VLC-2-EIP

USER MANUAL

Version 1.0

Disclaimer

The contents of this user manual are intended to be as accurate as possible, but may be subject to change without prior notification. SMAC shall not be liable for any damages that may arise as a consequence of the use of information presented in this user manual.

Document Version	Note	By	Date
1.0	First released version	RZ	5/13/2022
1.1	Updated the VLC-2-EIP picture and connector numbering. Added a new section on programming guidelines.	RZ	7/29/2022

Contents

1 Introduction

The VLC-2-EIP is an ODVA-conformant Ethernet/IP servo drive that is based on SMAC's VLC-25-07 2-axis integrated controller/driver and an additional layer that provides the Ethernet/IP connectivity. As opposed to the traditional daisy-chaining of two separate Ethernet/IP servo drives for the control of 2-axis system such as SMAC's LCR/LAR series actuators, a single VLC-2-EIP is able to achieve the same task at a lower cost and a lower installation complexity.

The VLC part of the servo drive is pre-programmed with system macros to accommodate control and monitoring functionalities of the servo drive. Additional macros can be programmed in the VLC to perform subroutines/functions that can be called from the Ethernet/IP master. Background knowledge on the VLC is required to configure the servo parameters of the VLC-2-EIP. Please refer to the latest VLC-25-07 manual for more information on the servo drive parameters and programming.

Table 1.1. VLC-EIP-25 specifications (based on Hardware version 1.0).

Description	Ethernet/IP 2-axis servo motor controller/driver
Operating Modes	Position, Velocity, Torque
Filter Algorithm	PID
Max. Servo Loop Rate	100 µS
Trajectory Generator	Trapezoidal, electronic gearing
Servo Position Feedback	Incremental Encoder with Index
Output	PWM (space-vector-modulated), 6.0 A Continuous and 7.8 A Peak.
Motor Type	3-Phase Brushless, DC Brushed, DC Linear Actuator
PWM Frequency	20.0 KHz
Current resolution	2.93 mA (approximate)
Encoder and Index Input	Differential
Encoder Supply Voltage	5 VDC
Encoder Input Voltage	5.5 VDC Max., -0.1 VDC Min.
Encoder Count Rate	40 million encoder counts per second
Position Range	31 Bits
Velocity Range	31 Bits
Acceleration Range	31 Bits
General Purpose Digital I/O	4x opto-isolated digital inputs, 5V to 24 V max 4x opto-isolated digital outputs, 60V, 200 mA max
Dedicated Digital I/O	2x opto-isolated coarse home inputs
STO (Safe Torque Off)	2x STO opto-isolated digital inputs, 5V to 24 V max 1x STO opto-isolated feedback output, 60V, 200 mA max
Analog Inputs	2x 12-bit pseudo-differential analog inputs, 0 to +/- 10V range 3x 12-bit analog inputs, 0V to 10V range (0V to <10V optional)
Analog Outputs	2x 12-bit analog outputs, 0V to 10V range (0V to 5V optional)

LEDs	1x Power on LED 1x Status LED 2x Fault LEDs
Serial Interface	RS-232 non-isolated, 9600 baud default, selectable between 2400 - 921600
Supply Voltage	+8 To +48 VDC
Protections	> Reversed power supply polarity connection > Driver overtemperature > I^2T > (excessive) servo position error
Program space (VLC part)	> Macro storage: 56286 bytes > Maximum number of macros: 512 > Maximum number of program registers: 2048

2 Hardware and Software Setup

2.1 Hardware

2.1.1 Power/signal/communication connectors

Figure 2.1 shows the VLC-2-EIP, consisting of a mother- and daughter- boards. The motherboard is essentially a VLC-25-07 (2-axis integrated controller/servo drive), whereas the daughterboard contains all the Ethernet/IP-related components. Pinout details of the connectors J1-J8, ETH1-2 and status LEDs in Fig. 2.1 are presented in the following pages.

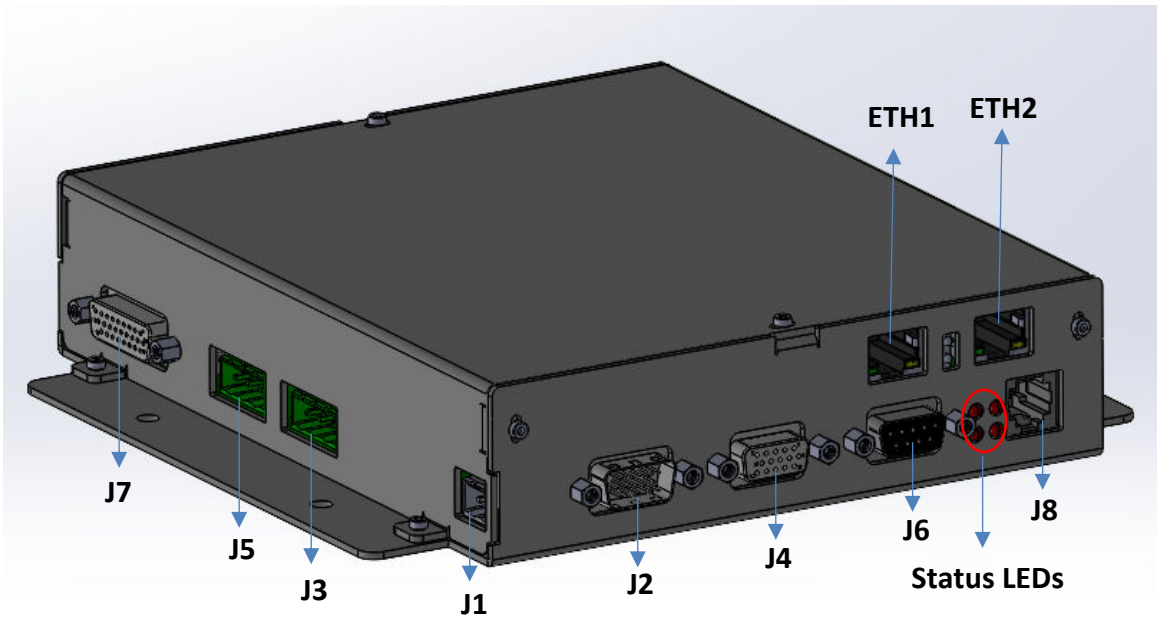
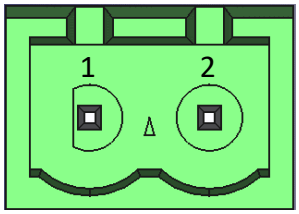


Figure 2.1. VLC-2-EIP

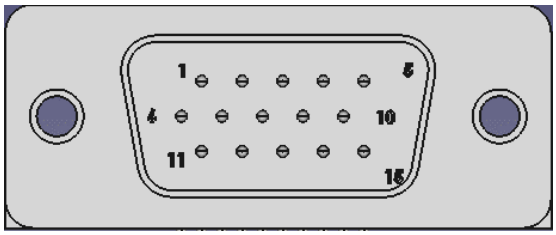
J1 - Power interface



2 pin terminal block header, 5.08 mm pitch.

Pin number	Signal	Description
1	V+	Power supply positive
2	V-	Power supply return / ground

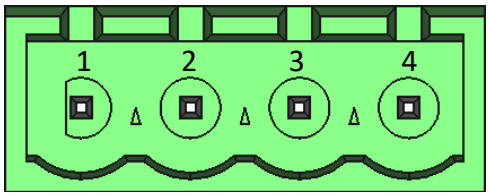
J2 – General purpose + dedicated digital opto-isolated I/O



D-SUB 15 connector, high-density, male.

Pin number	Signal	Description
1	GPI0	General purpose digital input 0
2	GPI1	General purpose digital input 1
3	GPI2	General purpose digital input 2
4	GPI3	General purpose digital input 3
5	GPI_COM	Common terminal for general purpose digital inputs
6	GPO0	General purpose digital output 0
7	GPO1	General purpose digital output 1
8	GPO2	General purpose digital output 2
9	GPO3	General purpose digital output 3
10	GPO_COM	Common terminal for general purpose digital outputs
11	+5V	+5V power for external circuitry
12	STO2	STO input 2
13	STO1	STO input 1
14	STO_FB	STO feedback output
15	STO_COM	Common terminal for STO's

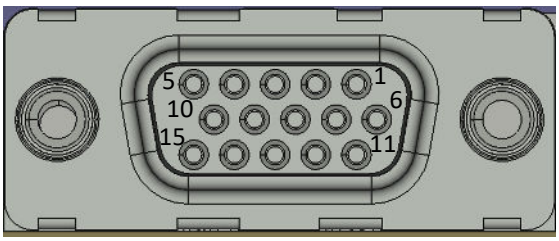
J3 – Axis 2 Motor Output



4 pin terminal block header, 5.08 mm pitch.

Pin number	Signal	Description
1	2MA	Axis 2 motor phase A/U (positive for single-phase actuators)
2	2MB	Axis 2 motor phase B/V (negative for single-phase actuators)
3	2MC	Axis 2 motor phase C/W
4	GND	Ground

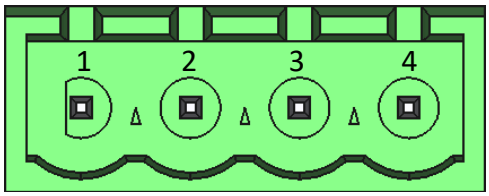
J4 – Analog I/O



D-SUB 15 connector, high-density, female.

Pin number	Signal	Description
1	AN_IN2	Analog input 2, single-ended
2	AN_OUT0	Analog output 0
3	AN_OUT1	Analog output 1
4	AN_IN0+	Analog input 0, differential input +
5	AN_IN1+	Analog input 1, differential input +
6	AN_IN3	Analog input 3, single-ended
7	GND	Ground
8	GND	Ground
9	AN_IN0-	Analog input 0, differential input -
10	AN_IN1-	Analog input 1, differential input -
11	AN_IN4	Analog input 4, single-ended
12	+5V	+5V power for external circuitry
13	+5V	+5V power for external circuitry
14	GND	Ground
15	GND	Ground

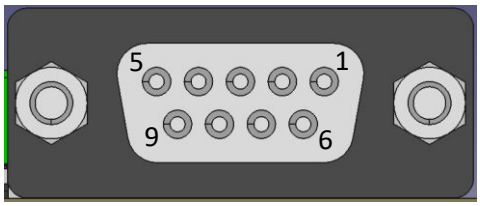
J5 – Axis 1 Motor Output



4 pin terminal block header, 5.08 mm pitch.

Pin number	Signal	Description
1	1MA	Axis 1 motor phase A/U (positive for single-phase actuators)
2	1MB	Axis 1 motor phase B/V (negative for single-phase actuators)
3	1MC	Axis 1 motor phase C/W
4	GND	Ground

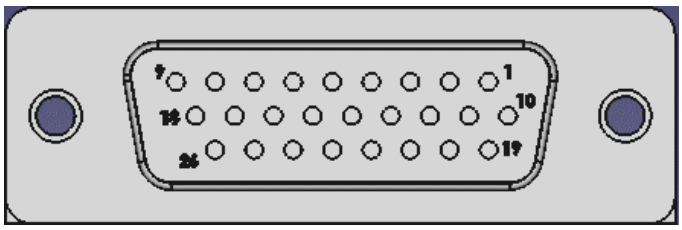
J6 – Communication (RS232)



D-SUB 9 connector, female.

Pin number	Signal	Description
1	+5V	+5V power for external circuitry
2	TX	RS232 Transmit
3	RX	RS232 Receive
4	N/C	Not connected
5	GND	Ground
6	N/A	Reserved, do not connect
7	N/A	Reserved, do not connect
8	N/A	Reserved, do not connect
9	N/A	Reserved, do not connect

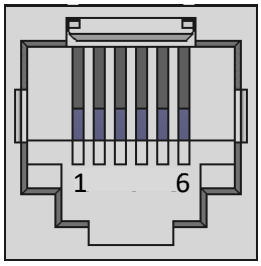
J7 – Incremental encoder interface



D-SUB 26 connector, high-density, female.

Pin number	Signal	Description
1	N/C	Not connected
2	N/C	Not connected
3	N/C	Not connected
4	+5V	+5V power for external circuitry
5	+5V	+5V power for external circuitry
6	2A-	Axis 2 encoder phase A-
7	2A+	Axis 2 encoder phase A+
8	1A-	Axis 1 encoder phase A-
9	1A+	Axis 1 encoder phase A+
10	N/C	Not connected
11	N/C	Not connected
12	1HOM	Axis 1 home input
13	GND	Ground
14	GND	Ground
15	2B-	Axis 2 encoder phase B-
16	2B+	Axis 2 encoder phase B+
17	1B-	Axis 1 encoder phase B-
18	1B+	Axis 1 encoder phase B+
19	2HOM	Axis 2 home input
20	N/C	Not connected
21	GND	Ground
22	GND	Ground
23	2Z-	Axis 2 encoder phase index-
24	2Z+	Axis 2 encoder phase index+
25	1Z-	Axis 1 encoder phase index-
26	1Z+	Axis 1 encoder phase indx+

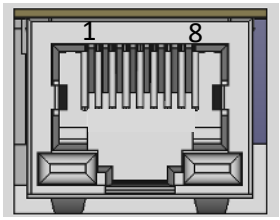
J8 – Expansion I/O



RJ-25 socket connector.

Pin number	Signal	Description
1	RX-	Receive data- input
2	TX-	Transmit data- input
3	RX+	Receive data+ input
4	TX+	Transmit data+ input
5	CLK+	Clock+ input
6	CLK-	Clock- input

ETH1 & ETH2 (Ethernet/IP ports)

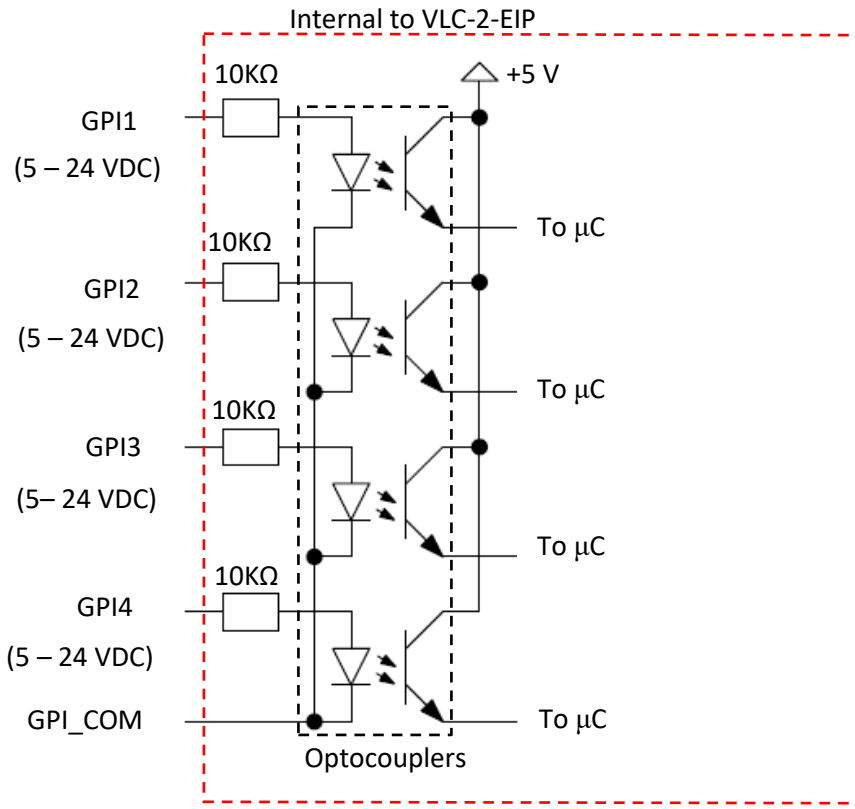


RJ-45 Jack.

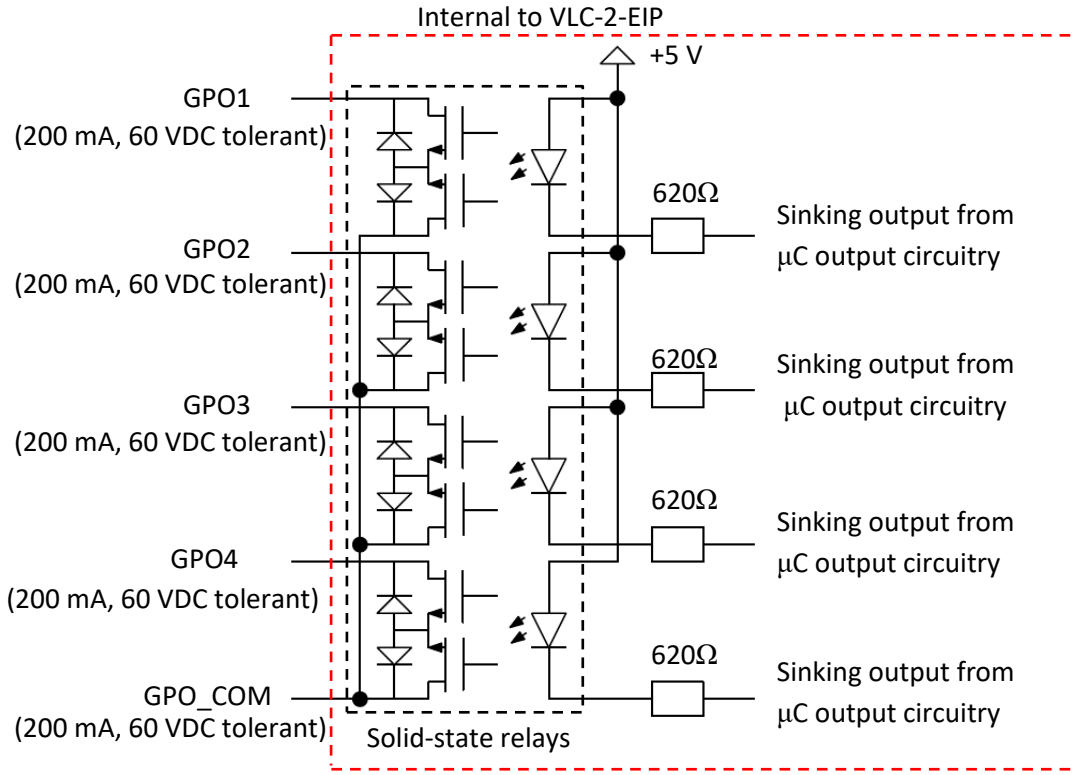
Pin	Signal	Description
1	TD+	Transmit data +
2	TD-	Transmit data -
3	RD+	Receive data +
6	RD-	Receive data -

2.1.2 I/O electrical schematics

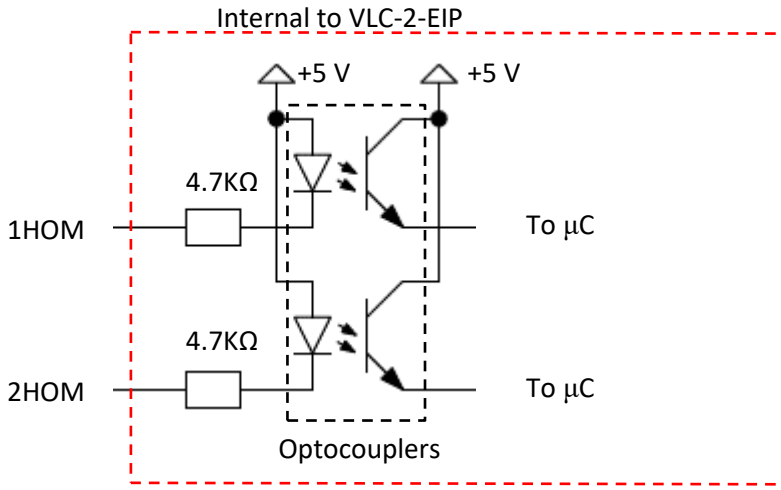
Digital inputs



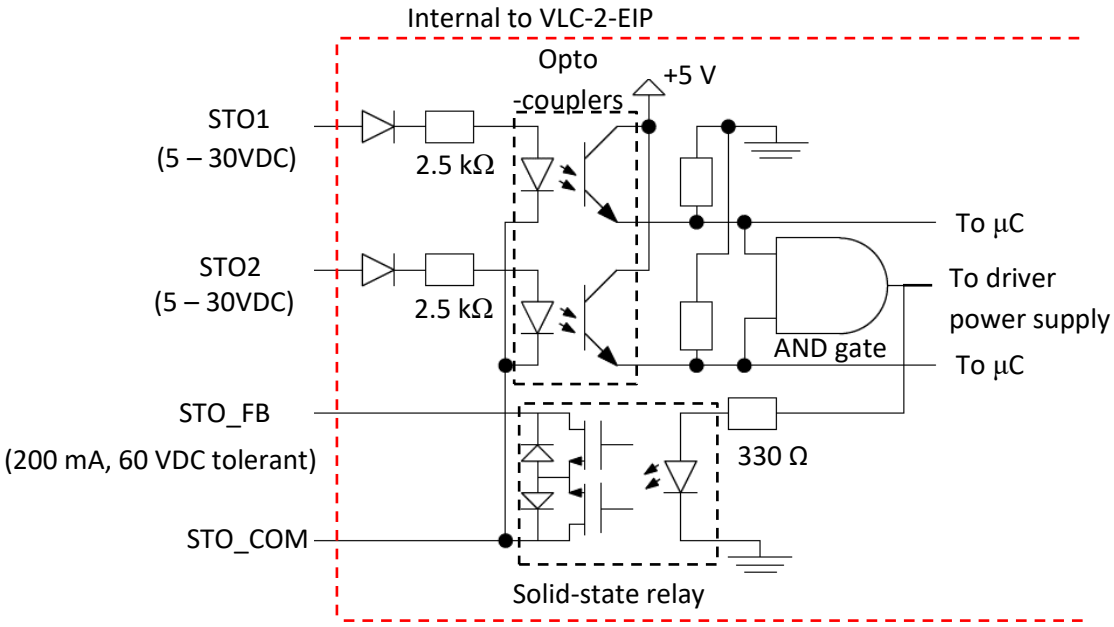
Digital outputs



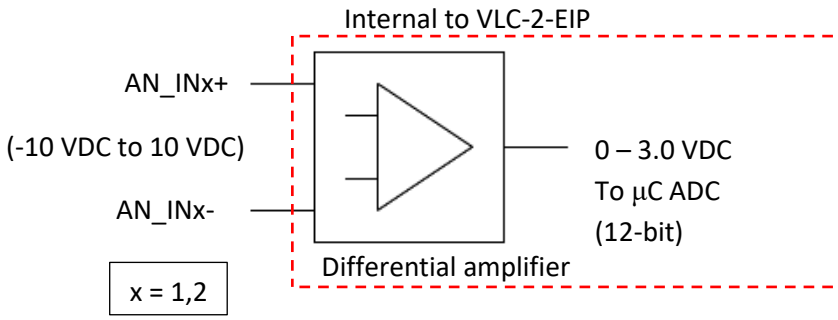
Home inputs



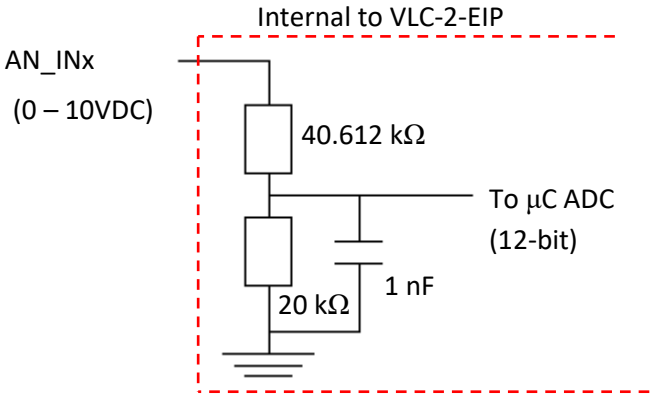
STO



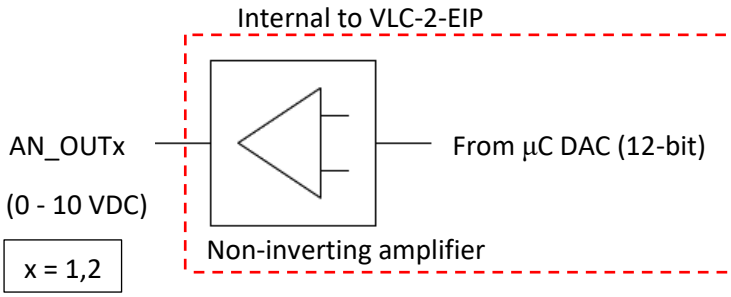
Analog input (differential)



Analog input (single-ended)



Analog output



2.1.3 LEDs

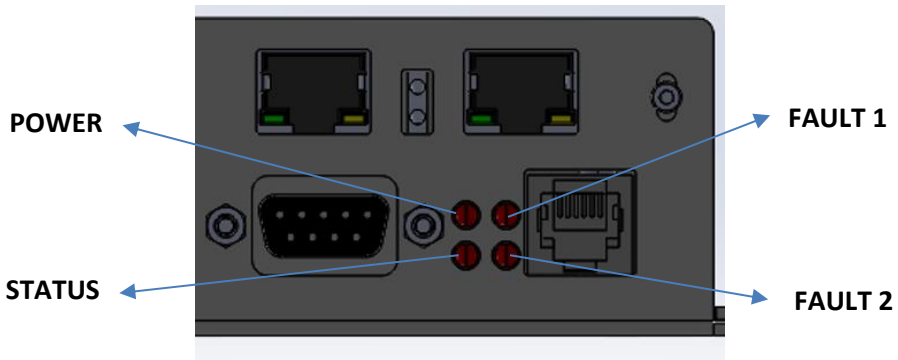


Figure 2.2. VLC-2-EIP status LED's.

There are 4 LEDs in VLC-2-EIP, namely power, status, axis 1 fault and axis 2 fault. The location of these LEDs can be seen in Figure 2.2.

- Power LED turns ON when the specified DC voltage is supplied into the controller
- Status LED blinks if an incorrect program command is executed
- Axis fault LED turns ON when the corresponding servo axis experiences fault such as driver overtemperature, I^2T trip and excessive servo position error (SE command).

2.1.4 Optional: disabling the STO

The two STO inputs (STO1 and STO2, see section 2.1.2) have to be supplied with the specified DC voltage in order to enable the VLC's driver power stage to operate the actuator. If the external means of supplying the DC voltage is not considered, the VLC's on-board +5V supply can be used to supply STO1 and STO2, and together with connecting the STO_COM with the GND, the power stage is enabled. This is shown in Figure 2.3. When both STO1 and STO2 are energized, the STO_FB output becomes active to indicate the drive is ready to be operated.

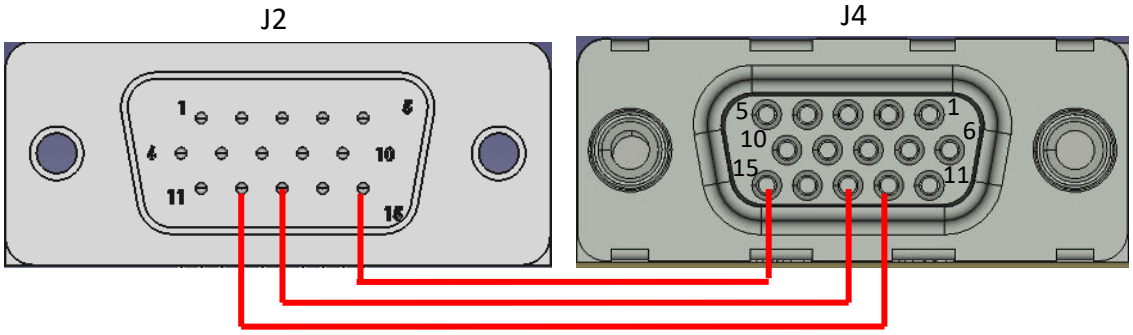


Figure 2.3. Disabling STO in VLC-2-EIP with the on-board +5V supply.

2.2 Software

2.2.1 VLC configuration

Remark: to perform VLC configuration, the user is expected to be familiar with programming the VLC/LAC. Refer to the latest VLC-25-07 manual for more information on the programming.

Serial communication can be established between the VLC part and a PC through the RS232 port (J6) of the VLC-EIP-25. A serial terminal software (with selectable baud rates of up to 921600, such as Tera Term) can be used to configure the VLC for the following purposes:

- Loading of system macros (unless the macros were pre-loaded in the VLC)
- Setting/tuning of actuator servo parameters (Optional, this can also be done through Ethernet/IP)
- Programming of custom macros to be called via Ethernet/IP (Optional)

Appendix A presents the system macros. Due to these macros, there are restrictions in programming the custom macros as follow:

- All macros can be used except the reserved: 0 – 3, 120 – 162, 300 – 326, 400 – 439
- All registers can be used except: 200-413

For the VLC configuration, follow these steps:

- Set the serial baud rate of the serial terminal software to 921600.
- Type in the command EN and press enter. Note that any commands will not show up in the terminal window, unless this step has been performed.
- Set the VLC baud rate to a lower value, e.g. 9600, through the command BR9600 and press enter.
- Set the serial baud rate of the terminal software to 9600.
- At this point, the VLC can be configured/programmed as it is typically done.

2.2.2 Modification of IP settings

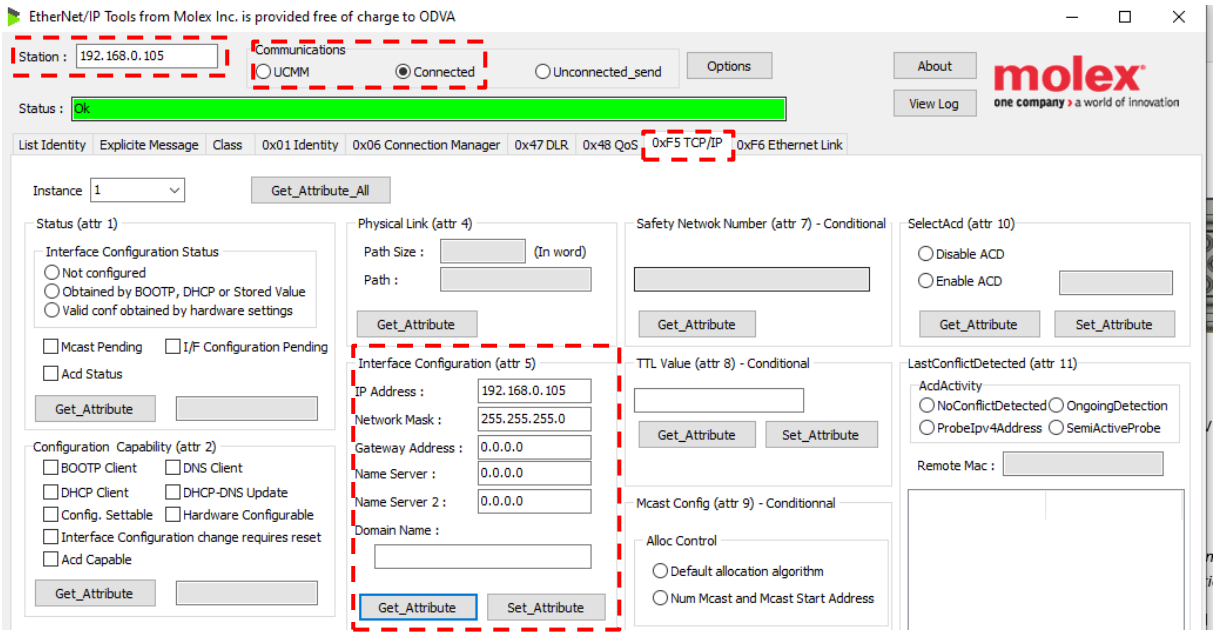
Table 2.1 presents the default values of the IP settings of the VLC-2-EIP. These settings can be modified through Ethernet/IP explicit message set attribute service of the standard TCP/IP object (Class 0xF5), instance 1, attribute 5 (Interface Configuration). The VLC-2-EIP will take the newly modified IP settings after a power cycle.

Table 2.1. IP-settings-related objects of VLC-2-EIP

Name	Type	Default Value
IP address	UINT32	0xC0A80069 (192.168.0.105)
Network Mask	UINT32	0xFFFFFF00 (255.255.255.0)
Gateway Address	UINT32	0.0.0.0
Name Server	UINT32	0
Name Server 2	UINT32	0

Users could use a free Ethernet/IP explicit messaging software such as Molex EIPTool to perform the IP settings modification. The steps are as follow:

- Set the PC's IP address to 192.168.0.1
- Open the Molex EIPTool software.
- Refer to the figure below and perform the following
    - Set the station to: 192.168.0.105
    - Set the Communications to either UCMM or Connected. Select the 0xF5 TCP/IP tab.
    - Click on Get_Attribute of the Interface Configuration (attr 5). This will show the default IP settings of Table 2.1.
    - Change the parameters of the Interface Configuration (attr 5) as required and click on Set_Attribute.
    - The newly set parameters (IP settings) will be applied after power cycling the VLC-1-EIP.



2.2.3 Connecting VLC-2-EIP to an Ethernet/IP network (with a Studio 5000 example)

The VLC-2-EIP is ready to be connected to an Ethernet/IP network, provided the following conditions are met

- System macros have been loaded and saved in the VLC
- The RS232 cable is disconnected from the RS232 port (J6) and after that, the VLC-EIP-25 is power-cycled.

2.2.3.1 Installation of EDS file

the EDS (Electronic Data Sheets) file of the VLC-2-EIP can be obtained from SMAC. In the Studio 5000 environment, create a new project. The EDS file installation steps are as follow (refer to Fig. 2.4):

1. Go to Tools>EDS Hardware Installation Tool
2. Click Next
3. Select “Register an EDS file”
4. Select “Register a single file” and use “Browse” to find the EDS file
5. Click “Finish” to complete the setup

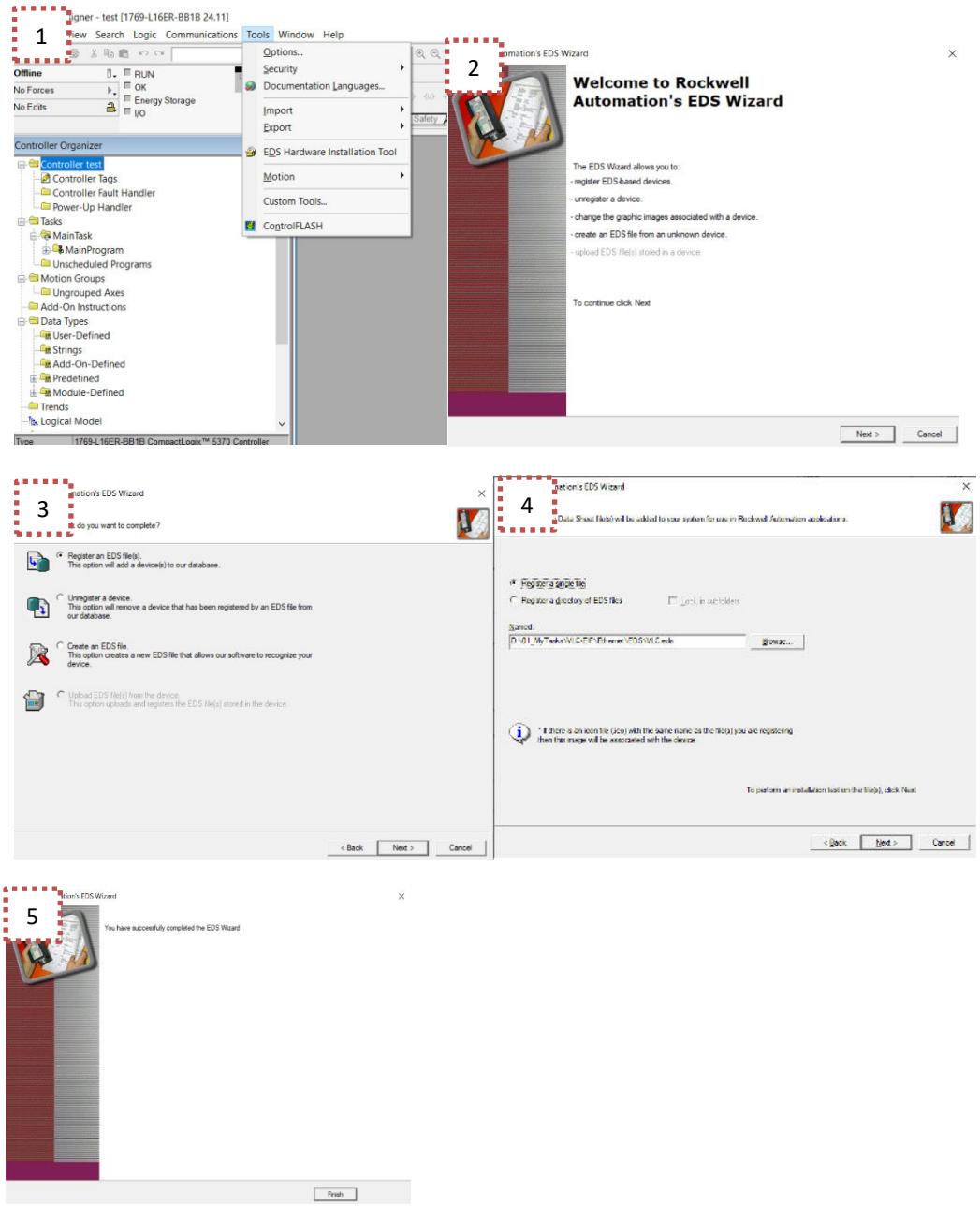
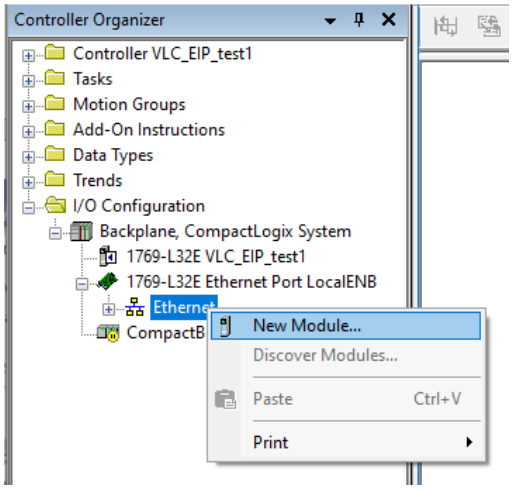


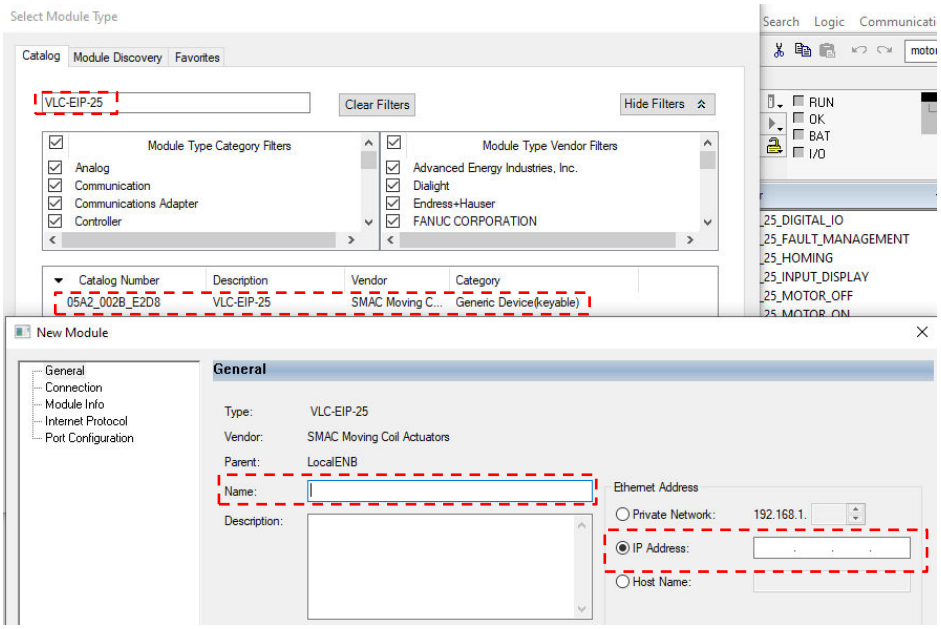
Figure 2.4. Installation of EDS file in Studio 5000.

2.2.3.2 Adding the VLC-2-EIP into the PLCs Ethernet/IP network

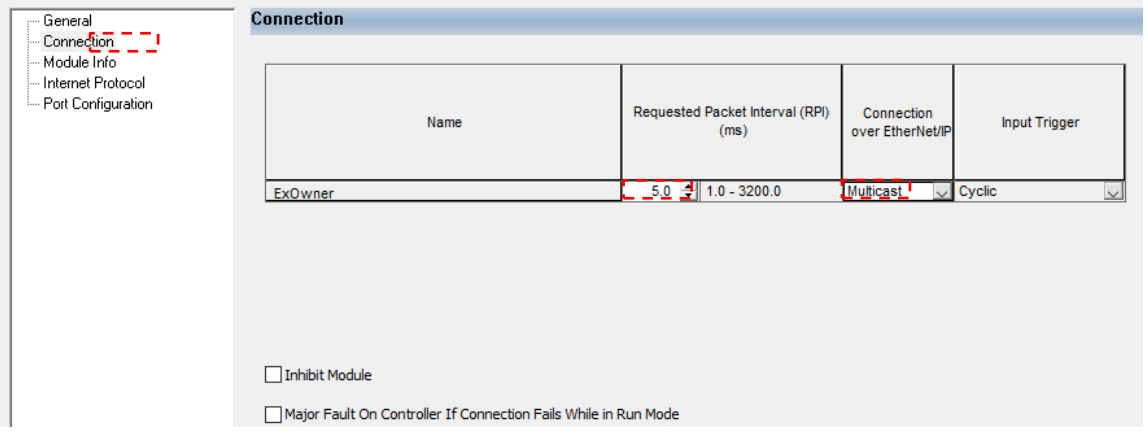
1. In the left-pane of Studio 5000 environment, right-click on ‘Ethernet’ and select ‘New Module..’



2. Search for the device’s name corresponding to the EDS file, as shown below, e.g. ‘VLC-EIP-25’. Double-click on the one corresponding to the VLC-2-EIP. In the ‘New Module’ window, specify a name for the VLC-EIP and the IP address based on the discussion in section 2.2.2 of this manual, whether the default one or a newly-defined one is used.



3. Select ‘Connection’, the RPI can be set as low as 5 ms and the Connection over Ethernet/IP can be set as Multicast.



3 Programming the VLC-2-EIP

3.1 Servo objects

Servo objects are parameters and variables that are used to perform control and monitoring of the VLC-2-EIP. From its update behaviour perspective, there are two servo object types in VLC-2-EIP:

- Acyclic: updated upon request, used for servo configuration purposes.
- Cyclic: updated periodically, manipulated and monitored by a motion program executed by the Ethernet/IP master.

3.1.1 Acyclic servo objects

Table 3.1 presents the acyclic servo objects of the VLC-2-EIP that are accessible through explicit messaging set and get services. All of the objects have an explicit message instance ID of 1. Objects with class IDs 0x68, 0x6A, 0x6B and 0x6C are standard ones that are also found in VLC-25-07, therefore, explanations on their usage are available in the VLC-25-07 user manual.

Table 3.1. List of acyclic servo objects. All of the objects have an instance ID of 1.

Class ID (hex)	Attribute ID (hex)	Object	Data Type	Data length (bytes)	VLC equiv. command/ variable
0x68		POSITION LOOP CONTROLLER PARAMETERS			
	0x1	Proportional constant – axis 1	UINT16	2	1SG
	0x2	Integral constant – axis 1	UINT16	2	1SI
	0x3	Derivative constant – axis 1	UINT16	2	1SD
	0x4	Integral limit – axis 1	UINT16	2	1IL
	0x5	Velocity feedforward constant – axis 1	UINT16	2	1FV
	0x6	Acceleration feedforward constant – axis 1	UINT16	2	1FA
	0x7	Derivative sampling frequency – axis 1	UINT8	1	1FR
	0x8	Integral Sampling gain – axis 1	UINT8	1	1RI
	0x9	Proportional constant – axis 2	UINT16	2	2SG
	0xA	Integral constant – axis 2	UINT16	2	2SI
	0xB	Derivative constant – axis 2	UINT16	2	2SD
	0xC	Integral limit – axis 2	UINT16	2	2IL
	0xD	Velocity feedforward constant – axis 2	UINT16	2	2FV
	0xE	Acceleration feedforward constant – axis 2	UINT16	2	2FA
	0xF	Derivative sampling frequency – axis 2	UINT8	1	2FR
	0x10	Integral Sampling gain – axis 2	UINT8	1	2RI
0x69		HOMING PARAMETERS			
	0x1	Homing speed – axis 1	UINT32	4	N/A
	0x2	Homing acceleration – axis 1	UINT32	4	N/A
	0x3	Homing offset – axis 1	INT32	4	N/A
	0x4	Position error threshold – axis 1	INT32	4	N/A
	0x5	Homing method – axis 1	UINT16	2	N/A
	0x6	Homing timeout – axis 1	UINT16	2	N/A

	0x7	Homing speed – axis 2	UINT32	4	N/A
	0x8	Homing acceleration – axis 2	UINT32	4	N/A
	0x9	Homing offset – axis 2	INT32	4	N/A
	0xA	Position error threshold – axis 2	INT32	4	N/A
	0xB	Homing method – axis 2	UINT16	2	N/A
	0xC	Homing timeout – axis 2	UINT16	2	N/A
0x6A		COMMUTATION PARAMETERS			
	0x1	Commutation phase – axis 1	UINT16	2	1SP
	0x2	Commutation voltage – axis 1	UINT16	2	N/A
	0x3	Commutation electrical cycle – axis 1	UINT32	4	1EC
	0x4	Absolute home – axis `	INT32	4	1DA
	0x5	Commutation phase – axis 2	UINT16	2	2SP
	0x6	Commutation voltage – axis 2	UINT16	2	N/A
	0x7	Commutation electrical cycle – axis 2	UINT32	4	2EC
	0x8	Absolute home – axis 2	INT32	4	2DA
0x6B		ADDITIONAL SERVO PARAMETERS			
	0x1	Servo speed – axis 1	UINT8	1	1SS
	0x2	Phase and sense setting – axis 1	UINT8	1	1PH
	0x3	Dead band – axis 1	UINT16	2	1DB
	0x4	Output offset – axis 1	INT16	2	1OO
	0x5	Maximum following error – axis 1	UINT16	2	1SE
	0x6	Current mode gain – axis 1	UINT16	2	1SC
	0x7	I2T Nominal value – axis 1	UINT16	2	
	0x8	I2T Trip value – axis 1	UINT32	4	
	0x9	Servo speed – axis 2	UINT8	1	2SS
	0xA	Phase and sense setting – axis 2	UINT8	1	2PH
	0xB	Dead band – axis 2	UINT16	2	2DB
	0xC	Output offset – axis 2	INT16	2	2OO
	0xD	Maximum following error – axis 2	UINT16	2	2SE
	0xE	Current mode gain – axis 2	UINT16	2	2SC
	0xF	I2T Nominal value – axis 2	UINT16	2	
	0x10	I2T Trip value – axis 2	UINT32	4	
0x6C		GENERAL PURPOSE REGISTERS			
	1	GPR11	INT32	4	AR11
	2	GPR12	INT32	4	AR12
	…	…	…		…
	15	GPR25	INT32	4	AR25

3.1.1.1 Homing parameters

Homing parameters (class ID: 0x69) are specific to the VLC-2-EIP. Prior to the execution of homing through the manipulation of cyclic objects (further description in the following subsection of this manual), the following objects need to be configured for each axis:

- Homing method (value depends on the chosen method below)
  - Current position (0): no motion is involved. This sets the position value = "Home offset" object.
  - Negative mechanical limit (1): retracts the shaft until actuator the rear bumper is detected, and sets the position value = "Home offset" object.
  - Positive mechanical limit (2): extends the shaft until the actuator front bumper is detected, and sets the position value = "Home offset" object.
  - Negative index (3): retracts the shaft until the index is detected.
  - Positive index (4): extends the shaft until the index is detected.
  - Negative mechanical limit and index (5): retracts the shaft until actuator the rear bumper is detected, extends until the index is detected and sets the position value = "Home offset" object
  - Positive mechanical limit and index (6): extends the shaft until actuator the rear bumper is detected, retracts until the index is detected and sets the position value = "Home offset" object
- Homing speed: speed of retracting and extending shaft movements during homing.
- Homing acceleration: acceleration of the shaft movement during homing.
- Home offset: the value sets to the actuator's actual position after homing is completed.
- Position error threshold: the position error value to conclude the existence of the mechanical limit.
- Homing timeout: the time period allowed to complete the homing. If homing has not been completed within the time period, homing is considered to be failed.

3.1.1.2 Commutation parameters

Except for the commutation voltage, the rest of commutation parameters are available in the standard VLC-25-07. The relevance of these parameters for the actuator operation are as follow:

- 1-phase (brushed/voice coil) motor: Commutation phase has to be set to 27307. See the VLC manual for more information on this object.
- 3-phase (brushless) motor: Commutation voltage and electrical cycles have to be configured to perform phasing. Additionally, the object Phase and Sense setting (Class: 0x6B; Instance: 2) have to be set to 1. See the program example in the VLC-25-07 manual for more information.

3.1.2 Cyclic servo objects

The cyclic servo objects in Table 3.2 are accessible through implicit message service. The INPUT and OUTPUT are seen from the Ethernet/IP master (or PLC) perspective. Some of the objects have their VLC equivalence and therefore, further information about them are to be found from the VLC manual. The OUTPUT object value is applied to the VLC-2-EIP upon a change of its value, rather than continuously being applied. GPR's 101 – 104 are only meaningful when they are used within custom macros that can be called by the Ethernet/IP master.

Table 3.2. List of cyclic servo objects.

Assembly instance	Object	Data type	Data length (bytes)	VLC equivalence
0x64 (100)	INPUT			
	Statusword – axis 1	INT32	4	N/A
	Modes of operation display – axis 1	INT32	4	N/A
	Position actual value – axis 1	INT32	4	1TP command
	Following error – axis 1	INT32	4	1TF command
	Current value – axis 1	INT16	2	IMON variable
	Statusword – axis 2	INT32	4	N/A
	Modes of operation display – axis 2	INT32	4	N/A
	Position actual value – axis 2	INT32	4	1TP command
	Following error – axis 2	INT32	4	1TF command
	Current value – axis 2	INT16	2	IMON variable
	Macro call indicator	UINT16	2	N/A
	GPR 101	INT32	4	Register 101
	GPR 102	INT32	4	Register 102
	GPR 121	INT32	4	Register 121
	GPR 122	INT32	4	Register 122
	Digital input	UINT8	1	BI command
0x96 (150)	OUTPUT			
	Controlword – axis 1	UINT16	2	N/A
	Modes of operation – axis 1	UINT16	2	N/A
	Setpoint – axis 1	INT32	4	N/A
	Profile velocity – axis 1	INT32	4	1SV command
	Profile acceleration – axis 1	INT32	4	1SA command
	Maximum torque – axis 1	INT16	2	1SQ command
	Controlword – axis 2	UINT16	2	N/A
	Modes of operation – axis 2	UINT16	2	N/A
	Setpoint – axis 2	INT32	4	N/A
	Profile velocity – axis 2	INT32	4	2SV command
	Profile acceleration – axis 2	INT32	4	2SA command
	Maximum torque – axis 2	INT16	2	2SQ command
	GPR 103	INT32	4	Register 103
	GPR 104	INT32	4	Register 104
	GPR 123	INT32	4	Register 123
	GPR 124	INT32	4	Register 124
	Macro call	UINT16	2	MS command
	Digital output	UINT8	1	BO command

3.1.2.1 Statusword

The statusword of each axis contains bits with various servo status, as described in Table 3.3.

Table 3.3. Statusword bits.

Bit	Description
0	**Initialization done.** This will be set to 1 after VLC-2-EIP performs its initialization process upon power-up, indicating that it is ready to be operated.
1	**Servo enabled.** This will be set to 1 when the servo is enabled by MN command. The bit is set to 0 if servo is disabled through MF command.
2	**Reserved.**
3	**Motion execution acknowledge bit.** Set to 1 on a rising edge transition the controlword "start motion" bit and set to 0 on falling edge transition of the same controlword bit.
4	**Trajectory complete.** Set to 1 if the servo has completed a position move. Set to 0 if the servo is busy executing a commanded move.
5	**Reserved.**
6	**Homing Success.** Set to 1 after homing has been completed successfully.
7	**Homing failure.** Set to 1 if homing fails.
8	**Phasing success.** Set to 1 after phasing is successfully performed. Set to 0 upon failed phasing or at power-up.
9	**Phasing failure.** Set to 1 after a failed phasing. Set to 0 upon successful phasing or at power-up. A failed phasing could be caused by incorrect "commutation electrical cycle", incorrect "phase and sense setting" or insufficient phasing setpoint value.
10	**Macro execution error.** Set to 1 if an undefined macro is called. Set to 0 when a new call to a defined macro is performed, or any of the mode of operation is executed.
11	**Macro execution.** Set to 1 when a macro is being executed. Set to 0 when macro execution has been completed.
12	**General fault.** Set to 1 in the event of overtemperature, I2T being tripped, or STO is activated. Set to 0 otherwise, or if the fault has been successfully reset.
13	**Servo error.** Set to 1 when the following error has exceeded the acyclic variable "Maximum following error". Set to 0 otherwise, or if the fault reset has been executed.
14	**Reserved.**
15	**STO status.** Set to 1 when STO is active (or if any of the STO inputs is not energized). Set to 0 when STO is inactive.

3.1.2.2 Controlword

For each axis, the controlword value represents a certain servo function, as described in Table 3.4.

Table 3.4. Controlword value.

Value (decimal)	Description
0	Terminates a macro execution (e.g. phasing/homing/user-defined macro) and turns off servo.
1	**Start motion/macro call.** Starts the execution of motion based on the selected mode of operation or executes a macro call.
2	**Stop motion.** Motion is terminated (for modes of operation 1, 2, 3) and servo is held in its position. Refer to Table 7, mode of operation details.
3	**Motor off.** Servo is turned off.
4	**Motor on.** Servo is enabled.
5	**Fault reset.** Resets any of the VLC faults.

3.1.2.3 Modes of operation

For each axis, there are nine servo modes of operation, for which the object "setpoint" has a dependent function, as described in table 3.5.

Table 3.5. Modes of operation for each axis.

Modes of operation	Value	Description	Setpoint function
Absolute position move	1	Equivalent to `PM,MA` in VLC.	Absolute target position value
Relative position move	2	Equivalent to `PM,MR` in VLC.	Relative target position value
Velocity move	3	Equivalent to `VM` in VLC.	Target velocity value. Can be either positive or negative, unlike in the case of `VM` in VLC, where direction has to be set through `DI`.
Torque move	4	Equivalent to `QM0` in VLC. Drives the actuator through an open loop voltage command.	Same as `SQ` value in `QM` mode.
Current move/QM1	5	Equivalent to `QM1` in VLC. Drives the actuator through a closed loop current command.	Same as `SQ` value in `QM1` mode.
Homing	6	Performs homing. See subsection 3.1.1.1 for more information.	N/A
Phasing	7	Performs phasing for 3-phase (brushless) actuators/motors. See subsection 3.1.1.2 for more information.	N/A

Current move/QM2	8	Equivalent to QM2 in VLC. Drives the actuator through a closed loop current command.	Same as SQ value in QM2 mode. The QI preload value is set through GPR103 (axis 1) or GPR123 (axis 2).
Macro execution**	10	Performs macro execution based on the "macro call" cyclic object value	N/A

The object "modes of operation display" follows the "modes of operation" value, such mechanism can be used as a handshake for control purposes.
The object "Macro call indicator" shows the macro number being executed during a servo move and during the execution of a macro based on the "macro call" object.

3.2 Executing motion through servo objects

The following are the steps to execute motion corresponding to one of the modes of operation:

- Configure the acyclic servo objects (Table 3.1) that are necessary for the selected mode of operation.
- Set the object "Modes of operation" to the desired value.
- Set the cyclic output objects required for the modes of operation as desired, for instance, to execute a position move, "Profile velocity", "Profile acceleration" and "Setpoint" need to be set to the desired values.
- Set controlword to 1 (given the previous value is other than 1). This will start the motion.
- Bit 3 of statusword will be set to 1 after the above to indicate the motion has been started.
- Set controlword to another value (except those in Table 3.4), for instance 10, this will be responded by bit 3 of statusword, as shown Figure 3.1.

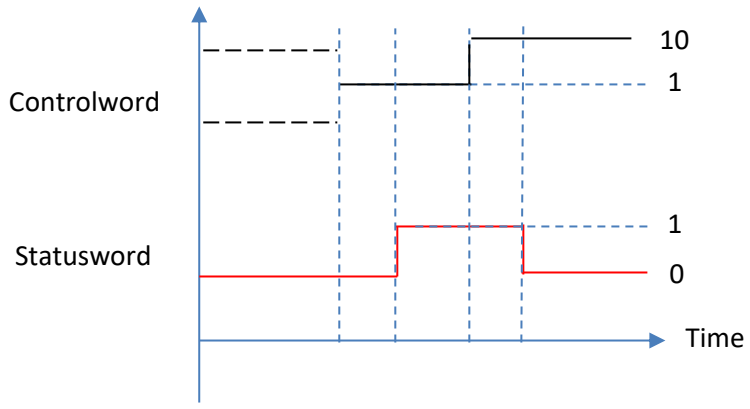


Figure 3.1. Controlword and statusword handshake mechanism.

3.3 VLC-2-EIP Programming Guidelines

3.3.1 General guidelines

Provided the system macros in Appendix A have been loaded into the VLC, the acyclic and cyclic objects (Tables 3.1 – 3.2) become accessible from the PLC. This allows the user to perform the necessary servo parameter configurations through the acyclic objects and monitor/manipulate the cyclic objects to execute motions following the instructions given in the previous sections of this manuals.

Typically, a PLC program to control a VLC-2-EIP is built up based on the following sequence:

- Configuration of acyclic objects. These object values may be obtained from SMAC or from a test that the user performed directly on the VLC (see section 2.2.1) or from a test on the PLC.
- Motion initialization: phasing (for 3-phase actuators only) and homing.
- Main program task: this contains the logic to execute the required actuator motion task that consists possibly of switching of modes of operation and coordination of multiple axis that are connected to the PLC.

Given the above, there could be times when a failure associated with phasing/homing or a VLC fault (servo error, general fault, see Table 3.3) occurs. Depending on the nature of the motion task that the PLC is programmed for, the user may need to terminate the PLC program execution and therefore special attention needs to be put on the statusword bits (Table 3.3) associated with the failure/fault. When such event occurs, the next step is about managing/clearing it, before resuming the PLC program execution.

3.3.2 Phasing/Homing management

Phasing and/or homing only needs to be executed once after the VLC-2-EIP is powered up. The execution could be done through the PLC or automatically in VLC at power up, by adding macros (refer to VLC-25-07 manual on programming the macros). In the latter case, the macros can be added right after the execution of system macro 0 is completed. Make sure that no MG command is used in the macros and note that phasing/homing done through the macros will not update the success/failure execution status in the statusword (Table 3.3). The subsequent PLC program action can be executed after statusword bit 0 (initialization done) is set to ‘1’.

When phasing/homing is executed through a PLC, the user will be able to obtain the success/failure execution status through the statusword. In most cases, a failed phasing/homing is a result of an incorrect commutation and/or homing parameter or parameters such as phase and sense setting (class ID: 0x6B, attribute ID: 0x2/0xA). Furthermore, to perform homing, the position control parameters, for example proportional and derivative constants have to be set. By setting the parameters correctly, possibly obtained after a series of tests, phasing/homing can be executed again and the PLC program can continue after the phasing/homing success bit in the statusword is set to ‘1’.

3.3.3 Fault management

A fault, as indicated by bit 12 or 13 of the statusword, could be caused by any of the following:

- Servo error (bit 13)
- I^2T limit is reached (bit 12)
- Driver overtemperature (bit 12)
- STO (bit 12 and 15)

In-depth discussions on each of the above items can be found in VLC-25-07 manual.

Servo error and I^2T fault will only be triggered if the acyclic object parameters “maximum following error”, “I2T nominal value”, “I2T trip value” are set to their non-default values, which would be less than their maximum possible values. Whereas driver overtemperature is rather rare since it will only occur when high current is involved to the point of raising the temperature of the MOSFETs in the VLC-2-EIP. Any of these faults can be cleared instantly by setting controlword bit 5 to ‘1’, but what is more important, is to identify whether the fault is indicating issues to be concerned of or simply a result of incorrect parameters being assigned.

As for the STO fault, the user has to make sure that the wiring of the STO inputs on the VLC-2-EIP is done properly, before clearing the fault by setting controlword bit 5 to ‘1’, otherwise the STO fault persists.

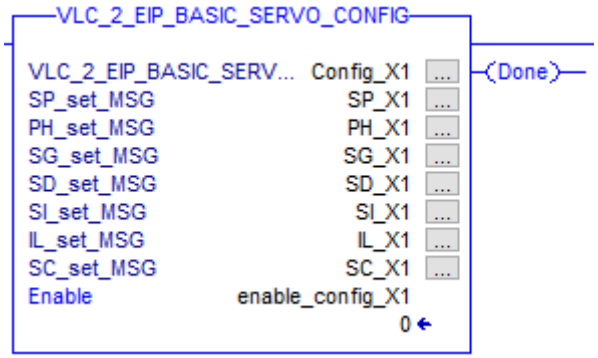
After the fault is cleared the PLC program execution could be resumed, or depending on the situation, the actuator may need to be moved to a safer position first prior to continuing the program execution.

3.4 Controlling the VLC-2-EIP with a PLC using Studio 5000 software utilizing Add-On-Instructions

The Add-On-Instructions (AOI) are made available by SMAC to simplify the control of VLC-EIP in RSLogix/Studio 5000 environment instead of having to manually address the acyclic and cyclic objects described previously. The AOIs are as follow

3.4.1 Basic servo configuration

This AOI has a container for explicit messages that are used to configure 'basic' servo control parameters that are required to perform various modes of operation, e.g. homing, position move, current move, etc.



Basic Servo Configuration AOI: input and output parameters			
	Parameter	**Unit**	**Description**
INPUT	SP_set_MSG	N/A	Explicit message container for the SP parameter.
	PH_set_MSG	N/A	Explicit message container for the PH parameter.
	SG_set_MSG	N/A	Explicit message container for the SG parameter.
	SD_set_MSG	N/A	Explicit message container for the SD parameter.
	SI_set_MSG	N/A	Explicit message container for the SI parameter.
	IL_set_MSG	N/A	Explicit message container for the IL parameter.
	SC_set_MSG	N/A	Explicit message container for the SC parameter.
	Enable	N/A	This bit enables the execution of this AOI.
OUTPUT	Done bit	N/A	This bit is active when all the message instructions have been successfully executed.

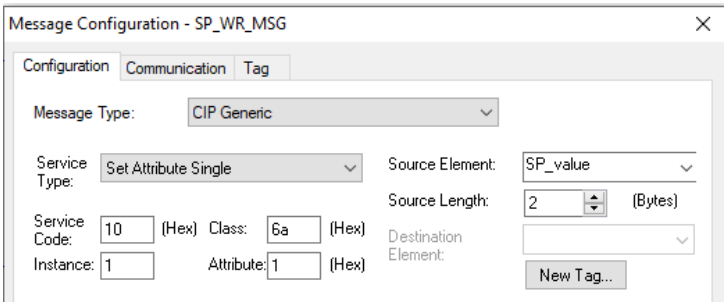
See the VLC manual for more information about all the input parameters above (SP, PH, etc.). A message instruction has to be defined for each '.._MSG' parameter above. The message instruction will have to be configured based on the corresponding acyclic servo object (see also table 3.1), as summarized in the following table.

Parameter		MSG configuration (all parameter instance ID: 1)				
		Service type	Class (Hex)	Attribute (Hex)	Source element	Source length
Axis 1	SP_set_MSG	Set Attribute Single	6A	1	SP_value[1] (INT)	2 bytes
	PH_set_MSG		6B	2	PH_value[2] (SINT)	1 byte
	SG_set_MSG		68	1	SG_value[1] (INT)	2 bytes
	SD_set_MSG		68	3	SD_value[1] (INT)	2 bytes
	SI_set_MSG		68	2	SI_value[1] (INT)	2 bytes
	IL_set_MSG		68	4	IL_value[1] (INT)	2 bytes
	SC_set_MSG		6B	6	SC_value[1] (INT)	2 bytes
Axis 2	SP_set_MSG	Set Attribute Single	6A	5	SP_value[1] (INT)	2 bytes
	PH_set_MSG		6B	9	PH_value[2] (SINT)	1 byte
	SG_set_MSG		68	9	SG_value[1] (INT)	2 bytes
	SD_set_MSG		68	B	SD_value[1] (INT)	2 bytes
	SI_set_MSG		68	A	SI_value[1] (INT)	2 bytes
	IL_set_MSG		68	C	IL_value[1] (INT)	2 bytes
	SC_set_MSG		6B	D	SC_value[1] (INT)	2 bytes

[1] Typical SP value: 27307 (1-phase actuator), 0 (3-phase actuators)

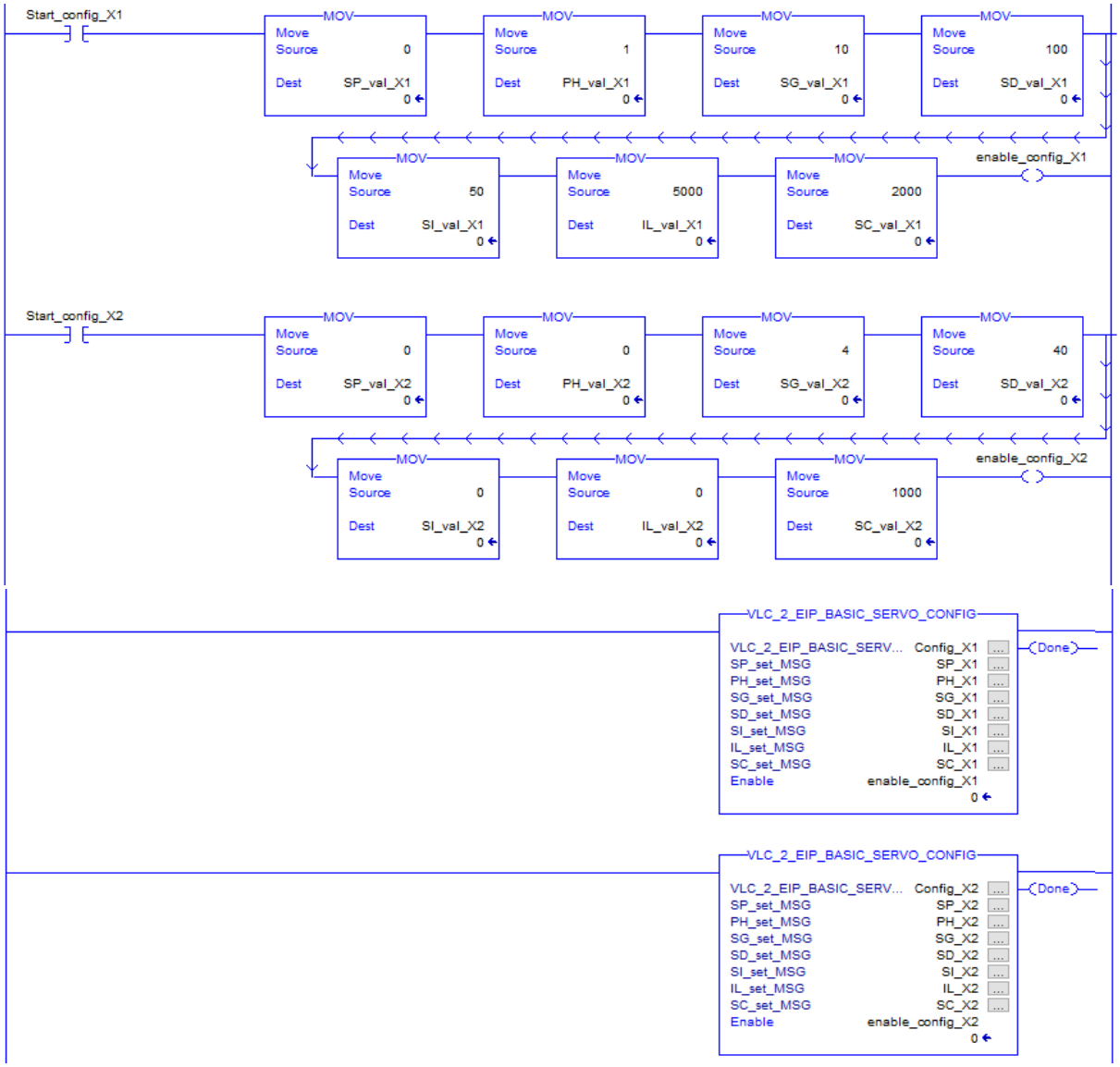
[2] Typical PH value: 0 (1-phase actuator), 1 (3-phase actuators)

The configuration parameters are to be specified in the message configuration window shown below.



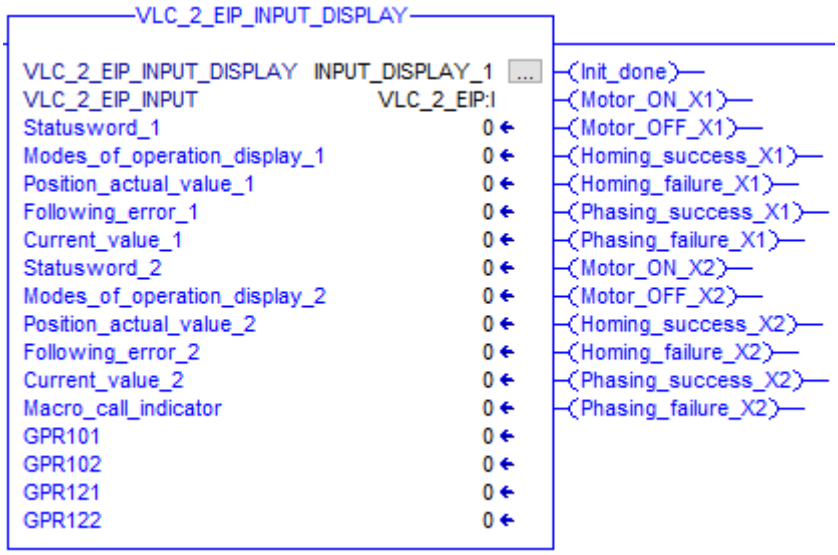
Furthermore, in the window above, under the 'Communication' tab, the path has to be specified according to the name of VLC-2-EIP that has been defined in the Studio 5000 project.

AOI usage example:



3.4.2 Input and status display

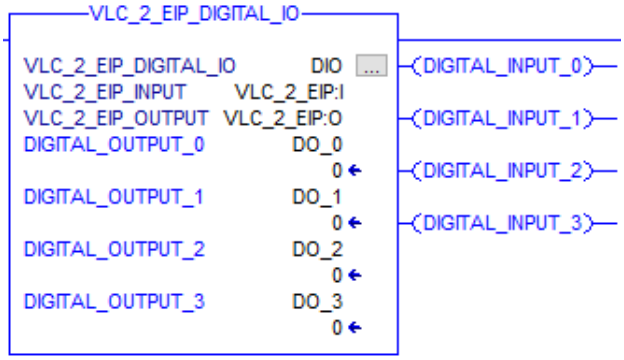
This AOI displays the cyclic objects of VLC-2-EIP and a selection of statusword bits relevant for in the context of PLC programming. Note that statusword bits that are associated with drive faults are part of the Fault Management AOI. Meanwhile, the digital inputs can be monitored in the Digital I/O AOI.



Input and Status Display AOI: input and output parameters			
	Parameter	**Unit**	**Description**
INPUT	VLC_2_EIP_INPUT	N/A	The input data of the VLC-2-EIP as they appear in the 'Controller Tags'. Typically, under the name of 'VLC_2_EIP:I'
OUTPUT	(shown in the AOI picture above)		See section 3.1.2 of this manual for explanations of the various cyclic objects incl. statusword.

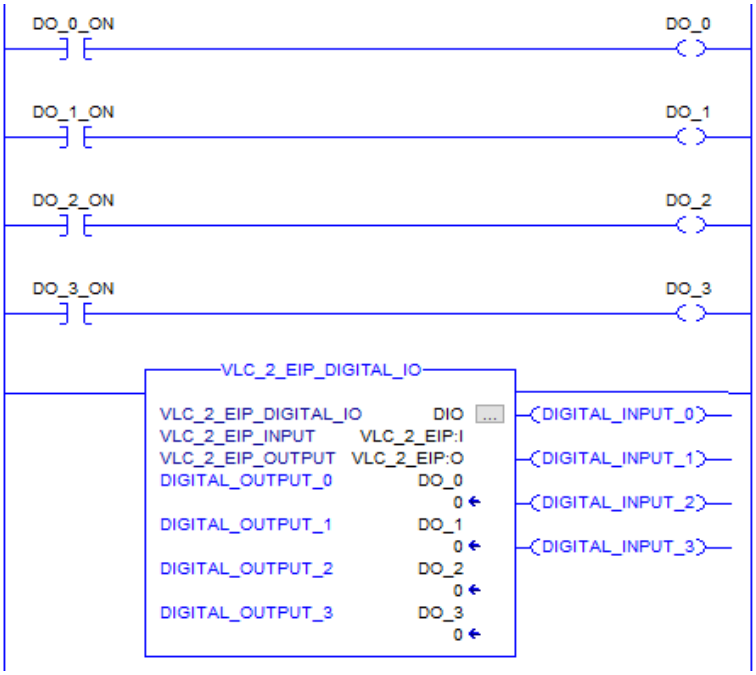
3.4.3 Digital I/O

This AOI controls the digital outputs and displays the digital inputs status.



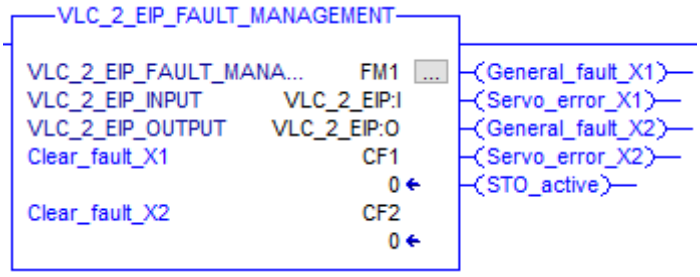
Digital I/O AOI: input and output parameters			
	Parameter	**Unit**	**Description**
INPUT	VLC_2_EIP_INPUT	N/A	The input data of the VLC-2-EIP as they appear in the 'Controller Tags'. Typically under the name of 'VLC_2_EIP:I'
	DIGITAL_OUTPUT_X	N/A	Where X = 0, 1, 2, 3 ; indicates the state of digital output channel of VLC-2-EIP. By setting this parameter with a bit value: 1, the digital output turns ON, and vice-versa.
OUTPUT	VLC_2_EIP_OUTPUT	N/A	The output data of the VLC-2-EIP as they appear in the 'Controller Tags'. Typically, under the name of 'VLC_2_EIP:O'
	DIGITAL_INPUT_X		Where X = 0, 1, 2, 3 ; indicates the state of digital input channel of VLC-2-EIP.

AOI usage example:



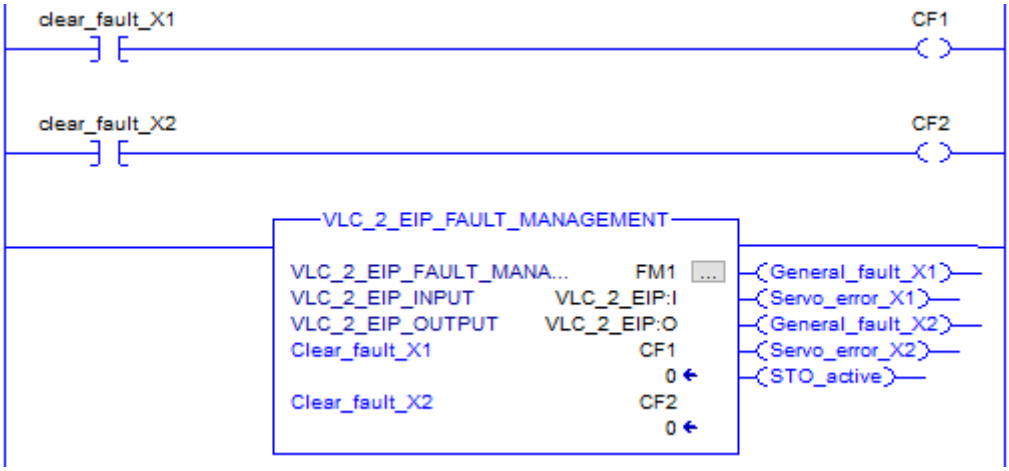
3.4.4 Fault management

This AOI displays the type of fault that has occurred in the VLC-2-EIP and allows the fault to be cleared.



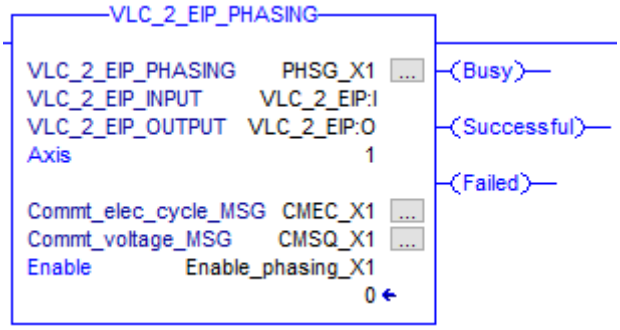
Fault Management AOI: input and output parameters			
	Parameter	**Unit**	**Description**
INPUT	VLC_2_EIP_INPUT	N/A	The input data of the VLC-2-EIP as they appear in the 'Controller Tags'. Typically under the name of 'VLC_2_EIP:I'
	Clear_fault_X1	N/A	This bit clears the indicated fault of axis 1. This is also used to clear the STO fault.
	Clear_fault_X2	N/A	This bit clears the indicated fault of axis 2. This is also used to clear the STO fault.
OUTPUT	VLC_2_EIP_OUTPUT	N/A	The output data of the VLC-2-EIP as they appear in the 'Controller Tags'. Typically, under the name of 'VLC_2_EIP:O'
	(fault indications shown in the AOI)		See table 3.3 in this manual for more information on the faults.

AOI usage example:



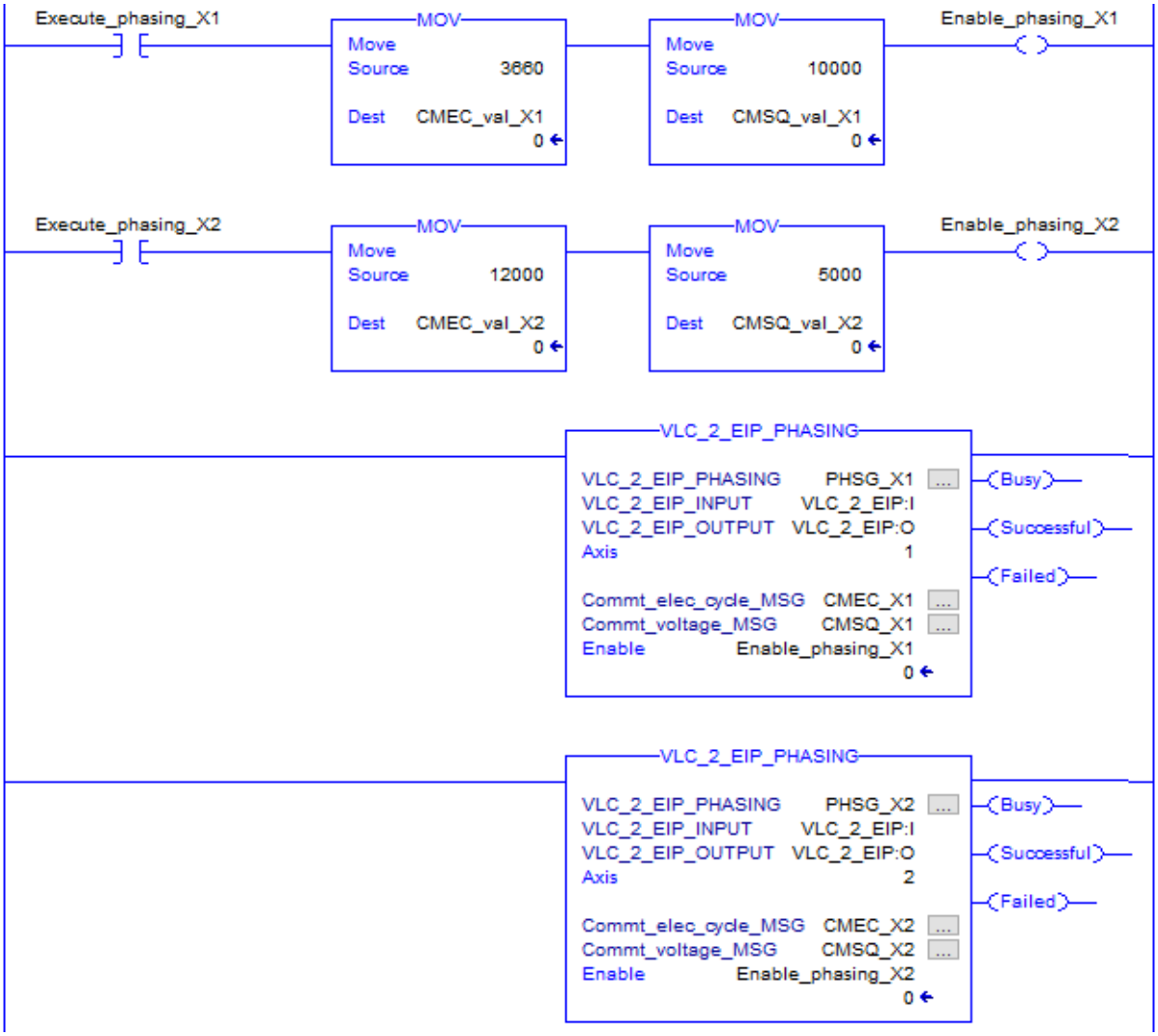
3.4.5 Phasing

This AOI performs phasing of 3-phase actuators, which must be performed prior to executing any other servo modes of operation. See section 3.1.1.2 for more information about the phasing/commutation parameters.



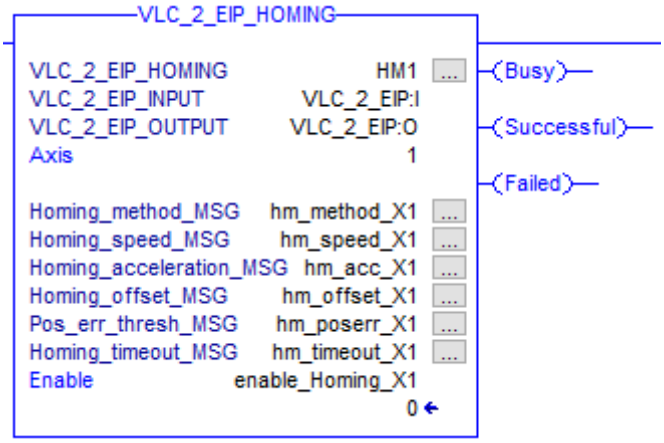
Phasing AOI: input and output parameters			
	Parameter	**Unit**	**Description**
INPUT	VLC_2_EIP_INPUT	N/A	The input data of the VLC-2-EIP as they appear in the 'Controller Tags'. Typically under the name of 'VLC_2_EIP:I'
	Axis	N/A	Pointer to servo axis 1 or 2, the value is set accordingly.
	Commt_elec_cycle_ MSG	N/A	Explicit message container for the EC parameter. Service type: Set Attribute Single, Instance: 1, Class: 6a, Attribute 3, Source length: 4. See section 3.3.1 for more information on how to configure these parameters in the MSG instruction.
	Commt_voltage_MSG	N/A	Explicit message container for the commutation voltage. Service type: Set Attribute Single, Instance: 1, Class: 6a, Attribute 2, Source length: 2.
	Enable	N/A	This bit enables the execution of this AOI.
OUTPUT	VLC_2_EIP_OUTPUT	N/A	The output data of the VLC-2-EIP as they appear in the 'Controller Tags'. Typically under the name of 'VLC_2_EIP:O'
	Busy	N/A	Indicates that phasing is executing.
	Successful	N/A	Indicates that phasing has been successful.
	Failed	N/A	Indicates that phasing failed, which could be due to wrong phasing parameters or wrong PH value (check the 'Basic Servo Configuration' AOI).

AOI usage example:



3.4.6 Homing

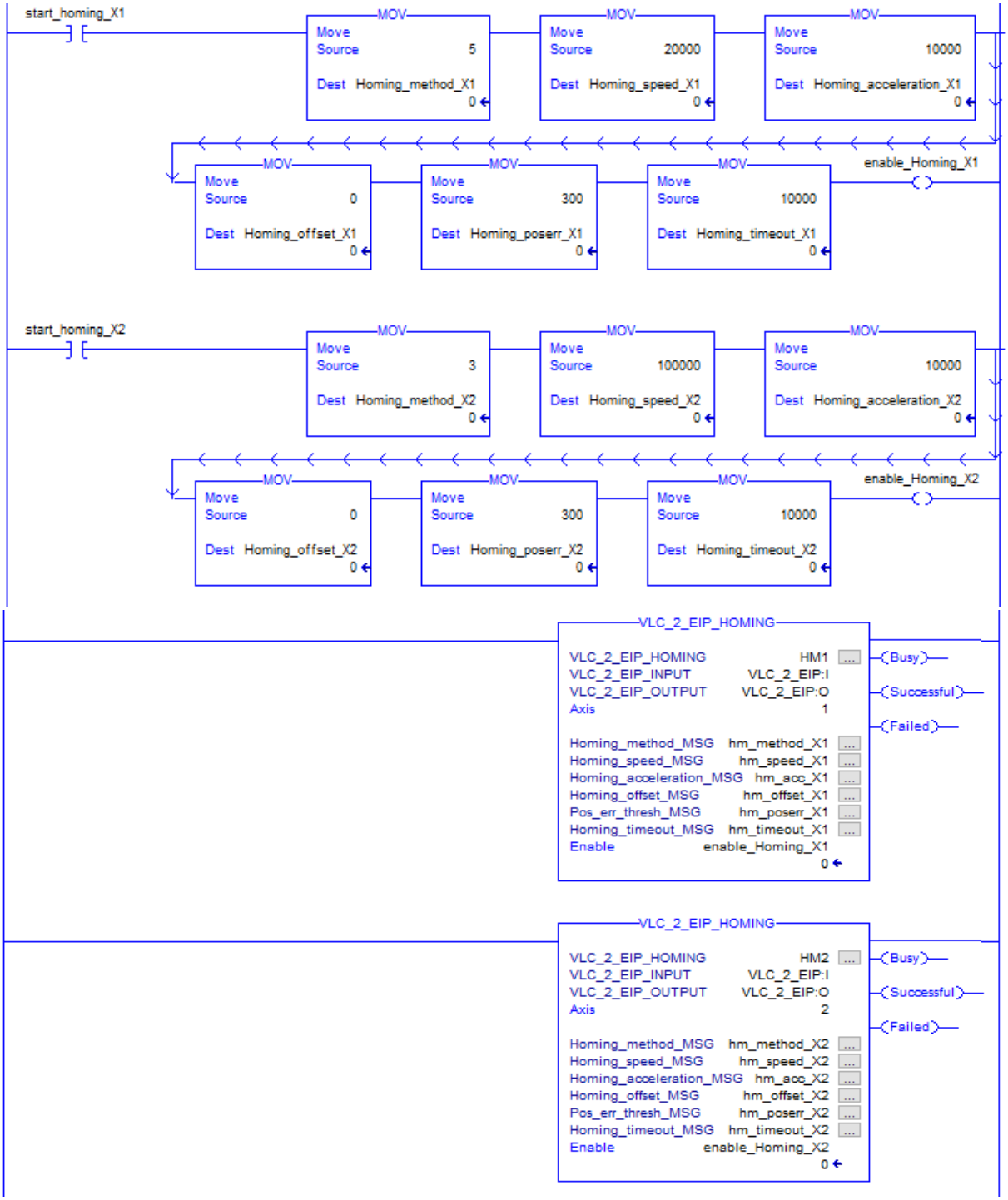
This AOI performs actuator homing. See section 3.1.1.1 for more information about the homing parameters.



See section 3.3.5 for descriptions of VLC_EIP_INPUT, VLC_EIP_OUTPUT, Axis, Enable as well as Busy, Successful and Failed indications. The other AOI inputs are explicit message containers for the homing parameters explained in section 3.1.1.1. The Message instruction configuration parameters are summarized in the following table.

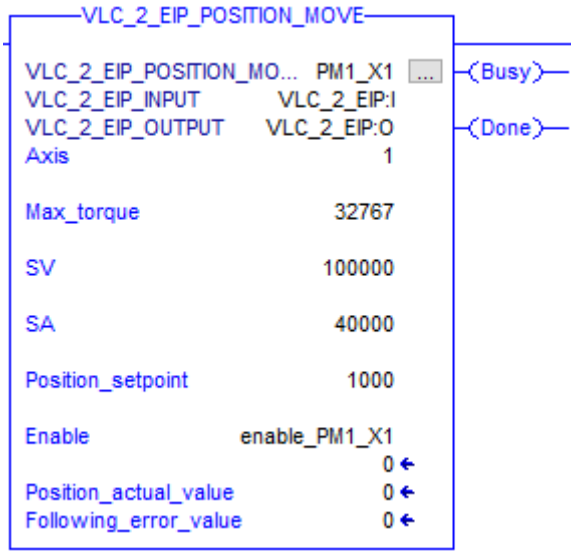
Parameter		MSG configuration (all parameter instance ID: 1)				
		Service type	Class (Hex)	Attribute (Hex)	Source element	Source length
Axis 1	Homing_method_MSG	Set Attribute Single	69	5	Homing_method (INT)	2 bytes
	Homing_speed_MSG		69	1	Homing_speed (DINT)	4 bytes
	Homing_acceleration_MSG		69	2	Homing_acceleration (DINT)	4 bytes
	Homing_offset_MSG		69	3	Homing_offset (DINT)	4 bytes
	Pos_err_thres_MSG		69	4	Homing_poserr (DINT)	4 bytes
	Homing_timeout_MSG		69	6	Homing_timeout (INT)	2 bytes
Axis 2	Homing_method_MSG	Set Attribute Single	69	B	Homing_method (INT)	2 bytes
	Homing_speed_MSG		69	7	Homing_speed (DINT)	4 bytes
	Homing_acceleration_MSG		69	8	Homing_acceleration (DINT)	4 bytes
	Homing_offset_MSG		69	9	Homing_offset (DINT)	4 bytes
	Pos_err_thres_MSG		69	A	Homing_poserr (DINT)	4 bytes
	Homing_timeout_MSG		69	C	Homing_timeout (INT)	2 bytes

AOI usage example:



3.4.7 Position Move

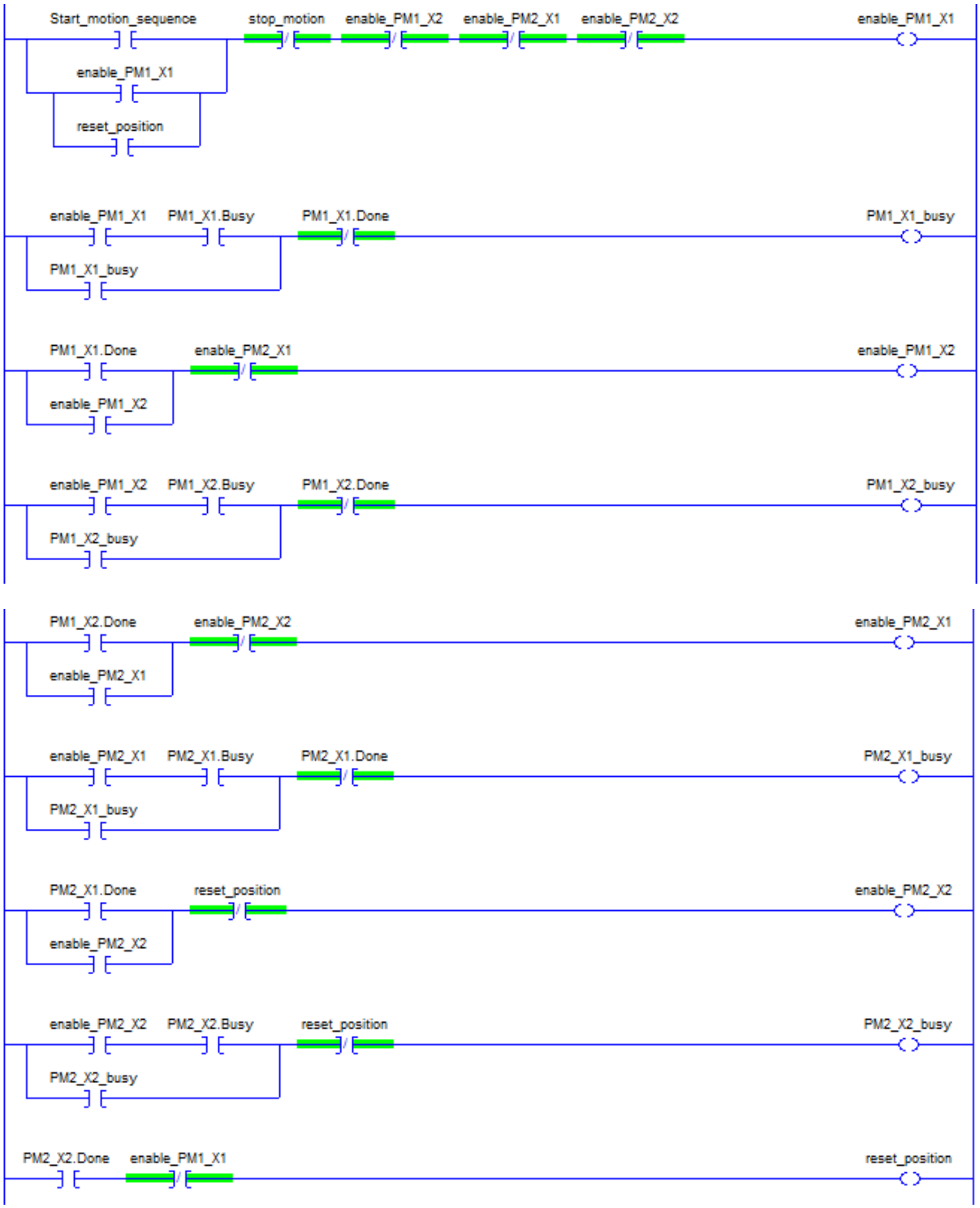
This AOI performs absolute position move, equivalent to PM command in VLC.

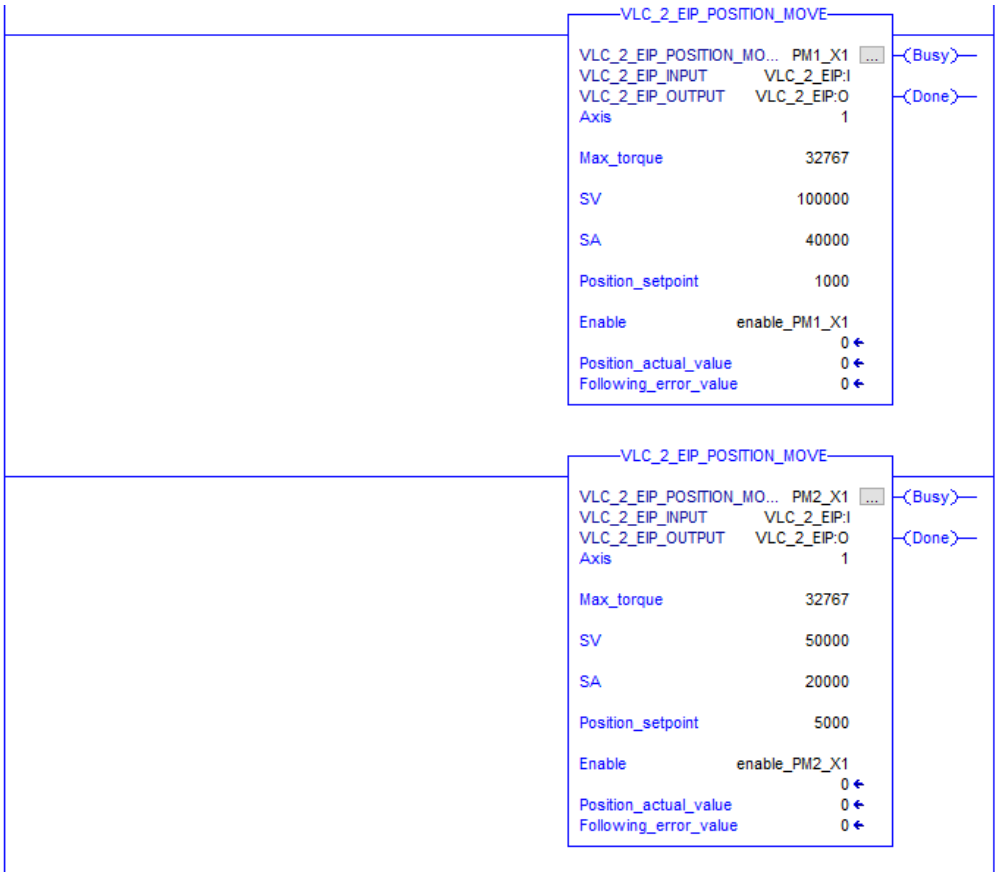


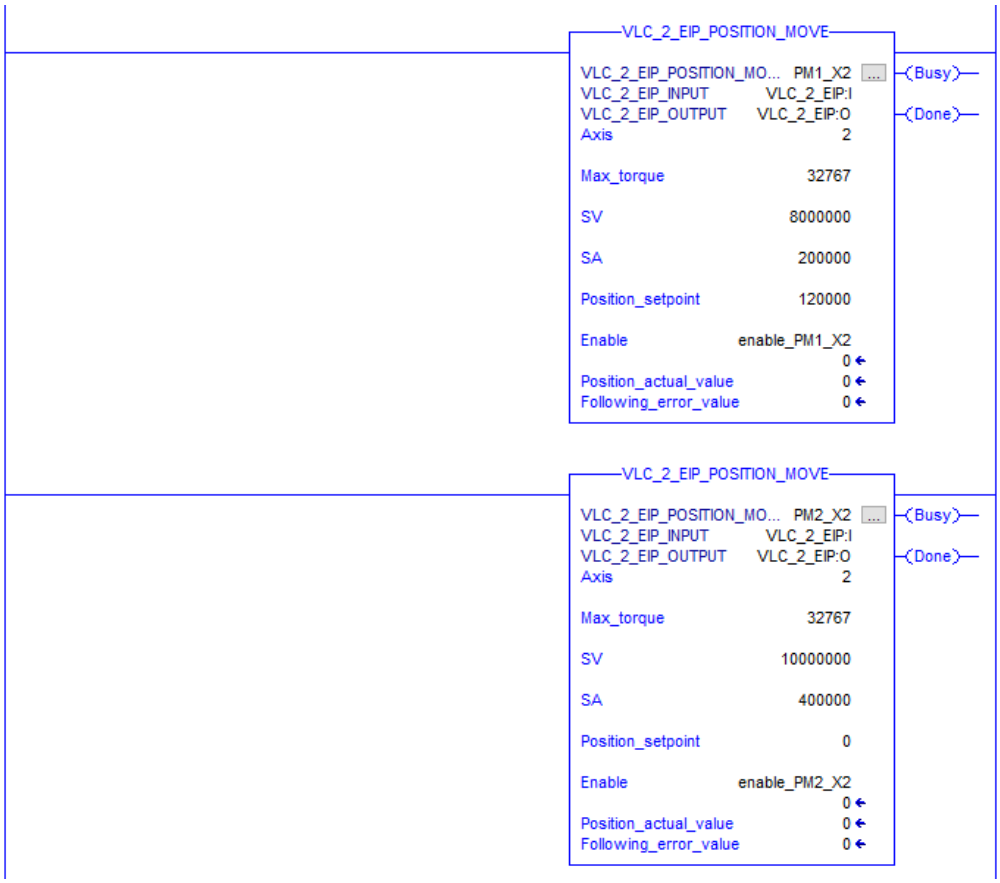
Position Move AOI: input and output parameters			
	Parameter	**Unit**	**Description**
INPUT	VLC_2_EIP_INPUT	N/A	The input data of the VLC-2-EIP as they appear in the 'Controller Tags'. Typically, under the name 'VLC_2_EIP:I'
	Axis	N/A	Pointer to servo axis 1 or 2, the value is set accordingly.
	Max_torque		Corresponds to SQ parameter of VLC. Set this value to 32767, or lower if necessary to limit the level of SQ value (control effort) during position move.
	SV		Corresponds to SV parameter (velocity) of VLC.
	SA		Corresponds to SA parameter (acceleration) of VLC.
	Position_setpoint	Counts	Setpoint for the position move.
	Enable	N/A	This bit enables the execution of this AOI.
OUTPUT	VLC_2_EIP_OUTPUT	N/A	The output data of the VLC-2-EIP as they appear in the 'Controller Tags'. Typically, under the name 'VLC_2_EIP:O'
	Position_actual_value	Counts	The parameter name is self-explanatory.
	Following_error_value	Counts	The parameter name is self-explanatory.
	Busy	N/A	Indicates that position move is executing.
	Done	N/A	Indicates that the position move trajectory, as defined by SV, SA and setpoint, has been completed.

AOI usage example:

By setting 'Start_AOI_PP' bit to 1, the following ladder logic performs a repetitive position moves consisting of a sequence involving 2 axis as defined by AOI's: PM1_X1, PM1_X2, PM2_X1, PM2_X2

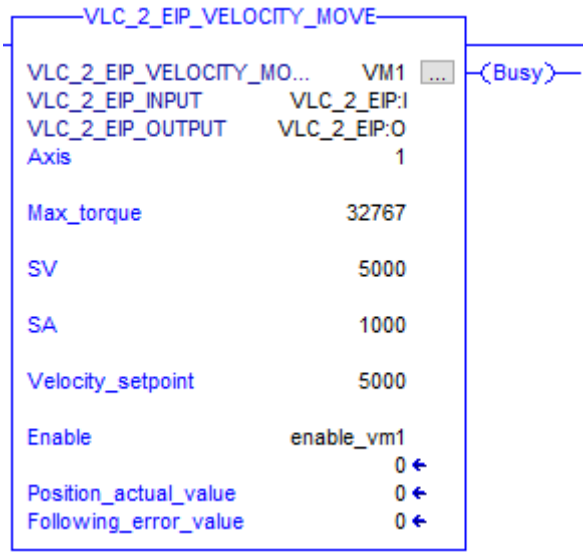



VLC_2_EIP_POSITION_MOVE
VLC_2_EIP_POSITION_MO... PM1_X1
VLC_2_EIP_INPUT VLC_2_EIP:I
VLC_2_EIP_OUTPUT VLC_2_EIP:O
Axis 1
Max_torque 32767
SV 100000
SA 40000
Position_setpoint 1000
Enable enable_PM1_X1
0
Position_actual_value 0
Following_error_value 0
Busy
Done
VLC_2_EIP_POSITION_MOVE
VLC_2_EIP_POSITION_MO... PM2_X1
VLC_2_EIP_INPUT VLC_2_EIP:I
VLC_2_EIP_OUTPUT VLC_2_EIP:O
Axis 1
Max_torque 32767
SV 50000
SA 20000
Position_setpoint 5000
Enable enable_PM2_X1
0
Position_actual_value 0
Following_error_value 0
Busy
Done


VLC_2_EIP_POSITION_MOVE
VLC_2_EIP_POSITION_MO... PM1_X2
VLC_2_EIP_INPUT VLC_2_EIP:I
VLC_2_EIP_OUTPUT VLC_2_EIP:O
Axis 2
Max_torque 32767
SV 8000000
SA 200000
Position_setpoint 120000
Enable enable_PM1_X2
0
Position_actual_value 0
Following_error_value 0
Busy
Done
VLC_2_EIP_POSITION_MOVE
VLC_2_EIP_POSITION_MO... PM2_X2
VLC_2_EIP_INPUT VLC_2_EIP:I
VLC_2_EIP_OUTPUT VLC_2_EIP:O
Axis 2
Max_torque 32767
SV 10000000
SA 400000
Position_setpoint 0
Enable enable_PM2_X2
0
Position_actual_value 0
Following_error_value 0
Busy
Done

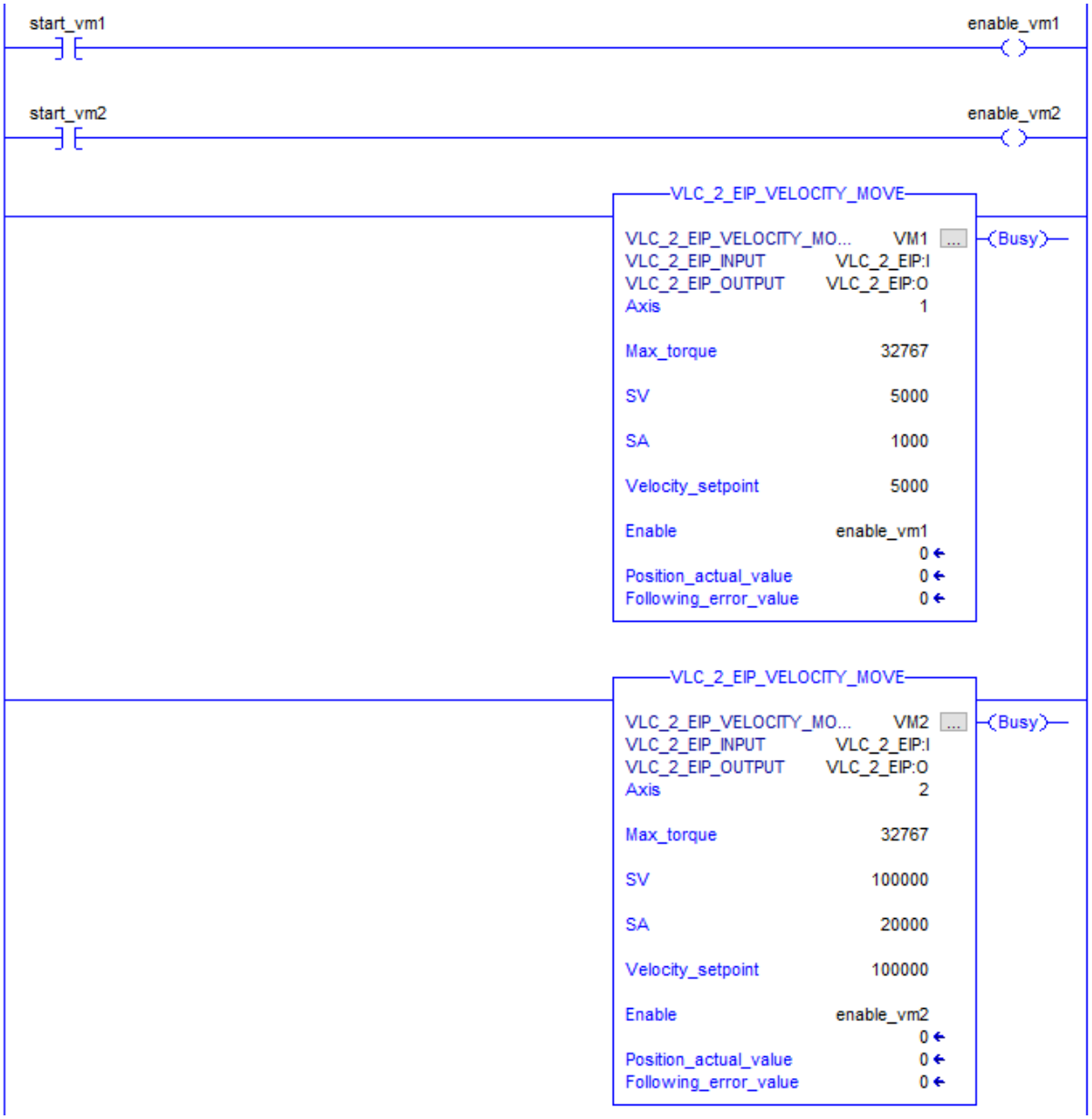
3.4.8 Velocity Move

This AOI performs velocity move, equivalent to VM command in VLC.



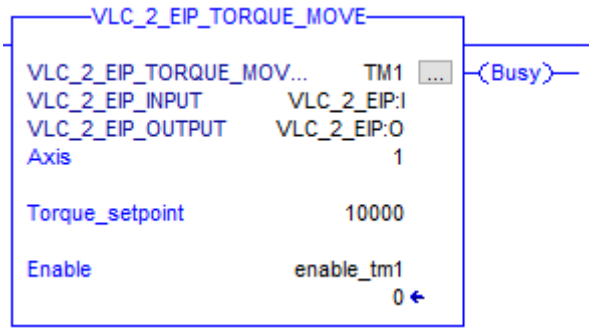
Velocity Move AOI: input and output parameters			
	Parameter	**Unit**	**Description**
INPUT	VLC_2_EIP_INPUT	N/A	The input data of the VLC-2-EIP as they appear in the 'Controller Tags'. Typically, under the name 'VLC_2_EIP:I'
	Axis	N/A	Pointer to servo axis 1 or 2, the value is set accordingly.
	Max_torque		Corresponds to SQ parameter of VLC. Set this value to 32767, or lower if necessary to limit the level of SQ value (control effort) during velocity move.
	SV		Corresponds to SV parameter (velocity) of VLC.
	SA		Corresponds to SA parameter (acceleration) of VLC.
	Velocity_setpoint		Setpoint for the velocity move. Could be positive or negative, which determines the motion direction.
	Enable	N/A	This bit enables the execution of this AOI.
OUTPUT	VLC_2_EIP_OUTPUT	N/A	The output data of the VLC-2-EIP as they appear in the 'Controller Tags'. Typically, under the name 'VLC_2_EIP:O'
	Position_actual_value	Counts	The parameter name is self-explanatory.
	Following_error_value	Counts	The parameter name is self-explanatory.
	Busy	N/A	Indicates that velocity move is executing.

AOI usage example:



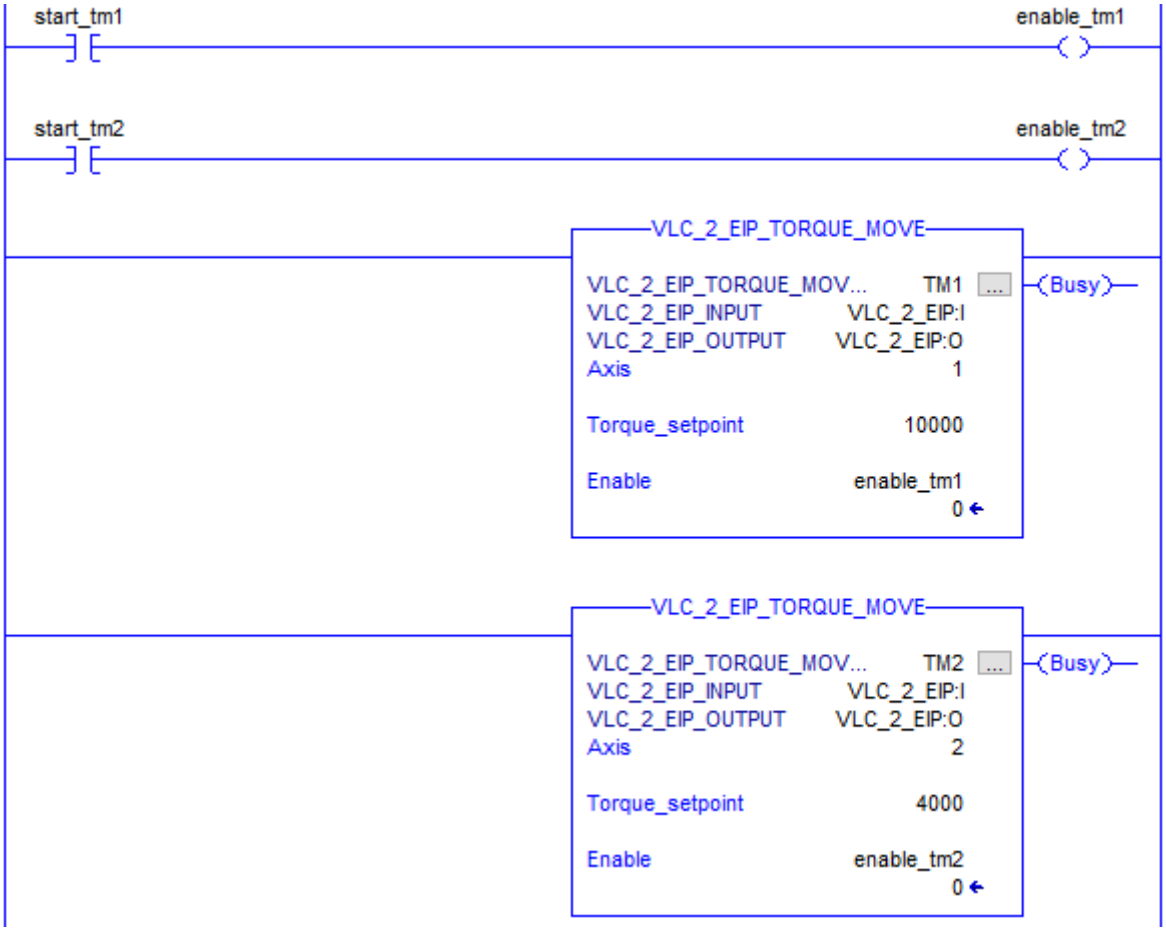
3.4.9 Torque Move

This AOI performs velocity move, equivalent to QM command in VLC.



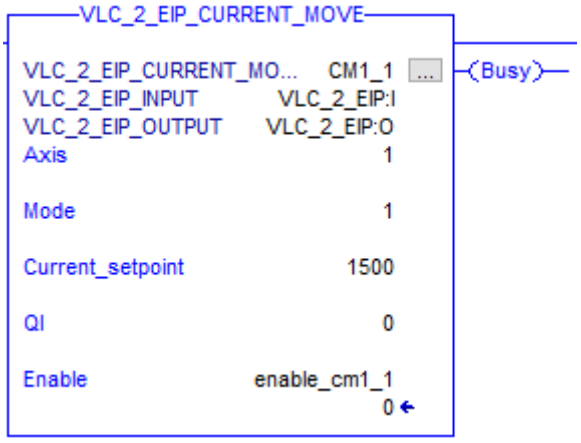
Torque Move AOI: input and output parameters			
	Parameter	**Unit**	**Description**
INPUT	VLC_2_EIP_INPUT	N/A	The input data of the VLC-2-EIP as they appear in the 'Controller Tags'. Typically, under the name 'VLC_2_EIP:I'
	Axis	N/A	Pointer to servo axis 1 or 2, the value is set accordingly.
	Torque_setpoint		Setpoint for the torque move, equivalent to SQ command in VLC.
	Enable	N/A	This bit enables the execution of this AOI.
OUTPUT	VLC_2_EIP_OUTPUT	N/A	The output data of the VLC-2-EIP as they appear in the 'Controller Tags'. Typically, under the name 'VLC_2_EIP:O'
	Busy	N/A	Indicates that torque move is executing.

AOI usage example:



3.4.10 Current Move

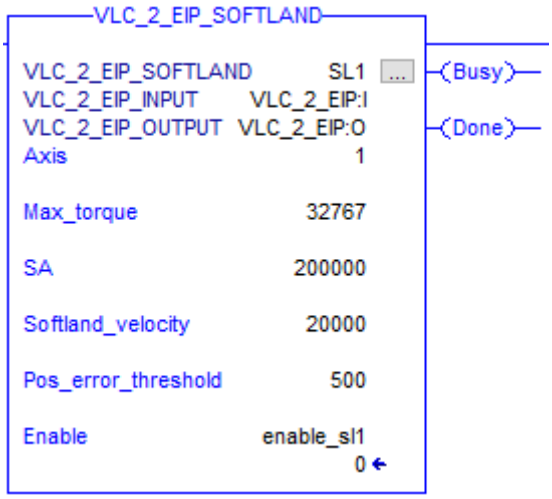
This AOI performs current move, equivalent to QM1/QM2 command in VLC. The AOI usage is similar to that of Torque Move.



Torque Move AOI: input and output parameters			
	Parameter	**Unit**	**Description**
INPUT	VLC_2_EIP_INPUT	N/A	The input data of the VLC-2-EIP as they appear in the 'Controller Tags'. Typically, under the name 'VLC_2_EIP:I'
	Axis	N/A	Pointer to servo axis 1 or 2, the value is set accordingly.
	Mode	N/A	Set this to 1 for QM1 mode, and 2 for QM2 mode.
	Current_setpoint		Setpoint for the current move, equivalent to SQ command in VLC, in the context of QM1/QM2.
	QI	N/A	QI preload value for QM2 mode. This value is irrelevant in QM1 mode.
	Enable	N/A	This bit enables the execution of this AOI.
OUTPUT	VLC_2_EIP_OUTPUT	N/A	The output data of the VLC-2-EIP as they appear in the 'Controller Tags'. Typically, under the name 'VLC_2_EIP:O'
	Busy	N/A	Indicates that current move is executing.

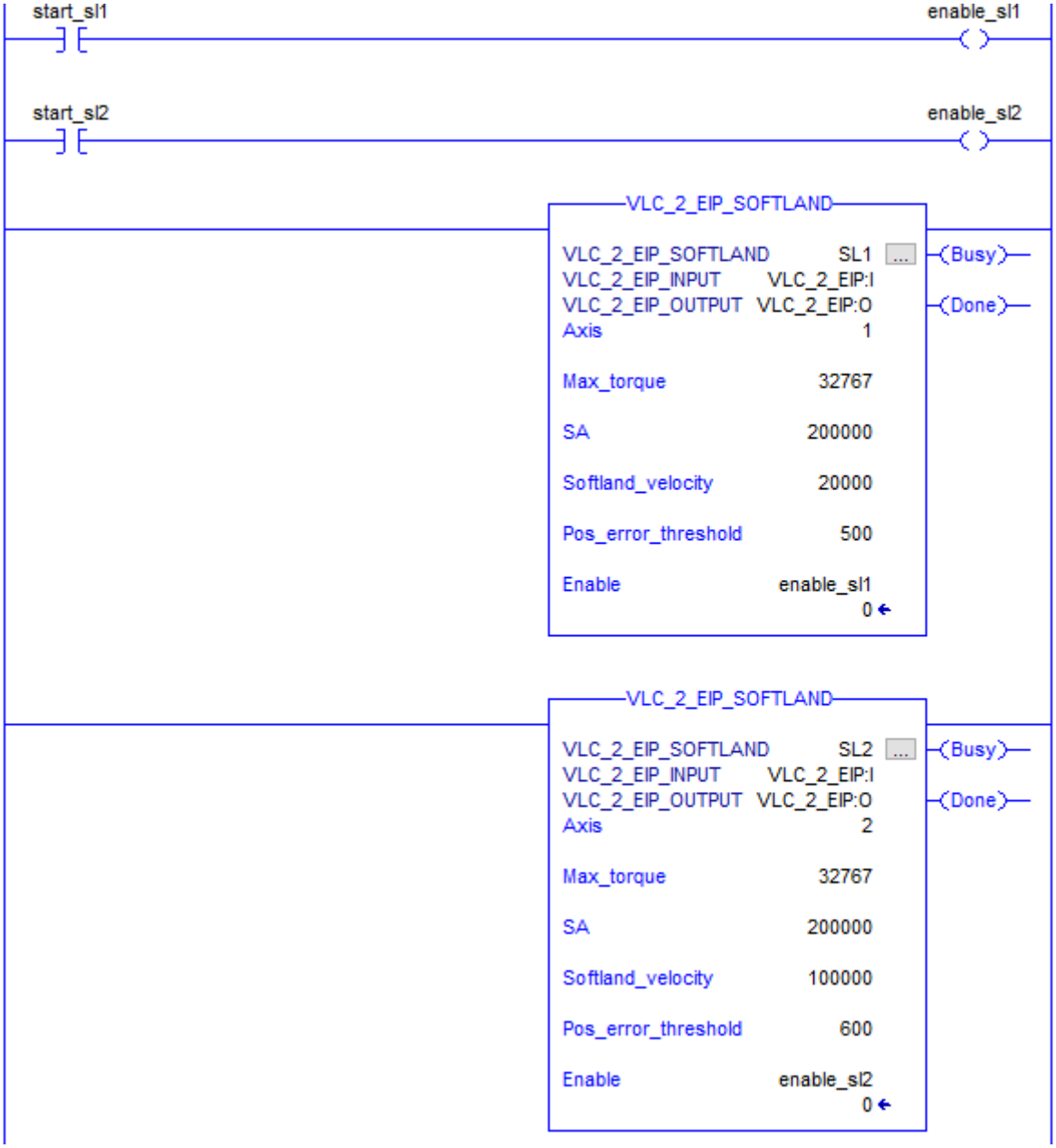
3.4.11 Softland

This AOI performs a softland routine. After softland is detected (Done bit: 1), the actuator shaft movement will stop.



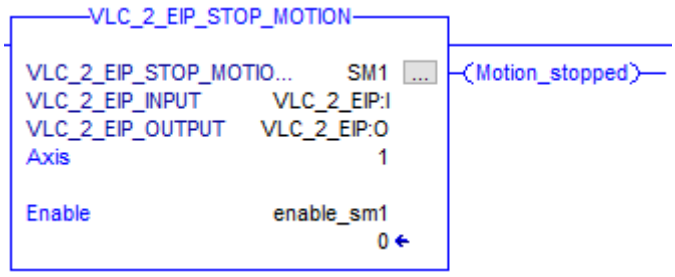
Softland AOI: input and output parameters			
	Parameter	**Unit**	**Description**
INPUT	VLC_2_EIP_INPUT	N/A	The input data of the VLC-2-EIP as they appear in the 'Controller Tags'. Typically, under the name 'VLC_2_EIP:I'
	Axis	N/A	Pointer to servo axis 1 or 2, the value is set accordingly.
	Max_torque		Corresponds to SQ parameter of VLC. Set this value to 32767, or lower if necessary to limit the level of SQ value (control effort) during velocity move.
	SA		Corresponds to SA parameter (acceleration) of VLC.
	Softland_velocity		Velocity setpoint during the softland approach movement.
	Pos_error_threshold	Counts	The position (following) error level to indicate a softland event.
	Enable	N/A	This bit enables the execution of this AOI.
OUTPUT	VLC_2_EIP_OUTPUT	N/A	The output data of the VLC-2-EIP as they appear in the 'Controller Tags'. Typically, under the name 'VLC_2_EIP:O'
	Following_error_value	Counts	The parameter name is self-explanatory.
	Busy	N/A	Indicates that softland is executing.
	Done	N/A	Indicates that softland has been completed.

AOI usage example:



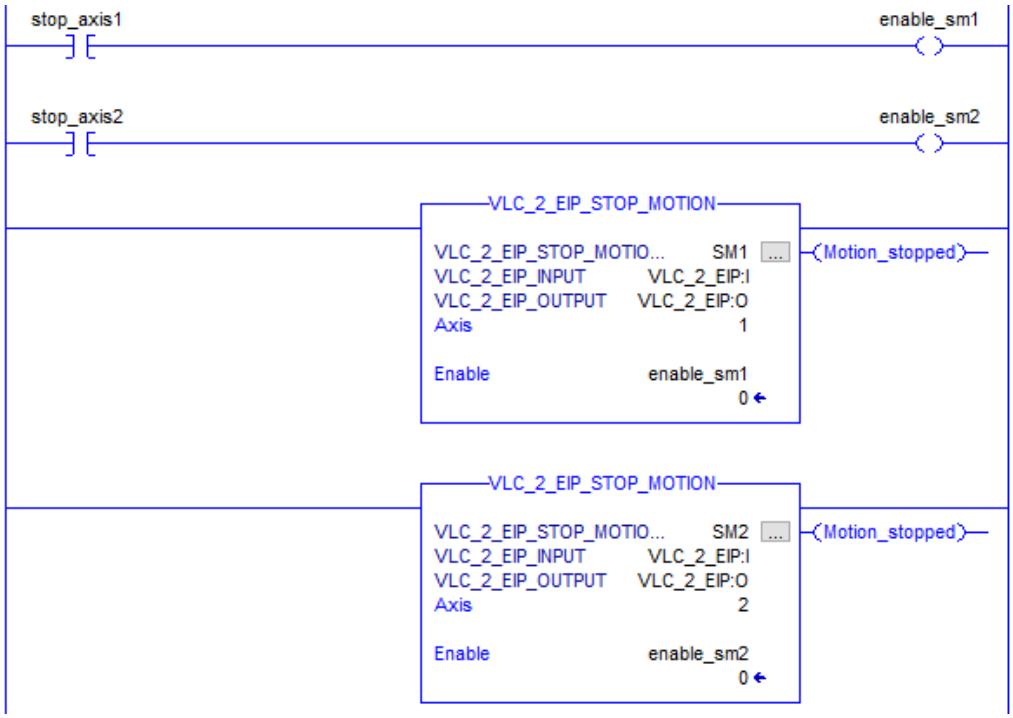
3.4.12 Stop Motion

This AOI can be used to stop the actuator shaft motion during a position or velocity move.



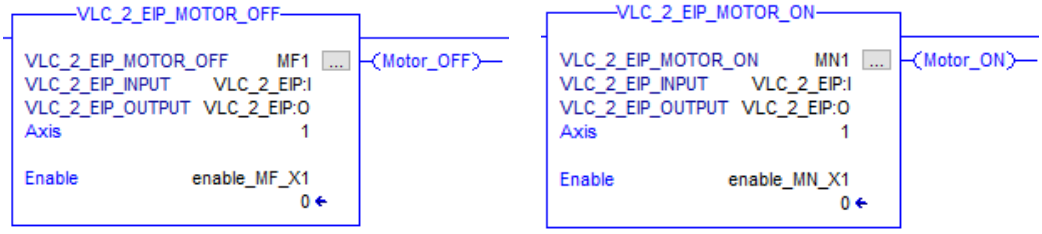
Torque Move AOI: input and output parameters			
	Parameter	**Unit**	**Description**
INPUT	VLC_2_EIP_INPUT	N/A	The input data of the VLC-2-EIP as they appear in the 'Controller Tags'. Typically, under the name 'VLC_2_EIP:I'
	Axis	N/A	Pointer to servo axis 1 or 2, the value is set accordingly.
	Enable	N/A	This bit enables the execution of this AOI.
OUTPUT	VLC_2_EIP_OUTPUT	N/A	The output data of the VLC-2-EIP as they appear in the 'Controller Tags'. Typically, under the name 'VLC_2_EIP:O'
	Motion_stopped	N/A	Indicates that the actuator shaft motion has been stopped.

AOI usage example:



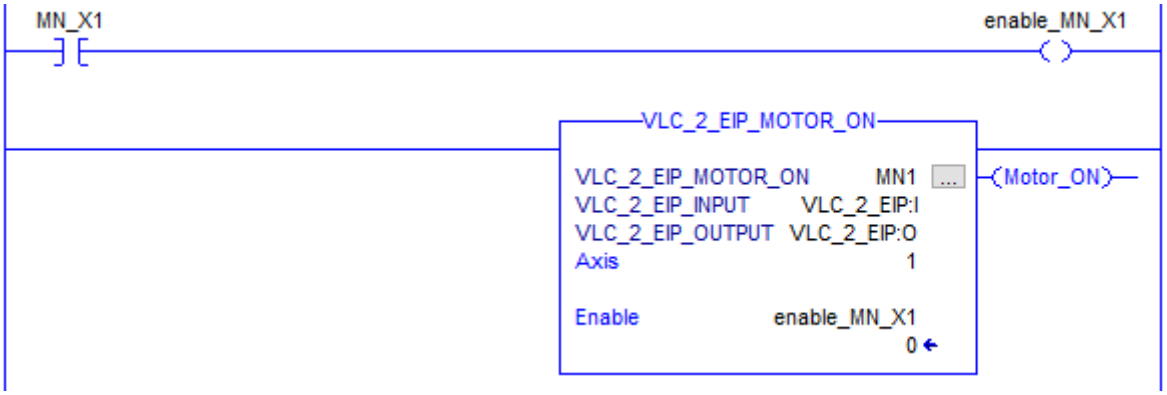
3.4.13 Motor OFF and ON

These AOI's are used to turn OFF and ON the motor/servo.



Motor OFF and ON AOI's: input and output parameters			
	Parameter	**Unit**	**Description**
INPUT	VLC_2_EIP_INPUT	N/A	The input data of the VLC-2-EIP as they appear in the 'Controller Tags'. Typically, under the name 'VLC_2_EIP:I'
	Axis	N/A	Pointer to servo axis 1 or 2, the value is set accordingly.
	Enable	N/A	This bit enables the execution of this AOI.
OUTPUT	VLC_2_EIP_OUTPUT	N/A	The output data of the VLC-2-EIP as they appear in the 'Controller Tags'. Typically, under the name 'VLC_2_EIP:O'
	Motor_OFF / Motor_ON	N/A	Indicates that the motor has been switched OFF or ON.

AOI usage example:



A Appendix A: VLC System Macros

```
; Initialization
MD0,EF,BR921600

; position move - axis 1
MD120,1PM,MN,MA@292,GO
MD122,1PM,MN,MR@292,GO

; position move - axis 2
MD125,2PM,MN,MA@392,GO
MD127,2PM,MN,MR@392,GO

; Velocity move - axis 1
MD130,RA292,IG0,1DI0,MJ131,1DI1,AM-1,AR292
MD131,1SV@292,VM,MN,GO

; Velocity move - axis 2
MD140,RA392,IG0,2DI0,MJ141,2DI1,AM-1,AR392
MD141,2SV@392,VM,MN,GO

; Torque move - axis 1
MD133,1QM0,MN,SQ@295
MD135,1QM1,MN,SQ@295
MD137,AL@103,AR1,AL@295,AR0,1QM2,MN

; Torque move - axis 2
MD143,2QM0,MN,SQ@395
MD145,2QM1,MN,SQ@395
MD147,AL@123,AR1,AL@395,AR0,2QM2,MN

;Axis 1 Homing parameters, R209: velocity, R210: acceleration, R213:
homing method, R211: home offset, R212: error, R215: homing status,
R214: timeout
MD150,AL0,AR215,1SV@209,SA@210,RL1830,AR226,RA212,AM-1,AR223,RA213
MD151,IE0,1DH@211,EP,IE1,1DI1,MJ152,IE2,1DI0,MJ153,IE3,1DI1,MJ154,IE
4,1DI0,MJ154,IE5,1DI1,MJ155,IE6,1DI0,MJ156
MD152,MC157,MC158,MJ160
MD153,MC157,MC159,MJ160
MD154,MC157,1FI,MJ161
MD155,MC157,MC158,1ST,WA50,DI0,MC157,1FI,MJ161
MD156,MC157,MC159,1ST,WA50,DI1,MC157,FI,MJ161
MD157,1VM,MN,GO,RC
MD158,RW538,IB@223,NO,RC,RL1830,AS@226,IG@214,NO,MJ162,RP
MD159,RW538,IG@212,NO,RC,RL1830,AS@226,IG@214,NO,MJ162,RP
MD160,1ST,DH@211,WS,AL1,AR215,EP
MD161,RL448,AN1024,IE0,MJ160,NO,RL1830,AS@226,IG@214,NO,MJ162,RP
MD162,1MF,AL2,AR215,EP
```

```
;Axis 2 Homing parameters, R229: velocity, R230: acceleration, R233:
homing method, R231: home offset, R232: error, R235: homing status,
R234: timeout
MD170,AL0,AR235,2SV@229,SA@230,RL1830,AR226,RA232,AM-1,AR223,RA233
MD171,IE0,2DH@231,EP,IE1,2DI1,MJ172,IE2,2DI0,MJ173,IE3,2DI1,MJ174,IE
4,2DI0,MJ174,IE5,2DI1,MJ175,IE6,2DI0,MJ176
MD172,MC177,MC128,MJ180
MD173,MC177,MC129,MJ180
MD174,MC177,2FI,MJ181
MD175,MC177,MC178,2ST,WA50,DI0,MC177,2FI,MJ181
MD176,MC177,MC179,2ST,WA50,DI1,MC177,2FI,MJ181
MD177,2VM,MN,GO,RC
MD178,RW746,IB@223,NO,RC,RL1830,AS@226,IG@234,NO,MJ182,RP
MD179,RW746,IG@232,NO,RC,RL1830,AS@226,IG@234,NO,MJ182,RP
MD180,2ST,DH@231,WS,AL1,AR235,EP
MD181,RL656,AN1024,IE0,MJ180,NO,RL1830,AS@226,IG@234,NO,MJ182,RP
MD182,2MF,AL2,AR235,EP

;acyclic object list read
;Position loop controller parameter - axis 1
MD300,RW516,TR,RW518,TR,RW520,TR,RW522,TR,RW526,TR,RW536,TR,RB550,TR
,RB552,TR

;Position loop controller parameter - axis 2
MD320,RW724,TR,RW726,TR,RW728,TR,RW730,TR,RW734,TR,RW744,TR,RB758,TR
,RB760,TR

;Homing parameters - axis 1
MD302,TR209,TR210,TR211,TR212,TR213,TR214

;Homing parameters - axis 2
MD322,TR229,TR230,TR231,TR232,TR233,TR234

;Commutation parameters - axis 1
MD304,RW604,TR,TR217,TR218,RL592,TR

;Commutation parameters - axis 2
MD324,RW812,TR,TR227,TR228,RL800,TR

;Additional servo parameter - axis 1
MD306,RB1822,TR,RB558,TR,RW560,TR,RW528,TR,RW542,TR,RW524,TR

;Additional servo parameter - axis 2
MD326,RB766,TR,RW768,TR,RW738,TR,RW750,TR,RW732,TR

;General purpose registers
```

```
MD308,TR11,TR12,TR13,TR14,TR15,TR16,TR17,TR18,TR19,TR20,TR21,TR22,TR
23,TR24,TR25,RC

;periodic cyclic objects read
MD310,1TP,TF,TS,RW548,TR,2TP,TF,TS,RW756,TR,TR101,TR102,TR121,TR122,
BI0,TR,RC

;Axis 1 Phasing system macros (R217: SQ, R218: EC, R314: phasing
status)
MD400,MC416,AL0,AR314
MD401,1MF,EC0,AL32767,AR302,AL16384,AR304,AM@218,IG0,AD65536,MJ402,R
A218,AD65536,AM@304
MD402,AR305,AM9,AD10,AR306,RA305,AM11,AD10,AR307
MD403,SP0,QM0,MN,SQ@217,WA100,MC411,AL1,AR329,MC408
MD404,AL0,AA@304,AR309,SP@309,WA100,MC411,AL3,AR329,MC408,AL1,AR329,
MC409
MD405,AL65535,AS@304,AR309,SP@309,WA100,MC411,AL5,AR329,MC408,AL4,AR
329,MC409
MD406,SP@302,WA100,MC411,AL1,AR329,MC408,AL1,AR329,MC410,AL3,AR329,M
C408,AL1,AR329,MC409
MD407,AL4,AR329,MC410,AL5,AR329,MC408,AL4,AR329,MC409,MJ415
MD408,RL494,JR@329,AR303,JR4,AR308,JR2,AR328,RC
MD409,JR@329,RA308,AS@303,JR3,RA303,AS@328,IG@306,IB@307,MJ412,RC,RC
MD410,JR@329,RA302,AA@304,JR3,RA302,AS@304,AR309,SP@309,WA100,MC411,
RC
MD411,RL494,AR311,WA10,RL494,AS@311,IE0,NO,RC,RP
MD412,RW604,NO,IB0,AA65535,AR310,AR310
MD413,RA218,AD4,AR312,RA310,AM@218,AD65535,AA@312,AR313,DA@313,EC@21
8,SQ0
MD414,AL1,AR314,UM1,MF,EP
MD415,AL2,AR314,SQ0,MF,EP
MD416,AL2048,WW606,WW608,AL0,AR400,AR401
MD417,GA1,AA@400,AR400,GA2,AA@401,AR401,WA1,RP999
MD418,RA400,AM-1,AD1000,AA2048,WW606
MD419,RA401,AM-1,AD1000,AA2048,WW608,RC

;Axis 2 Phasing system macros (R227: SQ, R228: EC, R334: phasing
status)
MD420,MC436,AL0,AR334
MD421,2MF,EC0,AL32767,AR402,AL16384,AR404,AM@228,IG0,AD65536,MJ422,R
A228,AD65536,AM@404
MD422,AR405,AM9,AD10,AR406,RA405,AM11,AD10,AR407
MD423,SP0,QM0,MN,SQ@227,WA100,MC431,AL1,AR429,MC428
MD424,AL0,AA@404,AR409,SP@409,WA100,MC431,AL3,AR429,MC428,AL1,AR429,
MC429
MD425,AL65535,AS@404,AR409,SP@409,WA100,MC431,AL5,AR429,MC428,AL4,AR
429,MC429
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MD426,SP@402,WA100,MC431,AL1,AR429,MC428,AL1,AR429,MC430,AL3,AR429,M
C428,AL1,AR429,MC429
MD427,AL4,AR429,MC430,AL5,AR429,MC428,AL4,AR429,MC429,MJ435
MD428,RL702,JR@429,AR403,JR4,AR408,JR2,AR428,RC
MD429,JR@429,RA408,AS@403,JR3,RA403,AS@428,IG@406,IB@407,MJ432,RC,RC
MD430,JR@429,RA402,AA@404,JR3,RA402,AS@404,AR409,SP@409,WA100,MC431,
RC
MD431,RL702,AR411,WA10,RL702,AS@411,IE0,NO,RC,RP
MD432,RW812,NO,IB0,AA65535,AR410,AR410
MD433,RA228,AD4,AR412,RA410,AM@228,AD65535,AA@412,AR413,DA@413,EC@22
8,SQ0
MD434,AL1,AR334,UM1,MF,EP
MD435,AL2,AR334,SQ0,MF,EP
MD436,AL2048,WW814,WW816,AL0,AR402,AR403
MD437,GA5,AA@402,AR402,GA6,AA@403,AR403,WA1,RP999
MD438,RA402,AM-1,AD1000,AA2048,WW814
MD439,RA403,AM-1,AD1000,AA2048,WW816,RC
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