called out in the registration statement.

Example:

```
MOVEDR  5, 1  ;Statement move a distance of 5 user units or registration position +
              ;1 user units if registration input is activated during motion.
```

There are two exceptions to this behavior:

Exception one:

The move will not be modified to “Registration position +displacement” if the registration was detected while system was decelerating to complete the motion.

Exception two:

Once the registration input is seen, there must be enough room for the motor to decelerate to a stop using the profiled Decel Value. If the new registration move is larger than the distance necessary to come to a stop, then the motor will overshoot the new registration position.

Segment moves

In addition to the simple moves that can be generated by MOVED and MOVEP statements, complex profiles can be generated using segment moves. A segment move represents one portion of a complete move. A complete move is constructed out of two or more segments, starting and ending at zero velocity.

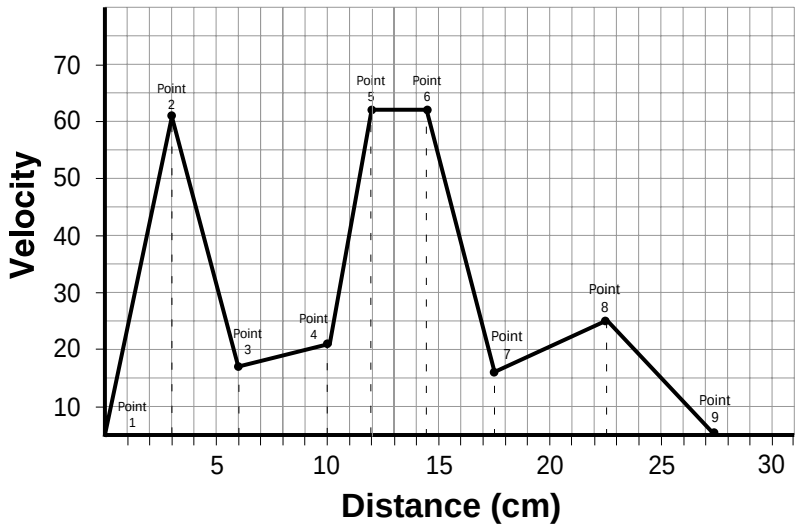
MDV Segments

Segments are created using a sequence of MDV statements. The simplified syntax for the **MDV** (**M**ove **D**istance with **V**elocity) statement is:

MDV <**d**istance>,<**v**elocity>

The <distance> is the length of the segment move. The <velocity> is the final velocity for the segment move. The starting velocity is either zero or the final velocity of the previous segment. The final segment in a complete move must have a velocity of zero. If the final segment has a final velocity anything other than zero, a motion stack under run fault will occur.

The profile shown in Figure S824 can be broken up into 8 MDV moves. The first segment defines the distance between point 1 and point 2 and the velocity at point 2. So, if the distance between point 1 and 2 was 3 units and the velocity at point 2 was 56 RPM, the command would be: MDV 3 , 56. The second segment gives the distance between point 2 and 3 and the velocity at point 3, and so on. Any profile can be programmed using MDV moves.



S824

This table lists the supporting data for the graph in Figure S824.

Segment Number	Distance moved during segment	Velocity at the end of segment
1	3	56
2	3	12
3	4	16
4	2	57
5	2.5	57
6	3	11
7	5	20
8	5	0
-	-	-

```
;Segment moves
MDV   3 , 56
MDV   3 , 12
MDV   4 , 16
MDV   2 , 57
MDV   2.5 , 57
MDV   3 , 11
MDV   5 , 20
MDV   5 , 0
END
```

The following equation can be used to calculate the acceleration that results from a segment move.

Accel = $(V_f^2 - V_0^2) / [2*D]$
V_f = Final velocity
V_0 = Starting velocity
D = Distance

S-curve Acceleration

Instead of using a linear acceleration, the motion created using segment moves (MDV statements) can use S-curve acceleration. The syntax for MDV move with S-curve acceleration is:

MDV <distance>,<velocity>,S

Segment moves using S-curve acceleration will take the same amount of time as linear acceleration segment moves. S-curve acceleration is useful because it is much smoother at the beginning and end of the segment, however, the peak acceleration of the segment will be twice as high as the acceleration used in the linear acceleration segment.

Motion SUSPEND/RESUME.

At times it is necessary to control the motion by preloading the motion stack with motion profiles. Then, based on the User Program, execute those motion profiles at some predetermined instance. The statement “MOTION SUSPEND” will suspend motion until the statement “MOTION RESUME” is executed. While motion is suspended, any motion statement executed by the User Program will be loaded into the motion stack. When the “MOTION RESUME” statement is executed, the preloaded motion profiles will be executed in the order that they were loaded.

Example:

```
MOTION SUSPEND
MDV   10,2        ;placed in stack
MDV   20,2        ;placed in stack
MDV   2,0         ;placed in stack
MOVED   3,C       ;must use “,C “modifier. Otherwise program will hang.
MOTION RESUME
```

Caution should be taken when using MOVED,MOVEP and MOVE statements. If any of the MOVE instructions are written without the “C” modifier, the program will hang or lock up. The “MOTION SUSPEND” command effectively halts all execution of motion. As the program executes the “MDV” and “MOVED” statements, those move profiles are loaded into the motion stack. If the final “MOVED” is missing the “C” modifier then the User Program will wait until that move profile is complete before continuing on. Because motion has been suspended, the move will never be complete and the program will hang there forever.

Conditional moves (MOVE WHILE/UNTIL)

The statements “MOVE UNTIL <expression>” and “MOVE WHILE <expression>” will both start their motion profiles based on their acceleration and max velocity profile settings. The “MOVE UNTIL <expression> statement will continue the move until the <expression> becomes true. The “MOVE WHILE <expression>” will also continue its move while it’s <expression> is true. Expression can be any valid arithmetic or logical expressions or their combination.

Examples:

```
MOVE WHILE APOS<20          ;Move while the position is less then 20, then
                            ;stop with current deceleration rate.
MOVE UNTIL APOS>V1          ;Move positive until the position is greater than
                            ;the value in variable V1
MOVE BACK UNTIL APOS<V1     ;Move negative until the position is less than the
                            ;value in variable V!
MOVE WHILE  IN_A1           ;Move positive while input A1 is activated.
MOVE WHILE !IN_A1           ;Move positive while input A1 is not activated.
                            ;The exclamation mark (!) in front of IN_A1 inverts
                            ;(or negates) the value of IN_A1.
```

This last example is a convenient way to find a sensor or switch.

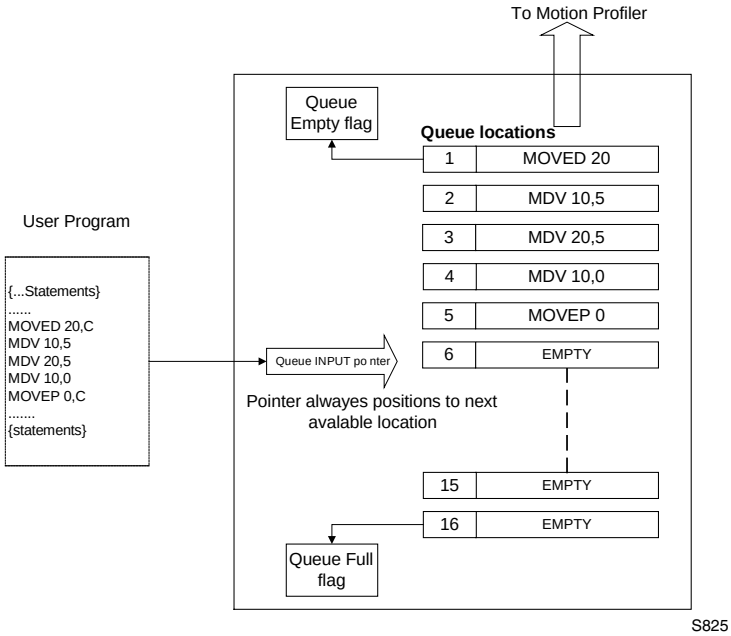
Motion Queue and statements execution while in motion

By default when the program executes a MOVE, MOVED or MOVEP statement, it waits until the motion is complete before going on to the next statement. This effectively will suspend the program until the requested motion is done. Note that “EVENTS” are not suspended however and keep on executing in parallel with the User Program. Like the EVENT command, the Continue “C” argument is very useful when it is necessary to trigger an action (handle I/O) while the motor is in motion. Below is an example of the Continue “C” argument.

```
;This program monitors I/O in parallel with motion:
START:
      MOVED 100,C       ;start moving max 100 revs
WHILE F_MCOMPLETE=0     ;while moving
IF IN_A2 == 1           ;if sensor detected
      OUT1=1            ;turn ON output for
      WAIT TIME 500     ;500 mS
      OUT1=0            ;turn output OFF
      WAIT TIME 500     ;wait 500 ms
      ENDIF
ENDWHILE
      MOVED -100        ;Return back
      WAIT TIME 1000    ;wait time
      GOTO START        ;and start all over
      END
```

This program starts a motion of 100 revolutions. While the motor is in motion, input A2 is monitored. If Input A2 is made during the move, then output 1 is turned on for 500ms and then turned off. The program will continue to loop in the WHILE statement, monitoring input A2, until the move is completed. If input 2 remains ON, or made, during the move, then Output 1 will continue to toggle On and Off every 500ms until the move is complete.
If input A2 is only made while the motion passes by a sensor wired to the input, then output 1 will stay on for 500ms only. By adding the “Continue” argument “C” to the MOVE statement, the program is able to monitor the input while executing the motion profile. Without this modifier the program would be suspended until all motion is done making it impossible to look for the input during the move. After the motor has traveled the full distance it then returns back to its initial position and the process repeats. This program could be used for a simple paint mechanism which turns ON a paint spray gun as soon as the part’s edge (or part guide) crosses the sensor(s).

Figure S825 illustrates the structure and operation of the Motion Queue. All moves are loaded into the Motion Queue before they are executed. If the move is a standard move, “MOVEP 10” or “MOVED 10”, then the move will be loaded into the queue and the execution of the User Program will be suspended until the move is completed. If the move has the continue argument, e.g. “MOVEP 10,C” or “MOVED 10,C”, or if it is an “MDV” move, then the moves will be loaded into Motion Queue and executed simultaneously with the User Program.



The Motion Queue can hold a maximum of 32 motion profiles. The System Status Registers indicate the state of the Motion Queue. If the Flag is set then the queue is full. If the possibility of overflow exists, the programmer should check this flag before executing any MOVE statements, especially in programs where MOVE statements are executed in a looped fashion. Attempts to execute a motion statement while the Motion Queue is full will result in fault #23. MDV statements don't have the "C" option and therefore the program is never suspended by these statements. If last MDV statement in the Queue doesn't specify a 0 velocity Motion, a Stack Underflow fault #24 will occur.

The "MOTION SUSPEND" and "MOTION RESUME" statements can be utilized to help manage the User Program and the Motion Queue. If the motion profiles loaded into the queue are not managed correctly, the Motion Queue can become overloaded which will cause the drive to fault.

2.14 System Status Register (DSTATUS register)

System Status Register, (DSTATUS), is a Read Only register. Its bits indicate the various states of the PositionServo's subsystems. Some of the flags are available as System Flag Variables and summarized in the table below:

Bit in register	Description
0	Set when drive enabled
1	Set if DSP subsystem at any fault
2	Set if drive has a valid program
3	Set if byte-code or system or DSP at any fault
4	Set if drive has a valid source code
5	Set if motion completed and target position is within specified limits
6	Set when scope is triggered and data collected
7	Set if motion stack is full
8	Set if motion stack is empty
9	Set if byte-code halted
10	Set if byte-code is running
11	Set if byte-code is set to run in step mode
12	Set if byte-code is reached the end of program
13	Set if current limit is reached
14	Set if byte-code at fault
15	Set if no valid motor selected
16	Set if byte-code at arithmetic fault
17	Set if byte-code at user fault
18	Set if DSP initialization completed
19	Set if registration has been triggered
20	Set if registration variable was updated from DSP after last trigger
21	Set if motion module at fault
22	Set if motion suspended
23	Set if program requested to suspend motion
24	Set if system waits completion of motion
25	Set if motion command completed and motion Queue is empty
26	Set if byte-code task requested reset
27	If set interface control is disabled. This flag is set/clear by ICONTROL ON/OFF statement.
28	Set if positive limit switch reached
29	Set if negative limit switch reached
30	Events disabled. All events disabled when this flag is set. After executing EVENTS ON all events previously enabled by EVENT EventName ON statements become enabled again

2.15 Fault Codes (DFAULTS register)

Faults in the drive are recorded in a special variable called the “DFAULTS” register or “Fault Register”. Specific flags are also set in the System Status Register.

Whenever a fault occurs in the drive, a record of that fault is recorded in the Fault Register (DFAULTS). In addition, specific flags in the System Status Register will be set helping to indicate what class of fault the current fault belongs to. Below is a table that summarizes the possible fault codes. Note: Codes from 1 to 16 are reserved for DSP subsystem errors. Codes above that range are generated by various subsystems of the PositionServo.

Fault ID	Associated flags in status register	Description
1	1, 3	Over voltage
2	1, 3	Invalid Hall sensors code
3	1, 3	Over current
4	1, 3	Over temperature
5	1, 3	Reserved
6	1, 3	Over speed. (Over speed limit set by motor capability in motor file)
7	1, 3	Position error excess.
8	1, 3	Attempt to enable while motor data array invalid or motor was not selected.
9	1,3	Motor over temperature switch activated
10	1,3	Sub processor error
11-13	-	Reserved
14	1,3	Under voltage
15	1,3	Hardware current trip protection
16	-	Reserved
17	3	Unrecoverable error.
18	16	Division by zero
19	16	Arithmetic overflow
20	3	Subroutine stack overflow. Exceeded 16 levels subroutines stack depth.
21	3	Subroutine stack underflow. Executing RETURN statement without preceding call to subroutine.
22	3	Variable evaluation stack overflow. Expression too complicated for compiler to process.
23	21	Motion Queue overflow. 32 levels depth exceeded
24	21	Motion Queue underflow. Last queued MDV statement has non 0 target velocity
25	3	Unknown opcode. Byte code interpreter error
26	3	Unknown byte code. Byte code interpreter error
27	21	Drive disabled. Attempt to execute motion while drive is disabled.
28	16, 21	Accel too high. Motion statement parameters calculate an Accel value above the system capability.
29	16, 21	Accel too low. Motion statement parameters calculate an Accel value below the system capability.
30	16, 21	Velocity too high. Motion statement parameters calculate a velocity above the system capability.
31	16, 21	Velocity too low. Motion statement parameters calculate a velocity below the system capability.
32	3,21	Positive limit switch engaged
33	3,21	Negative limit switch engaged
34	3,21	Attempt at positive motion with engaged positive limit switch
35	3,21	Attempt at negative motion with engaged negative limit switch
36	3	Hardware disable (enable input not active when attempting to enable drive from program or interface)
37	3	Undervoltage
38	3	EPM loss
39	3,21	Positive soft limit reached
40	3,21	Negative soft limit reached
41	3	Attempt to use variable with unknown ID from user program

2.16 Limitations and Restrictions

Communication Interfaces Usage Restrictions

Simultaneous connection to the RS485 port is allowed for retransmitting (conversion) between interfaces.

WARNING!

Usage of the RS485 simultaneously with Ethernet may lead to unpredictable behavior since the drive will attempt to perform commands from both interfaces concurrently.

Motion Parameters Limitation

Due to a finite precision in the calculations there are some restrictions for acceleration/deceleration and max velocity for a move. If you receive arithmetic faults during your programs execution, it is likely due to these limitations. Min/Max values are expressed in counts or counts/sample, where the sample is a position loop sample interval (256μsec).

Parameter	MIN	MAX	Units
Accel / Decel	65/(2^32)	512	counts/sample^2
MaxV (maximum velocity)	0	2048	counts/sample
Max move distance	0	+/- 2^31	counts

Stacks and Queues Depth Limitations

Stack/Queue	Motion Queue	Subroutines Stack	Number of Events
Depth	32	32	32

2.17 Homing

2.17.1 Homing Overview

The homing function is available on the PositionServo drives with firmware revision 3.03 or later. For drives with firmware revision prior to this, home functions are implemented as a collection of the User's program subroutines. However functionality of the routines is the same as described in this section for built-in homing functions. Contact technical support to obtain the homing function's user code if your drive firmware version is less then 3.03. When using homing subroutines copy the code for corresponding method you are planning to use into your program.

In order to use home methods involving Motor Index Pulse (zero pulse) the index pulse of the motor MUST be connected to registration input. The motor index pulse is located on terminal BZ+ of the P3 connector. Connect P3-36(IN_C_COM) to the digital ground terminal P3-5 and P3-39 (IN_C3) to P3-11 (BZ+). The BZ- terminal can be left floating.

2.17.2 What is Homing?

Homing is the method by which a drive seeks the home position (also called the datum, reference point, or zero point). There are various methods of achieving this using:

- limit switches at the ends of travel, or
- a dedicated home switch.

Most of the methods also use the index pulse input from an incremental encoder.

2.17.2 The Homing Function

The homing function provides a set of trajectory parameters to the position loop, as shown below. They are calculated based on user supplied variable values such as:

VAR_HOME_OFFSET

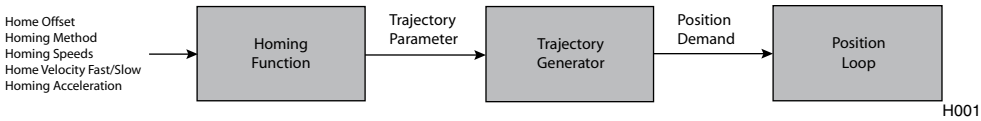
VAR_HOME_FAST_SPEED

VAR_HOME_SLOW_SPEED

VAR_HOME_ACCEL

VAR_HOME_METHOD

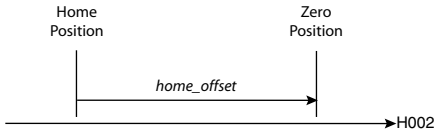
Also variable VAR_HOME_SWITCH_INPUT provides selection of the input used for Home Switch connection (if used for homing). Figure H001 describes the homing process.



2.17.3 Home Offset

The home offset is the difference between the zero position for the application and the machine home position (found during homing). During homing the home position is found and once the homing is completed the zero position is offset from the home position by adding the home offset to the home position. All subsequent absolute moves shall be taken relative to this new zero position. This is illustrated in Figure H002.

VAR_HOME_OFFSET (#240 or #241)



2.17.4 Homing Speeds

There are two homing speeds: fast and slow. The fast speed is used to find the home switch and the slow speed is used to find the index pulse.

VAR_HOME_FAST_SPEED (#242)

VAR_HOME_SLOW_SPEED (#243)

2.17.5 Homing Acceleration

Homing acceleration establishes the acceleration rate to be used for all accelerations and decelerations with the standard homing modes. Note that in homing, it is not possible to program a separate deceleration rate.

VAR_HOME_ACCEL (#239)

2.17.6 Homing Method

VAR_HOME_METHOD (#244)

The Home Method establishes the method that will be used for homing. All supported methods are summarized in the table herein.

Mode	Home Position
0	The current position
1	The location of the first encoder index pulse on the positive side of the negative limit switch.
2	The location of the first encoder index pulse on the negative side of the positive limit switch.
3	The location of the first index pulse on the negative side of a positive home switch. A positive home switch is one that goes active at some position, and remains active for all positions greater then that one.
4	The location of the first index pulse on the positive side of a positive home switch.
5	The location of the first index pulse on the positive side of a negative home switch. A negative home switch is one that goes active at some position, and remains active for all positions less then that one.
6	The location of the first index pulse on the negative side of a negative home switch.
7	The location of the first index pulse on the negative side of the negative edge of an intermittent home switch. An intermittent home switch is one that is only active for a limited range of travel.
8	The location of the first index pulse on the positive side of the negative edge of an intermittent home switch..
9	The location of the first index pulse on the negative side of the positive edge of an intermittent home switch.
10	The location of the first index pulse on the positive side of the positive edge of an intermittent home switch.
11	The location of the first index pulse on the positive side of the positive edge of an intermittent home switch.
12	The location of the first index pulse on the negative side of the positive edge of an intermittent home switch
13	The location of the first index pulse on the positive side of the negative edge of an intermittent home switch

14	The location of the first index pulse on the negative side of the negative edge of an intermittent home switch
15	Reserved for future use.
16	Reserved for future use
17	The edge of a negative limit switch.
18	The edge of a positive limit switch.
19	The edge of a positive home switch.
20	Reserved for future use.
21	The edge of a negative home switch.
22	Reserved for future use.
23	The negative edge of an intermittent home switch.
24	Reserved for future use.
25	Positive edge of an intermittent home switch.
26	Reserved for future use.
27	The positive edge of an intermittent home switch.
28	Reserved for future use.
29	Negative edge of an intermittent home switch.
30	Reserved for future use.
31	Reserved for future use.
32	Reserved for future use.
33	The first index pulse on the negative side of the current position.
34	The first index pulse on the positive side of the current position.
35	Set current position to home and move to new zero position (including home offset). This is the same as mode 0 except that mode 0 does not do the final move to the home position

These homing methods only define the location of the home position. The zero position is always the home position adjusted by the homing offset. Refer to the Homing Methods section.

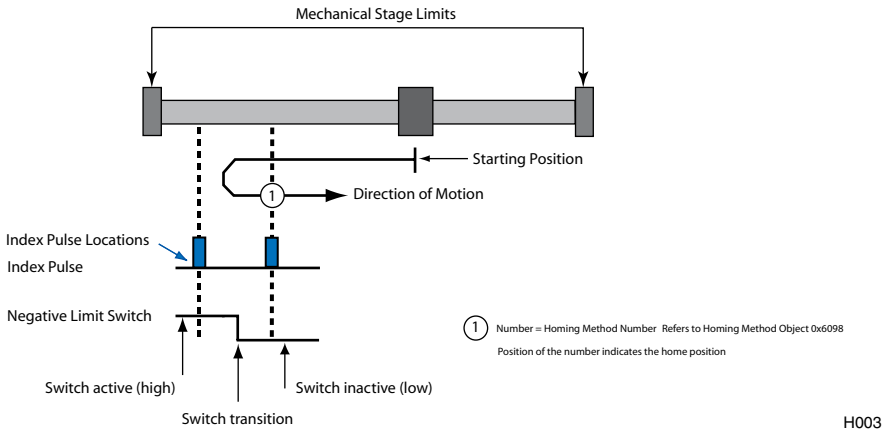
2.17.7 Homing Methods

There are several types of homing methods but each method establishes the:

- Homing signal (positive limit switch, negative limit switch, home switch)
- Direction of actuation and, where appropriate, the position of the index pulse.

The homing method descriptions and diagrams in this manual are based on those in the CANopen Profile for Drives and Motion Control (DSP 402). As illustrated in Figure H003, each homing method diagram shows the motor in the starting position on a mechanical stage. The arrow line indicates direction of motion and the circled number indicates the homing method (the mode selected by the Homing Method variable).

The location of the circled method number indicates the home position reached with that method. The blue rectangular blocks on the index pulse line indicate index pulse locations. Longer dashed lines overlay these stems as a visual aid. Finally, the relevant limit switch is represented, showing the active and inactive zones and transition.

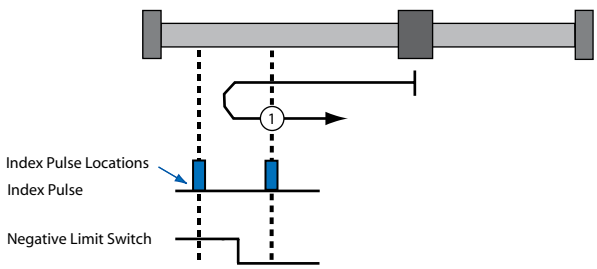


Note that in the homing method descriptions, negative motion is leftward and positive motion is rightward.

2.17.7.1 Homing Method 1: Homing on the Negative Limit Switch

Using this method, the initial direction of movement is leftward if the negative limit switch is inactive (here shown as low). The home position is at the first index pulse to the right of the position where the negative limit switch becomes inactive.

Method 1: Homing on the Negative Limit Switch

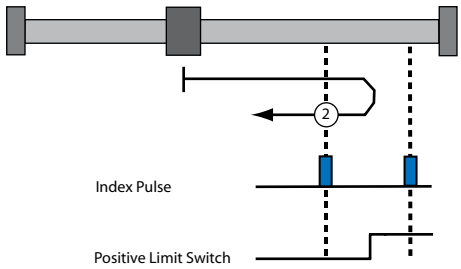


H004

2.17.7.2 Homing Method 2: Homing on the Positive Limit Switch

Using this method the initial direction of movement is rightward if the positive limit switch is inactive (here shown as low). The position of home is at the first index pulse to the left of the position where the positive limit switch becomes inactive.

Method 2: Homing on the Positive Limit Switch



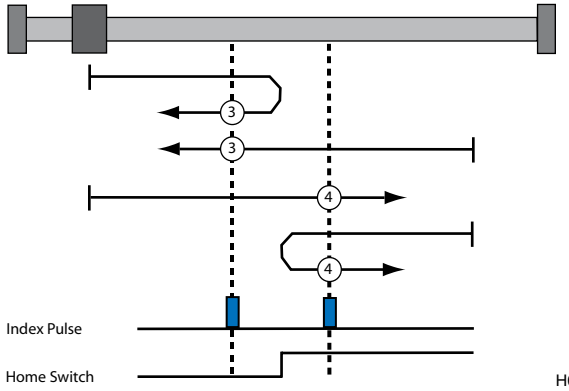
H005

2.17.7.3 Homing Method 3 and 4: Homing on the Positive Home Switch and Index Pulse

Using methods 3 or 4, the initial direction of movement depends on the state of the home switch.

The home position is at the index pulse to either to the left or the right of the point where the home switch changes state. If the initial position is located so that the direction of movement must reverse during homing, the point at which the reversal takes place is anywhere after a change of state of the home switch.

Method 3 & 4: Homing on the Positive Home Switch & Index Pulse



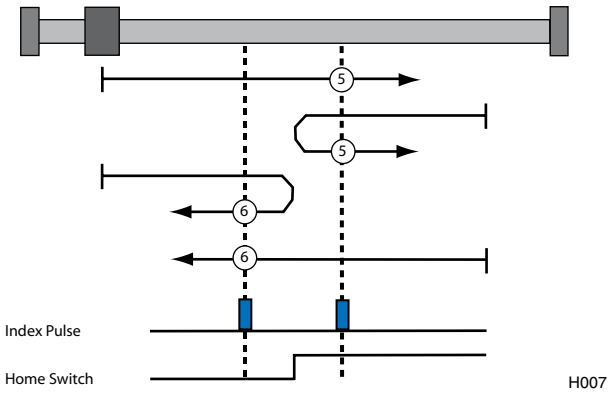
H006

2.17.7.4 Homing Methods 5 and 6: Homing on the Negative Home Switch and Index Pulse

Using methods 5 or 6, the initial direction of movement depends on the state of the home switch.

The home position is at the index pulse to either to the left or the right of the point where the home switch changes state. If the initial position is located so that the direction of movement must reverse during homing, the point at which the reversal takes place is anywhere after a change of state of the home switch.

Method 5 & 6: Homing on the Negative Home Switch & Index Pulse



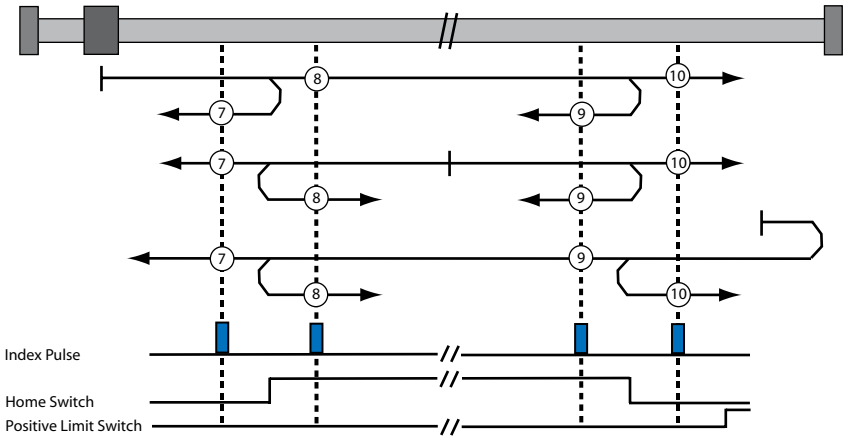
H007

2.17.7.5 Homing Methods 7-14: Homing on the Home Switch and Index Pulse

These methods use a home switch, which is active over only a portion of the travel. In effect, the switch has a momentary action as the axis sweeps past the switch.

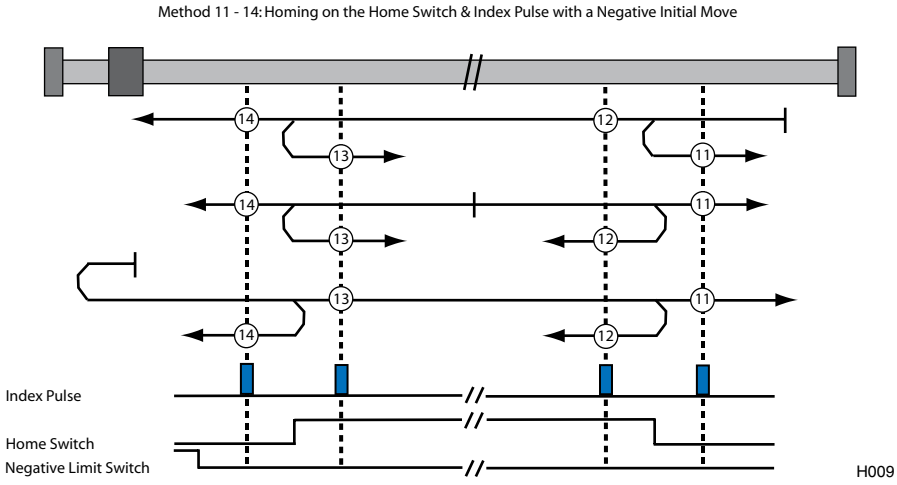
Using methods 7 to 10, the initial direction of movement is to the right. Using methods 11 to 14 the initial direction of movement is to the left, unless the home switch is active at the start of the motion. In this case the initial direction of motion depends on the edge being sought. The home position is at the index pulse on either side of the rising or falling edges of the home switch, as shown in the following two diagrams. If the initial direction of movement leads away from the home switch, the drive must reverse on encountering the relevant limit switch. Figure H008 Illustrates a homing sequence on the home switch and index pulse with a positive initial move.

Method 7 - 10: Homing on the Home Switch & Index Pulse with a Positive Initial Move



H008

Figure H009 illustrates a homing sequence on the home switch and index pulse with a negative initial move.



2.17.7.6 Homing Methods 15, 16, 20, 22, 24, 26, 28, and 30: Reserved

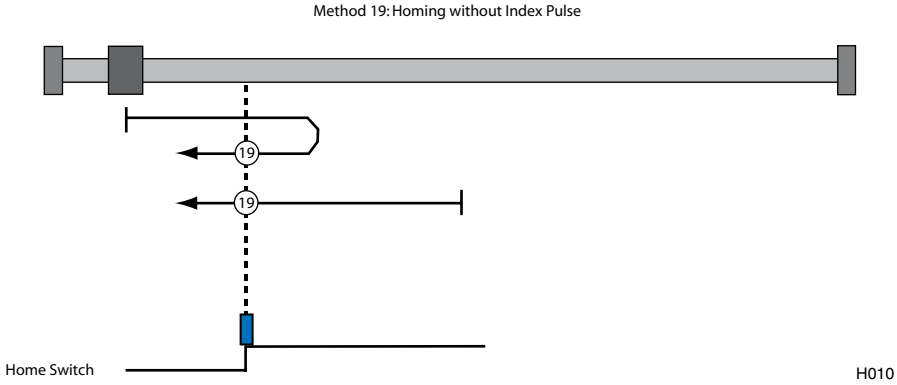
Homing methods 15, 16, 20, 22, 24, 26, 28 and 30 are reserved for future use.

2.17.7.7 Homing Methods 17 and 18: Homing without an Index Pulse

These methods are similar to methods 1-2, except that the home position is not dependent on the index pulse but only on the relevant limit switch translation. Method 17 uses the negative limit switch, and method 18 uses the positive limit switch.

2.17.7.8 Homing Methods 19, 21, 23, 25, 27, and 29: Homing without an Index Pulse

These methods are similar to methods 1 to 14, except that the home position does not depend on the index pulse. Instead, it depends on the relevant home or limit switch transitions. For example, method 19 is similar to method 3 as shown in Figure H010.



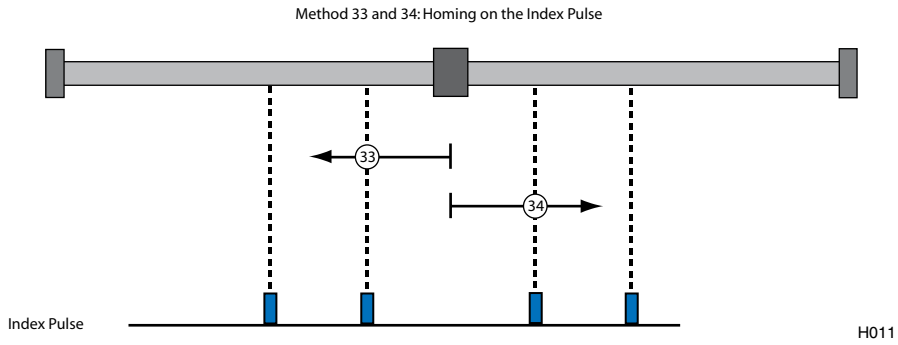
This means method 19 and 20 (as described in the Profile for Drives and Motion Control) both imply the same home algorithm and location, because methods 3 and 4 are only different in which index pulse the locate. Likewise, 22, 24, 26, 28, and 30 (as described in the Profile for Drives and Motion Control) are redundant. For this reason, in AC Tech amplifiers, the following redundant home methods are reserved: 20, 22, 24, 26, 28, and 30. The equivalent home method (one less then each of these values) should be used instead.

2.17.7.9 Homing Methods 31 and 32: Reserved

Homing methods 31 and 32 are reserved for future use.

2.17.7.10 Homing Methods 33 and 34: Homing on the Index Pulse

Using methods 33 or 34 the direction of homing is negative or positive respectively. The home position is at the index pulse found in the selected direction.



2.17.7.11 Homing Method 35: Homing on the Current Position

In homing method 35, the current position is the homing position.

2.17.8 Homing Mode Operation example.

The following steps are needed to execute the homing operation from the user program or under interface control.

1. Set Fast homing speed: Variable #242
2. Set Slow homing speed: Variable #243
3. Set Homing accel/decel: Variable #239
4. Set home offset:
   a. In User Units Variable #240
   b. In encoder pulses Variable #241
5. Home Switch input Variable #246
6. Home Method Variable #244

To start, set the homing variable VAR_START_HOMING (#245) to 1. Consider example below:

```
;Program start----------------------------------------------------------
;
;
        UNITS=1                             ;rps

        Accel =1000
        Decel=1000
        MaxV =20

;  some program statements……
;
;
;Homing specific set up..
        VAR_HOME_FAST =             10      ;rps
        VAR_HOME_SLOW=              1       ;rps
        VAR_HOME_ACCEL=     100     ;rps/sec^2
        VAR_HOME_OFFSET=            0       ;no offset from sensor
        VAR_HOME_SWITCH_INPUT       4      ;input B1  (0-A1, 1-A2…3-A4, 4-B1,…11-C4)
        VAR_HOME_METHOD             4       ;see table below

        VAR_START_HOMING    =1              ;starts homing sequence
;Drive homed

; Program statements….

END
```

3. Language Reference

Format

Each statement, system variable or operand is documented using the format shown below. If there is no information in one of the fields the label is still shown.

KEYWORD	Long Name	Type
Purpose		
Syntax	KEYWORD=value Variable=KEYWORD Arguments	
Remarks		
See Also		
Example		

KEYWORD:	The KEYWORD is the name of the statement, system variable or system flag as it would appear in a program.
Long Name:	The long name is an interpretation of the keyword. For example: MOVEP is the keyword and Move to Position would be a long name. The long name is provided only as an aid to the reader and may not be used in a program.
Type:	This field identifies what type of statement or system variable the keyword is.
Purpose:	Purpose of the keyword.
Syntax:	This field shows proper usage of the keyword. Optional arguments will be contained within square brackets [ ]. Arguments will be written in italics.
Arguments:	The data that is supplied with a statement that modifies the behavior of the statement. For example, MOVED=100. MOVED is the statement and 100 is the argument.
Remarks:	The remark field contains additional information about the usage of the statement or system variable.
See Also:	This field contains a list of statements or system variables that are related to the purpose of the keyword.
Example:	The example field contains a code segment that illustrates the usage of the keyword
Reference	

ASSIGN	Assign Input As Index Bit	Statement
Purpose	Assign keyword causes specific input to act as a particular bit of system variable INDEX. After such assignments changes in input state will cause changes in a particular bit to which the input is assigned.	
Syntax	ASSIGN INPUT <input name> AS BIT <bit #>	
Input name	Input name (IN_A1..IN_A2 etc.) Bit# INDEX variable bit number from 0 to 7	
Remarks		
See Also		

Example:

```
ASSIGN INPUT IN_B4 AS  BIT 0     ;index bit 0 state matches state of input B4
```

DEFINE	Define name	Pseudo-statement

Purpose DEFINE is used to define symbolic names for variables and constants for programming convenience. It is a pseudo-statement, i.e., it is not executable.
DEFINE can be used also to substitute a symbolic string.

Syntax DEFINE <name> <string>
name any symbolic string
string any symbolic string

Remarks: DEFINE must be located before any executable statement

See Also

Example:

```
DEFINE  Five     5
DEFINE  Three    3
DEFINE  Result   V1
DEFINE  SUMM Five + Three

ProgramStart:
Result = Five + Three           ;Is same as V1 = 5+3
Result = SUMM                   ;same result as above
End
```

DISABLE	Turns drive OFF	Statement

Purpose DISABLE turns OFF the power to the motor and disables the drive.

Syntax DISABLE

Remarks Once the DISABLE statement is executed, power to the drive is turned off and the motor can move freely. APOS will continue to display the current position of the motor. Even though TPOS will be updated to the value of APOS once the ENABLE statement is executed, it is recommended that the motor be re-homed.

See Also ENABLE

Example:

```
DISABLE
```

DO UNTIL	Do/Until	Statement

Purpose DO <statement(s)> UNTIL <condition> executes the statement(s) between the DO and the UNTIL repeatedly until the <condition> specified becomes TRUE.

Syntax DO <statement(s)> UNTIL <condition>
<statement(s)> any valid statement(s)
<condition> The condition to be tested.
The condition may be a comparison, an input being TRUE or FALSE (H or L) system flag or a variable used as a flag (if 0 - false, else - true). Comparisons compare the values of two operands and determine if the condition is TRUE or FALSE. A comparison may be greater (>), less than (<), less than or equal (<=), or greater than or equal to (>=). The operands of a comparison may be user variable, system variables, analog input values, or constants.

```
IN_A1          ;an input is evaluated to true if active
V1             ;user variable. True when non 0, false when 0
INPOSITION     ;System flag
V1 > V2        ;user variable comparison
V1 > APOS      ;comparison user and system variables
APOS < 8.4     ;compare system variable to constant
```

Remarks Unlike the WHILE statement, the loop body will always be executed at least once because the DO/UNTIL statement tests the <condition> AFTER the loop body is executed.

See Also WHILE, IF

Example:

```
DO MOVED V1     ;Keep looping through the Do Move statements
UNTIL IN_B4     ;Until the input is made
WHILE IN_A2     ;IN_A2 is activated (TRUE)
```

ENABLE	Enables the drive	Statement

Purpose Turns ON power to the motor and enables the drive

Syntax ENABLE

Remarks

See Also DISABLE

Example:

```
ENABLE      ;drive turns on after this statement
```

END	END program	Statement

Purpose This statement is used to terminate (finish) user program and its events.

Syntax END

Remarks END can be used anywhere in program

See Also DISABLE

Example:

```
ENABLE   ;servo turns on after this statement
```

EVENT	Starts Event handler	Statement

Purpose EVENT keyword creates scanned event handler.
Statement also sets one of 4 types of events possible.

Syntax

1. EVENT <name> INPUT <inputname>
   Or
2. EVENT <name> INPUT !<inputname>
   Or
3. EVENT <name> TIME <period >
   Or
4. EVENT <name> <expression>

name	any valid alphanumeric string
inputname	any valid input “IN_A1 - IN_C4”
period	any integer number. Expressed in ms
expression	any arithmetic or logical expression

The following statements can not be used within event’s handler:

MOVE,MOVED,MOVEP,MOVEDR,MOVEPR,MDV
MOTION SUSPEND
MOTION RESUME
STOP MOTION
DO UNTIL
GOTO
GOSUB
HALT
VELOCITY ON/OFF
WAIT
WHILE

While GOTO or GOSUB are restricted, a special JUMP statement can be used for program flow change from within event handler. See JUMP statement description in Language Reference section.

Remarks

For syntax 1 and 2:

The Event will occur when the input with the <name/number> transition from L(Low) to H (High), for syntax 1 and from H (High) to L(Low) for syntax 2.

For syntax 3:

The Event will occur when the specified , <period>, period of time has expired. This event can be used as periodic event to check for some conditions.

For syntax 4

The Event will occur when the expression, <expression>, evaluates to be true. The expression can be any valid arithmetic or logical expression or combination of the two. This event can be used when implementing soft limit switches or when changing the program flow based on some conditions. Any variable, (user and system), or constants can be used in the expression.

See Also ENDEVENT, EVENT ON, EVENT OFF

Example:

```
     V0=0
     V1=0
EVENT InEvent IN_A1
     V0 = V0+1               ;count
     ENDEVENT
     EVENT period  TIME 1000 ;1000 ms = 1Sec
     V3=V0-V1                ;new count - old count = number of pulses per second
     V0=V1                   ;save as old count
;-------------------------------------------------------------------------------
     EVENT  InEvent  ON
     EVENT period     ON
     {program statements}
END
```

ENDEVENT	END of Event handler	Statement
Purpose	Indicates end of the event handler	
Syntax	ENDEVENT	
Remarks		
See Also	EVENT, EVENT ON, EVENT OFF	

Example:	`EVENT InputRise IN_B4`
	`  V0=V+1`
	`ENDEVENT`	

EVENT ON/OFF	Turn events on or off	Statement
Purpose	turns ON or OFF events created by an EVENT handler statement	
Syntax	EVENT <name> ON EVENT <name> OFF <name> Event handler name	
Remarks		
See Also	EVENT	

Example:

```
EVENT    InputRise ON
EVENT    InputRise OFF
```

EVENT ON/OFF	Globally Enables/disables events	Statement
Purpose	Enables/Disables events execution previously enabled by EVENT Eventname ON statement. This is a global ON/OF control. Effects flag #30 in DSTATUS register - F_EVENTSOFF. After executing EVENTS ON individual event's on/off states restored.	
Syntax	EVENTS ON Restores execution of previously enabled events. EVENTS OFF Disables all execution of all events	
Remarks	Events are globally enabled after reset and controlled by individual Event Eventname ON statements.	
See Also	EVENT ON/OFF	

Example:

```
*******************************************************************************
    EVENT SKIPOUT IN_B4     ;check for rising edge of input B4
    JUMP TOGGLE             ;redirect code execution to TOGGLE
    ENDEVENT                ;end the event
    EVENT OVERSHOOT IN_B3   ;check for rising edge of input B3
    JUMP SHUTDOWN           ;redirect code execution to SHUTDOWN
    ENDEVENT                ;end the event
*******************************************************************************
    EVENT SKIPOUT ON
    EVENT OVERSHOOOT ON
*******************************************************************************
    ……..…User code……..
    EVENTS OFF              ;turns off all events
    ……..…User code……..
    EVENTS ON               ;turns on any event previously activated
```

FAULT	User generated fault	Statement
Purpose	Allows the user program to set a custom system fault. This is useful when the custom program needs a standard fault process for custom conditions like data supplied by interface out of range etc. Custom fault numbers must be in region of 128 to 240 (decimal)	
Syntax	FAULT FaultNumber	Sets system fault. Faultnumber - constant in range 128-240 Variables are not allowed in this statement.
Remarks	Custom fault will be processed as any regular fault. There will be a record in the fault log.	
See Also	ON FAULT	

Example:

```
    FAULT 200       ;Sets fault #200
    V0=200
    FAULT V0        ;Not valid. Variables are not allowed here
```

GOTO	Go To	Statement
Purpose	Transfer program execution to the instruction following the label.	
Syntax	GOTO <label>	
Remarks		
See Also	GOSUB, JUMP	

Example:

```
    GOTO Label2
    {Statements…}
    Label2:   {Statements…}
```

GOSUB	Go To subroutine	Statement
Purpose	GOSUB transfers control to <subname> subroutine.	
Syntax	GOSUB <subname> <subname> a valid subroutine name	
Remarks	After return from subroutine program resumes from next statement after GOSUB	
See Also	GOTO, JUMP, RETURN	

Example:

```
DO
GOSUB  CALCMOVE
MOVED    V1
WHILE  1
END

SUB      CALCMOVE
   V1=(V2+V3)/2
RETURN
```

HALT	Halt the program execution	Statement
Purpose	Used to halt main program execution. Events are not halted by the HALT statement. Execution will be resumed by the RESET statement or by executing the JUMP to code from EVENT handler.	
Syntax	HALT	
Remarks	This statement is convenient when writing event driven programs.	
See Also	RESET	

Example:

```
{Statements…}
HALT
```

JUMP	Jump to label from Event handler	Statement

Purpose This is a special purpose statement to be used only in the Event Handler code. When the EVENT is triggered and this statement is processed, execution of the user's program is transferred to the <label> argument called out in the "JUMP" statement. This statement is particularly useful when there is a need for program's flow to change based on some event(s).

Transfer program execution to the instruction following the label.

Syntax JUMP <label> <label> is any valid program label

Remarks Can be used in EVENT handler only.

See Also EVENT

Example:

```
   {Statements…}
EVENT ExternalFault INPUT IN_A3   ;activate Event when IN_A3 goes high
   JUMP ExecuteStop               ;redirect program execution to <ExeceuteStop>
ENDEVENT
   {statements…}
StartMotion:
   EVENT ExternalFault ON
   ENABLE
   MOVED 20
   MOVED -100
   {statements}
END
ExecuteStop:
   STOP MOTION                    ;Motion stopped here
   DISABLE                        ;drive disabled
   GOTO StartMotion
```

ICONTROL ON/OFF	Enables interface control	Statement
Purpose	Enables/Disables interface control. Effects flag #27 in DSTATUS register F_ICONTROLOFF. All interface motion commands and commands changing any outputs will be disabled. See Host interface commands manual for details. This command is useful when the program is processing critical states (like limit switches for example) and can't be disturbed by the interface (usually asynchronous body to the program state/event)	
Syntax	ICONTROL ON ICONTROL OFF	Enables Interface control Disables interface control
Remarks	After reset interface control is enabled by default.	
See Also		

Example:

```
EVENT LimitSwitch IN_A1      ;limit switch event
   Jump LimitSwitchHandler   ;jump to process limit switch
ENDEVENT

V0=0
EVENT LimitSwitch ON
Again:
HALT                        ;system controlled by interface

LimitSwitchHandler:
   EVENTS OFF               ;turn off all events
   ICONTROL OFF             ;disable interface control
   STOP MOTION QUICK
   DISABLE                  ;optional DISABLE
   V0=1                     ;indicate fault condition to the interface
   ICONTROL ON
   EVENTS ON
   GOTO AGAIN
```

IF	If/Then/Else	Statement

Purpose The IF statement tests for a condition and then executes the specific action(s) between the IF and ENDIF statements if the condition is satisfied. If the condition is false, no action is taken and the instructions following the ENDIF statement are executed. Optionally, using the ELSE statement, a second action(s) may be specified to be executed if the condition is false.

Syntax

```
IF <condition>
{statements 1}
ELSE
{statements  2}
ENDIF
```

The, <condition>, is the condition to be tested. This condition may be a comparison, an input being TRUE or FALSE (H or L), system flag or a variable used as a flag (if 0 - false, else - true).
Comparisons compare the values of two operands and determine if the condition is TRUE or FALSE. A comparison may be greater (>), less than (<), less than or equal (<=), or greater than or equal to (>=). The operands of a comparison may be a user variable, system variables, analog input values, or constants.

```
IN_A1           ;an input is evaluated to true if active
V1              ;user variable. True when non 0, false when 0
INPOSITION      ;system flag
V1 > V2         ;user variable comparison
V1 > APOS       ;comparison user and system variables
APOS < 8.4      ;compare system variable to constant
{Statements 1}  ;statements will be performed if condition is TRUE
{Statements 2}  ;statements will be performed if condition is FALSE
```

Remarks Only {Statements 1} or {Statements 2} will be performed. It is impossible for both to take place.

See Also WHILE, DO

Example:

```
IF APOS  > 4
    V0=2
;-------------------------------------------------------
ELSE
    V0=0
ENDIF
;-------------------------------------------------------
If V1 <> V2 && V3>V4
    V2=9
ENDIF
```

MOVE	Move	Statement

Purpose MOVE UNTIL performs motion until condition becomes TRUE. MOVE WHILE performs motion while conditions stays TRUE. The statement suspends the programs execution until the motion is completed, unless the statement is used with C modifier.

Syntax MOVE [BACK] UNTIL <condition> [,C]
MOVE [BACK] WHILE <condition> [,C]

BACK	Changes direction of the move.
C (optional)	C[ontinue] - modifier allows the program to continue while motion is being performed. If a second motion profile is executed while the first profile is still in motion, the second profile will be loaded into the Motion Stack. The Motion Stack is 32 entries deep. The programmer should check the "F_MQUEUE_FULL" system flag to make sure that there is available space in the queue. If the queue becomes full, or overflows, then the drive will generate a fault.
<condition>	The condition to be tested. The condition may be a comparison, an input being TRUE or FALSE (H or L) system flag or a variable is used as flag (if 0 - false, else - true).

Remarks

See Also MOVEP, MOVED, MOVEPR, MOVEDR, MDV, MOTION SUSPEND, MOTION RESUME

Example:

```
{Statements…}
MOVE UNTIL V0<3
MOVE BACK UNTIL V0>4
MOVE WHILE V0<3
MOVE BACK WHILE V0>4
MOVE WHILE V0<3,C
```

MOVED	Move Distance	Statement

Purpose MOVED performs incremental motion (distance) specified in User Units. The commanded distance can range from -231 to 231. This statement will suspend the programs execution until the motion is completed, unless the statement is used with the "C" modifier. If the "S" modifier is used then S-curve accel is performed during the move.

Syntax C[ontinue] MOVED <distance>[,S] [,C]

The "C" argument is an optional modifier which allows the program to continue executing while the motion profile is being executed. If the drive is in the process of executing a previous motion profile the new motion profile will be loaded into the Motion Stack. The Motion Stack is 32 entries deep. The programmer should check the "F_MQUEUE_FULL" system flag to make sure that there is available space in the queue. If the queue becomes full, or overflows, then the drive will generate a fault.

S[-curve] optional modifier specifies S-curve acceleration.

See Also MOVE, MOVEP, MOVEPR, MOVEDR, MDV, MOTION SUSPEND, MOTION RESUME

Example:

```
{Statements…}
MOVED 3          ;moves 3 user units forward
MOVED BACK 3     ;moves 3 user units backward
{Statements…}
```

MOVEP	Move to Position	Statement

Purpose MOVEP performs motion to a specified absolute position in User Units. The command range for an Absolute move is from -231 to 231 User Units. This statement will suspend the program's execution until the motion is completed unless the statement is used with the "C" modifier. If the "S" modifier is used then an S-curve accel is performed during the move.

Syntax MOVEP <absolute position>[,S] [,C]

C[ontinue] The "C" argument is an optional modifier which allows the program to continue executing while the motion profile is being executed. If the drive is in the process of executing a previous motion profile the new motion profile will be loaded into the Motion Stack. The Motion Stack is 32 entries deep. The programmer should check the "F_MQUEUE_FULL" system flag to make sure that there is available space in the queue. If the queue becomes full, or overflows, then the drive will generate a fault.

S[-curve] optional modifier specifies S-curve acceleration.

See Also MOVE, MOVEP, MOVEPR, MOVEDR, MDV, MOTION SUSPEND, MOTION RESUME

Example:

```
{Statements…}
MOVEP 3         ;moves to 3 user units absolute position
{Statements…}
```

MOVEDR	Registered Distance Move	Statement

Purpose MOVEDR performs incremental motion, specified in User Units. If during the move the registration input becomes activated (goes high) then the current position is recorded, and the displacement value (the second argument in the MOVEPR statement) is added to this position to form a new target position. The end of the move is then altered to this new target position. This statement suspends execution of the program until the move is completed, unless the statement is used with the "C" modifier.

Syntax MOVEDR <distance>,<displacement> [,C]

C[ontinue] The "C" argument is an optional modifier which allows the program to continue executing the User Program while a motion profile is being processed. If a new motion profile is requested while the drive is processing a move the new motion profile will be loaded into the Motion Stack. The Motion Stack is 32 entries deep. The programmer should check the "F_MQUEUE_FULL" system flag to make sure that there is available space in the queue. If the queue becomes full, or overflows, then the drive will generate a fault.

See Also MOVE, MOVEP, MOVEPR, MOVED, MDV, MOTION SUSPEND, MOTION RESUME

Example:

This example moves the motor 3 user units and checks for the registration input. If registration isn't detected then the move is completed. If registration is detected, the registration position is recorded and a displacement value of 2 is added to the recorded registration position to calculate the new end position.

```
{Statements…}
MOVEDR 3, 2
{Statements…}
```

MOVEPR	Registered Distance Move	Statement

Purpose MOVEPR performs absolute position moves specified in User Units. If during a move the registration input becomes activated, i.e., goes high, then the end position of the move is altered to a new target position. The new position is generated from the second argument in the MOVEPR statement, (displacement). This statement suspends the execution of the program until the move is completed, unless the statement is used with the C modifier.

Syntax MOVEPR <distance>,<displacement> [,C]

C[ontinue] The "C" argument is an optional modifier which allows the program to continue executing the User Program while a motion profile is being processed. If a new motion profile is requested while the drive is processing a move the new motion profile will be loaded into the Motion Stack. The Motion Stack is 32 entries deep. The programmer should check the "F_MQUEUE_FULL" system flag to make sure that there is available space in the queue. If the queue becomes full, or overflows, then the drive will generate a fault.

See Also MOVE, MOVEP, MOVEPR, MOVED, MDV, MOTION SUSPEND, MOTION RESUME

Example: This example moves the motor to the absolute position of 3 user units while checking for the registration input.
If registration isn't detected, then the move is completed .
If registration is detected, then the end of the move is changed to a new absolute target position of 2 user units.

```
{Statements…}
MOVEPR 3, 2
{Statements…}
```

MDV	Segment Move	Statement

Purpose MDV defines incremental motion segment by specifying distance and final velocity (for each segment) in User Units. Acceleration (or deceleration) is calculated automatically based on these two parameters. This technique allows complicated moves to be created that consist of many segments. Each MDV move starts and ends with a velocity of 0. Based on this a MDV move must have at least two segments. The MDV statement doesn't suspend execution of the main program. Each segment is loaded into the Motion Queue immediately. If the last segment in the Motion Queue doesn't have a final velocity of 0, the drive will generate a "Motion Queue Empty" fault #24. If the "S" modifier is used in the statement, then the velocity acceleration/deceleration will be S-curved as opposed to be linear.

Syntax MDV <[-]segment distance>,<segment final velocity> [,S]

S[-curve] optional modifier specifies S-curve acceleration.

See Also MOVE, MOVEP, MOVEPR, MOVED, MDV, MOTION SUSPEND, MOTION RESUME

Example:

```
{Statements…}
MDV  5, 10      ;Move 5 user units and accelerate to a velocity of 10
MDV  10,10      ;Move 10 user units and maintain a velocity of 10
MDV 10,5        ;Move 10 user units and decelerate to velocity of 5
MDV  5,;0       ;Move 5 user units and decelerate to velocity 0.
                ;The last MDV must have a final velocity of 0.
{Statements…}
```

MOTION SUSPEND	Suspend	Statement

Purpose

This statement is used to temporarily suspend motion without flashing the Motion Queue's contents. If this statement is executed while a motion profile is being processed, then the motion will not be suspended until after the completion of the move. If executing a series of MDV segment moves, motion will not be suspended until after the all MDV segments have been processed. If the Motion Queue is empty then any subsequent motion statement will be loaded into the queue and will remain there until the "Motion Resume" statement is executed. Any motion statements without the "C" modifier (except MDV statements) will lock-up the User Program.
To illustrate this program lock-up, reference the following program:

```
;Program locked-up after MOVE statement executed
…{statements}
MOTION SUSPEND    ;Motion is put on hold, or suspended
MOVE 20           ;Motion profile is loaded into the Motion Queue
                  ;and the program is suspended until the move is
                  ;completed.
…{statements}     ;These statements never get executed because
                  ;the drive is waiting for completion of the
                  ;above move which will never get processed
                  ;because motion is suspended.
MOTION RESUME     ;Like the above statements this command will never
                  ;get executed and the program will be LOCKED-UP.
```

You can only unlock this situation by a reset or by the execution the MOTION RESUME command from a Host Interface.

Syntax

MOTION SUSPEND

Remarks

Performing any MOVEx commands without "C" modifier will lock-up the user program. You will be able to unlock it only by performing the Reset or Host Interface command "Motion Resume"

See Also

MOVE, MOVEP, MOVEDR, MOVED, MOVEPR ,MDV, MOTION RESUME

Example:

```
…{statements}
MOTION SUSPEND       ;Motion will be suspended after current motion
                     ;command is finished.
…{statements}
```

MOTION RESUME	Resume	Statement

Purpose

Statement resumes motion previously suspended by MOTION SUSPEND. If motion was not previously suspended, this has no effect on operation.

Syntax

MOTION RESUME

See Also

MOVE, MOVEP, MOVEDR, MOVED, MOVEPR ,MDV, MOTION RESUME

Example:

```
…{statements}
MOTION RESUME  ;Motion is resumed from current command in  motion Queue (if any)
…{statements}
```

ON FAULT/ ENDFAULT	Resume	Statement

Purpose This statement initiates the Fault Handler section of the User Program. The Fault Handler is a piece of code which is executed when a fault occurs in the drive. The Fault Handler program must begin with the "ON FAULT" statement and end with the "ENDFAULT" statement. If a Fault Handler routine is not defined, then the User Program will be terminated anytime the drive detects a fault. Subsequently, if a Fault Handler is defined and a fault is detected, the drive will be disabled, all scanned events will be disabled, and the Fault Handler routine will be executed. The RESUME and RESET statements can be used to redirect the program execution from the Fault Handler back to the main program. If these statements are not utilized then the program will terminate once the ENDFAULT statement is executed.

The following statements can't be used in fault handler:
MOVE, MOVED, MOVEP,MOVEDR, MOVEPR, MDV, MOTION SUSPEND, MOTION RESUME, GOTO, GOSUB, JUMP, ENABLE, GEAR ON/OFF, and VELOCITY ON/OFF

Syntax
```
ON FAULT
{…statements}
ENDFAULT
```

See Also RESUME, RESET

Example:

```
…{statements}          ;User program
FaultRecovery:         ;Recovery procedure
…{statements}

END
ON FAULT               ;Once fault occurs program is directed here
…{statements}          ;Any code to deal with fault
RESUME FaultRecovery   ;Execution of RESUME ends Fault Handler and directs
                       ;execution back to User Program. If RESUME is omitted
                       ;the program will terminate here
ENDFAULT               ;Fault routine must end with a ENDFAULT statement
```

REGISTRATION ON	Registration On	Statement

Purpose This statement arms the registration input, (input IN_C3). When the registration input is activated, the Flag Variable "F_REGISTRATION" is set and the current position is captured and stored to the "RPOS" System Variable. Both of these variables are available to the User Program for decision making purposes. The "REGISTRATION ON" statement will also resets the "F_REGISTRATION" flag.

Syntax REGISTRATION ON — Flag "F_REGISTRATION" is reset and registration input is armed

See Also MOVEDR, MOVEPR

Example:

```
; Moves until input is activated and then come back to the sensor position.
…{statements}
REGISTRATION ON        ;Arm registration input
MOVE UNTIL IN_C3       ;Move until input is activated, (sensor hit)
MOVEP  RPOS            ;Absolute move to the position of the sensor
…{statements}
```

RESUME	Resume	Statement
Purpose	This statement redirects the code execution form the Fault Handler routine back to in the User Program. The specific line in the User Program to be directed to is called out in the argument <label> in the “RESUME” statement. This statement is only allowed in fault handler routine.	
Syntax	RESUME <label>	<label> Label address in User Program to be sent to
See Also	ON FAULT	

Example:

```
…{statements}
FaultRecovery:
…{statements}
END
ON FAULT              ;Once fault occurs program is directed here
…{statements}         ;Any code to deal with fault
RESUME FaultRecovery  ;Execution of RESUME ends Fault Handler and directs
                      ;execution back the “FaultRecovery” label in the User
                      ;Program.
                      ;If RESUME is omitted the program will terminate here.
ENDFAULT              ;Fault routine must end with a ENDFAULT statement
```

RETURN	Return from subroutine	Statement
Purpose	This statement will return the code execution back from a subroutine to the point in the program from where the subroutine was called. If this statement is executed without a previous call to subroutine, (GOSUB), fault #21 “Subroutine stack underflow” will result.	
Syntax	RETURN	
See Also	GOTO, GOSUB	

Example:

```
…{statements}…
GOSUB MySub       ;Program jumps to Subroutine “MySub”
MOVED 10          ;Move to be executed once the Subroutine has executed
                  ;the RETURN statement.
…{statements}
END               ;main program end
MySub:            ;Subroutine called out from User Program
…{statements}     ;Code to be executed in subroutine
RETURN            ;Returns execution to the line of code under the “GOSUB”
                  ;command, (MOVED 10 statement).
```

SEND/SEND TO	Send network variable(s) value	Statement	
Purpose	This statement is used to share the value of Network Variables between drives on an Ethernet network. Network Variables are variables N0 through N31. The variables to be sent out or synchronized with, are called out in the “SEND” statement. For example, “SEND [N5]” will take the current value of variable N5 and load it into the N5 variable of every drive on the network. The SENDTO statement only updates network variables of the drives with the same group ID listed in the command.		
Syntax	SEND [Na,Nb, Nx-Ny],	a,b,x,y	Any number from 0 to 31
	SENDTO GroupID [Na,Nb, Nx-Ny]	GroupID	GroupID of the drives who’s variables will be affected (synchronized)
See Also	Network variables		

Example:

```
…{statements}…
N1=12            ;Set N1 equal to 12
SEND [N1]        ;Set the N1 variable to 12 in every drive in the Network.
SEND [N5-N10]    ;Sets the N5 through N10 variable in all drives on the Network.
N20=25           ;Set N20 equal to 25
SENDTO 2 [N20]   ;Set the N20 variable to 25 only in drives with GroupID = 2.
…{statements}
END              ;End main program
```

STOP MOTION [Quick]	Stop Motion	Statement
Purpose	This statement is used to stop all motion. When the “STOP MOTION” statement is executed all motion profiles stored in the Motion Queue are cleared, and motion will immediately be stopped via the deceleration parameter set in the “DCEL” variable. If the “QUICK” modifier is used, then the deceleration value will come from the “QDECEL” variable. The main use for this command is to control an emergency stops or when the End Of Travel sensor is detected. Note that the current position will not be lost after this statement is executed.	
Syntax	STOP MOTION	Stops using DECEL deceleration rate
	STOP MOTION QUICK	Stops using QDECEL deceleration rate
See Also	MOTION SUSPEND	

Example:

```
…{statements}…
DECEL = 100
QDECEL = 10000
…{statements}
STOP MOTION QUICK
```

VELOCITY ON/OFF	Velocity Mode	Statement

Purpose The VELOCITY ON statement enables velocity mode in the drive. The VELOCITY OFF statement disables velocity mode and returns drive to its default mode. (Default mode is Positioning). The velocity value for this mode is set by setting the System Variable “VEL”. All position related variables are valid in this mode.

Syntax VELOCITY ON
VELOCITY OFF

Remarks The “VELOCITY ON” statement is considered one of the motion related commands. It has to be implemented when the drive is enabled. If the “VELOCITY ON” statement is executed while the drive is disabled, fault # 27-”Drive disabled” will occur.
Execution of any motion related profiles while the drive is in Velocity mode will be loaded into the Motion Queue. When the “VELOCITY OFF” statement is executed the drive defaults back to Position mode and immediately begins to execute the motion profiles stored in the Motion Queue. Please note that the “VEL” variable can be set on the fly, allowing dynamic control of the velocity.

See Also

Example:

```
VEL=0            ;Set velocity to 0
VELOCITY ON      ;Turn on Velocity Mode
VEL = 10         ;Set velocity
…{statements}
VELOCITY OFF     ;Turn off Velocity Mode
```

WAIT	Wait	Statement

Purpose This statement suspend the execution of the program until some condition(s) is(are) met. Conditions include Expressions TRUE or FALSE, Preset TIME expiration, MOTION COMPLETE.

Syntax	WAIT UNTIL <expression>	wait until expression becomes TRUE
	WAIT WHILE <expression>	wait while expression is TRUE
	WAIT TIME <time delay>	wait until <time delay> in mS is ;expired
	WAIT MOTION COMPLETE	wait until last motion in Motion Queue completes

Remarks

See Also DSTATUS System Variable, User Variables and Flags section

Example:

```
WAIT UNTIL (APOS>2 && APOS       ;Wait until Apos is > 2 and <3 APOS>1)
WAIT WHILE (APOS <2 && APOS>1)   ;Wait while Apos is <2 and >1
WAIT TIME 1000                   ;Wait 1 Sec (1 Sec=1000mS)
MDV 20, 20                       ;Start MDV moves
MDV 20,0                         ;Start MDV moves
WAIT MOTION COMPLETE             ;Waits until motion is done
```

WHILE/ ENDWHILE	While	Statement

Purpose The WHILE <expression> executes statement(s) between keywords WHILE and ENDWHILE repeatedly while the expression evaluates to TRUE.

Syntax
```
WHILE <expression>
 {statement(s)}…
ENDWHILE
```

Remarks WHILE block of statements has to end with ENDWHILE keyword.

See Also DO/UNTIL

Example:

```
WHILE  APOS<3        ;Execute the statements until Apos is <3
{statement(s)}..
ENDWHILE
```

Appendix A. Complete list of variables.

A complete list of the PositionServo accessible variables is given in the table herein. These variables can be accessed from the user's program or any supported interface protocol like RPC over Ethernet, PPP over RS232, MODBUS-RTU over RS485, MODBUS over TCP/IP or CANopen. Any variable can be accessed by its name from the user's program or by index value using the syntax: @<VARINDEX> , where <VARINDEX> is the variable index from the table herein. Any interface variable can be accessed by its index value. The column "**Format**" gives native format of the variable:

W: 32 bit integer
F: float (real)

When setting a variable via an external device the value can be addressed as floating or integer. The value will automatically adjusted to fit it's given form.

The column "**EPM**" shows if a variable has a non-volatile storage space in the EPM memory. The user's program uses a RAM (volatile) copy of the variables stored on the EPM. The EMP's values are not affected by changing the variables in the user's program. Interface functions however could change both the volatile and non-volatile copy of the variable. If the host interface request a change to the EPM (non-volatile) value, this change is done both in the user program's RAM memory as well as in the EPM. When the user's program reads a variable it always reads from the RAM (volatile) copy of the variable. Interface functions have the choice of reading from the RAM (volatile) or from the EPM (non-volatile) copy of the variable. At power up all RAM copies of the variables are initialized with the EPM values.

The column "**Access**" shows if a variable is R-read only, W-write only or R/W - read/write. Writing to a R-only variable or reading from a W-only variable will not work.

The column "**Units**" shows units of the variable. Units unique to this manual that are used for motion are:
UU - user units
EC - encoder counts
S - seconds
PPS - pulses per sample. Sample time is 255μs - servo loop rate
PPSS - pulses per sample per sample. Sample time is 255μs - servo loop rate

Index	Name	Format	EPM	Access	Description	Units
1	VAR_IDSTRING		N	R	Drive's identification string	
2	VAR_NAME		Y	R/W	Drive's symbolic name	
10	VAR_M_ID		Y	R	Motor ID	
11	VAR_M_MODEL		Y	R	Motor model	
12	VAR_M_VENDOR		Y	R	Motor vendor	
13	VAR_M_ESET		Y	R	Reserved	
14	VAR_M_HALLCODE		Y	R	Hallcode index	
15	VAR_M_HOFFSET		Y	R	Reserved	
16	VAR_M_ZOFFSET		Y	R	Reserved	
17	VAR_M_ICTRL		Y	R	Reserved	
18	VAR_M_JM		Y	R	Motor Jm	
19	VAR_M_KE		Y	R	Motor Ke	
20	VAR_M_KT		Y	R	Motor Kt	
21	VAR_M_LS		Y	R	Motor Ls	
22	VAR_M_RS		Y	R	Motor Rs	
23	VAR_M_MAXCURRENT		Y	R	Motor's max current(RMS)	
24	VAR_M_MAXVELOCITY		Y	R	Motor's max velocity	
25	VAR_M_NPOLES		Y	R	Motor's poles number	
26	VAR_M_ENCODER		Y	R	Encoder resolution	
27	VAR_M_TERMVOLTAGE		Y	R	Nominal Motor's terminal voltage	
28	VAR_M_FEEDBACK		Y	R	Feedback type	
29	VAR_ENABLE_SWITCH_TYPE	W	Y	R/W	Enable switch function 0-inhibit only 1- Run	Bit
30	VAR_CURRENTLIMIT	F	Y	R/W	Current limit	[A]mp

Index	Name	Format	EPM	Access	Description	Units
31	VAR_PEAKCURRENTLIMIT16	F	Y	R/W	Peak current limit for 16kHz operation	[A]mp
32	VAR_PEAKCURRENTLIMIT	F	Y	R/W	Peak current limit for 8kHz operation	[A]mp
33	VAR_PWMFREQUENCY	W	Y	R/W	PWM frequency selection	
34	VAR_DRIVEMODE	W	Y	R/W	Drive mode selection 0-torque 1-velocity 2-position	
35	VAR_CURRENT_SCALE	F	Y	R/W	Analog input #1 current reference scale in A/V	A/V
36	VAR_VELOCITY_SCALE	F	Y	R/W	Analog input #1 velocity reference scale in RPM/V	RPM/V
37	VAR_REFERENCE	W	Y	R/W	Reference selection: 1 - internal source 0 - external	
38	VAR_STEPINPUTTYPE	W	Y	R/W	Selects how position reference inputs operating: 1 - Quadrature inputs (A/B) 0 - Step & Direction type	
39	VAR_MOTORTHERMALPROTECT	W	Y	R/W	Motor thermal protection function: 0 - disabled 1 - enabled	
40	VAR_MOTORPTCRESISTANCE	F	Y	R/W	Motor thermal protection PTC cut-off resistance in Ohms	[Ohm]
41	VAR_SECONDENCODER	W	Y	R/W	Second encoder: 0 - Disabled 1 - Enabled	
42	VAR_REGENDUTY	W	Y	R/W	Regen circuit PWM duty cycle in % Range: 0-100%	%
43	VAR_ENCODERREPEATSRC	W	Y	R/W	Selects source for repeat buffers: 0 - Encoder connected to P4 terminal 1 - Feedback module (if available on particular module)	
44	VAR_VP_GAIN	W	Y	R/W	Velocity loop Proportional gain Range: 0 - 32767	
45	VAR_VI_GAIN	W	Y	R/W	Velocity loop Integral gain Range: 0 - 16383	
46	VAR_PP_GAIN	W	Y	R/W	Position loop Proportional gain Range: 0 - 32767	
47	VAR_PI_GAIN	W	Y	R/W	Position loop Integral gain Range: 0 - 16383	
48	VAR_PD_GAIN	W	Y	R/W	Position loop Differential gain Range: 0 - 32767	
49	VAR_PI_LIMIT	W	Y	R/W	Position loop integral gain limit Range: 0 - 20000	
51	VAR_VREG_WINDOW	W	Y	R/W	Gains scaling coefficient Range: -5 - +4	
52	VAR_ENABLE	W	N	W	Software Enable/Disable 0 - disable 1 - enable	
53	VAR_RESET	W	N	W	Drive's reset (cold boot) 0 - no action 1 - reset drive	
54	VAR_STATUS	W	N	R	Drive's status register	
55	VAR_BCF_SIZE	W	Y	R	User's program Byte-code size	Bytes
56	VAR_AUTOBOOT	W	Y	R/W	User's program autostart flag. 0 - program has to be started manually (MotionView or interface) 1 - program started automatically after drive booted	

Index	Name	Format	EPM	Access	Description	Units
57	VAR_GROUPID	W	Y	R/W	Network group ID Range: 1 - 32767	
58	VAR_VLIMIT_ZEROSPEED	F	Y	R/W	Zero Speed value Range: 0 - 100	Rpm
59	VAR_VLIMIT_SPEEDWND	F	Y	R/W	Speed window Range: 10 - 10000	Rpm
60	VAR_VLIMIT_ATSPEED	F	Y	R/W	Target speed for velocity window Range: -10000 - +10000	Rpm
61	VAR_PLIMIT_POSERROR	W	Y	R/W	Position error Range: 1 - 32767	EC
62	VAR_PLIMIT_ERRORTIME	F	Y	R/W	Position error time (time which position error has to remain to set-off position error fault) Range: 0.25 - 8000	mS
63	VAR_PLIMIT_SEPOSERROR	W	Y	R/W	Second encoder Position error Range: 1 - 32767	EC
64	VAR_PLIMIT_SEERRORTIME	F	Y	R/W	Second encoder Position error time (time which position error has to remain to set-off position error fault) Range: 0.25 - 8000	mS
65	VAR_INPUTS	W	N	R	Digital inputs states. A1 occupies Bit 0, A2- Bit 1 … C4 - bit 11.	
66	VAR_OUTPUTS	W	N	R/W	Digital outputs states. Writing to this variables sets/resets digital outputs, except outputs which has been assigned special function. Output 1 Bit0 Output 2 Bit 1 Output 3 Bit 2 Output 4 Bit 3	
67	VAR_IP_ADDRESS	W	Y	R/W	Ethernet IP address. IP address changes at next boot up. 32 bit value	
68	VAR_IP_MASK	W	Y	R/W	Ethernet IP NetMask. Mask changes at next boot up. 32 bit value	
69	VAR_IP_GATEWAY	W	Y	R/W	Ethernet Gateway IP address. Address changes at next boot up. 32 bit value	
70	VAR_IP_DHCP	W	Y	R/W	Use DHCP 0-manual 1- use DHCP service	
71	VAR_AIN1	F	N	R	Analog Input AIN1 current value	[V]olt
72	VAR_AIN2	F	N	R	Analog Input AIN2 current value	[V]olt
73	VAR_BUSVOLTAGE	F	N	R	Bus voltage	[V]olt
74	VAR_HTEMP	F	N	R	Heatsink temperature Returns: 0 - for temperatures < 40C and actual heat sink temperature for temperatures >40 C	[c]
75	VAR_ENABLE_ACCELDECEL		Y	R/W	Enable Accel/Decel function for velocity mode 0 - disable 1 - enable	
76	VAR_ACCEL_LIMIT System variable for ramp parameters in MotionView	F	Y	R/W	Accel value for velocity mode Range: 0.1 - 5000000	Rpm*Sec
77	VAR_DECEL_LIMIT System variable for ramp parameters in MotionView	F	Y	R/W	Decel value for velocity mode Range: 0.1 - 5000000	Rpm*Sec
78	VAR_FAULT_RESET	W	Y	R/W	Reset fault configuration: 1 - on deactivation of Enable/Inhibit input (A3) 0 - on activation of Enable/Inhibit input (A3)	
79	VAR_M2SRATIO_MASTER	W	Y	R/W	Master to system ratio. Master counts range: -32767 - +32767	EC
80	VAR_M2SRATIO_SYSTEM	W	Y	R/W	Master to system ratio. System counts range: 1 - 32767	EC

Index	Name	Format	EPM	Access	Description	Units
81	VAR_S2PRATIO_SECOND	W	Y	R/W	Secondary encoder to prime encoder ratio. Second counts range: -32767 - +32767	
82	VAR_S2PRATIO_PRIME	W	Y	R/W	Secondary encoder to prime encoder ratio. Prime counts range: 1 - 32767	
83	VAR_EXSTATUS	W	N	R	Extended status. Lower word copy of DSP status flags.	
84	VAR_HLS_MODE	W	Y	R/W	Hardware limit switches. 0 - not used 1 - stop and fault 2 - fault	
85	VAR_AOUT_FUNCTION	W	Y	R/W	Analog output function range: 0 - 8 0 - Not assigned 1 - Phase Current (RMS) 2 - Phase Current (Peak Value) 3 - Motor Velocity 4 - Phase Current R 5 - Phase Current S 6 - Phase Current T 7 - Iq current 8 - Id current	
86	VAR_AOUT_VELSCALE	F	Y	R/W	Analog output scale for velocity quantities. Range: 0.1 - 5	mV/Rpm
87	VAR_AOUT_CURSCALE	F	Y	R/W	Analog output scale for current related quantities. Range: 0.1 - 10	V/A
88	VAR_AOUT	F	N	W	Analog output value.(Used if VAR #84 is set to 0 - no function) Range: 0 - 10	V
89	VAR_AIN1_DEADBAND	F	Y	R/W	Analog input #1 dead-band. Applied when used as current or velocity reference. Range: 0 - 50	mV
90	VAR_AIN1_OFFSET		Y	R/W	Analog input #1 offset. Applied when used as current/velocity reference Range: -1000 - +1000	mV
91	VAR_SUSPEND_MOTION	W	N	R/W	Suspend motion. Suspends motion produced by trajectory generator. Current move will be completed before motion is suspended. 0 - motion enabled 1 - motion disabled	
92	VAR_MOVEP	W	N	W	Target position for absolute move. Writing value executes Move to position as per MOVEP statement using current values of acceleration, deceleration and max velocity.	
93	VAR_MOVED	W	N	W	Incremental position. Writing value <>0 executes Incremental move as per MOVED statement using current values of acceleration, deceleration and max velocity.	
94	VAR_MDV_DISTANCE	F	N	W	Distance for MDV move	UU
95	VAR_MDV_VELOCITY	F	N	W	Velocity for MDV move. Writing to this variable executes MDV move with Distance value last written to variable #94	UU
96	VAR_MOVE_PWI1	W	N	W	Writing value executes Move in positive direction while input true (active). Value specifies input #	
97	VAR_MOVE_PWI0	W	N	W	Writing value executes Move in positive direction while input false (not active). Value specifies input #	
98	VAR_MOVE_NWI1	F	N	W	Writing value executes Move negative direction while input true (active). Value specifies input #	
99	VAR_MOVE_NWI0	F	N	W	Writing value executes Move negative direction while input false (not active). Value specifies input #	

Index	Name	Format	EPM	Access	Description	Units
100	VAR_V0	F	N	R/W	User variable General purpose user defined variable	
101	VAR_V1	F	N	R/W	User variable General purpose user defined variable	
102	VAR_V2	F	N	R/W	User variable General purpose user defined variable	
103	VAR_V3	F	N	R/W	User variable General purpose user defined variable	
104	VAR_V4	F	N	R/W	User variable General purpose user defined variable	
105	VAR_V5	F	N	R/W	User variable General purpose user defined variable	
106	VAR_V6	F	N	R/W	User variable General purpose user defined variable	
107	VAR_V7	F	N	R/W	User variable General purpose user defined variable	
108	VAR_V8	F	N	R/W	User variable General purpose user defined variable	
109	VAR_V9	F	N	R/W	User variable General purpose user defined variable	
110	VAR_V10	F	N	R/W	User variable General purpose user defined variable	
111	VAR_V11	F	N	R/W	User variable General purpose user defined variable	
112	VAR_V12	F	N	R/W	User variable General purpose user defined variable	
113	VAR_V13	F	N	R/W	User variable General purpose user defined variable	
114	VAR_V14	F	N	R/W	User variable General purpose user defined variable	
115	VAR_V15	F	N	R/W	User variable General purpose user defined variable	
116	VAR_V16	F	N	R/W	User variable General purpose user defined variable	
117	VAR_V17	F	N	R/W	User variable General purpose user defined variable	
118	VAR_V18	F	N	R/W	User variable General purpose user defined variable	
119	VAR_V19	F	N	R/W	User variable General purpose user defined variable	
120	VAR_V20	F	N	R/W	User variable General purpose user defined variable	
121	VAR_V21	F	N	R/W	User variable General purpose user defined variable	
122	VAR_V22	F	N	R/W	User variable General purpose user defined variable	
123	VAR_V23	F	N	R/W	User variable General purpose user defined variable	
124	VAR_V24	F	N	R/W	User variable General purpose user defined variable	
125	VAR_V25	F	N	R/W	User variable General purpose user defined variable	
126	VAR_V26	F	N	R/W	User variable General purpose user defined variable	
127	VAR_V27	F	N	R/W	User variable General purpose user defined variable	

Index	Name	Format	EPM	Access	Description	Units
128	VAR_V28	F	N	R/W	User variable General purpose user defined variable	
129	VAR_V29	F	N	R/W	User variable General purpose user defined variable	
130	VAR_V30	F	N	R/W	User variable General purpose user defined variable	
131	VAR_V31	F	N	R/W	User variable General purpose user defined variable	
132	VAR_MOVEDR_DISTANCE	F	N		Registered move distance. Incremental motion as per MOVEDR statement	UU
133	VAR_MOVEDR_ DISPLACEMENT	F	N		Registered move displacement Writing to this variable executes the move MOVEDR using value set by #132	UU
134	VAR_MOVEPR_DISTANCE		N	W	Registered move distance. Absolute motion as per MOVEPR statement	UU
135	VAR_MOVEPR_ DISPLACEMENT	F	N	W	Registered move displacement Writing to this variable makes the move MOVEPR using value set by #134	UU
136	VAR_STOP_MOTION	W	N	W	Stops motion: 1 - stops motion 0 - no action	
137	VAR_START_PROGRAM	W	N	W	Starts user program 1 - starts program 0 - no action	
138	VAR_VEL_MODE_ON	W	N	W	Turns on “profile” velocity. (Acts as statement VELOCITY ON) 0 - normal operation 1 - velocity mode on	
139	VAR_IREF	F	N	R/W	Internal reference for Current or Velocity mode. In Velocity mode: In Current mode	RPS Amps
140	VAR_NV0	F	N	R/W	User defined Network variable. Variable can be shared across Ethernet network.	
141	VAR_NV1	F	N	R/W	User defined Network variable. Variable can be shared across Ethernet network.	
142	VAR_NV2	F	N	R/W	User defined Network variable. Variable can be shared across Ethernet network.	
143	VAR_NV3	F	N	R/W	User defined Network variable. Variable can be shared across Ethernet network.	
144	VAR_NV4	F	N	R/W	User defined Network variable. Variable can be shared across Ethernet network.	
145	VAR_NV5	F	N	R/W	User defined Network variable. Variable can be shared across Ethernet network.	
146	VAR_NV6	F	N	R/W	User defined Network variable. Variable can be shared across Ethernet network.	
147	VAR_NV7	F	N	R/W	User defined Network variable. Variable can be shared across Ethernet network.	
148	VAR_NV8	F	N	R/W	User defined Network variable. Variable can be shared across Ethernet network.	
149	VAR_NV9	F	N	R/W	User defined Network variable. Variable can be shared across Ethernet network.	
150	VAR_NV10	F	N	R/W	User defined Network variable. Variable can be shared across Ethernet network.	
151	VAR_NV11	F	N	R/W	User defined Network variable. Variable can be shared across Ethernet network.	
152	VAR_NV12	F	N	R/W	User defined Network variable. Variable can be shared across Ethernet network.	

Index	Name	Format	EPM	Access	Description	Units
153	VAR_NV13	F	N	R/W	User defined Network variable. Variable can be shared across Ethernet network.	
154	VAR_NV14	F	N	R/W	User defined Network variable. Variable can be shared across Ethernet network.	
155	VAR_NV15	F	N	R/W	User defined Network variable. Variable can be shared across Ethernet network.	
156	VAR_NV16	F	N	R/W	User defined Network variable. Variable can be shared across Ethernet network.	
157	VAR_NV17	F	N	R/W	User defined Network variable. Variable can be shared across Ethernet network.	
158	VAR_NV18	F	N	R/W	User defined Network variable. Variable can be shared across Ethernet network.	
159	VAR_NV19	F	N	R/W	User defined Network variable. Variable can be shared across Ethernet network.	
160	VAR_NV20	F	N	R/W	User defined Network variable. Variable can be shared across Ethernet network.	
161	VAR_NV21	F	N	R/W	User defined Network variable. Variable can be shared across Ethernet network.	
162	VAR_NV22	F	N	R/W	User defined Network variable. Variable can be shared across Ethernet network.	
163	VAR_NV23	F	N	R/W	User defined Network variable. Variable can be shared across Ethernet network.	
164	VAR_NV24	F	N	R/W	User defined Network variable. Variable can be shared across Ethernet network.	
165	VAR_NV25	F	N	R/W	User defined Network variable. Variable can be shared across Ethernet network.	
166	VAR_NV26	F	N	R/W	User defined Network variable. Variable can be shared across Ethernet network.	
167	VAR_NV27	F	N	R/W	User defined Network variable. Variable can be shared across Ethernet network.	
168	VAR_NV28	F	N	R/W	User defined Network variable. Variable can be shared across Ethernet network.	
169	VAR_NV29	F	N	R/W	User defined Network variable. Variable can be shared across Ethernet network.	
170	VAR_NV30	F	N	R/W	User defined Network variable. Variable can be shared across Ethernet network.	
171	VAR_NV31	F	N	R/W	User defined Network variable. Variable can be shared across Ethernet network.	
172	VAR_SERIAL_ADDRESS	W	Y	R/W	RS485 drive ID. Range: 0 - 31	
173	VAR_MODBUS_BAUDRATE	W	Y	R/W	Baud rate index for ModBus operations: 1 - 4800 2 - 9600 3 - 19200 4 - 38400 5 - 57600 6 - 115200	
174	VAR_MODBUS_DELAY	W	Y	R/W	ModBus reply delay in mS Range: 0 - 1000	mS
175	VAR_RS485_CONFIG	W	Y	R/W	Rs485 configuration: 0 - normal IP over PPP 1 - ModBus	
176	VAR_PPP_BAUDRATE	W	Y	R/W	RS232/485 (normal mode) baud rate index. 1 - 4800 2 - 9600 3 - 19200 4 - 38400 5 - 57600 6 - 115200	

Index	Name	Format	EPM	Access	Description	Units
177	VAR_MOVEPS	F	N	W	Same as variable #92 but using S-curve acceleration/deceleration	
178	VAR_MOVEDS	F	N	W	Same as variable #93 but using S-curve acceleration/deceleration	
179	VAR_MDVS_VELOCITY		N	W	Velocity value for MDV move. Writing to this variable puts MDV segment to motion stack subsequently causing motion to be executed (unless motion is suspended by #91). Distance is taken from #94 variable which must be written prior writing to this variable.	UU
180	VAR MAXVEL	F	N	R/W	Max velocity for motion profile	UU/S
181	VAR ACCEL	F	N	R/W	Accel value for indexing	UU/S^2
182	VAR DECEL	F	N	R/W	Decel value for indexing	UU/S^2
183	VAR_QDECEL	F	N	R/W	Quick decel value	UU/S^2
184	VAR INPOSLIM	W	N	R/W	“In position” limit	UU
185	VAR VEL	F	N	R/W	Velocity reference for “Profiled” velocity	UU/S
186	VAR UNITS	F	Y	R/W	User units	
187	VAR_MECOUNTER	W	N	R/W	A/B inputs reference counter value	Count
188	VAR PHCUR	F	N	R	Phase current	A
189	VAR POS PULSES	W	N	R/W	Target position in encoder pulses	EC
190	VAR APOS PULSES	W	N	R/W	Actual position in encoder pulses	EC
191	VAR_POSERROR_PULSES	W	N	R	Position error in encoder pulses	EC
192	VAR CURRENT VEL PPS	F	N	R	Current velocity in PPS (pulses per sample)	PPS
193	VAR CURRENT ACCEL PPSS	F	N	R	Current acceleration (demanded value) value	PPSS
194	VAR_IN0_DEBOUNCE	W	Y	R/W	Input de-bounce time in mS Range: 0 - 1000	mS
195	VAR_IN1_DEBOUNCE	W	Y	R/W	Input de-bounce time in mS Range: 0 - 1000	mS
196	VAR_IN2_DEBOUNCE	W	Y	R/W	Input de-bounce time in mS Range: 0 - 1000	mS
197	VAR_IN3_DEBOUNCE	W	Y	R/W	Input de-bounce time in mS Range: 0 - 1000	mS
198	VAR_IN4_DEBOUNCE	W	Y	R/W	Input de-bounce time in mS Range: 0 - 1000	mS
199	VAR_IN5_DEBOUNCE	W	Y	R/W	Input de-bounce time in mS Range: 0 - 1000	mS
200	VAR_IN6_DEBOUNCE	W	Y	R/W	Input de-bounce time in mS Range: 0 - 1000	mS
201	VAR_IN7_DEBOUNCE	W	Y	R/W	Input de-bounce time in mS Range: 0 - 1000	mS
202	VAR_IN8_DEBOUNCE	W	Y	R/W	Input de-bounce time in mS Range: 0 - 1000	mS
203	VAR_IN9_DEBOUNCE	W	Y	R/W	Input de-bounce time in mS Range: 0 - 1000	mS
204	VAR_IN10_DEBOUNCE	W	Y	R/W	Input de-bounce time in mS Range: 0 - 1000	mS
205	VAR_IN11_DEBOUNCE	W	Y	R/W	Input de-bounce time in mS Range: 0 - 1000	mS
206	VAR_OUT0_FUNCTION	W	Y	R/W	Programmable Output function 1: Zero Speed 2: In Speed Window 3: Current Limit 4: Run time fault 5: Ready 6: Brake 7: In position	
207	VAR OUT1 FUNCTION	W	Y	R/W	Output function index	

Index	Name	Format	EPM	Access	Description	Units
208	VAR_OUT2_FUNCTION	W	Y	R/W	Output function index	
209	VAR_OUT3_FUNCTION	W	Y	R/W	Output function index	
210	VAR_HALLCODE	W	N	R	Current hall code Bit 0 - Hall 1 Bit 1 - Hall 2 Bit 2 - Hall 3	
211	VAR_ENCODER	W	N	R	Primary encoder current value	EC
212	VAR_RPOS_PULSES	W	N	R	Registration position	EC
213	VAR_RPOS	F	N	R	Registration position	UU
214	VAR_POS	F	N	R/W	Target position	UU
215	VAR_APOS	F	N	R/W	Actual position	UU
216	VAR_POSERROR	W	N	R	Position error	EC
217	VAR_CURRENT_VEL	F	N	R	Current velocity (demanded value)	UU/S
218	VAR_CURRENT_ACCEL	F	N	R	Current acceleration (demanded value)	UU/S^2
219	VAR_TPOS_ADVANCE	W	N	W	Target position advance. Every write to this variable adds value to the Target position summing point. Value gets added once per write. This variable useful when loop is driven by Master encoder signals and trying to correct phase. Value is in encoder counts	EC
220	VAR_IOINDEX	W	N	R/W	Same as INDEX variable in user's program. See "INDEX" in Language Reference section Of this manual.	
221	VAR_PSLIMIT_PULSES	W	Y	R/W	Positive Software limit switch value in Encoder counts	EC
222	VAR_NSLIMIT_PULSES	W	Y	R/W	Negative Software limit switch value in Encoder counts	EC
223	VAR_ SLS_MODE	W	Y	R/W	Soft limit switch action code: 0 - no action 1- Fault. 2- Stop and fault (When loop is driven by trajectory generator only. With all the other sources same action as 1) --	
224	VAR_PSLIMIT	F	Y	R/W	Same as var 221 but value in User Units	UU
225	VAR_NSLIMIT	F	Y	R/W	Same as var 222 but value in User Units	UU
226	VAR_SE_APOS_PULSES	W	N	R/W	2nd encoder actual position in encoder counts	EC
227	VAR_SE_POSERROR_PULSES	W	N	R	2nd encoder position error in encoder counts	EC
228	VAR_MODBUS_PARITY	W	Y	R/W	Parity for Modbus Control: 0 - No Parity 1 - Odd Parity 2 - Even Parity	
229	VAR_MODBUS_STOPBITS	W	Y	R/W	Number of Stopbits for Modbus Control: 0 - 1.0 1 - 1.5 2 - 2.0	
230	VAR_M_NOMINALVEL	F	Y	R/W	Induction Motor Parameter: Nominal Velocity Range: 0 - 20000 RPM	RPM
231	VAR_M_COSPHI	F	Y	R/W	Induction Motor Parameter: Cosine Phi Range: 0 - 1.0	
232	VAR_M_BASEFREQUENCY	F	Y	R/W	Induction Motor Parameter: Base Frequency: Range: 0 - 400Hz	

Index	Name	Format	EPM	Access	Description	Units
234	VAR_CAN_BAUD_EPM	W	Y	R/W	CAN Bus Parameter: Baud Rate: 1 - 8 1 - 10k 2 - 20k 3 - 50k 4 - 125k 5 - 250k 6 - 500k 7 - 800k 8 - 1000k	
235	VAR CAN ADDR EPM	W	Y	R/W	CAN Bus Parameter: Address: 1-127	
236	VAR_CAN_OPERMODE_EPM	W	Y	R/W	CAN Bus Parameter: Boot-up Mode: 0 - 2 (Operational State Control) 0 - jumps to pre-operational state 1 - jumps to operational state 2 - pseudo NMT: sends NMT Staert Node command after delay (set by variable 237)	
237	VAR_CAN_OPERDELAY_EPM	W	Y	R/W	CAN Bus Parameter: pseudo NMT mode delay time in seconds (refer to variable 236)	sec
238	VAR_CAN_ENABLE_EPM	W	Y	R/W	CAN Bus Parameter: Mode Control: 0, 1, 2 0 - Disable CAN interface 1 - Enable CAN interface in DS301 mode Concurrent user's program execution possible 2 - Enable CAN interface in DS402 mode Concurrent user's program execution possible	
239	VAR_HOME_ACCEL	F	Y		Homing Mode: ACCEL rate: 0 - 10000000.0	UU/sec^2
240	VAR HOME OFFSET	F	Y	R/W	Homing Mode: Home Position Offset	UU
241	VAR_HOME_OFFSET_PULSES	W	Y	R/W	Homing Mode: Home Position Offset in encoder counts	EC
242	VAR_HOME_FAST_VEL	F	Y	R/W	Homing Mode: Fast Velocity	UU/sec
243	VAR HOME SLOW VEL	F	Y	R/W	Homing Mode: Slow Velocity	UU/sec
244	VAR HOME METHOD	W	Y	R/W	Homing Mode: Homing Method: 1 - 35	
245	VAR_START_HOMING	W	N	W	Homng Mode: Start Homing: 0, 1 0 - No action 1 - Start Homing	
246	VAR_HOME_SWITCH_INPUT	W	Y	R/W	Homing Mode: Switch Input Assignment: 0 - 11 0 - 3: A1 - A4 4 - 7: B1 - B4 8 - 11: C1 - C4	
247	VAR_M_VALIDATE_MOTOR	W	N	W	Makes Drive accept Motor's parameters Previously written as 'validate motor data'. Motor parameters are variables whose identifier starts with VAR_M_xxxxxx	
248 to 258	RESERVED Do Not Use	F	Y	R/W	Reserved for Future Expansion	
259	RESOLVER_EMU_TRK	W	Y	R/W	Resolver Emulation Track Number: 0 - 15 If resolver module has encoder emulation capability, emulation resolution can be set by sstting the emulation track. Refer to resolver module manual for details.	

NOTES

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